Bringing Power and Knowledge Together

Information Systems Design for Autonomy and Control in Command Work

Per-Arne Persson

INSTITUTE OF TECHNOLOGY
LINKÖPINGS UNIVERSITET

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Dissertation No. 639

Department of Computer and Information Science
Linköpings universitet
SE-581 83 Linköping, Sweden

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THE PHOTOGRAPHY ON THE COVER SHOWS A DISCUSSION BETWEEN THE COMMANDING OFFICER AND STAFF OFFICERS OVER THE TACTICAL SITUATION MAP, AT THE DIVISION'S FORWARD COMMAND POST DURING A JANUARY 1998 EXERCISE

Abstract

THIS THESIS PRESENTS an empirical ethnographic study that has been conducted as fieldwork within army command organizations, leading to a qualitative analysis of data. The title of the thesis captures the contents of both command work and research, both domains being affected by new technologies during a period of drastic changes in the military institution. The overriding research question was why efforts to implement modern information technology are so slow, costly, and why the contribution from the output as regards higher control efficiency is so uncertain. Two cases will be described and analysed. One is a meeting and the other is the development of a computer artefact. Based on these two cases, the study suggests that social value and not only rational control efficiency defines what is applied, both in the development process and in practice. Knowledge and power, expertise and authority, represented by experts and formal leaders have to be brought together if the work is to be efficient. Both knowledge from research and information technology will be rejected, if considered irrelevant. I have called this applying a *rationality of practice*.

From the case analysis it can be said that command work is not ordinary managerial work. Rather, it is a kind of *design work*, dynamic and hard to define and control. Command work is knowledge-intensive; it designs and produces symbols. Therefore it is very flexible and involves interpretation and negotiation of both its content and products. The most important symbol is the Army, which must be visible and credible, built from real components.

Command work is pragmatic and opportunistic, conducted by experts in the modern military command structure who transform the operational environment, and control it through controlling actions. In that respect *autonomy*, a prerequisite

to meet evolving events—frictions—and *power* become core issues, interchangeable goals and means for flexible social control, in cybernetic terms *variety*. Key concepts are social value, function and visibility. Actors must be visible in the command work, and make work visible. Consequently, when designing control tools, such as information systems, the design challenge is to reconcile dynamic and pragmatic demands for power, autonomy and control with demands for stability. Such an organization becomes a *viable system*, one that can survive, because there is no conflict between its mind and physical resources. In operational terms, this means having *freedom of action*. The prerequisite to achieve this is *one perspective* on knowledge and information and that information systems match the needs growing from within the work because work builds the organization.

Acknowledgements

THROUGHOUT THE WORK my supervisors, Henrik Eriksson and James (Jim) M. Nyce, headed by Sture Hägglund, have continued to guard and guide me. Each one, from his position, has tried to make me an insightful Information Systems researcher, to discover what design of information systems means, and to apply this knowledge in my professional domain, the military institution. To write a thesis is a lonely task and the isolation in distant Stockholm has contributed to this situation. It is with great relief and gratitude that I have completed the work, much helped by the empathy from my local colleagues.

In the Swedish army several persons have provided support and let me occupy their time. I am most grateful toward those from the division and brigade headquarters who generously welcomed me during the fieldwork, sharing their experiences, especially the anonymous interviewees mentioned in the text, who even afterwards accepted my curiosity.

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Lastly, I thank my family, Ann, Frej, Åsa, Erik and Arvid, who saw little of the work, lived with its consequences, understood less than I did, but nevertheless continued to believe. My father was another believer, originally inspiring to a life of learning, but did not live long enough to see the completion of my work. He was a supporter who only reluctantly admitted that modern technology and its social effects could be beneficial. I have to consider his feelings.

Stockholm June 2000

Per-Arne Persson

Foreword

THE THESIS IS A SUMMARY of two related issues. The first is a long process of graduate studies within a new discipline, Information Systems Research (ISR). Actually I was in this process during a few years around 1980 but then within Cinema Science. Now these disciplines have begun to converge. The second issue is the research topic, command work as one kind of human activity aimed at social control. It is a component in the very long tradition of how to develop and use pragmatic techniques for social control where theory recurrently has been second after the practice. The thesis gives highlights from its history and describes, in a detailed manner, some of the latest achievements within ISR and command work, thus being another building block in what sometimes is called a science of command and control.

During the study I have had the privilege to be able to reflect over and use previous personal experiences from more than two decades' work with information systems (ISs)[1] for military purposes, successively seeing much in a new light. I have studied the army where traditions together with old and new control technologies form a dynamically evolving patchwork where *contradictions* are abundant. New control technologies tend to make the organisation and the work a new entity, actions becoming less visible and simultaneously more intertwined. Life becomes

1. I have decided to use (with few exceptions) abbreviations for some of the most common terms within the research domain, for example IS (Information System), IT (Information Technology), ISR (Information Systems Research), ISD (Information Systems Design), aspiring for clarity, hoping this will not offend those who for good reasons try to limit the general tendency to use ever more abbreviations, often as a way to mask the world and dominate the discourse.

harder both for the practitioners who want to be in control, and for the researchers studying them.

The perspectives on information technology (IT) has shifted during these decades, from information as a quantifiable resource and design of ISs according to an ideal objective rationality, to ISs as individuals' tools, difficult to formalize. Computers had been used earlier for various kinds of calculations, for example within the air defence. Most early efforts aimed at administrative rationalization, making managerial tasks and operations feasible and efficient. Interservice cooperation was and still is limited: army, air force and navy each had their own command philosophies and technical solutions for their infrastructure.

A new joint command structure had begun to be developed during the 1960s. At that time the theoretical foundation for ISR in Sweden was developed at Stockholm University, headed by professor Börje Langefors (Dahlbom et al., 1995). Early in the 1970s his evolving theoretical foundation guided the military (Lundeberg, 1970; Folcker, 1974). The heritage from these enterprises still lives in the legacy systems which now, thirty years later are replaced by integrated networks, advanced workstations and mobile technologies. Now in the beginning of a new millennium the armed forces are just a fraction of their former volume but the complexity and the costs of its modern control mechanisms are reaching new heights.

There are few conclusions about the suitable theoretical and scientific foundation for its new command practices. One of the few Swedish attempts is Orhaug's (1995) analysis and discussion where he outlined the prerequisites for a science of command: clarification of concepts, definition of the scientific area for a science of command (and control) and its links to leadership and decision theory, and the development of a proper vocabulary and language for the area. The aspiration behind his discussion was the establishment of a coherent science out of scientific but piecemeal work in various subfields. I aspire to make ISR a framework which contributes to this tentative science of command, enriching what has already been achieved within other disciplines, a reunion of IS theory and practice after a few decades of practical engineering.

The mixture of perspectives and technologies within military command practices generates contradictions. Occasionally practitioners feel their autonomy threatened, not only in the battlefield, but also within their own organization. If control technologies mean reduced autonomy, people pragmatically search for self-help solutions and strategies to manage urgent control needs and easily reject also their own control technologies. This dichotomy explains the strong tendency to improvise, to rely upon interpersonal relations, to search for new control technologies and the readiness to abandon initiatives rather than fulfil them with support from a consistent knowledge platform. Such elements have constituted the military practice since long.

The thesis has five parts which together describe the whole ‘expedition’:

Part I, *Mapping the Arena*, consists of chapters 1, 2, and 3. Chapter 1 introduces the work, provides an overview of the work and the results. Chapter 2 presents the research domain, the military institution. I discuss the concepts of information, information system and design in Chapter 3 and present a new conceptual framework for these constructs.

In Part II, *Checking the Equipment*, chapters 4 and 5, I summarize previous work, again checking its result and discuss especially the conceptual and theoretical meanings of command and control as components within a long tradition of social control, for example within accounting. An analysis of common concepts involved in control relates them to command practices and creates a bridge to the application of IT and the practical part of the ethnography, the fieldwork.

In Part III, *Fieldwork*, I describe methodological issues, fieldwork and data. Chapter 6 is the method overview. The fieldwork during the ethnography is described mainly in Chapter 7.

In Part IV, *The Return...*, I organize the result around two cases which were defined during the fieldwork. Both illustrate aspects of command work and the use of IT. They are an urgent *meeting* during an exercise, and the development-in-work of a *control artefact*, a computer application built with a PC spreadsheet program during a six-month period, as a self-help complement to a centralized IS. In order to provide a rich description, I present data about the background to the cases and about the ongoing army change process in Chapter 8. The cases illuminate the junctions when important command tasks are conducted, between technology and work, each from its position. I analyse them in Chapters 9 (the meeting) and 10 (the application).

Part V, *Reflections*, is the concluding analytical and argumentative parts of the study (Chapter 11), and IS design principles and suggestions (Chapter 12). I present a new perspective on command work as a kind of *design work*. I summarize the analysis, the proposed new theoretical framework for command work, and present suggestions for both continued research and practical engineering work.

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PART I
Mapping the Arena

THE ARENA IS THE RESEARCH, its direction and results, its physical and theoretical path, and its textual record, the thesis. This first part describes the purpose and issues involved in the research, the military domain and the research process. It provides an overview of the thesis and briefly presents the contributions. A review of the research domain and control-related issues within military practice comprises another part of the background. Lastly, when studying military issues, it is necessary to outline some theoretical and methodological issues of social science. Because this thesis is about information and information systems, I will also give an overview of various conceptual perspectives and approaches to information system design.

My argument, and a basic hypothesis, is this: with a relevant picture of what command work is, and if requirements upon technology come from practice, then theoretically informed methods and techniques for the design and the use of control technologies can be defined. Costly mistakes may then be reduced. The kind, capacities and number of control mechanisms can be balanced so as to strike a proper relation between ambitions and available resources, and between change and traditions within command work.

Chapter 1
Introduction

IN THIS CHAPTER I briefly describe first the military as a research domain, because from there the research rationales evolve, then research purpose, questions, process, and contributions. Contextual conditions are important to include in a qualitative study, in this case conducted as an ethnography[1]. Following the intentions coming from the method, I introduce the theoretical framework for the research method and the analysis. Consequently, I present the legal and social framework that defines the overall military structure, its history, and how it controls and forms the internal control methods. Training, the immediate fieldwork context, is one of these control mechanisms. Because control generally relies heavily on technology, ISD is a common concern. The chapter also provides an overview of the whole thesis.

1. Ethnography - one of the types of qualitative studies according to the source book *Qualitative Inquiry and Research Design*, Sage, Creswell, J. W. (1998). An ethnography is a description and interpretation of a cultural group in the form of a holistic cultural portrait. Other types are biography, phenomenology, grounded theory, and case study. The first part of my work, for example, is an example of grounded theory.

1.1 Purpose and Content of the Study

1.1.1 PURPOSE

This thesis reports the results of a two-step qualitative Information Systems Research (ISR) study, aimed at a theoretical understanding of pragmatic military command activities. The primary purpose of the study is to provide input for continued development of *command work* together with design and use of modern control technologies, ISs and other computer artefacts. The term *command work* is the military analogy to what is called managerial work elsewhere (discussed by Lind and Arvidsson, eds., 1998). Within the dynamic military command environment such technologies are vital both for dynamic control purposes in the field, and for the management of short-term and long-term organizational and technological change. Many efforts to modernize practice by applying information technology (IT) are discouragingly slow and expensive and their effects are unclear. Currently, the radically changed political context, nationally and internationally, enforce dramatic reorganization of the whole military organization.

Uncertainties grow concerning the roles and missions for the military, what efficient command work is, and how supporting ISs should be designed (even ‘design’ is ambiguous). As in many domains, new operational requirements and IT mean demands for new knowledge, also concerning research methodologies and techniques.There is a growing need for a deeper and theoretical understanding of work practices for command and for the management of change.

1.1.2 RESEARCH APPROACH AND CONTENT

In order to achieve its purpose, the study has been conducted in two phases. Based on the early experiences from the UN operations in Bosnia, the first phase aimed at a grounded theory for military command (Persson, 1997). It has guided the second phase that provides the main content of this thesis. This phase has been an ethnography informed by this grounded theory, that looks at the practice of command in mainly one Swedish army tactical (division) headquarters (HQ) during a series of Command Post Exercises (CPXs). This HQ was faced with the task of using new control technologies within the framework of a new organization. In accordance with this approach, I have conducted field studies of command work activities, followed by an analysis of certain core aspects within them. This bottom-up approach allows a description of practices, relating them to theory, and complements other studies. The model in Figure 1.1 gives a view of the whole study.

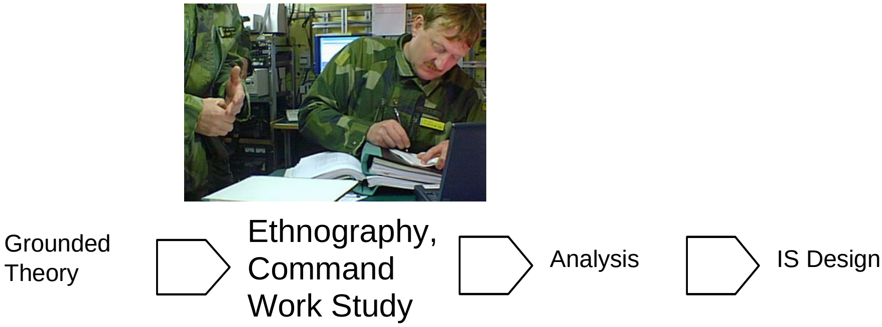

Figure 1.1: Overview of the study.

Its purpose has not been to evaluate and provide feedback to the current military efforts to form a new practice. Rather it is to widen the insights into command work. Ultimately, this research will expand both practitioners' and other researchers' understanding, not forgetting representatives of IS development and computer industries.

Foster (1988) argued for research which generates close-up insight and makes command more science than art. His main concern was the gulf between command practitioners and researchers, leading to the development of theory separate from practice, theory that does not match practice. One of his claims was that science should not provide just answers, but instead extend the practitioners capacity for judgement, integrating theory and practice, a "marriage of the quantitative and the qualitative" (p. 224).

The practical part of my research, this ethnography, has been intersected with an analysis of historical antecedents to modern military command, development of IT, organizing and control thinking.

1.1.3 Design of Information Systems

Being both process and product, design is not a clear-cut issue and can be directed at various components and attributes. As a *verb* 'design' means to create, plan, to conceive and plan out in mind, or to make a sketch. The *noun* 'design' is a purposeful scheme or mental project, a preliminary sketch showing the main features of something later to be executed. Lastly, it is the creative art of executing aesthetic or functional design (Merriam-Webster Online dictionary, http://www.m-w.com). What is left then is to find out what ISD is and out of what, which can be difficult because as Löwgren and Stolterman (1998) stated that IT is the "material without properties". Nevertheless, IT design knowledge concerns social change, "good use", it is empirical and normative (Magoulas and Pessi, 1998).

The focus of ISD has shifted during the computer era. Ehn (1988), for instance, brought out the question whether it is art, science, or just marketing, a matter of style. Löwgren and Stolterman (1998) outlined the history of IT-design, and described how focus has shifted from systematic problemsolving, via efforts to solve problems as iterations between solutions and insights in operational and work problems, over to their own design thinking. To them, IT design is a process that leads to an IT-artefact which is a comparatively clear item, however complex. They treat the IT-design concept as a superimposed level, beneath it is IS development, ISD, and software design. In their perspective, separate ISD sub-fields are Human-Computer Interaction (HCI), Man-Machine Interface (MMI), usability considerations, and Participatory Design (PD), the latter being a means to reconcile issues of power and bringing sufficient knowledge about operations into the design process.

Design as *IS architecture*, lastly, is the theme for Magoulas and Pessi (1998), who saw two perspectives. These perspectives are the *enterprise based* design theory and the *information based* theory, partly overlapping, partly different. The prolongation of these schools is the VBS-strategy (VerksamhetsBaserade System) and the IRM-strategy (Information Resource Management).

The art (or science) of how to conduct *work-oriented design of computer artefacts* is a topic discussed and analysed at length by Ehn (1988). Except from mediating and supporting both communicative and instrumental activities, these artefacts can augment, replace or constrain individual or collective activities. Thereby they affect the whole workplace; it is not only a matter of design of interfaces. What distinguishes computers from other artefacts is that computers can *manipulate symbols*. Ehn tried to unite the social and the instrumental, stating that within 'design' it is necessary to include both the technical knowledge interest in instrumental control and the practical knowledge interest in intersubjective communication which leads to a "doubleness" and that, disciplinary boundaries between established sciences must be transcended. To conclude, for Ehn, design is

> a concerned social and historical activity in which artefacts and their use are anticipated; an activity and form of knowledge that is both planned and creative, and that deals with the contradiction between tradition end transcendence.(p. 161)

I see a tradition within the IS domain from calculations and book keeping, to the integration of larger but fewer artefacts, over to a concern for the whole workspace.

For my research, Ehn's concept 'computer artefact' is more open-ended than just 'information system'. In the presentation I will use both, making further distinctions when considered necessary. Let us conclude that "design" gets its meaning depending on the perspective of "information system". Conversely, if a certain aspect of 'design' or 'information system' is chosen, some aspects will be treated but others left out.

Probably design meaning *creative art* and not based upon mathematics (Ferguson, 1992) is valid independently of perspective. Because of their ambiguity, the related concepts of design and IS will be discussed later on (chapter three). In the next two subsections, I present command work, which is where information is needed and the methodological and analytical framework for the study.

1.2 Object of the Study – Command Work in Brief

1.2.1 A General Structure and Model for Organizing Command Work

Operationally, the Swedish Army consists of a professional cadre and a few temporary units, engaged in basic or refresher training. Neither army, navy nor air force has been permanently physically organized even if some formations are operational as training and stand-by units. The army exists merely as formal organization charts, except during the rare occasions when exercises – or operations for instance in Bosnia – form the context for actual teams executing real command. During training and exercises, being exceptions rather than the rule among other managerial duties, people in their roles try to make sense of what they have got and make the best of the situations. Unfortunately each such occasion and event differs from the previous one in some respect. Therefore conclusions and solid scientific knowledge are hard to reach. Participation in international operations is a growing part of its concerns and operations.

Now as in past centuries, staff form HQs where control is basically centralized, (what is now named) bureaucracy being the dominant organizing principle. Commanding Officers (COs) are pivots in the hierarchical chain of command. Within this framework, to be applied when suitable, decentralization is achieved with the help of complementary control mechanisms.

Modern army tactical level command work is conducted in mobile, protected "offices-in-the-woods" (on wheels, tracks, on board ships, in aircraft, tents or indoors) designed to be self-supporting and to provide a stable, reliable (and relatively comfortable) usually concealed environment in the battlefield. Mobile units

Figure 1.2: Establishing a Forward Command Post, equipped with armoured vehicles, May 1998.

are equipped and trained to be able to move frequently or with very short notice from one location to another in order to avoid the effects of hostile countermeasures and to keep up with mobile operations over large areas when necessary.

A tactical army HQ may be divided into one Forward Command Post (FCP) and a few other subunits, each having its own functional responsibilities. These are supported by a similarly mobile infrastructure where functions such as transport, protection, internal logistics, and telecommunications are managed. In all, the HQ where the main fieldwork was done consisted of about 150 staff, a mixture of career and reserve officers, and conscripts of various classes. Its main sections were divided into subsections and groups that formed cross-functional teams in the distributed structure and work. The support organization was about five times this size. Figure 1.2 shows the deployment of a FCP where armoured vehicles, to be linked with a LAN, constitute the workspace.

Command work is consciously designed, supported by secure communication and robust IT. Network planning and operation, together with security are central issues, affecting the conditions for the command work. The network allows a combination of radio, telephone, and data communication. During a CPX or a staff exercise, a simulated environment and a scenario constitute the context where actions are illustrated by game control and special task units. The length of an exercise varies between a few days up to a few weeks. Figure 1.3 shows the principles

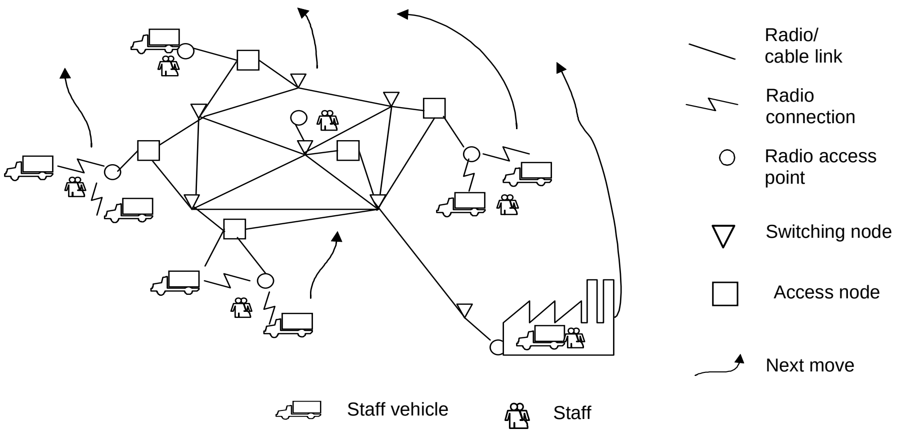

Figure 1.3: The networked command structure and its operating principles, mobile, using outdoor or indoor positions for HQ subunits.

for this kind of mobile command network and how it is operated (see Rice and Sammes, 1989, for a more detailed description of these kinds of structures).

1.2.2 DEFINING COMMAND WORK

To move from theoretical to factual control capacity requires more than technology, namely *work*. Lind (in Lind and Arvidsson, 1998) discussed the content and concept inherent in *managerial work* or management, from which I have derived the term *command work*. The analogy is that Van Creveld (1985) stated that what is management elsewhere, is better labelled *command* when studying the military. Thus, command work is characterized by or contains the following:

- the interplay of both formal, informal and cultural conditions;
- communicative activities, where situated and experience-based knowledge is important;
- cannot be summarized in abstract and general principles;
- it is normally conducted under severe time constraints and demands;
- reactive mechanisms and reflective actions are more important than formal decision analyses and strategic planning; and
- it is about to focusing attention and reducing uncertainty in order to create stable conditions for actions in war.

Figure 1.4: Staff Briefing in a tent, up to 15 persons can be housed, January 1998.

Numerous attempts are made in order to reconcile the principles for work in the peacetime administration and how work is conceived in the field unit HQs that are organized for war, in peacetime. Command work is institutionalized in various ways in order to cope flexibly with difficult battle situations, for instance through training. On the surface there are differences but deeper down similarities between management in general and command work methods and techniques to handle uncertainty, the attempts to formalize work and use IT and the efforts to create favourable conditions for actions. At least in computer technology, military requirements have set the performance standards over decades (Tilanus et al., 1997). Figure 1.4 shows a traditional Staff Briefing in a tent, a map and standard presentation technology constituting the tools.

Control technologies are mainly developed and implemented within the framework of the (scientific) ideal rational bureaucratic peacetime management, and how command work is conceived there in order to fit very different contexts. I interpret the search for and application of new technologies and methods, attempts to develop leadership models that support organizational change and decisive actions, as constituent parts of the command work. Such mechanisms are either compensations for the limitations of the ideal bureaucracy-model for social organization, or new components within it.

Mintzberg (1983) expressed one of the issues for the study of organizations but one that is hardly satisfactory:

> …so much of what managers do remains beyond recorded knowledge that management can hardly be called a profession…Their work is craft, they learn it by observation and working with masters…(p. 43)

Just because little is recorded, the more there is to discover. My approach will take this as a first priority because it is in command work that people and technology are brought together, more or less successfully.

1.2.3 CONTROL THINKING, TOOLS AND PRACTICES

Military command has traditionally been conducted in a pragmatic way rather than following a consistent theoretical foundation of its own. A mechanistic way of organizing set the tone in Prussia during the eighteenth century and became the ideal model, finally inspiring theorists of classical management theory (Morgan, 1986). Moreover, in the absence of war, armies have had to build their command practices on a *theoretical* conception of war and battle management rather than on first-hand experience. Salner (1989) called this kind of knowledge base *pretheoretical* as compared to *scientific*. When designing and training the command system, major efforts are made to re-create the dynamics of war in order to achieve reliable control mechanisms. Murray (1997) recalled a statement by the British military historian Sir Michael Howard about this difficult work:

> Michael Howard has compared the military in peacetime to a surgeon preparing for a series of operations at an unknown time and place under unidentified conditions without the benefit of having previously worked on live patients. Rather he must rely entirely on what he has read and on incomplete and inaccurate models. (Murray, 1997, p. 73)

Speed, *precision*, *decisionmaking* and capacity for *prediction* are primary concerns within command work. Because behaviours of or choices made by commanders are usually presented as products of rational choice (within the dominant control paradigm), to find still better decision support technologies dominates much of the work on ISD. This approach means that by and large computerization now complements bureaucratization as a technology for information processing (Beniger, 1986) and is often combined with it, building on the same kind of control thinking and rationality where information is treated as resource. In addition, computers can also be used for preprocessing; that is, rationalizing the information to be handled. Currently, a central concern is to create an integrated system of systems (SOS) of all components involved in the distributed command work (Whitaker and Kuperman, 1996).

Figure 1.5: Interior of staff vehicle, the traditional crowded workspace, May 1998.

Figure 1.5 is the interior of a traditional truck-mounted staff vehicle, still constituting the most common type of workspace.

Computerization usually presupposes formalization of work. Command work, according to my definition, resists thorough formalization because of its shifting character. There is also some evidence that users often reject or circumvent formalisms (Shipman III and Marshall, 1999) during ISD, not only because of interface problems. Users hesitate to formalize because they fear a premature formalization, especially in a collaborative setting.

One purpose for rationalization is to get overview, reducing the complexity of the real world and instead make a representation of the control object(s). However, in the same way as command work changes character over time, many actions and effects in the battle field are invisible, some of which possible to monitor only after considerable delays or by using sophisticated tools (Jenvald, 1999). The graphic representation of work and battle dynamics is attractive but increasingly difficult, not technically but hard to design and to realize in a relevant and acceptable manner if it will help to handle *uncertainty*, perhaps the most problematic aspect of war.

In summary, those who are involved in command work and control efforts are positioned in and usually have to adapt to organizational principles emanating from classical management theory and scientific management (Morgan, 1986), whether they realize it or not. They try to pragmatically expand the limits of these theories in order to exceed previous best practices. They rely upon internal work procedures and technologies, all designed to achieve effect in battle, but are seldom free to follow spontaneous impulses. They are parts of an integrated command work system, surrounded by high technology for communication and dependent on remote sensing. This context — rules, resources, law and missions — has a decisive influence on the work.

The research community and the military must take this context into account if new knowledge about command work, its prerequisites and how to design control tools is to be acquired. The design and implementation of control technologies must be combined with a clear idea of command work as a means to achieve social control and what kinds of representations that are suitable. There should be a fit between command work, its technologies and their design and development.

The chosen approach, an ethnography, shall lead to an output which is relevant and applicable within ISD because it is based on theory and implies a close but not a decontextualized reading of work. In addition, it shall guide further research.

1.3 Methodical and Analytical Framework of the Thesis

1.3.1 Methodical and Conceptual Framework for Command Work

The choice to perform this ISR-study as qualitative research, focusing on clarifying what constitutes military command work has lead to some obligations concerning the perspective and the framework of the study. This has two aspects, one analytical and one concerning the perspective on the empirical field, the military organization.

First of all, the type of qualitative study, grounded theory, I have used in order to arrive to the later close-up study forms a *transactional system* of analysis (Strauss and Corbin, 1990), which examines action and interaction in relationship to their conditions and consequences. This system functions as a *conditional matrix* with the studied action/interaction in the middle. As layers around them are other levels of conditions, some of which are close, directly influencing while others are remote, having indirect relations to the centre. Some of the layers are related to time and history, others to various levels of organization and consciousness. These levels function as *causes, contexts,* or *intervening conditions* on the action/interaction core, and therefore have to be included in an analysis (Figure 1.6 shows simplified matrix). Interaction is carried out as in the form of interaction processes, where social actions are performed, either strategic or as routine actions. These interac-

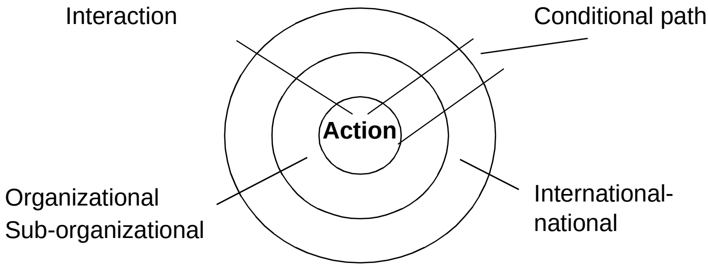

Figure 1.6: Conditional Matrix, conditional paths between layers transfer influences.

tions/actions constitute *command work*. The ethnography is a similar system of analysis.

During an analysis, tracing what are called *conditional paths* across the layers operationalizes the matrix. This means finding and then exploring the relations between action/interaction all the way to the outer shells, or, conversely, tracing the action arising from a certain external condition, aiming for the discovery of conditional paths. Because command work is the product of several outer layers, it is necessary to include them in the analysis

This kind of analysis is similar to what is done when using *Activity Theory* as analytic support (Kuutti, 1991; Engeström, 1999). An activity is the minimal context for individual actions, and is an intermediary concept and an analytic level between complex organizations, and individuals' social actions taken out of context. Activities consist of chains of actions which contain operations, well-defined routines (Kuutti, 1991). Activity Theory provides an elaborated and graphical structure for analysis of social action, its social, historical and organizational context, its purpose and the outcome, and works explicitly with *contradictions* (Engeström, 1987). Hence I have chosen to use this theory as the direct support, when structuring the closer analysis (chapters 9 – 10), without deviation from the qualitative-method approach.

Because of this approach, I will outline the framework for the ethnography: the historic conditions for command work, and its organizational context, which explains some of its peculiarities. Part of the context is the way the *organization* is built, perceived and used, and how this affects its actions. Therefore, in this overview, some factors will be described as a way to work along the Conditional Matrix schema.

The context for this kind of nation state military practice is the “Western way of war”, where technology and discipline are primary concerns for infliction of damage and for survival (Parker, 1995). Underpinning technology and discipline, said Parker, is a continuity in military theory, ability to change (or conserve) practices according to circumstances, and to raise funds for military build-up. Within this context and its related socio-economic structure, bureaucracy as control technology (even before it was theoretically analysed and defined) satisfied many needs, and has been considered adequate up to the point of contact in battle and even longer. In battle, other mechanisms intervene—leadership, training, team cohesion, and fear for sanctions and for the enemy—still within the framework of bureaucracy. Information and control technologies have been applied in order to obtain predictability, based upon reliable social control. Not until communication technology caught up with the requirements for rapid, flexible, and long-distance communications, did control in battle in its current meaning become possible and with it systematic command work.

1.3.2 The Military within Society

Various theories attempt to explain war, independently of whether war is seen as inevitable or not in society. There is general agreement that war is a social institution, which is where my research commences. McRandle (1994) viewed warfare as an institution, carefully marked by rituals and separated from the profane life of everyday affairs. He concluded, “...warfare is a human institution like marriage and religion. Its central ritual is battle” (p. 47). Keeley (1996) discussed whether war is a basic condition in society or if it has become so when society evolved from primitive to more complex modern states. He claimed that war serves various functions in society. A pragmatic position is that war is like trading but its opposite: a way to get what one wants when commerce is out of question. Peters (1999b) was as pragmatic but stressed the role of belief systems, not necessarily dominating ones, channelling and amplifying conflicts: ”the killing minority drives history” (p. 32). Finally, Parker (1995) concluded that every culture develops its own form of war.

Because the modern military is an institution within the nation-state, the consequences from a control viewpoint need to be considered. It is from them that internal command work grows. A closer examination of the control aspects of the transitions of the military from a tribe of warriors into an instrument of the nation state requires emphasizing some traits in particular. From the seventeenth century and onward, bureaucratic state administrations have penetrated and been accepted by the military (Howard, 1976; Brown, 1995). Bureaucracy (involving advantages and disadvantages) allowed control from the outside and from within. Altogether, this transformation of the military in Europe, from aristocratic private business during the seventeenth and eighteenth centuries, to a modern nation state institution, required a new kind of social stability with suitable control mechanisms. Suffice it to say that the bureaucracy implies a close relationship between knowledge and power. Zuboff (1988) recalls what Weber has said about this, that authority is the *legitimate* exercise of imperative control, and that

> ...obedience to authority is achieved through a belief in a hierarchical order that creates the mutuality of command and obedience. Legitimate authority need not depend on either violence or reasoned argument to elicit the desired action (p. 221).

It is important to remember that the military is the nation-state institution which has got a legal and strictly regulated right to use violence and to train people to kill other humans (defined as “enemies”) if necessary. Dandeker (1999) expressed one view of the dominant military thinking:

> For the military the core values of military culture are subordination of the self to the group and the idea of sacrifice: the individual must be willing to subordinate him or herself to the common good - the team and the common task. Furthermore, there must be a willingness to sacrifice one's life for the team in peace and war - without this an armed force will risk defeat. Ideally, as a result of leadership and training, these values will be upheld voluntarily as a result of conscience. However if necessary, coercion may be required. This is what makes military discipline - an effective structure of command for the giving and receiving of orders - quite different from other organisations in terms of the demands it places upon personnel. (p. 85)

This description may give the illusion that harmony and orderliness dominate the relations between the military and society, and that internal control certainly can be difficult but is largely unproblematic because of structure and discipline. This conclusion is incorrect. Instead, *contradictions* affect the practice, meaning control problems and pragmatic solutions to them within and outside the organization. Military practitioners work within the peacetime organization and training system most of their career. Obliged to be competent, they are now faced by the need to reform their practices and organizations, and design for flexibility and efficiency. In spite of all efforts to forecast and plan, *uncertainty* dominates the military horizon in peacetime and in war—missions, environment, resources, and requirements on the organization—complicating both command work and research.

1.3.3 AN ANALYTICAL FRAMEWORK FOR COMMAND WORK: BOUNDARY MANAGEMENT

In this ongoing work to develop the command practice, theories covering relevant aspects of control are required in order to guide both research and organizational change. Having said this, I will first outline a perspective on the military and its command activities, relating it to cybernetics, systems and organization theory, which promises to be consistent with what actually occurs and not add to the gap between theory and practice (Foster, 1988). Later on, this framework defines how ISs are designed, implemented and used in the control action/interaction cluster.

According to systems theory, a system needs resources for its survival and therefore must execute control over part of its environment which then is transformed into resources (Schoderbek et al., 1990). Emery (1969) stated that the primary mission for management is to handle the organization's boundary conditions where different levels of exchange regulate the survival of the organization, and said:

> The boundaries … can be managed only by managing the co-variation of internal and external processes. In so far as a manager has to co-ordinate or otherwise resolve internal variances then he is distracted from his task. (p. 9)

Emery stated that the basic regulation of open systems is self-regulation, providing its members certain autonomy and "selective interdependence" (ibid., p. 11). These conditions underpin the necessary *commitment*, without which actors may be less willing to respond to emergencies. This *boundary management* (Figure 1.7) regulates the degree of integration and autonomy between an organization and its environment (Morgan, 1986). In the *boundary zone* between an organization and its

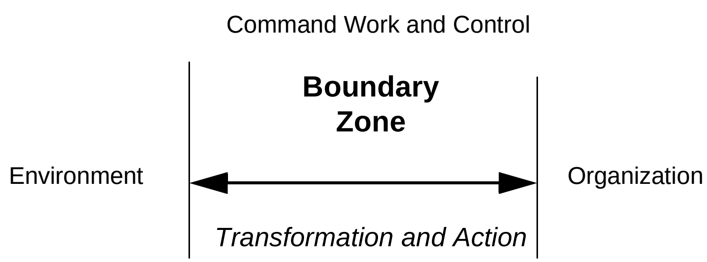

Figure 1.7: The organization, its boundary zone and the environment.

environment, whether it concerns a large rational bureaucracy or a small team, certain *boundary phenomena* appear. The same idea is applicable in command work, military management. The organization faces a dynamic, in war even a hostile environment, which needs to be made controllable through social action. The military in fact has a dynamic boundary zone all the time, not only in war, where contradictions must be reconciled. There is a parallel to ISs development when social action is transformed and (more or less) formalized into organized action. There is a boundary zone separating and insulating the formally organized and the not yet organized part of social action.

This perspective of an organization and its environment (Figure 1.7), and the intersected boundary originates from cybernetics, illustrated by Beer in his Viable System Model (VSM) (Beer, 1981). A Viable System consists of autonomous subunits (subsystems) which become viable because they can exhibit the necessary *variety* for handling evolving situations, having the capacity for self-repair, self-awareness, recursion and maintenance of identity (Skyttner, 1996). Such a system is able to adapt, to respond to unexpected and previously unknown events (SYNCHO, 1992). Its Requisite Variety is maintained through the Viable System (Beer, 1981). In the military environment, competitors (enemy) face the own organization (forces) and add to its dynamics. In Bosnia, for instance, the troops found themselves *in* a war, without *waging war*, which meant hitherto unknown constraints, from *control of emotions* when faced by atrocities or shot at to *inaction* during long periods. The boundary conditions cannot be predefined or managed with the help of rules and rigid programs along established channels for cooperation and communication or according to the (military) Standard/Standing Operating Procedure (SOP).

Espejo (1997) used this theory when closer analysing preconditions for control. Making the environment less uncertain and confusing with the help of distinctions is the first step towards augmented control. To manage the unavoidable ignorance well is critical because it is impossible to know everything in a situation. Espejo distinguished between *practical* (few, related to practices) and *mental* (varied, unrestricted) *distinctions*, the latter supporting the former. The practical distinctions define the detailed complexity in the operational domain while the mental ones may be inventions with the help of language, increasing the complexity (Espejo and Pheby, 1999). The two-way transformation process (Figure 1.7) is first when the environment is interpreted and defined (its complexity being reduced) and then when the distinctions support organized actions with sufficient variety (detailed design). If the way the organization works does not allow useful distinctions, then operators experience problems initiating actions. Another way to express this is to say that an organization that does not admit rich communication, support innovation and expression of ideas, risk to be left with inadequate practical

Figure 1.8: A provisory briefing area in a large barn, May 1998.

distinctions and variety is attenuated. Figure 1.8 shows a provisory indoor briefing area when the HQ main (rear) part was deployed in a large barn, illustrating how staff tried to create satisfactory workspaces.

Not only rational (in its quantitative, objective meaning) or efficiency-based forces are at work. Socially constructed belief systems and normative rules exercise strong control, for instance that modern IT can provide Dominant Battlefield Awareness (DBA). Unfortunately systems theory and related theories do not recognize the *social character* of what is "control", which makes the recognized actions/ interactions delimited to rational processes, possibly amplified by the design of control technologies. Such efforts can be seen as attempts to make the organization a *sphere of ontological security* (Giddens, 1991), a phenomenon related to the socialization process discussed by Berger and Luckman (1966), aiming at the establishment of an orderly sub-universe and a manageable reality.

1.3.4 CYBERNETICS AND THE VIABLE SYSTEM.

Beer (1981) stated that already the expectation of a loss of control, a *cybernetic breakdown* in the institution, counts as a crisis. Loss of control is not only the inability to impose decisions; the institution itself is out of control. Command work means crisis management and we need relevant models and theories when analysing and executing it. The Viable System Model (Figure 1.9) promises to be such a framework, resting on cybernetics. A Viable System has five key sub-systems corresponding to different functions (ibid.; Espejo and Gill, 1998).

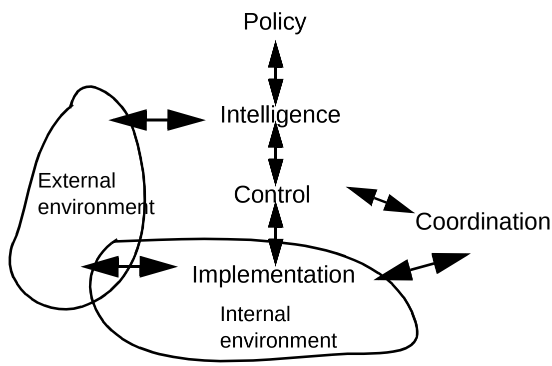

Figure 1.9: The Viable System Model with five subsystems, the Implementation transforming the external environment into a controllable entity.

1. **Implementation**, producing the products or services implied by the organization's identity (military actions, battle);
2. **Coordination** of the operations (implementation) by primary sub-units;
3. **Control**, where resources are negotiated, direct line management instructions are issued and accountability reports flow upwards to keep the meta-level management in touch with events. This function contains reporting systems and has its own monitoring channels;
4. **Intelligence** is the two-way link between the Viable System and its external environment. Intelligence is fundamental to adaptivity. It provides the primary activity with continuous feedback on environmental conditions, technology changes and all external factors that are likely to be relevant to it in the future. It plans the way ahead, and projects the identity and message of the organization into its environment. Intelligence needs an up to date model of the organization;
5. **Policy**, its main roles being clarity about the overall direction, values and purpose of the organizational unit; and to design, at the highest level, the conditions for organizational effectiveness.

In cybernetic terms, and when comparing a CPX and the organization with the VSM, the Intelligence subsystem (4) has little to do because the simulated environment cannot be provided with sufficient variety, meaning difficulties to really plan ahead and work farsightedly during limited exercises. Moreover, the formal organization does not correspond with the VSM components. A related complicating factor is that during an operation the division of responsibilities between the subsystems 2-5 (Coordination, Control, Intelligence and Policy) is hard to strike. The same people have shifting roles, or rather, find themselves rotating between various positions. In the absence of input from Intelligence, the useful interaction between Control and Intelligence is difficult to explore, and the boundary between Coordination and Control easily becomes blurred. This means that too much might become controlled in a very detailed manner when instead mutual adjustment would solve several coordination needs and the autonomy among the type 1 subsystems would be preserved.

1.3.5 SUMMARIZING RESEARCH ISSUES AND FRAMEWORK

In order to think about and to enter into a meaningful analysis of any research domain a researcher needs a high-level conception of it. On this level, theories are applied, to guide the research and help in understanding the organizational development and its attributes. I have presented a framework where the roles of a few contextual and control-related factors are outlined, because these mark the pivots for the study. *Control* is the central topic in this research, executed via *command work*. The building blocks for this control study originate within the military where *power, authority,* and *knowledge* are intimately linked (I will return to these issues in the next section, and in the method chapter). Theoretically, the study is an application of cybernetics because cybernetics is the science of control (Beer, 1981).

In order to understand what happens in command work, it is necessary to investigate its context and its foundation. The military's position as a *nation-state institution*, and how its internal control and command mechanisms are organized will be given attention to, not just be taken-for-granted. It is, for example, not possible to study the command work without a careful analysis of the influences from the bureaucracy.

Zuboff (1988), discussing the conditions in modern organizations, meant that individuals have to be their own authorities instead of relying on a superimposed authority system, and that knowledge and authority risk being on a collision course. When authority and power, or to use Giddens' (1991) phrase "ontological security"[2], is threatened, redefinition of the system of authority is probably needed also in the military. Research has to follow when new conditions for the practice of com-

2. Giddens (1991): "a sense of continuity and order in events, including those not directly within the perceptual environment of the individual" (p. 243).

mand work arise. Eventually, the application of organisation theory should be consistent with IS theory, hopefully leading to practical solutions that have few built-in contradictions; *second*, because of the immature theory and the largely pretheoretical military practice, both researchers and military practitioners need more. The VSM indicates one of the theoretical directions thereby.

An organization involves itself in successful *boundary management* in order to remain a viable system, capable of handling the variety in the environment (Beer, 1981). I regard the command work, involving several coordinated activities, as this boundary management, a two-way transformation process in the boundary zone. The work defines the environment, makes it intelligible and communicable, develops control strategies and social action, and implements them with sufficient requisite variety. This work must be continuously adapted to the dynamic character of the environment, with considerations of the internal situation in the organization.

Training, the context of this study, is part of the total command work and practices. Several peacetime agendas coincide in training, directly and via the economy. The basic constraint is to train, demonstrate and to learn from what is possible and manageable, as opposed to what is the *desired* realism.

1.4 Guidelines from Human and Social Sciences

1.4.1 TRUTH AND CERTAINTY

What is “true” about war is usually debatable already when they are going on. In the *peacetime military* it is common that conflicting camps compete for influence about what is true in command work and in its control object, operations in war (Åselius, 1999). When many already feel themselves critically evaluated by society, by media, or are under political pressure the risk is obvious that results from science are rejected. The opposite to rejection is that new knowledge is welcomed, because it empowers individuals who can direct their own and others’ efforts to redesign what has become obsolete.

Turning to the human sciences, Salner (1989) discussed the human-science researcher’s work and claimed that it cannot lead to absolute certainty. The observer and the observed are both part of an interactional system, an interacting unit. Any observation is coloured by social, historical, and cultural bias. Human-science research rests ultimately on the actualities of human experience, what people *actually do* is what counts, not descriptions of it:

> Since the human science researcher does not accept this correspondence theory of truth, traditional textbook discussions of empirical validity are largely irrelevant and not clarifying the questions of validity in human science research. (p. 47)

Star (1992) argued that there is a failure for rationalism to account for or to prescribe people's behaviour. In addition, both formally and empirically, knowledge is indeterminable, not specifiable a priori because the *meaning* of knowledge is given in its consequences in a "community of listeners." If this is true, how can a description capture what is essential? Star continued:

> Much writing in the sociology of science since the late 1970s has been aimed at a similar deconstruction of scientific practice. Again, the target here is overly formal, rationalized, or idealized reports of scientific problem solving, which delete the contingencies of practice...Yet these practices become abundantly clear with ethnographic observation in the laboratory, and these studies tend to debunk idealized notions of scientific discovery. (p. 399)

By choosing the ethnographic perspective, I wish to avoid this kind of descriptions, and emphasize the contingencies of everyday problem solving, instead of staying at deceptive but obsolete charts of rationalized decisionmaking. It follows that part of this perspective is to openly present the result, from data to interpretation where some knowledge and meaning are claimed.

1.4.2 The Task of the Qualitatively Working Human Science Researcher

As a qualitatively working researcher, my task is to produce a holistic cultural portrait of the chosen social group: description, analysis, and interpretation of this group. Culture is inferred from words and actions of members of the group (Creswell, 1998). The task includes to reformulating the operational activities for use within the ISR community, then to feed back some of the result which this community produces. The overriding concern is to describe, clarify and articulate the theoretical foundation for military command activities. I have chosen to do this from an ethnographical standpoint so as to discover *new aspects* of the actual work. Hypothetically, through this close-up view, re-conceptualizations and complementary insights can be gained.

Salner (in Kvale, 1989) stated that what *empirical* social science can let us "see" is either the subjective experience of the single individual or the "brute facts" of externally observable events. To "make visible" is a key concern in research. We are all prisoners in our concepts, which limit what we see. Therefore it is necessary to develop concepts that support sensibility towards the social world and provide the ability to label it.

What is perceived as *human reasonableness* is coloured by the dominant cultural form and by its language. Researchers have to realize that Western rationality is just one particular cultural form of human reasonableness. The outcome of human reasoning therefore is not necessarily "truth". Not only its outcomes but also its procedures should be evaluated. Constraints that are the results of human social dynamics distort human reasoning and produce results that are un-reasonable in the way war is often (but not always) perceived. The outcome of reasoning reflects interpersonal (social) agreements to follow certain agreed-upon procedures and forms in making and communicating decisions (ibid.).

A look at historical descriptions and how they are made to be attractive to readers illustrates these arguments. The reason behind the common emphasizing of drama and tactics in them instead of minute details in for instance *logistics* is that they were written for the elite, said Luttwak (in Lynn, 1993). Logistics were not an aristocratic concern except in their broadest sense. An army had to be led, exhorted, commanded, but the supplies merely followed. Åselius (1999) recalled similar thinking in the Swedish army during the Cold War period. Much detailed tedious work today is related to systems development, and the will to dive into it is not very widespread. Perhaps there are causes that unite these biases.

What powers or interests are then present, affecting the process of establishing the functional relationship between the researcher and the particular community to whom the research is addressed? The chain of connections between methods and research purposes necessitates a critical perspective on the part of the researcher. To be a *conscious participant* means to be conscious of the discourse in the studied community, as distinct from the one that the researcher is involved in within the research community. Concerning the role and task of the researcher and the impact I had on the work, I asked the Chief Logistician (ChLog, one of the main informants) at the end of the longer final CPX whether my presence had affected the work. I was relieved when he said it had not, even if he admitted that my interest had promoted some extra effort to produce documentation, templates and routines.

1.4.3 VALIDITY REQUIREMENTS

The last section showed that validity is generally problematic within social science. Valid knowledge claims – both *about* command work and *within* it – are not given, but come from the conflicts and differences between the research community and the military, affecting how interpretations are communicated and negotiated among the people who share decisions and actions:

> This conclusion leads inevitably to increased emphasis in human science research on linguistic communication and on interpersonal negotiation of conflicting interpretations. (Salner, 1989, p. 61)

I share some validity problems with other researchers who investigate military command practice. A researcher is involved in an ongoing social construction of *a reality* rather than defining Reality. What is seen as the truth is therefore negotiated first between the researcher and the actors under study. Second, a researcher negotiates his or her claims to an understanding of these events with a wider community outside the research situation. This, together with the researcher's interpretation leads to a double (at least) hermeneutic problem. Salner labels this work as a process of reaching *defensible knowledge claims* rather than of validity per se.

Without realizing that interpretation — and the role of the context for what is understood from the interpretation — are the core concerns, it is easy applying the empiricist researcher's way of regarding data and language as representations: representations carrying their meaning, interpretation then becoming unproblematic. I conclude that focused attention is necessary on the social dynamics of the context in which the research is set.

> Human science research thus becomes a product of the methodological framework of the humanities rather than of the natural sciences, in that social reality is conceptualized as a symbolic reality; social reality is socially constructed. (Salner, p. 62)

The researcher must also be aware of *his* position within another social institution, social science, which is also part of the Western traditions and thought.

On one level it may be less problematic to define *that* certain events have occurred and reach an interpretation that satisfies practitioners. On another level it can be very difficult to establish something's *meaning*, and then initiate action within practice, for instance ISD, and then virtually impossible to *prove* what is best practice. There are a few contributing elements to these validity difficulties. The *access problem* in war makes it difficult to produce data. In addition, Keegan (1976) demonstrated how history is often created as *post-hoc stories*, hard to analyse. It remains to do *peacetime* research, and try to establish its validity and relevance, so that results are applicable when preparing for missions *in war*. So far, however, my choice first to work with other persons' experiences *from a war* (Bosnia), without being able to participate in the operations myself, and to generate theory, has led to a meaningful theory. A particular validity problem grows from the ethnography and my own professional military position: can an officer avoid bias and partiality? Is it possible not to "go native" because of the fieldwork? I see ethnography as a way to avoid critique: data, theory and results are presented openly.

As regards the second phase of the study, it is a common strategy for researchers and military practitioners alike to work extensively with simulations as substitutes for reality, and to draw conclusions from them. Exercises are simulations, but also *real* and constitute almost full-scale events when many real social events have to be managed under very constrained conditions. Thus, to study the people in the present organization and their job was as close to real practice as possible. Together, the two phases of research complement each other, but it is also possible to compare them, thereby providing some indications about the total validity. As a matter of fact the qualitative approach (grounded theory, ethnography) have produced advances beyond previous studies. It provided new insights in a complex work, which is how to design command work and its control technologies for future requirements.

1.4.4 Cornerstones: Mutual Knowledge, Common Sense, Colonization of Mind

Giddens (1979) discussed the role of sociology and articulated the researcher's task, especially concerning the need to distinguish between *mutual knowledge* and *common sense* ("The object of sociology is to check up on common-sense beliefs", p. 249). The mutual knowledge is the available knowledge of both the researcher and actors in the field, the medium of access in the mediation of frames of meaning. The social scientist is dependent on mutual knowledge in order to generate characterizations. Mutual knowledge is, however, not corrigible to the sociological observer while common sense "is corrigible in the light of claimed findings of social and natural science" (p. 252). This check on common sense can confirm or – better – *reveal something new* about it. While common sense therefore is the "unbracketing of mutual knowledge", the consideration of the logical and empirical status of belief-claims involved in forms of life, the researcher goes one step further. Again, some risks are close to hand. Rationalization when explaining human action is one, forgetting that every rationalization is bounded, instead of *investigating* these bounds: “it is in exploring the nature and persistence of these bounds that the tasks of social science are to be found.” (p. 250). In Giddens’ words: “The progress of science punctures the delusions of customary habitual beliefs” (p. 248).

Mignolo (1995) described convincingly such a process during the Renaissance when America was colonized and “science” took over. When the Spanish concepts and the encyclopedic way of organizing knowledge was imposed on the American culture, this culture virtually disappeared because its organization of knowledge was replaced by another paradigm. What was pretheoretical knowledge from the European perspective disappeared when the scientific way of organizing knowledge was introduced. There are parallels with systems development, when the concepts from one universe of discourse (systems engineering) penetrate an empirical field (work), or when the social scientist’s terms are used as a means of dominance. In both cases the powerful newcomer, intentionally or involuntarily, augments his power and autonomy, and reduces what was before. Language certainly is a means of domination and affects the agenda for the discourse. The presence of researchers thus has two aspects, one of which is to contribute to the delusions, further reducing the power of practitioners, or to provide insight and empower them.

Giddens (1991) added some related words of warning concerning modern society. Technical specialists may appropriate terms from lay discourse, give new meanings to them, and these new meanings later return to lay discourse, adding meanings and maybe confusing the discourse. Consider how IS development starts with mutual knowledge (work as perceived by practitioners and systems developers/experts), then continues with a common sense notion of this (process models and technical solutions) according to what kind of support is necessary. Again, this common sense must be analysed critically because the use of language to define the mutual knowledge is already pre-rationalized as regards to what kind of perception is presupposed of the work involved.

A concrete example is that people who have no prior experience from a domain such as the military may take the words of the practitioners for granted, or may themselves carry terms with them, ignorant about how these fit in or are interpreted by the military. Consequently, when these mutual knowledge expressions are shallowly transformed into common sense knowledge about, for instance, command work and practices, the outcome in the form of ISs is not what people wanted, but it is hard to question the result: Everything fits into common-sense knowledge, self-fulfilling prophecies. A sequence of good intentions thus might end with an inadequate result and a “foreign” technology. What happens in such a situation is close to a modern *process of colonization*.

The empirical domain (military practice) is still dominated by pretheoretical knowledge. Glued onto this are common-sense interpretations of what it is all about, as are the common-sense solutions to urgent problems according to another (maybe articulated) theory (or ontology, epistemology). Practice then becomes colonized, and experiences a loss of autonomy and, consequently, of power. Zuboff (1988) saw this development: after change come the interdependent transformations of knowledge, authority, and work techniques that indicate the necessary comprehension of the strategy for making descriptions of the work and re-designing it. When all actors involved are in a boundary zone, what is needed is a learning environment where new skills can develop. In this way, training becomes a crucial activity, not for repeating what is known, but for creating something new.

1.5 Research Issues, Answers and Thesis Content

1.5.1 Research Issues

The superimposed research issue is why attempts to implement and use IS in military command work become so slow, costly and cumbersome processes, and imply such uncertain prospects for the achievement of efficiency. My research hypothesis is that a close study of actual command work will lead to insights and indicate alternative and complementary approaches for the design, development and use of IS. Bardram (1997; 1998) called this *informed design*, when theory gives form to design. Anderson (1994) went further and stated that not only techniques for notations and formalization, but also a kind of sensibility is necessary, one that marks the boundaries of the design problems and approaches.

Based on this I have formulated three questions:

1. How do people conduct command work when faced by a dynamic environment, what kinds of social interaction occur with what result?
2. What technologies are used and with what result and effects?
3. What theoretically informed ISD principles (methodology, functionality, and position within the command work) can be formulated, and can some application be outlined?

1.5.2 Answers

The thesis responds the research issues in the following ways:

1. The analytical content is a summary of a series of fieldwork periods conducted according to the requirements of qualitative method, and is highly descriptive;
2. The description illustrates, with the help of two case situations and some additional data, how command work is conducted and the role technologies play. It provides examples of actual development and implementation of IT as part of the boundary management, and formulate conclusions as to how this should be done with reference to established theories and practices for systems development; and
3. Suggestion for a new perspective on the organization, a theory for what “command work” is and what humans actually do. I define this kind of work as *design work*, where choice between different rationalities, to work elastically while applying various rationales, is required in order to reach solutions that meet requests for social usability rather than objective rationality. Humans’ expertise and work should be the starting point when designing support mechanisms. Information systems shall empower experts’ and allow their knowledge to be recognized, applied and thus contribute to the command work.

This perspective puts humans into focus when designing work practices and tools, hopefully diminishing the latent gap between power in an organization, technology, social organization and knowledge. Most importantly, it recognizes the need for *balancing autonomy and control requirements* in order to achieve viability. In addition, it acknowledges older practices and positions command work in a historic and social context. These results, in addition, bear evidence of the applicability and values in this kind of research, thematically and methodologically.

1.5.3 Structure and Content of the Thesis

The presentation of the second phase is designed as an expedition from a home base, and the return with a treasure, field data. The data are analysed, and ISD principles are outlined. In addition to the fact that this journey is a way to provide a structure to the presentation and a way to reconceptualize or even rationalize what I had been involved in, it is close to the actual knowledge development process. The content in each of the five parts are briefly outlined in Figure 1.10.

Part I, *Mapping the Arena*, Chapter 1, introduces and summarizes the work. Chapter 2 presents the contradictory research domain, the military institution.

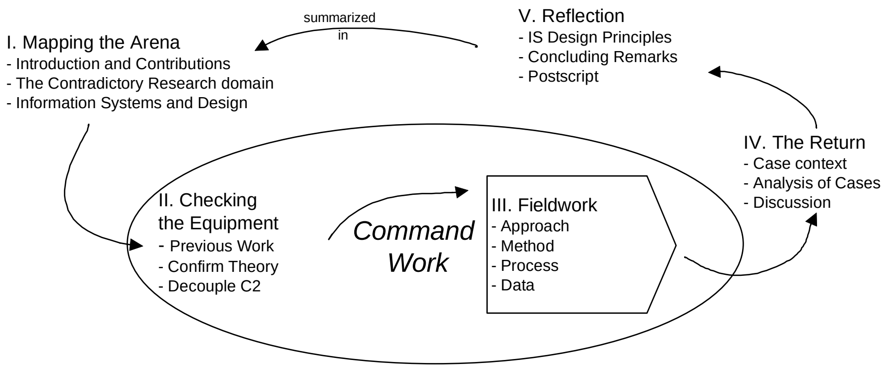

Figure 1.10: Work and Thesis Overview.

Chapter 3 is a presentation and discussion of the concepts of *information*, *IS* and *design* related to the military context and command work leading to a new way to conceptualize an IS.

In Part II, *Checking the Equipment*, Chapters 4 and 5, I summarize previous work, and discuss especially the conceptual and theoretical meanings of command and control as components within a tradition of social control. The analysis is consolidating previous work and bridging to the ethnography.

Part III, *Fieldwork*, starts with methodological issues (Chapter 6), and describes fieldwork and data (Chapter 7).

In Part IV, *The Return...*, I organize the result around two cases which arose and were defined during and shortly after the week-long last CPX. In order to provide a rich description, I present contextual data about the background to the cases and about the ongoing army change process in Chapter 8. The cases illuminate the junctions when important command tasks are conducted, between people, technology and work, each from its position. Both illustrate aspects of command work and the use of IT. They are a *meeting*, and the development-in-work of a *control artefact* during a six-month period, as a self-help complement to a centralized IS. The meeting was initiated in order to solve an emergent need for design of action and to restore the command organization. The artefact was an application built on top a commercial PC spreadsheet program. I analyse them in Chapters 9–10.

The analysis illustrates important issues in command work:

- the need to shorten the distances between data and knowledge, and within the organization between knowledge and authority to act, essentially between *knowledge* and *power*;

- the interplay between *rationality, knowledge, technology* and *power* in an organization, and specifically how *information* and consequently *information system* are defined;
- the *roles of bureaucracy* as the common context for command work and ISD, and also as a tool for social action;
- the importance of *visibility,* both of humans and when designing control technologies, from meeting spaces to individual and cooperative artefacts;
- how IS applications have to *integrate social context and instrumental control requirements* with the development of work;
- choice of *strategies and techniques for representation of reality,* from where knowledge grows; and
- the need to integrate workspace, work and control technologies through design. What counts is not development *for* the work but development *in* the work;
- the importance of pragmatic social value (power and autonomy) in the work. Viability means effect, and is closely related to dominating interests.

Part V, *Reflections,* contains the higher order analytical and argumentative parts of the study (Chapter 11), and ISD principles and suggestions (Chapter 12). I present a new perspective on command work as a kind of *design work*. I summarize the conclusions from the analysis, the proposed new theoretical framework for command work, for continued research and practical engineering work within Computer Science and ISR. Lastly, in Postscript, I formulate some reflections about the whole work and some insights I have gained about the military, conducting research, and about modern control technology.

1.6 Overview of the Research Process

Seen from above, the study reflects the overriding change process during the 1990s. Stepwise the Swedish defence and nation have had to accept successive involvement in external military affairs on a new scale, the beginning of which was Bosnia. Some changes are politically driven while others are technologically driven, both organizational adaptations, one after the other. The ongoing change and IS development process in the army include the implementation of new control technologies where input from concurrent practice is introduced. The implementation was conducted as a joint effort between practitioners and system engineers, designed mainly according to well-established principles for participatory development

(PD). Deep insights are needed about the command practices in order to inform the process by theory because the confrontation between the products and the real world is often a conflict zone between theory and practice.

Figure 1.11 illustrates the whole research process, phase two being shadowed.

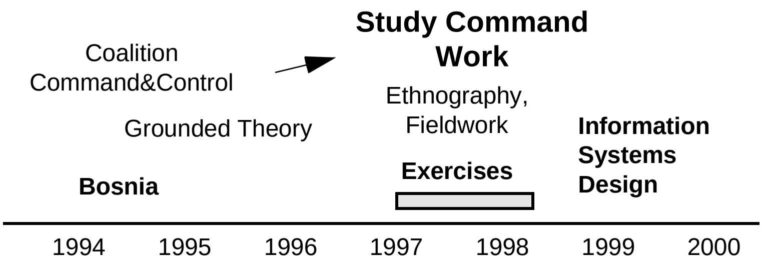

Figure 1.11: Research process.

First I worked with experiences gained from Bosnia (Persson 1997) in order to gain insights into practices when new features and demands arose. This new environment involved work over a long time period within a new coalition, and under conditions of war which then required interoperability and handling of cultural differences.

The UN Bosnia operation did not lend itself to direct participation. Therefore I had to exploit the chances to build new knowledge from current domestic training and other practice, still trying to formulate theoretically informed general ISD principles. The research focus during the second phase of the work has been the army's detailed modelling and efforts to implement a new command organization since the early 1990s.

The whole study has been an iterative process of discovery and fieldwork together with data production. The fieldwork provided me a new large set of qualitative data consisting of documents, field notes, digital photos and audio recordings from exercises. The last CPX was a large and week-long exercise where several army, air force and marine (coastal artillery) command units were involved. These data have then resulted in a description of what happens inside the command organization, and what kind of coordination efforts are executed and supported during boundary management. The applicability of the term *constraint management* was confirmed and further developed during the second phase and was a stepwise formulation of theory together with refinement of research methods and techniques.

In retrospect, this process is the final part of a longer period during which I have actively been involved in successive attempts to shape the military practice according to new demands. In some respects feedback has been provided, but on a limited scale, partly as a direct answer to questions and partly in the form of memos and reports, covering limited aspects of the events.

1.7 Summary of Contributions

The research illuminates how people in command organizations with the help of, and in some cases in spite of their own control technologies, struggled to manage the boundary conditions of their organization, creating *unity of effort by maintaining variety and viability.* In this struggle, which dominated the command work, they creatively used and adapted their own expertise, the organization and its control technologies in unforeseen ways. The ongoing immediate on-location analysis when the social function of a meeting and the importance of the self-help application for resource management and control were discovered, indicated that a few fundamental factors influenced the command activities. At the same time as command work is explicitly about transformations, of the environment and the organization, it is also simultaneously transformed under influence of the new technologies.

The contributions of the thesis, answers to the three concrete research questions, have five components and a sixth issue:

1. *Descriptions* of how control technologies were used in dynamic command work illustrated by the meeting and the computer application, and how contradictions were managed and reconciled. The description implies that a knowledge perspective on *information as a social construct* is required, not that information (or knowledge) are resources possible to define in advance;
2. Based on field data I provide an *alternative perspective* on *command work* as *design work.* As such it is knowledge-intensive, producing and using symbols, one of which is the army, a viable organization. In peacetime it is merely virtual but has real components. The relations between technology, autonomy and power with the development of control artefacts are analysed. Different sets of rationality were used interchangeably, whereupon mechanisms for integrating them, within a *rationality of practice,* were invented and applied.
3. A new conception of "information system" as a social phenomenon, consisting of functionally related but distributed subsystems. This view lifts design from the pure HCI-domain to a wider area, matching the nature of work and corresponds to the VSM. This conceptualization has four components (subsystems): an informating, a mediating, an informing and an abstract IS that is formed by

interpreted data.

4. A set of *research issues* within four related fields: knowledge representations, knowledge communication and distribution, design work, and IS architecture. The purpose is to better bring knowledge and power together both in the design and in the work, achieving unity of effort, uniting mind and matter both operationalized as operations and logistics and in work in general, between social action and computer artefacts.
5. Based on this I suggest a *set of ISD principles*. If command work is a kind of *design work*, then *support of design work* is required rather than support of standardized office work. Design has to look at the whole conglomerate of computer artefacts, not being detached from work but part of it. Design artefacts need to *support communication between people*, design of *open processes*, and allow a *maximum of autonomy* in order to *augment social flexibility* and support *coordination of resources for action*.

Within ISD these principles mean that technologies for *externalized representations* of knowledge, events and actions in the world will admit *high computational efficiency* (Larkin and Simon, 1987), meaning *overview* and a *short path between representation* and *control- relevant knowledge*. The ability to '*compare between*' (for example representation and reality), has guided design of control artefacts for thousands of years, and is still crucial.

6. The *sixth issue* is related to *researchers'* autonomy and control and the relation between research objects and agents. Researchers, in the same way as people in command work, must invent *their* proper concepts as to facilitate the description and the generation of theory.

For researchers it is a strategic choice either to work within a domain trying to improve its efficiency or to work in order first to promote reflection and understanding, and then how it can be modernized. Independently of strategy, research presupposes autonomy and power in order to make validity claims on its output, forming a viable research process. Each domain needs its own concepts, being related to actions in the world. Research cannot *prescribe* what is relevant knowledge. Instead knowledge must be recognized and interpreted as opportunities rather than threats.

Chapter 2
The Contradictory Research Domain

THE MILITARY INSTITUTION is an instrument of power and a large-scale control mechanism, born out of contradictions in and between societies. The instrument was formed to be able to reconcile them in a social institution named *war* when considered necessary, and carries contradictions. Except for the dynamics arising from the current changes and the validity problems (Chapter 1), contradictions may complicate access, research and ISD in the military. A researcher has to be conscious of them. Security and safety are often complicating issues, but research obstacles may also arise from ignorance. I will investigate some of the contradictions, represented in current political and social contexts, in order to map conditions that intervene or coincide both in command work and in research: those originating in the history of command practices, internal contradictions related to belief systems, the thinking and design of control mechanisms, and finally contradictions present during the fieldwork. Through this approach I follow the qualitative research tradition and work through the conditional matrix, keeping in mind the contextual conditions and how they influence actions.

2.1 Military Features and Contradictions, an Overview

2.1.1 KNOWLEDGE ABOUT AND WITHIN THE MILITARY

> There may not be a simple, universal answer to the question of how unique the military is and should be. But until sovereign states and war are eventually abolished, it seems premature to consider the problem of military distinctiveness anachronistic. (Boëne, in Caforio et al. , p. 349)

On the surface many kinds of identity marks and resources distinguish the military within society (see Chapter 1). Weber, recalled Caforio (1998), even saw the military as the mould for the modern industrial enterprise. This view motivates a closer analysis also at what goes on *inside* the military, but wars involve both danger and formal access problems, and peace-time conditions are not war.

What kind of research is then relevant, capable of producing valid knowledge, having a chance to proceed? Researchers cannot command and direct operations in order to achieve advantageous conditions for research. *Combat data* are difficult to achieve and to make use of (Thomas, 1997; Keegan, 1976) which complicate both the modelling of future command structures and historical analyses. Access obstacles appear not only because of real dangers, physical or timely distances to operations. Researchers may lack protection from rules and law which define who is a combatant (and has some formal protection), and who is not. In peacetime, access is defined and regulated by various organizational gate-keepers. According to Caforio (1998), there is even a military reluctance toward sociological research. Both in war and peace, researchers need not only be trusted in order to gain access and sufficient autonomy, they have to conquer this resistance. The historical paradox is that research on the military and application of scientific knowledge have a mixed record, but that the needs repeatedly have surpassed the supply.

Ellis' (1976) description of the introduction of new technologies, especially the machine-gun, and the shock when in World War I (WWI) the century-old concepts of strategy and tactics and the "comfortable" understanding of what war was proved to be inadequate, can be used as evidence for a dominant institutional inertia. Now and then it is succeeded by furious competition when pragmatism, not science and theory, rules. Graham and Bidwell (1993) meant that the attitude of military and civilian students of warfare towards 'science' was ambivalent. 'Scientists' had begun to be seen as possessors of a new kind of wisdom during the nineteenth century. Thus there could be a *science of war*, the discovery of formulas which if followed would lead to success. Mechanisms for systematic research and

Figure 2.1: Throwing a grenade, WWI, Champagne, France.

study of applications of technology to military purposes did not exist up to WWI. There was no ‘sociology of innovation’ in the conservative and authoritarian military institutions; instead military pioneers could invent unhindered by the bureaucracy or interference by superiors who did not understand what happened or could imagine its consequences. This war was succeeded by efforts to redefine *military art* and the establishment of a scientific foundation for the military practice (Menning, 1997). The new kind of industrialized war required more thorough thinking and inclusion of logistics in its modern meaning, before technologies could be operationalized. The social history of the machine-gun is a telling example (Ellis, 1976). Figures 2.1 and 2.2 show WWI episodes in France, typical for the contradictions between the new and old in war.

The Soviet military led the development of new theory during the 1920s’ “golden age of military thought” (Menning, 1997, p. 23). The growth of the “sociology for the military” followed the outbreak of the Second World War (WWII), and had to be pragmatic as to support the war efforts, finding large-scale solutions to vast managerial (and command) requirements (Caforio et al., 1998). Systems theory, cybernetics (Kelly, 1994; Richardson, 1991), and cognitive science (Gardner, 1987) became the post-war responses from research.

Fifty years later, in the present era of advanced industrialization implying rapid social and technological change, there is still a search for relevant management (command) principles within the military (and in industry). More *heterogeneous* but perhaps not larger force structures than before—a mixture of new and old types and new control mechanisms—require a new insight in order to be efficient. If technology *promises* solutions to some command requirements, there is a growing insight that the operational demands, social conditions and realities, instead *chal-*

Figure 2.2: France, WWI, coachman killed in a convoy.

lenge, in a deeper sense, established knowledge, calling for courage to question old truths.

> We cherish the fiction that technology will be the answer to all of our dilemmas, but our enemies know that flesh and blood form the irresistible answer to our technologies. (Peters, 1999b, p. 35)

Perhaps the most important feature in the military is the number of *contradictions*, dialectic relationships, that affect both command work and research. Many of these contradictions originate in the gap between ideal solutions and real demands. If Peters' words express one position, then Dandekers' (1999) words express another, realistic but also ideal view:

> The military is unique in the nature and extent of the demands it places upon its personnel. They are obliged to train to kill and to sacrifice self, to participate in a military community where one works, lives and socialises with other service personnel and, when necessary, to respond to a 24-hour commitment with the risk of separation from family at short-notice. (p. 85)

I do not mean that the demands are fictitious, but as recent events show, various constraints intervene in this vision and reduces its potential. For instance, while the military institution basically is national, international operations have become a rule. Seemingly then, contradictions, the military's special features, affect the military practice and research from the lowest to the superior levels.

Because of these macro- and micro-level conditions, new research approaches are required. Unfortunately historical investigation cannot penetrate social events

Figure 2.3: German plane crashed at Verdun, spectators studying the plane and the photographer.

as they are taking place. Events must be studied, either by observers with limited overview, sometimes from a distance, or as history but they occur within a *system* of contradictions and are impossible to study in isolation without considering the roles and influences from these contradictions. This third photography from WWI (Figure 2.3) shows a “social event”, its contradictions worth investigating, out of reach for the contemporary historian but if analysed revealing a lot about military practice and thinking, and what constitutes an enemy.

2.1.2 WHY LOOK AT CONTRADICTIONS?

Strong emotions grow from social contradictions. Consequently powerful mechanisms for social control are required first to control the military institution, and also for its internal control. A variety of control mechanisms, from technologies to belief systems are consciously developed in order to check disorder, to control an enemy, providing sufficient variety to handle upcoming events during the boundary management (Chapter 1). Most control mechanisms are not entirely unique for the military. They penetrate business and Western societies, being well known within the research community. However, they are perhaps most thoroughly elaborated in the military. The more security and redundant control mechanisms in order to get ontological security and reduce anxiety, the more complex is this organizational *protective cocoon* (Giddens, 1991), and the greater is the risk that it will fail.

The military instinctively promotes uniformity in order to reduce complexity and achieve controllability, but conflicts often arise. The *uniformity – diversity* contradictions occur from the highest levels, from belief systems, ontology and theory, via economy and funding, down to pragmatic actions in the work. A similar dichotomy is strong during efforts to develop and use modern IT.

Certain IS development methods within the Scandinavian tradition, for instance activity theory, even exploit contradictions. Use of *Activity Theory* and the *professional work practice approach* means to examine actual work practices and contradictions respectively (Iivari and Lyytinen, 1998). Conflict management is a necessary part of a PD process (Sjöberg, 1996).

One consequence of these contradictions is that research and its results can also be drawn into and become part of them, whether used to support a position or for being accused of being partial and not “scientific”. The ethnographic researcher, in order to find focal points for a closer study in the field and later to understand what goes on, needs to be aware of contradictions, perhaps even exploit them and question what is accepted as a “natural” order. Thereby data can be interpreted better and made sense of when the cultural portrait is completed. In the next sections I will present some contradictions, contributing to and affecting command work, and their research consequences.

2.1.3 Components in the Current System of Contradictions

This is first an overview of some components in the system of contradictions that influences the military institution. The subsequent discussion will trace their origins, and illustrate what influenced events during the fieldwork. First, there is the *relation between the military* and *the civilian society*, where *divergence* or *convergence* is what sets the stage (Caforio, 1998). Eventually, what matters for the military is how to achieve desired autonomy, funding, means for the definition and achievement of professional competence, and a recognized social position in society. The outcome either is integration in society or separation from it. The civil-military balance defines both how the *external control* of the military is executed, and how its internal control mechanisms are designed.

A common dichotomy is between *centralization* and *decentralization* which in turn leads on to what is maybe the most generic contradiction, *between control* and *autonomy*, present at any social situation, named the *dialectic of control*:

> The dialectic of management control is thus derived from Giddens’ idea of the dialectic of control in social systems. It explores the complex issues of power, its relational nature, contradictions and conflict in organisational life, which it is argued, have rarely received sustained and systematic consideration in conventional management control literature… (Nandan, 1997, p. 6)

Command work thus is strongly related to issues of power, knowledge and values. The trade-off between high-level *political* contradictions between power and knowledge both defines what *professionalism* is and affects research. In a modern organization (Giddens, 1991), the traditional union between much formal power and expertise is blurred. The related operational contradiction is between those who have formal power and responsibility—are authorized to *define knowledge* within the organization—and those who have not, but nevertheless are key persons for its survival. Within ISD, *emancipation* is more than just a gender-related issue, having more or less weight depending on the perspective on work and the design process. Hirschheim (1989) defined it as removal of constraints to social freedom and personal growth, Engeström (1999) described how research can aim at emancipation, "bringing recognition and appreciation of work that usually goes unnoticed" (p. 63), and Ehn (1988) stated that emancipation is a fundamental knowledge interest. I conclude that those who have to solve difficult military missions should have decisive influence over their resources and equipment. Studies of command work and ISD from an emancipatory perspective are definitely justified. As regards gender-related emancipation I observed how the few women reservists and conscripts worked alongside men, but did not include the influence of gender in the study even if this aspect is relevant too.

Contradictions are probably inevitable between the *desired military quantity, capacity* and *functionality*, and the *resources to achieve them*, foremost money, and available man- and brainpower. The ever threatening gap between commanding officers (tacticians), and logisticians (in staff), is translatable into the dichotomy between *art* (few rules, ideas and innovation) and *science* with *engineering* (systematic work, natural laws and mathematics), in the same way as within design (Ferguson, 1992). This *art-science dichotomy*, between what is desirable and what is possible, between tacticians (commanders and leaders) and logisticians (rational bureaucrat-experts) is old. Historically, logistics is where formally rational and scientific methods have been applied most. There, perhaps, more than in any other section of military control work, the tensions between scientific, rational, and pretheoretical practices are likely to exist; possible to translate into contradictions between *knowledge* (science) and *power* (art). Some of this was illustrated in the Bosnia study (Persson, 1997). I will discuss art versus science in the next section.

The technology-related *change-stability contradiction* made its presence particularly felt during the fieldwork and what had preceded it. Prolonged systems development over many years is a seemingly slow process, at the same time as the technical components change shape often. There is an institutional interest to be able to create large and closely integrated command structures where stability facilitates reliable control and prediction. Especially as regards IT the efforts to keep up with the increasing pace of change in the environment and the technical evolution, while at the same time maintaining steady state operations become costly, require competence, and cause troubles in projects (RRV, 1997). As it has been up to now, the Swedish military has been largely dependent on industry and consultants for any kind of ISD, which has complicated project management (ibid.). The eventual *implementation* of new technology then leads both to operational control crises (Beniger, 1986), and may overturn power relations (Winograd and Flores, 1993).

When we look for a probable reason behind both the generally slow progresses of science (development of command theory) and the difficulties in applying IT these general contradictions may not be primary causes. Instead the contradictions *between the ideal descriptions* and *the real content* of command work appear. A hypothesis is that the military want to be perceived as rational, and willingly produce tales of rationality, which are then taken-for-granted but later may cause trouble and frustration. In addition, technology (engineers) often promises ideal performance while reality causes real frictions.

Turning the attention to control thinking and mechanisms, organizations can be designed according to one out of two competing control traditions. Either they can be like Giddens' (1991) extremely well guarded protective cocoons where tight internal administrative control is upheld by abstract systems, sophisticated technology and expertise. Security is what counts. Alternatively they can be very flexible, likewise relying on technology, but designed for rapid adaptation to new environmental demands. Richardson (1991) discussed the development of control thinking and mechanisms, and provided a theoretical and explanatory model. The first model follows what he called the *servomechanics thread* with roots in engineering and formal modelling, and focus at the capacity of the internal control system. The latter is called the *cybernetics thread* where emphasis is on aspects connoted with communication theory, and a concern for randomly varying system inputs. Causes of system behaviour are *outside* the system, and control is maintained through *homeostasis* and *adaptability.*

2.2 Military Knowledge and Thought Contradictions

2.2.1 THE ART OR SCIENCE DEBATE OVER WAR IN HISTORY

Belief systems and knowledge claims fuel most actions and conflicts. This art/science-debate has been ongoing for a long time, and is complicated by the very "elastic" use of these two concepts which reflects historical meanings and purposes. What is labelled *art* is a matter of choices and conventions, whether the word is vernacular or the result of serious efforts to systemize concepts. This discussion is ongoing, and is similar to the debate over *design*, whether design is engineering or art (Ferguson, 1992). Ferguson's distinction was that engineering is based on mathematics (and thus has more rigour, lending power from the natural sciences) while art is not. Independently of which to start with, portion of design involves intuitive choices and cannot be verbalized. It involves a sense of fitness, conventions, style or personal preference.

In the early 1990s, the US Army had developed a Battle Command Concept (TRADOC, February 1993) stating that command is the "art of war" within the whole domain of command while control is the "science of war", being "a more empirical process" (pp. 2–3). This, in turn, reflects the development of managerial and theoretical thinking underpinning both *strategy* and *tactics*. In nineteenth century Prussia *strategy* was categorized as the transfer of knowledge to practical life, an "*art* (emphasis added) of acting under the pressure of the most difficult conditions" (by Field Marshal Helmuth von Moltke; Hughes, ed., 1993, p. 47), or a "scholarly discipline" in contemporary German thinking (ibid.). The third meaning is the concept as part of the development of management during the early nineteenth century, relying heavily on means for objective and rational control, leading to a "power-knowledge regime" on the highest management level, in the military and in business (Hoskin et al. 1997). The position one takes in this debate also defines what is good command theory and practice, whether it is art or science, and ultimately, what relevant research means.

Friedman and Friedman (1996), themselves having focused on technology (and excluded the social factors) in their book about future war, cited an argument from Karl von Clausewitz that war had little to do with mathematics:

> We say therefore War belongs not to the province of Arts and Sciences, but to the province of social life. …It would be better, instead of comparing it with any Art, to liken it to business competition, which is also a conflict of human interests and activities. (p. 45)

According to this view "war cannot be codified into a science or an art because it is too lively, too filled with interests, too competitive to have the predictability science insists upon" (ibid.). Sir Michael Howard (1983) who has written a "Past Masters" book about the still dominant military thinker stated that:

> All art, all thought (for as Clausewitz himself expressed it, all thought was art), was creative activity, not an imitative or derivative one. And the same applied with particular force to the conduct of war. (p. 14)

Evidently, according to earlier thinking, *geniuses* had the capacity and the right to transcend, to make new rules ("It was indeed the activity of the geniuses, of the masters of their craft, that made the rules.", ibid., p. 30). "Genius" is not a neutral concept but a social construct and can be used consciously (a gift of God), being a product of the Enlightenment. *Genius* is democratic: anyone and not only an aristocrat can prove to be a genius (Friedman and Friedman, 1996). Here, again, we recognize the notion of *autonomy*, the need to be allowed to stand above rules, even an institutionalized capacity. Simultaneously, the *scientific* ideal of "rationality" was sought after in military practice:

> Throughout the eighteenth century there was a widespread impatience that, in an age when the universe was yielding more and more of its secrets to scientific enquiry and when reason was replacing custom and superstition as the criterion of human judgement, the conduct of war should not be such a clumsy, wasteful and uncertain business. (Howard, 1983, p. 12)

Howard continued by describing how there was a widespread belief that war in the hands of experts could be carried on with such skill and moderation as to be virtually blood less, which is common today as well, after the rhetoric around military operations in Kosovo (1999) and elsewhere:

> Military thinkers sought for rational principles based on hard, quantifiable data that might reduce the conduct of war to a branch of the natural sciences, a rational activity from which the play of chance and uncertainty had been entirely eliminated. (Howard, 1983, p. 13)

From other domains, similar questions evolve. It seems like a coincidence that when Killion (1995) discussed the role of Clausewitz today he equals his *geniuses* with today's *experts*. The last voice to listen to here is Foster (1988) who was harsh in his critique of contemporary military practice and thinking: as long as command lacks theory, it is "destined to remain a lost art form in this country [the US]" (p. 225) and continued:

> Professionalism, after all, means not just wanting to do well but actually being able to do well. For military professionals, who must shoulder the ultimate burden and bear the ultimate sacrifice in defending the nation's interests, the imperative seems clear: to turn command from obscure art into accessible science. (ibid.)

2.2.2 WHAT KIND OF SCIENCE?

Command as a form of *management underpinned by science* has been an early ideal, its authority and thus its social power consequently being enhanced also by belief systems from science. There has, for example, been an ongoing struggle for centuries to make command scientific and develop theory while creating a niche for art (Gat, 1989; Howard, 1983). Graham and Bidwell (1993) discussed the ambivalent search for a science and a theory for command and war within the military, the acknowledgement and application of rational techniques being basic. During the nineteenth century some science was easily accepted (formulas) while other issues were harder to apply (philosophy of science, scientific method). Except from the old *conflict between the science* and the *art perspective* on the practice of military command, a later *engineering perspective* on command work can be added. Then, if command is an art, to systemize knowledge development, to design IS, and to train is different as compared to what is suitable from an engineering or a "pure" scientific perspective. Moreover, the latter then requires a choice between which scientific position to work from, the natural or the social sciences? Miser and Quade (1985) described this dilemma:

> Technical Rationality is the heritage of Positivism, the powerful philosophical doctrine that grew up in the nineteenth century as an account of the rise of science and technology to the well-being of mankind. Technical Rationality is the Positivist epistemology of practice. (p. 287)

According to Miser and Quade, positivism presumes that scientific knowledge is the only basis for problem solving, and that a professional practitioner must be able to map a problem he faces onto this kind of knowledge. The result is to make the 'arts of practice' appear as 'puzzling anomalies' (ibid.). The contradiction is that while admitting that practical knowledge exists, the positivist cannot fit it neatly into positivist categories because it is not science. The effect is that the arts of professional craft, for instance systems analysis, do not fit into technical rationality.

Salner (1989) gave still other aspects of art as compared to science. His argument was that art, unlike science, "takes what is *already known* (tacitly) and makes us consciously or explicitly aware of it" (p. 57), is free from geniuses and divine inspiration. Further, the power of art, says Salner, relies on *direct participation* and the *immediacy of experience*. I conclude that "to command" in its meaning of a *human act* presupposes direct participation and by its very nature is enacted in order to be as powerful as possible. Command as art certainly relies upon and demonstrates authority, power. To conclude, "art" certainly is supported by science, but connotes a creative ability to apply existing knowledge and human resources in *new ways* where rules and programs do not suffice.

From this dynamic discourse it is a small step to the choice between *what kind of science* should have priority, the ideal from the *natural sciences* or from the *social sciences*? The "sociology of the military" has been evolving since the beginning of WWII as a cross-disciplinary, pragmatic enterprise supporting the creation of large force structures, but its slow progress is surprising, said Caforio (1998). Caforio's view was that this science has had to grapple with strong cultural resistance on the part of the military establishment. It develops just because "the researcher manages to elude the hostility of the military brass and to conduct research in a semi-clandestine fashion, or at least without the seal of official approval" (p. xxiii). It is not clear whether this resistance comes from supporters from the art- or the science-perspective. Probably, in areas such as research on human factors, Human-Machine Interaction (HMI) in complex weapon systems, or psychology, there has been a shared interest in the direction of research. Research has usually been conducted pragmatically in these and similar areas according to the dominating research ideals from the natural sciences, using quantitative methods. However, when it comes to ISs, less is clear about suitable research approaches. In order to counter the limitations of technical rationality, an *epistemology of practice* is needed (Miser and Quade, 1985). Unfortunately, practice often has a weak voice when it comes to the establishment of norms and standards for scientific work.

One conclusion, after this review of contradictions, and worth consideration when it comes to the design of ISs, is that many difficulties grow from the "strongly embedded Cartesian mind-body dualism and the limits of formalization" (Ehn, 1988, p. 6). This dualism not only concerns ISD methods (Ehn's focus) but the view on the whole organization and on humans, and a related belief that with the help of rationality and formalization it is possible to achieve controllability. Commanders are important persons and are expected to be professional. The dualism is first institutionalized in the chain of command and its ideal, rational, control perspective, and then it is reconciled by enabling mechanisms which are similarly institutionalized: people are highly visible, are appointed leaders and taught how to practice leadership. It is important to examine more closely some contradictions and how they are overcome as is done in modern sociology and management theory, strongly related to ISD (Giddens, 1991; Deetz, 1998).

2.2.3 THE CURRENT SEARCH FOR A SCIENCE OF COMMAND

We have seen some of the long evolution of what science is, and its outcome concerning control thinking, knowledge, and practices. Foster's (1988) late 1980s discussion is to a large extent still valid:

> The current state of command and control theory is one characterised by an inchoate level of conceptual development, a diffuse focus, and a set of highly conjectural, largely underdeveloped hypotheses concerning seemingly random aspects of the command and control process. (p. 213)

Foster claimed that there was a gap, perhaps wider than in any other field, between theorists and practitioners in the command and control arena. This situation is surprising, when considering that command (and control) is central in military practice, that research has been ongoing for a very long time, and that because of its centrality, theory *should* be welcomed and underpin practice.

It seems as if after two or more decades of efforts to establish a "science of command and control", not much has been clarified (Levis and Levis, 1994). It is hardly sufficient to be faithful to certain scientific dogmas when even the question of what is science is disputable. Miser and Quade (1985), who discussed methods for Operational Research (OR) and systems analysis concluded that

> "science as craftsman's work" means to do the most and best with the materials and tools at one's disposal. Just measurement at any cost means the adoption of a "vulgar-positivistic view of science" while for a craftsman, "precision is not to be sought for alike in all discussion, any more than in all the products of the crafts" (p. 37).

Thus, exact data might be irrelevant when *some conclusions* can be drawn already from very rough data. Part of the efforts to reach stability is to invent concepts that allow categorization and communication. The traditional "command" has, during the decades since WWII been combined with "control" into a twin concept. Holley (1988) stated that "control" was added when it became evident that the individual commander had to exploit technical intermediaries as substitutes for the eye and the voice. Usually the concepts of "Command" and "Control" are treated as an entity in the military, abbreviated "C2", sometimes with some additional letter signifying some command attribute. Van Trees (1989) meant that research on C2 was not yet over the academic threshold, and was conducted too detached from the real world, command theory being developed in a vacuum. The term C2 is much weighted and defined, an indication of a common belief that absolute precision in concepts promotes reliable control. Foster (1988) was precise and his critique of the concepts is still valid:

> Command and control, though, is a deceptively vague construct, the precise nature of which eludes even so-called experts in the field. (p. 202)

I was encouraged at the end of the first part of my study to break up this combination and exploit the two concepts separately (See Chapter 5). Contradictions are also hidden in them, between the human who should be “in command,” and the instrumental character of “control” (Pigeau and McCann, 1999). The concepts merit clarification in order to also discover the actions behind them, which is necessary within ISR and when conducting systems development. The underlying rationality and how concepts are formed in practice should be investigated to the extent that the agendas and epistemologies driving both practice and research can be opened for inspection. *Ethnographic methods* promise to provide such insights.

2.3 Contradictions, Military Control Mechanisms and Command Work

2.3.1 Before Bureaucracy

From early on, both the military institution, forerunners such as the crusading orders (Bartlett, 1993) and later within states, have been hierarchically organized according to the criteria of a *bureaucracy*. Armstrong (1982) argued that what became called *bureaucracy* was not meant to be an instrument for promoting the effectiveness of the nation’s land forces but was designed around the much older bureaucratic rationale of assuring tight control of public funds. Certain techniques were invented as early as the early Middle Ages (Hoskin and Zan, 1997): the use of formalized procedures, creation of precise measurement of achievements, the division of labour, and the use of writing and calculation in evolving accounting practices (Pacioli, 1494). Successive formal rationalization has led to administrative efficiency (Beniger, 1986), the achievable precision and reliability of which has even inspired what is “scientific” (Goody, 1996).

To be more concrete about operationalized control mechanisms being refinements of older artefacts used for control purposes (see Chapter 5): from the eleventh or twelfth centuries the use of *texts* in society (business, administration) as a means for formalizing social action contributed to make social organization both replicable and controllable (Bartlett, 1993). *Control* began to be formalized in this new era of textual order and layout (Hoskin et al., 1997). Later, during the sixteenth century, printed texts, carrying greater visual clarity, began to influence the military thinking and practice. Hoskin et al. who analysed the modern use of the concept "strategy" in military and civilian management even claimed that

> There is by 1600 an evolving Art of War, but ironically this is totally derived from applying a new power of writing. And even then, this cannot be confused with the modern practice of strategy. (Appendix A)

The supply and the demand sides have traditionally been organized in separate sections or units. As early as the beginning of seventeenth century in Bavaria, bureaucratic principles were successfully implemented within military logistics (Croxton, 1999). With the birth of the nation states the dialectic was institutionalized, for example in France. In order to establish reliable control of supplies, ammunition, financing, and orderly recruiting, a special civilian bureaucracy of inspectors, the *intendance*, was established. Howard (1976) described how every level detested them when they visited units every two months, accompanying them in the field.

One important invention for the control of the military was to give officers *commissions from the crown* and make them obedient state servants as compared to the mainly self-appointed leaders from earlier periods. The first application of this practice was in France during the fifteenth century, later during the seventeenth century the system was completed. Well into the nineteenth century, class-structure was maintained in the British army where commissions were bought and the gentry controlled the recruitment of officers, wealth being a determining factor. The first commissioned officers in France were lieutenant-colonels who commanded regiments in the field, and generals who were in command of the higher formations (ibid.). A commission thus meant favours in return for loyalty: Social status, career, power and a certain autonomy, although constrained.

2.3.2 THE PRINCIPLES OF BUREAUCRACY

Bureaucracy was the state's remedy for achieving effective political control over the military (Howard, 1976; Brown, 1995). It had qualities which also made it suitable *within* the military because it could advance and assimilate very old social control practices which had over a long time proven their value, and reconcile control with a certain autonomy. Bureaucracy could make a stable career possible, it could provide funds and salaries, and it transmitted the legal power through the chain of command, all the way to the soldier, supporting discipline. Its influence grew because of its capacity for mediated social control over long distances, time periods and when many people were involved.

Within the command organization there is a prolongation of the political–institutional contradiction, between the intraorganizational *political power* (represented by commanding officers) and the evolving *organizational power* (represented by staff). It is possible to translate into the dialectics between command and control (partly depending on the definition of the base concepts). In short, commanders are given formal authority by the state (through the chain of command), and have to obey orders even if their unit is threatened by extinction (this idea of efficiency and little consideration of emotions is inherent in the ideal type bureaucracy). Brown (1995) meant that schematically Weber portrayed bureaucrats as "automatons lacking flesh and blood" (p. 2). Contributing to the strength of the bureaucracy is the distribution of power and responsibilities onto individuals which makes them *accountable*.

In Figure 2.4, the rational ideal control (left flow) is completed by the necessary power, together with responsibility allocated in *individual* actors (right flow). This

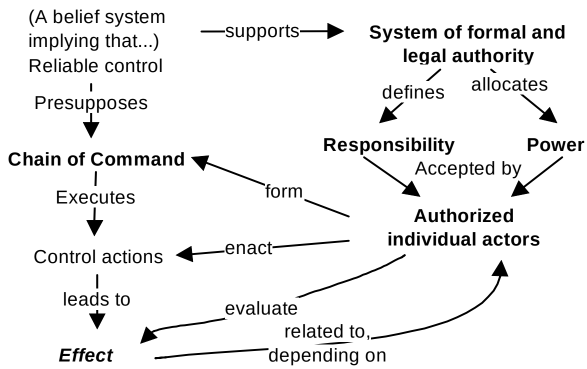

Figure 2.4: Basic components and functions in the ideal rational military power and control bureaucracy.

perspective promotes measurable and instrumental control features and thereby easily disguises or overrides the social, less mechanical context. Commanders are however also members of their unit and are obliged to see to its well being. In social life, what is defined as truth and knowledge is however often open for interpretation, sometimes defined by superior authorities, recalling "reason" or inventing other rationales (politics), occasionally depending upon local conditions.

In this study, some other aspects of the bureaucracy will be dealt with. What I have described hitherto is its control efficiency. What must be realized is how it also *supports autonomy*. Rules, for instance, once they are written can be turned the other way and support abuse or circumvention of them. Accounting practices ("cosmetic dressing of performance indicators") provide pedagogical examples (Nandan, 1997). The bureaucracy thus has a capacity to reconcile many contradictions: it allows bypasses, it is possible to make a career and achieve more autonomy, at the same time as justice and law are generally guarded. Nandan used Giddens' (1991) words:

> The more tightly-knit and inflexible the formal relations of authority within an organisation, in fact, the more the possible openings for circumventing them. (p. 148).

Especially when *science* and *rationality* are used as arguments for action, there is consequently reason to take another look (for the same reason that "art" might be a facade). Paradoxically enough, bureaucracy is also an efficient means for transmitting power *from individuals upward* in an organization.

2.3.3 Pragmatism and Institutionalization Within Military Control

Scientific progress and related social and technical inventions coincided with and probably promoted the birth of the European nation states (seventeenth century) where new urgent control requirements grew and funds could be raised efficiently. Then, in accordance with Beniger's (1986) discussion and analysis of the strategies and methods to handle new technology, new control mechanisms had to be invented. The military institution is operationalized in a specific enabling organization. As a bureaucracy it contains certain mechanisms, which distribute formal power, and are simultaneously both flexible and adaptable. They make the whole structure robust and hardy. *Discipline*, upheld by many mechanisms, is still a basic control component, supported by the scientific and highly rational character of the whole enterprise (the "Western way of war", Parker, 1995). In addition, the whole bureaucratic structure also includes a system for rewards and sanctions. It rests upon an *ethos* (Averill, 1992).

The Prussian model for command made it possible to conduct war according to scientific principles, calculations and professional expertise (Howard, 1976). The lack of method demonstrated by Napoleon was succeeded by systematization (Van Creveld, 1985). From the early twentieth century, when the German (Prussian) General Staff had set the standards, the systematic use of written orders had succeeded earlier forms (see Swift, 1906; Corlett, 1925), which made it possible to apply bureaucracy in most aspects of the command work. Because of its capacity to promote systematic organization of knowledge, combined with mathematics and geometry, bureaucracy provided military strategy and control with tools for a new efficiency, supporting an institution where the value of drill and training was already recognized. The technologies of the bureaucracy, IT, have been applied since then. Van Creveld (1989) stated that until about 1830, technologies did not have to be coordinated, just men, but that since then technological devices have had to be combined into *systems*. This meant that during the rapid technical development during the rest of the nineteenth century, technologies that supported standardization and communication had crucial roles for the coordination of others.

However, bureaucracy, even if it has a strong appeal and control power, is not sufficient within the military. Up to the end of the 1930s a stable traditional pattern with little competition dominated, and the military were conservative as regards new technologies. There was hardly any use for more efficient management other than the traditional control techniques and procedures. During and after WWII when the requirements to respond rapidly grew and new technologies were needed in competition between opponents, control crises occurred and had to be solved, either new organization or products/technologies were needed (e.g., the first atomic bomb, a man on the moon). Previous control (management) techniques and organization were inefficient. Modern computer technology (originally called electronic brains, and often used as calculators) were implemented in the new control race.

Still more pragmatic solutions, such as *project managemen*t, became necessary and possible. Engwall (1995) provided its rationales which can inspire continued development of command practices. Project management techniques, even if its roots can be traced to the fifteenth century (Hoskin and Zan, 1997), have been developed within the larger shell of management science, using its impetus. Consultants or reflecting practitioners formed the core of project management theory, the ideological basis of which was scientific management. The conclusion is that it is as relevant today to investigate practice and then see how it can be reconciled with dominant power structures.

2.3.4 THE PRACTICES OF THE DIALECTIC OF CONTROL

Through the ages, contradictions have been handled pragmatically through a mixture of more or less control (Persson, 1996). Most efforts are now institutionalized, basically following the ideas of scientific management (Morgan, 1986). Strong traditional and institutionalized (if not always formalized) ingredients, are issues of values, recruitment, mechanisms for socialization, the central role of formal leaders, and the emphasis on leadership issues in command work. Together, such components form a control culture in the military where the dialectic of control is often illustrated (Section 2.1.3).

Interestingly enough, from the early nineteenth century there is evidence for a growing need to maintain independence from superior command; that is, more *autonomy* in the lower command levels (Samuels, 1995), but for various reasons. Van Creveld (1985) gave more details about the French Imperial command system. The Napoleonic armies were organized as a body of units capable of independent missions within the centrally planned operation, thus reducing the need for detailed control—which neither was technically possible. Dispersed movements facilitated surprise, logistics, and flexible redirection of forces. The centralized planning and command in the Napoleonic armies in combination with this organizational principles meant that central command could initiate rapid action and live with greater uncertainty. In addition, none of the marshals who commanded the main formations would defer to any of the others: the design of the command system made this less of a problem.

The Prussian principle of *directive command* (Ger. *auftragstaktik*) was part of a command theory and doctrine where a subordinate commander could change his duties as long as his actions were within higher command's intentions (Samuels, 1995). Graham and Bidwell (1993) used the term mission-directed tactics. They stated that it was the remedy to communication breakdowns and enemy action. The term, they said, was more than a tactical formula: it was an idea central to the whole art of command of modern armies. The idea is old, based on the insight that the close grip by a commander in the field could not be extended beyond his field of vision, but the term now encourages initiative at every level of command.

The nineteenth century German forces (as compared to the French) were organized within a coalition where the presence of various nationalities made it difficult to control the force as one homogenous force (there was no Germany at that time). In the absence of the Crown which intervened and commissioned officers (as in

France), subordinate commanders did not take orders from any other person (Howard, 1976).

To conclude, it seems as if directive command as practised by Napoleon and in the Prussian/German army for similar reasons became both virtue and theory. Directives were used instead of strict orders because timely central control was practically impossible in the absence of modern communication technology. Moreover, it was unsuitable for reasons of prestige and to avoid conflicts. Finally, a certain freedom also *inspired* and *motivated* subordinate commanders more than tight detailed control. Commanders were free to exploit success as long as it fitted into the superior battle plan, especially when they were geographically distributed and out of reach of other control systems. A modern example is when Pagonis (in Pagonis and Cruikshank, 1992) reported how during the Vietnam War he switched off radio equipment during battle in order to avoid his superiors' intervention. Van Creveld (1985) also vividly described command 'pathologies' in Vietnam, for instance micro management that promoted such actions.

The conclusion is that *directive command* or, as the concept is known today, *mission tactics* is institutionalized as a means to achieve autonomy, but has a clear social (and not only formal rational) origin. The principle of directive command has been tested in war and found useful. Moreover, it has a double advantage: directive command gives a superior certain autonomy because details do not need to be dealt with, and it gives a subordinate arguments when greater autonomy is desirable.

Today, this is about to change. The opposite of directive command is *coercive control* (Foster, 1988), the execution of detailed centralized and more restrictive control. Modern management (command) presuppose, and control techniques and instruments can make a force a highly integrated unit where little slack is allowed if the unit is to function as intended. Efficient communication systems provide opportunities to rapidly transfer detailed information across large structures today, and promote centralized *and* detailed control, given that the necessary formalization, coding, and formatting have been done. This capacity may counter growing social demands for autonomy, being both justified and unavoidable. Further, the rules and programs may be controlled from long distances and hard to affect directly. Therefore we can foresee a greater tendency to oppose tight control, and invention of numerous attempts to circumvent them.

Even today, and enhanced by the easy access to modern technology for secure voice communication, verbal and informal communication is frequent and appreciated. Formalization takes time and means constraints (Shipman III and Marshall,

1999) and nuances easily are lost; in addition it may be necessary to be skilled in computer use.

To conclude, technology is a two-edged sword. It is necessary to maintain autonomy, power, and not get involved in a too rigid control system, being forced to use resources to lessen its grip, and to be able to use text and calculation within the whole span of practices these techniques allow. The same precision and speed that is required in accounting, Air Traffic Control (ATC), in network planning, and programming, admitted by technology, can easily be turned into tools for micro management. Possibly the most important need and prerequisite for control is technologies for communication, because if the communication within the organization is interrupted, breakdowns may evolve (Winograd and Flores, 1992) and may be hard to repair, even lead to dissolution of an organization (Weick, 1993). Also, we have seen that technical and automatic communication of signals, by no means guarantee that a receiver is actively interpreting them.

Finally, most contradictions meet in command work, the central topic for this study. According to the introductory discussion, there are several contradictions that have to be resolved. Therefore it is necessary to go into some detail about these contradictions. Through this, I will formulate ideas for the fieldwork and some IS design directions.

2.4 Humans Versus Technology During the Chain of CPXs

2.4.1 Obstacles and Uniting Efforts

Exercises are typically relatively short (up to a week), and they start and end at certain times. During the chain of CPXs during winter and spring 1997/98, which constituted my field site, the elements of a new organization with new control technologies were close to being overwhelming. The command organization was real. Most people had the positions they were supposed to fill had the HQ been deployed in war, but it was temporary and not well-trained as a unit until during the later exercises.

It was all a large test situation: new organization, methods, communication systems and ISs which had been implemented rapidly and late. Because the exercises were real with many people involved, people had to use what they had got and do their best. The needs to act decided what had to be done both *between* exercises (systems development, part task training) and *during* them (command work). Eventually the practitioners achieved much, demonstrating their capacity to reconcile many contradictions.

The command organization where career officers, reservists and conscripts were brought together worked hard in order to find out how to finally design its practices in detail. Every effort was made to re-create the dynamics of war, and at the same time preserve the full controllability of the organization. Some contradictions grew from within the exercises (orderly peacetime events) and the scenarios (war). What was often heard indicated a *polarization between humans* and *technology*, and that it was necessary to maintain a human-centred perspective on the practice.

The validation of control technologies (with additional people involved) had to be done in a realistic setting, because only during full-scale conditions when people actually are working, certain effects show up. In early April 1998, during one of the CPXs, there was an indication that a generator supporting part of a HQ (computers, networks, light, communications) suddenly stopped because of fuel shortage. This event caused a breakdown in a computer server with a database, which became very complicated to restore. Work was interrupted. The fuel shortage had probably been caused by larger than usual demand for electric power when a complete staff worked in the organisation, much larger than during the previous training without a staff working. The supporting unit, being trained separately, had not expected the additional load on the generators, and refuelling routines had to be reconsidered.

Similar surprises occurred within logistics and data management where one weeks exercise meant considerable demands. In addition, one week of work produced a lot of bytes to save and store. There is thus a contradiction between the idea of the HQ as a physical technically well-integrated organization and the means to achieve it, and the HQ as consisting of well-trained and skilled command teams which work day and night.

In summary, contradictions appeared between wishful thinking as regards new technical systems and their high control efficiency, and the lack of time, material resources and competence to design, learn and then test new solutions. Application of modern IT risks augmenting the contradictions of centralization – decentralization. This risk depends partly on a belief in and appreciation of the technology's capacity to instrumentally transmit information, partly because of unconscious design or choice of approaches and methods when funding and control is centralized and experience from ISD is limited. Problems *were* expected because of the variety of new components, some being substitutes for tools that were to be designed later on. Additional contradictions were the dichotomy between central control of projects and resources, and the local need to do the best within sharp time

Figure 2.5: Staff members' quarter at the end of the last CPX (May 1998).

constraints. It became clear that humans need real food and sleep (Figure 2.5), and that data and information were not only technical abstractions but instead part of the work.

The accumulated dynamics (frictions) were probably close to the constraints in a real command situation. Because of its pragmatic character, close monitoring is desirable to really capture the control actions. The fieldwork offered many opportunities to study them closer.

2.4.2 MODERN INFORMATION SYSTEMS AND TECHNOLOGY, THREAT OR TREAT?

Contradictions pile up when it comes to command work and modern IT. Technology promises much but achieivements are far from self-evident. If scientific management guided command efforts before, when it comes to ISs as control tools, solutions are less straightforward. Depending on the perspective, explanations vary. Continuing with contradictions, I will explore cybernetics some more. Its introduction led to a hope for realizing what had been hitherto impossible, a theory for feedback control and automation of complex processes, and solutions to growing military control difficulties achieving high-speed and precision. Electronics provided the means, eventually for the control of information. Now, we experience the problems to control information and its technology, and to remain in the control-loop. The contradictions are that this technology has a high use value, but also a very high exchange value, it is expensive, a central analytical argument used by

Engeström (1987) who explicitly works with these kinds of contradictions in his general model of human activity within Activity Theory. The unavoidable contradictions then leads to a search for cheap solutions with the help of mass-produced standard technology which fulfills the criteria for low costs but unfortunately reduces the use value: fragile, complex, security problems, requires high competence, implicitly presupposing standard procedures.

Holley (1988) pointed at the problems with designers' solutions far from the battlefield, the dependence on abstractions, demands for additional training (users) and requirement on surplus personnel for maintenance, and the way ISs trigger work and require reserve routines. Information management, for example reporting, seemingly becomes more important than fighting the enemy, and responsibility for programming errors is hard to resolve. Few know much about the "best practice" in the dynamic military environment and scientific and well proven methods for development of IS are rare. Disputes may occur when power is questioned, or alone is insufficient to reach solutions. These phenomena occurred during the exercises, causing much work and some frustration. One officer sighed during the fourth CPX, after a complicated discussion about the movement of his HQ, "we are in the hands of technology".

IT ideally promises to allow rapid centralized control based upon perfect situation awareness. This aspiration is based upon the vast capacity to technically transmit meaningful signals. If the insight is shallow about how humans interpret and what knowledge is, more signals can be perceived as a very efficient way of building knowledge to satisfy an urgent need but there is no such correlation. Centralized command structures perhaps discourage initiatives by locals with (assumed) inferior insight in the big picture. Without basic mutual trust within the organization and freedom to act, both being social requirements, more control technology is likely to be counterproductive. Conversely, if there is suspicion towards technology (the "control" component, Holley, 1988), potential tools may remain threats while humans are sacrificed, still believing in science and rationality.

2.5 Conclusions: Cultural Understanding and Research

2.5.1 The Role of the Military Culture

My theoretical support concerning culture comes from Carrithers (1992) who analysed why humans have culture (the title of his book) and stated that *sociality*, "a capacity for complex social behaviour" (p. 34), to "track a complex flow of social action" (p. 177) and respond appropriately within it, is what distinguishes humans, *not* culture. This is the central argument in his *sociality theory*, as compared with *culture theory.* According to the sociality theory people *create and use* means that we can describe as "cultural", while culture theory means that people do things *because of* their culture.

From the horizon of qualitative research c*ulture* is what the researcher attributes to the group which is studied, inferred from *what people say*, *do* and *use* (Creswell, 1998), not neglecting *what they say* they do and use. Hofstede et al. (1990) used another schema when discussing organizational culture which they saw as consisting of *values* and *practices*, the latter visible symbols, rituals and heroes. Culture, by carrying many traditions, can be an active component in command work, but its exact role may be impossible to decide. Without going into details, because the meaning of the concept is not univocal, *culture* can *reconcile contradictions* by development of value systems, practices, rituals etc. Considering the rich choice of contradictions, there is a need for culture a resource for resolution of them.

Carrither's theory makes it necessary to make clear distinctions between the organization's *own definition* of its culture (in order to handle its social reality) and how it is *inferred by the researcher* who does not have a social instrumental purpose of his own (or another purpose). Hypothetically, the former culture must be redefined, given new properties when appropriate. If it is static, then it loses the capacity to meaningfully support social behaviour. Researchers unfamiliar with the military may forget that military practitioners, because of insufficient training and ever new organizational solutions, may experience problems in describing and designing their practice, even if they *use* the concept "culture":

> The topic of investigation for researchers would then be the common-sense methods that people use in making sense of their social environments (May, 1997, p. 38)

One of these methods may be to create an idea of what their own culture is and then carefully nurture it as a method to make sense of their social reality (in my study the army): supporting convergence or divergence, adherence to the servomechanics thread or the cybernetics thread (Richardson, 1991). It is likely that because of the mixed population in the studied HQ, and that all was a peacetime event, "culture" (not the researcher's concept) had to be consciously created in order to be useful. One issue, based on the heritage and the often problematic relations to technology is what it means to be human, how human values are defined and applied, and the relations between humans and technology, especially IT.

2.5.2 RESEARCH IN THE MILITARY

In the same way as ideas can initiate war, and the real consequences tend to be surprises, ideas dominate in the military practice, and their implementation is seldom confronted with real effects. Some of the roots of military thinking originate in the peacetime identity of the military, where the transformation of war into something that is manageable and trainable takes place. Other ideas, still influential, originate in the theories developed by Clausewitz which have been reinterpreted and applied flexibly: the importance of decisive battles, of moral forces, the role of frictions, the need for independent action by local commanders, and the total war (Howard, 1983). The dual use of technology as effectuator and controller seems first to have been unanticipated, which is explainable because it was not recognized as a decisive element, necessary to coordinate until after 1830 (Van Creveld, 1989). These ideas have had appeal.

Military command work, in order to achieve speed, precision and reliability, often sacrifices criteria for scientific evidence and validity. Social and situated value are first priorities. When it comes to IT and culture within the military, it is likely that some technology is considered foreign and rejected, or applied with unsatisfactory results, possibly attractive but theoretically and conceptually less integrated. In fieldwork it is therefore necessary to look for such phenomena, how technology supports either participant in their work and is appreciated. Researchers need to approach their objects from various perspectives (Pettigrew, 1985), and require freedom based upon trust. The power–knowledge relationship between the military and researchers is one research issue. Both research, design, and systems development methods are likely to profit from work with technology-related and other contradictions, tracing causes behind events and relating phenomena to them. Research should therefore be conducted close to the work activities in order to discover what culture to infer from behaviours, language and artefacts (Creswell, 1998). In particular, research must approach the questions as to why design and development of the IS component (usually conducted in peacetime) is so complex, and why the combined processes of change and the implementation of control technologies (IT) within the military work practices are so difficult to coordinate.

Researchers have to recognize the peacetime characteristics of the military and not only what war (probably) is like according to the military (culture). Faced by war, probably few disputes occur over engineering methods and the goals of science, and power is not questioned. Friedman and Friedman (1996) provided one view of how science and IT became accepted by the military in mid twentieth century. The military wanted to use the insights of science to get things done, and actually did not wait for theory to be developed. The attractive scientists' power came from their ability to understand the workings of the physical world. Probably this need within the military led to a cultural change in order to handle the otherwise latent contradiction, a change which has to be ongoing when more competence is considered necessary to incorporate.

Salner (1989) even claimed that a human science researcher must have a thorough understanding of the evolution and development of rational thought in Western culture as well as an awareness of the criticisms that have been levelled against that tradition. The implication of these arguments is that this kind of researcher must achieve an ability to see and understand his position within this Western cultural tradition and evolution. What is required is a thorough contextual, historical and cultural preunderstanding.

The relations within the military between rationality, power and knowledge originate from a social order where certain persons are allowed to define knowledge even if it is highly pretheoretical. Consequently this social order and its underlying rationality are important to trace and define, and not only use concepts as "geniuses" or "art" as given common sense-explanations.

Research, even in peacetime, should originate from the uncertainty, the social, situated and the dynamic character of action, keeping the military quests for survival, stability and control as cornerstones when interpreting the institution and its control efforts. When positioned in the field, researchers must also cope with the *research-related problems* emerging from new control technologies. For instance, the modern organization that relies upon new technologies also may mean new *ethical problems* for the researcher. Technically these environments may allow automated data production, without anyone noticing, and data being unintentionally transmitted to unauthorized persons. Such methods in the military organization easily may violate security and safety issues. Recurrently some issues have appeared in the overview of the military domain:

- the ambiguity versus science and technology (threats and opportunities), how social and instrumental control aspects collide and can be reconciled within the bureaucracy;
- the search for autonomy, rational and scientific control solutions;
- the strategies to reproduce the traditional values and win professional recognition while using arguments from science and art respectively;

- the clash, in war and command work, between ideas and reality (practice), a consequence of a too theoretical view on practice or from a conscious separation of them, and for research:
- to define a scientific foundation for command work which does not invite to application of a rationality which becomes a prison, leading to a perspective on humans as machines, when instead humans in extreme situations, hardly rational, should be the starting point.

This overview and presentation of contradictions and research rationales has covered some of what promotes and inspires research, and is mostly general, in some aspect it covers primarily Swedish conditions. Its purpose has been to describe some aspects of the military arena, leading to understanding of the conditions for command work, and as explanations to some of the events that may seem confusing. Research should be designed for military conditions but oriented so as to find research problems common with other dynamic domains. Such an approach will broaden the reference area for comparisons and clarify probable parallels; it does not by itself augment the risk of missing the implication growing from the features specific for the military institution.

Chapter 3 Information, Design, Work and Information Systems

THIS CHAPTER is an analysis and a presentation of the central concepts of information, information systems, and systems design – issues central to this thesis. Because the meanings of these widely used concepts are perspective- and context-dependent, it is necessary to analyse them and try to reduce their ambiguity. The analysis originates from a work orientation, from what command work is, its purpose, conceptualization and the context, because it is the practical use of computers in work that is central. It is the command work requirements that informs, provide information for, design of support systems. I present highlights from previous IS design research and practices, mainly from approaches which are directly related to military practices or seem most relevant within the total study. The chapter completes the description of the research domain and issues. The discussion also underpins the view on my previous research (Chapters 4–5) and eventually leads to the method considerations (Chapter 6).

3.1 About Command Work, Information and Information Systems

3.1.1 THE ANALYTIC PATH

Hypothetically there should be a certain “fit” between command work and the methods, tools and approaches for the design and development of ISs. The result of this study should also be usable within continued ISD research and applicable in design studies. In order to achieve this goal, it is necessary to scan the design field and to establish the meaning of some concepts. Specifically, the issues are: what ISs and design are, what design for command work is about, whether other studies can guide the work, how the fieldwork should be directed, and finally what requirements are on data suitable for design. Figure 3.1 illustrates this idea. Through an

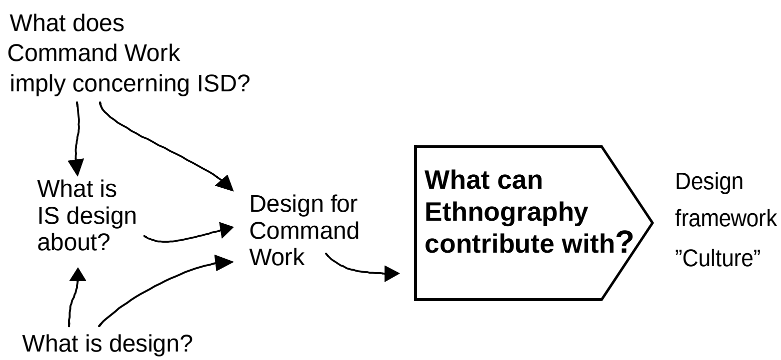

Figure 3.1: The relations between concepts and research in this study.

analysis of what research has revealed, theories for information and ISD, what previous research has produced as regards design for work and what command work implies, this chapter establishes the foundation for the field work, the ethnographic basis. In the fieldwork, from what can be seen and recorded (work), values are inferred and an idea of the *culture* is formulated, which in turn informs the design.

In order to answer these questions, this chapter analyses command work from an ISD perspective, presents an overview of the (IS) design concept and the field, and relates it all to systems development. Initially a conceptual analysis is made of “information system”, recalling previous research. Finally, I formulate some conclusions concerning method and fieldwork. The contributions to design from an ethnography will be dealt with in Chapter 6 (Method).

In this chapter, I recall some of the discourse within Information Systems and major design areas such as Computer Supported Cooperative Work (CSCW), distributed decisionmaking (Sage, 1987), participatory design (PD) and work oriented design (Ehn, 1988; Iivari and Lyytinen, 1998). I provide some examples of modern workspace design and the use of new technologies (for instance Grinter, 1999; Streitz et al., 1999). The sample of military command design thinking consists of previous studies from the US (Beaumont, 1994; Fischhoff and Johnson, 1990: Kahan et al., 1989; Sorenson, 1989; Whitaker and Kuperman, 1996), from recent Swedish military design thinking, and from ergonomics (Bernotat, 1991). Theoretically, I present theories and ideas about design (Ferguson, 1992) and information systems (Langefors, 1974 and 1993; Hirschheim (et al.) 1989, 1996; Nissen, 1985; Nurminen, 1988) together with design conclusions from the use of Activity Theory (Kuutti, 1991; Bödker, 1991, Engeström, 1987, 1993 and 1999; Bardram, 1998) and ethnography (Bucciarelli, 1988; Anderson, 1994) — just to mention some.

3.1.2 COMMAND WORK AND INFORMATION SYSTEMS DESIGN ISSUES

In the first chapter I defined *command work* as occurring during boundary management, implying interpretation of the environment of an organization, and the transformation of ideas to control actions toward it. In short, it is about the establishment of organized action in the context of the environment and is characterized by or containing:

- interplay between formal, informal and cultural conditions;
- communicative activities, where situated and experience based knowledge is important,
- cannot be summarized in abstract and general principles;
- is normally conducted under severe time constraints and demands;
- reactive mechanisms and reflective actions are more important than formal decision analyses and strategic planning, and
- is about to create stable conditions for actions by focusing attention and reducing uncertainty.

Development of IS can be conducted according to one or several strategies, emphasizing a certain aspect of the system. Hirschheim et al. (1996) distinguished between strategies for control, sense-making and argumentation, where explicit design criteria, instrumental variables, methods and tools, goals and principles drive the design. "Systems engineering" is related to *technical control* issues, while *social control* span communication engineering, organizational design, manipulative communication design and political organization design. The *sense-making orientation* means a focus at the potential role of IS in interpretation and mutual understanding. Lastly, the development strategies in the *argumentative/discursive orientation* emphasize the IS for clarification and justification of claims, and the provision of evidence and reason. Here we find the argumentation of whether an IS shall be designed at all, and issues of rationality.

When trying to infer what design of ISs for command work is about (without having specified what strategy or perspective to apply on such systems), pragmatic issues include:

- the mastering of unpredictability and suddenness as regards to demands;
- ISs should be ready for use with very short delay, be ready-at-hand;
- data (presumptive information) exist in many formats which must be possible to use in combination;
- technology and results must be possible to use anytime; there are no finite solutions as to the answer to demands for information, which makes specifications very hard to determine;
- communication technology should admit any format and degree of formalization, not only standard formats, and it must be possible to use within temporary organizations;
- short "cognitive distance" between data and interpretation (to acquire knowledge from data).

To this can be added security issues and economy. Another aspect arises from one of the current research directions within Computer Supported Cooperative Work (CSCW). Nardi and Engeström (1999) pointed out the need to gain a firm foundation of knowledge "about how work actually gets accomplished" (p. 1) when initiating new technologies and restructuring a workplace. They specified four kinds of "invisible work", relevant within the whole work:

1. work done in invisible places, behind-the-scenes work;
2. routine or manual work, requiring considerable skill and competence;
3. work done by invisible people such as domestics; and
4. informal work processes that are not part of anybody's work description but still crucial for the collective functioning of the workspace—generator operators, regular but open ended meetings, informal conversations, gossip, humour, and storytelling.

Command work is probably invisible to a large extent. All work becomes invisible for researchers, too, who do not apply a research paradigm (affecting theories and concepts) and methods (for data production) that makes it visible. Then they cannot describe it. Similarly, conventions about what "real work" is may lead to negligence toward important but less glorious parts of it, as for instance when decision-making is lauded but all too often materializes only in rare formal situations, and even then is very difficult to describe.

The researcher who wants to observe and trace what work is has the same requirement as those who try to control it, namely to find ways to informate (Zuboff, 1988) the work processes and actions. This means to make them visible through the creation of traces of them, and to relate visible and (previously) less visible parts of it. To conclude, visibility is vital if the total work is to be easy to monitor and control. I accept Ehn's (1988) words as a guideline for design and research: neither detached reflection over computer design or to talk about it in system terms is satisfactory. Both the options to see the roles of existing computer technology and what happens when future support systems are imagined depend upon the result of this visibilization of work and computer use.

3.1.3 INFORMATION AND INFORMATION SYSTEMS

There are both theoretical and pragmatic meanings of these two concepts. The concept of *information* was given the meaning of *signals* during the 1940's primarily by Claude Shannon (Roszak, 1986). Shannon took the concept (information as item of knowledge, something told) and then applied it out of context, meaning *any* transmitted signal. Roszak strongly regretted this choice, because from then on it has been acceptable to call any signal "information". At the time when this shift was done, there was a growing insight that signals could be used for control of action, given that they were carrying some meaning, and when transmitted to humans were interpreted according to the intentions of their originators. Axelsson (1998) used a simple conception of information as related to knowledge: information builds knowledge, provided that a meaningful interpretation is possible. Moreover an IS is a device for computerized information processing or management. Except when the information is concrete and externalized in a kind of representation, and interpretation is necessary, it is an abstract entity.

Consequently, when discussing information, we have to take into account the different and mostly *abstract* meanings of "*information system*". Langefors (1993) described how he began to use the term because he realized that the artefact that *informs* people could be called this; the system of information he perceived was (interpreted) data about an organization, important for controlling it, achieving organizational goals and must fulfil the criteria for a system if shall be meaningful. He also said the whole organization could be seen as an IS. He supported his viewpoint concerning the relation between data and information with his *infological equation:*

$$I = i\,(D,S,t)$$

The equation (which is no algorithm, instead the representation of an idea) says that *i* is the interpretation, *t* is time for interpretation, *S* is the preunderstanding (previous knowledge), *D* the data that are interpreted, and *I* finally is the information (new knowledge). It follows that information cannot exist without the presence of human beings, and it certainly involves more than signals. Langefors was still more precise. The only reasonable definition of "information system" is any system (independently if computers are involved) used to "provide information (including its processing) for whatever use can be made of it" (Langefors, 1974, p. 938). Bansler (1987) presented a similar view that builds upon Langefors' theory: A *computer system* forms a s*ystem for automated data processing (with subsystems)*, in turn underpinning an *information system* that has a *control purpose*. Such a system cannot exist independently of an *object system*, an organization. An IS can be partitioned in one part that can be formalized and another that can not.

Nurminen's (1988) analysis of the *sociotechnical perspective* on ISs points at its similarities with Langefors' view. An IS is a data system that is made meaningful by human beings, and humans are integrated parts of the system. Axelsson (1998) also pointed out the IRM-perspective implies that "information system" means an integrated database and local applications working from this database. The VBS perspective, on the other hand, builds upon the existence of local and autonomous but cooperating information systems, machines that both store and process information, both being far from the more sublime and abstract result of interpretation. Axelsson presented a definition, here synthesized with some other attributes: an IS is a socially embedded computer-based artefact, created for business and work according to rules originating from this business. ISs are intended to inform interpreting actors in their work, the result of information processing, involving communicative actions. It is part of the business, however technically implemented.

There are complementary views. Winograd and Flores (1993) saw the *computer* as a structured dynamic communication medium that must be understood in new ways. Communication is not a technical process of transmitting information or symbols but one of commitment and interpretation. Ehn (1988) used the concept *computer artefact*, an artefact that can manipulate symbols. The artefact is what we use it for, for communication or to use as an instrument, or to design other artefacts from. The last source to be recalled here is what Zuboff (1988) formulated, related to what both Ehn and Winograd/Flores said:

> The data interface is a symbolic medium through which one produces effects and on the basis of which one derives an interpretation of "what is happening". These symbols are abstractions; they are experiences as remote from the rich sensory reality to which people are accustomed…In a symbolic medium, meaning is not a given value; rather, it must be constructed (p. 76).

Lastly, a pragmatic military view. Rice and Sammes (1989) meant that the physical realization of a piece of information is a *pattern of symbols* that has some real world meaning. These symbols represent real world objects or ideas. What these symbols represent depends on the context dependent rules to generate and interpret them. Basically, any meaning can be given to any symbol. What has happened now is that *more information* has been seen as the remedy to conquer uncertainty in the battlefield, and that IT can generate ever more "raw information" which can unproblematically be made meaningful.

3.2 What is Design About?

3.2.1 THEORIES ABOUT SYSTEMS DESIGN AND ENGINEERING

Any organized social action presupposes some formalization when it comes to control, data and information being crucial components. ISD and the use of computers imply a further formalization in order to admit automation and use of machines for data processing. Because of the social aspects, not only the individual's requirements have to be treated, but also the organizations'. Design, therefore, has to span issues about strategies and detailed solutions, from the organization-wide architecture to the MMI-aspects. Magoulas and Pessi (1998) analysed strategy perspectives for architecture, the *enterprise-based* design theory and the *information-based* theory perspectives, the VBS- and the IRM-strategies. The first stresses coordination between ISs that are administered by the part of the organization that uses the system, and can define this according to their own needs. The second builds upon a perspective as information as a central resource that has to be controlled centrally, can and has to be defined once for all, and then treated as a commodity.

Development (and design) of any technology can be a matter of *engineering* (based upon calculation and a scientific ideal mainly from the natural sciences), or an *act of art* (when mathematical calculation is not within reach). Both approaches imply that large portions of open-ended questions have to be resolved in social interaction, according to style, convention, intuition, a sense of fitness, personal preferences, time and costs (Ferguson, 1992). Ferguson underlined the need for visualization and the importance of non-verbal thinking and expressions during design. He stated that the modern engineering style that promotes only mathematically supported solutions is unsatisfactory because much about design is totally intuitive. A sense of reasonableness can be reached by visual impressions. A ready design both informs the learning designer and is an instruction to its implementers.

Ferguson presented other insights. Design is about control. The planned system must be predictable and controllable (his example is the medieval fortress). Process: first define the boundaries of the system that is to be designed, then carefully determine the permissive inputs and outputs. Nothing may cross the boundaries unobserved or unaccounted for. No place for unpredictable actions, either by machines or by people! Design then is about economy and elegance. It is the result of *a social process*, including informal components. Engineering design is always a contingent process and not a formal sequential process. It is subject to unforeseen complications and influences as the design develops. The precise outcome cannot be deduced from its initial goal.

Bucciarelli (1988) defined design as a social process where values are important, identifying three types of discourse in the design work: *constraining*, *naming*, and *deciding*. The perception of design depends upon one's interests and perspectives. If a theory of design is sought after, the inherent ambiguity and uncertainty in the work is missed if the process is represented as engineering, a mechanical process. Bucciarelli stated that "technology, as engineering design, is a social process" (p. 161). In *process* words and data are plastic, perhaps gone when the project is interrupted. Formal productions in design, can never capture the social design process. Produced *documentation* is not the design but data. Possibly their role and status become enhanced because they are printed words. Design objects are given shifting physical and social constraints (including specifications, costs) by different participants in a design team, and agreement about constraints is the first step in the process. The *naming* can reduce constraints, before decisions are formulated.

Concerning design of computer programs, Ferguson (1992) stated that small decisions may be turned over to programmers who are more likely to be "engineering scientists" than experienced designers, thus being capable of more than just engineering. Predicting all the points of judgement and decision in the realization of an extensive computer program is difficult if not impossible. Even tiny decisions can be fatal for the success of the design.

Methods are means for control of the design/development process, must lead to a product, and are often supported by design tools. Early choices in the design process concern what method and process to apply. Either a specification is made first, and then after approval the system is built, or an evolutionary process with incremental steps of design–development–test is chosen. Design means to work on various layers at the same time, from considerations of the environment, over to the work content and purpose, integrated work processes, individuals' operations, then (in computer artefacts) software functions and finally hardware capacities. The partition between external and internal properties, and the independent definition of them, first the external, and then the internal, was propagated by Langefors (1993). He underlined the need for a structured method, the basic problem being to define data which allows references to its object system, which shall be controlled by the IS. The infological (and theoretical) problem is how to define and to provide information (meaningful symbols and signals) which satisfies its users. The datalogical and internal design problem is how to structure and to operate the system (Langefors, 1974). When he wrote this, he stated that the infological problem is "usually totally neglected or taken very lightly by the data system designers" (p. 938).

When we look at work, there are close links that cannot be neglected between the external and the internal. Command work is not primarily about control of continuous processes (even if there are some). Rather it is about the handling of a sudden outburst of action in order to maintain stable state operations. A comparison between the design of bridges (Ferguson, 1992) and ISs shows the difference between design requirements. A good design of a bridge means that the construction starts from the loads on the bridge and makes it strong and lean, reducing unnecessary material. Once built, a bridge is not flexible. Design of computer artefacts for data processing in work must instead be *elastic* as regards to variations in the workload, and allow even heavy loads, perhaps even easily be strengthened when an extra load arises.

3.2.2 INFORMATION SYSTEMS DESIGN, AN OVERVIEW

Evolution of methods and methodologies for the predictive and controlled design and development of computer-based ISs has been ongoing for decades and several perspectives have been explored and used (Nilsson, 1995). Nurminen (1988) discussed three: the Systems-Theoretical, the Socio-Technical, and the Humanistic perspectives. The term “Systems Development” often means a structured engineering process (software and hardware) aimed at a highly integrated technical IS infrastructure and automation of work processes. Sometimes *development* actually means a far-driven change and re-engineering process where work becomes invisible and disappears into computer programs. In other cases the term means new functions and business processes, or support for collaborative work. Löwgren and Stolterman (1998), discussing *design of IT artefacts*, underlined some core issues: mutual learning, practical understanding, support of the dialectics between tradition and novelties, and the use of artefacts. They argued that design is to creating conditions to change people’s freedom of action, leading to a product, abstract or concrete. It is important to include not only formal but also informal work in the design process where political, ethical and aesthetic considerations meet.

The superordinated message in Langefors’ theories and in the basic design principles is that design is a rational, purpose- and meaningful process. A closer look at some sources reveals that more is involved. Organizational culture, power and IT are often conflicting factors. Ehn (1995), Holmström (1995) and Juustila (1995) have discussed rationality and separated between different rationalities—objective, social and subjective—that have to be handled and eventually integrated in a successful design process.

Hirschheim and Klein (1989) summarized classical development theory, describing four paradigms for IS development. They discussed, ultimately, how to balance humans and technology, to decide in matters of responsibility, to consistently and consciously work within a paradigm where contradictions can be managed to the benefit of the work and those who are active in it. Their four paradigms were *functionalism* concerned with rational choice, effective systems development and achievement of social order and status quo. Then there was the *social relativist* paradigm where individual consciousness and subjectivity and the individual as a social actor were issues. Third, the *radical structuralist* paradigm which focuses on economic power relationships, and the transcendence of existing social and organizational arrangements; and the *neohumanist paradigm* where radical change, emancipation and barriers to it (power, ideology, social constraints) are concerned.

These perspectives lead to different *types* of ISs independently if they are abstract or build upon computer artefacts. Different classes constitute a variety of artefacts, from management information systems (MISs) over group support systems (GSSs) to individuals’ artefacts, decision support systems (DSSs) or expert systems. Perhaps the most important criteria for efficient design is the close link between work as a purposeful activity and what informs or controls this work, systems of information, usually implemented technically. The social purpose of the IS (which defines it), is the primary concern. *Context* and *contradictions* play important roles during the design process. This context involves time, space, resources, and organization.

Hermann and Just (1995) studied *expert systems* (ES) and argued from a very pragmatic position. According to them, an ES is an expert's system for support. An ES does not make the expert. What constitute an expert is a mixture of competence: domain-specific, domain-extending (experts can build bridges between their own and other disciplines), meta-competence (experts can judge and reflect on their competence), and social and communicative competence (ability to represent oneself as an expert and to behave like an expert, to legitimate methods, to gain confidence, to work in teams). It follows that there are no finite formal procedures for these achievements. No matter how skilled experts are for instance in planning a course of action, they must be *recognized as experts* in society or a company. When turning to ISD, experts work and use of ESs occur in *different modes*, each having to be recognized by designers. The authors wanted to separate between interaction modes and modes of use. Experts work is cyclic, non-plannable, work/system use modes are non-monotonic problem solving, exploration, medium, and modification, require specific system's functions. These use modes are general role models when designing up-coming technologies. Expert-users shall have great freedom to design the dialogue and problem solving process, even violating rules and regulations because otherwise the organization cannot react to exceptions or exploit opportunities. They need to interact with any computer system, especially with ES, on experts' terms. Official regulations do not always determine how experts' work is done. Lastly, Hermann and Just saw problems when design is oriented at factual context of problem diagnosis but not at the actual social use context.

Paepcke (1996) who studied the requirements of support in technical work settings had a similar view. When information is likely to be used in multiple and unanticipated ways, developers need to give priority to support for users (workers) building their own organizations and new structures for the information. By adding to existing structures and flexibly making new versions, information tools must be designed as "enablers, not inhibitors, of change" (p. 87). These researchers argued for what Nurminen (1988) called the use of a humanistic perspective, meaning that individuals are active and autonomous subjects, not components in an organization.

Espejo (1997) provided another comment on the way ISD is applied and why design fails because of mismatches between ISs and work processes. It is wrong, he stated, that creating their ISs could create organisations. A better perspective is that *people's communication* build the organization. To handle complexity by responding effectively in the vital operational domain relies upon the capacity of these communication structures' to transform the external disturbances into meanings that trigger more effective performance in the organization. These ideas summarize what boundary management is about.

3.3 Design for the Military

3.3.1 Systems Development for Reliable Control

The design, development and implementation of command support systems is usually a very long process. Basically, the reliability and stability of the development of the military originates in its status as nation-state institution, where bureaucracy provides a variety of control mechanisms (Brown, 1995; Mommsen, 1980). Actually, reliability is the purpose of the bureaucracy, but we will go down a few steps and look closer at the specific IS level, where other demands for reliability appear. The long duration of development means that technologies which are available early may have been replaced several times on the market even before the product is ready, not to mention changes during the total life cycle. It is likely that a complex melange of legacy systems and new technologies evolve. Acquisition is part of very complex procedure and is coordinated with the total training system within the military bureaucracy. That the organization is not operational except in piecemeal fashion contributes to this situation. Few at a time use the technology. Moreover, the technology, even if components are tested and known, is often new and is intended to satisfy demanding specifications. In addition, economic uncertainty and external influences affect what is relevant at all, and add to the complexity.

Control of such processes becomes very difficult. It is necessary to design for *any* situation, instead of choosing standard solutions for methods, software, and hardware. The aggregated uncertainty arises when projects become large. Uncertainty about the design relevance have to be reduced. If this is done via tests and trials of the products, then these must have enough functionality to allow *some* work and make users feel comfortable because trials are primary occasions to achieve and demonstrate professionalism. What is a successful test may be a disastrous exercise.

The development of control technologies, the problems that originate from the developers' poor understanding of the contextual constraints that affect the users of information systems were discussed by Graves and Nyce (1992). They argued that the concerns of speed, power, and precision, common for developers, must be subordinated to user-centred concerns and suggested that (1) it is necessary to identify the end-users, and (2) social scientists should assist domain experts and designers during systems development.

Such approaches make the traditional division of labour and responsibilities between users and developers less adequate. Their discussion is also relevant within military command studies and systems development. Because of the complexity, few practitioners are experts and many are novices. The fact that real military operations are rare makes both them and their substitutes (exercises) might be difficult to access and analyse. Probably the main concern during development should be focused on work which is independent of technical solutions, and what must be defined as to be easily executed *in any technology,* provided that certain minimum (technical) capacities are achieved.

Beaumont (1994) perceived command as a blind struggle where commanders and staffs were engaged, without clear format and quantification of risks and hazards that vary widely from one situation to another. He saw a risk that unrealistic expectations, caused by rationalization, guided efforts to design control technology. Unfortunately the dominance of logic and categories in bureaucratic ordering and record keeping within research and work development, may determine what is retained and what is discarded during design. Sorenson (1989) went one step further and exemplified how development did not match the requirements. People in the operational forces were frustrated by the inability of the development community to field systems that even approach the capabilities they can imagine, given their involvement with personal computers. People developed self-help programs that actually solved some of the immediate day-to-day problems. Such self-help applications-systems tend to lack focus and duplicate efforts, lead to an emphasis on the details of a solution while broader issues were not considered ("they generally do not address, adequately, interface and integration issues that arise at other than local levels", p.13). The implicit design approach becomes bottom-up instead of considering broader issues, the top-down interests, to make a true C2 system—a system of systems (SOS). Sorenson strongly promoted a *disciplined systems engineering approach* for the design.

Bernotat (1991) has studied *ergonomics* and human factors engineering (HFE) in the design of Human Machine Systems (HMSs) and provided some concrete guidelines. He stated that special research is necessary for military practice, because military HMS differ from civilian ones on some important points. Military organizations and systems are characterized by wide user population variation, limited training time and thus uncertain performance level. The military deployment

Figure 3.2: Staff vehicle where generations of technologies are used in combination.

conditions are special: any time, varying climate and weather conditions, use of protective gear, vehicles etc. may intervene with design. Insights into ergonomics are limited, and careful experiments are not possible because of lack of time. Lastly, use duration is frequently more than 20 years. A system (e.g. embedded and other control systems related to vehicles, weapons, communications) may be 30 years old (including 10 years of design). Much happens during the life cycle and opportunities for late changes are rare. Figure 3.2 shows workspace which is equipped with a variety of technologies, illustrating the successive introduction of IT-artefacts for communication.

According to Bernotat, research should aim at lower costs, avoiding errors, facilitating training, and a gain in tactical advantages. More automation, he said, as a strategy to lower costs and save manpower, instead leads to higher costs and the need for more and specialized personnel in the organization. Because the military environment is highly unpredictable, a reduced level of automation is recommended: not what is technically possible but instead what is achievable through adaptation to individual operators via software. Finally Bernotat warned for the effects if humans have less personal contact because motivation, teamwork and mutual support may be negatively affected.

3.3.2 INFORMATION, COMMANDER CENTRED WORK AND COGNITIVE SCIENCE

Kahan et al.(1989) summarized several years of research in mainly cognitive science, decision science, and information science, conducted by military and civilian researchers. Their key topic was *commanders' information needs* in the whole command-and-control operating system where human systems integrate collective intuition, training, and experience with data. The authors stated that only when these internal systems (the human systems) are understood, "can we begin to specify a design for the external systems that exchange information between the command post and the external world" (Summary, v). The latter are the technology that design usually is concerned with.

The authors concluded that the reviewed studies, even though they may provide some insights, showed serious conceptual and methodological shortcomings, were seldom validated, and their reliability not investigated. Assumptions guiding diverse studies were that commanders' information needs are finite, specifiable, and applicable across all possible scenarios. However, neither a task-analysis oriented approach nor a system design approach lead to decisive insights in the issue of information needs and satisfiers. In general, broad solutions were favoured and *situated demands neglected*. Further, *"information needs"* were seen as *items external to the commanders*, and had to be transported to them rather than were sought by them. Finally, there was an assumption that *information needs can be ranked*. The authors concluded that these cannot be given priority a priori and abstractly.

The commander's "dynamic image" was a central concept for them: this image is not a depiction but instead a *mental model* of the whole situation that may take many forms and differ substantially in detail. Images can be conveyed in metaphors, verbally or in written form. Detailed data are usually less attractive to commanders than conclusions and aggregated values on capacities. This image framework contains both battlefield history and futures that provide meaning to new input information. Important requirements were linked to terrain, map information, and capacities of subordinate units. Commanders' request "data" for reasons related to images and image sharing, seeking options and assessments appropriate to their image rather than specific data. By using his image as support, a commander understands what action has to be taken and what information needs to be shared among staff members.

> Since the image, which is a mental representation, cannot be directly inspected, the commander must do what he can to communicate it. (p. 17)

It is therefore a central issue whether people understand and share the commander's image, which is decided primarily at personal meetings. There was however no consensus among the studies. Different commanders have different images and differing needs, and these needs do not predict how good a certain commander is. The ultimate link in the information processing chain is to *translate an image into action* - by other persons than the commander himself. We recognize the idea of boundary management, one of the transformations in this discussion. The interactivity of information exchange is stressed, acquired by asking, face-to-face contact, and an unstructured continuous flow. Consequently, much communication goes on in order to achieve this. Communication can be verbal, metaphoric, or by means of some concrete pictorial or physical analogy.

In ISD, Kahan et al. stated that current (late 1980s') technology did not allow communication directly in images (neither depictions, nor physical features). Technology was not (or was expected to become) flexible like staff officers when other kinds of information or interaction is crucial. The authors gave three design recommendations:

(1) Identify means for *more direct image sharing*. They exemplified this with the dynamic weather maps used on television. They also state that the traditional map, a pivot in the work where people often discuss and communicate, should be studied and developed as medium of communication;

(2) Use *short-term local storage* and *processing capacity*, functioning as a distributed database from which search can be performed when required, from across a whole command organization. This database should allow forwarding, print-out, retrieval and analysis.

(3) Establish an interactive *end-user to end-user communications orientation*. This means for instance to better show the difference between routine and urgency, to minimize redundancy, and to admit direct access without mediating communications centres.

Later, this information-centred development has continued within *cognitive science* (Whitaker and Kuperman, 1996). When IT is seen as enabler of both internal control and for infliction of damage on an adversary, performance is treated as a function of capacities for communicating and processing information. Research drives progress for the development of optimum communications and information processing on the part of warfighters. Such work is within the category of *cognitive engineering* which is about the application of analytical and engineering principles to issues of human cognitive performance as a means to improve cognition-relevant features of practical tools and methods. Cognitive engineering aims at the application of relevant parts of the pure cognitive sciences to the design and construction of ISs that engender effective interaction between the artefacts and the people they support. In Whitaker's and Kuperman's report, knowledge (preunderstanding) has become an issue for the engineering of meaning out of new data, something that links data and decisive action. Actually, decision is the process through which knowledge guides action. Unless this capacity is achieved, the visionary command "System of systems" (SOS) cannot be realized. The "commander's image" has turned into a shared information pool, a *Common Battlespace Picture* (CBP). This picture is achieved via the *"Shared information space"*, a medium that can be used dynamically to help people share their view of the world with others through joint manipulation of each person's personal models of the situation. This space is a key concept in the field of CSCW. To equalize access to critical information across the widely-distributed set of SOS actors, sharing critical data, all actors can orient themselves and their actions to a common "picture".

3.3.3 DECISION SUPPORT THINKING AND DECISION SUPPORT TECHNOLOGY

Decisionmaking is a central activity in the military, and there are several opinions about the best way to support it. Sage (1987) analysed IS engineering from within a decision-making paradigm (distributed decisionmaking) where cognitive science and systems theory support design and a suitable engineering methodology. I assume his discussion represented state of the art and will point out some details. Keywords in his discussion were skill-based reasoning and expert knowledge, knowledge representation and knowledge bases, decision support systems (DSS), distributed ISs, problem-solving, and multi-agent real-time dynamic and distributed decision-making.

Sage realized that information and knowledge imperfections belong to a distributed environment. He suggested redundancy ("if properly exploited", p. 921) as a remedy even if this also adds to the complexity. One of his hypotheses was that imperfection, in turn, will create a need for cooperative interaction and consequently the acquisition of means for communication in the organization. Humans, he said, apply a blend of knowledge perspectives in their efforts to control actions in the social world while computer aids...

> …in no way, guarantee an increase in either the effectiveness, efficiency, or explicability of the resulting problem-solving or decisionmaking task. Just the opposite may well occur. The complexity of tasks may increase, due to technology infusion such that there is a reduction in the quality of the resulting information processing and judgments. (p. 922)

In spite of the mixed record of the blessings of decision support technology, Sage remained true to his decision-making paradigm, and reflected upon the observation of some researchers that during decision-making (by definition aimed at the choice of a “best course of action”) actors *sublimate decisions with problem solving*. This tendency was caused primarily by information imperfections, leading to lack of understanding of a situation because of aggregated ambiguities. Moreover, humans easily accept judgements based upon rules from simple mathematical logic. A related conclusion was that there was no straightforward relation between more information and better understanding. The opposite may be true as well. According to cybernetics (Beer, 1981), what counts is *preserved variety*, not more information. Moreover, in reality people seldom concentrate on one task; instead they consider, unsystematically and in a parallel manner, a diversity of problem-solving situations.

The assumptions of behavioural decision theory and downplaying of humans (as “intellectual cripples who are very prone to the use of seriously flawed information processing heuristics and the resulting cognitive bias”, Sage, 1987, p. 923) in reality may be incorrect, stated Sage. In real settings (as compared to laboratory experiments) people continuously adapt to ongoing events. Group-based judgements lead to higher quality outcomes (as compared to the single commander discussion by Kahan et al., 1989). What is required, however, is a common language suitable for the translation and expression of thoughts and ideas. In theory, a Group Decision Support System (GDSS) shall assist thereby.

In distributed organizations there is always, especially in a military context, a risk that communication lines are broken, that channels are narrow and slow with troubled access conditions. Information is thus not available when necessary. Again, there is a gap between ideal theory and actual practice. The practice then becomes *more bounded* than expected. Decisionmaking, when this term then continues to be used, becomes less “ideal” but more of pragmatic problem solving. During the 1990’s, naturalistic decision-making has become an approach for decision methods (Whitaker and Kuperman, 1996), however less rigorous and consequently giving little concrete guidance for those who follow the approach.

Sage (1987) described more drawbacks in the real world compared to the ideal premises behind the decision-making paradigm. What is “information” is not self-evident but may be suspected of bias, because of conflicts and power struggles colouring what is defined as information. Information in addition is a *symbol that suggests rationality.* It may be attractive to produce and demonstrate it. The result is that much is requested but little is used. To be “informed” may be an expression of the desire to gain power, and not at all the selfless, rational, often formal attribute described in decision theory and engineering work. Temporary (sleep deprivation) or systematic bias (political or power related phenomena) lead to reductions or simplifications. Action may be necessary on any occasion because there is an unknown final time to reach decision optimality, not a fixed one. Conclusion: ISD should allow for a combination of various approaches to knowledge representation (for novices, experts, and others) used in heterarchical and chaotic working procedures. Fischhoff and Johnson (1990) were critical when they discussed decision-making and support. Many efforts are aimed both at the creation of decision aids *and* the avoidance of them.

> Equally clear (as the difficulties to proliferate decision aids) but perhaps more subtle evidence is the variety of devices used by people to avoid analytic decisionmaking; these include procrastation, endless pursuit of better information, reliance of habit or tradition, and even the deferral to aids when there is no particular reason to think that they can do better (Corbin, 1989). A common symptom of this reluctance to make decisions is the attempt to convert decision making, which reduces to a gamble surrounded by uncertainty regarding what one will get and how one will like it, to problem solving, which holds out the hope of finding the one right solution. (ibid., p. 26)

There are contradictions. Behavioural decision theory builds upon persons who already know what they want and how to get it, the economic perspective, and it is hard to get response to support ideas from them. Decision analysis, stated Fischhoff and Johnson, has taken on a life of its own with caveats regarding the quality of the help that it is capable of providing and the degree of residual uncertainty surrounding the most heavily aided decisions. In summary, there is either a belief in decision-making and tailored support technologies or confusion whether it is at all relevant to try to systemize what it is about. Some thought that "problem solving" was a suitable concept but was not willing to go further with it (Sage, 1987), while others claimed that it to be a way to evade from responsibilities into a futile search for The Solution to a "problem" (Fischhoff and Johnson, 1990).

The design principle that Fischhoff and Johnson launched was that "how the system keeps people from doing their jobs provides more realistic expectations of overall system performance as well as focuses attention on where people need help" (p. 49). According to them, design principles often tend to embody a deep misunderstanding of people in person-machine systems. This indicates a belief in the possibility of engineering the human side as if it was just another mechanical or electronics side, while part of the genius of people is to see and respond to situations in unique and unpredictable ways. Sensitivity is to incorporate operators in the design process. Detailed empirical work is needed, resisting simple design philosophies: design for all occasions, to idealize human operators' capacity, even to avoid the human element. Unofficial intelligence (what people have learned and how to respond to faults, i.e. problems that are not supposed to happen) is not recognized within the design space, it may have to be hidden, unable to acquire resources. A political question is that focus on detailed technical solutions may distract attention from the broader question of how systems are created and conceptualized.

3.3.4 Highlights from Current Army IS Design in Sweden

The Swedish army has been managing a large development project since 1994, the ATLE project, a Swedish abbreviation for the Army Tactical Command System. This process was planned to continue during almost a decade. It was the first wholly coordinated Army effort to achieve a consistent (command) control structure including a mobile communication system, and was accompanied by similar efforts in the navy and air force. Within this context a new integrated IS, the ATLE-IS, was designed for the support of tactical command. In order to illustrate the current thinking in this work, I will present a few highlights and compare it with the other sources. I rely upon two specification documents from 1996[1].

The ambitious ATLE-IS specification and modelling work was conducted in several part time subgroups, representing various command levels and functions (for example logistics, artillery, signal and communications). The perspective guiding this process is similar to Kahan's et al. (1989) commander focus. The new networked architecture should allow fast and direct access to information. "Information system" meant technical support systems, artefacts, and infological infrastructure to collect, store, process and present information. The system had to be technically integrated in order to achieve one common view of the situation in the battlefield. "Information" was described merely as items that were introduced in the command system, stored and which could be retrieved and processed automatically. There has been a strong influence from the ideas underpinning the concepts of a SOS and a CBP in Swedish thinking.

In principle, the central military authorities in the FM HIT[2] (1995) specified the kind of computer and software components that were to be used. Detailed recom-

1. Försvarsmakten/Högkvarteret (1996). Preliminär Systemmålsättning för Arméstridskrafternas Ledningssystem–Prel Symm ATLE [Preliminary Requirements for the Army Command and Control System]. 23 January, 09 611:71763; Försvarsmakten/Högkvarteret (1996). Målsättning för Arméstridskrafternas Taktiska Ledningssystem [Preliminary specification army tactical command system]. 6 December, 09 833:73741.
2. Handbook IT; Försvarsmaktens handbok för informationsteknologi (1995)

Figure 3.3: Old staff vehicle with standard PCs during the fieldwork.

mendations were given about a standard technical platform with a certain technical capacity for components. *Openness* was a keyword—commercially, technically, towards users, and maintenance—few main types of systems to handle. Several requirements across the total organization promote the use of technical and procedural standards: training of personnel, security, use (re-use) of common information and software, exchange of equipment must be simple, the normal high personnel mobility and the need for rational maintenance and system logistics.

This standard technical platform was an important prerequisite to realize the vision of one common command and control system. Well-established and commercial technology was a first-hand priority. The workspace equipment should be the PC.IT was treated as any other technology. According to the HIT, *systems development* must be controlled like any activity, guided by the requirements from work, and normally managed by the military. Cooperation with industry was seen as advantageous in order to exchange experience. The handbook prescribed a tight control of the successive introduction of new versions of software and a stepwise implementation of new systems in order to learn from experience. A common methodology for development was previsioned, including object-orientation, design of autonomous systems and PD. IS intended for use in war should be used already in peacetime.Therefore standard office IT products (Figure 3.3) were considered especially important in command-system functions

In command work written orders either summarize previously given oral orders and directives or are first-versions. Operations orders are normally *written*, they

Figure 3.4: Map-work in truck.

control and coordinate action and regulate allocation of resources linked to missions, while the latter can be given orally, also via mediating technologies. Now, ‘order support‘ was considered necessary in the form of templates containing known type missions (standardization), completed with overlays with symbols illustrating battle plans and actions, ‘graphical orders’. Overlays were to be distributed electronically via the communications systems. Such successive and graphical orders were then supposed to lead to rapid execution of missions.

Previously, the synchronization of the situation maps across an organization had been very difficult; there has been a strong concern as regards to the precision and actuality of traditional situation maps with plastic overlays carrying symbols and notations. Ordinary maps tend to become large (several m^2) in the normal scales (1:50000 and 1:100000) which make digital maps, stored as terrain databases and presented in monitors, attractive in narrow workspaces. Digital technology now promised to be a means to achieve long desired capacities primarily to get *one common situation picture*, easy to distribute. Figure 3.4 shows typical map-work when the narrow workspace does not allow full unfolding, in the way larger work-containers or open areas do.

Integrated technical solutions and tools were required for the close coordination of fire, manoeuvre, and communications, and the establishment of a common view/ opinion of own and enemy capacities, and positions across the command organization, together with analysis of weather and terrain capability. The guiding vision was that all information should be managed and stored in digital form. Reliable and sufficient *automatically updated* and *distributed* relevant information at the right occasion were some of the new computerized HQs hallmarks. The foundation and prerequisite for this part of the vision was a common database (or replicated databases) where all information was to be stored. We see an attempt to combine an IRM and a VBS approach, while what Whitaker and Kuperman (1996) suggested had fewer VBS traits. Within division and brigade HQs, autonomous subunits should be able to command operations in different directions.

In summary, new support tools were considered necessary for the collection and processing of information, allowing graphical presentation of decision information and facilitating overview, representation of own and enemy situation together on map. Rapid distribution of information was central, sustaining and providing each command level with a picture of the situation. The meaning of “picture”, however, varies between internal and externalized items, and the design requirements for supporting computer artefacts consequently are hard to define. Unfortunately the first ambitious ATLE-effort could not deliver the desired output in time and was interrupted, which later on enriched my fieldwork.

3.3.5 SUMMARIZING PREVIOUS DESIGN EFFORTS AND THINKING

Kahan et al. (1989) stressed the need to respect individual and situated requirements that can neither be quantified, nor defined, aimed at the support of something abstract (a mental image) that must be communicated between people as messages. Because the image itself can not be seen, communication in messages can (and must) take many forms. The span of modes and media covers verbal communication, acting, text, imagery, models etc. Their study revealed that decision briefings occasionally were shows to demonstrate how commanders’ decisions fit into a context. In this way we can see a pattern of behaviours aimed at providing sufficient autonomy, augmenting (hopefully) the power of the commander, including the emphasis on information as the central asset in command. Kahan et al. correctly realized that the information exchange with the external world (boundary management) was vital and that this exchange could not be organized until the integrating hierarchical *social* system in the organization was understood.

To summarize Sage’s (1987) discussion, humans must, because of their unique capacities and because of the situational requirements in a given organization and its context, be allowed considerable resources for communication. Humans need this (1) in order to actively search and reach acceptable interpretations and agreements about what is going on, (2) to conclude about common action, and (3) to execute these actions. Complementary but simple forms for presentation and personal face-to-face interaction are required in order not to add to the always threatening confusion. While Sage acknowledged differences between people, this is not Whitaker's and Kuperman's (1996) signum. The progress of cognitive engineering and the strength in the rhetoric of new technologies (after the Gulf War) during the decade between Sage's paper and their report had made knowledge unproblematic and permanented a belief in the capacity of the "system" to produce a common view. One capacity of the effective CBP was "mutual interpretability" (p. 49), to make provision for individual actors' frames of reference (differing knowledge schemes and terminology) with respect to the information delivered to them. Does this mean an automatic adaptation to each and anyone, and the use of different media and formats? This idea of information and knowledge presupposes that actors behave and infer identically when studying the CBP.

While it is often assumed that knowledge, interpreted as what humans have, only poses a *representation and presentation problem*, the matter at hand is *use*, at any time, because neither time nor other resources (communication links) may be available in a real world situation. Ideally, the mode and media for representation (and presentation) should reflect the kind of knowledge that is expressed, but conversely, it should be possible to use any available resource and admit sufficient granularity or qualitative discrimination. Few excuses will satisfy co-actors if action is delayed because of a lacking "decision" or "solution to a problem". There is a risk that the media, when only one kind is present, streamline "knowledge" into a similar form, independently of its character. If knowledge is accepted as a social construct, then it becomes evident that any separation of it from its social context and presentation only in an instrumental form risks deleting something vital. One interpretation of the focus at presentation is that the need for visibility is deeply acknowledged, but that IT often means only one way to do it. Beer (1981) meant that technology used as tools determine the nature of the problem-solving mechanisms aimed at viable operations, balance through self-regulation, *homeostasis*. Technology both nourishes the problem and is part of the solution to the problem. Technology deployed can therefore never be judged aside from the problem-solution homeostasis.

Within the ATLE framework the aim was to create a system designed for humans' capacities, and the requirements under severe external strain and workload. The Swedish design approach also demonstrated the strong belief in technology to convey meaning and knowledge, materialized as a common image and electronically distributed. By using modules for the construction of the workspaces, and providing individuals with "walkstations"[3] with all hardware, software and necessary information, people could move freely or gather in larger areas when needed. Finally, preparations for non-conventional reserve procedures were supposed to be part of the new command thinking. Implicitly what is *work*, command work or other kinds, was defined through the standard technological platform. Because of the 1995 HIT handbook, local initiatives and new solutions to urgent communication problems are (were) likely to be treated as satisfying the formal design and development requirements. It was required to find out just what reserve procedures could be prepared and trained in, and what resources could satisfy them.

3.3.6 DESIGN CONCLUSIONS FOR THE MILITARY

I conclude that the belief in automation that is strongly related to the use of computer technology, must be considered in the context of the social system, the required ability to adapt and to control action in *previously unknown situations*, which characterize command work. Conventions might mask the actual requirements. Systems development practices might lead to models of command work that mask its inherent changing character. Such uncertainties lead to some ideas concerning support technologies:

- theory must underpin design and development, not only express wishful thinking (rational, scientific decisions) but also the social and human aspects of turbulent command work;
- systems design should recognize and balance contradictions (see chapter 2), not adding to them;
- test and design of new technologies must be part of practice and not separated from it; and
- the work on final design can only be done by the practitioners in their work.

The infological equation (Langefors, 1993) supports claims for decentralization in order to “enable a design of data such that data can be informative to the people they are intended for, and isolated from those who could only misunderstand them” (p. 30). Langefors also saw a dichotomy between what is desired and what industry wants to sell. Perhaps this is what makes systems development most tedious because vested power interests can evolve from each position.

Langefors, promoting decentralized organizations in order to increase flexibility of actions, control and motivation (we can compare with the origins of directive command), and improved information support within the local units, distinguished between information *availability* and information *use*. Information can be available

3. This visionary concept was used, but at the time when the specification documents were written, the common technical platform was the PC.

for all, but usable only for members of local bodies. In order to form one organization, to coordinate and (to some extent) control the parts, *translocal information* is produced. Translocal information is necessary in order to coordinate "global" command functions (commander's intent and operations plan, communications, intelligence, anti-aircraft) but much more is purely local, derived from the translocal and as response to local (space, time) requirements.

In the military, because of the urgent need to create a functioning machine-like organization, this portion easily becomes very large. We are faced by the threat of a very large quantity of translocal information if the insistence on working with the CBP and the SOS concepts (Whitaker and Kuperman, 1996) guides action, or a very limited one. The latter is what is practically possible to agree upon and make comprehensible for all, but one that has little local value for command work. Put another way, the very large CBP may require considerable efforts, attention and time, strongly controlling people's actions and thoughts, but reducing variety, leading to a diminished capacity to respond, capturing people's attention (knowledge being given and not open for investigation). Command work then will involve much discussion about the common picture, much work to administer it, and little attention to what really goes on. Intentionally or not, the efforts to create one organization instead may lead to negligence towards local needs, and that people enter into compensatory activities – self-help systems (Sorenson, 1989). With these enterprises, the military certainly may be more specialized and professional, but not necessarily more clever than before. We can, in addition, see the remaining and perhaps amplified contradiction between efforts to create an efficient organization of one's own, and to obtain advantages over the enemy's (Whitaker and Kuperman, 1996). The real battle then is an *information war* (IW) on several fronts, one of which is survival even without hostilities.

Turning to the design portion of the study and accepting the idea of a "dynamic image", some issues arise. Whatever is used, must be easy to store locally, to retrieve from a distance (or to communicate on demand), to update, to adapt to different needs. Moreover, a message must be easy to interpret but not invite to be seen as an object carrying knowledge out of its social and (abstract) image context. Instead of a set of fixed symbols, it should be possible to invent symbols and use them locally, supporting variety. People must then invent the rules for generation and interpreting them, which is what much in command work is about (Rice and Sammes, 1989). It is debatable whether it is possible at all to produce one image that will carry and deliver the common image, but understandable if technology gives this impression. The support technology should not only confirm what is known, it should be a resource whenever the mental image must be revised. A commander centred perspective is understandable, but it is not likely that staff officers accept to just be confirmers of what a commander already has decided (Kahan et al., 1989). They have to feel they can make a contribution.

3.4 Design for Work

3.4.1 DESIGN OF COMPUTER ARTEFACTS

The art and science of how to conduct work-oriented design of computer artefacts is the topic at length discussed and analysed by Ehn (1988). He tried to unite the social and the instrumental: to design artefacts in order to facilitate dialogue and intersubjective communication, and to support control of objects as well. For Ehn, design is

> a concerned social and historical activity in which artefacts and their use are anticipated; an activity and form of knowledge that is both planned and creative, and that deals with the contradiction between tradition end transcendence.(p. 161)

Ehn stated that it is necessary to include both the *technical knowledge interest* in instrumental control and the *practical knowledge interest* in intersubjective communication. There is thus a ‘doubleness‘ involved in this kind of work which must be, states Ehn, and consequently disciplinary boundaries between established sciences must be transcended. His third scientific interest is to acknowledge the *emancipatory interest*, which I translate into *autonomy* as a cornerstone in command work. Ehn is quite harsh against traditional design of computer artefacts:

> In a similar way it can be understood why traditional systems descriptions do not work in communication with users... The descriptions may be useful for the designer's detached reflection, but they are not mirror images of the user's situation. All they represent to the users is breakdown of traditional understanding. (p. 79)

Artefacts can also augment, replace or constrain individual or collective activities. What distinguishes computers from other artefacts, says Ehn, is that *computers can manipulate symbols*. The interface influences the users’ knowledge about what can be done and how, it is both form and function. Because computers are new phenomena, there is little experience of their use in an activity. His advice is to “design computer artefacts metaphorically, as something new with family resemblance with something well known” (p. 165), because this would diminish the risk for breakdowns for the user. Ehn emphasized that computers can be understood only as practical artefacts. Detached reflection will not reveal their nature.

> My point is that computer science and systems design has to a large degree been unsuccessful in relating design knowledge as detached reflection to design knowledge as practical skill. The latter has been made invisible. (p. 41)

The main design effort should be aimed at creating signs that make sense in the language-game of use. There is a danger: computers become the mould for the perception of what work is, “work is cast into design artefacts”. Thus the instrumental aspects of work easily dominate over intersubjective communication.

3.4.2 Activity Theory and Design of Information Systems for Work

Foreboding Activity Theory, Nissen (1985a) sketched on an integrative theory of information systems, stressing the need to study the context of an organized human activity, including history, and all kinds of stakeholders involved in the pragmatic use of symbols. He pointed at the need to bring design and use closer, to integrate two separate fields, the field of human activity and the one of automatic signal handling, each one seen as unproblematic of its promoters, and added the concept of *community if interpreters* to Langefors’ basic theory. From the early 1990’s, Activity Theory has inspired researchers’ attempts to get support for ISD. Kuutti (1991) explained how *mastering of contextuality* was the main problem. By this he meant that the context of an IS, the work activities, had to be taken into account because it was not sufficient to design only the technical core. In addition, a further complication was that this context belonged to the realm of the social sciences and that therefore it was (and is) not clear what is the nature of this context, and how to best study it. For Kuutti, therefore, the use of Activity Theory was a novel approach and a practical methodology for developing work activities. Kuutti stated that ISs have a well-defined but secondary role and that work activities and work must come into focus.

Bödker (1991) reacted against rationalistic thinking, insufficient as a theoretical basis for systems design, seeing the need for a “framework for understanding the totality of human work and praxis, and the deliberate processes changing this, i. e. a totality encompassing organizational development, design and use of computer artefacts” (p. 551). At the same time as the main purpose of systems design was to try to predict the future use activity we will never be able to fully make such a prediction because the future will always shape itself differently from what is predicted. Bödker stated that it is necessary to widen the scope of systems design to include not only design of standard ISs, but the *change of the total work* when computer technology is involved (work space, influence, praxis, etc.). Furthermore, Bödker believed in a better design process but foresaw a conflict between advanced standard products as ideals as compared to what she called “ordinary systems design projects” (p. 554). This was also a conflict between the design activity and the work activity. Design, said Bödker, is an on-going collective re-design and learning process where artefact and organization are developed together, including the design of operations, social and organizational features. Bödker suggested bringing creation and use together, returning from the situation when design *separates* creation and use, making it a collective learning process among designers and users, designers acting as facilitators when trying to implement new technology they initially bring to the design process. Bödker suggested a research challenge, that research of the 1990s “should focus on how computer applications can be designed to mediate human work, starting out from the human practice” (p. 560).

Thereby it is necessary to include historical analyses of how the use practice in question has evolved, not only to start with a given situation. Engeström (1993) recommended that a collective activity system should be analysed, that contradictions should be explored, and that a historical analysis should be undertaken of an activity. Researchers should work close to the activity and help visualize and analyse what occurs, highlighting contradictions, while staff suggest new solutions, and then help model these. His methodology focuses on the work processes and the combination of information processing and actual work practice (in his hospital context: keeping the patient in the centre).

To Engeström, contradictions that called for negotiations were “essential ingredients and energy sources, not mistakes or anomalies to be eliminated” (p. 91). Engeström finally warned against too instrumental an approach where the necessary social-organizational re-mediation of an activity system has remained untouched. Bardram (1998) used a structure (Figure 3.5) based on Activity Theory when he discussed how to design for the dynamics of cooperative work activities.

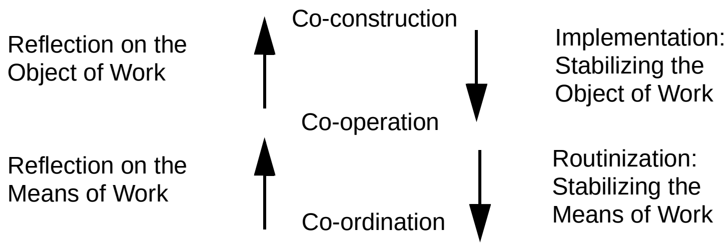

Figure 3.5: The Dynamics of Cooperative Work (Bardram, 1998, p. 92).

The collective activities in an activity system form a hierarchical structure with three levels. The *upward transformations* are caused by reflections when work breakdowns occur and must be considered in cooperation, or even be resolved as a cooperative effort. A resolution may lead to a *downward transformation,* sometimes a thorough re-design of the organization and the work (Co-construction) before a new coordinated work situation is established. Bardram claimed that ISD is about support of work activities at all three levels, the dynamic transition between these levels, and integration of this support for dynamic cooperation supporting work. For instance, when IT is developed and implemented, probably a dynamic iteration upwards and downwards evolves, rather than a straightforward sequential process. Bardram, with his model, explained the importance of communication in work which, he stated, is why communication technologies – electronic mail and conference systems – are the most successful category of CSCW applications. Further, it is essential to support operational and communicative aspects of work, both doing and talking. I will describe Activity Theory closer in Chapter 8, before I apply it in the presentation and the analyses of the cases.

Recalling what Kahan et al. (1989) stated, the desired image-sharing and the end-user-to-end-user orientation may be achievable when an activity is the basic unit, where people can work close to each other and develop a shared field of knowledge. In other words, what Kahan et al. promoted was something where the instrumental and the social context are not separated but kept together.

3.4.3 CURRENT RESEARCH IN INFORMATION SYSTEMS DESIGN FOR A DISTRIBUTED WORK SPACE

Support of work in a distributed organization is high on the research agenda. Iivari and Lyytinen (1998) thoroughly described several Scandinavian ISD approaches. According to the *professional work practice approach*, the more experienced users, the less application of ISD methods. It is important to first study and to analyse actual work practices of professionals before attempting to improve them, and then to look for realistic changes. They recognized the Activity Theory approach because this approach relies upon *explicit articulation* of the work activities.

Grinter (1999) had made a qualitative study on production of large and complex telecommunications systems, where the design was done across organizational and institutional boundaries, specifically the early design stages called “architecture”. The role of architect has evolved from systems engineering because in large system structures no-one cared about the total structure, and thus failure in many systems was caused by this gap. What make Grinter’s argumentation interesting is the concern and a growing interest for how design (“architecture work”) is performed in practice. Grinter claimed that much research has focused on the *outcome*, the architecture as a product or attribute, while less has been directed at the *process*. The product of design is perhaps less interesting than how design work actually is completed, the *content aspect*. This includes coordination across wide organization, negotiation and presentation of design (architecture) ideas. Grinter pointed out the need for *autonomy* in design. When trying to reach a trade-off between obedience to suggested requirements’ solutions and the necessary freedom to follow one’s own ideas, negotiations and coordination are necessary. Grinter considered it necessary to turn attention to the design work and its support tools, telephone, email and presentation (viewgraph) packages built on standard presentation packages which offer advantages: architects can themselves *draw*. Standard packages allow sharing and customizing, and finally, they are portable across an organization. Web technology now offers new opportunities to search for information. Slides that previously were faxed can now be put on servers.

Because design is performed across boundaries, and heterogeneous groups have to be coordinated, *boundary objects* which link diverse groups must be implemented, being both plastic and robust (see Star, 1989, for a comprehensive discussion of this concept). Such objects evolve when a design process involves multiple groups, serving as bridges between different teams and units, facilitating the use of the same materials and a common understanding. Again we see how the needs for sharing of “images” appear. Above all, design is a social process and its executives must be good communicators and listeners. Even the architects themselves can be seen as boundary objects. Conversations and meetings are social ‘boundary occasions’ when architects work for a shared understanding.

3.4.4 WORK SPACE DESIGN, TEAM WORK AND ARTEFACTS

Virtual worlds may be designers' dreams, but not the only means to create modern workspaces with the help of advanced technology. Several studies have been conducted on Air Traffic Control (ATC) as a domain where the demands for reliability and security are high, work means teamwork. There is a dependency on technology for communication and coordination, and the activities are ongoing. Hughes et al. (1992) analysed and discussed the findings from an ethnography. There are similarities between the work in the ATC suite and the command centre (FCP), in both a mixture of diverse technologies for representation and communication, but the military army HQ (so far) has had a more dynamically shifting team and less long-term stability due to the short but intense exercises, not having to find a stable mode of operations extending over years. A 'protective cocoon' is built around the ATC controller, all resources being at hand so s/he can concentrate on the job. Actors in the ATC suite develop a working division of labour where they can act as experts (demonstrating the types of competence that Hermann and Just (1995) defined), involved in a 'free flowing gestalt contexture' (p. 117).

Lately, within CSCW and HCI-studies, the whole workspace has been treated as an interactive area to use for information management in the work (Streitz et al., 1999). Interaction is no longer restricted to individuals' workstations. Instead, new technologies make work possible practically *anywhere* (see Want et al., 1999). Still it is possible to maintain links to the larger parent-organization by 'wearable computing' (see for instance Billinghurst et al., 1997), and 'Hybrid Computing Environments' (Rekimoto and Saitoh, 1999). Such technologies work with paper artefacts with the help of machine-readable codes (Nelson et al., 1999), applications for note-sharing (Davis et al., 1999), whiteboard techniques (Mynatt et al., 1999) and PCs, allowing informal work practices and providing services to flexible work activities outside traditional offices.

By using technology and computer artefacts, and "augmenting" physical objects with tags that are recognizable by computers, physical and virtual electronic worlds can be bridged (Want et al., 1999). Recognizing the need for interfaces that require physical interaction (favourable when people are tired), allowing even distributed groups to interact in real-time, work with tangible interfaces seems worth consideration (Brave et al., 1998). Such interfaces may make people who work conscious about change and what happens in different and more distinct way than when, for instance, electronic mail messages are announced by icons on a screen. The awareness of the social world easily gets reduced by mediating technologies, instead of making the devices part of the physical and social world, also allowing context to be taken into consideration.

In an ethnographic CSCW study of media for scheduling group coordination, Whittaker and Schwartz (1999) have compared how electronic and “material” tools are used in projects for management and coordination. They found that material tools had certain advantages over electronic ones: some group processes could thrive because the public tools encouraged greater responsibility, commitment and even updating the tool, thereby stimulating more reflective planning. Because it was public, it also encouraged interaction in front of it (for arranged and opportunistic interactions; people want to be seen working), in a manner similar to what occurs in visual command work in front of the large maps in briefing areas. Electronic tools may impose artificial constraints and not admit the kind of flexible layout that was appreciated in the planning process:

> A key reason why many CSCW applications have been unsuccessful lies in the fact that they impose additional work on individual users, or require changes in work practice, without those users accruing personal benefit. (p. 201)

The authors claimed that the optimal coordination tool needs to combine the benefits of the electronic and the material media, the former being some aspects of formalization together with distribution, interaction, and integration with other information and data, the latter being its contextuality, social character, and presence. As regards to choice of perspective on the work, it is not only a cognitive but a motivational, hence a social one.

Whiteboards

An example of research aimed at support for long-term, informal use in an individual office setting is the study by Mynatt et al. (1999). They augmented an ordinary whiteboard interface with computer technology for manipulation of input via the virtual whiteboard-like and touch-sensitive surface where input was projected. Basically they saw four functions of whiteboard technology today, which support thinking, space for ‘everyday content’, clustering such and short-term content, and as a semi-personal device. The augmenting meant that the surface could be expanded automatically, that contextual factors and history could be saved, and that the design supported ongoing continuous work across a host of domains, rather than a series of meetings. However, if meetings are seen as events within continuous (command) work, then this kind of approach promises to be worth a closer look. The research also aimed at keeping the worker in control over the device. A similar approach is described by Streitz et al. (1999) who studied the use of interactive landscapes “for creativity and innovation”. In particular, the complex windows handling in today’s ISs is the result of efforts to design for access to diverse sources, but easily becomes a problem in itself. More flexibility and support wherever people meet are their guides. They authors claimed that the whole environment around us (the workers) becomes more of an interface to information which can and should be presented in many forms.

Paper-based artefacts

ATC-studies (for example Hughes et al., 1992) have focused at the 8x1 inch flight control strips and analysed their use and functions within the ATC team. The strips actually are where work takes place, they are public, seen acted on, produce history, visualize work processes. Relations between strips when positioned in a rack above the radar displays convey meaning, upcoming workload, relations between flights over time. The internal position of a strip affects the meaning of its values about the flight it represents (flight number, position, direction, altitude), and the whole of it for the operators means a chance to see at a glance the total situation. The authors discuss possible design solutions to precision and reliability in a more automated track and control system. There is a direct link between work on the strips and what happens in the RW: “ordering the strips is a means to creating order in the sky” (p. 18). I conclude that further design for work should start with such artefacts as the strips, keeping the social and qualitative aspects of work in mind.

Related work is the development of *tools for note-sharing within groups* (Davis et al., 1999): personal notes are loaded into a computer tool that then can display them together, as complements or for comparisons. Another kind of *paper interface* (Nelson et al., 1999) were printed index cards with a content that could be identified by both humans and computers, and worth more attention.

Small notebooks are (probably) the most common individual tools in command work (portable, pocket size, robust). Similar technologies, such as physically transmitted 3x5 index cards, have proven their value in command work. The cards can be carried, faxed, distributed, combining the social and the instrumental aspects of an organizational communication system. Each card carries its own history in the form of signatures. It is possible to see who has signed it. Pagonis and Cruikshank (1992) described how an efficient command practice was built on these devices during the Gulf War (Pagonis, the highest commanding officer, was the only one using green ink). Such primary objects may be suitable starting points when new technologies are considered.

The last design example to be recalled are the *kanban cards* (Schmidt and Simone, 1996) which were used not in a collaborative situation but by individual operators but within a work setting. In order to handle complex production coordination a Japanese cabinet industry developed a *kanban* (means *card, visible record*) system. A set of cards acted as the carrier of information about the state of affairs as well as transmitting production orders, instructions to initiate certain activities at distinct stations within production. It was widely used in manufacturing to denote a just-in-time production control system (source ref. 1982, Schonberger p. 219). Kanban cards acted as a script rather than a map. To an operator, a new card meant reception of a new production order. There was no flexibility within a card or when they were distributed, but operators, cards being withheld, could temporarily reconfigure the whole system. Loosely interdependent processes could be coordinated by exchange of cards between processes. A specific card was attached to the container when a new batch of parts or sub-assemblies had been produced, and followed the batch "downstream" from the current work station to the next station where it was to be further processed. When the operator at the work station downstream has processed this batch of parts, the accompanying card was sent back to the operator who produced these parts. Again we see that visibility and autonomy can be maintained by very basic techniques.

3.4.5 SPREADSHEETS AND CALCULATION SYSTEMS

Avdic's (1999) study of spreadsheet-based ISs, named calculation system (Sw. *kalkylsystem*), spreadsheets being both design- and use-tools, terminates the overview. These programs allow direct development and manipulation by persons who have domain and work knowledge but do not presuppose the use of a programming language. The systems are developed by people *in their work*, allowing independent development and use, and satisfaction of information needs (which does not necessarily involve calculations). Some contradictions are reconciled by this kind of programs, for instance the bottleneck of knowledge transfer to designers/developers from users, and the need to standardize work. When turned into systems in the work, they allow full readability all through the development. An idea which is evident in this kind of systems design is that relevant ways of "informating" the environment and workspace (Zuboff, 1988) can be exploited, making work visible and augmenting the knowledge about what happens, and the control of it.

Even if the originator of a system experiences a more rational work practice, calculation systems have drawbacks on the organizational level. Systems may be undocumented and their existence depends upon a few persons. They may lead to less than optimal solutions (seen from a design specialists' point of view), ending in a "systems anarchy". To conclude, while such systems are appreciated, they certainly do not erase all contradictions. New ones evolve.

3.5 Another Perspective

3.5.1 ANOTHER PERSPECTIVE ON INFORMATION SYSTEMS

When viewing control of human action and work (in the military instantiated through *command work*), some characteristics are central and in turn defines an IS. From my perspective, there are four aspects of "information system" to consider if any "information" shall appear[4]. These aspects can be seen as representing four separate subsystems within the total IS in an organization.

There is the (social and technical) *informating system*, the *mediating system*, the (technical) *informing* system, and an abstract *system of information*, an *information* system. I assume that the informing subsystem is usually thought of when design matters are discussed, constituting the interface, but the whole produces services within an organizational framework. Within this context humans, forming the *interpreting subsystem*, produce information when interpreting data through work and interaction (the centre of the conditional matrix). All four can be used as instruments during action, three of them being artefacts involving technology and people, the fourth highly abstract. These subsystems are realized in a technical infrastructure (including software), whereby different architectures and strategies are applied (for instance the IRM or the VBS architectures). Architecture affects each component and the work. Different requirements for security, communications, competence and economy evolve from the choice. Repositories (databases) can be needed in any subsystem. Once accepted, and depending upon its penetration/dominance, any strategy can support different kinds of work (boundary management), from automated routines to situated command work.

I illustrate this model in Figure 3.6 where the four subsystems interact.It follows that the whole of it has to be controllable as an entity.

4. I rely mainly on Langefors' (1993) definition of information as the product of interpretation of data.

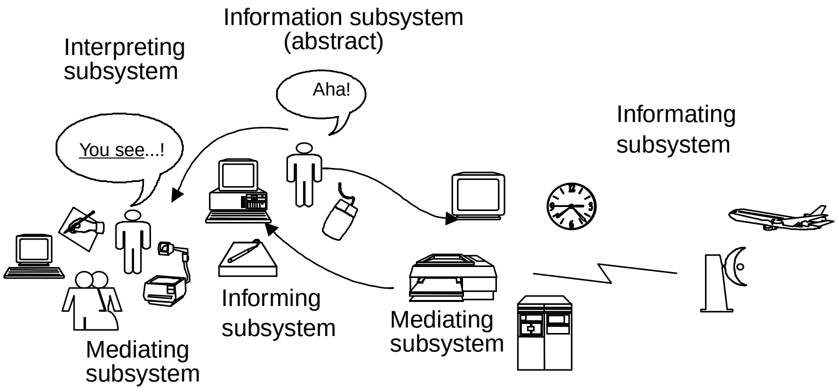

Figure 3.6: The four information-related and linked subsystems.

3.5.2 THE INFORMATING SYSTEM

The *informating system* is the technical or/and the social system measuring or recording events, representing them in data that can later be given meaning. Part of *command work* is about the *definition, production and interpretation* of such data. Another part is the *control* of these components. Information technology easily can be used to "informate". Devices (that automate) also register data about these activities. They generate new streams of information (interpreted data), feed back information (data) to the organization, making processes and events visible (compare the log file in an electronic document), sharable, knowable in a new way. They contribute to a new order of reflexivity. Then events can be controlled in a new way. A (production) process becomes visible only in a rationalized and perhaps abstract form, but the work itself usually becomes invisible in these records (Zuboff, 1988).

Events are thus transformed, coded into data in a form that facilitates future storage, retrieval, sensemaking within at least a certain organizational or professional group. These data are by definition designed to be able to *inform*. Another way to describe it is that the informating system intentionally produces (possibly governed by a program) data about events in the world in a systematic manner, for instance for control purposes. Data must therefore be relevant for the actual control requirements and not randomly produced out of what is easy available.

3.5.3 THE MEDIATING SYSTEM

The *mediating system* transmits messages, containing what people want to inform other people about, or links the subsystems. A variety of media can be used. The modern command organization relies on several technologies, each complementing or substituting for another. Behind it all is the purpose of the whole conglomerate, whose attributes are reliability, security, and robustness. Who is to be informed and what is to be controlled by whom? It is necessary to define where and what the mediating system is between the informating and the informing subsystems.

Even if the ideal is to digitize all communication, and then to be able to index and store it, reality in the military environment means that various media are used in combination. The total capacity must admit what the informating and the informing components require, and to admit information to be created via interpretation. Modern war means the use of advanced weapons to destroy all communication and any technical system. Hence, even the tiniest channel must be sufficient.

3.5.4 THE INFORMING SYSTEM

The *informing system* is either managed (controlled) by humans or automated according to certain rules and executed by programs formulated (designed) by humans. This system intentionally manipulates and displays data that are meaningful or can be given meaning by people via interpretation, in their work or for other social purposes. These operations are kept within discrete functions, executed by partial applications working with processes. It is the most visible of these systems, and consists of hardware and software components forming an interface. Part of it is semantic, handles and is formed by symbols representing data that are or have been manipulated (processed) according to rules and programs (cf. the position of Rice and Sammes, 1989). Another part is about the semantics of the total IS control system and the computer control subsystem (for example window- or data-base management, streamlining the way data from the field are presented). Probably ISD is usually most concerned with this subsystem because it is always there, as compared to situated and social requirements which are hard to define in advance but are at the centre of the work.

To *be informed* is not a matter of passive monitoring of displays presenting representations of the object system or reading printouts. Instead it means to be actively involved in interaction with computer artefacts and people in the social environment, interpreting and communicating over for example representation of knowledge and of the world. With few exceptions, research underlines the need to interpret, but *technically* much is about watching and looking. The informing system must be easy readable which in turn makes environmental and cultural factors, training, and conventions necessary to include in the physical and logical design. To be informed includes the social interaction in the whole work group, where power, knowledge and experience are (inevitably) unevenly distributed. In a military team it is usually obvious who have power and experience because of uniforms and signs showing training and professional identity. The signs and the team thus at a glance demonstrate, *afford* where knowledge and power is, including the functionality of the whole group (Anderson and Sharrock, 1993). According to affordance theory, "information pick-up is not the passive processing of information given by the ambient array, but the active construction of the-world-for-the-individual-in-a-particular-context....Knowledge and action is conjoined" (p. 149). The intention when it comes to design is that artefacts must afford their functionality, the more social they are the more important to include affordance of the *social functionality:*

> Affordances provide strong clues to the operation of things...When simple things need pictures, labels, or instructions, the design has failed. (Norman, 1988, p. 9).

New artefacts should be designed as to include experiences from legacy systems, from their predecessors when it comes to function and use. Rules for interpretation and the supposed knowledge elicitation should be afforded "at a glance". Artefacts must not confuse and require tedious work first to reveal the signs, then to interpret them. Another way of expressing this capacity is that the organization and function of the whole work space shall be understandable, provided that an actor has a basic cultural understanding. Another example is that when it comes to the design of dialogues with the computer system, certain basic functions should be handled in the same way throughout. A final reflection: affordance may also lead to the exclusion of alternative ways of seeing things, which might lead to blind spots. Therefore the informing system must also be transparent and allow re-interpretation and source-critical reasoning.

3.5.5 THE ABSTRACT INFORMATION SYSTEM

The *abstract information system* is the outcome of human interpretation and its design may be done by each interpreter into a mental image. This system constitutes the actual knowledge and preunderstanding, part of this abstract image of a situation. The "dynamic image" (Kahan et al., 1989) is an (abstract) information system according to this schema. Depending upon the products (data) from the informating subsystem, the attributes of the informing subsystem and the interpreting humans' capacity, the gap between the output from the informing subsystem and "information" is wider or smaller, whether it makes sense or not. We can actually talk about an interpreting aspect or part of the total system. Interpretation is situated and dependent upon purpose, work, and context. Information is not a given entity but instead divided into one semantic and one logic, or rather pragmatic aspect: What does the semantic information mean—just now? What knowledge evolves? This last system is what people try to communicate in their work, via other informing systems and technologies. In order to be able to use it in work practice, this abstract system must be made visible, *externalized*, but how this is done probably is a matter of local conditions, conventions, and situated needs.

3.5.6 Work, Design and Development

All four aspects (systems) must be dealt with when designing and developing computer artefact, eventually balanced under the influence of economic and other considerations. An elaborated conception is that computer systems are a certain species of computer artefacts (hardware and software), while data systems are organized structures of data, intentionally produced. The relation between these aspects of an "information system" is that

- both an informating and an informing system build upon, consist of, or in other ways involve computer artefacts, while the abstract information system is usually formed by or derived from the output from a computer artefact (which can have various shapes);
- work "informs" a computer system (or artefact), gives it meaning and capacity, for instance to store data which are representations of events in or descriptions of the world and to handle applications (software); the artefact then becomes an informating or an informing system;
- an informing system informs work with the help of interpretative symbols (representing knowledge, intentions) which are interpreted into information;
- work decides whether a computer system (artefact) becomes a relevant informating or informing system, and whether an informing system really can support or produce an (abstract) IS;
- a total IS and its components are actively created by work, as an important part of it;

- work (possibly with the help of software, artefacts) makes the information sharable and communicable via the mediating system, enhancing its visibility and permanence, and
- work changes an IS and can be directed to change an informating system and an informing system, which is called design of such a system, involving architecture, followed by development/implementation.

All four aspects and subsystems are involved in control (command work). Depending on the ISD, command work and the situation, there is a mutual influence between people and artefacts: whether people are controlled by the informating system, they control other people via mediating technologies and through the informing system, or influence the way interpretation is done. The latter issue is delicate because there is a considerable rhetoric power in many technologies, sometimes in accordance with (some) humans' intentions and interests, sometimes countering them.

3.6 Conclusions

3.6.1 THEORY AND DESIGN

The examples from previous research show that the insights are old about how a design theory should be defined and used. The suggested new perspective on the total IS is possible to relate to established cybernetic principles. Beer (1981) defined four cybernetic requirements of stability for a well-regulated viable system which have implications for the design of the total IS:

1. The system is obedient to Ashby's Law of Requisite Variety. Theoretically, only variety absorbs variety. This means ability of generating requisite variety to balance that which is generated by a developing crisis, remembering that just more information does not imply variety.

2. Information channels maintain variety entrusted to them. Beer stated that there are not only two but three notions of information: Except from bits and semantic meaning: also variety.

3. Transducers neither attenuate nor amplify variety. Transducers are sensors and links, bringing information across boundaries in the system. More information does not mean richer variety.

4. The time cycle is synchronous for all subsystems. This means that subsystems are equally dependant on the availability of technical infrastructure and humans' working

rhythm and that these components have to be coordinated, synchronized according to available communication channels.

Another implication is that subsystems with very different action cycles are difficult to integrate into one organization (viable system) for crisis management. If on one level of control very different subsystems meet, then coordinating between them become complex. Continuous operations then add to the control difficulties and variety risks being reduced by standards and rationalizing routines. This last requirement concerns how far-driven automation and continuous processes are integrated with human operators who have to be replaced now and then.

A comparison with these cybernetic requirements leads to the following reflections on the proposed outline of a total IS. One subsystem cannot be treated detached from the whole system. The informating and the mediating subsystems (being transducers) shall repeat variety without just producing (transmitting) more data (information). The generated variety must be preserved, and respond to augmented variety in the real world (crisis). Filtering in mediating technologies or administrative routines and techniques must not destroy variety or constitute mechanically operating filtering mechanisms. The flight progress strips allowed the operator to master the variety but did themselves not reduce (attenuate) the variety in the air; instead they became one set of tools ready at hand for the operator, the whole team functioning as a 'boundary management team'.

When turning to the outward transformation process variety must be augmented all the way from the Policy system level to the Implementation, across the boundary zone. This must not turn to micro-management. As regards the control of this total IS, if not adaptive to the external variety it is likely that the technology will be perceived as intervening between actors and environment, or obstacles to action, and rejected or circumvented. Caution is necessary against a deceptive reduction of variety because of work along the servomechanics thread (Richardson, 1991), when instead preserved variety is crucial. Military history willingly demonstrates command failures, how the need for autonomy has been neglected or operationalized, and that learning from mistakes or change are not taken for granted processes. Habits and culture are strong organizing elements.

3.6.2 PERSPECTIVE-DEPENDENT DESIGN ISSUES

The prevailing matter is how command work, and design work, are defined, from what perspective and why, whether centrally defined and directed, built on practice and whether there are contradictions. Another perspective-dependent issue is whether "information" is viewed as a resource that can be defined in advance and represented according to standard rules, or whether it is an abstraction (image), close to knowledge, defined by the situation. The first easily leads to a rational engineering process based on mathematics, using stable processes and standard procedures. If, on the other hand, it is abstract and follows another kind of rationality (for example being "art"), then other aspects become important.

If we mean the abstract IS, then little can be defined because from the logic of the infological equation (Langefors), what is valid is a matter of personal preferences, preunderstanding, and the situation. It becomes impossible to define any specific information needs in advance. Then what becomes central in the information-as-resource view is to maximize the technical capacity to informate, to mediate, and to inform (assumed to follow the "laws" of the common technology), confirming a central authority. The other perspective instead means (re-) composition of the whole according to the situated requirements, to be able to reconfigure subsystems until both desired and acceptable usability and interpretation are possible.

Both the engineering and art interpretations of 'design' include parts that are not possible to formalize. Given that there are data representing the culture (what people do, say, use, and values), fewer interpretations are possible. Communication is what counts, not *The* technology; but any technology which satisfies the organization and its members. What is designed might have to be used at *any stage of completion*, also when used operationally and redesigned in the work practice. Thus, design for interruption and immediate use instead of build-up of "ready" solutions are what count. It is necessary to include the whole chain from informating to interpretation in the process.

The overview of design approaches indicates that participation is a prerequisite for any achievement and for not splitting the responsibility for design and use, in accordance with Bödker's (1991) proposal to bring use and design back together. The boundary between design and practice then becomes blurred, but not for the worse. It is justified to have a strong influence on the design of control technologies when the design can be a matter of extinction or survival. In the dialectics of "tradition and transcendence" (Ehn, 1988, p. 7), what design is about, it is vital to support people's own interests (professionalism, power, competence, autonomy). They must be able "to express all their practical competence in designing their future" (ibid.). During design, the social context and history must be kept in mind, and also the fact that actors in an organization remain visible in both the design process and the product. There are several technologies that support ISD, from modelling tools, methods, to programming devices and graphical editors, applied depending on the actual needs and to cover the whole span of perspectives and subsystems. The final choice between different main architecture strategies (e.g. IRM, VBS or networked structures) may be guided by several factors and lead to compromises where the actual business processes better can influence what is done (Axelsson, 1998), or an *architectural IT-management* where design and development are coordinated to a harmonic whole (Magoulas and Pessi, 1998).

3.6.3 TECHNOLOGIES AND METHODS

In the military CP there is a struggle against fear, noise, and sleep deprivation in order to avoid what Beer (1981) called a cybernetic breakdown. What matter is to make work and actors visible (Nissen, 1985a), and to include the whole workspace in the design enterprise. Sage (1987) discussed but did not question the relevance of an artificial order with little resemblance to the nature of command work. In the same spirit it is common that design means a well-developed automation, something that Activity Theory rejects: what has to defined is a suitable and achievable "zone of proximal development" (Engeström, 1987; Kuutti, 1991), underlined also by Hughes et al. (1992). Negligence towards the conditions in the social environment is likely to lead to a bad design of the computer artefacts, in the words of Fischhoff and Johnson (1990), if a manager's philosophy is:

> …oversimplified or overconfident, then the system will be too, despite superficial complexity. The goal of a task analysis then becomes to expose the precise ways in which this vulnerability expresses itself. (p. 52)

In order to start somewhere, looking at informating and informing artefacts, it seems worthwhile to study the army's concept of "walkstations" together with the recent technical solutions to integrated and ergonomic workplace design. These components can hardly be studied in isolation without including for example sensor technology (IR, radar, night vision and image technology). Such an analysis might lead to the need to even redefine what a computer artefact is like. Using "augmenting technologies", for instance building upon the 3x5 cards (Pagonis and Cruikshank, 1992) where the social remains visible, means that the social aspect is afforded by a technology. Another fruitful idea was the Swedish army's vision of the use of a *graphical order*. It is vital to shorten the path from mental image to representation, to generate symbols and, conversely, to interpret these symbols and make sense out of them with little effort. Research has identified some principles that seem to promote interpretation and sense-making. *Affordance theory* (Anderson and Sharrock, 1993) is one of them.

One of the suitable forms for representation might be the simple matrix or template-spreadsheet that can be a complement to the traditional map that has a central role during the communication of the image – information – knowledge. *Kalkylsystem* (Avdic, 1999) may be a design framework and technology, given that their drawbacks can be handled. Together, both affordance and simple interpretation can be achieved, and Langefors' (1993) IS principles are respected: local use, meaning and value.

No representation is capable of carrying a univocal meaning, and then lead to the desired effect, whether controlling action or knowledge. Much work may be required on location to reach agreements about the meaning of signs and symbols, about the components of an IS, even if there is one at all. Hermann's and Just's (1995) experts' systems study showed how experts use ESs: cyclic, non-plannable work, system use modes are non-monotonic problem solving, exploration, medium, and modification, require specific system's functions, in order to admit variety. These modes to some extent correspond with my proposed conceptual structure of a total IS.

PART II
Checking the Equipment

BEFORE GOING INTO DETAILS about the second phase of the research, I summarize and present the research rationales and the contributions from the first part of the study. They are the input supporting the ethnography and the subsequent analysis. I make a brief complementary analysis in order to validate and confirm the first theory, before it is used for guidance of the fieldwork.

The presentation includes the background, the research problems and the process, from methodological aspects to the contributions. In short, the licentiate thesis contains the result of a qualitative analysis of command activities, an application of Grounded Theory. It aimed at theories for description and design of command practices, and for the development of adequate command support technologies (Persson, 1997). This summary of previous work leads to an analysis and discussion aimed at a higher conceptual level of the core category (Strauss and Corbin, 1990) and a separation of the hitherto common concept within the military of "Command and Control" (C2). Altogether this overview and the complementary analysis illustrate the kind of iteration that is part of the research work within the qualitative method. The review consolidates the foundation for the continued work.

Chapter 4
Research Rationales: From Previous to Continued Work

WHEN THIS RESEARCH BEGAN, not only had coalitions and international operations begun to influence the military, but also the increasingly rapid technical change within IT. Starting from the ISR framework, my first field of study was the UN operations in former Yugoslavia during 1993 and 1994. The Swedish military captured experiences from the UN operations in several ways. After-mission seminars were organized at the Swedish International Centre (SWEDINT). The National Defence Research Institute (FOA) conducted a study since 1993 and the Swedish War College (now National Defence College) contributed (Andersson, 1994; Johansson, 1996). The previous focus at domestic operations had to be completed by a wider perspective. My object of study was the *command work* – activities, procedures – within a *military coalition*. My study had three new traits. The first was the focus on *coalitions*, hitherto relatively frequent and relevant for many countries, but so far not in Sweden. The second was to study military command from an *ISR perspective*, which meant approaching the military domain from a new direction. The third was to use a *qualitative method*, initially an opportunistic consequence of the first decisions but, once chosen, it was relevant.

4.1 Introduction: the New Military Practice and Information Systems Research

Behind my research lie primarily three factors. Two of them have led to urgent demands on the command work, control mechanisms and technologies, and thereby to requests for new theory and knowledge. One is the changed European political situation after 1990 which has led to a chain of domestic Swedish events, among these efforts to adapt the armed forces and its command structure to a new political situation, simultaneously modernizing the forces and their command structure. Participation in coalition command structures is one practical consequence of this process. On the level of command work, requirements for interoperability and development of interorganizational ISs (including civil-military relations) mean new requirements on ISD.

Second, in the aftermath of the Gulf War from 1990 and onwards, technological change and its practical consequences have been a recurrent theme in the military agenda, in turn causing social as well as technical changes. Command structures and technologies have become central issues. These socio-technical changes have been a concern within the armed forces for a long time, but the need to find new ways has become evident and urgent, in order to avoid earlier problems and mistakes and reach a new professionalism. Moreover, not only must new and efficient control strategies and solutions be developed, they need to be cheap, adapted to the new political situation, and part of the training system. In other words, they have to be well integrated components in the armed forces, providing a considerable freedom of action for any future mission and context. One cornerstone in this new organization is a theoretically and scientifically informed development of the command practices, the command work, and the related implementation of supporting IT.

Finally, these experiences and events during the last decade together indicate that the general research situation and agenda (outlined in Chapter 2) need to be critically evaluated and completed. This new situation means a control crises which consequently has to be approached with the aim of finding a new “control layer” (Beniger, 1986).

ISR is a young and immature domain that contributes to the total pretheoretical knowledge level in the empirical domain. The debate within the research community about the way to conduct ISR and implement change, between supporters of the hard sciences and engineering, of the social sciences and use of qualitative method, and the possible contributions from ethnography, completed by ideas about Business Process Re-engineering (BPR) has been ongoing (see Nissen, 1985b; Ehn, 1988; Nyce and Löwgren, 1995; and Nilsson, 1995). This situation within research contributes to a confused conceptualization of practice and its relation to ISD. Together, these shortcomings indicate the need for alternative or new research directions, and constitute the starting point for my research. Not only must the social and situated character of the work be clarified, but also the intentions and rationalities at hand, in order to properly interpret and conceptualize work. The continued use of a qualitative approach, now from an ethnographic perspective, will allow this kind of analysis. Then historical and other contextual conditions and contradictions (Strauss and Corbin, 1990; Engeström, 1999) can be illuminated.

4.2 Research Initiation, Overall Design and Early Contributions

4.2.1 INITIATING EVENTS AND INITIAL WORK

In February 1992 the UN Security Council confirmed the creation of the UNPROFOR[1] for the operations in Bosnia as a consequence of the war in parts of former Yugoslavia since 1991. In March 1992, it spread to Bosnia from those parts of Croatia that were previously controlled by the Serbs. A series of armed conflicts then broke out in Bosnia during 1992 and 1993. War in Bosnia and the threat of war in what became the Former Yugoslavian Republic of Macedonia, FYROM, faced the forces. When the Swedish forces first arrived in Macedonia in early 1993, the build-up of the UN contingents was still in process. The situation there did not escalate into war.

The situation in Bosnia required significant co-operation within the UN forces, and between them and Non-Governmental Organizations (NGOs) and Private Voluntary Organizations (PVOs), together with local and regional civilian and military authorities from the different parties. The Nordic battalions (a mixture of Swedish, Danish, Finnish and Norwegian subunits) all worked within this turbulent environment. Each national contingent also had to handle contacts with their national defence headquarters and with the media, from locals up to global actors. These contacts were sometimes very intense and direct. In all, the command function had to operate in a highly dynamic environment because of the unique character of the whole operation.

1. The United Nations Protection Force.

My primary interest was to study the experiences of the first NORDBAT 2 (named BA 01 as the first battalion in Bosnia) because of the complex and dynamic situation they had to deal with. I contacted the battalion before it was deployed in September 1993, intending to make interviews shortly after their return to Sweden, six months later. I investigated the possibility of visiting the units on location but my application was rejected. In order to compensate for this restriction I did some fieldwork in Vienna and in Macedonia in order to learn about international and coalition operations.

Initially my assumptions were (1) that communication systems and supporting ISs within a coalition had to be designed with the recognition of cultural differences, and (2) that ISs and IT can facilitate communication and cooperation among culturally different subgroups. Consequently I assumed that cultural factors and differences can be described and their influence analysed satisfactorily. In my first straightforward ISR approach, I assumed that cultural differences complicate the common actions of the participants and could be analysed and overcome.

Quite soon it became apparent that the concept of culture, and cultural differences, were complicated and that the initial approach was too simplified, far too wide, and the domain too complex (Persson, 1995). This insight is of course a known phenomenon. Silverman (1993) underlined the risk of errors by inexperienced researchers and confirms that meagre initial results are common.

The revised and more modest research hypotheses became (1) that conflicts and contradictions appear frequently in coalitions and threaten common activities, and (2) that an analysis of coalition command, especially the central functional requirements of communication and coordination, will lead to new insights in the domain. These insights, possibly in the form of research problems, can then guide efforts to develop theories and tools for C2 as such, especially concerning the use of IT.

4.2.2 New Issues, Coalition Command and Interoperability

My purpose was not to examine *UN operations* per se, but instead how the international coalition context affected command work and what kind of requirements which grew from it. Maxwell (1992) defined a coalition as a *temporary, expedient arrangement between states to defeat an adversary or to accomplish some other agreed task*. The problems which surface originate from the need to satisfy various demands for interoperability in order to contribute to the unity of effort.

As the technical command infrastructure grows in complexity, it is intentionally (by an opponent) or accidentally accompanied by a constant risk of fatal breakdowns and inflicted damage (Holley, 1988). A coalition example from the Gulf War (1991) is that in order to establish technical interoperability for a brigade from the Middle East nations within the alliance, required work by 70 soldiers during 80 days and 27 tons of equipment (Scales, 1998). In this war, liaison officers were other necessary means for cooperation. It is understandable that internationally too the demands for interoperability is now strong (Rigby, 1995), possibly further stimulated by this war. One of the foci for what is called the International Digitization Strategy is multinational cooperative programs among most Western nations, the belief being that digitization is the way to follow because it will:

> enable the 'Army of the 21st century' to win the information war, and provide deciders, shooters and supporters with the information each needs to make the vital decisions and win the overall campaign.... This information is tailored to the needs of each [one] allowing...a clear and accurate vision of the battle space necessary to support both planning and execution. Digitization allows the warfighter to communicate vital battle information instantly rather than through slow voice radio and even slower liaison efforts (p. 28).

Only the technical meaning of the word is insufficient; any kind of information processing and communication must be included. Such an infrastructure, new kinds of operations and urgent communication and cooperation demands, together emphasize the need for theoretically informed control efforts and organizational engineering.

4.2.3 PREVIOUS RESEARCH PROBLEMS AND CONTRIBUTIONS IN BRIEF

The research problem, to prescribe or suggest how to support military command, especially in coalitions, consisted of four parts, one method-related and three content-related:

1. What research methods and strategies are appropriate?
2. What characterizes "Command and Control" in coalitions? Problems?
3. What theories are applicable for support of coalition command? General applicability?
4. How should supporting ISs be designed and developed?

Derived from some ISR research directions, I formulated hypotheses or made conclusions about the conditions or phenomena in coalitions and what the study should focus on. I expected the occurrence of and wanted to look for a wide spectrum of phenomena such as:

- the existence of ill-structured problems,
- possible suspicion of IT,
- efforts to establish reliable procedures; lack of reliability,
- the importance of social relations and sensemaking (Weick, 1993; 1995),
- the use of informal communication as a way to overcome the obstacles of predefined procedures and means of communication,
- systems development in situ or something similar, and
- examples of de-conflicting and interpretation of control information.

The *contributions* of the first study (Persson, 1997) are answers to the research problems which also underlines the value of a qualitative ISR approach (one of the research problems). The transformation of operational military problems into researchable ISR problems is an important methodological and pedagogical phase that hardly was approached however. One conclusion was that command and control (C2) consisted of goal-oriented but basically non-rational processes. An aspiration that still waits to be achieved is that the result should be sufficiently practical to be considered relevant by the military who really needs efficient command methods and support systems. In summary, this qualitative study

1. demonstrated the application of grounded theory;
2. presented an evolving grounded theory for it: *Constraint theory*;
3. outlined some aspects of *support of constraint management*, aimed at guidance for IS design and development.

The first phase left out some issues that could not be clarified. Basically, the *validation* of the grounded theory remained unsolved. Another need was to explore the conceptual relations within the combined and vague everyday military concept of "Command and Control" (C2), less suitable for research purposes. I concluded that the outcome of the first phase, the grounded theory, may be especially applicable in continued research in logistics. These matters are analysed and discussed in some length, because they have informed the second phase of this study. In order to open the result for investigation, extracts from the data and some analyses are presented.

4.3 Overview of Research Method, Process and Data

4.3.1 METHOD CONSIDERATIONS

Madnick (1995) states that researchers' need to understand the management problems and the available technology. My own military experience certainly was a resource to rely upon but at the same time necessary to use with distinction in order to avoid biases. After having considered Giddens' discussion (1979) of the role of researchers' and operators' *mutual knowledge* in order to understand and explain the latters' *common-sense* knowledge and behaviour, I realized the risk of being too ready to accept this common sense.

Within ISR various procedures and methods are suitable: a combination of qualitative and quantitative methods, multi-methodological approaches, case studies and even systems development (Zigurs, 1993). The latter is referred to as the "hub of information systems research" that "interacts with other methods to form an integrated program" (ibid. p. 115). The two domains, the military and the ISR community that becomes united through the research influence both research method decisions and process decisions. Each domain or "community" (Keen, 1991) is a framework that models the research problems and their description.

Because I perceived the practice of military command as pragmatic rather than theory-based, and the theoretical consciousness generally being low, the new conditions justified a closer study in order to discover what command was about. In particular, a better understanding of practical command problem solving was required as an entry point to a deeper analysis leading to a theoretical insight. The choice of qualitative method, even if tentative, was assumed to enable a discovery of new aspects of command and the *generation of hypotheses* (theory) rather than testing them (it).

The research strategy thus became a translation and feed-back process, an attempt to be true to a suitable method and take one step after another. Operational problems must be iteratively tested against other cases. Once operational problems are defined, they have to be formulated as to be researchable, before they can enter the ISR commity.When results are fed back, scientific solutions might be sufficient for subsequent research efforts but validated in a dialogue with the practitioners before they enter into the field of command for implementation. As it turned out, the habitual concepts from practice remained a concern and a threshold to overcome. In the absence of theory, few alternatives existed when trying to describe the

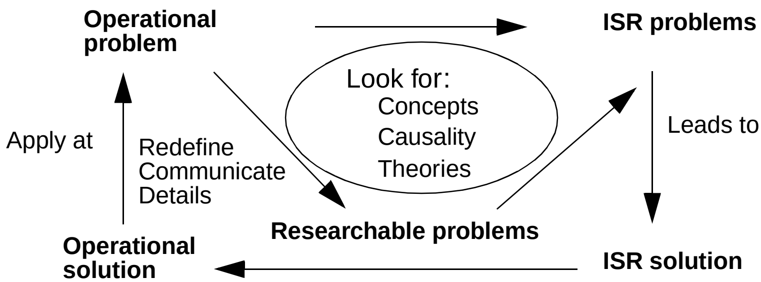

Figure 4.1: Transformation of problem and solutions with iteration.

practice and work on a higher level of understanding and abstraction. The process is illustrated in Figure 4.1,

The choice of perspective on the research domain and how ISR is framed then affects the successive decisions about method and process. Influences from the academic community guide the conceptualization and structuring of the result. In summary, several steps in the research process receive input from the research domain and from the research community, from the data production to the analysis of the data.

4.3.2 GROUNDED THEORY

The interviews of and discussions in Sweden with individual Swedish officers who worked within the Nordic battalions and as members of the multi-national staffs were the main method of producing data. The research tradition of *Grounded Theory* (Crabtree and Miller, 1992), means using a stepwise analytic approach to analyse data, to create theories and then to iterate between these activities (Strauss and Corbin, 1990).

Grounded theory, according to Strauss and Corbin, is inductive but with a strong iterative trait because of its successive validation in data. There are voices *against* the use of grounded theory (Silverman, 1993): grounded theory says more about the *generation* of theories than *testing* them and may also “degenerate into a fairly empty building of categories” (ibid., p. 47). However, because my aspirations were modest, this would cause few troubles.

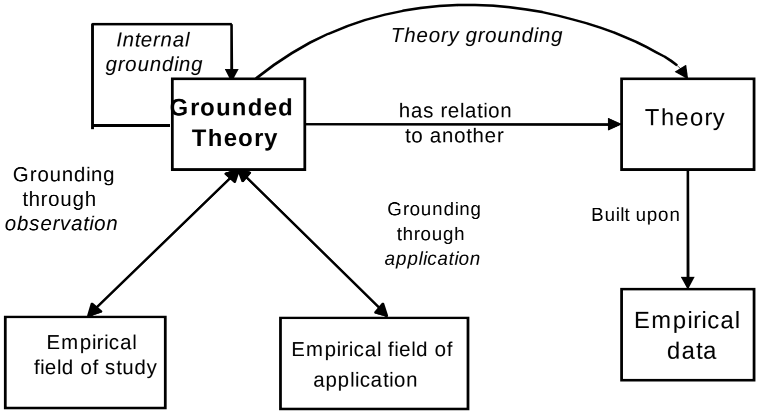

Figure 4.2: Anchoring of the grounded theory.

The principal ways of this "grounding" are shown in Figure 4.2. The grounded theory itself is "anchored" in three directions. The directions are (1) in other theories, (2) in the actual case through additional observations, and (3) in another empirical field.

Miles and Huberman (1994) underlined the content of the qualitative analysis and said that a "chronic problem of qualitative research is that it is done chiefly with words, not with numbers. Words are fatter than numbers and usually have multiple meanings" (p. 56). Keeping this in mind, I had to keep a record of the context and surrounding events. Also, when analysing interviews I had remember that the words were created during the interview but described events before it, and I had to try and compare this with other accounts and if possible with other data.

The General Systems Theory (GST) (Schoderbek et al., 1990) was the basic theoretical framework for the initial analysis of control (and command) activities. The use of specific theories for IS design considerations was outside the first part of the study. To some extent I applied a methodology for change analysis as a framework.

Whether the study would be sufficient for testing the method was uncertain. Some assessment of its validity became possible because of the iteration during the process. As it turned out, the research became a process of discovery, rather than a process of validation.

4.3.3 RESEARCH PROCESS – SCHEDULE AND DATA PRODUCTION

Before the actual interviews about Bosnia, I made one-week visits to the internationally composed Initial Operations Planning Group (IOPG) in February 1994 in Vienna (working under the European Security Conference), and in March the UN forces (among them Nordbat 1) in the Former Yugoslavian Republic of Macedonia (FYROM). The limited purpose was to make observations and interviews on location and to acquire a feeling for what international operations might mean. The experiences from these trips were valuable and provided several insights into the coalition perspective and concerning military-political interaction. Conversations with two of the Swedish battalion commanders gave valuable complementary insights.

When the first Bosnia battalion (BA 01) returned to Sweden in April and May 1994, it was easy to re-vitalize the contacts from September 1993. Most BA 01 interviews were made shortly after their return. I repeated this procedure for some additional information later when BA 02 had returned (winter 1994-95). In the meantime some complementary data production was performed during the BA 01 after-mission seminar at SWEDINT. The interviews were mainly focused on the common activities performed during military staff work. Little effort was made to link this to ISR during the interviews, even if the basic questions were formulated so as to cover communicative activities and information issues, and to capture situations or procedures that were conceived as problematic. The choice of interviewees was made in accordance with the considerations that they should:

1. be of sufficiently high rank or have been in such positions where they had been involved in command on tactical–operational levels; and
2. have been in contact with cooperating partners from various nations and with NGOs and PVOs.

Those who were interviewed had served in common staff positions, from Chief of Staff (COS) and below (Operations, Signal, Liaison and Logistics). A few had been commanding officers (battalion or a company). Three persons who had served in the Bosnia-Herzegovina Command (BHC) HQ from September 1993 to September 1994 when the BA 01 and BA 02 battalions were in Bosnia belong to the interviewees. Most interviews were recorded on audio-tape lasting approximately 1.5 hours. In all there is around 15 hours of recorded conversation from 10 interviews, all transcribed, plus notations and documents from other meetings and conversations. In addition to the interviews I also gained access to reports, official documents, regulations and military publications as well as memos and letters. Finally, I produced notes from the BA 01 and BA 03 after-mission seminars.

The data have a considerable breadth concerning the positions that are described. The interviewees generally describe more of their overall work rather than going into detail in some special situations. However, it was possible to analyse some situation from more than one perspective because of the accounts of it provided by more than one person, thereby gaining a deeper insight into the command practices.

4.4 Contributions of the First Research Phase

4.4.1 THE QUALITATIVE ANALYSIS

A basic requirement on a qualitative analysis process is that it should be well documented (Miles and Huberman, 1994). Because the whole work is highly iterative, I started out by trying to describe primarily what has been done and the rationales for my choices, pausing at some stages. I followed the methodology outlined by Strauss and Corbin (1990). The steps in the coding procedure during the stepwise analysis, are:

1. *Open coding*, meaning “the process of breaking down, examining, comparing, and categorizing data” (p. 61);
2. *Axial coding*, meaning “a set of procedures whereby data are put back together in new ways after open coding, by making connections between categories” (p. 96). A certain coding paradigm is used as a model or schema, and may be designed according to the actual data and purpose of study; and
3. *Selective coding*, meaning “the process of selecting the core category, systematically relating it to other categories, validating those relationships, and filling in categories that need further refinement and development” (p. 116).

The purpose of the stepwise analysis is to find categories/ phenomena which can, in the selective coding, be grouped around a core category.

The phenomena I started with were, for instance, command activities, information processes and communicative actions, technologies and related problems.

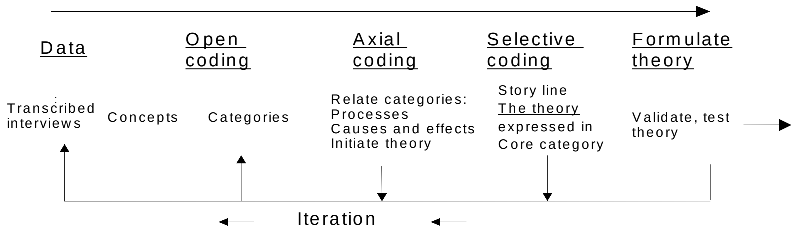

Figure 4.3: The qualitative coding process with iterations.

I illustrate the analytic steps in Figure 4.3.During the *open coding* I created or used concepts according to the data, compared and established categories. During the *axial coding* I used the first categories and re-defined some of them as *subcategories* of a certain *major category.* This was achieved via a *coding paradigm*, a structure for support of the establishment of the *causal links* and the *relations* between the open coding categories.

The difference between a plain *description* of a case and a *qualitative analysis* is the structured re-coding during the axial coding. The *selective coding* is an integration of all categories on a higher and more abstract level (ibid. p. 117). The *story line* is a way to "conceptualize a descriptive story about the central phenomenon of the study" (ibid. p. 119), which when analysed becomes the *core category* (ibid.). (Everything can and must be *arranged* around this category, said Strauss and Corbin). The relations between all these (former) categories, now subcategories and core category, express the *grounded theory.*

4.4.2 OUTCOME OF THE ANALYSIS

The *open coding* resulted in 16 categories, each one derived from several concepts, either present in the data or derived from it. These categories were grouped into five subgroups in order to facilitate my understanding: first those related to the *UN forces and the internal mostly structural conditions* within the battalion. Then there are four categories of *communication and other C2 activities*. The third group contains *cultural factors, emotions and relations*, and the fourth group *unpredictable factors, incidents, events and errors*. Finally, the fifth is of a *concluding character*, and contains *constraints and constraint resolution*.

During the subsequent analysis, which was based upon the conviction that causal chains can be defined in these kinds of activities (even if rationality may seem blurred), I looked for issues such as relationships between problems, shifts between media or modes during communication and use of mediating technologies. No mathematical relations exist between events. Rather, a number of situations together successively led to assumptions about causality and then allowed a structuring effort. Table 4.1 contains the schema for the *axial coding*.

Table 4.1: The definitions of the axial coding paradigm terms.

Terms	Definitions
Causal conditions, event/state	Some are interpreted as problems, external or internal within the command organization; Can be the actual state, a report or a physical event.
Command intention, idea or goal	What the interviewees describe or we infer as their intention, command action category or managerial activity, possibly a problem.
Contextual factors	Represents the set of properties around a phenomenon, its dimensions, and is also the set of conditions around the actions taken to manage the phenomenon.
Communicative and command activities	May be independent or systematic routines, individual or collective activities, formal or informal
Result/Consequences	The effect of the communicative action; intentional or unintentional

An example of the axial coding is as follows:

For unknown reasons artillery fire at a coalition unit which is escorting a convoy (*causal conditions*), leads to the intention (*desired result/goal*) to make a protest or to respond with fire such as Close Air Support (CAS) (*communicative action*) and stop firing (*result*). If possible to announce it all to the world (another *result*) because the mass media influence the parties involved (*contextual factor*). The firing occurred during daytime with good visibility and was close, unannounced, and sporadic during a period of half an hour in spite of the presence of UN vehicles (*event*). Furthermore, the convoy was carrying supplies to a refugee camp (*contextual factors*). The ROE do not permit immediate response, nor is it possible to reach the superior commander because of unfavourable radio traffic conditions (*contextual factors*). The efforts are initiated with the help of the communications system, pre-specified report format and procedures (more *contextual factors*). However, a counterattack may later lead to retaliations and hit back at the UN force (*possible causal conditions*). Efforts are initiated first to verify and gather detailed information and then to send a report, written or vocal (*command actions/ interaction*). The outcome may be that the request for fire support is not accepted (new *causal condition*) and that the hostile firing is not reacted upon in other ways than via the report (*consequences*).

Initially, the axial coding left me with 10 new categories that formed the foundation for the core category. The *story line* (foundation for the core category) which summarized all actions described how commanders and staff were busy trying to manage physical, mental, formal, administrative, and a multitude of other *constraints* which came in many shapes, some of which were clearly coalition-related. Because the situation was dynamic and changing, the same management strategy was not automatically applicable from one time to another. In summary, the core category was labelled *constraint management*.

The overwhelming constraint *in war* is between the need to survive and the obligation to manage continued operations and achieve the objectives and goals at any cost (almost) if necessary. To this can be added to keep the distinction between who are enemies and who are not, controlling emotions, obeying rules and laws. The situation in Bosnia was not that difficult even if the UN framework meant constraints of another kind (economy, large administration, rules) when troops *were in a war*. In order to resolve goal constraints, an organization and its actors may negotiate, define and redefine the mission, the derived goals and their significance. The coalition meant *diminished* constraints in other respects, such as access to additional sources of power and competence; resources for communication, intelligence or Close Air Support (CAS), and specialized forces other than the national ones. BA 01 could, for instance, rely upon its tank squadron, armoured vehicles, satellite communications, wide economic frames, and helicopters.

The core category and the related subcategories from the axial coding are illustrated in Figure 4.4. Everything else can be grouped around the core category:

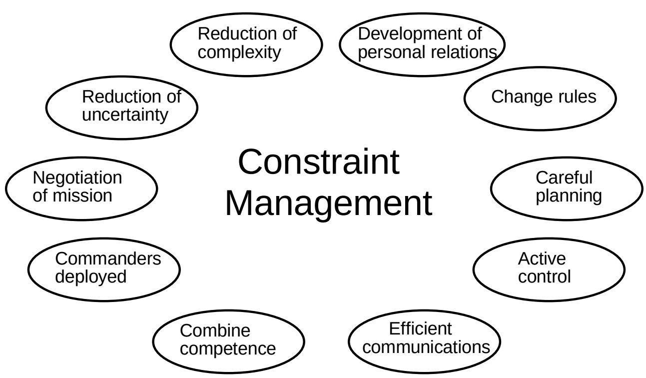

Figure 4.4: The Core Category and the surrounding subcategories.

every action or strategy, all subcategories, describes a certain attempt to facilitate work and reduce complexity in everyday C2 activities.

4.4.3 EXEMPLIFYING THE THEORY

A few extracts from the transcribed interviews demonstrate the accounts and the analysis. The description made by Person J (interview data) is one of the most striking examples of constraint management. In Table 4.2 his account is referred to sentence by sentence, with comments according to its content. Here we see the use of *in situ* development when J explains how he used his PC software.

Table 4.2: Several approaches are combined during constraint management:

Accounts from interview (data)	Constraint	Constraint management
"We had for example an enormous amount of routine work.	The amount of routine work	Routinization, and to overcome amount, boredom?
One wrote reports that were identical from day to day you see. I mean to have templates and such things saves lots of time and effort ... [mm] ...	Reporting took time	Common format, standards, templates
So to ... all this record keeping	Many records to update, manage	Records have pros and cons
I sat down on my own and made for the logisticians	Logistics means *work*	
down there Excel commands which sorted containers and such things ... to get them in different classifications and how many there were and so on.	Individual work tedious, takes time, J a manager who might have other things to do: Few other were skilled	To learn Excel, to do it without intermediaries; Sorting and categorizing
One just could feed them in and then press a button	Constrained input	Simple handling of software
and then one knew how many and which containers were in Split at that very moment ... [yes]...	Split is a remote harbour town	Overview and relevant data, a quantitative control mechanism.
. [...] ... for me it is evident that these support ... support systems are necessary		Support technologies
but one <u>must have</u> a typewriter, one must have a calculator all the same for no human can do without.	To be left without technology	Supporting technologies for communication and quantitative work
Except the commanders themselves who can do without because there are other persons around who do it for them."	Commanders generate jobs	Social system, definition of roles and division of labour

Another example, also from the interview with Person J, is the following where he describes the need for personal relationships and simple communication when emergencies occur:

> A thing which one can verify is important for the function of the information flow between commander and subordinate commanders on every level and between HQs is actually that the individuals have met. We tried to practise and practised to some extent that our Dos (Duty Officer) for instance were out at a company for 24 hours and sat together with their DO. Our DOs visited BHC HQ and met the DO there and then it became very pleasant to talk for two weeks or a month with a person over the telephone and see him in front of you. It becomes so much easier next time when it is no longer a routine report but something special which has happened and one calls and talks not in terms of a written message, but talks officer to officer in some way. To know with whom one is talking. Independently of how one automates the message flows one must know in some way or another what kind of individual it is at the other end ... [...] ... It is very much such things that one definitely needs the human communication just to exchange values and judgements. Factual information preferably can be sent in a standardized format.

Formalized methods often become irrelevant because the social world resists organizing in that way, and instead mean new constraints. Several alternatives were often exploited because new constraints and resistance within the social world occasionally make the first choice irrelevant. Especially in logistic matters where bureaucracy was strong, this was common. The notion of *constraint management* is consistent with the conclusions that van Creveld (1985) formulated:

> it is vital that the formal communication system be supplemented by an informal one that acts, so to speak, as lubricating oil [...]. As several examples in this study have sought to demonstrate, the danger that formal communications reduce command, and indeed thought itself, to trivia is a real one indeed. It must be guarded against by a design that deliberately leaves room for face-to-face, unstructured interaction among people who know each other well enough in order *not* to limit their exchanges entirely to the line of business. (van Creveld 1985, p. 273)

I had formulated a hypothesis about expected findings that might be pointers toward research problems and approaches for continued work. I conclude that in the data, for instance, phenomena such as the existence of ill-structured problems, the importance of social relations, the use of informal communication as a way to overcome certain coalition conditions and systems development *in situ* demonstrated the search for solutions to command problems.

Military actors seemingly share a common social and professional capacity, or culture. It makes them inclined to use various pragmatic techniques in order to initiate and participate in a complex flow of social and communicative actions, aimed at the establishment of new purposeful action patterns and procedures. This phenomenon confirms Carrithers' (1992) sociality theory describing the role of cultures and social behaviour: "people do things with, to, and in respect of each other, using means that we can describe, if we wish to, as cultural" (ibid. p. 34). Furthermore, it implies that in a coalition it is possible to establish a common standard or style for ISs as well. The common socio-professional culture, once its values and practices have evolved, penetrates also the formalized system. Supposedly this culture values the achievement of objectives irrespectably of the means as long as prestige, life or goods are not threatened. Behaviours become opportunistic and rarely possible to predefine.

4.4.4 OUTLINING AND VISUALIZING THE THEORY

First, I modelled the theory for command as a very straightforward process model. This process reduces constraints to the extent that they allow decisive operational activities in order to solve the problem and to accomplish the mission. I illustrated this as a simple process model in Figure 4.5. The perceptions of a problem consti-

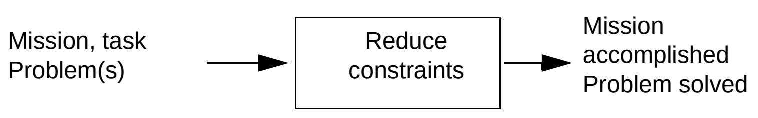

Figure 4.5: The model of the theory.

tute the input, whereupon a process for the management of constraints is initiated.

Figure 4.6 presents an action-oriented theory graph that frames the situation as related to a problem, the mission, the problem solving and the management of constraints. Social actors define problems and frame situations. It implies that a certain "situation" which calls for attention can evolve and then be defined at any time. Some kind of organized action must be executed to resolve the problem, leading to

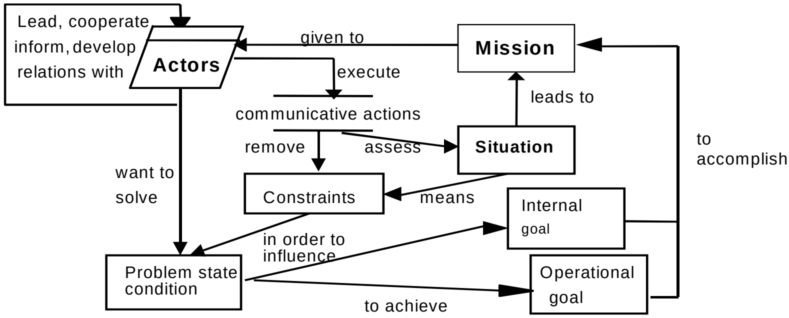

Figure 4.6: Core command activities. Actors assess situation, initiate actions based upon their perceptions to achieve goals.

accomplishment of goals. Together with other actors, subordinated or others, and *with the help of command actions*, the situation is *assessed*, and *constraints can be eliminated* till the problem is solved and the goals are achieved. The interaction and the communicative actions are often mediated via some kind of technology, in real-time or as a sequence over time. Obviously these mediating factors can turn out to be other kinds of constraints. A tentative definition of "Command and Control", based upon the qualitative analysis, and relevant also outside coalitions was:

Command and control is the enduring management of internal and external constraints by actors in an organization in order to achieve imposed and internal goals. Command and control is executed through the balanced application of more or less control via agreed and complementary command and other communicative activities.

(When I worked ahead, I replaced "Command and Control" with only Command, and will come back to this.)

4.4.5 CONSEQUENCES

The results indicated that the basic research hypothesis, questions and problems concerning coalition command could be partly confirmed. Established theories and doctrines for command are *not* insufficient for these new conditions, even if the dominant "rational" paradigm is less relevant and needs to be reinvestigated. *Bounded rationality*, to work with simplified models of situations, to achieve good enough solutions with less than complete knowledge (Schoderbek et al., 1990) was frequent, but the question was what kind of rationality guided the whole effort.

The data indicated that the complex and seemingly irrational interaction of formal and informal actions, communication, and the reliance upon personal and social relationships differed from the ideal orderly, highly structured and routinized activities usually associated with military operations. The latter are certainly easier to define, design and integrate in the command procedures, while the former might be impossible to specify without far-reaching simplifications and generalizations which make them irrelevant in the face of a real situation. Furthermore, actions or rules aiming at machine-like precision (Machiavelli's ideal) instead might be perceived as constraints. Within logistics, this seemed to be common, because of the new mission, supply chains and managerial control from within the UN administration, and because of the long distance to Swedish authorities.

The (grounded) constraint theory can lead to relevant solutions to practical control problems. The results of the analysis indicate that we must question how we describe our work practices and what kind of rationality to rely upon. The results should also affect how the military define themselves and their own professional command activities, and how ISs are designed and used.

A detailed problem analysis during systems development should be conducted with the insight that informal practices are necessary and that constraints are a consequence of actions and *cannot be mapped out in advance*. Standard procedures may have a very limited value, and may sometimes even be perceived as constraints. Problem solutions and outcomes *may seem rational* but in reality hide other kinds of actions, which should be described and analysed.

4.5 Research Rationales and Direction from Previous Work in the Next Phase

These circumstances mean that the basic research rationales that guided the first phase of my research (Persson 1997) still exist. The (limited) aspirations in my work therefore were and still are, first, a higher level of scientific knowledge about and within the domain, and second, the need to find theoretically informed design principles for control technologies, primarily computer-based ISs. Even if army units and to some extent combined such (some accounts from integrated Bosnia headquarters) have been the primary field sites, the result presumably is applicable in a wide range of similar command organizations.

To use Salner's (1989) term again, the understanding of the both the command and the research practices by the practitioners and researchers respectively tend to be *pretheoretical* rather than theoretically founded. Especially when it comes to applied ISR and the use of control technologies, the evident vagueness become counterproductive, often contributing to misunderstandings (Davis and Blumenthal, 1991). The next phase therefore also includes a close conceptual analysis of these common concepts, aimed at a theoretical level of this command discourse, sufficiently underpinned possibly useful for researchers.

This overview presented what inspired the research and what the approach led to. New knowledge claims must be perceived as relevant in order to be able to influence practice. Conflict over knowledge claims must be taken seriously, in the same way as what is relevant knowledge when it comes to war and command work may be very hard to define "scientifically". However, if pretheoretical knowledge ever should enter into a new stage of scientific knowledge, thereby not being reduced to just low status belief systems but taken serious, this is not a finite process. The ethnographic researcher's tasks therefore is to interpret, not only to describe what is going on (Nyce and Löwgren, 1995), but questioning the rationales that are available (Anderson, 1994):

> Rather, the point is to place at the center of design an orientation to the perspectivalism that is explicitly set aside by the adoption of the problem-solution framework and to pose the interweaving of such perspectives (and not their reconciliation) as the challenge for design. The artefacts we design should not subvert the practical logic of the routine world in the name of the rational view from above. Rather, if it is efficiency, effectiveness, and productivity (among other things) we want, why can we not have an efficiency, effectiveness, and productivity that enhances and takes advantage of that logic? (p. 178)

The outcome from the first phase now has guided the next one – focus, method, and process, in the following way: basically, the (emerging) theory for military command and control is by no means validated (even if it promises to be generally applicable). More work is necessary in order to make it more solid and a continued application of qualitative method is necessary. Further, because of the confused concepts within the practice—the terms *command* and *control* usually being treated as an entity, defined by many but hard to analyse, often intersected for instance by *leadership*—the theoretical understanding of what command is becomes obscured. These concepts need to be analysed.

4.6 Summary

The work demonstrates the value and strength of the *qualitative method* as a research methodology. I mapped several problems that occurred in the coalition and was able to generate a theory for support of command, probably not only in a coalition. *Constraint management* was the central phenomenon, the core category, which integrated all command efforts and conceptualized military command. The management of constraints evolved from the meeting between a *situation* and *actors* who had to initiate some kind of common actions in order to achieve their goals. Some constraints were material and physical, for instance lack of resources such as fuel or money. Others emanated from social and political factors (and were present as Rules of Engagement, ROE), formalism and status, or demands for standards and uniformity.

The last step in the analysis led up to a *story line*. Its main content was this:

A tribe of warriors had been engaged in efforts to establish itself temporarily in a potentially hostile territory in a mission where war had broken out, in order to calm down the situation. Some of the surrounding tribes in the mission area were civilized to some extent, but others seemed almost incommunicable and appeared dangerous. Few could be trusted, but it was possible to trade and gain advantages, and even socialize and exchange information. On the whole, cooperation was possible, but had to be conducted according to formal procedures and other rituals which belonged to the common ancestors of the tribes. Sometimes actions had to be imposed with use of force.

Conflicts lured among the men who came from different parts of the own territory, and had few chances to relax and find some leisure. In all, these conditions caused much trouble and emotion, which constantly had to be monitored and checked. The regional mighty chief was extremely fond of bureaucratic procedures and much work was required in order to get resources and supplies, to organize transports and achieve freedom of action. 'Our' tribe had some attractive equipment that facilitated its efforts to settle and became recognized and their identity was positively reinforced after some successful actions. Such an outcome could be a valuable asset even in their home territory after the mission. As it turned out, the result justified the means to achieve it. Eventually the tribe returned safely.

The *constraint management* practices were basically social interaction about technical support, development of routines, and establishment of personal relations for easier communication. The "non-rationality" of actions meant that actors did not hesitate to oppose certain orders and when suitable violate rules in order to overcome constraints and accomplish their mission. The constraints that could not be overcome by the military themselves on location had to be communicated to higher levels and possibly be managed by other means and aided by external resources. What the interviewees described was how the actors used action types they previously had used, relied upon, and could handle over time. Even if breakdowns were frequent, they could regain their functionality.

Concerning the idea of specific requirements in *coalitions*, most temporary organizations, for instance in emergencies, share characteristics with coalitions, even if they are domestic. They rely upon efficient cooperation, interservice formations and protocols for unpredicted actions. Keeping in mind that interoperability is crucial, methodologies and tools for urgent *in situ* development and *redesign* of already implemented support systems are other central issues in command support.

Support of constraint management then becomes the logical concept for a closer study of IS research and design but has to be made concrete. Some examples of this kind of management are the identification of constraints in a situation, and investigation and analysis of constraints in order to assess their character. All this requires *communication* with other actors in order to find bypasses, how to reduce the constraints or to simply accept them. Similarly, support of a long-term enduring process rather than only few and formal decisions is an important capacity for support technologies. The control structure have to support flexible and dynamically evolving work and social interaction, also re-arrangement of the structure itself, unless it is considered a constraint to be circumvented.

Some issues could not be treated in depth in the first phase of the work. Theoretical and conceptual consistency as regards to the central concepts of command, control and constraints was desirable but beyond the present scope. Also, a more careful analysis of logistics was considered fruitful but had to wait.

Chapter 5
Consolidation and Bridging to the Next Phase

THE PURPOSE OF this second retrospective chapter is consolidation, to fill in some of the gaps from the first research phase and to bridge between the grounded theory to the ethnography. The chapter presents a closer look at the first phase of the study and of the command work as visible in the data, and ends with some conclusions concerning ISD. I advance the qualitative analysis and reach a new category level which covers more of the social actions implied but not obvious in "constraint management".

Forestalling ISD it is desirable to break up the usually linked concepts of "command and control" (C2) in order to better understand what social actions were undertaken beneath them. My search for the meaning and the origins of these concepts has turned into a search for the roots of control thinking and of principles for social control, and attempts to refine the constraint theory.

5.1 What was left out?

First, most of the work was based on *accounts* from the Bosnia operation. A short trip to Macedonia early in 1994 only gave a brief impression and limited data about environment and work. Moreover, the qualitative analysis, which led to the conceptualization of command and control as *constraint management*, was by no means exhaustive. The components of the command work could only be assessed, even if an account like this from an officer who served in Bosnia 1993 tells a lot about the content of work:

> To precisely plot the situation on the map, write out coordinates in the battalion order, to record personal conversation, to go out and meet people in the field, to have structured exchanges of duty officers (DO) where you follow a written protocol. Everything like that…boring routines which we learn, it turned out that they make the crucial difference, when something broke down in the staff work, it was almost always possible to trace it back to something we should have done but did not follow…because you become lazy…typically those DO exchanges. If you do not bark at them they will end up waving to each other when they change at lunch time and think that it will work. And then someone calls just during lunch time and there sits a DO who is sitting there only during lunch time and does not know anything. So much about the personal communication….many times it was discovered: But *that* was reported over the telephone by someone to *that person*. Only that you had forgotten to tell the others and it was not documented. (Person J)

As regards ISs and command work, details behind accounts from computer use and systems development have to be more closely investigated, for instance these:

> Well, you got to have some kind of guide, a core, functions which you must recognize both from the staff work in field units at home and in the peace time administration but of course then there have to possibilities to build, and to store your own stuff, to find ways to structure it because you never know in advance….these are the…this is jargon…but you cannot predict all problems that will appear in such situations. And therefore you should not have systems that are too rigid, tailored for an armoured battalion's attack but instead they must be capable of managing these things too...and I think our systems did all right. (Person J)

One account (Person H) concerned the archiving function, the use of computers for storage of archives, and he definitely rejected this use:

> Because such a machine has so many opportunities to break down when you work in the kind of environment we talk about independently if it is a field HQ or a UN staff, it is definitely no office work space. Climatization and such, or…Instead you take out everything on paper, archive safe paper, and archive it in some way. That you have to do. Because if you have something stored here in the memory then you must have the machine in order to be able to search and retrieve and because most systems have limitations in their search and other systems, you have to be extraordinarily structured if you want to save paper or save information in this. So still you have to have access to the paper version…and in addition the technology is so fast and changing so if you have saved in computer media then reality has soon disappeared. (Person H)

When talking about the use of computer use, a commanding officer stated that:

> And there is a tendency, if you do not hunt the staff members that the computer becomes a goal in itself. That is my experience. That people sit behind the damned computer and write and write and write. You allocate too much time to formalities and when the computer is very good for large volumes of information within logistics….absolutely, to send orders rapidly and widely. The paperless office are we, have never been further away from it than when the computers entered. And this I think, I see as my…an important task to see that they do not get stuck behind computers. People have to get out from the HQ too. (Person D)

On the whole, pragmatic and often traditional solutions that worked, guided by the successively growing experience, dominated over theoretically informed engineering efforts. In general, contradictions were numerous (especially in logistics) and seldom resolved neither in practice nor elaborated in the analysis during this first stage of the research. In order to perform a complementary analysis, a closer investigation and reconceptualization of the origins of control thinking is necessary. An unresolved higher level issue from the first phase of the work was the meaning and the relation between the two usually linked concepts of “Command and Control”.

5.2 Constraints and Control, Theory versus Practice

5.2.1 Rationality, Constraints, and Constraint Management

The dominating command work paradigm favours the rational and orderly perspective on actions. This kind of rationality, for a long time underpinning virtually all modern societies, implies that the course of action follows what has been defined as a *logic* process (Goody, 1996). This logic also paves the way for standardization, bureaucracy, and uniformity, hallmarks of the military and parts of its control strategies. Through putting constraints in the foreground instead, military command work becomes interrelated activity and ISs, applied according to *some kind* of logic. Another rationality, added onto the first one, seemingly guides the actions. It includes improvisation, compromises, negotiations of goals and missions, and occasionally even violations of existing rules and establishment of new ones. *Emotions* and *conflicts* were frequent and crucial parts of practice and must not be neglected because of a “rational” perspective on what work is. Even if a certain rationality and formalization have been necessary because of scale, time factors, or spatial conditions, the spoken language still has a strong position in military command, co-existing with formalized modes of symbolizing and expressing social action and relations. The question is whether there are two kinds of rationality, one related to oral and the other (dominant) related to written communication, and if they mutually *support* or *oppose* each other.

Recognition of the role of constraints gives priority to another perspective on decisions than the “best choice approach”. Miser and Quade (1997) cited Herbert Simon, who expressed his view on decisions:

> It is doubtful whether decisions are generally directed towards a goal. It is easier and clearer to view decisions as being concerned with courses of action that satisfy a whole set of constraints. It is this set, and not any of its members, that is most accurately viewed as the goal of the action. (p. 181)

Morgan (1986) held a pragmatic view, and I will conclude with this one. In his chapter on organizations seen as political systems, he discussed the role of *power* and *control*. Specifically, he mentioned the tendency to break rules partly as part of a power play, because they can either block or control activities: “Rules and regulations are thus often created, invoked, and used in either a proactive or retrospective fashion as part of a power play” (p. 165). He continued and described a purposeful and rational kind of constraint management related to control of decision processes: People hungry for power are “wheeling and dealing in terms of agendas that are often hidden to create the decision outcomes that they desire” (p. 166). These kinds of actions are thus purposeful and not random, and should be taken into account when analysing workplace activities aimed at control.

5.2.2 CREATING AND ANALYSING CONCEPTS FOR ORGANIZATION AND SOCIAL CONTROL

It is not possible to understand, as well as desirable, the social actions, meanings and the mechanisms the military usually group under “Command and Control”. Consequently ISD, when relying on these concepts, only gets a high-level conception as the blueprint for systems engineering. During the first phase (Persson, 1997) I did not clarify the meanings of this combined concept, nor did I disconnect the two parts of it, investigating whether more clarity was possible. It seemed sufficient to treat them as the military community usually do, together. Later, when I chose the term “Command” and consequently “command work” I was inspired by Van Creveld (1985) who recognized the problem with abbreviations and military jargon that concealed people’s actions. He suggested to using only the single word *Command*, as “Management” is used in business. When making this choice, his intentions were hardly to enter into a systems development phase and he did not have to be more detailed. My current use of "command work" highlights both formal and informal communication and the interaction between people (Figure 3.8 and the subsequent definition), together called *work*. Eventually, still more pregnancy is required within ISD.

The military institution encourages and searches for reliable control mechanisms because of its very character of an institution with special purposes and capacities. Principles and mechanisms such as unity of command (each person shall have only one superior), chain of command, responsibility, discipline, redundancy, traditions, signs and symbols and various complementary control attributes are applied and represent the core of classical management theory (Morgan, 1986). Words are used or invented to label evolving practices. I interpret the evolution of control-related concepts as the answer to the social need for words, for communication in order to achieve the desired organization and thereby control efficiency. Requirements for (social) control have, over the ages, been the rationales to find and apply suitable concepts. Today the word "computer" is only part of the overt social function of the machine, but the term from the old days survives, born when computing was an important part of controllers' work.

5.2.3 THE THREE-LEVEL CONCEPTUAL SYSTEM

The continued work has indicated that concepts both within command work and research are used in several levels, from the very substantial everyday concepts to higher level abstractions. These levels are the result from historical and professional evolution (Figure 5.1). Some are recognized and formalized, others constitute a fluent mass, used in a flexible manner, constantly recreated. In order to better understand the actions in the social world and direct the development of ISs, the

Level 3: Theoretical level based on practice. Further abstractions and aggregations of actions and events in the social world: dominate, win, conquer, rule, power.

Level 2: Aggregated level of practice. Abstractions and aggregations of actions and events in the social world: control, command, interpret, calculate, negotiate, discuss, plan.

Level 1: Practice. Actions and events in the social world: talk, point, scream, count, control, look at.

Figure 5.1: Analytic approach for the reconstruction of concepts

relations between the different conceptual levels seem worthwhile defining. The ISs researcher, especially when it comes to systems development, has to discover what the actual and original practices were, and consequently has to drill through at least three historical and conceptual levels.

Many concepts are related and hard to distinguish from each other. Perhaps they express “rational” perspectives on social action but can hardly be used in research because they are both vague and part of practice where they belong, carrying implicit and “given” assumptions about the world of practice. To repeatedly define them according to the circumstances seems to be part of the necessary evolution of command work in order to make them usable in varying situations, e.g. supporting control. If the systems designer stays at the intermediary level he might have to use concepts that are ambiguous, too general, theoretically inconsistent or lacking theory. When turning attention to systems engineering, few open-ended issues are allowed: clarity and precision are sought after.

There is probably a strong dependency on artefacts on the lowest level in order to make these actions robust and efficient in large organizations. Another kind of artefacts are needed at the second level, for support of complex operations. Probably it is here that ISs appear, especially when several persons are involved, even if IT can be used on a very basic level, for support of individuals’ action, communication and memory. Concepts have to be analysed in order to find the actions they imply. However, when few details are known about the micro level operations, and if a generic but less precise concept level is applied, the completed “system” easily becomes obsolete if the built-in low-level actions, assumed to be suitable, do not fit the context of implementation.

Researchers’ concepts have a similarly levelled structure, reflecting the needs within research, which are different from those in the (military) practice: to support and control build-up of knowledge, another control factor. Researchers therefore should develop or use *another* concept system in order to be able to talk about what they see and think, but without being dependent upon concepts that are already elastic and constantly renegotiated. Seen from the perspective of practice, this is probably not a sign of weakness, but rather strength in the concepts. In the social domain, flexibility is what counts and concepts which are rigid are likely to meet opposition. Langefors (1993) expressed a kind of concept creation when he discussed the growth of ISs theory: “To make a new science one has to start with the pre-theoretical concepts” (p. 57). Like Langefors I start from practice but will try not to being dependent on its concepts.

5.2.4 THE ROOTS OF CONTROL THINKING: CONCEPTS, VISIBILITY AND COMPARISONS

By describing this successive development of concepts and practices, it is possible to better understand the current, somewhat confused, situation. The most obvious social control practices are aimed at level 1 and possibly level 2 control (Figure 5.1), and are older than the nation state formations. Once “command” and “control” both signified everyday visible actions and IT had many simple shapes.

I have traced a few control-related concepts in order to demonstrate their social origins and meanings (using the chronology from mainly Merriam-Websters Online Dictionary). Most are common in military command work. Their parallel development in European languages has made some synonyms and metonyms, effects of the branching and evolution over centuries. *Lead, leader, command* and *control* were first used in the early Medieval Ages. *Lead* comes from Old High German and Old English and means to go, or to guide on a way (especially by going in advance), to direct (on a course or in a direction, operations, activity, or performance), to have charge of, to go at the head of, to be first in or among. A *leader* is a person who leads: as a guide or one who directs a military force or unit, a person who has commanding authority or influence.

Command has about the same age, meaning to direct authoritatively, to exercise a dominating influence over, to overlook or dominate from a strategic position, to have military command of as senior officer. *Control* is younger, from the 15 - 16th centuries, meaning both artefact and activity. It comes from *contrerolle* (French) meaning a copy of an account, a double register, and is derived from Medieval Latin *contrarotulus.* It means to check, test, or *verify by evidence*, to incorporate suitable controls in (something). Persons who controlled were called *controllers*. They had power, exercising restraining or directing influence over others.

Manage (1561) and *management* (1598) appeared later but have similar meanings, related to commerce and typical for the Early Middle Ages. *Manage* means to handle or direct with a degree of skill; to exercise executive, administrative, and supervisory direction of (a business, to direct or carry on business or affairs), and to achieve one's purpose. *Management* consequently is the act or art of managing : the conducting or supervising (of a business), or the collective body of those who manage or direct an enterprise. *Leadership* dates 1821, meaning the office or position of a leader; capacity to lead; the act or an instance of leading.

Management connotes a certain level of organizational and economic activities. The surprising jump to *leadership* from its forerunners reflects the need for a higher-level concept when business organizations and industry grew into larger entities, left the family domain, and professions had to follow.

I assume that each concept, being the answer to a need to communicate, to control, to describing and organizing human activities, giving them a social sense, presupposed a basic social organization and means of communicating intentions. But we do not know exactly which actions or what work these concepts expressed or summarized, how power relations were established, or what artefacts they were related to, except for *control*. I present the findings here because there are well-established experience to learn from.

I traced control practices and artefacts used within accounting because there the practices seemed to have been remarkably robust and widely used. The duplicate register (*contrerolle*) had its predecessors. I reached not only the *contrerolle,* but also simpler tools that shared its functional properties, for example to verify by evidence, although not exclusively based on writing. One of these was the *tally* or *tally stick:*

> The *tally* was a piece of wood or a twig (tally is derived from a Latin word *talea* meaning cutting and twig). Marks could be cut in it, as messages or records of calculations (symbols, data). In Medieval England tallies were used when taxes were delivered by sheriffs to central London authorities (Chatfield, 1977). A narrow hazelwood stick, eight or nine inches long, notched to indicate the amount received. After the amount of the sheriff's proffer had been carved, a diagonal cross cut was made an inch or two from the thicker end of the tally, and the whole stick was split down the middle into two identically notched parts of unequal length. The flat sides of both pieces were inscribed in Latin to show that they related to the same debt, and as additional protection, the cross cuts were made at various angles on different tallies, so that the halves were unique and could not be united except with the right half. The sheriff departed with the stick as a receipt, and the foil was kept by the treasurer for the archives. At Michaelmas a Receipt Roll was centrally compiled when the sheriff returned. The calculator was positioned by the Exchequer table (another artefact) and there the coins according to the tally stick were positioned. After the tally stock and the foils were fitted together in order to make sure the cuttings corresponded a new tally was made for the adjusted amount of money received/delivered. In England tallies had a central role during 600 years and were not abandoned until the early 19th century (Grandell, 1982). There were various types of tallies, both single and double: reckoning tallies, message tallies, turn tallies (used much like relay-race baton), and occult tallies (telling the future or for drawing lots).

Artefacts are, almost without exceptions, an expression of a certain logic and rationality resting upon the belief that control can be separated from human intervention, it is a basic idea and explains their strength. They symbolize the abstraction and rationalization of social control by other means, distinct from direct human intervention. The whole artefact is a symbol (of authority, rationality), its marks (cut, written) representing additional meaning. Payrolls (*the modern contrerolle*), written law, the ten commandments, spreadsheets, computer programs, are all designed to be or can function as *instrumentalized means* for social control in its abstract meaning. Each presupposed specific, often combined actions for social control, including coding and decoding of meanings.

Turning to *command* and *lead*, humans were involved but text and signs were not prerequisites (Chatfield, 1977; Massie, 1987; Antvik, 1999). Instead the *human was the symbol* or even *artefact*, marked by uniform and insignia.

5.2.5 CONTROL, FROM VISIBLE PRACTICE TO ABSTRACTION

Control presupposes a goal, plans, intentions, something to measure against and compare, in order to guide and direct actions and decisions. The modern concept of "control" (signifying both concrete actions and artefacts, and abstractions) originates from the variety of social control methods humans have invented and formalized in order to achieve controllability external to the human who is in command, the manager. Two aspects are crucial. One is that control connotes a certain *visibility* of the social control, overview, possibly with the help of abstractions or indicators, involving various mechanisms in order to achieve social control: commanders, law, procedure. Engeström's statement (1999, p. 63) that "Attempts at making everyday practices of work visible are driven by different motives. In various management techniques, the overriding motive of visibilization is control" is valid. The other is that what occurs is a *comparison* from which a goal or purpose is first derived, and then used as one part of the double register for verification. In management theory, *controlling* is the "process that measures current performance and guides it toward some predetermined goal" (Massie, 1987, p. 5). Humans try to implement technologies, foremost IT, to get the desired result: predictability and controllability. Technologies became important in early and medieval commerce, and allowed calculation of costs, profits and losses (Hoskin and Zan, 1997), double-entry bookkeeping described by Luca Pacioli already in 1494 in his accounting manual (Pacioli, 1494 (1994 ed.); Massie, 1987). Assumed but not explicit in this definition are means and tools for comparing and correcting actions, hardly scientific solutions but rather simple and pragmatic means for social control. Presumably, the faster and more accurate the comparison and subsequent correction, the better and more efficient the control. History demonstrates that even the simplest artefact can promote stability and precision.

Control has, more than command, along with the development of systems theory and cybernetics quite recently got a more abstract theoretically loaded meaning

(Persson et al., 1999). It has become more "scientific" while "command" has been seen as art (TRADOC Battle Command Concept 1993) and is weak in theory. By continued use but without trying to reveal the presupposed but subtle, often invisible acts, assumptions and work behind them, more confusion threatens, especially when trying to design supporting technologies.

From F.W. Taylor's work and onwards we talk about *scientific management* (Morgan, 1986). My review shows that Taylor hardly invented control methods and artefacts, but instead conducted systematic studies of work and made work standards and repetitive tasks the norms. When studying command work similar approaches are necessary in order to get data for ISD, but the augmented complexity and its non-repetitive actions, and those actions implicit in modern IT, complicate scientific efforts. Both researchers and practitioners experience knowledge and control requirements that push for the pragmatic invention of new artefacts and techniques, guided by theory but not controlled by norms treated as given.

5.3 Military Control, Conceptual Analysis and Synthesis

5.3.1 Modern "Control", Theory and Technology

Concerning the concept of *control* and how it is used in the military, some remarks and an overview are necessary before the renewed analysis, just to relate the whole work to ISR and Computer Science. *Control* exemplifies, as we have seen, a certain kind of rationality. When activities evolved over long time periods, long distances and with many people participating, the control practices had to be reliable. Just because of the need to make processes independent of individuals, people invented and applied methods and technologies to overcome the limitations (constraints) of having individuals responsible.

Control methods based upon writing led to the fact that more complex chains of reasoning (formal logic, mathematics) and transactions could be tracked and recorded (Goody, 1996). The development of the *written operations order* has been systemized mainly during the last two hundred years (van Creveld, 1985; Filiberti, 1987). Its evolution reflects the organizational context where it is produced and used. Earlier, written texts occurred, but were rather messages between commanders and subordinates, for instance letters of instruction (Corlett, 1925). The first modern operations orders were written *before* the actual battle, in a headquarters, intended to be received and processed by another headquarters. Another order category is when successively given orders (orally) are summarized in text format.

When a social organization can rationalize its control methods, there is less risk that they become corrupt: the ideal bureaucracy exemplifies this kind of thinking. Thus the tools involved in and designed for control show a remarkable continuity. To apply a rationalistic perspective, we say that they aimed at neutralizing the ‘unreliable human factor’, the tendency for behaviour so often demonstrated by humans and seen as erratic. Unfortunately, the imposing of logic and categories in bureaucratic ordering and record keeping may determine what is discovered, labelled and retained, and what is thrown away when change is initiated.

When in the mid-nineteenth century technological evolution seemed to threaten hierarchical authority, changes related to mechanization and electrification were harnessed to enhance the centralization of command authority. The stratified pyramid remained the basic model of authority in armed forces. The general staff in Prussia was an attempt to make command and control/management scientific, maintaining the myth that the king still commanded the army in the field in war (Beaumont, 1994). The tradition lives on. One of the informants from Bosnia said, when commenting upon the modern basic work routines:

> Of course there is a difference concerning the design of headers and footers on pages but oral briefings for instance, all officers in every country in the world do, damn it, oral briefings in exactly the same way. Yes, sometimes I wondered, it would be a very interesting study if all this originates in the German General Staff during von Moltke’s time, when they started to construct everything about staff work. Sometimes I wonder whether it would not be possible to trace all this back…(Person J)

Looking at modern control technology, for a long time *what can be automated?* was the fundamental question underlying all computing (Denning et al., 1989) and humans being regarded mainly as operators of computers following the logic of calculation. More recently, Dahlbom and Mathiassen (1997) suggested another approach to the computing discipline, one that is closer to my work. They stated that the study of computers *in use* must be given higher priority because computers now penetrate all aspects of organizational life, having become more important and pervasive. For them, a computing professional needs to be attentive to the role of computer applications as instruments of control (I would like to stress, as instruments for *social* control, because this is what matters in work). Earlier work within computing disguised this. Comparisons, central in control, certainly can be automated, given that there is something to compare between. This “something” first has to be defined by humans and once this is done, modern IT can support action.

Recalling the notions of constraints and constraint management, it is perhaps more relevant to talk about how to achieve a goal by *not* following a certain (automated) procedure within social systems. Instead, to vary the procedures yet reach the intended goal from time to another is what counts, equifinality, and construct arguments and concepts that support such behaviour. A modification of the previous automation tendency when studying social systems is that the control certainly must be a continuous process, but its methods must vary considerably between implicit and very detailed explicit control actions.

5.3.2 CURRENT CONCEPTUALIZING OF CONTROL

When I consciously used the combined term of "Command and Control" (often abbreviated C2) as an entity, although it could be defined in a multitude of ways I was influenced by the international command discourse and literature. Rice and Sammes (1989) stated that Command and Control at the same time are the most obvious of the terms available for command, but that all commanders and staffs, unfortunately, have their own interpretation of its meaning. Holley (1988) gave a probable explanation to the appearance of this double concept:

> When technical intermediaries had to be substituted for the eye and the voice of the commander, it gradually became evident that two rather distinct functions were present. Command….involves perceiving and deciding…Control, on the other hand, involves the communication of the commander's decision to his subordinate echelons, followed by continuous monitoring, not only to ensure compliance and to coordinate the actions of diverse elements, but to sense the changes in the situation that may require modification of the initial decision. (p. 268)

Holley's metaphor is that command is the pilot while control is the autopilot, acting within the settings defined by command. While he has made some distinctions, he still has not reached anything usable for the ISR: the concepts still are mid-level constructs (Figure 5.1), being both intransparent and presupposing diverse actions (Figures 4.4 and 4.5). Their concepts' multiple meanings have been further complicated by the tendency to add more "C's" (Computers, Communication, etc.). When the combined term "Command and Control" is used, *control* has both new theoretical *and* old practical meanings. The *theoretical* 'control' now is executed in many ways in social life. To *command* is itself an act of control, to "direct" towards a goal by a socially and legally recognized person in an appropriate manner.

Behind the everyday level 1 and 2 concepts (Figure 5.1) are manifold actions. Because some concepts are used by both researchers and practitioners and on more than one level, confusion threatens. Even the subtlest term can lead to revolutionary changes if only it is interpreted and accepted as a signal (to follow or to oppose). Just as with many words, they are useful in everyday life but do not yield analytical precision or support the development of a scientific foundation for one of the most dynamic social institutions, namely war. Theoretical and rational control seldom touches upon the human and social aspects of practice, which remain unobserved and unnoticed.

5.3.3 SEPARATING COMMAND AND CONTROL

If the concepts Command and Control are separated and their theoretical relation clarified, some will be gained. Command, diverse practical efforts and tools, tend to be subsumed under control (McCann and Pigeau, 1999). Consequently, it is difficult for IS developers and users to get a clear idea of what kind of actions in the social world the concepts presuppose, when 'control' is the common term. This problem has contributed to the difficulties when modern IT is *applied in the social practice of command*, but *designed mainly for abstract control functions* according to what is perceived as the common rational practice in command work. Systems science is closely linked with assumptions that have guided the development of information (control) technology and easily leaves out what is not "rational". Pigeau and McCann (1998)[1] tried to redefine the control concepts. They saw that

> …the human component of C2 has been chronically underemphasised and underresearched (Pigeau & McCann 1995). It has been all too easy to get swept away by the allure of technology (e.g. battlefield digitalisation) with C2 becoming obscured in conceptualisation of structure and process. We have also argued that existing definitions of Command and Control have provided little guidance either to the military or to industry for allocating scarce resources for supporting Command. (ibid., p. 2)

> ...Command is the authoritative and responsible expression of human will for the attainment of a mission, whereas Control is the application of structure and process for the purpose of bounding the mission's problem space. C2 should be more than a simple restatement of these two concepts. It should be *consistent* with Command and with Control (as separate concepts) but it should also make a unique contribution of its own.

1. Pigeau, R, and McCann, C (1998). Re-defining Command and Control. Proceedings of the Human in Command Workshop (unpublished), Kingston, Canada, 8–12 June 1998. Proceedings later edited to "The Human in Command: Exploring the Modern Military Experience", Plenum Press 1999; Pigeau and McCann pp 135-160.

> *Command and Control: The establishment of common intent and the transformation common intent into co-ordinated action*...(ibid., p. 3)

From their point of view, *only humans command*. In my terms, in the practice humans “command”, but in theory (concept levels 2–3, Figure 5.1) humans *control*. They do it, for instance, through commanding and through multiple other actions in the world, some of which are mediated through abstract systems, while others are physical and visible artefacts.

I assume that the vernacular “Command and Control” is the answer to a need within the military practice for an all encompassing concept, satisfying practitioners and sufficiently scientific to be credible. This twin concept includes both the actions by commanders and the work by staff, either making command more reliable, or preserving traditions where the human factor has had a strong position. However, its meaning is seldom stable enough to be used directly within research. The concept is often used in doctrines and regulations.

Lastly, the concepts only express half the practice, leaving out that control as part of *command work* is a two-way process, a recognition of the *dialectic of control* (Nandan, 1997). By applying a one-way perspective, even modern uses of control-related concepts contribute to a lack of clarity when it comes to understanding what happens in command work. This debate over meanings reflect the debate over power in an organization without making this explicit. The discourse excludes many actions which constitute command work and are prerequisites for any IS development, and mainly stays at an abstract level where most can argue without risking to touch on sensitive issues. I conclude that the separation of these concepts of practice from research is a simple way to avoid that research gets bogged down in the swamp of continued definition problems.

5.4 Autonomy - Continuing the Qualitative Analysis for a Grounded Theory

What happened in Bosnia, according to the first part of the study (Persson, 1997), was that the strategies and techniques for constraint management were directed at the achievement of sufficient freedom of action, to relax the constraints which evolved over time. The common military term *freedom of action* (Holley, 1988) describes the desired end state.

Huguet et al. (1996) have led me to the notion of constraints and *autonomy*. Their discussion is based upon the notion of *decision centres* in an organization. When an analysis shows that constraints are threatening operational ability, that there is an *autonomy defect*, and decisions *on* the constraints are necessary. But when the autonomy defect is not obvious, decisions *under* constraints are what is operationalized. Thus the presence or absence of autonomy defects — either too much or too little autonomy — determines the mode of operation (Figure 5.2).

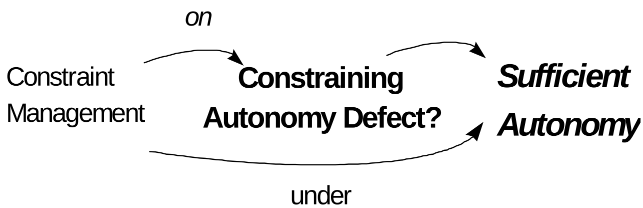

Figure 5.2: The striving for autonomy in case of autonomy defects.

The operations at these centres constitute the organization's choice of action. There can be a defect either the autonomy is objectively too wide (no goal or mission) or there are severe limitations in the available space of action, hence the search for *autonomy*, which I realized, was the idea driving the constraint management.

Recalling the Grounded Theory and selective coding (Strauss and Corbin, 1990), *Autonomy Achievement* thus might well be the new superimposed *core category*, superseding constraint management. The concept of *autonomy* is well known within systems science, organization and management theory. Within management theory, Davis and Olson (1984) mentioned autonomy as one of five important job dimensions which affect the motivation of workers, which important to satisfy in job design. Autonomy is worth close attention in my study because, evidently, it opposes constraints. Perhaps autonomy even is a superimposed concern. The idea of control (and command) is the achievement of enough autonomy to obtain certain goals.

In organizations, nowadays more than previously, technologies are prerequisites for obtaining autonomy, whether we look at operational autonomy or the one related to control of actions. When control technologies are obligatory for control and their complexity presupposes a high level of specialization and competence in these technologies, the dependence upon competent experts grows. Earlier, when one control technology failed or became insufficient, another could easily be applied. Now it has become difficult and hazardous to circumvent them, for

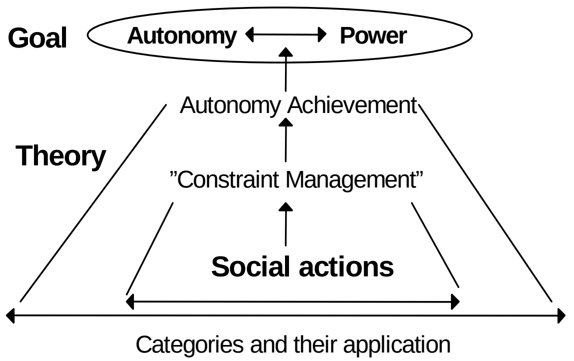

Figure 5.3: Stepwise generation of theory, the levels of categories generated from "constraint management."

instance when neglecting security matters. In peacetime, violations of rules may not cause fatal consequences, but may in case of war lead to risks that are unacceptable. Figure 5.3 illustrates, following the grounded theory methodology (ibid.) the position of this category and its role as regards to power, together with its capacity to unite a wider span of social actions. When Morgan (1986) elaborates upon power, autonomy issues are close, in the military even institutionalized under the heading of decentralization or *directive command* (Samuels, 1995).

In summary, I claim that behind many (most?) efforts to overcome constraints there is a constant *search for autonomy*, supposedly a central concern in social interaction. We have begun to discover that the traditional strong integrating mechanisms in the military (rules, artefacts) are accompanied by rich and innovative efforts to preserve autonomy. Constraint management is a balancing act. General Gus Pagonis (later in his career chief logistician during the Gulf War, 1990–91) described how in battle, during the Vietnam War, radio equipment was simulated as being broken to avoid interference from higher echelons (Pagonis and Cruikshank, 1992). The conclusion is that if we look at the roles of autonomy, opportunity and constraints, we could get a better understanding of command and how it should be taught and practised. Seen from this perspective, "leadership" becomes a power play, maybe even an autonomy game which (ideally) should end in a win-win outcome without losers.

5.5 Reflections over the Previous Work

5.5.1 Qualitative Method

The modern international Command (and Control) research community has attempted to establish a scientific foundation for military command. The concept of a "Science of Command and Control" has been outlined as a framework in the U.S. (Levis and Levis, 1994) since the late 1970s. So far, there has been a gap between theory and social practices (Foster, 1988). My study supports the recommendation by Foster that it is necessary to find a multidisciplinary approach which

> must effectively integrate basic and applied research, as well as science and social science, if it is to converge on the true essence of command and control. This will require the rigor that attends quantification yet the human understanding that can be derived only from qualitative methods. (ibid., p. 224)

Likewise, it is time to reconcile the old art-–science dichotomy which reflects the social efforts to control practice and achieve power rather than offering reliable scientific explanations and tools for researchers. I consider the use of qualitative method and qualitative analysis an efficient approach because of the purpose of the study and the nature of the empirical field. By using a qualitative method, I succeeded in formulating a grounded theory for command work, and have been able to say something about the IS design and development and to direct fieldwork. The theory presented after the first stage was sufficient as an initial first attempt and the whole study gave access for the continued work.

Leaving the lack of scientific progress in military command and turning to ISR, Hirschheim (1985) stated a similar lack depending on the conceptions for what "science" is. These deficiencies might have similar causes. My qualitative analysis (Chapter 3) indicates that it is necessary to question what kind of rationality that governs the practice and what kind of studies, either from the practitioners of command work or researchers, which intend to illuminate command work. Kaplan and Norton (1996) described how qualitative data were valuable complements to the quantitative reports in business ("telling the stories behind the numbers", p. 259). The military command units share some characteristics with business and practitioners have tried to apply the same management techniques. In both domains the ability to strategic learning all over a networked organization is a primary concern. Both have to react with short delay and require outstanding communications. Both consist of (linked) experts who have competence and must be committed to use it for the best of the organization in cross-functional teams. In both domains, qualitative method can provide valuable complementary insights about what work is and about the world behind the numbers.

5.5.2 AUTONOMY AND POWER, CENTRAL IN A THEORY FOR COMMAND

The idea of a uniting command theory is fed by the belief that it is possible to discover such regularities that theories are possible to formulate, a seed for much debate between supporters of a positivistic view on science (and such theories) and those opposing it (advocating other theories). Very clearly, Foster (1988) argued *for* such an enterprise. The move from the concept of *constraints*, via *autonomy defects* and then to the issue of *autonomy (achievement)* as being a new core category (Strauss and Corbin, 1990) in command work, promises to be fruitful, autonomy and power being key issues. The historical experiences and attempts from the early nineteenth century (Chapter 2) carry such evidence. Holley's (1988) discussion of *freedom of action*, specifically how to exploit the relations between technology and command, is another part of this discourse. One of the Bosnia commanders talked about the basic requirements to define the capacity for action:

> I think it is seldom you need a briefing about the situation in the force, that you have X tanks and this or that much fuel and other things. This will be inherent in your knowledge, I experienced it that way in Bosnia too. I knew very well, I had fuel for one week, we had ammunition, we had so many APCs on tracks…(Person D)

The stronger the constraints, the more powerful the efforts and methods to overcome them. When the external conditions were unpredictable, the need grew for social action aimed at autonomy. Not all such kinds of interaction can be institutionalized. The relations toward *alcohol* in military units, often get little attention in analyses of command work. As reported from Macedonia[2], alcohol was involved in most disciplinary actions:

> A majority of the disciplinary offences have been committed under influence of alcohol. Despite detailed regulations concerning purchase and consumption of alcohol this issue needs constant attention from officers on different levels. (Section 4.7.4, Legal matters)

When a phenomenon catches attention and requires efforts, in this case alcohol, it should be brought to the surface in order to be true to the grounded theory

2. Welff, M (1994). Nordbat 1–Evaluation Report. UN Mission report September, 1993–February 1994, 18 February. Col. Welff commanded the second Nordbat 1. The report was given me by his successor, Col. Kallio, in March 1994.

approach, and made explicable within the theory even if it perhaps is less relevant for ISD. Tentatively, I interpret this issue as a matter of autonomy. People sometimes use alcohol in order to feel autonomy, that is, be free of responsibilities, or they have autonomy and use alcohol as a means or a symbol to this state. Acquisition of alcohol is the symbol of autonomy because rules usually restrict it. To be allowed to use it and to drink, signifies a certain degree of autonomy.

When it comes to ISs, basic design ideas should be opened for investigation, for instance to what extent systems de facto control or what kind of transformations of practice they imply or inflict. It seems as if the military command organization on the surface and publicly still apply the hierarchical top-down control system, but that in practice freedom of action and autonomy are what count. The ways to achieve these qualities resist many studies.

5.5.3 CONTRADICTIONS

Focusing on the ISs and the control issues, several contradictions appeared in the Bosnia operation. Within the UN contingent there were contradictions between national forces. National contingents obeyed national authorities in certain matters, and interpreted mission and mandate differently. Issues such as salary, judicial system and rotation periods, and also how the daily routines were managed continued to be hotspots. Between the forces and the UN bureaucracy topics such as economic control, budgeting, the rules for purchase and acquisition of resources were long-term problems.

Furthermore, at the same time as the forces had no formal enemy, they were fired at, but could not or were not allowed respond. If they wanted support from the air, they had to be very certain about the target, while even short delays usually meant that hostile forces moved. To work through various bureaucratic command levels was tedious work. One Swedish commanding officer (interview) talked about the contradictions within the command system when events were formalized and described in reports. He complained over the loss of emotional content and how he had problems in really describing what he had experienced when finding himself faced by the effects of atrocities. The transformation from event to phenomenon gave massacres a formal, instrumental character that emptied them from emotional content but made them suitable for organized action.

My data tell also about suspicion towards the military and doubts about the military identity in an environment where NGOs and PVOs formed a large heterogeneous organization. Other researchers who have studied the operations in Bosnia have described similar contradictions. Some examples are that primary group bonding which usually is considered beneficial proved to be counterproductive and impeded actions according to superior level's intention. Units became closed enclaves where subcultures flourished (Winslow, 1999). Within command work there is a need for trust, someone to talk with, not more of the rational formal structures. Vogelaar and Kramer (1999) articulated the need for trust, created through training. They stated that unless superiors' ideas were known in a unit, sufficient autonomy could not be provided and exploited in the dynamic environment where rapid action was necessary. The lack of mutual trust in Bosnia led to precise orders, and failures. Several factors thus made the conditions in Bosnia very demanding as compared to Northern Ireland and even the Gulf War (Breakwell, 1999).

Design of control systems tend to be based upon unrealistic expectations because of reconstruction of historical experiences as being more rational than possible, as if complexity and chaos were obscured. When systems development focus on what is rational and its means for description (methods) only allow a rationalized representation of what goes on or is necessary (social actions in the world), requirements' specifications may be insufficient and cover less relevant aspects. This leads to conclusions concerning ISD (final chapters).

5.5.4 RETHINKING INFORMATION TECHNOLOGY AND PRAGMATIC SYSTEMS DESIGN

Let us turn our attention to IT and the issue of pragmatic design. In Bosnia, there was a need to rapidly define pragmatic command work solutions and then to successively expand their use during a multi-year operation. The accounts indicated that the basic traditional work principles learnt in Sweden were useful. Only *simple* solutions based upon available standard PC technology could be used. The environment was far from being an office environment. The forces risked being cut-off by the war and the weather conditions. The narrow supply sector was fuel. Autonomy was occasionally threatened because of both fuel shortage and lack of papers for printing out documents (Person H). In the staff work, only internal expertise had to be relied upon, when at the same time solutions had to be transferable to the next battalion. As a means to solve urgent control requirements, spreadsheet tools were used for a simple application to provide an overview of the locations and content of containers in the distant harbour where supplies arrived (Person J).

The accounts from Bosnia consequently report about the need for *flexibility*, to be able to build on location or adapt existing applications to the new context. Managerial constraints were the overwhelming paper work, and requests for reports to superior command levels, which did not serve any immediate local needs, each battalion being there for six months. There was a need for superior communication resources but command work should be possible with very meagre resources.

A good understanding of work and control mechanisms and the mutual influences between them is a prerequisite of relevant design of the modern control tools. Sage (1987), who studied distributed decisionmaking, complained that IT could contribute to complexity and that decisionmaking often was impossible because of lack of information and had to be substituted by *problem-solving*. Nardi and Engeström (1999) underlined the importance to understand and not erase *invisible work* for ignorance.

There are problems to find a theory suitable for ISR, ISD and systems development that includes leadership (personal relations, matters of power, the abstract and the concrete acts of control implied in leaders' behaviour) and one which includes autonomy. One theoretical step of progress is related to the latter concept. What does the theoretical concept *constraint management* mean among artefacts and actions in the social "real world"? Obviously people used or violated rules according to their goals, possibly remembering that they "only" symbolize or portray social relations. Rules are not definite "scientific" principles of doing business, thereby being above questioning. The same can be said about ISs: they are used for social purposes and fall under the influence of humans, as means for autonomy or defence against autonomy demands originating in other persons' control initiatives.

Ågerfalk (1999) presented a new way of perceiving ISs that promises to correspond with the grounded theory (Chapter 4). He used the concept *actability*, because the most important quality of an IS is to "perform actions and to permit, promote and facilitate users to perform their actions both through the systems and based on messages from the system, in some business context (p. 147)". This action enhancement is called *pragmatization of information systems*. Recalling the model I presented (Chapter 3), the informating, informing, and mediating subsystems together will support actability. Ågerfalk's view on ISs as *vehicles for communication* implies a combination of an *action potential (a repertoire of actions and a vocabulary)*, a *memory of earlier actions and prerequisites*, and of *actions performed interactively by the user and the system and/or automatically by the system*. This view is different from looking at systems as an *image* or *simulation of reality* (ibid., p. 146) which people look at instead of directly and actively *observing the world*, represented via a variety of data. People do not just look at and talk about an image of the world, they do things, act and communicate in the social world.

5.6 Summary

The result from the first phase of the research opened a complementary way of investigating management problems, not only military ones. It provided a new way to conceptualize “Command and Control” (C2) which promises to stimulate development of relevant and working solutions to command and control problems in the work. In all, the actions by the NORDBAT battalions demonstrate how they tried to get control over their environment and to achieve sufficient autonomy, as regards to supply as well as in operational issues. They acted in their boundary zones, with all their resources, and demonstrated a variety that helped them. Representatives for the battalions testified (final reports, interviews; Persson, 1997) how they developed and had to enforce people to use robust and rational methods and techniques for reporting, staying in contact with authorities, and getting hold of supplies: oral communication does not promote robust methods. At the same time, the accounts show how crucial personal relations and social actions are in the social world. Had not initiative spread downward or upward from key personnel, not much would have been achieved. Commanders achieved autonomy, and mostly had the ability to act within the mission-specific constraints; however, personal conflicts and contradictions also belonged to the command work.

Basics, and a context, the role of which cannot be neglected were legal systems, administrative routines and mechanisms for social reproduction, methods to distribute formal authority. Social practices and technologies grew and were means to communicate in spite of wide areas, long lines of communication and across different time zones. There are two aspects of the pragmatism: the first is that certain very powerful techniques were applied, most of them based upon logic, formalization, writing and calculation like in office work. These techniques proved their value. The second is that when inadequate, technologies have been left behind, and social actors have redefined what is “best practice”, possibly followed by a rationalization, or “scientification”.

I have chosen to make a distinction between the theoretical concept of control and its instantiation in the social world. This is only the beginning of a theory, but a valid start of a complex project. Most importantly, perhaps, is that a common theory may be within reach. The continued conceptual and historic analysis illustrates the relations between control actions in the world, artefacts, and our concepts and the everyday concepts (and what they connote). They are not created to achieve “scientific” rigour, but instead social relevance and efficiency. Thus, they are extremely elastic and flexible, reflecting the situated needs in an uncertain world where humans contribute to its unpredictability.

Research approaches such as the qualitative method are likely to produce results that will better illuminate practice, produce new kinds of data and guide the design of change, technologies and the actual practice. My contribution may be the bridge between what is taken for granted in management theory and other kinds of social control theory. Rationalization is a powerful technique, but it is necessary to realize that behind what have become modern instruments for rational control, there are social needs in the world. Social relations are important, even if rationalized and *symbolized* by concepts and artefacts. Tallies and accounting practices have been used much longer than management has been science, being means to satisfy basic social needs, allowing reliable control, and supporting communication.

When modern IT leads to autonomy defects, it risks to be rejected. Acceptance of ISs and transparency concerning functions and effects must be clarified during acquisition processes. Hidden agendas may lead to conflicts and countermeasures. Social needs, not satisfied, may later lead to disruption and breakdowns. Still, modern IT promises to help people in their work. The models it rests on are very old, some forerunners to the calculation systems (Avdic, 1999), most demonstrating means to achieve social value, and *affordance* (see Chapter 3; Norman, 1988; Anderson and Sharrock, 1993). The challenge is to transfer these qualities and design IT for both the structured and other control actions in command work. Perhaps what matters is to realize that control actions have a larger diversity in the world than the common control technology can handle and that rational control only is a minor part, and face the consequences of this when rethinking ISD. Ralph Peters (1999a) captured much of what goes on and indicated what is at stake in the military in the late twentieth or early twentyfirst century:

> We are about to enter a new century constrained by the last century's narrow and inadequate definitions of warfare. Countries and cultures make war; the military is merely the bluntest of humanity's broadening range of warmaking instruments. (p. 167)

PART III
Method and Fieldwork

THIS PART FIRST PRESENTS the high-level and concrete research methods. Methods are related to issues of ISD and command work and the relations between these activities. Theoretically and methodically, a perspective on what command work is about and what design for command work might be guides the fieldwork in order to produce relevant data. The ethnography is one of the qualitative research traditions, and I outline its possible contributions to the practical fieldwork. I refer to previous ethnographic research and the role of workplace studies for design of ISs.

I present a few fieldwork guidelines, born from the interplay between fieldwork opportunities and methods, and ISD. Briefly discussed but nevertheless important are issues of validity concerning the research approach and the data.

In the fieldwork chapter, I describe the context for the research process during 1997 and 1998, and what data production techniques I used up to the final writing process. I describe the military workplace, the kinds of data which have been produced and the main phases in the data analysis process.

Chapter 6
Method

AFTER HAVING PRESENTED what design is about and provided a suitable perspective on ISs and command work (Chapter 3), I continue and describe the method. This chapter brings together command work, design of ISs, ethnography as a method, and the techniques to apply in the field (see also Chapter 7). I presented some guidelines from the Human and Social Sciences in Chapter 1. Now they will be operationalized.

Once the choice to continue along the qualitative method was made, and to perform it as an ethnography, what mattered was to find suitable methods and techniques for the field work and the analysis. There is a “theory first” requirement (Creswell, 1998) linked to an ethnography. Consequently, I entered the fieldwork guided by the grounded theory from the first phase of the study, and the notion of command work as *boundary management* within a viable organization (the VSM model, Chapter 1) and I will comment upon that. Specifically, theory, the conditions for the fieldwork and the ambition to reach principles for informed ISD, constitute three lighthouses for navigation in the field.

6.1 Ethnography and Workplace Studies – Implications for Fieldwork

6.1.1 OVERVIEW OF QUALITATIVE TRADITIONS

The reasons for entering into a qualitative study are to understand how work is performed, to explore a certain activity in its natural setting and to get a detailed view of what happens. My background as an officer has guided the strategy because of my pre-understanding (which is a trap for bias as well and can lead to validity problems), first facilitating communication with people and later on the interpretation and data analysis. I present Creswell's simple diagram to separate these traditions in Figure 6.1. This diagram guided the choice between his five traditions: biography, phenomenology, grounded theory, ethnography and case study:

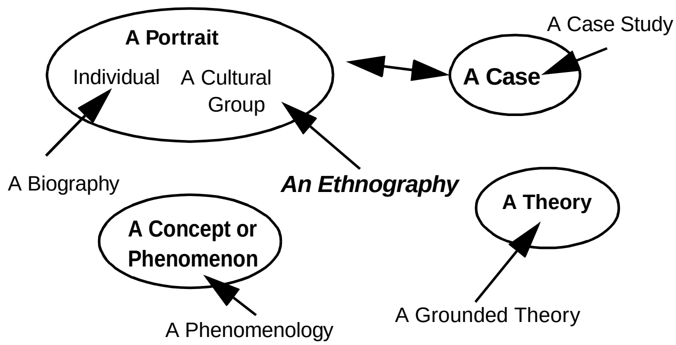

Figure 6.1: Differentiating Qualitative Traditions by Foci (After Creswell: Figure 3.1, p. 37).

My intention to continue to work qualitatively sprung from the needs for the second part of the study. I already had a *grounded theory*, the development of which had led me to an interest in a closer look at for instance the *phenomenon* of integration between logistics and operations but eventually designed the study as an *ethnography*. Miles and Huberman (1994) claimed that within analysis of data, conclusion drawing and verification are concurrent activities (the two other being data reduction and data display), ongoing during the data collection (production).

> In this view, qualitative data analysis is a continuous, iterative enterprise. Issues of data reduction, of display, and conclusion drawing/verification come into figure successively as analysis episodes follow each other. But the other two issues are always part of the ground. (ibid., p. 12)

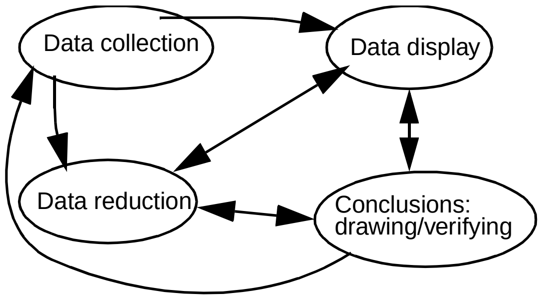

Figure 6.2: Components of Data Analysis: Interactive Model (after Miles and Huberman, p. 12).

Conclusions are verified as the analysis goes on, which Figure 6.2 illustrates. This approach is an interactive cyclical process, where I prefer the term "data production" instead of "collection": the researcher actually intentionally *produces* data, even if the opportunities evolve over time. Data are not "out there" just by themselves. Like in any empirical research, it is the visible part of the activities that can be recorded. The researcher too needs to *informate* his environment in order to learn about what is going on through interpretation. Data have to be produced, which implies a basic terminology and categorization. The meanings evolving from the analysis successively are tested, validated: plausibility, sturdiness, and "confirmability" (ibid.). This validation is achieved through cross-checking within data, discussions with other researchers or perhaps with those who were observed or provided data in one way or another. Strauss and Corbin (1990) had a similar view on validation. They stated that during the coding intended at establishing higher-order categories (Chapters 4, 5), the analyst moves back and forth between various analytical and categorizing steps, modifying categories and conclusions till a sufficient match appear between data and conclusions.

6.1.2 Relating Research Purpose, Method, and Object in Workplace Studies

Fieldwork is the method (involving several techniques) to get knowledge about the work, transformable into design input. Rather than being generic, design knowledge has to be substantial and practical. It might be possible to find generic objects or phenomena that are both common, concrete and important in command work, perhaps in any work.

Bardram (1997) defined four ways of using workplace studies: (1) concurrently in the design process, (2) as an evaluation or review of design specifications, (3) as "quick and dirty" studies in order to solve specific design questions, (4) re-examinations of earlier studies. Because my study is about *principles* for design, not aimed at any specific design project, it spans (2) and (4) and only to some extent (1).

I will briefly discuss the relations between *method*, *purpose* and *research object* with the help of Sayer's (1993) *method triangle* (Figure 6.3). Each factor must be

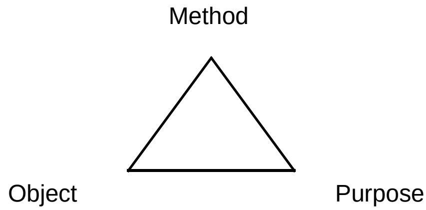

Figure 6.3: Sayer's method triangle (Sayer, 1993 p. 4).

considered in relation to the other two. The high-level method as a framework, the qualitative approach from the first part of the study, continues because of the need to explore the workplace activities. Creswell's (1998) criteria for qualitative studies are that they occur in natural settings, span multiple methods and are interpretative. Moreover, qualitative researchers rely on few cases but many variables.

Applying substantial fieldwork methods and techniques during short exercises and among temporary teams raises challenges for the researcher. In any workplace, it is essential to monitor the source activities but not to influence them through intrusive behaviour. Social scientists cannot, as in the laboratory and natural science research, during workplace studies isolate any one factor because many things happen simultaneously and work is not done in advance, it continuously unwraps itself. Researchers might feel the need for intrusive technologies to get data when the normal business activities are less obvious. Any activity from researchers aimed at enforcing overt behaviour by the people in the situation in order to make them more articulated also changes the situation. Thereby the validity may be spoiled.

My object, *command work*, contains flexible and opportunistic actions, rapidly adapted to changing circumstances. In the laboratory things can go wrong, but can be compensated for because of the controlled situation. In a real workplace, however, the researcher has minimal control. Plans for field work may be impossible to follow even if they can be made. The researchers' constraint management when work shifts must thus be considerable. If the preparations become outdated by the actual events, then perhaps there is nothing more to do at the time. Everything might have to be "quick and dirty".

6.1.3 METHOD-RELATED QUESTIONS

In order to launch the practical part of a study, it is necessary to consider the purpose (to inform design of ISs for support of command work) and methods to achieve a result that is relevant and applicable. How an operational or a design problem is defined by practitioners and by researchers depends on values (originating from culture), history and social power (May, 1997). Relations between power and knowledge in the command work originate from a specific social order where the definition of knowledge, conducted by certain persons, is a central social practice. (I discussed this situation in Chapter 2.) It is thus important to trace and define this social order when aspiring to introduce and get acceptance for new knowledge. Needless to say perhaps, but the development of design knowledge is performed under the same conditions. The researcher needs a preunderstanding of the empirical field. Just to "see what happens" is hardly a satisfactory approach. In my study part of this understanding is to avoid the structuring of knowledge (inferred from observations, data) as to fit the ideal models behind most command/control cycles and current systems development enterprises.

Ideally, new design knowledge claims have to be defensible in themselves. It is the answer to these requests. An *ethnography* must lead to a holistic portrait of a *cultural group*, what its members *say, do* and *use* (Creswell, 1998). We saw (Chapter 2) that Hofstede et al. (1990) included *values* in the concept of culture but for obvious reasons values have to be inferred from what is visible. The practical research process opens with the researcher observing, interviewing, and exploring emerging themes. The study will deliver a detailed description about the behaviour of this group, a "recording of human behaviour in cultural terms" (Creswell, 1998, p. 39). Thereby stories, myths and artefacts can be found. This description is followed by an analysis and interpretation. The analytic result then guides design work in order to make it reliable, relevant and controllable. The following questions have to be answered, some of them by the practical part of the research, the fieldwork:

1. What is command work about?
2. What is ISD for work, especially command work?
3. How can qualitative method and ethnography inform design?
4. How to do the study and the fieldwork?

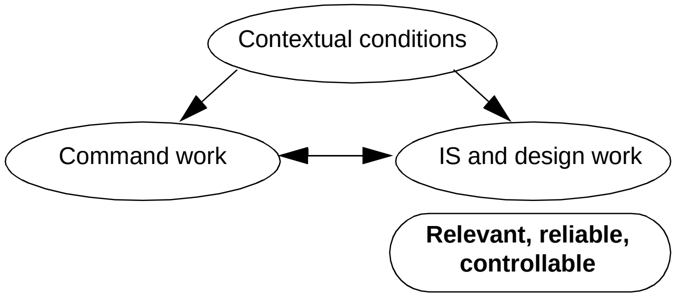

Figure 6.4: Model of the research approach, planning for the field work.

I have outlined my method in Figure 6.4. Before entering into and describing fieldwork (and certainly before it is analysed and presented) it is necessary to “inform it” by putting together experiences from (command) work to find theory about ISD for work, and to try to find guidance from previous research.

6.1.4 INFORMATION SYSTEMS DESIGN AND ETHNOGRAPHY

There is a considerable analytical/practical step between analysis and illumination of what work is and what is important in this kind of work, to the elaboration of practical guidelines for design. The difference between ethnography and ISD is that basically systems design is about intervention and change, while ethnography originally should *not* affect or change what was studied (Bardram, 1997). We need to engage in a dialogue, said Bardram, between current work-practice and future computer supported work-practice, between work and design. Hughes et al. (1992), having studied ATC, concluded that the ethnographic approach cannot be predictive in a detailed manner about ISD, instead it is an additional resource. Formal methods (another analytic and methodical design approach) are most heavily stressed where safety-critical performance is necessary, but the systems, the authors claimed, must be built on an understanding of the qualitative character of the work itself:

> Many errors and ‘violations’ arise precisely out of the necessity to tinker with a troublesome system to make it capable of serving its purposes at all. Hence the characteristics of a system do not exist in the abstract, as absolute features in their design, but are emergent properties of systems in use. (p. 121)

The ethnography can then discover the emergence of these properties. The creative aspect in ISD can neither be based upon only technological thinking or on attempts to imitate existing work practices. As this study indicates, a third aspect has had a strong influence in the military work, which is to imitate or advance office-work into a new state-of-the-art mode, or, possibly, to find complementary or alternative solutions to requirements for support of command work. Perhaps researchers are persons who with Bardram's own words best can "provide the deep understanding of a work-setting needed for engaging into a design dialogue with the people working there" (ibid., p. 3) and make it the input to cooperative design instead of a static requirements list.

Anderson (1994) described the value of ethnography as a way of creating a common view of technology and the social, to achieve "the collapse of the technologism and sociologism dichotomy" (ibid., p. 167) and to avoid what looks like a forced choice between them in design.

Ethnography can contribute through a design-oriented practical sociology. More precisely, ethnography can "open up the overall problem-solution frame of reference in the context of some proposed solutions to specific identified problems" (ibid., p. 170) by demonstrating that different rationalities are present in a work setting, enabling designers to "question the taken-for-granted assumptions embedded in the conventional problem-solution framework" (ibid.). Anderson stated that there is a pragmatic rationality of daily life and that what looks like redundancy, inefficiency or ineffectiveness may instead be precision engineering, conducted in the opposite direction as that of science. He provided a few examples on design related issues, when describing how permanent pieces of paper are preferred for preservation of texts when teams' composition may vary considerably, and how tangibility has its own quality: it exists in the world as a visible symbol of a relationship or decision. Anderson concluded that

> The artefacts we design should not subvert the practical logic of the routine world in the name of the rational logic from nowhere. Rather, if it is efficiency, effectiveness, and productivity (among other things) we want, why can we not have an efficiency, effectiveness, and productivity that enhances and takes advantage of that logic? (ibid., p. 178)

There is a debate about the blessings of an ethnography. It is well known that ethnography has described practice as "contingent, often problematic, informed by context and seldom rule bound" (Nyce and Löwgren, 1995, p. 39). However, ethnography at the same time has been seen as a method that just "counts and describes" (ibid.). Instead, it can support a foundational analysis of assumptions and "common sense" ("command work is just another kind of office work"). Moreover, what is "work" is usually not clarified, for example the content of "command work". The roles of meetings, for instance, may vary and also what kind of support mechanisms that can make meetings efficient, perhaps even reduce them to situations when people really have to meet. Likewise, the meaning of PD must be questioned, for instance, and not taken for given. To apply this approach as a label but without significance may not lead to any useful artefact.

Hughes et al. (1992) stressed the role of the ethnographer as a bridge between the domain and the system designer, one who supports a dialogue between the parties. The role of design is, for instance, to reach a requirements specification, to contribute to a consistent process thereby, for achieving the goals of a system, cost-effectiveness, or to distinguish what kinds of effectivity or efficiency are crucial in a certain domain. My study did not aim at immediate design participation or being this kind of bridge. It remains an open question to what extent and how it may influence future design, inside the army or in other contexts, or if its result are less relevant than the method per se as an example of a design study.

6.2 What then is the Practice of Command Work?

6.2.1 Describing and Analysing Command Work

Studies and descriptions of command work are often oriented at decision-making (e.g. Sage, 1987) and information processing, resting upon a strong current of common sense thinking, technology and techniques. The broad summary by Kahan et al. (1989) of previous research about command and information pointed at research shortcomings and a meagre research output. The way these authors described command work, illustrates central issues which indicate what work means:

> Rather than employ a structured, scheduled briefing, the staff constantly interact. They monitor, analyse, and plan, occasionally pushing extraordinary information at a fellow staff officer and demanding information from peers that they need in order to perform their tasks. (ibid., p. 27)

The authors correctly stated that it is necessary to understand the human systems that integrate collective intuition, training, and experience (before ISD starts) and gave a few examples, for example theatrical decision briefings ("a commander typically makes his decisions before the decision briefing take place; hence, the main function of that meeting is to provide a common context in which those decisions can be understood", p. vii). Van Creveld (1985) recognized the need for a formal component in command, but stated that informal methods are necessary as lubricants. One can ask what relations exist between formalized decision support technologies, command work, and what happens before and after public events, the interaction between formal and informal work.

In spite of these accounts, there are more abstract top-down stories than ISR-relevant bottom-up descriptions. Little is said about the social component, what work is about, including thoughts about "invisible work" (Nardi and Engeström, 1999) and its visible manifestations. In order to conduct fieldwork, for the same reasons of clarification, it is necessary to move from abstract concepts such as constraint management or Boundary Management to something practical, often disguised by cognitive maps and 'systems'. What counts are the social communicative and other actions in the world, and how technologies are used in order to informate, inform about, being tools, mediators or whatever technologies do as contributions to the work. It is necessary to see what happens when people handle contradictions (Chapter 2), are involved in constraint management (Chapter 4), and what control and command mean in the world (Chapter 5). Portions of it may be *engineering* (based upon mathematics, according to Ferguson's, 1992, distinctions), but *art* (direct participation and immediacy of experience, to work with what is known; Salner, 1989) may be a more suitable label. Whether *science* is involved (to systematically develop new knowledge), or if what happens is just a matter of re-interpretation is open for a debate. In summary, what signifies command work when contradictions are handled and reconciled (hopefully) is:

- *negotiation*, of knowledge claims, actions, influence, etc.;
- *decision-making*, either formal procedures and processes and technologies involved in them or *problem solving*, of structured, semi-structured or ill-structured problems where not *one* but multiple types of approaches can be found;
- *coordination* of distributed rapid and slow, short and long-term social and technical processes,
- *transfer of work* between individuals (teams, organizations) either electronically or in direct formalized or informal personal interaction;
- *repair work, when* interruptions are followed by restarts in work;
- *tool development* and *use*;
- *control actions in the world*: type, result, mediating technologies, procedures;
- *interpreting* and *sensemaking* procedures and
- *transmission of power and authority.*

Basic in an ethnography on command work is the understanding and interpretation of a situation. Any situation that researchers meet only by already existing labels and concepts, may be expressed not according to the requirements growing from the situation but from what is possible within the existing concepts (from the practice or from ISR).

This overview leads to some issues for the fieldworker's practice:

- How to make the work visible and augment visibility? Permanent records?
- What techniques are appropriate for the data production, respecting security, integrity, etc.?
- What should be a sufficient variety and how to reach endurance once in the field?
- What reserve options to prepare and how to act if complementary data production has to be done?
- How to save data about context in order to later interpret what happened?

6.2.2 Design Requirements for Command Work

Different requirements must be met in the design. Design must provide answers to When, Where, By whom, What, and How to design ISs. Design can be done before or during work, on design sites or in the workplace, by one or many persons, designers or workers or as joint efforts (PD). Further, either it concerns small or large systems, it can be directed at hardware or/and software, at the whole work or minor portions of it. Moreover, the design method can mean to make a model first, then implement it, or to follow some iterative design tool supported prototyping procedure. Depending upon the situation, a variety of methods and (linked) tools can be applied.

The needs for *translocal information*, to allow the *informing* to fit diverse groups (while making data available for many), to avoid misinterpretation and abuse outside the local group (Langefors, 1993), promote great care in design. It is likely that the labour intensive command and control process can be assisted by computers, and that database systems and spreadsheets can replace the grease boards and pencils (Sorenson, 1989). Commanders will most often need information that provides a broad view of the situation (Sorenson, 1989), while others need detail to handle individual unique issues. In order to avoid problems with usability Sorenson prescribed evolutionary improvement and rapid fielding to construct on-site prototypes with extensive user involvement. Previously (Chapter 3) I presented a new structure of a total IS that illustrates the need to study a chain from sensor to work where sensors can be humans as well.

The strong belief in the concept *Common Battlespace Picture* (CBP) (Whitaker and Kuperman, 1996) illustrates current thinking about computer artefacts but involves a few difficulties to handle and to reconcile. The CBP is about capacity and status of one's own and enemy forces. Focus for the cognitive engineering is the usability of the CBP in the work independent from its physical/technical implementation. The CBP must satisfy criteria for accessibility by all relevant actors, mutual interpretability, mutual meaningfulness ("the right information at the right time"), and mutual manipulability (updating or correcting shall be possible for anyone given access to the system). The one who thinks there is something that everyone should know shall act.

In distributed organizations the difficulties grow to judge *who heard what*, and to know *who knows what*, especially when work is continuous and people rotate between positions. Even in the same workspace it can be impossible to discover misunderstandings, especially in a heterogeneous organization. Fischhoff and Johnson (1990) suggested design of organizations which are homogenous (specialized) but where individuals are generalists, or to design heterogeneous organizations where generalists are the specialists linking the parts. There are various other approaches for design analysis and choice. They are to investigate solutions to highly specific problems, such as communications protocols or optimal visual display for a particular heterogeneous system, or to develop only general design principles, suggesting what to do instead of detailed specific studies.

The idea inherent in *calculation programs* (Avdic, 1999) may be relevant for design in command work. According to Avdic, such programs seem to be relevant when spontaneous, non-routine information needs arise, or when requirements are hard to formalize. In Langefors' (1993) words, when used they allow *heurithms*, which are substitutes when algorithms are not (yet) possible to develop to control a process, but input and required output may be what algorithms normally work upon, figures. Disadvantages may be their efficiency and lack of documentation. The same lack of standardization may reduce compatibility across larger organizations.

Avdic's study pointed out the considerable social value of simultaneously being in control of the development process and of the work. What makes this study relevant for command work is that similar applications were developed and used on location in Bosnia (Persson, 1997). Given those circumstances, the developers/users were, in Hutchins' (1994) words, "cognitive bricoleurs – opportunistic assemblers of functional systems composed of internal and external structures" (p.

172). The artefacts themselves were far from advanced graphics with “live world” qualities. Avdic reported that people’s commitment grew when they saw the result of their work with short delays. Functional and at least locally relevant representations of reality can be made based upon people’s professional knowledge, but must be handled with care because the systems also get a manipulative capacity. Avdic’s informants mentioned, for instance, the yield with high precision, which then leads to persuasive power from the tools in use. The applied format is a mix of simple graphics in diagrams, and figures. When necessary one spreadsheet can be partitioned into several. Calculations can be made interactively in a document, algorithms and models being developed also for odd but important sudden needs.

Finally, in military design the use of models and simulations is widespread either design is about change of operational command work activities, or it is about creating something where previous experience or expertise is limited. Because my complementary approach means studying work that is, and seeing whether new insights can be defined, already the fieldwork must lead to design input. Remembering that command work is not available for study all the time, but instead occurs during short periods, perhaps even is difficult to get access to, a researcher’s work has to be designed accordingly.

The ethnographic researcher must try to capture how people use and design their technologies and make them useful instruments, when and why redesign is brought to the surface of work. During the design process, with the help of storyboard techniques, the use of an IT artefact (the product) can be tried out in a dynamic (imagined) work environment, and people’s values illustrated (Löwgren and Stolterman, 1998). It might be useful to work actively, already in the fieldwork, with such sketches and storyboard techniques when design is discussed, because important events may pass fast. Consequently, in fieldwork and in design work, tools that admit rapid action are essential. Such techniques make it possible to use nonverbal descriptions, that are considered essential in design (Ferguson, 1992).

6.2.3 BRIDGING TO THE PRACTICE OF INFORMATION SYSTEMS DESIGN

The idea of design theory is to free the designers from preconceptions of “one best way”. Instead theory is based upon a pragmatic value rationality, it is action-oriented and context-dependent. The design process is characterized by reflection-in-action and development of theory-in-practice (Löwgren and Stolterman, 1998).

Recent research indicates that formalization may be related to serious difficulties. Shipman III and Marshall (1999) tried to explain why users rejected or circumvented formalisms, and were unwilling or unable to make structure, procedure or work content explicit. This behaviour is similar to what Fischhoff and Johnson (1990) described: dismissal of information that threatened favoured beliefs, exaggeration of personal immunity to threats, and oversimplification of other persons' behaviour. People did not feel at ease with computational rules. If they made computations, different rules were used, perhaps a variety of simple rules in order to avoid hard choices. Sorenson's (1989) description of self-help applications fits too, in the same way as the observations by Sage (1987): 'problem solving' may be what is left when decision-making is not possible.

It is understandable that when faced by uncertainty, people are reluctant to make choices. Any formalization also means a loss of autonomy and overview. In addition, much design enforces a double formalization (meaning a cognitive load): both as regards the work to get access at all to the informing subsystem, and then to manipulate its content. This tendency must not lead to still more emphasis on *control* of design, method and formalization, but instead what Shipman III and Marshall (1999) suggested: a gradual process, not *enforcing* a premature structure (similar to a "colonization of mind"; Mignolo, 1995). This approach means close cooperation between designers and users, designers who participate in training, and that design will start from a study of current practice and informal structures of information, leading to an ethnographically informed design.

By definition, it is not sufficient that an *individual* uses an IS, it is an artefact for an organization. The IS therefore must be formalized to some degree so it can be used in an organization or in command work, but it does not prescribe that computers must be applied. Not only inexperience to formalize, but also the users' and designers' perspective on information and IS and method direction may leave much work invisible. Depending on the perspective and meaning of the concept "information system", systems either *supply* actors with the needed information, or they *create* it with the help of their ISs (abstract or visible) and technologies. It is their *interpretation of data* that decides whether there will be any system or not. As long as the technology and the output (created by people in their work) make sense, all is well. An example of a technique that makes it possible to theoretically illustrate workflow is how Activity Theory (Kuutti, 1991; Engeström, 1987) works with schemas (Figure 6.5).

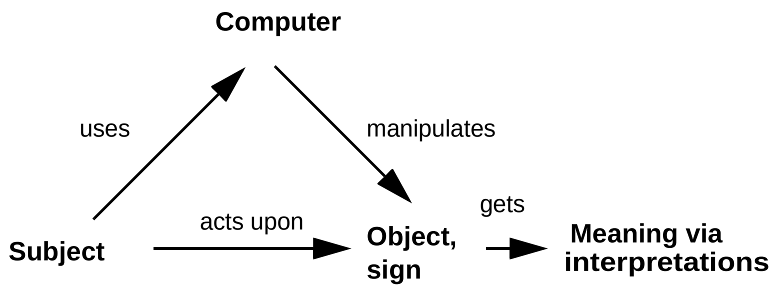

Figure 6.5: Activity Theory inspired model of what computer artefacts are used for based upon Ehn's (1988) discussion.

Looking at the technical aspects of control (once the social components are sorted out), a few common requirements exist. Any control system must allow *comparison between control variables*, the output from the informating subsystem. They have to be the modern *contrerolles* or tallies (Chapter 5), supporting 'verification by evidence'. It is likely that the control artefacts have to be manipulable to fit new needs. Moreover, they will give the opportunity to work with actualities, as compared to retrieval of data from databases, some of which may be stored by other persons or are outdated for other reasons (their relevance checked when retrieved). The artefacts must allow situation overview and also be usable for studying details. They are socially constructed and used rather than being single-user mechanisms, which is where the difficulties begin. They have to be accepted socially, responding to the requirements in workgroups and organizations where single users work alongside or in distributed groups. Here, security issues arise.

There are strategies for reducing the demands for formalization which are beneficial for control purposes. I mentioned (Chapter 3) to work with maps and recalled Avdic's (1999) study on calculation systems. According to Avdic, an information system has a few other attributes, for instance it collects, stores, processes, presents and distributes information sets. This view corresponds with my IS model (Chapter 3) containing informating, mediating, informing and interpreting subsystems. *Informating* subsystems may be linked to machinery (sensors) or to organizations, their result ending in the same *informing* system.

Because we talk about artefacts for the control of social action, it is worth remembering what Hirschheim et al. (1996) wrote. While natural laws and measurements of empirical states provide a reliable base for technical control, individuals' behaviour defies natural laws. Instead voluntary norm compliance, power, or

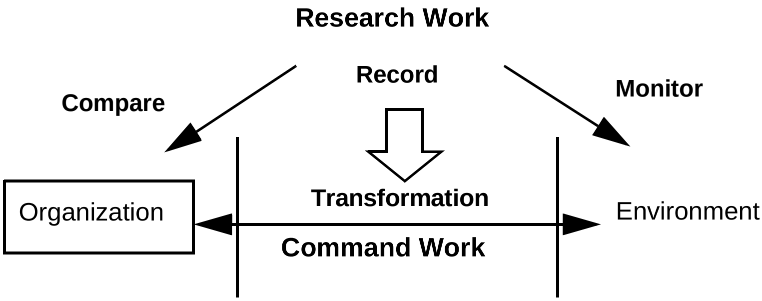

Figure 6.6: Research work related to the research objects, the organization, its boundary zone and environment.

maximization of individual benefit are used as control stimuli. It remains to see whether systems or cognitive engineering can promote these qualities, and how, or if other strategies are more relevant.

6.3 What should the Fieldwork Investigate?

6.3.1 MODEL OF THE PRACTICAL RESEARCH WORK

The fieldwork had to profit from a series of CPXs, some long, some shorter, that were scheduled between fixed times. From early on I realized that it would be possible to find people between and after the series of exercises and follow up on items that needed more investigation.

Building on the VSM (Beer, 1981; Espejo and Gill, 1998) and Emery's statements (1969), I have modified the first model of boundary management (Chapter 1) into another one (Figure 6.6) where *research work* (fieldwork and analysis) cross-investigates what the boundary management is about. Events can be traced from one side to the other across the boundary zone.

The way they are described can show what the command work does with them, what tools and artefacts are used and how, the ways events are transformed. Triangulation through the use of complementary techniques augments the options to analyse an event. Considering the supposed dynamically shifting work, the researcher has to be able to follow what happens instead of hoping that work will evolve according to his own position. Redundancy of data might be a valuable strategy to respond to breakdowns in one's own technology.

Key informants must be found and then relied on. Rapid recording and indexing is necessary, because indexing might be impossible later when the work has terminated. After a certain event or hour, databases might well be both distant and shut down, and the operators may have left for other duties. In order to be sufficiently close to critical events, socializing with technical staff can be the only way to monitor activities that are hidden or elsewhere regarded as unimportant (invisible). Another reason (and a solution to data requirements) is to get access to operational ISs and possibly to have them adapted to the researcher's needs. After all, at the sources, much the same data sets are produced initially (the informated environment) but later used differently by operators and researchers. The former has business processes to manage, while the latter must use what becomes available for another kind of analysis, if necessary via the production of secondary data and use of meta-data about the context.

6.3.2 METHODOLOGICAL GUIDELINES

Basically, an ethnography can take considerable time and require many researchers and practitioners contribution. Except from this, there are some theoretical guidelines. Miser and Quade (1985), in their review of systems analysis, let Peter Checkland express his thoughts on the systems analyst's task, as opposed to the scientist working in his laboratory: "His problems exist in the real world; the phenomena he investigates cannot be taken into a laboratory, and they are usually so entangled with many factors as to appear inseparably linked with them" (pp. 151–152). The systems analyst finds himself in a mess of real world problems. Furthermore, because of this mess, the analyst may well find that the outcome of his work strays somewhat from what he anticipated in his initial problem formulation. Miser and Quade continued their discussion and recalled ideas about an *epistemology of practice* that places technical problem solving within a broader context of reflective inquiry. This epistemology shows how reflection-in-action may be rigorous in its own right. It links the art of practice for the management of uncertainty and uniqueness to the scientist's "art" of research. This quest is similar to what Ehn (1988) prescribes, when he proposes tools that provides a *knowledge-at-hand*. One example of how to operationalize such tools are Avdic's (1999) *calculation systems*, designed and used in work for the locally relevant knowledge requirements, for decision-making. They can function as tools for development of Decision Support Systems (DSS), "DSS generators" (ibid., p. 230).

Hutchins (1994), who looked into navigation has found that "deeper problems" may be either made shallower by artefacts or not treated at all in the practice. Further, individuals must be seen as persons involved in a *cognitive division of labour* and not only division of labour. Lastly, he discusses the existence of confirmation bias, when an organization narrows its span of interpretations and then may display a constraint variety in its output. The military want to reach a common interpretation fast, which is achieved via rich communication. I conclude that it is necessary to look for bias, the character and form of communication, and whether diversity in interpretation is sometimes beneficial because of the need to maintain variety. Symon et al. (1996) underlined the need to look at the relationship between formal and informal practices, and to realise that formal process may exist only in theory, the claimed existence has social and political functions. Further, formal process disguises power relations. This fact is not realized by designers (Langefors, 1993, p 69: "The theory of information systems is not concerned with how the power should be distributed in the organization."). The claimed existence of formal procedures has a more *symbolic function*. It is to provide an agreed description of the work which is possible to refer to ("the rules say…"), and thereby provide an image of the organization that it is in control of its activities.

There are some practical aspects too. It is necessary first to explain idea and purpose of the study to the participants. Secondly, getting access and acceptance in order to find and use materials produced within the HQ required a formal procedure and later a clearance as regards the photographic data. Practical constraints are that the researcher has to eat, rest, and get sleep, and therefore has to choose carefully what to engage in. Other constraints originate from the fact that a single researcher is one person and cannot cover everything that happens, at least not during a one week CPX over a large area. Neither can he (or should) intervene and inflict disturbances in the subjects' business. However, in order to see and hear and understand them, it is not possible to stand outside the operational activities. Neither is the truth value of assessments and the relevance of what goes on establishable by a single person because anyone watching detailed work has only a limited partial view. In all, what is demonstrated is a true bounded rationality.

6.3.3 Bring the Social to the Surface

We saw (Chapter 3) that Bucciarelli (1988) defined design as a social process and identified three types of discourse in the design work, *constraining*, *naming*, and *deciding*, the last one being the formalization phase meaning that design is a kind of boundary management. He stated that the perception of design depends upon the interests and perspectives involved and that formal productions in design can never capture the full social process.

Also, the organization of design is part of the design, can not be separated from the process. Because a social design process bridges across disciplines, different object-worlds must be united in a design discourse where negotiations are part of the effort. One of the components in the process is formulation of constraints on contextual conditions, software, hardware, operator qualifications, etc. The development of language and names defines the arena where design takes place. By naming, inventing or using concepts, the world is constructed. If symbols such as figures, mathematical abstractions, are used, they can easily deceive the reader. They should be read together with the context they define. Inferring from Bucciarelli, technology is instantiated knowledge, but the social context where this knowledge is defined is important for understanding this knowledge (technology). Thus the design process as social interaction is important to understand and to keep traces of it if technology is to be understood. Figure 6.7 illustrates social interaction, use of technology (watch) and how roles and division of labour are instantiated in design of care. The situation involved real and not fictitious medical care. Together (as Hermann and Just, 1995, discussed), the experts interacted, designing.

Figure 6.7: Discussion about real medical care between medical officer and doctor and medical orderly (May 1998).

Increasingly, ethnographically-inspired fieldwork techniques (what Bucciarelli used) are integrated with traditional PD techniques employed to gain insights into unarticulated aspects of the work and to develop shared views on the work. Kensing and Blomberg (1998) specifically said that PD must not be applicable only in a 'greenhouse environment' but in the real conflict- and constraint dominated world. They concluded that

> Traditional approaches to systems design make it difficult for users to see the connections between their work and abstract and technically-oriented descriptions of new systems.....these approaches '....provide little opportunity for designers to learn about the everyday work practices of potential users' and we would like to add for workers to learn about possible technology futures. (ibid., p. 175)

Because command work is basically about actions in the social world (and interpreting the world to be acted upon), command work is also about design. The work artefacts must allow a fine-grained, dynamic and flexible design and re-design process at the most basic symbol level where variety is at its greatest. What occurs is naming and renaming, interpretation and re-interpretation. Because it is impossible to make a complete model of the work in the boundary zone, defining symbol handling on an aggregate level or to design higher level processes is difficult. The task at hand is to find tools and methods to support this design process, to further develop what emerges (Hughes et al., 1992). Traditional design means construction of complex tools and components, and leads to a high degree of division of labour. The costs of this process probably will make it difficult or impossible to have technical specialists as full time participants, which then leads to a further separation of design from its arena of application, and risks for new communication breakdowns. If the design object is defined as a "product", and a method is aimed at the definition of unambiguous concepts, then it will inevitably fail because it will be less adaptive to the social reality.

6.4 Fieldwork Principles

6.4.1 Applied Social Science

The social sciences deal with open systems but lack the advantages of the natural sciences of having relevant closed systems sciences to draw upon. To interpret events and social actions is difficult: what looks like clear cause-effect relationships can be something else. However, the fieldwork is conducted because

> it is not enough to accept the taken-for-granted aspects of culture and society in which we collectively live and act. (Salner, 1989, p.66)

It is not sufficient to stay at what is taken for granted in research either. However, some imperatives exist. Salner (ibid.) specifically argues that there is an ethical dimension of human-science research because the result of research can be used for social control. The ethical aspects are important to handle also when designing and implementing ISs, because socio-political domination is a common issue related to control technologies: who is allowed to control whom and for what purpose?

One of the main reasons for the openness of social systems is that people "can interpret the same conditions and statements in different ways and hence learn new ways of responding, so that effectively we become different kinds of people." (Sayer, p. 123). Therefore it is imperative to try to get contextual data (time, space) and try to trace phenomena in the way prescribed by Strauss and Corbin (1990) and Creswell (1998). Rich descriptions are required and techniques will facilitate this. Giddens (1991) stated that *fateful moments*, defined as "moments when the individual must launch out into something new, knowing that a decision made, or a specific course of action followed, has an irreversible quality, or at least that it will be difficult hereafter to revert to old paths (p. 114)"are important to trace, as are breakdowns in the work.

Evaluation of interpretative understanding is the most problematic; the double hermeneutic problem being one of the complexities. In short, scientists have to mediate between their own frame of meaning and that of the actors when creating explanations and descriptions, and when evaluating such constructs, possibly leading to disputes about their relevance or accuracy. The validation problems come together when we try to examine ISs. First, whether something is an IS has to be open for interpretation. A conclusion is that only because some artefact satisfies technical specifications defined against a hypothetical relevant functionality (they are what become verified) its role as an *information system* (informing etc.) is not verified.

Both *what is seen* and the *interpretation of it* are social constructs or the effect of such factors. Therefore interpretation of conflicts and discrepancies need to be reported and explored. Without being openly conducting a *critical ethnography*[1] (Creswell, 1998), a researcher may find the result of a study criticized because conflicts and contradictions are revealed and discussed. In my case, contradictions *are*

1. Creswell, 1989, p. 211: In a critical ethnography the emphasis is on the political purpose to challenge research, policy or other forms of human activity. "Critical ethnographers further speak 'on behalf' of their subjects as a means of empowering them, giving them 'voice'. The critical ethnographer begins with the assumption that all cultural members experience unnecessary repression to some extent."

relevant entries for fieldwork and analysis, for instance the boundary between logistics and operations, the divergent opinions on decision-making/problems-solving, the dichotomy between central control interests and power in the work, or whether an efficient 'system of systems' has priority before capacity toward an opponent.

I realize that because of the 'power-density' involved in command work and ISD, and recent problems to develop the military practice, the work may be interpreted as a critical ethnography even if this is not my intention. Perhaps such an interpretation is unintentional but unavoidable given the present state of affairs in the domain where strong quests for autonomy have to be balanced by control actions aimed at the organizational unity.

6.4.2 On Validity and Verification

Eventually, an analysis is judged by its outcome. Whether a study can be good ethnography, said Creswell (1998), is linked to the result. A study that contributes to our understanding of important questions and fulfils certain standards is likely to be good. My theory about constraint management was grounded in a *real operation*, although the data was primarily interview data and not first-hand records. In the second phase of the study which builds upon the first, the empirical field is *domestic training*, and data has been produced from first-hand records. This leads to a question of validity of the approach and the outcome from it: is the result valid and usable as a guide for analysis also during training?

One indication is whether similar events and social actions within training support the accounts from Bosnia. Another is whether practitioners think it is valid and relevant. The external evaluation of this study so far is limited. The internal evaluation is part of the effort to write it down and to demonstrate data and conclusions. This validation is the starting point for a discussion about validity and (to some extent) on verification (which complements what was said in more general terms in the first chapter).

Let us turn our attention to the research domain, the military context. The people who populate it solve problems related to their own and other people's survival, sustaining their capacity to control subordinated units and resources. The organization rests upon trust between individuals and upon technology. Those who work together know that if their unit is deployed in a real mission, most of them will be involved. Outsiders can hardly experience what has been successively formed during the CPXs. Researchers can hardly decide upon the "reasonableness" of a given act or action because they are not acting within the belief system of the actual domain.

Continuing to the idea of much training and command work, it is about the establishment of rules to apply when generating and decoding symbols (Rice and Sammes, 1989). What is *accepted* will do. My position and military experience allowed me to share some instances of this belief system but for obvious reasons not all of it. Many of the participants and those engaged in the CPX management have experiences from recent missions abroad and have an idea about what is realism and relevant problems. Researchers' interpretations therefore cannot be focused upon the *truth value* of this social matrix (including rules). Instead, if people are satisfied with their technologies, work, and combined efforts, this is an indication of the experienced *social value* within the bounded CPX rationality. It is hardly possible to question such a situation. In addition, in front of researchers, perhaps extra efforts are made to be competent.

To conclude, sufficient validity and relevance is what concerns both practitioners and researchers within the military, either the latter work *within* and *for practice* or trying to develop knowledge *from within* it. In fact, there is a double validity and relevance problem. Each CPX that was studied was a real event. People acted in a social environment and had to face upcoming situations, some of which were simulated and others were not, as for instance real sleep deprivation, misunderstandings and illness occurred. The military tried to establish a foundation for operations in "war" (or a certain span of type missions and contexts), at the same time as "war" must be defined. Either an "ideal traditional war" is defined, or radically new scenarios are created, the choice is between defining "war first – methods later" or "methods first – war later". When possibilities for simulation and training are reduced because of force reductions and economic factors, how to train and at least establish some basic capacity (in some possible mission type) are required. What kind of test platforms are needed for development of basic competence?

Another validity problem is whether it is at all possible to conduct *peacetime research* in the absence of war and then derive conclusions that are valid and relevant *in war.* The approach to using qualitative methods has both advantages and disadvantages as compared to traditional approaches of a quantitative character. First, to work anthropologically allows a closer study of how people act when faced by constraints, what strategies they develop when faced by unexpected and inexplicable events. From this kind of study, rather than from an ideal design based upon theories of war, useful results for the basic design and thinking about practice promise to come. The disadvantage (not a weakness) is that the close detailed study and analysis of the social reality make validation complex too (Kvale, 1989). Kvale consequently warned against paying too much attention to validation because it can lead to verification of what is known instead of new knowledge.

I conclude by realizing that my task is not to evaluate whatever occurred in terms of being good or bad. The more modest aspiration is to describe what was done, and to analyse what kind of contradictions were resolved, how this was achieved, and to find explanations. To start with, the fieldwork will provide data for such as description.

6.5 In Summary, Field Work Direction

The field work should proceed so as to lead to descriptions of what actually goes on in the command organization, what command work is, and not only be accounts from participants. In this work, because the issue of *autonomy* is of vital interest, autonomy defects of any kind indicates where command work must leave its planned process. Special attention must be paid to the design aspects of autonomy. As Shipman III and Marshall (1999) explained, enforced formalization is close at hand in common design work. It should not be countered by still more formalization but instead respected and deeper explanations sought.

Kensing et al. (1998) summarized a PD project where a methodology of five steps was used:

- Fieldwork,
- Design workshops for outlining of future work practices,
- Sorting out ideas and findings from the analysis,
- Data modelling, and
- Prototyping.

My study is only the first step. It is important to look for phenomena interpreted as constraints and contradictions. The *power relations* between commanders who represent the political power and the organization that generates its own power or dynamics—in the modern organization *experts' power*—are worth looking for. Another way of conceptualizing this issue is the tension between the will of the commanders and the constraints in the organization, whether it is bureaucracy-like or has another design features. In order to produce sufficient data for an analysis, the fieldwork techniques and methods should include observation/ recordings and conversation/interviews. An exploration of the potential gap between logistics and operations, supply and demand, means to study how resources are defined and used and how this affects the whole work, and might lead to insights where support efforts are relevant. In the command work, then, it is necessary to trace and describe:

- What is visible and possible to monitor, and what meanings of these actions are there?
- How is transformation in the work conducted, and what kind of transformations have become new constraints? This question is also related to the design of ISs.
- What actions become invisible, hard to describe, control, and study?
- What mixture occurs between rational techniques and other and less rational methods in the command work?
- What artefacts are used as instruments for control actions?
- Are there situations where rational control leads to negative social affects?

This concern with what is actually taking place is close to Hutchins' (1994) theory of distributed cognition in his study of navigation. He said for instance that "pointing isn't more information than a detailed verbal description: it is a different kind of information that can be put to work in a different way" (p. 230). Therefore pointing (or other physical actions) should be analysed and interpreted before it is disregarded and rationalized away.

Finally, in spite of the proximity to action, the ethnographic researcher should not "go native", but instead maintain autonomy, conceptually and operationally, building trust to get access and openly declare purposes and interests. Contradictions have to be exploited, not pointed out and criticised. Instead relations should be clarified and explanations formulated about the situation in the social world.

Chapter 7
Context, Fieldwork and Data

THIS CHAPTER DESCRIBES how the ethnographic approach was implemented in fieldwork during the exercises. It outlines the social and physical contexts during military command work and exercises, the techniques that were applied in the work, and the data. The purpose of the fieldwork was to produce data for a rich description of the command work, suitable for a closer qualitative analysis and formulation of principles for the design of computer artefacts and ISs. It aimed at discovery, visibilization and recording of work. The decision to work qualitatively led to certain observation positions and a search for indications of the work activities there and their result. The technology-dense organization, a partly temporary structure during short and intense exercises, turned out to be a stimulating and demanding environment.

7.1 Context: Command Organizations and Exercises

7.1.1 THE MILITARY HEADQUARTERS AND ORGANIZATION

A deployed army tactical HQ constitutes a mobile networked organization which is an infrastructure for continuous command and management of army operations and manoeuvres in cooperation with navy and air force units. Forces are organized in the tactical levels (from bottom) battalion, brigade, and division. Normally a division HQ commands some army brigades and associated (supporting) Navy and Air Force units. It coordinates tactical ground operations in cooperation with authorities and organizations in society as well (the concept of a total defence). HQ B (together with its subordinated units) piloted the practical part of the army change process from 1998. For me it was an available and sufficiently complex structure in order to study command work from an ISR perspective, where new support and communications systems were implemented and tried out. An army division HQ is divided into three to four cooperating units that are distributed according to the actual mission and operations (Figure 7.1) occasionally moving with the progress of an operation.

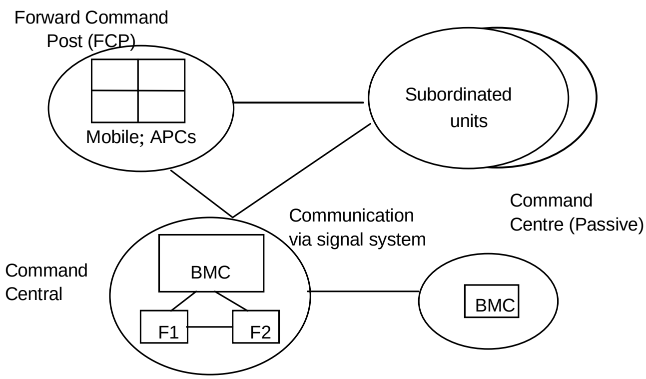

Figure 7.1: Deployed division HQ, main structure.

In the HQ that was studied (B) the new organization implied that an active Command Centre (CC) contains a Battle Management Centre (BMC) and Functional (Combat) Support Cells (F1, F2), where for instance Communications, Artillery and Logistics sections are located. Within the highly mobile FCP, close contact with subordinated units is maintained and operations are monitored. Vehicles (trucks, APCs[1] equipped and designed for work) and large tents function as workspaces. The HQ can be deployed outdoors or in large buildings, being autonomous and using its own generators for electric power. The battle command is executed from the FCP where representatives from each function work, and where the CO usually is. The COS directs the whole HQ structure. The coordination of control activities and work among the HQ subunits and the subordinated units requires considerable efforts, with regards to the distributed and mobile infrastructure. Hel-

1. The FCP uses modified Armoured Personnel Carriers (APCs) to get mobility and protection for command teams and technical core functions.

Figure 7.2: Examples on workspaces, APC and tent (January 1998).

icopters belong to the means for transportation and communication within the HQ. The distance between the parts of the HQ may be considerable, during the final CPX occasionally 50 km or more (Persson and Söderquist, 1999). In each work module and compartment communication facilities, local LANs and servers providing computer support, replication of data over the whole structure, and backup. Figure 7.2 shows two examples on workspaces.

HQs are supported by a larger organization, in this case a battalion, which provides the necessary infrastructure for internal and external communication, transportation, protection, supply and logistics. This means demands for strict obedience of the procedures for maintaining safe, secure and stable communications and enduring support of staff and command work, including data management and computer use. The whole structure is operational around the clock, with some shifts of responsibilities depending upon the actual personnel status, the need to visit external organizations, and to rest.

7.1.2 COMMAND POST EXERCISES

Training is prerequisite for any effect, being a very important component in military peacetime activities. The military bureaucracy therefore often makes monumental efforts when exercises are planned and conducted. If failure (within the scenario and the game) threatens, it must be tweaked to the best, and most important: real accidents or casualties must not occur. Because exercises are (comparatively) rare occasions and offer precious opportunities for individuals to practice in their supposed position within the wartime organization, leading and commanding real persons, exercises are also occasions when assessments of prospects for promotion are part of the work. Most realize that what they do is both forming their career and a way to develop their professional competence where the next time, like

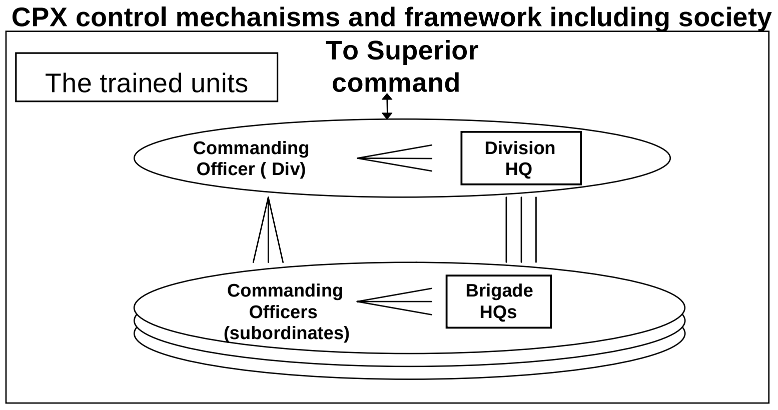

Figure 7.3: Communication and interaction lines within the total command organization; society/environment outside box.

in Bosnia, may be within a war context. Figure 7.3 illustrates the principal structure of a two-level exercise involving one division and three brigade HQs. The idea behind the communications' architecture is to create a closed system with 'fire-walls' against the environment.

Each HQ conducts training regularly (wholly or partially) and organizes some activities each year, larger events (like in May 1998) being more rare. Depending on the purpose, a CPX may appear as a realistic double-sided game with advanced computer support for simulation of the scenario, the social and physical context, either conducted within a limited space/area (type one), or as full scale events over large distances and areas (type two). Both types were represented during the field-work. Teams acting as subordinate and surrounding units can be co-located in or near the training site together with the game and exercise control (type one), or be deployed as other CPs in the terrain (type two). Staff in the fieldwork site interacted with such units and had to use various tools in the work and for communication depending on the type of exercise.The organizational context can be simulated and participating units only represented by their command teams. It is up to those who have been given roles to enact them and to create drama which is credible enough to make people committed. The exercise controllers monitor and judge what happens.

Rules for time delays caused by the friction of physical movements of forces and transports are hard to define and institutionalize. Negotiations and agreements between interacting partners guide the evolving processes in the operational area. Sometimes the whole game becomes speeded up. Researchers then have to decide

Figure 7.4: Brigade Command Post under deployment (March 1998).

on issues as realism and validity of observations: actions are real but products of a scenario with embedded short-cuts. Researchers have to follow their examples.

Restrictions may be imposed on research because of safety regulations and security. In the standard CP equipment and vehicles there is not much room left for researchers. Seldom does the CPX plan admit special arrangements for repeating a certain phase or activity. Occasionally time-out is possible but might be an option only when something goes really wrong and must be corrected or repeated. Because of the purpose of the exercises in the superimposed army change process during the fieldwork, and the focus of the research, some immediate results were desirable to communicate to the organization fast. I did this shortly after or even during some exercises.Figure 7.4 shows a brigade CP with APCs.

In short, exercises are short intense periods of activities in a simulated environment and a scenario that is arranged and executed with the participation of domain experts. Efforts are initiated for the highest possible level of realism in the simulated interaction with the external world, except, of course, use of force. Exercises are part of the total command work and learning process within the army as a knowledge-intensive organization. In one way they are real and the only occasions where the military professionals can demonstrate – for each other and for the environment – what they can do. Therefore exercises are opportunities when staffs can thrive in a territory which is their own, and experience a relative freedom from the ordinary bureaucracy.

7.1.3 APPROACHING THE EMPIRICAL DOMAIN: RESEARCH PROCESS DURING 1997 AND 1998

The study on Bosnia (where the military themselves discovered many demands on the command work) paved the way to the second research phase and helped me to get access to do the fieldwork. During the fiscal year 1997/98 a series of CPXs were scheduled for the development of working practices, procedures and field tests of new equipment. I could relate my study to this army change process which is the context of the research (Chapter 8 gives a richer background to the analysis and interpretation of data). I accepted some involvement in the superior army change process in order to get access, on my way to the final exercises.

The actual fieldwork occurred in two phases, a preliminary sequence during exercises from November 1997 to April 1998 and the final weeklong exercise in early May 1998. It was conducted in the HQs of two divisions (labelled A and B) and one brigade. I wanted to use the often-threatening gap and the interaction between Logistics and Operations as my breach and see how integration was operationalized, and what it meant for the rest of the work. After the series of exercises I made some complementary interviews with participants during the fall of 1998, 1999, and the last one early in 2000. Table 7.1 gives an overview of the exercises and the research except for details about preparations and the data analysis between exercises. Only the first CPX involved HQ A. From January 1998 HQ B succeeded HQ A as the army test and development site which meant that actions and initiatives were brought forward to HQ B from A.

Table 7.1: Events, methods and data, an overview

Fieldwork event	Purpose	Data
CPX HQ A November 1997 3 days	Method development; Phase 1: Specific study on equipment and workplace/space technology as preparations for main exercise May 1998.	Audio, notes, documents, photos; Interview (short audio)
CPX /staff exercise HQ B January 1998 3 days	Familiarity with workplace; Establish personal relations and inform about research interest, method refinement.	Notes, documents, photos Interview(audio)
CPX March 1998 3 days (brigade)	Learn about command level subordinate to division HQ. Continued work with workplace factors and methods.	Notes, documents, photos

CPX April 1998, HQ B 4 days	First attempt to study Logistics - Operations interaction. Analysis of command principles and control. Personal relations and workplace conditions.	Notes, documents, photos
CPX late April, HQ B 2 days	Short exercise as rehearsal before main event; Personal relations; information about research interest. Logistics – Operations interaction.	Notes, documents, photos
CPX May 1998 One week, HQ B	Interplay, coordination Logistics – Operations. Phase 2 of workplace study.	Audio, notes, documents, photos One post-ex interview
Data analysis June 1998–January 1999	Reconstruct situated in situ IS development.	Two interviews
February 1999	Verify chain of events; Complementary conversation with key informants.	Group discussion, one interview (audio)
April 1999	Group meeting and review at division HQ B of a CPX report.	Notes
June 1999	Complementary data to fill in about CPX events.	Interview
November 1999 – February 2000	Complementary data about events during 1996 – 1998; the evolution of artefacts in work.	Documents from army project ATLE; interview

7.2 Fieldwork

7.2.1 DESIGN OF THE FIELDWORK AND DATA PRODUCTION

The design of the fieldwork depended on short time to work between and during exercises, the focus at human actors in a high-tech context and its accumulated complexity. The ethnographic researcher studies the interactions in the culture-sharing group, for instance its behaviours, customs, and language (Creswell, 1998). With the help of data from the field I wanted to make a *portrait* of the personnel in the division HQ B as a cultural group. The result depends upon being close, and to be able to discover, interpret, and to make sense of what goes on in the work, what people do, say and use (Figure 7.5).

Figure 7.5: What people say, do and use...(March 1998)

Most HQ positions are centrally coordinated within the military and changes are formalized. Career officers and reservists form the operational core, normally belonging to the same HQ for a couple of years. The CO of a division or brigade (brigadier, colonel) is appointed in his rank by the government. He and his COS (LtCol, Colonel) are given their positions by the Supreme Commander. Some career officers pass through or climb within the same unit during several years, or alternate between similar units depending on vacancies. Some, also reserve officers, may become "tradition carriers" in a HQ. Civilian experts can be recruited as to provide expertise within certain key areas, for example medicine, psychology, accounting and are often given officer's rank.

Lower ranked groups are the staff sergeants and privates (a few different classes). Most of them were doing their basic training (seven to twelve months service) during the fieldwork. After their first service period some are positioned in the reserve cadre in the mobilization army and are called upon for refresher training. Because the formal and bureaucratic organization is divided into main functions such as Operations and Logistics with combat support functions ordered in sections or branches (for example Artillery, Engineering, Signal, Personnel, Maintenance, Transport) projects or cross-functional teams are often formed, as short- or long-term organizational solutions. Potentially, no actor is too unimportant to be an informant, to study and talk with. Because of the complexity and the distributed organization considerable time must be spent before it is possible to combine impressions, ask the right questions, see where competence is, and discover and

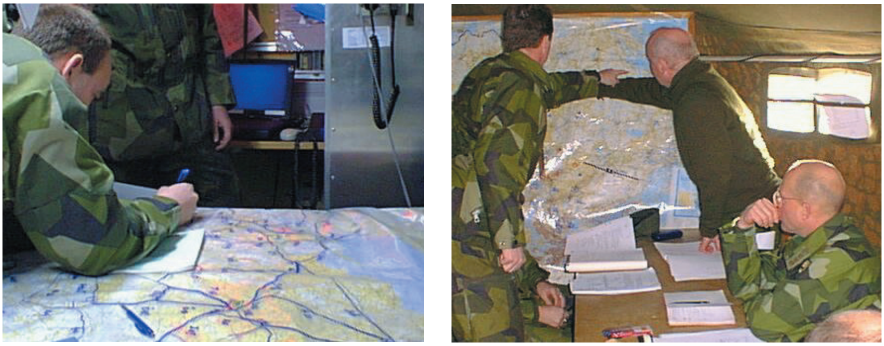

Figure 7.6: Map use varied a lot, between detailed transport planning (left) and the CO's tactical discussion (right) (March and January 1998).

understand patterns in the work.Events may be parts of long-term or rapid processes, or temporary phenomena. A researcher (team) may therefore have to analyse data in a few different time scales, guided by immediate and long-term goals of the fieldwork. One exercise and a discovery could as well lead to a dead end. Map use, for example, evidently had a central role in command work, which motivates a closer study of it (Figure 7.6).

It was evident from the very beginning that the amount of fieldwork and the possible outcome in the form of data could be overwhelming. The process I wanted to follow had no detailed script, it was a flow of complex events in a new organization where almost anything could happen. From the first exercise I tried to learn about the command work and management procedures, to finding out where to look and what research techniques to use, and who were key gatekeepers and informants.

Basically, what counts for researchers (and command practitioners alike) is what is visible, or can be made visible with the help of fieldwork (command work) methods, tools and techniques. The concept "informating the environment" (Zuboff, 1988) suits the research in the same way as it is applicable in a general sense: IT 'informates' the environment. Devices that automate also *register* data about these activities, generating new streams of information, contributing to a new order of reflexivity, possible to use to build a new 'control layer' (Beniger, 1986). A production process becomes visible in a rationalized form in a flow chart, but the *work* often remains invisible in such records.

The researcher has to realize that he/she is not one who just *captures* data. There is no data 'floating around' waiting to be "captured". Instead, data are *intentionally produced* (meant to be used as information), results of a choice, of reduction and rationalization and must be interpreted when used. Data production is thus an active effort, potentially also influencing a situation. This production is often not possible without assistance from the technical staff and other actors. Simplicity in methods and technology, and preparations for rapid analysis and re-design were prerequisites because of the succession of exercises. As it happened, two other researchers participated in the last and most demanding exercise. One of them was involved in action research in an actual position among staff, the other studied the workplace activities from an organizational learning perspective. Thereby opportunities for continuous analysis appeared, and comparisons with other research approaches. During and after the exercise we could discuss each other's experiences and provide complementary data (See Persson and Söderquist, 1999).

7.2.2 Conclusions about Techniques in Fieldwork

The previous chapter has led to some conclusions concerning *fieldwork focus* and *principles*. When combined with the guidelines for *research standards* that Creswell (1998) presented, I have formed the following prescription. During the fieldwork, the

(a) research questions drives the data production, but evolving events may mean opportunities;

(b) research techniques should be simple. Autonomy as regards the infrastructure is desirable;

(c) researcher's assumptions are made explicit;

(d) the study has overall warrant, i.e. if it is robust, it uses respected theoretical explanations and discusses disconfirmed theoretical explanations (a critical perspective), and

(e) the study has value both in informing and improving practice, and protecting confidentiality, privacy and truth telling. The last criteria are the ethical aspects of a study.

Creswell also recalled some standards linked to an *ethnography.* Some of these are: contextuality and prolongation in observations, a variety of techniques, systematic knowledge elicitation form informants, hypotheses and instruments, agendas, questionnaires, and generation of codes in situ, to let themes emerge. Concerning verification, feedback from informants was one of Creswell's suggestions.

The following issues and phenomena promise to provide insight in ISD requirements:

- Use of techniques in command work that *enhance the visibility* of work, utilization of the whole workspace,
- *Complaints* about problems (what kind and why?); causes behind breakdowns and conflicts,
- Use of *formal and informal operations and information*, and the shift between,
- *Face-to-face contacts* and why,
- The existence of *not formalizable problems* and what happens next,
- *In situ development* of tools, use of new symbols and why,
- *Transfer of work* between actors – how and with what support,
- *Knowledge representation techniques*; support from procedures and rituals.

The key to any result was to get access and formal right to participate. During large exercises, instructors, CPX management personnel and researchers usually swarm over the organization. Each additional participant has to motivate his presence. I was helped by the first phase of the study (on Bosnia) and got a request to look at certain aspects in the workspace equipment in addition to my own interests.

The technologies and tools for data production should be easy to use standard equipment allowing non-intrusive work, and robust enough to withstand field conditions (dust, bad weather). Permanent records would have to be created. Long shifts mean additional risks for sleep deprivation and forgetfulness. Technical trivia (such as synchronization of clocks, need for vehicles, batteries, and passwords) can overthrow the most carefully designed research enterprise. In short, I had to prepare for a lot of writing, photography, audio recording, trying to get output from the ordinary IS in the HQ from printers and from people. Altogether these techniques would admit triangulation.

Because the series of CPXs was a test situation for new command and control technologies, working procedures and environments some HQ equipment and ISs were prototypes or preliminary versions of future technologies. The units involved consisted of a few of the war-time organizational command units (partly manned in peace-time), primarily a handful or so of the army brigades and one of the division HQ were there. Although these should be the same units through all exercises, their actual composition varied somewhat during the period depending on the use of these exercises.

When I worked as an observer, trying to be close to people and follow evolving events, I made short interviews but occasionally recorded conversations with individuals or during meetings. In every situation it was necessary to record context and conditions in order to facilitate later interpretation. I did not spend the nights in the HQ because of the need to maintain sufficient endurance during the whole weeklong exercise. Therefore, when arriving to the HQ in the mornings I attended to briefings, made short interviews in order to get fresh insights into upcoming events, profiting on opportunities to catching up with the work in the same manner as ordinary staff members.

7.2.3 SOCIAL ASPECTS OF THE RESEARCH PRACTICE

To get access to a HQ is both a formal and a practical social procedure which may take some time. Because the army is a fairly small organization, many were acquaintances or had been former colleagues. It is necessary (for the qualitatively working researcher) to try to get close to the practitioners and establish personal relations with core informants and a general acceptance from most people involved. It was beneficial to wear a uniform and to fit into the context. At the same time, there was a risk to 'go native'. I assume that my rank (LtCol) and my acquaintance with many facilitated access and work. However, much care is necessary in order not to misuse trust and confidence, violating followers' research.

To use the terminology of Berger and Luckman (1966), while the military institution is one recognized by society and existing as or within a sub-world in the nation-state 'base-world' and as such concerned with the socialization (a secondary socialization for a partial reality) of its members with the help of training, researchers belong to another sub-world. Berger and Luckman even meant that researchers basically may be marginalized by society. Because researchers usually do not belong to the military institution and ideally resist going native, they may be perceived as potential competitors when creating their knowledge structure about the research domain. This possibility may anytime lead to conflicts and have to be managed, and also affect the results of research. If, on the other hand, researchers are seen as harmless, they may get access but their result neglected.

The ongoing changes in HQ B (the main field site) meant that I had to adapt too and be flexible, able to improvise if I wanted to track what people were doing. I deliberately tried to explain and demonstrate the research methods before the exercises. Primary 'gatekeepers' in the HQ were the COS, and because of my interest to study the interaction between Operations and Logistics, the Chief Logistician (ChLog), each one given authority and, theoretically, being the definer of the reality

Figure 7.7: Discussion between CO, ChLog and BMC Team leader, representing Operations (January 1998).

in his institution (ibid.). Figure 7.7 illustrates a meeting during planning between operations, logistics and the force commander.

Empirically founded and socially recognized experiences are appreciated when development of work practices and ISs are at hand. What is characterized as recognized and empirically founded knowledge depends on the situation and who defines it. Empirical evidence of distant events might be hard to capture when the only witness is the researcher, but assistance might be given by the operators if a situation is handled carefully. As a means of sharing experiences I produced feedback of various kinds, and reminded about the important mutual learning researchers – operators which occurred during the exercises. I also gave rapid feedback on certain issues, as a way to pay back, in some cases each day at staff briefings and in other as memos or informal reports.

Finally, failures from both actors and researchers may be embarrassing and prestige can be at stake. I had constantly to balance the need to know with the risk of intrusion and influence, because of time constraints and pressures on the actors.

7.3 Data

The total work and communication were difficult to track and occurred in several media. Personnel moved physically between subunits and HQ subsections. They organized and participated in meetings, some contingencies and other routine assemblies. Between the different parts of the HQ they normally communicated in parallel, on more than one channel. Shifts of media or method often occurred during the same chain of interaction, possibly distributed over long periods, often intersected by pauses and other tasks, depending on the persons involved.

Databases in the HQ stored messages and outgoing orders. Barriers to access and insight into them varied between pure technical to social constraints, from admittance to participate and get passwords to the secure IS, distant back-up files, tempo and physical distances. I have tried to get specific data about one of my cases after the exercises but two factors have prevented progress. These are (1) the *amount* of data automatically saved and stored during exercises, (2) that *very few persons* can or are authorized to search and retrieve these data. They have been very busy in their normal occupation, not possible to convince that retrieval was important.

Clarification of observed actions sometimes was necessary, but impossible to get immediately. Primary data from the source might have to be stored for a future follow-up interview and combined with the result from a later, a secondary data production. As it happened, once I could ask two persons to delay a conversation a few minutes till I had fetched the tape recorder, in order to let me produce data from their conversation. In another situation I could ask for a fresh comment on a discussion that had just been finished and take photos of the people who had participated. The follow-up interviews and conversations have been possible because the limited number of participants and informants, and most have been recorded.

Technically, the data were field notes from observations and conversations, printouts and copies of documents and of messages from the electronic mail system, together with audio recording and still photo. The first three-day CPX (HQ A, November 1997) left me with about 90 digital still photos of equipment, situations, and artefacts. Some three hours of audio were recorded with a small tape-recorder, preserving dialogues, general briefings and conversations. In all, after the series of exercises, follow-up interviews and acquisition of documents, roughly 15 hours of audio, some 300 still photos, hundreds of documents (official together with those produced on location), notebooks with field notes, and transcriptions of audio recordings constitute my total database. Figure 7.8 illustrates a short meeting (late April 1998) which became a closed session (work becoming invisible for me) and where additional data were provided shortly after it ended.

Figure 7.8: A short meeting that virtually closed itself for me, I followed up and got document data, printouts (April 1998).

Over the fieldwork period, certain types of events could be traced and evolutionary work processes reconstructed. Certain individuals were central actors and informants throughout. For this thesis, as is necessary when working within qualitative method, it has been possible to use and explore only a minor portion along some tracks which are representative for the kind of work and study. Best of all, much has been able to relate to ongoing ISR research, being described in literature.

7.4 The First Impressions from Routines and Interactions in Work

One of the common ideas driving the evolving scenario during staff exercises, in the actual cases a minor regular war, was to promote cooperation between and within units in HQs and between command levels. It is desirable to demonstrate the importance of cooperation between command functions, to stimulate people to produce integrated solutions to emerging problems, for instance between Operations and Personnel (within Logistics). Thanks to my tools, it was quite easy to *produce* data technically and formally, but harder to *make sense* out of them.

Within the work and organization, the communication lines usually are complex, meaning that information about and originating from actions often is distributed with delays. This was further promoted by the comparatively large and distributed HQ where delays did not need to be simulated. Many were real. Modern communication technology offers a multi-channel/-media structure (LANs, WANs, radio, cables) where individuals normally achieve a considerable freedom to communicate (as compared to earlier technologies where manual switchboard operators regulated most communication) but legal decision authority nevertheless remains centrally controlled and restricted. Even if the LANs were used for the intense email communication, meetings, teleconferences, radio and telephone communication were common and ongoing around the clock.

According to common army principles, HQs usually have a certain freedom to organize their internal work according to the personal preferences of COs or as adaptations to missions and circumstances. Because the whole organization and the sequence of exercises (table 7.1) was a series of trials to verify new methods and technologies, the uncertainties and contingencies were numerous, improvisations being frequent, often sequential, one after another. Some procedures required close interaction and coordination between the parts of the HQ, as for instance planning and of the subsequent manifestation of plans in operations' orders. Different parts of a plan had to be consistent and synchronized, orders had to be edited, distributed, often followed by amendments. The whole product had to be presented to the CO or those who were given authority to confirm it, the formal decisionmakers.

The COs (division and brigade commanders) cooperated frequently, often informally, for instance during recurring 'commanders' conferences'. Interpretations and agreements of situations were important outputs from their interaction and had to be continuously communicated to the rest of the HQ. In parallel, combat support function representatives acted on behalf of the COS or the CO, maybe regulated by the SOP or were event-driven, making detailed decisions about work and its agenda from day to day. The vertical and horizontal interaction within each HQ was tightly interwoven but also informal. In spite of this, now and then the distribution of insights was uneven and some persons knew while other were ignorant about upcoming situations. One informant/officer from the division HQ (during a February 1998 conversation) remarked when complaining over the need to walk between vehicles in order to capture what was going on and to distribute directives. Person U said:

> ...less often in the Battle Management Centre with three different compartments people walk between these compartments …I also noticed occasions when I went between different vehicles and talked to people, suddenly such information popped up which was highly relevant and I say directly 'we must find out more immediately' and they have had it there for a quarter of an hour…(Person U)

Figure 7.9: Necessary to get close to see what was going on, but access limited (March 1998).

Figure 7.9 shows work in traditional staff vehicle at a brigade HQ. Major or minor breakdowns occurred, both real within the HQ and among the subordinate units, some of which were simulated by just a few persons. During the succession of CPXs, a few factors augmented the risk for breakdowns. The new technical components within the total command organization had not been developed in a coordinated manner as a consistent system, but rather as loosely connected partial systems. Some breakdowns had to be and were neutralized thanks to rapid counteractions, while others could grow unnoticed till they were "ripe" and caused or threatened to lead to major disturbances. For instance, frictions or failures in the new telecommunication systems or the central IS had to be managed and acted upon immediately, they could not be lined up in a queue.

Normally actors in the HQ, usually the leadership (COS, middle managers), met twice each day at regular morning and evening staff briefings. These occasions were arenas for cross-functional distribution of reports, directives, and discussion about upcoming actual or possible events. It was common to work in temporary project organizations with some persons participating in several ongoing parallel actions and teams, some short (hours or less), other during several days. The detailed distribution and organization of work, sleeping hours and meals was often left to individuals or managed within teams, where different models were applied

Figure 7.10: Morning briefing in HQ B (May 1998).

depending on the circumstances. The character of test exercises added to this dynamism. Figure 7.10 illustrates a regular morning briefing.

7.5 Summary

Any researcher can be at just one location at a time and therefore has a limited field of vision. Choice of viewpoint must be made carefully. The researcher therefore needs help from both sensors and humans to informate the environment, making it visible through permanent data. Phases of data production must be intersected by indexing, preliminary analysis of data, and rest. After a few days of fieldwork exhaustion threatened. Without the help of tools, the task would have been still more complex. At the same time, to carry and be prepared to use a variety of technical equipment might be a very distracting experience. In addition, too much involvement in the work and technical apparatus can be interpreted as intrusion and then cause other difficulties; after all, the fieldwork had to go on for quite a long time. Openness for inspection as regards to research purpose and result was a first hand concern throughout the study.

Quantitative data can be analysed qualitatively, given that they can be traced back to the moment when they first were produced, so that the context can be kept within sight. One example is the central HQ diary, a logbook, with detailed accounts and records of events and actions. It can be interpreted in various ways. It contains traces of actions, but the actions themselves may had been difficult to discover at the very moment they occurred. However, a reconstruction may as well lead to false causal relationships.

Thanks to the use of different methods and techniques, and the prolonged work during several exercises, it was often possible to triangulate, producing notes, audio, documents and photo from the same occasion or situation. Several follow-up conversations further widened the context and the data.

The analysis was tedious work and required considerable time, for example transcriptions of audio recordings. Printouts from the central computerized logbook for one and a half days can be a list of hundreds of messages and notations, many being related and necessary to analyse together. It is a record of events or actions which can be interpreted to some extent during the exercise but only with difficulties after it.

Precise indexing (time) and reconstruction of actions were possible with the help of the digital photos, the tape-recordings and then printouts from email-systems where message are stored and their paths can be traced. A minor complication was that the clock in the computer system in the HQ was often incorrectly tuned, from a few up to 10 minutes late on one occasion. Thus, every mail might have passed through more than one time zone and its automatic indexing might have become ambiguous.

After all, the distributed research activities during the CPXs made it possible to reconstruct and begin the modelling of work processes as a first step toward an informed design process. As the cases will show, both minor and major actions in the work could be given meaning and used. Recalling Creswell's (1998) standards for an ethnography, I got some *feedback from the informants*, both during and after the fieldwork, and could explain my actions when needed. My impression is that my presence did not disturb but instead encouraged people to continue their work as normally as possible. My *hypothesis* to investigate the probable gap between Logistics and Operations was rewarding and led to valuable contacts with informants: *there is* a problematic space and interface between these arenas. Some actors seemed glad to help me, appreciating that they had found someone who could be a speaking partner and a listener.

Themes did emerge, in fact many and a choice was necessary (Persson and Söderquist, 1999). The *use of questionnaries* was limited to two attempts. One was a thorough survey and analysis during the first CPX, of expectations before and then about the outcome of the exercise; the other was an electronic (but very limited) survey in the last hours of the last CPX when I tried to evaluate a computer application. *Contextuality* was maintained throughout the study and the presentation, and *prolongation* was a cornerstone: I could follow *evolving themes and events* from one CPX to another. I could successively inform myself by certain individuals who became used to my curiosity and were more than willing to provide answers which for me were valuable qualitative data. Finally, for reasons of privacy and ethics, I have made informants anonymous by using letters when using accounts (Persons R – X), a letter-suite which is compatible with the one used in the licentiate thesis (Persson, 1997). The photo illustrating the first case (the meeting) have been manipulated when introduced in the thesis because the individuals identity is not considered necessary for the analysis. The other, undistorted photos from the HQ B exercises in have been wholly accepted for publication by military authorities. Except from these some details from the HQ A exercise (November 1997) illustrate the early phases of the second case.

PART IV
Return from Field Work for Data Analysis

PART IV CONTAINS THE RESULTS from the fieldwork, two cases illustrating command work, and an analysis of them. The analysis suggests where answers might be found to the questions Why? How? and What? should be designed as command work support tools. I open with a description of the context of the field-work, some of the social, cultural and historical elements around and in the HQ, which form the background of the cases. The cases supplement each other and illustrate complex work interactions, the roles and use of IT. They are

1. a short meeting between four people in order to satisfy an urgent need to reorganize the command and force structure. The meeting was immediately identified as a possible case. The continued analysis and an interview confirmed its potential;
2. an evolutionary process over six months, of intertwined development of command work and ISs (computer application) distributed among staff. The start of the process was discovered early and then caught my attention a few months later in the middle of the fieldwork period. Post-exercise interviews confirmed its value.

Both cases exemplify “repair work” when work breakdowns threatened or had occurred, by and large caused by built-in or emerging contradictions. The meeting relied on and used organizational structure as a lever for continued organized action. The integrated work and application development illustrates development of a decentralized structure of computer artefacts aimed at support of distributed work processes and cooperation. It was the response to the constraints when a central IS architecture in the HQ was rapidly designed and implemented. Activity theory has inspired and structured the first case analyses.

Chapter 8
Introduction to the Data Analysis: Cases Overview and Analytical Approach

FOLLOWING THE PRINCIPLES for an ethnography (Creswell, 1998; Chapter 6) as a description and interpretation of a cultural and social group (system), and intending to produce a result which is applicable within ISR, I chose to present the output from fieldwork as a rich description. It contains details about social interaction and the use of IT in command work. I decided that case stories could make the presentation relevant and concrete. Because I wanted to achieve both *depth* and *detail* and *cover different aspects* of command work, I had to limit the number of cases. Eventually I defined two that were representative, related and could supplement each other.

The idea inherent in qualitative studies is to include contextual conditions in the research in order to facilitate interpretation and understanding of the research. Therefore I open with a description of the background to the cases, and continue with a closer look at my analytical framework, supplementing the previous chapters (6 and 7) about method and fieldwork.

8.1 General Introduction of Context, Cases, and the Analysis

8.1.1 OVERVIEW OF THE FIELDWORK AND CASE CONTEXT

In order to frame the sufficient context and history of the cases it is necessary to sketch a fairly wide background. Choices and actions during military ISD and systems development efforts originate in the quests for robust control mechanisms underpinning command work. To maintain autonomy and create ‘firewalls’ against the environment reflect the justified needs to protect the organization and its capacity from hostile actions. Such tendencies are theorized by Giddens (1991), who meant that modern organizations build ‘protective cocoons’ in order to maintain controllability and ontological security, implying trust. Clearly, contradictions arise, because cocoons may also have disadvantages. The introductory presentation in this chapter will treat some of these contradictions and what was done in order to reconcile them.

The Gulf War (1990–91) had shown what was perceived as possible and necessary for control in modern war: to gain information superiority (to know without being known of[1]), to survive electronic warfare (EW), and to conduct command work by day and night. Advanced IT, operationalized as robust and integrated ISs and telecommunications systems, is considered to be prerequisite for control efficiency.

The Swedish army change process aiming at a new infrastructure (system) for control and communication (organization, doctrine, technology and corresponding command work methods) was brought forward since 1994 as the ATLE[2] project which included an IS-component, the ATLE IS. Various events and circumstances within this longer process influenced what happened during the first half of 1998 when I did the fieldwork. My summary is composed mostly from a preliminary specification document[3], and some project documents from 1996[4].

1. The term is widely used and has various interpretations. I provide a lay version.
2. I present the data, combine and interpret them in order to reach common ISD principles, aware that the further army development since 1998 has led to a radically new situation. I have chosen to use the actual names: the ATLE project and the ATLE IS, and the real name of an interim IS, the FENIX IS, the first version of which was developed and implemented as a substitute for the ATLE IS during the fieldwork period. The reasons are that the data (accounts, documents) and the description specifically cover the situation in 1998, and conclusions can be easier evaluated. Because all was new 1998, I cannot claim that what I saw in use, or rather, my interpretation of it, was what developers and users intended it to be. However, a presentation and discussion in the HQ a year after the fieldwork (spring 1999) supported the ongoing analysis.

The army planned for an evolutionary development process, each step adding functionality (RRV 1997:49; project documents). In principle, the ATLE development responsibility was decentralized within the command structure given the demands to form one army: centrally regulated allocation of authority, budgetary rules and limits for financing, and standards as regards working methods. Deliveries of three subsequent integrated system versions, successively tested and evaluated during exercises, were scheduled between 1997 and 2002, stepwise covering the whole organization. The new mobile army telecommunications system developed since the late 1980s was part of the command infrastructure and the backbone for reliable, secure and automated communication over large areas.

Between their exercises and training periods, staffs are usually busy within the peacetime administration, planning and supervising subordinate units' training and exercises, or preparing for or serving abroad (for example in UN missions). Exercises are precious occasions for practice, also being the visible proofs of the army's existence. Such occasions are all the more critical as a consequence of the non-standing Swedish army organization, meaning that each HQ 'materializes' just for training periods and exercises. The organization changes considerably because of vacancies and conflicting requirements. The army training cycle was therefore integrated with the ATLE work, regulated by a long-term detailed plan which controlled which field units were to be trained and the introduction of new technologies. Before any CPX, participants work intensely with their immediate needs, the detailed design of organization and working methods, reviewing plans and brushing up competence through refresher training. Because of the ATLE process and what it implied, such preparations got a few extra ingredients during 1997 and 1998.

8.1.2 INFORMATION SYSTEMS, PLANS AND REALITY

Personnel from various command levels and units were involved in the modelling and development effort which successively, from 1996 and onwards, engaged more people from the army tactical command units. Responsibilities for piloting systems development and test (verification) within the army were re-allocated to those lining up for the next version of the command system (here: HQ B), and were accom-

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3. Försvarsmakten. Målsättning för Arméstridskrafternas Taktiska Ledningssystem [Preliminary Specification for the Army Tactical Command System], 6 December, 1996; 09833:73741.
4. Mainly ATLE Styrgruppsmöte [Project Board Meeting], 6 September, 1996, LSC, RP-96034, Enköping, Sweden.

panied by a series of exercises, to be managed and as training occasions. In this way, the ISs were continuously evolving with each new unit preparing for and then conducting training. Some designers and practitioners followed the process, carrying key competence from one HQ to another. This group consequently got a central role and streamlined the development effort because of the close link to real exercises when things just *had to function*.

The first full-scale test situation for the new integrated command infrastructure was scheduled (already during 1996) for HQ B and its subordinated brigade HQs in May 1998. The primary purpose was to test the new tactical communications system, not the new IS architecture. However, prerequisites to this test were IS components (the projected first version of the ATLE IS) together with skilled and committed command work practitioners.

In late 1996 it became evident (project meeting protocol) that the project could not deliver any IS in time for this CPX. Therefore an *interim* IS solution (the immediate context of the fieldwork and contributing to my second case) was rapidly put together during the winter 1997–1998. A group of army officers and a consultant company formed this system out of some existing applications and commercial products (being loyal to the 1995 military handbook IT, the HIT). One of the first times this interim IS and its infrastructure were tested by a division HQ (A) in November 1997. The subsequent six-month long systems development process was very complex. Few reflections were possible once the initial choices of strategy and technology were made, and the series of CPXs had started, one being a preparation for the next. This interim system is described in subsection 8.2.

These efforts demonstrate the institutional power and ability within the military to launch and coordinate a major development and implementation effort, but also some shortcomings. The output of the first process was a very ambitious plan and a large modelling effort conducted by experienced practitioners, aimed at the design of an ideal integrated systems solution (the ATLE IS). When it failed a smaller but still very complex process was initiated and rapidly led to a result (the interim system). Both my cases can be traced back to elements within these development processes, and how central ISD issues were resolved.

There are several reasons, relevant to the ISR community, to pay attention to the 1990s' army systems and work development process. The early work, which had occupied many officers before 1998, directed the design also of the interim system. In order to make the latter a satisfactory solution, command work methods that had been designed within the interrupted project were further refined. Later, events *within* the interim framework during the fieldwork—from the case of application development to what triggered the meeting—likewise can be linked to the design history.

These events illustrate how contradictions intervened, and were pragmatically 'attacked', because the designed products had to function satisfactory before May 1998. ISR issues of interest are how people participated in the design processes and how common sense notions of computer artefacts met reality when used in the command work. Moreover, the thinking as regards all aspects of change and work and how different control layers were consciously used in order to achieve controllability and rationality, form another group of research issues.

8.1.3 ANALYTICAL PROCESS IN BRIEF

My choice to work systematically according to the structure of the Conditional Matrix (Strauss and Corbin, 1990), has led to this first description of the context (the outer layers of the matrix), and a search process towards the actions in its centre. The ethnographic fieldwork produced a description of aspects of and actions in command work that the army's previous work could neither have discovered nor incorporated in the ongoing design and development.

According to Bardram (1998), theoretically *informed design* means design which is *informed by theory*: given *character* and *form* by it. The first step of the analysis was a reading and categorizing phase, where field notes, accounts, interview and other data (audio, tapes, and photographs) were studied together and coded. The structuring scheme was similar to the analytic principles from the grounded theory approach (ibid.), linking causes and effects, but lends its structure from Activity Theory (Kuutti, 1991). The whole sequence of work during the study is illustrated in Figure 8.1.

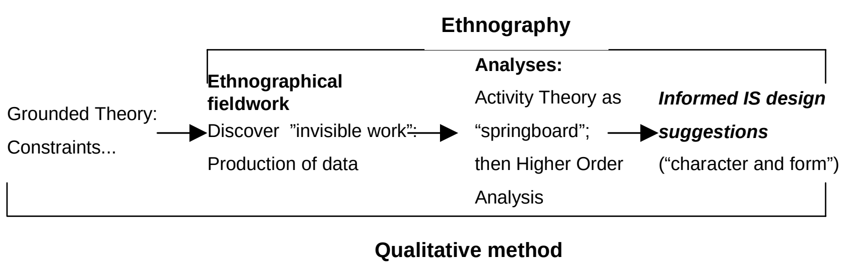

Figure 8.1: Overview of analytic approach within the whole study; discovery and analysis of "invisible work"

Activity Theory structurizes the first data analysis. I use this theory mainly as a *springboard* (ibid.) to help in freeing up the thinking about the work. This structural analysis serves as the entry point to a second qualitative and theory generating analysis and discussion (final chapters). Consequently, the design proposals become informed by work along qualitative method, and within this Activity Theory, and the outcome of a higher order qualitative analysis. In summary, the analytical steps were:

1. Description and interpretation, locating the text (data) in its context;
2. A structural analysis, inspired by Activity Theory;
3. A final analysis in order to relate data to central theoretical command work categories, leading to a discussion of informed ISD.

8.2 The Interim System

8.2.1 Vision Succeeded by an Interim Information System

Up to mid-1996, when difficulties grew, the deliverance to the army of first version of the ATLE IS was scheduled to August 1997. Later, difficulties have been related to the overall project management, the allocation of responsibilities among central defence organizations, and the recruitment and staffing of the projects (RRV 1997:49).

The army authorities decided, probably late in 1996, to develop a substitute to satisfy the May 1998 CPX demands. This substitute emulated key functions of the ideal ATLE IS. It was called FENIX[5] because it was built upon the ashes of a whole ‘application-family’, remnants from recurrent efforts to implement modern IT for tactical command work during the preceding decade. This substitute was eventually fielded[6] within an interim architecture called the ATLE 98, the 1998 version of the new total command system[7]. The main parts of it compared with the specified ATLE IS and the FENIX structures are illustrated in Figure 8.2 (source: description September 1997). The *ATLE 98* included FENIX as a collection of specific appli-

5. After the mythical bird, PHOENIX.
6. During 1999 and 2000, continued sharp reductions in the army command structure and forces were announced, meaning a new command structure which will lead to a re-thinking of the whole process.
7. ATLE project: ATLE general description and command methods. In eds. Berggren, J-G, Hallström, J, Karlsson, G, Norelius, C H, Persson, Å, Rydbecker, L and Saveros, K. Technical description/memo, ATLE project, 2, 22, 27 April. Enköping, Sweden.

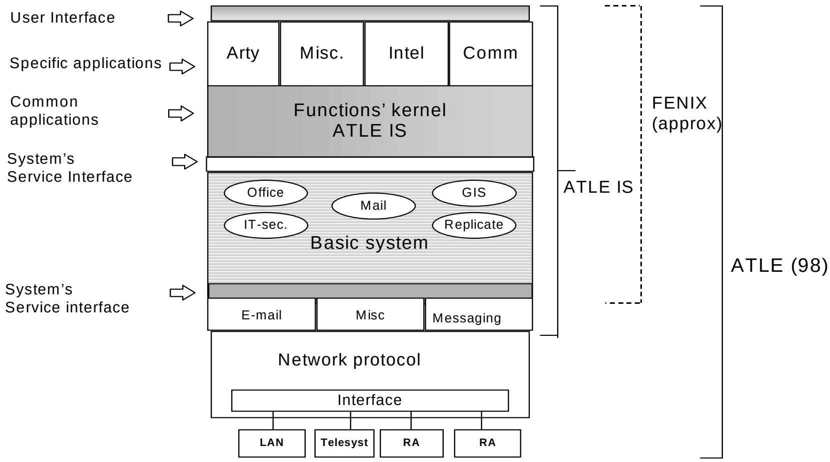

Figure 8.2: The principal structures of the envisioned (September 1997) ATLE IS compared with the FENIX (the exemplified specific applications are artillery, intelligence, communications).

cations (FENIX technical overview 1997-10-12). Within the total structure, the FENIX was a minor part, but as such the *interface* of the whole system, informing about its services.

8.2.2 DEVELOPMENT AND CHARACTERISTICS OF THE INTERIM SYSTEM

The rapid evolution of the FENIX meant that people entered into a bricolage[8] process (Levi-Strauss, 1966) where close interaction between specifiers–users and developers was organized to manage technical, organizational and work-oriented issues. The interim system in being was used from its first versions by staff who tried to make the best out of it, successively inventing how to use it. One informant (Person V, audio recording) complained that few if any contributions could be achieved from the earlier modelling of the interrupted ATLE IS when he and some other practitioners from HQ B were thrown into the new urgent task to create a satisfactory product within less than a year.

A tactical HQ had a networked architecture where workstations (2-4 in each staff and command vehicle), were linked via a LAN integrated with the mobile commu-

8. This term means construction or something constructed by using whatever comes to hand, and was used by Levi-Strauss (1966). *Bricolage*, as work, frames argument, action and object and defines what they could or might be in relation to each other.

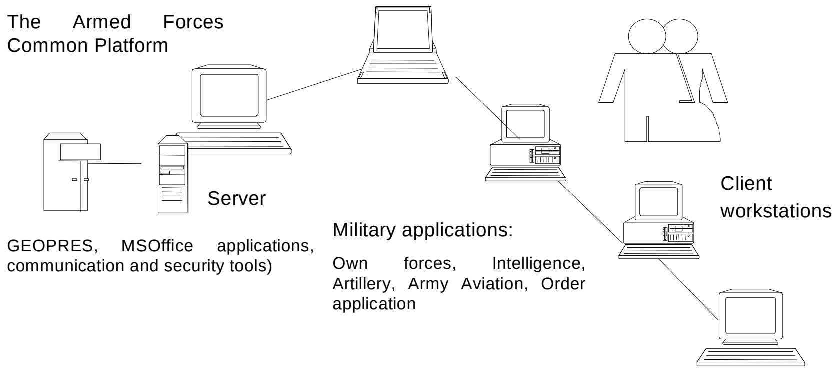

Figure 8.3: The principal architecture of the FENIX IS.

nications system. Some computers were main servers for data-bases and communication purposes, while others were individuals' workstations. Figure 8.3 illustrates the principle architecture. The software consisted of components from a technical Armed Forces Common Platform (as defined in the FM HIT) consisting mainly of standard applications (MS Windows, MS Office) and a GIS. The most important *military applications* (see figure) were modernized applications designed for the management of information (situation data) about own forces, artillery (separate function), intelligence, and map information.

Such data could be exported and imported between users within and among different units via the standard e-mail system. The applications also supported presentation of such data as overlay symbols on a digital map. Another central resource (see Figure 8.3) was a MS Word-based "order application" which supported production of the operations order (usually a large document with several appendices for detailed coordinating of operations and resource management). Then there was an "Activity journal" (interface to a database, designed mainly as a register) which was the site for storage of (ideally) all in- and outgoing messages (copying, pasting and possibly editing electronic messages, and summarizing verbal communication.) Special care was needed when files were given names and stored because of constraints concerning how to name and store them in the catalogue system in the servers. Figure 8.4 illustrates the narrow APC workspace and instructions for file naming.

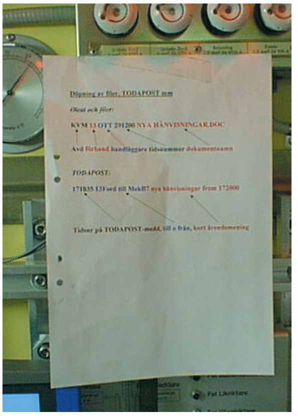

Figure 8.4: Workplace (APC) and file naming instruction.

Another system component was an advanced MS Excel-based application (the BERRA System) for making detailed *aggregated prognoses*, forecasting possible outcomes of operations and action, as quantitative resource overviews. Finally there were simpler applications designed from traditional work practices and artefacts, for example *templates* for planning and managing staff work, an *actualities' table*, and a *long-term prognosis*. In the March 1998 method handbook these were clumped together as “Office applications”, i.e. “macro-commands in MS Word and MS Excel” (and I will come back to these).

Technical system and data management was complicated, required precise procedures, and allowed few shortcuts. Data management was critical especially when an HQ (or its parts) moved from one area (location) to another and simultaneously had to rely on a new server which had been activated. The prescriptions concerning the direction of the data (information) flow within the HQ and to subordinate units and how it should be managed were very detailed and evolved tentatively during the suite of exercises. The regulations for storage were strict, because the organizational utility and functionality depended on the exact obedience about where to store, how to move data between servers, and how to inform about it. Some constraints evolved from security regulations (arriving late), while others had technical causes.

Figure 8.5 illustrates the principles for the operations of a tactical HQ within the new command organization. A Forward Command Post (FCP) where all command functions are represented handles the immediate command of forces. The rest of the staff works in rear units. One is a Battle Management Centre (BMC), providing

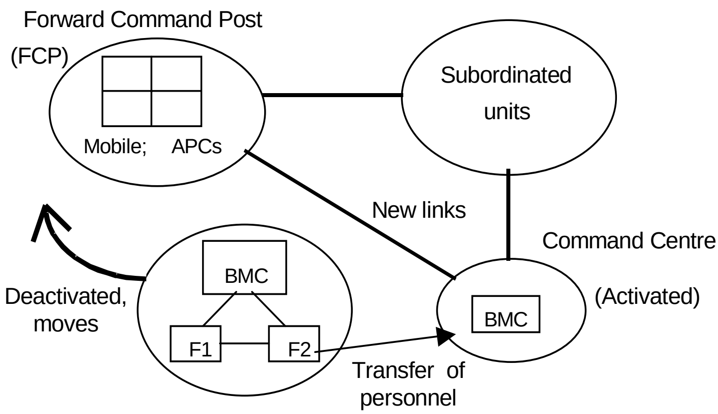

Figure 8.5: Principles for moving the HQ. Some teams unite with new Command Centre after transport to next site.

support and planning for future operations, coordinating the external contacts within the total chain of command. A rudimentary passive HQ prepares for take over when the BMC moves, data are moved, the communications are re-routed, and a new shift starts working (see Rice and Sammes, 1989, for a more comprehensive generic description).

I was able to follow the stepwise iterative process of FENIX use and development from November 1997. In summary, staff in the brigade and division HQs (A, B) struggled to get something that worked. They succeeded in doing so, but at the cost of much effort. All the time, during the exercises when the interim system was fielded, tested, and generated considerable additional work, they had to discover ways to do their own job in an efficient manner. The exercises were real.

8.2.3 SUMMARY

The overriding idea driving both the ATLE and the FENIX development was efficient control, i.e. to achieve *freedom of action* versus the enemy and in the battlefield environment with the help of efficient methods and tools, and *autonomy within* the distributed command structure in spite of disruptions. The *vision system* (ATLE IS) was designed from assumptions of what information is and what promotes efficient command work, probably based on a system of shared values, ideas, and beliefs in what constitutes efficient command work and practices and what IT means. Contradictions between the ideas and their manifestation in technology were numerous, some leading to its interruption. The FENIX system carried portions of the vision, emulating central functions. It was accompanied by additional personnel during the exercises as a compensation for its reduced functionality as compared to the ATLE IS (see Figure 8.2).

Let us look closer at some aspects of the modelling of work processes and the thinking behind it. The focus on *information* (required for decisions) was central, as was the *modular thinking* when designing the system, and foremost, the *belief in technology* and *standards* to reach new levels of efficiency. The process models perhaps, in a very detailed manner, visualized perfect working processes for analysis, production and editing orders, for planning, for artillery fire control, just to mention some of them. Even if the models grew out of practitioners' experience, they were designed according to the requirements and expectations originating in the common IS development method, and seem to have left the actual command work far behind. In their work, most staff handled several processes at a time and hardly could concentrate on one. The model language may even had added to the basic conceptual confusion when discussing and analysing command, control and work (see discussion in Chapter 5). According to the project's terminology, "command" signified the *superordinated control efforts*, while "control" meant direction *during the execution* of "commands".

Speed and precision in the work were cornerstones. A central design idea was the belief in graphical interfaces. Text-based information ideally should be replaced by or have an efficient complementary *graphical presentation* (orders and the automatically distributed common situation map overlays). Furthermore, the desire for *integration* of work and communications was another central issue. The technical systems' integration was necessary in order to achieve timely tactical *coordination of fire and manoeuvre*, and to provide a *common view of their own and enemy situations*, including status, weather information and the terrain possibilities and constraints. A farsighted idea in the original vision was the concept of *"walk-stations"* which would allow individuals autonomy in the command work, but presupposed advanced mobile technologies. The interim system did not, for obvious reasons, include such technologies, but (civilian) mobile telephones and hand-held computers were numerous (however not being integrated in the system).

A few contradictory requirements had to be solved: *yes* to autonomy and user participation but at the same time considerable *integration and use of standards* for hardware, software, procedures and concepts. Ideally this would lead to *cheap* and *easy to use* solutions, and ultimately efficient command work. The close integration during development and operational ideally should end in a reliable machinery with high security levels, but in reality the autonomy of its parts might be threatened. What was described as an ideal VBS structure in reality had much in common with a IRM structure because the whole structure was implicitly hierarchical and centralized. Finally, documents and images easily became heavy files which had to be *compressed* so that they could be transmitted via the mobile communication system with its limited capacity.

Now let us listen to some accounts from the FENIX development, before the cases are presented.

8.3 Accounts from the Development and Use of the FENIX Interim System

8.3.1 THE ACCOUNTS

Two informants in particular (Persons R, V) from the division HQ B have described the development process during the latter part of 1997 and the first six months of 1998, supplementing my own impressions and conversations with staff during five CPXs. After the interim IS decision, a few practitioners studied the existing software, and figured out how it could be used. The applications named “Own forces” and ”Artillery Fire” were already there. An early principle became to work with overlays and a digital map (a dedicated ‘map application’ existed). When the first version of the system existed in late November, staff did not know how to apply it in their work but once methods had been decided on (tentatively), further requirements on the system could be formulated. The whole bricolage process was a “crash program”, everything moving simultaneously. Distribution of new versions, additional applications and hardware components occurred in parallel with the exercises.

Person R, being a reserve officer and software consultant, described (audio recording) how he became like glue between command work activities and technicians, a glue that originally was missing. Another remark from him was that simple everyday applications are not considered very attractive or exciting by consultants. Some issues have a higher status than others. To exploit new complicated technologies is “finer” than using simple ones. *Users* know about their own problems but not where technology stands and consequently what can be achieved. *Developers* are often stuck in a certain genre, know the technology, but do not realize the business problems. It is hard to reconcile these views. However, the cooperation with the consultants did not seem to have been too difficult:

> No we never had any difficulties controlling them, when we have known what we wanted and told them that they have done so as close as possible, but….the problem for them is that the users are so damn vague, we do not exactly know what we want, can't express it, there are different opinions…and that is their problem. Therefore the decision situation has been that the consultants have decided and done something and then demonstrated it: 'Something like this?' Then we say, 'well, yes it is probably fine'. (Person V)

During the weekend before the late January 1998 CPX, a group of three officers from HQ B studied the first complete application cluster (Person V). A basic problem was how to select information for the overlays and present what was interesting, to select data. When changing the scale of the digital map, symbols easily became either cluttered (zoom in) or just too small (zoom out) to read. Thus a system of alternative overlays and overlay sketches (drawn with a drawing tool) and special management techniques were developed. Another problem was identified when using the applications together within their "shell", the map program which was not from the MS Office "family". Its drawing tool was rough. People did not recognize the 'Office style' and had trouble using the map application. The shift from draw-mode to presentation-mode made the image technically unstable. Staff had to accept distribution of intelligence reports with pasted MS PowerPoint pictures instead of sending overlays as separate files. As a consequence files had to be compressed (zipped). The transmission of large files had to be announced to the central system manager.

Person R gave his version of the early 1998 process. At the end of a training week in January they realized that there was no users' handbook and made one ("our famous weekend session, sat and wrote a method handbook which became an immediate best seller"). The development was like throwing a ball up in the air, to the developers who caught it. A couple of months later they threw it back into the work activities where it was tested before it was returned along with additional requirements ("OK this is good but we must have this [too]"). For example, to be able to export data as (situation) sketches was implemented in April.

Another HQ B informant (Person U) described (February 1998, after participating in two CPXs, audio recording) how when a report was handled in the intelligence application, many operations and keystrokes were needed to get any result. The activity journal was similar. An artillery officer, Person S, recalled (interview June 1999):

> The situation maps weren't plotted it did not work, the data from the brigades never came, it was tedious, when we got the situation from them, how we had to work when we wanted to feed it into the computers you see, it was incredibly difficult…[comment]…as I said it was so difficult it made no sense you had to intervene and do God knows how many, eh –-.tasks in order to get it right on the map and then see that it was placed…all right I can't all about this it was very very difficult one had to delete everything old and enter what was new and keep it in mind–-terrible you see–-it meant that finally you stopped capturing the information from below maybe you opened the file and read 'this is their opinion about the situation' and then you concluded that aha this was correct seven hours ago…(Person S)

The capacity to automate the distribution of data was attractive. The vision in the original ATLE IS contained an idea of *automated* updating within the command organization of the common (tactical) situation image or overview (system objective as in the December 1996 specification). The FENIX required *manual work* for similar central information operations (Person V):

> Some weird things have evolved. The overlays again. We had one overlay from the beginning. The situation map should inform about the work activities, tell what the symbol does or has done. The programmers came up with the idea of an 'activity overlay', although originating among staff, the overlay was the programmers' solution but it is not necessary, it is there [now] but is not used. The overlay never worked. The problem is that it is so difficult. When a unit symbol is moved, changes are required in many places [i.e. within the distributed IS]. When a symbol is moved on the map, the overlay does not follow. The symbol is there but is not used. Instead people draw on a separate overlay, a sketch is drawn instead. These possibilities have appeared successively too. (Person V)

Behind this account lie the preunderstanding of how symbols are used on the map and the common sense about computer capacities. Traditionally, simple static symbols have been used on maps, drawn or as adhesive tape markers, usually completed with notations: actuality, movements, whether preliminary information, confirmed or just planned activities. With the regular military symbols it is possible to illustrate force types and sizes, enemy/own (red and blue), activities, mission types, individual objects (weapons, HQs, minefields, terrain artefacts). Now when computers were introduced, more complex symbols were imagined, allowing dynamic changes, and automatic updating for accuracy and actuality (one map leading, other following). What the informant said indicates a belief in automated updating as well (from informating the battlefield to informing actors) and that the symbols even *are* reality ("what the symbol does or has done"), when it only represents actual (historical) events. Such added capacity presupposes several functions, especially in the distributed, mobile "office-in-the-woods" where communication may be very constrained and disruptions are normal.

According to the FENIX user handbook (version March 26th, 1998) the objective was that all information in the HQ should be stored as digital data. The primary communication media within the HQ and in the command organization was intended to be electronic mail. A late comment from one HQ B staff member (Person X, May 1998) about the message handling reveals the complications with a common procedure, recurrent when messages were forwarded, visible as icon-envelopes in the screen, and the (final) receiver got the message:

> …then there is clicking because there is one envelope in another, and then double-clicking and then it is zipped. There is a hell of a lot of clicking before one has got it up on the screen what there is written inside the envelope… (Person X)

What the informants tell about are the consequences from the overriding development perspective and situation and the rapid design process this perspective eventually promoted. One consequence of the approach was that the "heavy" system components (the interim FENIX IS, the telecommunications system) which were not designed together now had to be combined. The files with formatted text documents (from the MS Word-based order application) when attached and transmitted in the standard e-mail system had to be zipped (prescribed in manuals), otherwise they easily choked the communication system. Standard applications were basically products for orderly office work, and to zip meant additional bottlenecks ("Zip" became a nasty word already during the November 1997 HQ A CPX because of the difficulties to execute this operation; later on some automation was introduced). System changes required continuous assistance from its developers and technical expertise. Effects of logical and technical collisions in networks and databases were reduced but not eliminated during the spring of 1998. I will summarize and comment on some of the most problematic issues.

8.3.2 COMMENTS ON COMMAND WORK AND TECHNOLOGY

There were three kinds of misconceptions that converged and complicated the ISD. First, *what command work is*, then a vague idea of *what an IS means* and what impact it can have, and finally the *unclear relations between these entities*. The study revealed additional details. During the CPXs operators had to use the system in spite of sleep deprivation (some occasionally worked between 20–30 hours without sleep and then had a few hours off immediate duty), movement of the HQ, and the technical inconsistencies. There was a considerable amount of evolving "IS work", probably caused by various factors: little experience, technical inconsistencies, security reasons, efforts to obey tactical doctrine and principles for movement (a way to avoid hostile actions and countermeasures, too), just to mention a few of them. When using the IS, a normal user first had to learn how to technically handle the tools together which meant a considerable workload. Then to learn the new standard operating procedures (SOPs) in the new organization—which themselves were tentatively designed—was complex and little time could be allocated to this. 'Pockets of resistance' appeared: use of own applications, outright disobedience, small pocket notebooks, much communication was not transformed and fed into databases, becoming digital data.

Impulsive shortcuts could be hazardous. A person, being involved in an IS operation, must be conscious about *where* in the system this occurs, its logical position and what path to follow out of it, and what might or might not lead to system breakdowns. In terms of boundary management, an *internal environment* evolved which had its own dynamic conditions and required considerable efforts in order to be manageable. The work processes in reality *bridged the HQs*: if someone did not follow the official formats when reporting, the receivers could not combine reports on aggregated levels using their systems. The consequent lack of success caused a lot of frustration of the few who had to do the tedious aggregation work. Because of this complexity, the internal communication became intense and meetings were abundant.

I conclude that the *foresight* in the ATLE vision of a new kind of IS structure was not matched by *insight* into the relations between work components and supporting technologies. When, for instance, the visionary concept "walk-station" was created, it was probably a recognition of the needs for mobility, flexible individual support and infrastructure. Several contradictions and constraints grew from actual system solutions. Internal work processes were logically interdependent between and within command levels. Few alternatives existed, given the existing level of experience and competence, to a few, complicated means for interaction and information management. Voice communication and meetings were probably means to reach the right person directly, bypassing formal and technical constraints. In spite of the general prohibition, urgent needs were occasionally satisfied by means of civilian telephone communication, even if security reasons required that 'firewalls' had to be sustained.

On the whole, the autonomy promised within the new IS structure and tool set was thus deceptive (the vision of a VBS-architecture became IRM). The electronic situation map had a deceptive actuality because the maps were not centrally updated as desired. Instead they often had to be updated on demand.

In all, a new level of professionalism was required in order to reach the ideal continuous command work processes, the redundancy and potential efficiency in the new infrastructure. The interim IS in many respects reduced the autonomy of the actors, and they tried to find ways to reduce the constraints emanating from hardware and software configurations, and security regulations.

If we return to the basic command work model, where boundary management occurs in a zone between organization and environment and can hardly be centrally controlled, the FENIX design and development was ongoing as actions in *another kind* of boundary zone, the one between work and design environment. This boundary management was a transformation between the requirements-in-the-world and the ready potential solutions in the "computer and IS warehouse", and back.

In spite of all troubles, staff *did* manage to produce command work. Through practising, actors learned how to master many challenges arising from the new infrastructure and to find ways out of the everyday turbulence. Initiatives by individuals could exploit opportunities within the bureaucracy and with the help of its resources, as the cases illustrate.

8.4 Cases Overview

8.4.1 General Description

The cases show related instances of command work within the "given" but new, dynamically evolving organizational structure. Both describe how social actions and artefacts were applied for coordination, control, and support of communication. They illustrate integrating efforts and "repair work" aimed at the linking of separate portions of the command work, in order to achieve unity of effort. The cases, both being emergencies, describe responses to needs which grew from within the command work, though of different kinds.

The first case, a *meeting*, was a *minisequence* of the command work and part of a succession of events during 24 hours toward the end of the last and week-long CPX. It was initiated when the established working structure and procedures did not lead to a satisfactory solution to an imminent breakdown in the chain of command. The meeting could, however, be arranged within the same basic command structure, and the outcome was handed over to it in order to be implemented.

The larger context (subsections 8.2, 8.3) is present in the second case, which exemplifies *command work development* and *tool use* with the help of standard software (MS Excel). The events I documented and describe as a case occurred over six months.

Staff and consultants tried to build efficient working methods from the basic functions provided by the mixture of standard applications and the legacy of existing military applications. The rapidly implemented FENIX structure caused constraints in the work when new versions or modifications were repeatedly introduced. In parallel, a computer application was formed out of some existing artefacts, traditional paper-based forms, tables and templates. What makes the situation interesting and important is that this self-induced work development along (as it turned out) well-known principles and traditions, occurred as a direct response to the implementation of the FENIX system. Furthermore, the result, an appreciated and functioning tool, was almost forgotten as soon as the exercise ended and the work terminated. When its role was rediscovered a couple of months later, the accounts (interviews) say that the same people who had been involved in the design of the interim system encountered difficulties in getting this other idea accepted by higher army authorities during the continued IS development.

Both cases demonstrate how autonomy in the work was achieved, and the roles of social power and individuals' expertise: the meeting illustrates the interaction between formal and informal social power, and how expertise is hardly an asset that exists randomly. Individuals and their social commitment must be recognized and articulated when work is designed. The second case shows how social power, autonomy and the roles of expertise were first reduced by one technology but eventually grew from within another. Let us take a closer look at both.

8.4.2 A Closer Look at the Meeting as a Case

For a few days during the final CPX (early May), the estimated capacity of one of the brigades had been discussed during the daily briefings. This concern in turn was part of a recurrent topic, specifically how to integrate quantity and quality in the evaluation of units and continued planning, and then reach a satisfactory knowledge level in the HQ about units' capacity and endurance. There had been a debate among staffs (at least) since November 1997 and onwards about how to work in order to integrate the output from the organizationally divided Operations and Logistics functions respectively. It is easy to apply figures and numbers when quantitatively assessing units, but more difficult to affix a number to motivation and spirit, and still more complex to establish a summative value which integrates quality and quantity. For me during the study, the degree of success thereby served as an indicator of how efficient the command work actually was. It was important to see if, how and with the help of what technologies and procedures integration was achieved.

The discovery of the meeting thus followed an ongoing investigation of what technologies, methods and procedures were applied, supporting integrated work. The full potential of the meeting as a case, however, was not discovered until after the CPX. Meetings certainly are frequent but have different origins and purposes and imply the use of various kinds of technologies. An interpretation and a wider characterization of the event was that the meeting occurred within an organization where the main work routines were developed and conducted by means of modern IT. Design of work and technologies that will reduce the need for meetings face-to-face in a very dangerous battlefield are generally attractive. Methods to achieve results when people cannot meet are therefore searched for. In brief, the situation had evolved like this:

It was the sixth day of the exercise, on the morning of May 8, 1998. During the exercise, effects and events from the field were transmitted to the staff via messages and personal meetings between staff and external actors within the scenario (the contrast between the peaceful May morning and the fictitious battlefield was large). Among the topics that occupied staff that morning were both real illnesses in the supporting battalion and real sleep deprivation, mixed with fictitious events: (simulated) battle consequences and fatigue among the subordinated units. Only after a few days do *Personnel matters* get weight and effects of earlier events and actions appear. These matters normally receive attention but it usually takes some time before events become known on the division level through routine reports, depending upon outcomes from the (simulated) battles, that some effects are handled in lower echelons, delays when reports are generated, transmitted to and received in command centres.

Looking at this morning's meeting, it was caused by a temporary lack of close contacts among staff (Operations and Logistics/Personnel) which led to an urgent need for re-established cooperation and better integration. What stands out here, as regards ISR, is how to design IS in a broad sense in order to minimize the risk that such breakdowns occur. If they do (in spite of the applied "best IS practice"), the issue is how to be able to handle them, whether people are distributed or co-located.

Design questions for meeting support are:

- What exactly is the work that deserves attention and support, its role?
- To what extent are standard solutions (group support systems, communication technology) applicable?
- Who knows what about the current issue, motivating the meeting?
- Are there different kinds of meetings that require specific solutions when it comes to support technologies?

I have chosen to label the meeting a “Power Play” because power to influence work and direct efforts seemed to have a crucial role among the people who met. Some had formal power and a certain position in the hierarchy. Others were or became power-holders because of their expertise, their way of acting, and the acquisition of additional power during the interaction. The interaction thus illustrated the inner life among experts within a modern organization (Giddens, 1991).

8.4.3 THE CASE OF THE NEW AND THE OLD ACTUALITIES’ TABLE

The second case is different but the issues it raises are directly related to the design and use of IT in work. From the first CPX (HQ A, November 1997) and onwards, I could see how other support requirements than those satisfied by the central IS (FENIX) grew from within the work, for example large tables as resource overviews in the workspace. Efforts to satisfy them with the help of IT were carried forward by a few key persons. Stepwise requirements were materialized and implemented as a concrete tool, building upon another older tradition and work practices. Historically, an Actualities’ Table or spreadsheet, a kind of matrix for presentation of essentials about the actual command situation and operations had belonged to the common tool set (Figure 8.6[9]). Now it reappeared in a modern form.

9. Translated and reproduced from a regulation for staff work in division and related HQs, StabsRA Fostab/Fördstab Öbil 1980.

				Actualities' Table (HQ)						
Date			**Force partition - orientation**					Updated		
Sun	Rise									
	Set									
Dawn/dusk										
Darkness										Subunits
Weather										
Wind										
Clouds	Clear	Clear								
	Mixed	Mixed								
	Grey	Grey								
Height										
Rain										Reinforcem.
Sight										
Temp.										
Misc.										Battle cap.
State of alertness			**Alarm - rescue**		**Misc.(i.e. codewords)**			**Signals**		
Transport										
Ops										
Arty										
AA										

Figure 8.6: Original 1980 Actualities' Table.

This older table was one of the so-called "macro commands" in MS Office applications (see Subsection 8.2.2). The name of the table in its new shape (the case), was also "Actualities' Table", inherited from this predecessor. Historically, as part of the paper-based and textual tool set in staff work, this kind of table (spreadsheet) has been a way to outline (not in great detail) on one sheet of paper all available units and resources with which a commander had *freedom of action.* Also, how he could reach and direct subordinates, the times for arrival of units after transportation, their status, and their state of alert. The table could be stored in a binder, pinned onto a wall or on a desktop, redesigned if appropriate, and easily communicated via fax or as a printout (when these technologies were introduced).

The case tells about a process of work development that was accompanied by an evolving IS structure but following traditional principles for design of work practices and tools. There are several parallels to the calculation systems that Avdic (1999) has studied. Conclusions about design of artefacts can be drawn.

8.5 Analytical Framework

8.5.1 CASES AND ANALYTICAL SCHEME WITHIN THE QUALITATIVE STUDY

Both cases represent instances of command work which was hardly visible. The meeting was *short*, just a little more than 10 minutes. Meetings either happen or are scheduled, and are *abundant*. Turning to visibility, the meeting passed as a *routine event*. The spreadsheet development process was ongoing, driven by a few persons who worked intermittently during the winter and spring and continued during the exercises in the same manner as resource monitoring and management are continuous and distributed routine activities, hard to isolate and define. The New Actualities' Table was not even given a name that announced its true character, so how could people realize what it meant? Besides, the thinking during "table manipulation work" is mostly a personal affair. Both cases also demonstrate how traditional command work practices (personal interaction and use of paper-based tools respectively) survive in a new environment, however affected by it.

Engeström (1999) discussed the need to discover invisible but valuable work. The invisible or hardly visible part of the work can give keys to a deeper understanding of what goes on. Because of the extreme division of labour in modern organizations, not even the practitioners themselves may be aware of how work is conducted or what certain actions mean. Engeström stated that

> Attempts at making everyday practices of work visible are driven by different motives. In various management techniques, the overriding motive of visibilization is control. In critical ethnographics of work practices, the motive is emancipation, bringing recognition and appreciation of work that usually goes unnoticed. (ibid., p. 63)

Development of IS can, as the second case shows, take a direction that can be quite unexpected or have surprising effects. Nardi and Engeström (1999) emphasized that "understanding the nature and structure of invisible work is crucial to designing and managing organizations" (p. 1). Often invisible but valuable work is eliminated during reorganization of work and organizations because no one understands its role and what it requires.

Actions that are visible get the most attention when restructuring work, but empirical evidence demonstrates that flow charts and metrics do not capture all work. The strength of ethnographic fieldwork is that it does not halt at descriptions made from a distance. Its purpose is to make *more* work visible. Both cases exemplify work that was omnipresent but situated, contextually dependent, very difficult to capture in static diagrams and charts.

In order to give a closer view of the analytical schemes and motivate the choice of Activity Theory, I present a comparison between this theory and the grounded theory (Strauss and Corbin, 1990).

8.5.2 COMPARING GROUNDED THEORY AND ACTIVITY THEORY

In the centre of the conditional matrix (ibid.), strategic and routine action is situated: action processes combined with interactional processes, what people do, say, and think, together or with respect to one another. The matrix is designed as to mark the influences or links between what happens in the work, and is a system of analysis that examines action/interaction in relationship to their conditions and consequences (Figure 8.7). The relationship between an action and its levels of

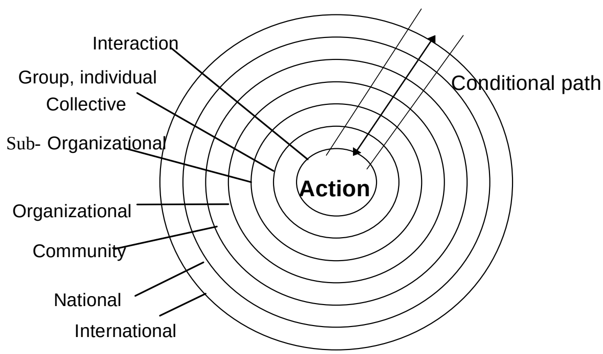

Figure 8.7: The (detailed) Conditional Matrix (Strauss and Corbin, 1990)

conditions is called the *conditional path*, along which conditions affect the action/ interaction. Conversely, actions lead to consequences which may have similar paths outwards. Conditions on each level can either be causes, context, or intervening conditions facilitating or perhaps standing between ideas and action, *constraints*.

As I discussed previously (Chapters 1–2), the military command system is a tightly interwoven system where a rich social control context, designed for reliable control influence actions, and historic control mechanisms prevail. Any analysis therefore must include context, and not stay at the perhaps unique, seemingly individual phenomena. Both Grounded Theory and Activity Theory work from this position and can guide an analysis.

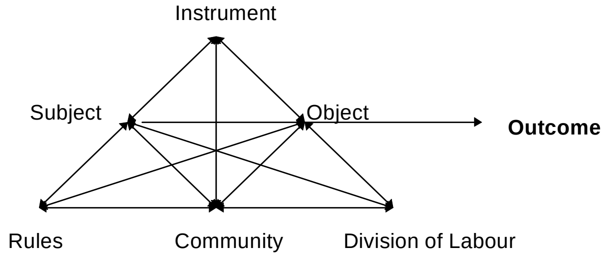

Figure 8.8: The mediating structure of an activity.

Even if its structural schema looks different, the basic structure of Activity Theory is close to the conditional matrix. There are several similarities between them. Activity Theory (Figure 8.8) prescribes that the role of contextual and historic conditions and factors and their roles in a current work situation shall be considered.

According to Activity Theory, an activity is the basic unit of work, in my case the command work in the actual HQ, partitioned into sub-activities. This activity is a historically developing collective phenomenon, its object/motive being realized through conscious and purposeful actions by subjects. *Action* is goal-directed behaviour that can only be understood in the context of an activity. Actions consist of well-defined habitual routines, operations. Iivari and Lyytinen recently (1998) have discussed this theory, and saw both strengths and weaknesses in the approach.

> AT is adaptive in the sense that both the work practice to be supported and the systems development process can be conceived as distinct but interrelated activities. (p. 157)

They meant that Activity Theory has a weakness (because of its youth) as an approach for ISs development (ISD), but also a strength to some extent: its generality. It opens the possibilities for a varied interpretation of cases. To conclude, the attraction of the Activity Theory approach is that it relies upon explicit articulation of the work activity. Both approaches facilitate the definition of "conditional paths" and recognize contradictions, constraints and conflicts; activity theory however is more explicit.

What is located in the centre of the conditional matrix (actions) in the Activity Theory schema instead is depicted as a horizontal flow in the process model or schema of the activity system (Figure 8.8). The schema distinguishes between *subjects*, *objects* and *outcomes*, and the *instruments* that are applied during the action. Control technology can be applied as to meet the requirements for the necessary precision, speed, or flexibility. The activity system also reconstructs itself continuously, whereby transformations take place between its components.

If we look at the transformations in the boundary zone of the viable command organization (Chapter 1), several *mediations* occur in its activity system: the subject – object relationship is mediated by instruments, tools. Instruments, mediating artefacts are not only physical objects but also psychological and social artefacts: procedures, experiences. Social mediators of activity are positioned in the lower part of the system. Signs and language are those artefacts being able to mediate activity toward other humans (Bardram, 1998). To exemplify, I used the Activity Theory scheme as an instrument when describing and analysing command work. Related to activity theory, the "outcome" (this thesis) is hopefully a clearer picture of what the research object and the activity "command work" is, than abstract concepts such as 'systems', 'control' or 'command' that say little about the social interaction and what work is.

When the scheme is applied instrumentally as a "springboard analytic scheme" (Kuutti, 1991) in an organization, it becomes possible to clarify and also take into account (some of) the multiple influences from the diversity of control mechanisms present in the military command work. Command work and the conditional paths become more explicit than when the conditional matrix is applied.

In the description of the cases and their context, we have seen examples of the contradictions that were described in Chapter 2. Because Activity Theory explicitly focuses on the role of *contradictions* in social situations, it is a logical step to actually *use contradictions as entry points* for an analysis.

When recalling the contextual framework which surrounded and stimulated the events (described in this chapter) which I have used as cases, it illustrates the relations between subjects (staff, actors), objects (instances of command work and IS), and community (army environment), where rules and division of labour influence actions. Instruments, in the form of technologies and social artefacts, were repeatedly invented, used, and redefined so as to provide what was desired. The closer descriptions and analyses of the cases (following chapters) will provide details from what builds command work.

Chapter 9
The Meeting: Power Play – Communication for Autonomy and Control Action

MEETINGS ARE ABUNDANT during command work. Some are regular daily events, others are common ways to solve interdisciplinary matters or to seek authority (vertical integration) for decisions in case of contradictions or when other demands rise from the work. Ideally, meetings are well integrated in the command work but deserve attention when it comes to support technologies. The reason is that meetings draw upon resources and individuals' capacities. A meeting may be virtually invisible and thus may leave few traces when it comes to modelling and systems design. The case here, in accordance with my basic model of command work, demonstrates the way people in the HQ engaged in boundary management. They transformed events into the organization and then designed actions in the social world. In all, it was an emergency and could as well have passed unnoticed.

9.1 The Events and the Data

9.1.1 THE ACTORS AND THEIR MEETING

One morning, shortly after the regular morning briefing (near 10 AM) I came to a group of four persons who had assembled in the briefing area in a large industry hall where the HQ was positioned. They had just entered into a discussion about an anti-aircraft artillery (AA) battalion, specifically how the chain of command could be repaired. The meeting was just the visible top of a large iceberg, built up during the preceding days under influence of the war and the procedures and practices of the command work. After a few days of fighting the CO of one AA battalion had shown signs of exhaustion (enacted within the scenario) and was considered unfit for his position. Another related topic at this occasion was the possible fusion of AA units because some were near total exhaustion, in order to once again create a reliable force.

The four persons who met were the Chief of Staff (COS) who coordinates the command work and has the formal power in the HQ. Then the Chief Logistician (ChLog), responsible for the supply of resources, the primary spokesman and coordinator for all issues related to personnel and material and heading one of the two main sections in the HQ. Further, there was the Army Aviation (AAv) operator who functionally belonged to the Operations section (the other main section), responsible for the operational use of the fighting units. Finally, there was the person who brought up the event that needed further attention (the AA battalion commander's situation), initiating the meeting. This person (here called Pers) was responsible for certain Personnel matters. Pers, recruited to the HQ because of personal expertise was a reservist holding the rank of Captain. The others were regular officers (Lieutenant Colonels).

I arrived shortly after the beginning of the meeting and could follow and record its course. After the meeting, I got copies of a few documents that described the history leading to the meeting. Some months afterwards I made an interview with Pers, which further revealed the circumstances preceding the meeting.

9.1.2 DATA ABOUT AND FROM THE MEETING

There are two kinds of data, those produced on the morning of May 8, and the data which have been produced later. The first group consists of the audio recording which is a little longer than 10 minutes. Then there is a photograph taken toward the end of the meeting, anchored to a specific moment by sound on the tape (the camera "beep" is heard). In addition, there are two documents, copies of messages to and from the superior HQ. These documents are background and contextual data, traces of the events and the actions during the night before the meeting. Field notes, covering the days preceding the meeting, constitute the last portion of the primary data.

Data that have been produced later are the transcription of the conversation, and a second audio recording of an interview with Pers six months after the exercise, together with a (partial) transcription of it. This interview revealed some of the background to the meeting, explained its course, and thus contributed to the context for the close qualitative analysis.

The discussion during the May meeting was a very tight conversation, where many full sentences occur but also several short utterances *(eh, yes, no, exactly, precisely, mm),* sometimes in the midst of a sentence, sometimes used instead of a full sentence. Such utterances mean confirmation or rejection, support, encouragement, or probably just mean *"yes, I understand, go on"* or *"I'm listening",* perhaps even *"I'm thinking, and trying to listen".* When used in the midst of a sentence by some of the actors, it is difficult to decide whether this utterance changed the sentence or whether the speaker just continued as intended. I put my own remarks and comments within brackets [mm], shorter pauses "…" while those carrying some meaning are marked "[pauses]".

9.2 The Events Preceding the Meeting

Representatives from Personnel regularly visited subordinate units in the field. The day before the meeting in the HQ (May 7), they visited an AA battalion (represented by its CO or deputy CO, officers belonging to the CPX management) in order to find out what was going on, its situation and status, and whether some kind of support was necessary. There, according to my data, they met (an arranged meeting within the scenario with a person acting as) the deputy commander (and possibly the CO). Personnel discovered that the CO was exhausted due to stress and battle effects on him, and that his subordinates had little or possibly no confidence in him.

After the discovery of the problems in the field, the need to do something was realized and decided upon in the HQ during the same evening. Shortly after midnight a message was sent (the e-mail system logged it 00:10) from Operations to the Regional Military Commander (RMC, next higher command level), suggesting certain specific organizational changes (the fusion of some AA units) and corre-

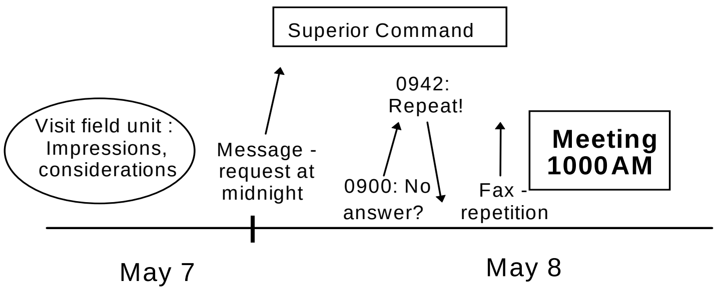

Figure 9.1: Timeline and actions preceding meeting when midnight message was lost, then requested from superior command and repeated via fax shortly before meeting.

sponding changes in the chain of command. The message was a request for a formal confirmation. The rationales for these mainly structural changes were given in the message. The message also included formal requests of additional ammunition supply. Actually these constituted most of its text, while the Personnel matters were less obvious.

Figure 9.1 illustrates the timeline and the events leading to the meeting. The HQ wanted an answer by 0900 the following morning, less than 9 hours later. Evidently, the superior HQ had or was supposed to have a certain minimum level of staff during night time. Thus it should be able to deliver an answer in time, according to the scenario and the rules of the command work. The message was also sent to the field units involved, but does not indicate whether Personnel or Logistics were actively involved in this art of the work. Neither did these sections (according to the address list on the message) get any copy within the HQ. It is not possible to judge whether any personal communication was conducted in parallel with this message. The printout of the message from the mail system is marked *logistics* (the identity of the printing section is automatically written on the hard copy).

The normal principle of organizing the work meant division of labour and responsibilities and use of day and night shifts, completed by a system for stand-by duty officers (DOs) who handled upcoming events from more than one work role. Some function could not have full capacity day and night. Personnel, for instance, normally had full capacity only during the daytime, which (according to one interviewee) caused some internal discussions at the next level of work, the Logistics section.

The format for regular reports up the chain of command did not allow rich descriptions of, for instance, personnel, but preferably rationalized and quantitative data, suitable for reporting numbers and percentage relations. In addition, the new integrated IS and communication system which was implemented and tested required tedious aggregation of reports up the chain of command. Reports were faxed, e-mailed, or in a wrong format altogether. Thus reports were often delayed, even before the complicated further distribution of aggregated reports within the (normally) dispersed HQ. These conditions probably promoted visits in the field, informating the command work and informing the individual actors supervising it.

Returning to the actual case, Pers knew about the situation and felt responsible for the wellbeing of this damaged battalion and its unhappy CO. When no answer had arrived by 09:00, some actors became concerned. A new request to the RMC (it is not clarified who sent it) led to an answer (e-mail) 09:42, saying:

> "Previously transmitted information and requests concerning immediate and long term actions with answer desired before 080900 AM can not be found. Repeat. Signed: RMC/ Logistics"

The next step for Pers was to bring more attention to the matter in order to make the organization conscious about it and initiate organized action upon the issues of repair of the command structure and the reorganization of units.

Immediately after the regular morning briefing, because of this nightly delay and some further confusion about who was responsible, Pers acted as the problem owner and gathered the key personnel: COS, ChLog and the AAv officer, closest to the AA unit because of his position within Operations.

The quartet thus contained the highest formal power holder within the HQ, one of his immediate subordinates, the ChLog, one representative from within his department (the problem owner, Pers), and the representative for the Operations section (the AAv Operator). Among them, the latter was the one most committed to the operational efficiency of this unfortunate AA battalion, important for the outcome of the whole defence operation.

9.3 Overview of the Work Context, the Meeting and of the Power Play

9.3.1 Communication Patterns and Actions Leading to the Meeting

Commanders frequently met other commanders, reached agreements and decided about future plans and actions, "sharing a picture" of the total situation. Their HQs communicated on their own level, exchanged other kinds of messages and data, and gained a deep and detailed insight in the situation among units in the field. There were signs that these two communities of practice occasionally drifted apart, the COs living with ideas and plans, but staff with another reality where details about social and physical resources dominated. Much communication was required in order to avoid this gap.

On the organizational level, informal communication between function experts was mixed with formal reports. Staff interpreted reports and followed up with questions in case reports were ambiguous. There was a certain competition to get the attention of the commanders. They may not only be distant, but are surrounded by various people who are engaged in intense activities. In order to get access both formalized routines and informal methods are necessary. Many activities within the HQ may well pass unnoticed and surface only by chance.

Let us return to the case situation. Probably the e-mail communication at midnight had not reached the intended receiver. Someone in the superior HQ was then alerted during the morning hours, but it is not clear how. An explanation of the delay and lack of response is that the superior command was not fully operational during night-time mainly because during an exercise, manpower means costs. Pers was upset because a sensitive personal matter was not treated satisfactorily: it was both handled over the e-mail and sent just as a copy to the units that were involved. Here we have the origin of the emergency. Pers wanted a more thorough personal action in order to resolve the problem and avoid further delays. The internal work had not succeeded in resolving an external urgent demand which required sensitive handling, not being any routine issue.

During the later interview, Pers said more about this meeting and what had preceded it. Pers finally succeeded in initiating action when exploiting an opportunity to gather a group carrying the key to action (among them the COS and the ChLog):

Pers: *Finally I gathered them and said Now! Yes as it happened, that once I had got them together, those who all the time blamed each other I said that well I take over this, re-assess the situation; I assessed it and then went to the CO and said 'now I have made these assessments', talked to these persons and I suggested that 'we have to replace the battalion commander', 'OK' he said 'we'll do that….'.*

The COS and the ChLog and Chief AAv, all… they had different… yes blamed each other…they had different opinions on who had decided what and so, you see, and it finally became necessary for me to assemble all three at one time so that none would be able to….

Q: *You were the one who gathered them?*

Pers: *Yes, if not, the whole thing may have disappeared into the sand…*

The actual events behind this summary by Pers (*...we have to replace the battalion commander...*) were far more complex. The perception of the situation as related in this account reflects one interpretation, given by a participant who certainly had a central role but it does not clarify all circumstances. The audio data offer further insights in the close interaction between these experts during a 10.5 minute period, each actor representing one work role in the HQ. Together with the other data, more of the context appears.

A later follow-up conversation (September 1999) with the ChLog confirmed the reasons behind the meeting. In the morning of May 8, Pers had probably been contacted by, had met or otherwise received feedback from the AA battalion commander who was upset because his near dismissal had been announced in an electronic message in the middle of the night. The cause behind the copy to this AA battalion in the middle of the night was unclear, but it became *The Big Mistake.* According to the ChLog, this may have triggered the meeting into an urgent affair with rather high priority in the morning hours. However, the meeting was in itself a normal way of handling such matters when more than one section of the HQ was involved. His opinion was that it could as well have occurred the day before when they defined the situation among the forces as a serious problem. In the next section, the whole discussion is outlined and some extracts are demonstrated.

9.3.2 THE MAIN STRUCTURE OF THE MEETING AND THE CONVERSATION

The meeting took place indoors in a wide space in a huge industrial building where the HQ had been positioned for several hours.

The overview was made based on a transcription, and a structuring of the flow of communication, whereupon each person's contributions became clarified. Some crucial moments are highlighted, for instance when resistance is changed to accept-

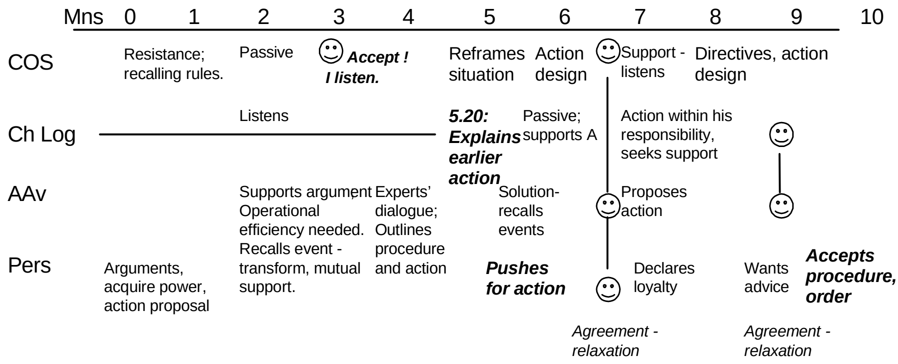

Figure 9.2: Visualization of the interaction during the meeting, "power play "; COS given much and Pers little formal power; coalition formation and innovation leading to agreements.

ance (by the COS), when some actors state the continued action and when agreements where reached.

Overview - explanation (Figure 9.2): During the first four minutes the COS went from hesitation to acceptance of the idea that something must be done. The COS and ChLog represented the formal power and bureaucracy. Soon the expert actors (AAv and Pers) formed a coalition, proposed action and got support. They described the state in the external environment and translated it into terms and concepts which could be used within the organization. ChLog was first passive until he described (5:20) how he had acted almost 10 hours earlier and explained why, it had to some extent, failed. Then he waited, eventually supporting the COS's action outline, until he could continue according to the formal distribution of responsibilities and the normal established procedures. After eight minutes, the COS being the most active, together they outlined what would be the optimal organized action.

Relaxation appeared, noticeable in some jokes and laughter on two occasions. The first occurred after 7 minutes and the last one shortly before 10 minutes when the meeting was about to end. I could not follow it further, but the statement made during the after action interview with Pers (see above) indicated that the desired outcome was achieved.

9.3.3 EXTRACTS OF THE DISCUSSION

In order to exemplify the turn taking and the power play, I will present some extracts from the conversation together with comments. Figure 9.3shows a simplified structure and how these sequences are allocated over time during the meeting. The photo was taken shortly after 7 minutes, logged 10:02:40. I have chosen eight sequences to illuminate certain decisive moments during the meeting.

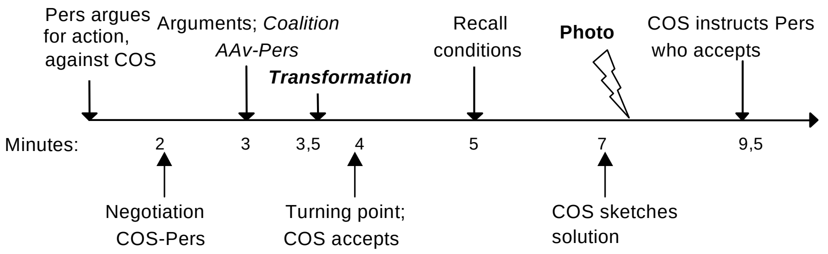

Figure 9.3: The eight analysed meeting sequences, allocated in time.

Opening the Discussion; Negotiation over Action

In the opening sequence of the recording, the COS and Pers entered into a dialogue about the necessity of doing something and how it should be done:

> COS: *...right now there is a commanding officer, and the deputy commander can never be charged with the responsibility…*
>
> Pers: *No*
>
> COS:*...which means eh...if they have made a deal there, the deputy can never be charged with responsibility because then it is still the battalion commander...*
>
> Pers: *Mm, and this means that this must be presented to the division commander so he can take the...take the decision if he needs the legal part of this cleared?*

<u>Comment</u>: COS restated the actual situation. Responsibility and accountability seemed to be central in his argumentation. Pers knew the formal procedure, how to legalize the change in the chain of command and made this clear. When Pers used this argument, Pers also exploited the formal power in the organization and countered COS who was the power holder but wanted another process.

The next sequence, after about two minutes, is when Pers and COS alone continued their dialogue - negotiating whether something should be done at all. The duration of this passage is about 60 seconds:

COS:*….but to take the step to, at a certain time, change the battalion commander…*

Pers. *Mm*

COS:*…then you shall have to replace the deputy commander as well…*

Pers: *Precisely*

COS: *…that is a decision by the Regional Military Commander*

Pers: *Yes I understand but doesn't this mean that we, as a further step, must bring it to the CO so he..*

COS: *Yes conscious yes…*

Pers:*…informed about this. I have talked to eh eh the...*

COS: *Yes…*

Pers: *…logistics officer at the command post [Comment: the FCP, the normal location for the division CO]*

COS: *Yes yes*

Pers: *…and he was not informed about it and has asked me to proceed…*

COS: *No, I see, yes good*

Pers:*… find out what…*

COS: *mm*

Pers: *…it is about…*

COS: *mm*

Pers: *…and that is as information for the..*

COS: *yes*

Pers: *…division CO*

Here, AAv entered the conversation, asked Pers and wanted an account directly from the field:

AAv: *You were there yesterday, what impression did you actually get about the status of this unit? They report more or less themselves that they are eliminated.*

Pers: *Yes they have one company left [comment: about one third of the force], in principle that is what they have, the rest is eliminated...it...they...yes.*

Comment: The COS tried to be formal and continued to see problems, but had to agree when Pers clearly demonstrated what had to be done and what had been done, for instance the communication with the FCP where the CO was. The references to the FCP and the CO (the central powerholder) possibly affected the position held by the COS, who realized that some kind of action might be necessary. It seems as if the internal HQ communication at this stage had not included the FCP. Result: Pers got more power, and autonomy.

To the question of AAv, Pers restated the situation as experienced, interpreted, added to the formal report and transformed a very chaotic situation into something that was communicable and manageable within the organization by making a reference to the actual state in the unit, describing it informally.

Formation of a Coalition - Persuasion

The next example was when Pers, AAv, and COS engaged in a new round after three minutes. Pers was eager to make it a more personal and respectful affair, living up to certain ethical standards in a very sensitive matter, not using electronic messages as had been done during the night:

> Pers: *And then…if you do so…then it is important that we have that discussion together with this battalion commander then…*
>
> AAv: *Agree*
>
> COS: *Mm*
>
> Pers:*…so he does not get it over email…*
>
> COS: *Nono*

Comment: again, Pers got more support from AAv. Together, they influenced the COS.

The fourth passage illustrates the transformation of event and idea into a formal action after almost 3.5 minutes. Pers described the event and situation in the field in everyday language. Once the event had a formal label, "rationality" was recalled (underlined) first by Pers and then by AAv:

> AAv: *There is motivation and…psychological illness there…*
>
> Pers: *Yes precisely*
>
> AAv: *.. where they don't even dare to use the radar…*
>
> COS: *Mm*
>
> AAv: *It is…*
>
> Pers: *No and it's a Personnel matter indeed*
>
> COS: *Yes*

Comment: Those present realized how grave the situation was when not even the radar was usable because of the risk of retaliation (hostile countermeasures such as EW can disable equipment, technically blindfolding the AA units, opening the way for missile attacks and rapid destruction). Pers then defined *"Personnel matter" and showed the path to a formal way out of this chaotic situation.*

The fifth sequence, some thirty seconds later, contains continued attempts by Pers to define a formal action, more support from AAv, whereupon the COS finally admitted action and support (the turning point highlighted in ***bold):***

> Pers (continued to relate about the visit at the AA unit and the meeting there): *...finally the deputy concluded that 'no I do not think I trust my commander right now'...*
>
> COS: *no..*
>
> Pers: *...and that...if one does not trust a person, then it is something serious...?*
>
> COS: *Mm, mm, mm*
>
> AAv: *And certainly it is not only he who feels that way either...*
>
> Pers: *No...*
>
> **COS: *No there...***
>
> Pers:*...certainly not.*
>
> **COS: *..are more persons in the unit...***
>
> AAv: *There is a lack of AA competence in here [the HQ]...*
>
> **COS*: Yes yes***
>
> AAv: *..I mean it is totally lo…gical to motivate that we lift him in here.*
>
> COS: *Yes*
>
> Pers: *Yes…*
>
> AAv: *But I think, as a complete …*
>
> COS: *It is a good solution.*

Comment: These arguments, recalling the issue of *trust,* do not mean a *threat to the established hierarchical order,* but instead a *solution out of a dilemma,* one which demonstrated formal rationality and at the same time protected the individual battalion CO.

Formal Matters - the Failing Decision

When five minutes had passed, the conversation touched upon the previous formal request to the Regional Military Commander, originally shortly after midnight. The COS seemingly was aware about its content:

COS: *We are waiting for that answer.*

AAv: *Well, the last part of the proposed solution is not put forward....to combine the two AA battalions into...*

ChLog: *Yes...it is done.*

AAv: *Great, one AA battalion!*

ChLog: *It would...I realize this, I should have sent a copy to the Chief Air Defence...but he sat eh...next to me when we wrote it, Chief Air...Air Operations*

AAv: *We have passed each other tonight he and I...*

Fifteen seconds later:

Pers	**AAv**	**ChLog**	**COS**
			When was the request sent to the RMC...0010 last night? (probably reading from the message print-out where this time is marked in the header)
		It ...was sent now.	
			It was sent now (?)
		It was sent now.	
			It was sent now!
	But here it says...		
			Then it is, then....[...]
From my point of view independently of what answer we get here, we must do something...	*...it says nothing about the 35. here* [no. of AA battalion]	*No, we did not have any information last night...*	*Yes, yes…*
	It...it is the same situation ...so that...this... perhaps it requires a restart in order to make ...a smart solution		
			Mm
	...in one step instead of make a two-step…		

Comment: The nightly message was repeated via fax, before the meeting started, after 09:42 when it was requested from the RMC via e-mail (saying that the original message could not be found). It is not possible to confirm the version from ChLog (working together with the Chief Air Operations) but his utterance reflects the situation in the HQ, how the normal division of responsibilities. Individual work may pass unnoticed, especially in the middle of the night. In addition, after five days, people might well have been tired.

Figure 9.4: The COS summarized and outlined a procedure that would be a satisfactory solution after 7 minutes, 10:02:40.

According to the after action interview with Pers, there was an ongoing debate during the CPX whether Personnel should or should not work during night-time. The outcome was that they did not. This in turn led up to the situation where, possibly, Personnel was not involved in the work during the night, but did discover the situation early the next morning. By then the problem identified in the field evidently had not been acted upon according to *their* ideas of what should be proper action.

Let us return to the meeting. After 7 minutes, the COS found a solution and he loudly explained (thinking aloud?) his view of the situation (Figure 9.4), summarizing it in this manner:

> COS: *…an order with this meaning, presented to the CO...for a decision [...] he must know the motive but…all the same…you have briefed those at the front about this or…and then we have handled the situation till the decision by the regional military commander arrives tomorrow then we have to talk about how this solution is to be handled later.*

<u>Comment</u>: the COS recalled what had happened and tried to commit those present to the solution, demonstrating the rationality which is involved. At the same time this action was a form of constraint management because no formal admission to act was given from above, because of the delayed communication. The military bureaucracy has precise rules for this kind of events, but for obvious reasons they could not be obeyed. Clearly something had to be done and he needed support for this, more power from the other persons. An emergency calls for action, but another choice could have been to delay action till the formal decision came from the RMC.

From Talk to Work

Lastly, when the procedure had been outlined by the COS, the agreements and the decisions led to action. During the last minute of the meeting the final directives were given about how an order was to be transmitted to the battalion commander not via email but during a visit to the unit, satisfying both formal and human aspects of the work:

COS: *...clarifying for the person that 'now you have got a new task'*

AAv: *Exactly.*

COS:*...and then you have the other part, that is the caring...part, you see....the social part if you say so [pauses 6-7 seconds] because you have to do it tactfully.*

Then the technical communication and the formal sequence of the work remains to be done:

COS: *No you <u>write</u> an order*

Pers: *Yes.*

COS: *...present it to the CO, that we suggest a solution like this*

Pers: *And when he says 'yes' so...*

COS: *Yes when he says 'yes' you do...*

Pers: *OK*

COS: *...and you can take it via e-mail or telephone and it suffices that he makes clear...if he says 'yes' you see...we do it this way, if he says 'no' we have to outline a new solution...but he really has no reason to do...*

Comment: The data reveal that the COS and the others were concerned that the order fulfilled formal requirements, was written and presented to the division CO as the basis for a formal decision, even if the procedure within the HQ was less formal. The suggested procedure built upon trust and demonstrated how subordinates and staff can push for a certain solution, not only the technical procedure, but also how the agenda can be influenced. An irony is that earlier during the night, when the formal requirements *were* satisfied, there was a lack of coordination. Neither solution nor procedure was sufficiently designed. Pers, who had not been pleased with how this matter had been handled, had energetically pushed for another solution, and consequently mistakes or negligence had been brought to the surface. Even if Pers now was the one who had to do the work, Pers also had won the "power play". The relaxation close to 10 minutes into the meeting (Figure 9.2) makes it plausible that no hard feelings remained. There was no loser. On the other hand, if all had disappeared into the sand (the fear Pers expressed afterwards), who would have cared? The next morning, the CPX was about to end.

It is possible to read something else into this dialogue, too. On the surface, the staff had successfully solved a difficult case and the meeting was within the normal procedures. During the meeting there was a balance both between the formal view of the situation and primarily its solution, and considerations of the emotional, social and individual aspects as entries for the invention of a solution. Eventually it was possible to transform the social issue into a satisfactory formal action so that the bureaucracy could act within the ‘Personnel matters’ toolset. In sum, the meeting reconciled several contradictions.

9.4 Structural Analysis of the Meeting

Following Activity Theory, I will use its structure (Figure 9.5) for the meeting and the ‘power play’. The purpose is to achieve a picture of the factors and forces surrounding the meeting, and to see the causal chains leading to the actions.

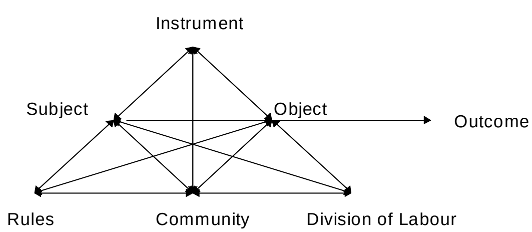

Figure 9.5: Basic Activity Theory Structure.

Object(s)

The command work, the boundary management, had to be efficient in order to make several objects, events and situations manageable within the HQ, manageable by the existing organization in order to reach a desired outcome. The transcription and the analysis illustrate that several objects appear during the meeting, approached in combination, both in parallel and in a sequence. One is the external chain of command in the division in the form of the battalion leadership of an AA battalion, and then the AA force structure, the ultimate goal for the efforts. A closely related object is the situation interpreted as a crisis within one AA battalion when its commander was no longer reliable, the event which had to be defined and communicated in order to be resolved. Then the personal situation for the unhappy battalion CO, labelled “Personnel” aspects, had to be resolved with respect to his integrity before any command chain repair work could be possible. Also, the superior command had to be influenced so as to allow this move and the changes. However, this latter object was addressed through formal routine methods. From the initiator’s perspective (Pers), the primary and related “objects” to affect might have been the persons who were brought together in the meeting, representing first the intertwined bureaucracy and the internal power structure, an abstract object. Among them the COS acted as the preserver of order, the gate-keeper to the ultimate formal power, allocated in the CO (who was in the forward CP). Evidently the CO was no problem. The normal working methods were efficient means for “controlling” him, setting the agenda, being adaptable as to the situation. We must remember that much can be done without asking anyone (along the internal paths of a bureaucracy), to bypass regulations or create delays, but formal action is necessary when re-allocation of power is needed in order to reach a legal solution. Thus the creativity of Pers and AAv is both directed at bypasses and of how to get the formal support which gives extra impetus to an idea. What mattered was to neutralize the contradiction between stability and change, and between a formal solution and what was socially necessary.

Outcome

The desired outcome was a functioning chain of command, a partial solution that was logical (rational), acceptable and ethical as regards to the battalion commander. The initiator (Pers) wanted action which was tactful and respected the individual. The data reveal that other criteria were a sufficiently good and temporary partial solution serving as a means to satisfy formal requirements, but without gaining full functionality: decision rationality but not necessarily of a kind that led to a long-term solution.

It is not possible to judge whether the events within the AA battalion, the breakdown first in the chain of command, and then in the internal command work which initiated the meeting, could have been avoided with the help of better cooperation within the HQ during the preceding days. Nor whether the chain of events had been carefully designed in detail by game control far in advance within the scenario, or if it started as a conscious effort by the game and CPX control units. As such it might have been a response to other actions or events or lack of commitment, and then turned into a contingency, driven by its own logic or lack of logic. Game control normally either "punishes" or "rewards" actions by those who are actors, depending upon what the first response. Neither is it possible (because it was the last day of a week-long peace-time exercise) to judge whether lack of (or further delayed) action had led to any serious consequences. After all, it was a game, but the situation was serious enough to initiate "repair work" of both the internal command work and of the chain of command.

Subject

More than one subject acted during the meeting, depending upon which of the objects was acted upon. Pers who initiated the meeting was the initial 'driver'. Both AAv and Pers were stepping out of it and back into their official roles, trespassing the boundary zone between the organization and the disorganized environment during the meeting. This was marked by the words they used, changing between vernacular and more formal labels on events. Then during the meeting all four constituted one subject (a team with heterogeneous members) which influenced the outcome. Other individual subjects were the COS who was the gatekeeper against "illegal" solutions and the ChLog who had been active earlier. Then Pers mentioned the CO, as a reminder, because only after his intervention could a legal and satisfactory solution be launched.

Instrument

Preceding the meeting was how communication and control technologies were used, according to the standard procedures and practices. During the meeting, the most frequent and important instruments, the mediating artefacts, were social rather than physical: language, procedures, supplemented by rules, accounts of previous experiences. The four persons were standing close to each other, carrying only personal notebooks and the print-out copies of messages. With the help of language the chaotic world was transformed and made logic and orderly, in accordance with the theories which Berger and Luckman (1966) outlined.

There were few contextual constraints once the meeting was organized. It occurred indoors, in a corner of the temporary conference space where the morning briefing had been held and where computers and network, maps, lamps, etc. had been installed. The meeting ended where the (imminent) use of IS and communication technologies through which other procedures and actions were about to be initiated.

The Mistake (according to the Chief Logistician) with the address on the electronic message which released the inherent turbulence illustrates a few of the characteristics of the present communication technologies. The way they were used easily separated the social action from the instrumental one. The speed-of-light communication can easily reduce any social action into a technical operation. Using modern control technology, anyone can hit single or multiple receivers with the same speed, precision (intentional or unintentional) and tactlessness. Earlier, when more was handled consciously, often in a very slow and tedious procedure where various technologies were used, mistakes could be discovered and corrected in time.

Rules

First, the explicit (even if they are not made explicit in a written document) rules during such exercises are that what happens is real and must not be neglected. Exercises normally are prepared over a long period and people have successively been immersed in the scenario. All participants are evaluated as part of the organization's reproduction. Then, the formal organizational rules allowed this kind of urgent meeting and were consciously used by the participants, now and then interpreted and used as tools. The rules for calling to a meeting, for instance, are probably implicit rather than explicit. Who can reject a direct appeal? Moreover, in order to rapidly overcome the division of labour and responsibility and get a personal commitment in the bureaucracy, this kind of meeting belongs to normal routines. ChLog stated that this had been given a high priority, which implies that those who gathered realized that they had to reach an outcome which satisfied several goals (the AA battalion commander, logic, healed the chain of command without harming the individual, formal requirements).

A "mechanical" solution might have affected the trust negatively and shall not be read as the first-hand military priority. After all, motivation is prerequisite for commitment and risk-taking. The basic rules were not changed, but complementary rules appeared, for instance that an action now could be confirmed or perhaps changed later by superior command. The most important thing seems to have been a continued process rather than a finite and permanent solution. This set of rules originating in the bureaucratic power structure demonstrated flexibility and elasticity.

During the meeting, another set of rules was referred to: logic. Arguments based upon logic become powerful. Such arguments were sought after when it was necessary to invent and find a way out of the dilemma to repair the chain of command but not to humiliate an exhausted commander. The solution had to be designed according to the specific situation and at the same time legal, other similar events may happen. What happened here was that a rationally objective and rapid instrumental process (first sketched in the midnight message), later was handled with utmost care and respect to social conditions. This case has a parallel during the Bosnia mission (Persson, 1997). There, a company commander was badly exhausted and was ordered to spend a few days in the battalion HQ in order to rest and get relief from a period of severe strain. The battalion commander (interview) told about how the company commander first refused but then realized his situation. Later on, the latter returned to his unit and fulfilled the mission. The lesson learned is that there is no given rationality, but instead what is "rational" was designed and built upon an individual's situation and a pragmatic solution.

Community

An aspect of "community" is that the whole event was situated within an exercise and that influences from this context initiated the meeting. The 'exercise community' materialized itself in a drama as a "battalion commander" in the field.

The small group reflected and represented the larger HQ community and power structure. In its outskirts we can see (hear about) superior command and the formally most powerful individual in the organization that was studied, the Division CO. The turntaking during the meeting showed few signs of formality but occurred within the authority structure, actors being true to their roles. Mutual respect was tactfully demonstrated. Pers and AAv shifted between a more personal-emotional position and their formal one, trying to make the border explicit between the direct personal experience and action space and the organizational space. The COS and the ChLog remained more formal. Twice the team members entered into another and less formal community, when they relaxed and joked after decisive shifts in the conversation. Then they became colleagues sharing a relief, escaping from the formal structure. The last time, near the end of the meeting, the three of them (COS, ChLog and AAv) evidently were relieved that they could leave the matter while Pers had to complete the procedure and do the paperwork.

Division of labour

The HQ consists of several small units, each one having its own agenda within the total command work. We see a strict division of labour as regards to the standard tasks in the HQ, and a similar power division among them. The labour division to some extent caused the breakdown because several subunits were involved but did not participate in the final phase during the night. Independently of the labour division almost anyone, however, could call attention to events. The division of labour then is what lends power to individual experts, providing them with autonomy. It was not questioned during the meeting and consequently Pers (lowest rank but formally responsible) remained the one who had to complete the administrative work.

9.5 Conclusions

9.5.1 Meetings as Dynamic Work

The meeting was a flexible and partly formal platform for the management and negotiation among competing and similar interests, within the formal power structure, without threatening it. When recalling the basic command work model as a two-way transformation, we saw that an event (an exhausted person) was pulled into and formally defined (as a troubled battalion commander, one direction) in a way that allowed organized action (the other direction). However, this was not a straightforward taken for granted process . Several contradictions had to be reconciled because only when sufficient autonomy had been negotiated (Pers) and an exchange of power had been reached (with the COS), could a legal process be designed (mainly by the COS). When solutions are defined as temporary, they require less formalization and are perhaps more socially accepted than finite ones.

When illuminated with the help of activity theory, the conversation reveals that during the meeting, the roles of subject – object – community shifted very flexibly depending on the outcome of the process, and that this nurtured the next phase of the process. Figure 9.6 illustrates these shifts. There were several parallel activity systems, reflecting the shift of situated communication power in the group.

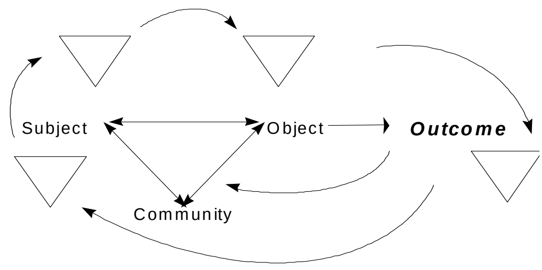

Figure 9.6: Shift of roles between subject, object and community illustrated with the Activity Theory structure.

This adaptation was flexible and allowed immediate response to new turns. The meeting was a social tool for integration because it promoted the necessary cooperation when a breakdown had occurred. It bridged the two main sections in the HQ, and the gap between the COS and subordinates on three hierarchical levels. As an arena for constraint management, the meeting illustrates the role of social power and how formal power, authority, might be the foremost constraint to be managed and utilized skilfully. Which authority can resist direct personal influence from someone close nearby, at least in the short run?

When analysing the meeting, several contradictions become visible and the communication process during the meeting illustrated how they were overcome. There was a certain struggle to overcome the desired stability and initiate change in the bureaucracy. Finally, there were contradictions between the need to communicate events which had a strong emotional load using technical media which hardly allowed rich descriptions. Also, there was a contradiction to overcome caused by the delay (and the breakdown) in the communication. Personal communication, both during the meeting and to the FCP, evidently was efficient and desired.

9.5.2 Activity Theory: Limitations and Opportunities

When it comes to the Activity Theory itself, some insights evolve. By following its structure, insights have been achieved concerning what command work is. Another and a meta-level insight is that Activity Theory and its structural schema has limitations. If obeyed to the letter and/or taken as “given”, the theory may lead the analyst to think that “objects” (together with “subjects”, “instruments”, “community”, “rules” and “division of labour”) are something that naturally appear, that they are “out there” like data, just to pick up and use. There is a contradiction between the simple two-dimensional analysis structure, and the complexities in the social world.

However, the close reading of the meeting revealed how the conversation shifted focus between various objects and that different subjects act, each having an outcome in mind: rapid action, formalization, minimal change, a temporary solution. But this is not enough. What happened was that events or phenomena in the social world first had to be consciously defined as some kind of objects (transformed into a suitable problem) before they could be brought into the universe of discourse, allowing orderly action (idea transformed into action). It took for instance some minutes before the COS realized that earlier actions had failed and that the situation really required renewed decisive action. The previous work became visible in the meeting and through the printouts

Referring to the basic command work model and as a two-way transformation across the boundary zone between environment and organization, what is "object" is consciously defined or socially constructed stepwise till it can be accepted and made manageable within the organization. Part of this event-to-object transformation might be negotiation till it becomes accepted as "*something worth attention*". We have the same situation when it comes to "subjects". During the meeting, Pers was immediately accepted as a subject, but this might change very fast if something goes wrong or if a conflict opens up. Also we can infer that what is "instrument" is socially constructed. An obvious instrument (telephone, fax machine) may have to be redefined as not suitable, while a meeting or direct personal interaction become a better approach. This discovery could be outlined with the help of Activity Theory which illustrates its opportunities.

The attractive simple triangular scheme then should be completed with a few other schemes, or used in a stepwise manner. Compared to how the Activity Theory is described in source materials, the course of actions during the meeting is consistent with, but also reveals more than Engeström (1991) stated:

> The activity system is constantly working through tensions and contradictions within and between its elements. In this sense, an activity system is a virtual disturbance- and innovation-producing machine. (p. 128)

In Figure 9.7 a-b the movement from one to another phase during the communication is visualized with the help of two schemes, the left being the transformation of event into an acceptable "object", the right being the work at this object (Person-

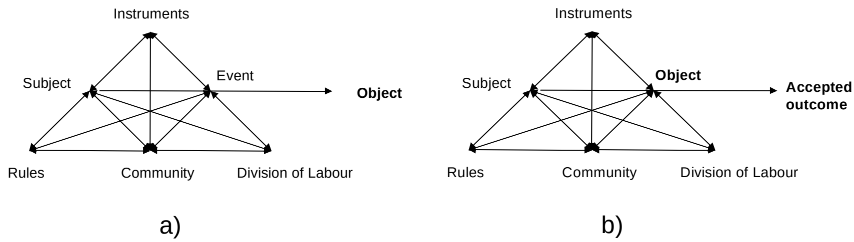

Figure 9.7: a) The social construction of "object", succeeded by b) achievement of "outcome" as (at least) a two-step transformation.

nel matter) in order to achieve a decisive result. What is objective and instrumental, in reality must be transformed into an artefact before it can be applied.

It is questionable whether this "machine" metaphor is suitable, because it may direct attention from the social to the technical aspects of this "system" of work. However, Engeström also stated that humans collectively construct these activity systems, and that artefacts are under constant reconstruction due to the conflicts that arise when they are applied. As regards contradictions, one is consequently between the perception of the activity system (organization) as a machine and the claim to apply the structure to a social setting (or rather, to define a social setting in a way that suits the basic structure of the theory). A similar contradiction is when social artefacts are treated as objects, when for instance ISs are seen only as technical components.

Engeström stated that between the components of the activity system, there are continuous transformations ("The activity system, incessantly reconstructs itself"; Engeström, 1999, p. 66). When it comes to computer systems and the implementation of databases, the consequence is that anything stored as categories or data types may have to be restructured. The statement about what might be seen when studying social action from the outside lends a machine-like capacity to the activity system. A more adequate way to describe what is going on is to say that actors collectively transform their activity system into a new temporary state from where action again is inspired; this time by the same subject for the same community towards the defined object, or by another subject within another community toward a different object. Similarly, other instruments can be applied.

When describing and later analysing this kind of "activity cluster", it is easy to see that rationality here has another meaning than the one publicly and ideally claimed as “best practice”. Part of the innovative work is directed at lending this kind of quality to the work at hand, even if the process is far from *“rational”*.

When AAv said *“It is motivation and…psychological illness there…(Pers: Yes precisely)*

and continues *“ ...where they don’t even dare to use the radar…”*

the human and social/psychological phenomena were given names, *“objectified”*, in a way that suited the organization.

A little further AAv stated another object: *“There is a lack of AA competence in here [the HQ]...”* which got approval from COS who then was prepared to listen to AAv’s next move *“...I mean it is totally lo…gical to motivate that we lift him in here”*, which then added momentum to the process *(COS: Yes; Pers: Yes…)* and the COS concluded: *“It is a good solution.”*

The analysis of the meeting with the help of Activity Theory thus has showed the utility of the theory, illustrating the inner details of a kind of command work, details which have a very important role. The analysis has also shown that all is socially constructed, something which Engeström said but is easy to forget once a model is drawn. It is certainly not a machine. It remains to label its rationality, whether it is an instrument or social activity that is reconstructed.

9.5.3 MEETING SUPPORT TECHNOLOGIES

Because meetings, organized for various reasons, are frequent and involve many persons, special attention should be given the requirements of support technologies for these occasions. Some are very short and urgent, even informal but nevertheless vital parts of the work. They have to be distinguished from each other. Depending upon the type (again a matter of social construction), and if the meeting unites distributed persons, the support solutions may have to be video links, group decision support systems (GDSS), conference systems, electronic messaging, telephones and so on.

Design can be directed as to minimize either the number of meetings, their length, or both. Or, the design of support systems may well follow the ideas of Streitz et al. (1999) who claimed that wherever people happen to meet, they should have some supporting facilities at hand: *roomware.* The whole workspace then becomes an “interface to information” which can be reconfigured, allowing individual and team work and linked to the larger organization. The meeting we have studied occurred within a temporary but tailored workspace in a large industry hall (a former saw mill), furnitured and equipped as to be an integral part of the HQ with telephones, notebook PCs and LAN nodes. Also the surrounding technologies have to be designed so as to reduce the risks for lack of coordination between a meeting and the rest. Functionally, design has to include every link in the ISs conglomerate: the informating, mediating, and the informing subsystems. Figure 9.8 illustrates two kinds of meetings, one within the ordinary workspace, the other outdoors.

Figure 9.8: Meetings, in the FCP tent and between cars.

The requirements Streitz et al. (ibid.) articulated may be what drives the development within the military HQs where larger open spaces are often created, less physically and socially constraining than the older vehicles. Command work, once ordinary office work has acquired a different character, reflects new requirements in the work. Unfortunately, what is office technology tends to be more static structures as opposed to mobile technologies ("wearables") that are used "out of office", being attractive in crucial moments. Occasionally actors used, against the rules, their mobile telephones in order to overcome communication gaps. Thereby they risked becoming de-institutionalized and losing power and credibility as persons violating rules, but if rules were commonly considered unsuitable but these tools useful, (bad) habits spread.

Bödker (1991) correctly claimed that technical as well as social and organizational aspects must be considered in ISD and clearly confirmed the course of action we have seen:

> "Activity Theory can explain to us why we are never really successful in creating a world that is like what we predicted, because it is the actual situation, the physical and social conditions of the activity that determines how the operations are carried out…" (p. 556)

This is perhaps the reason why few IS become what they were aimed at. Surprises seem to be what awaits any designer – implementer in the same way as the additional receivers in the email address header was what turned the meeting into an urgent prioritized affair. When it comes to “object”, Engeström (1999) was clear: the “object is understood as a project under construction, moving from ‘raw material’ to a meaningful shape and to a result or an outcome. In this sense, the object determines the horizon of possible goals and actions” (p. 65).

What he said is that the variety of possible goals and actions may differ considerably depending upon how the object is defined. Probably any organization wants as wide a span for action as possible, which implies that this kind of command work can hardly be designed as to follow a given course with only predefined alternatives. Instead, it is this kind of meeting that plays a crucial role when the span of future action is created.

Winograd and Flores (1993) described the organization as an ongoing conversation where managers are involved in an ongoing dialogue about future actions, reinterpreting history in order to create new options. What we saw here was the reshaping of history from something static and passé to something which could be managed. It is crucial to shorten the way between event and action, between data and (re-) interpretation. Ultimately, such reinterpretation may have to be radical and allow new solutions. If proper definitions-solutions cannot be reached, or if power is masked and not outspoken but instead prevents satisfactory work, blood may be shed. If the organization “affords” (Anderson and Sharrock, 1993) knowledge and responsibilities, thus making both the social and the instrumental resources visible, efficient work can be conducted.

However, as we have seen, it may be possible to discover the relevant methods and requirements on instruments (artefacts) only in the real work spaces when people get together. Any ideal solution designed in advance may fall short of the needs and just become another system to bypass, for instance through face-to-face meetings even if they mean personal risks and long transports. According to technologies (instruments), individual actors bring components that must be (made) compatible in some sense (see for instance Davis et al. 1999 who have studied technologies for lightweight note sharing within groups). They are put together, and when the group splits and other forms of work (re-) starts, the outcome must be able to carry away and connect to other parts of the environment, even institutionalized within the wider organizational context in order to be legal.

Chapter 10
Case 2 - The Actualities' Table

THE DATA ABOUT the Actualities' Table were produced during the sequence of CPXs from November 1997 to May 1998, and consist of documents, interview data and photographs mainly from the division HQ B, the primary fieldwork site. Later on, printed documents such as source material, some official handbooks and data files have been used. After the CPXs I made four interviews with staff members who had participated in the exercises and the interim system (FENIX IS) development.

10.1 Resource Management, Control and Artefacts

10.1.1 Standard Approaches, Tools and Options

> In short, the story of command and control in relation to technology is a tale of the way military leaders at all echelons have made use of advances in technology while striving to maintain their freedom of action and their command authority. (Holley, 1988, p. 268)

Resource management is at the centre of command work, to balance objectives and resources, demand and supply. Mainly within Logistics but ongoing in integrated cross-functional command teams, quantities are transformed into and treated as capacities: in battle, transportation, and endurance; and situations are analysed in order to assess the need for resources. This transformation is part of the boundary management when the environment is made controllable and ideas materialize into plans. Resources, situations, and goals are continuously monitored, interpreted and negotiated whereupon decisions are taken and control actions initiated. When operations (and exercises) start, the resources and capacity of each unit are usually well-defined and known among staff (fed into registers and databases), each command (sub-) function according to its responsibilities.

The regulating command work and its control actions balance supply and demand through the use of stand-by missions, and preparations for alternative situations. Ideally, the close interaction between the main sections in the HQ should be maintained through the SOPs (for example daily briefings) and supported by common documents and artefacts, for example prognostication tools for assessing possible (usually statistical) outcomes of operations. The Logistics section, through traditional book-keeping techniques and tools, monitor and supervise resources in greater detail. To look at, these tools and artefacts are applications of traditional techniques, whether they are spreadsheets or lists. Without exception, they and the management techniques are based upon a rationality that is materialized in writing techniques and calculations, successively transformed into computer programs.

Report systems have been modernized and rely upon standard formats and inventory lists, and function through regular and special reports. Reports from the field along the chain of command, or rather, within the logistic report and communication network indicate new demands. Resources are ordered from supply bases or contractors who are continuously updated about the situation.

The system and rules for reporting are basically focused on quantitative measures (personnel, ammunition, fuel). "Soft data" (qualities) are harder to express and communicate but vital to get a full picture. In the standard report form, for example, "Battle capacity" was given one position allowing an aggregated value (numbered 1 –5) while each kind of resource (vehicles, ammunition, personnel) had its quantitative value in the report template. During the CPXs and the current process of better "informating" actions and units with the help of IT, I often heard dissatisfaction with this single rough figure which did not say very much and was vulnerable to subjective opinion. In order to provide more details to better represent units' statuses, still making it 'processable', several efforts were directed at adding more parameters and gaining precision.

Computer technology has promised to lead to more reliable resource management and better cooperation, allowing better communication, digital reports and registers and the use of databases. The whole reporting system was redesigned into a computerized system (ideally) using only digital report formats and templates, an attempt to exploit the capacities in modern IT. These changes were implemented during 1997 and 1998 in the command organization and caused initial frictions.

The most shifting standards and procedures were practised when actors did not or could not obey depending on the successive inventions and new technologies, or when communication links failed. Much effort was spent with the reports, but the output was late and unreliable. There was a widening gap between the formal requirements on work coming from these closely integrated routines/systems and what could be achieved. Whether the CPX conditions (peacetime, accelerated battle tempo, new technology, temporary organization) just *admitted "quick and dirty" reserve routines* (but less relevant had it been a real operation), or *enforced innovation* of something that would be an efficient new reporting system is hard to say. Independently of which, the new IT infrastructure provided new options and innovations were initiated.

At the end of the week-long final CPX the problems still were large, caused by lack of routines, IS-skills, or technical failures. The following utterance during a late evaluation discussion from an officer whose task had been to receive and combine all regular tactical reports within the Logistics section expresses a dilemma:

> now we spend half day hunting for functioning documents from the forces, we have no time to read it, analyse it, especially not act upon them…so probably the only alternative is to pull it [the report system] out with roots and all, and see that all the roots really are there…(Person X)

10.1.2 THE PC-BASED DEVELOPMENT

The 1980s and 1990s saw ongoing attempts to use computers in the army command work. When waiting for a decisive army command support system the strategy originally launched in the late 1980s was to exploit PC-technology as a means of gaining experience from (any) computer use within command work (Thorell, 1987). The portable PC had a very limited capacity, but was attractive because it was transportable in ordinary briefcases, initially fragile but possible to use in vehicles and provisory workspaces. The primary early use were word processing, use of registers, spreadsheet and calculation programs, for example within communications. Around 1990 the development started of a family of applications for resource management and organization overview (equipment, activities). Some were centred around electronic maps and symbol presentation as access areas for detailed data and further integrating the report systems in the work.

Computer use grew but the attempts to use standard technology did not lead to any common integrated IS for support of command work. In Bosnia 1993, for instance, the first battalion used some applications and developed its own, relying on standard spreadsheet-tools (Persson, 1997). By then, mobile technologies for communication and email had been introduced. When in 1997 the latest development phase started, of the FENIX IS and the Actualities' Table, regular officers in the command units had been involved in or knew about the modelling within the larger army project framework (ATLE and the ATLE IS) during the preceding years (Chapter 8). Most were familiar with ordinary PC technology and its application in their ordinary workplaces.

There were exceptions to the standard applications. One was BERRA, an advanced and authorized military application, based on standard spreadsheet technology and MSExcel, for making prognostications. A preliminary version was tested during the CPXs. The tool was intended for the identification of problems and to inform decision-making. It had been developed over a few years, based on very detailed bottom-up combat data and modelling, calculations and simulations. It worked with a statistical model for calculation of requirements for medical care, logistics (transportation, repairs, resources) and aggregated availability over time (weeks) of personnel and material in army units[1]. Its output, used as printouts together with other similar artefacts, were diagrams, spreadsheets, and tables, where colour codes (red/yellow/green) were used to enhance the meaning of other data. The ChLog who was one of its designers modified its design from time to time. This advanced tool shared some characteristics with the Actualities' Table which, I considered, was a more interesting case because it evolved in the work. Both were used in parallel. Before turning to the case, let us look at the principles in the resource management and when artefacts are developed.

10.1.3 INTEGRATION OF DATA FOR AGGREGATED ESTIMATION OF CAPACITY

The tactical planning usually is integrated via a common effort where a whole HQ is involved and provides input, influencing the design of the plan. During many peacetime exercises, feedback from the simulated battlefield is seldom very detailed except when specific events occur. The meeting-case, Chapter 9, is an example of such an event. Effects are to some extent buffered in lower echelons and only after some time (days) do they enter the higher levels' command work agenda in detail, requiring well-integrated work between Operations and Logistics (with Personnel), often including contacts with the mass media.

The planning is documented in, for instance, a continuously updated long-term forecast (prognostication) that is used for control and coordination, expressing the

1. The Defence Material Administration (FMV), BERRA manual 19 March 1998, FMV:AUH

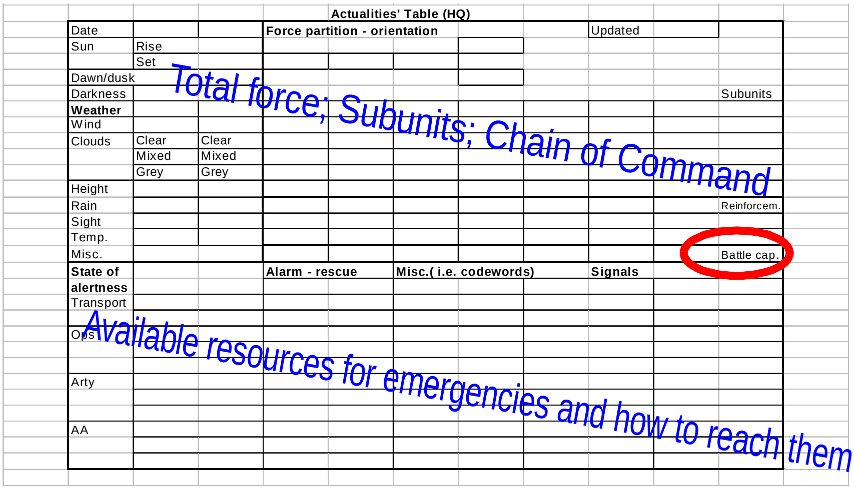

Figure 10.1: Original 1980 Actualities' Table.

degree of *freedom of action* over time. The forecast is also used for detailed Logistics planning among supply units where demands are derived from these overviews.

Other tools are various templates for *resource overview*. One of them is the Actualities' Table, usually handled within Operations but related to (and perhaps replicated) in command support functions according to their requirements (the 1980 official standard version reproduced in Figures 8.5 and 10.1). Its main features are:

- Weather conditions upper left corner;
- Alertness for certain units lower left;
- Main field – upper half: force composition and partition; who is on the address list and assessed Battle Capacity (marked in figure, see additional comments in text); Also notification of time when updated;
- Main field – lower half: Detachments for alarm and rescue missions, signal addresses.

Such a table can easily be modified according to other needs. Its format allows printouts that can be pinned or taped on walls in the workspaces or distributed physically and electronically.

"Battle capacity" (fighting capacity) expresses the aggregated qualities and capacities of subunits, using a number between 1 - 5 ("1" indicates unfit for any action, "3" considerable limitations but still some capacity in the main functions of a unit, "5" fully operational). The figure/number is derived from reports and observations. Usually the plain number is supplemented in a report by written comments from the CO (Commanders comments) expressing contextual data and what is not easily quantifiable.

In a draft document[2] concerning the meaning and future handling of “Battle capacity” the Army stated that it is necessary to visually and more precisely represent fighting capacity on the situation map. Alarm signals should be created when capacities drop (The aspirations in the FENIX IS environment were that the unit symbols on the electronic map representing the tactical situation (image) had links to additional unit data[3]). In order to achieve this new control capacity, computer artefacts have important roles.

Seen against this background it is important to stress that both these traditional tools and the advanced BERRA were or included *diagrammatic representations* (Larkin and Simon, 1987). They can be read either according to the letter, or used as tools for thinking when they can provide an overview, admit comparisons, heuristics and inferences even when containing alphanumeric data. They can be interpreted in several ways, carry (much of) their own context with them, and can be used flexibly and communicated in different formats. This introduction was the context to a closer presentation of the evolution of the *New Actualities’ Table,* which carried a tradition of work further when it was implemented in a new technological environment. The table admitted freedom of action in the command work, and presumably helped achieve it in the operations in the operational domain.

10.2 The New Actualities’ Table

10.2.1 Overview of the Table Design and Development Process

The development of the new Actualities’ Table took place in the period November 1997 – May 1998, but its roots are considerably older. Some accounts (presented below) describe ongoing work in the mid 1990s with computer versions. One of the starting points for the new phase of development and evaluation was the first HQ A CPX in November 1997. By then, besides the FENIX IS, a number of tables (templates, spreadsheets) belonged to the common toolbox[4]. Each (sub-) section and function (Artillery, Intelligence, AntiAircraft-Artillery, Engineering, Logistics)

2. Army TActical Centre (ATAC) 1998-01-22 19100:
3. 4. div HQ, SOP, 31 October 1997
4. ibid.

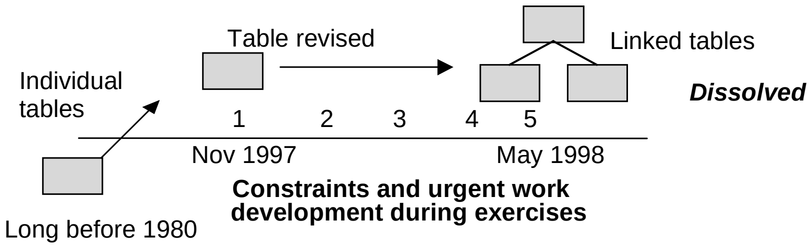

Figure 10.2: Timeline for the development and life of the modified Actualities Table.

had its own tables according to their needs. An "Actualities' Table" belonged to this set. Its further development during the fieldwork (Figure 10.2) was both stimulated by and a response to the other army top-down change process (see Chapter 8). In the new IS environment it could easily be stored in any computer, printed out, and distributed.

In the course of his work in the new Operations Centre or Battle Management Centre (BMC) an Operations officer in HQ A (Person U) discovered the need for a better overview of subordinate units' status during the November 1997 exercise. The BMC concept was part of the new command organization, intended to coordinate work all over the HQ, manned by various function experts and some staff sergeants. Resource overview was essential for all present. This officer drew by hand a large table and taped it onto a wall next to himself, adding new features and data when needed.

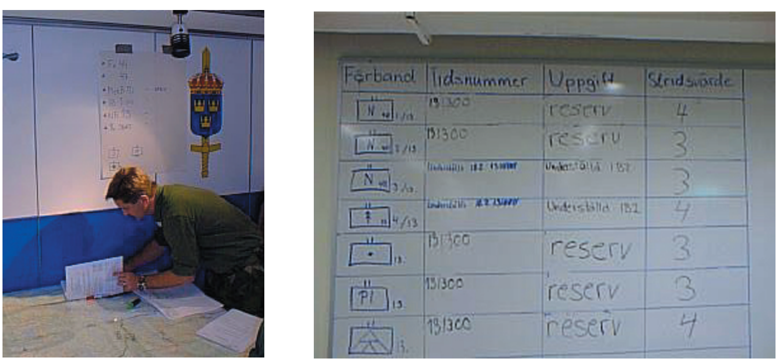

Figure 10.3: November 1997, the first sketch (left), later a growing Actualities' Table: units, actuality, activity, battle capacity (Nov 1997).

Another probable stimulus was that the BMC had the role of Information Management Centre as well, responsible for the updating of the whole HQ of the situation and making information available, if possible via the LAN. Daily briefings were conducted there. Quite soon projectors were used for projecting overviews and images from computers as complements to the hand-drawn tables.

During the second CPX (January 1998) Person U was assigned to HQ B. There, another influence to find new ways to inform about the situation seems to have come from the then new division CO. He wanted to get a better overview of his resources, given the brand new IS structure and functions which was implemented immediately before and even during the exercise. Later, I happened to be present in HQ B during the third CPX in early April 1998 when Person U, having imagined that the design requirements could be satisfied by off-the-shelf spreadsheet applications, began to discuss possible design alternatives with a visiting colleague, Person J. His idea got support. This colleague (J) himself had developed similar MSExcel-based tools when serving in Bosnia in 1993 (See Chapter 5; Persson, 1997).

10.2.2 DESIGN AND USE OF THE TABLE

The intention became to integrate and arrange charts, spreadsheets, and text documents, among them command functions' own tables, under a common interface, an upper level "gate table", called Actualities' Table (like its predecessor), but controlled and distributed from the BMC. This gate table should be updated in the BMC and contain an overview of the total force and some common information about it, links to the actual operations order, weather forecast etc. Macro commands would then make the different linked tables accessible by clicking in cells (Figure 10.4).

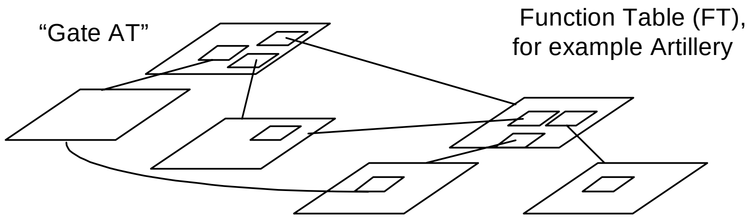

Figure 10.4: Envisioned structure of new MSExcel Hypertext Actualities' Table.

Then each command function was supposed to develop its own complement as a command function table (FT) with details relevant only within the function (artil-

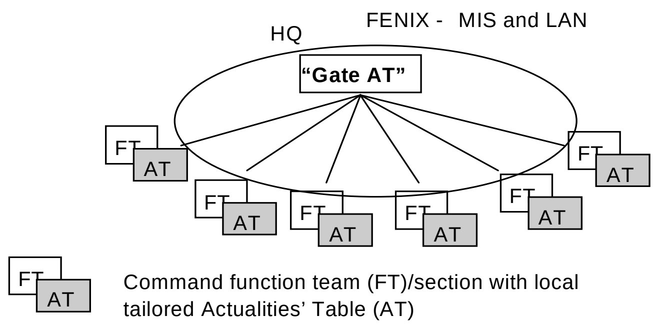

Figure 10.5: Overview of the two IS architectures in HQ, the FENIX covering all.

lery, engineering), but linked to the upper level, forming a kind of hypertext structure. Within the total HQ this structure was intersected into the larger MIS (the FENIX IS) where work stations and other PCs could house the tables, and operators send them via the LAN among themselves in the different parts of the HQ.

The new bottom-up application was sketched out, designed, built and then continued to evolve during the first half of 1998 but not as to satisfy a particular, explicit set of design requirements. Instead it was designed as a loosely connected cluster of work tools, visualization aids, and coordination mechanisms (mainly documents such as operations orders, plans, directives and assessments). Nor was it ever "complete" or "finished". For instance, the macro-commands only became partially functional. Once the last and longest CPX started (early May), the first version of the new table being operational, little time could be allocated to develop details (interview, Person R, audio). In spite of this, its hypertext character was efficient and allowed a flexible use over the dispersed HQ. When used during the last two CPXs it became an appreciated toolset (see the subsequent evaluation section). In practice, two separate IS structures evolved. One was the top-down/PD evolving MIS structure called the FENIX IS. The other consisted of the work-oriented MSExcel applications which built upon the older practices and grew in the work. These were not yet integrated in the FENIX structure (Figure 10.5) but were dependent on the same LAN and communication services.

The development process essentially led to a more flexible, multi-view version of the old 1980 table with different linked documents – one which any workstation in the new IS infrastructure could support. The linkage could not be completed during the last exercise to the extent the initiators wished. The "upper" table interface, similar to the old version (Figure 10.1), was an MSExcel spreadsheet that listed the subordinate units, their current status and situation over time, further augmented by the use of a colour scheme (numbers, staples in red/alarm to green/OK) for certain capacities. By clicking in various cells, a user could access other linked documents (or tables), such as detailed figures on technical and operational capabilities or a long term prognostication sheet that visualized the current operations plan and displayed activities across time (days). An exploited MSExcel design option was that a red marked corner in a cell meant that additional information was available through clicking in it.

The application was implemented in the client-server architecture, to some extent "mirroring" the central interim IS (MIS) as well. Some data were even input data in both structures although these operations had to be done separately. On some occasions, people complained that separate updating was necessary in them, when one should be enough, possibly automated, they thought.

While the hypertext application served mainly internal local demands, the MIS structure, its functions and output were a distributed resource that spanned several command units within the division. The architecture both promoted and allowed development of amendments in the form of easily designed and distributed new spreadsheets or documents according to the situated needs among the HQ subsections. Written orders, notations and reports could be produced and partly or wholly shared by the other (local) hypertext structure or used autonomously as print-outs. In Langefors' (1993) words, there were translocal ISs together with local ones.

The combination of traditional tools with new technologies (the PC, MSExcel, LAN and the communication system) provided valuable new capacities in the new environment. The table structure relied on spreadsheets and cells (buttons) providing an alternative view of critical data, one that was a compressed representation of the object-world. One (or just a few) pages were enough to get an overview instead of an interface consisting of abstract catalogues or files which had to be opened before they could be read. The same MSOffice standard software for data access was used in both structures. Basically, the central IS could be by-passed, but more importantly, traditional information resources, devices and work methods were refined into new ones with enhanced capacity.

10.2.3 ACCOUNTS FROM THE DEVELOPMENT OF THE ACTUALITIES' TABLE

The data from the development come from a few complementary sources, because there were more than one process that later converged. One informant (Person V) explained his experiences from earlier work: During exercises in 1994 there was a paper-based table in the HQ. The thought of making an *augmented* Actualities' Table was there from early on, but:

> In the fall of 97 we talked about an Actualities' Table with templates, but could not make it explicit. Then in week 49 [Comment: early December 1997] it began to be concrete - there was soon to be a CPX. During this week we had an exercise, how to design the table application? But then after another CPX [late January] we said 'now we have to do something'. Actually it was during a later exercise in...when TS [initials for a colleague] was there, we started to play .[....] when *we* were the CPX control unit [...] we made that Excel spreadsheet [...] we saw we could link notes to it, we saw we could link other files to it, we could put templates in a template register so we could retrieve it mathematically you see, then it grew out like a flash of lightning.
>
> ---
>
> We had a discussion about whether to store information in the catalogues in the computer, or, there has been a lot of discussion...basically it is a stupid way to store and save files in directories because you want to have them easily accessible. Then we said it is in the Actualities‘ Table, it is [emphasis added] *there we should save information, it is there we want to search for information, we will develop it into an instrument for saving information. So instead of linking the files to these fields we had, for instance, in Intelligence, we will save the information at Intelligence.*(Person V)

This raises some issues that will be treated later in the thesis, about the need to flexibly design work processes from an open structure, and how this is matched by common sense solutions in standard computer artefacts.

Later (a May 1998 conversation) the team leader in the HQ B Command Centre described how he and his colleagues took a sheet of paper (sometimes in the period late January – April) and started to sketch out on a design. They saw this as 6 or 7 subordinate (function) tables all linked to the top level, each one showing an aspect of the command information and situation. They included for instance the Long-Term Forecast, (battle) capacity, current and distributed orders and the mailing list. Other pages included weather forecasts, daily agendas and an HQ work schedule.

A January 1999 interview with Person R, a reservist, revealed more about the development process. Prior to the first demonstration in late April 1998, outside the design and development group, the new application was described as and thought to be just another table or template and did not attract much interest. He made it clear how surprised he was when he who worked in the IS section in the HQ, at the first demonstration, realized what exactly the new Actualities Table was and how far it had evolved:

> Then there was a call to a meeting concerning "templates". April, mid April at…[a training field]. I did not understand what it was, neither did my boss. We though it had something to do with paper, a kind of templates on paper, report forms and such things so noone was very eager to go to these meetings. And he who last attended it did not come back and report anything worth attention. This went on for a week, the first week we were at P 2, when we had a week of preparations.
>
> ---
>
> I assume the first call to the meeting came on the Tuesday. Then came Friday and the concluding briefing after this week, when they were to demonstrate the "templates". Then to my horror they threw up MSExcel, and a whole bunch of linked Excel spreadsheets with lots of buttons here and there and then suddenly I realized what "template" is and just then I remember very clearly what I felt when I sat there. First I thought it was sad that I had not understood what was about to happen because I was supposed to represent some kind of IS -competence, I had the formal title of IS officer and I had not been involved at all, I had...had no idea what had been ongoing and then I realized when I sat there and looked at what it was, it did not take many seconds until I realized a number of problems which would appear then with this solution, with my background as a computer technician. (Person R)

Had he knew about the direction this work had taken (during the late April CPX the COS used the term "template"), he said he probably would have been able to contribute to a more robust design, himself seeing how to avoid some difficulties. Other key actors in this work were a number of soldiers and sergeants who were skilled in computing. One of them implemented the macro-commands in the MSExcel spreadsheets during the fourth CPX.

The first LAN tests of the new Actualities' Table in late April were inconclusive partly because it had initially been designed as any *single user MSExcel application a*lthough consisting of several documents and spreadsheets. Few of those involved had realized the complexities arising when they implemented it in a multi-user environment. Person R described how he helped with some necessary macro-commands in late April before the fourth CPX:

> And...eh…then there was a weekend holiday and then we came out in the woods and there some of the problems manifested themselves. My next contribution…I had some difficul…maybe I had a wrong and negative attitude to this Actualities' Table from the start. Partly I had not been involved at all in it and then I realized that this was not the smartest way to do things; shall we really occupy ourselves with such things during a blazing exercise but because I realized then that there would be many problems with it I offered to take it home and fix it a little. So when we left the woods the first weekend I took the whole table with me and wrote a few macros in Excel which should at least

> reduce the worst problems and then I was not that involved. Then among many other things I noticed that the Actualities' Table was used during the CPX and did not look much more at it. (Person R)

Data quality control and the problems of how to allocate write/read responsibilities in the actual environment were, however, never entirely resolved. A partial solution was to make a "read only" copy available over the network and to allow only those who were authorized at the BMC to update the Master (Gate) Table. This end-state followed the intentions in the November 1997 SOP in the HQ A.

10.2.4 Accounts from Parallel Work with Tables for Artillery Control

The account by Person S (Artillery) illustrates the reasoning about technology and integrated development of command work and artefacts. Let us continue to listen to his accounts when in 1998 he took up his position in the HQ and how he recalled previous IT experiences:

> In 1994 we had an embryo [to IS support] where we had the artillery support function intelligence function...when I used it during a training session I turned it off after four hours. Then when I saw what the FENIX was, it was the same thing, in principle. Then I started to protest and said we must do something to make it better. --------
>
> I thought there were too many positions to write things, you see, which you really had no use of. In principle it was...there were some things missing which one *should have.* I can give you an example, well, to keep the deployment areas 'rolling' so that you know future positions, where are units now and what will they do after that and such things you see. This I wanted included so I could just write it into a database and then retrieve the information, the fire permission management or support control. I thought it was inferior...(Person S)

Then S told how he had worked with another kind of tool which resembled the present table when he was positioned in an armoured brigade CP, his workspace being an armoured vehicle (APC). The APC working space was very limited and tools had to be designed accordingly. His original table was attached onto a soft wood-fibre board where needles could easily be pinned. Like the original (1980) standard Actualities' Table, resources could be tracked there, for example ammunition (lower right field), and action (the rest of lower half). During our conversation, he made a drawing of the old pinboard from his memory (Figure10.6). He had carried his board with him, using it together with the ordinary map, being able to know exactly what was said and done, and could keep a record over the evolving situation.

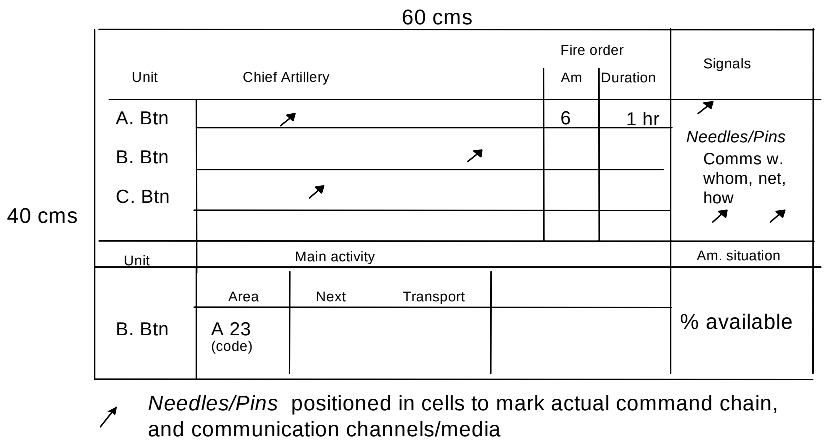

Figure 10.6: Transcription of hand-drawn Pinboard during interview, sized as to be usable in armoured vehicle; *simplified layout.*

On the pinboard the positions of needles (shifted around) marked the actual tactical disposition of artillery units (upper half), how to reach them via signals (upper far right field), and their physical positions (bottom). It was also possible to write on the pinboard surface. It was especially important to keep track of who was in command over the units, for how long and when the order for this was given.

Early in 1998 (the fieldwork period) he realized that something had to be done in order to be able to do his job in the FCP, maintaining overview over his function and coordinating the artillery units in close cooperation with the artillery regiment supporting the division. The regiment executed the orders from the division CO, and handled logistics for the artillery units. He described how he reflected on solutions:

> This one [the table], we said, in *this* way, we must do something about this one and send it between the BMC and the FCP so we can keep in mind what we did. Then it was developed a little you see...it was done during the exercise...
>
> Q:1998?
>
> Yes there is a template that we artillery officers used which was built something like this. I think we took that away (points at the drawing) because we could get it in other ways…
>
> Q: When you say 'template' it was in the computer...?
>
> In the computer and we sent it via the email system between Command Post...
>
> Q: Excel spreadsheets?

> Yes and behind them there was... then you could click in here you see and then you could retrieve something else...and this was done...the one we send between us...
>
> Q: Part of this which was called the Actualities' Table…
>
> The BMC managed it, updated it you see then they sent it forward to me, then they had information, I had information, the information I felt was incorrect I sent back to them.
>
> Q: It was part of the Actualities' Table?
>
> Maybe it was...suppose it was
>
> --------------
>
> Then we had...behind this there were others which were linked into the first one where we could ?[not possible to hear]. AC [Comment: initials; the Chief of Artillery] sat towards the end [of the CPX] and redesigned it, during the last days, it became quite good eventually…but then we had to write in the values all the time...and in reality we left the FENIX...even if we worked within the FENIX too in order to manage ??? [not possible to hear] we did two things with this one, what we sent with this one was that we had control, exact control, between the BMC and the Command Post that we had the same information, *that* was what we did, but the foundation was the old template. (Person S)

10.3 Interpreting and Concluding about Table Design and Use

10.3.1 INTERPRETATION

In the new command system, the attractive single common image of the situation and the capacity to make all information available were long desired qualities. The data and the first accounts (from late 1997, early 1998) indicate that the need to gain advantages through the new IS infrastructure, to better solve requirements for information management, central control and coordination in the HQ, inspired innovation. In the process of finding work methods, the MIS resource soon was bypassed by the Actualities' Table. The threshold to the FENIX IS which was implemented in parallel (dependant on external expertise and resources) stimulated the innovation which was dependent on simple and cheap artefacts, what was available on location. The solution satisfied the need, but according to a different strategy than the established (SOP) design and method principles.

The account by Person S tells how the work practices and the control requirements guided the development of the spreadsheet application. The mail system replaced the IS-infrastructure with databases, allowing satisfactory control over the data, and its distribution. The informant realized that – when it came to the work – they used the two IS tools/systems as complements but that their own table replaced the interim system which was not designed according to the requirements growing from the work practices. The interface of the oldest control artefact (the pinboard) gave an operator an overview of his situation. He could *physically* manipulate the surface, the representation of the tactical operations, with very simple means: numbers, letters, needle positions. The operators had to write in themselves what they knew and wanted. The tool did not impose an ideal sequential work process but instead allowed work with parallel issues. More important was that the redesign in 1998 was made as a cooperative effort between this officer and the Chief of Artillery, working close to each other mainly in the FCP.

The augmented quality of the computerized version as compared to the original version was that the existence of the data communication network allowed the distribution of the medium in a way that was practically impossible before. Earlier, commands had to be communicated by other means (voice or written messages, perhaps enciphered, often slow). With their own enhanced tool, the actors had full control over storage and transmission of data. The tools they developed in their work was part of it, existing within the social environment, synchronously developing with it. They could easily enter into a dialogue over the content, by voice or over the email.

The informants emphasized how they communicated each day over these capacity figures, and how unit commanders had to give their view especially upon the most severe limitations. Commanders had close contact, especially when troubles appeared and units had difficulties. These conversations were occasions for persuasion and negotiations, and seem usually to have led to agreements about the situation. Low battle capacity (3 and below) were alarm signals which triggered personal contacts, a finer-grained model was desirable. The ChLog also remarked that to *listen* to a voice was essential, because it revealed more than a report.

In summary, as judged from the accounts, the normal reporting system was complex, required much aggregation work before any output, which still lacked actuality and accuracy. The Table was used distributed over the HQ and actors further developed it in their work, creating satisfactory representations of the world for themselves.

10.3.2 Conclusions from Design and Use of the Table

All in all, the common sense perception of the computer technology perhaps is different from what is seen in the accounts: storing and retrieval is unproblematic and something which is taken care of by the technology, which is like the genie in the lamp: just rub it and wish. Writing was not very popular when comfortable automatic operations can be designed. Just push a button and there it is, the desired information, ready to use. Let us listen to Person S some more, when he gives his opinion on some minor fixes:

> What I mean is this, if I would like to *retrieve information* instead of writing in everything, then I want to pick it up in the database and it should be possible just to push a button [??] the consultants said it was no problem doing that, but there was no time for it but they saw there was some time. I said all information is at the bottom of the FENIX if you only fix the FENIX add a few things and so on, then I do not write in the FENIX then it is ready. (Person S)

An after action conversation with the CO, the COS and the ChLog revealed more about the rationales behind the table and design of the IS artefacts:

> One of the reasons for the table with a field in it named Battle Capacity is that we have a document to stick to when we… which all, when they switch on the screen can see. (ChLog)

What the Chief Logistician said fits into the common perspective on IT: just switch on the screen and there it is, serving control and coordination purposes in the HQ. There is first a structural control, to have to turn to the computer screen, having to be in the right compartment/vehicle; and then an informational control, to rely on one single source which supports the social reality in the HQ. Another example of the perception of the capacity of the technology is this statement:

> I want to get rid of the writing here and writing there, I could use...we write into a database, you see and then I retrieve it wherever the division CO and the Chief of Artillery are... (Person S)

The accounts indicate an overestimation of the capacity of the technology to *produce command work.* Perhaps there is an underestimation concerning (1) what efforts are required in terms of updating in order to get something back from a database, and (2) the value of actively working with (as opposed to watching) data and information, being representations of the tactical situation. Often command work like this merely disappears (into an IS), and the older procedure despite its visibility passes unnoticed or is rationalized away. It is likely that the writing procedure constitutes a very important part of active command work. In his analysis of requirements for successful understanding, Sage (1987) especially mentioned enactment, meaning that action should be introduced early and be integrated with thought. Automated updating might be comfortable but, hypothetically, might lead to a loss of involvement in the actual operations, and a lack of insight into changes as compared to the insights arising from the mental and physical work involved in the active writing. In addition, the table carries and presents an overview, however rationalized, of its own context.

The same kind of rationality (write, link resource to action) which promoted the older tools, also leads to both IS and computer applications. The social character of requirements in the computerized IS, later made explicit in the work with and use of the artefacts, becomes squeezed into a form where *division of labour* is a first-hand priority instead of *cooperation* by those trying to master dynamic event flows. The new technology even implies new expert competence and a new division of labour in order to handle the complexity; the organization becomes what Giddens (1991) called a modern organization.

The aggregated complexity when several individually very simple technologies were combined and used in a dynamic social environment came as a surprise. The reservist Person R expressed it this way:

> And then one can [...] the Actualities' Table as a kind of defence in this, or? FENIX probably is good but we don't understand all, you see, now let us do something simple that solves our problems. (Person R)

What we hear is that the simple tool can be combined with the requirements growing from the command work. Being a self-help application, it allowed people to do *something* on their own, not being dependent on a far more sophisticated product. When one informant (Person V) explained how "save and store" was better in the tables than in the ordinary file and directory structure he realized that easy access to IS resources from the work mode is essential. "Retrieve" must be a simple procedure. What he said was this: The artefact that is part of the work, like the table, is preferable because the operators do not have to shift from "command work mode" to an "IS-work mode" where they easily get lost. To be able to stay in work mode all the time is what promotes efficiency.

There is another aspect of the use of tables and numbers. When people in the chain of command search for and create easily recognizable figures and try to make them still more informative, they act according to old principles and methods for accounting. It is easily explainable that figures still attract interest because they have considerable power (well known within accounting), are easy to use, store, and communicate. Figures are "rational" but are basically abstractions, symbolizing social relationships. Langefors (1993) describes the concept of *heurithm*: When a process cannot be described in an algorithm but there is an input and output (possibly in the form of figures), a system is an open system. A cooperative model of operations arises, involving people who can make sense of the in-/outputs. Their meaning is clear as long as they can be accompanied by personal interaction, can be updated continuously; as long as they are used within a closed group of people, the creators and the users of them, who can interpret these numbers (symbols).

At the same time, however, these figures fulfil the requirements for automated processing and simple transmission. They can, unfortunately, easily be separated from and used outside the social context where they were created. Then, interpretation may become complicated, possibly distorted. It can be done at great distances and by others, but because an aggregated and rationalized value hardly suffices to capture the precise details in a multifaceted social reality, some aspects then may be lost. The figures also get another meaning: as something that is *precise, credible, has precision,* yet may *lack content and richness.* People tend to keep on trying to make them still more precise, yet at the same time rationalizing and organizing the social world and actions in still more details. So we see that the fight along well tested rational paths to use the capacity of the technology, to get wisdom and ability to better predict what will happen, will have some consequences which risk overthrowing the result. It becomes easy to automate monitoring and control, to get an overview on the map. It will lead to many but less accurate (exactly inaccurate) consequences, perhaps outdated and having a low social value, needing to be controlled again and again. Precise figures need continuous updating which requires much work.

When we hear how people designed and used the Actualities' Table, part of their own command work, they could probably recognize the social real world they lived in behind the numbers even if they were meagre. An IS with carefully designed images or symbols, updated at a distance, may express much but be hard to interpret, perhaps lack contextual awareness all the time. What looks like an unproblematic corresponding image instead becomes another kind of metaphor that requires careful interpretation, not by individuals in isolation but as a cooperative effort. A comparison with the VSM and its five subsystems (Beer, 1981; Chapter 1) says that the Table helped integrate these systems, especially the Policy, Intelligence, and the Control subsystems.

10.4 Evaluations of the Actualities' Table

10.4.1 EXTRACTS FROM THE ON-SITE EVALUATION

I made an attempt to evaluate the table during the last evening of the final CPX as an electronically distributed questionnaire. The reason was to capture, on location, something from the seemingly fruitful development and use of this table. The attempt to use the LAN was a way to save time and to test this kind of survey now that the technical means existed. Very few answers were returned after the initial difficulties to distribute it had been overcome (network overload and then transformation of the attached questions to plain text in a message). Contributing to the low answer frequency was that this was the last evening and that many other competing activities occurred. Several persons were not in the HQ but rested. This effort demonstrated (1) the difficulties to use the network for such tasks, and (2) that, even if the answers to my questions were few, the Table had been used and appreciated.

<u>From the BMC</u> (where one of its designers answered):

The idea to electronically "update" the Actualities' Table origins from the early April CPX, the table then being accessible for all to look at the current situation. Then to link subordinated sections' tables was a natural consequence because the network would facilitate an easy search process. Within the BMC it was used to continuously and was a simple way of monitoring and recording the situations within subordinated units, what units there were, when units were taken over and left according to superior command. The data were taken from operations orders. The table had been used very often, for instance as a support when shifts rotated.

Even if the idea with links and updating from the BMC and outwards was not fully implemented what was done was considered to be a step in the right direction. Some functionality could not be completed, for instance the overview of the order production and editing process.

<u>Logistics</u> said that the table was used very often, with a very favourable ratio work/output, especially that everything was on one sheet. Another Logistics reply was that they had used their three table sheets continuously. In summary: good. A third answer was that not everyone in the HQ updated their tables but it was advantageous that anyone can make updates, that sections can add more by themselves.

Army Aviation had used it at the rotation of shifts, sometimes more often after updating. The table gave a good overview, especially valuable that updating could be performed from separate documents because otherwise the accessibility would have been too constrained.

Fire support (artillery and related systems) had used it for updating between different locations within the total HQ (as told by Person S), the table was used in the same manner as before the computerization, a positive and easily applied principle. As compared to the FENIX IS, the table meant considerably less work for the updating, was more easily accessible and efficient for the exchange of information within the HQ. An aspiration was that in future versions the information in the table should be created automatically.

10.4.2 AFTER ACTION EVALUATIONS OF THE ACTUALITIES' TABLE

A few weeks after the last CPX, staff evaluated work procedures, the central (interim) IS, the organization and its infrastructure for communication and support. This evaluation took the form of a structured questionnaire that was distributed from the central army authorities, designed as to "cover" the centrally provided technical systems and the methodology how to use it. It was intended to provide input for the next phase of design and development within the central army project.

In their evaluation report[5], primarily its appendices, the Actualities' Table was positively mentioned and supported by some. The table is mentioned in varying degrees in 7 of 10 appendices including once in the summary appendix. This phrase from the Operations' appendix was repeated in the summary:

> During the exercise an Actualities' Table was developed which gave an overview of how units could be reached with orders (Sw. *"orderläge"*, 'order situation'), when they were subordinated to the division, current operations order, etc. The table can become a valuable instrument which gives a rapid overview of the 'order situation'. It should, however, be integrated into the FENIX system and not remain an own *document*.[emphasis added] (Evaluation report App. 1, p. 18, no special heading)

An overview of other appendices:

Anti Air Defence most positive, but this was not evident in the summary, three sentences; Operations twice. Positive, two sentences; Intelligence, just mentioned twice; C2 systems - once, positive; Logistics – mentioned briefly once, neutrally advocating but not enthusiastic; Central expedition once: the expedition used and

5. Evaluation document 13. division, June 16, 1998, 19 630: 30 285

updated the table about the progress of order editing and distribution. The table should be developed, possible to update continuously and automatically, able to be used by several users in parallel.

The little attention is surprising given that the table had emerged and evolved over at least three CPXs, and that end users had found that it not only complemented but extended the central IS resources. The reasons why the table was appreciated might be (from the evaluation document):

> Present command support (especially ISs) has unsatisfactory capacity. The raw data in today's IS located in too many places, updating and reporting/orienting/informing routines too time-consuming. (ibid., App. 1, p. 2)
>
> …the development has just started, we make progress and have got experiences and references. Present FENIX too time-consuming, slow, lack sufficient precision, does not provide overview. Other larger method constraints are the Battle Capacity Report and the Export/Import function. (ibid., App. 1, p. 15)
>
> The problem with the current IS is that the information is fragmented and difficult to get presented in an adapted and processed form. Now much time is spent searching for the 'right' information, both within and outside the HQ. (ibid., Artillery, App. 3, p. 5)
>
> As regards the monitoring of the order situation it was done for instance by Central. The outcome was made available for other persons in the BMC through continuous updating of the Actualities' Table (especially when an operations order was distributed until all had received and confirmed that the order was received). (ibid., Central exp., App. 10, p. 2)

Further, under heading Actualities' Table:

> The version which was used during the final CPX should be further developed in order to reach readability, updating, etc. faster and that it becomes more user friendly with more people simultaneously with continuous automatic updating. (ibid., p. 4)

Operations has a similar opinion concerning the slow interim IS which led people to use traditional methods such as telephone (chat on the situation) and use of plastic template on maps. They recommended some kind of *web-interface* which would admit rapid access and direct links to stored information (data). They assumed that a first step could be the developed table.

Air Operations is direct: The only functioning database was the updated Actualities' Tables. The most frequent method for transmission of information was to send it via email to receiver. *Intelligence* had a similar view on transmission and search: to call the person who had produced the information and ask.

Among the three most important further developments of the interim IS stated by Air Defence, the first a dedicated application for air defence fire zones and helicopter flight corridors; to develop the table for a multi-user environment ranked second; the third was an undo-button (!).

In the same evaluation the interim command support IS was considered to have too limited a capacity: basic data in too many places, introduction of new data and the report procedures were too time-consuming. In order to reach an optimal coordination between different parts of the HQ, these parts must be updated concerning the CO's intent, actual situation, and successive decisions (better integrated VSM subsystems). The given HQ structure presupposed a much more powerful IS (not specified). Updating often had to be done via a telephone call because different databases existed in the HQ segments: regrettably not one database in the HQ.

10.4.3 CONTINUED DEVELOPMENT

Two follow-up interviews helped explain what had happened. Person V who had been working with the central IS design and management, said that the staff had first simply forgotten the application. When they finally (early autumn 1998) discovered its potential and tried to get it back into the larger IS project, they met resistance.

> What was strange with the Actualities' Table was that we had it during the exercise, but the day after, the table died. It was a good aid you see but there was no interest from any direction to grab it and continue to develop it…and still it was what was used the most during the CPX.
>
> Q: Why did it die?
>
> …many who did not understand its importance…it really has been hard work to get it back into the project, it has been No from the beginning, we tried…AM [initials] tried to push it back in again but the answer was No. He [a third officer] has no understanding of it, its importance. Now it has re-entered…now it has been included because of the aspect to save information, to use as an interface in order to be able to save and manage information. It is from those aspects we have got it back in the process--This is a need you can't see concretely until you are faced by the task and have to solve it. (Person V)

During the autumn of 1998 a meeting was arranged between the people from the HQ, the Defence Material Administration representatives and the consultants who had done the FENIX design and development:

> ...we sat and talked there about various kinds of problems and then we realized that the problem should be a non-problem if we had a functioning Actualities' Table and it was related to issues such a data transport and rights and information exchange and similar topics. So, instead of sending over email it could as well be stored in a Table and then we started to realize too that this Actualities' Table had not at all been received and accepted by the FENIX or the ATLE project. Not one of the consultants had heard of it and then

> was launched…we had a few more meetings where our beliefs were strengthened concerning the qualities of the Actualities' Table and that it was important and then we started lobbying in order to have it accepted and taken care of. (Person R)

A tactic when the idea of the table was again launched, confirmed by another informant, was to give the application a new definition – one more "interesting" than the "simple", descriptive one it had inherited: it was to be (part of) the new "intranet web-interface". Such a project had been thought of centrally, but not yet worked with during the 1997–1998 development cycle. Now, something could be used as a starter.

According to the two interviewees, under this name, the table entered the hub of the continued project, now designed to support convenient, rapid access of information stored on the HQ servers. Information was previously accessible only through the central (substitute) IS with its standard set of finding tools and file directories. With this new interface and an intranet, these tools may even no longer be necessary to access the central IS resources.

Together, the new interface and an intranet would allow direct and easy access to servers and databases, allowing users to bypass the central IS standard MS Windows interface. This interface had been an obstacle for many during the 1998 exercises, because it presupposed use of pre-defined procedures. In addition, after a few days the amount of data made information management via the standard interface (Windows Explorer) a heavy task and slowed down certain procedures within the command work. This last step during 1998 illustrates Bucciarelli's (1988) theories (see Chapter 3). After the constraint (resistance, not primarily a physical constraint) had been framed, the next step was re-naming, reducing the constraint, and then the design could continue (deciding).

10.4.4 CONCLUSIONS FROM THE EVALUATIONS

The accounts give several examples of common-sense thinking about what command work is, what requirements for support there are, and what a computer application is and how it should be designed: automation, databases, less work to do. The notion of the networked MIS as the dominant IS architecture colours the way "problems" are defined and how later " "solutions" are designed. Also, the common-sense division of labour (and thinking) within the army is illustrated when continued development was discussed.

On other occasions the simple spreadsheet tools appeared both in the advanced BERRA and elsewhere. They were easy to re-design. One situation was when, after a morning staff briefing (the managers, section leaders) some of the participants gathered outdoors to discuss the design of a BERRA Long-Term Forecast spreadsheet. The specific topic was the Battle Capacity. Situated choice and interpretation of influences from contextual factors were necessary in order to better interpret the values in the spreadsheet, for instance enemy air situation which had a decisive influence on own movements. The request was to have it added on the spreadsheet, which was done within half an hour by the ChLog who appeared with a new design (and handed me a copy).

Finally but not the least important, the actors used concepts as tools in order to define their issues in a way that paved way to acceptance from the rational superordinated social system. This last phase also demonstrates, with the words of Berger and Luckman (1966), the socialization of the local initiative and how it became legitimate part of the larger universe of practice, having been developed within an autonomous sub-universe.

10.5 Structural Analysis of the New Actualities' Table and its Evolution

The contradictions between the command work and its standard artefacts are more obvious in this case than the first one. In the same way as the analysis of the meeting, I will use Activity Theory (basic scheme shown in Figure 10.7) to structure the first analysis.The purpose is to achieve a picture of the factors and forces surrounding the table, and to see the causal chains leading to the actions.

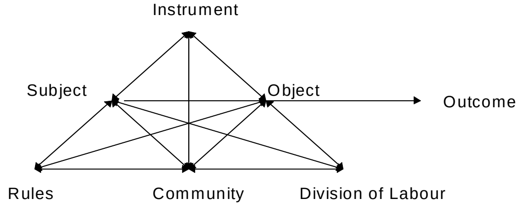

Figure 10.7: Basic Activity Theory Structure.

Object

I conclude that the primary object is the command work, as perceived by individual actors and teams, organized according to an idea of division of labour. However, the purpose of the work is to sustain the subordinated units' fighting capacity and direct them in order to achieve goals. Work has constantly to be directed and coordinated into a stable mechanism. This is done with the help of another object, technologies, which in a similar manner are applied, reshaped, and used in a multitude of ways. There are several such objects involved in the case: the FENIX IS, the Actualities' Table, standard software, the communication system and other parts of the infrastructure. Instead of being static (an object-perspective) "command work" evolves dynamically, in order to be efficient. Within Artillery, late in April, according to conversations during the next to last CPX, most efforts were still aimed at finding efficient working methods.

The FENIX IS was an *intervening object* which presumably was perceived as something separate from the work. Also the communication system was an intervening object because via it, staff easily could send standard files. These had to be compressed but sometimes were not (which caused communication bottlenecks), or could not easily be compressed (MS PowerPoint slides were drawn because of the threshold to use the rough drawing tool in the FENIX IS, mentioned in the June 1998 evaluation report). Some continued to use MS PowerPoint because this was familiar to them, in spite of the risk of effectively choking the network.

The IS structure remained an obstacle for many. Some worked exclusively trying to make it usable. Before the late April CPX, software in every computer was changed to a new version which took five days of work for the team which was detached for it (source: conversations with staff), but later fixes were necessary. After such changes, hard work was required to re-establish working routines.

Many were used to the traditional Actualities' Table. It promised to be transformable into a new shape with new qualities. Because of the chosen software, little coordination was required once the responsibility for the "gate table" was defined. Many could refine the standard design by using previous experience. People tried to develop MSExcel into a new multi-user application, with some, but limited success that did not prevent the use of it during the work, and that it became appreciated.

Outcome

The accounts tell about how people felt out of control of their own environment when confronted by and trying to learn how to use the interim IS. The desired outcome was an efficient way to do the tasks within command work. Actors wanted a tool which allowed satisfactory control over their own work, a tool which was easily updated, distributed, transparent, and contributed to an updated representation of the tactical situation. It is likely that the total outcome, both the efforts to use the new technologies, and the invention of the new table, were considerable contributions to the army's ability to solve difficult missions.

A central command work goal, what kind of IS capacity and functionality should be developed, was difficult if not impossible to define in advance. A statement by one informant ("This is a need you can't see concretely until you are faced by the task and have to solve it", Person V) expresses the inability to imagine what command work is in a new environment, even by an experienced officer. Instead, a particular set of common-sense beliefs governed the FENIX design and use. This belief set meant that "work" was seen as an object rather than a social and dynamic activity system, and that it is possible to define in advance to a fine granularity. The MSOffice software in particular supported the perception of the work as office-work, and led to an infrastructure where much could be seen as overkill. Certain components became constraints that had to be overcome. The beliefs, as expressed by the informants, were that some work was merely produced in and by this infrastructure, almost automatically. The most obvious consequence was that a new kind of command work evolved, which was a demanding IS work aimed at the management to satisfy the requirements from the system: data. This work required a lot of effort before command work could be done.

Subject

Many individual experts/operators contributed. There was a large span of competence between the persons who were involved, from computer technicians to some without specific computer experience. Because there are several objects involved, more than one subject acted. The accounts tell about soldiers, reservists/consultants, and officers who saw new possibilities but did not realize the complications that accompanied the obvious simple solutions. Others acted vigourously in order to find methods that provided satisfactory freedom of action. There are mainly three reasons why so many could contribute: people could apply previous experience and tools, the software was well known, and the management encouraged autonomous and problem-solving innovations, which then led to creativity. However, as we have seen, had the table got another name, either its design could have been done properly by more actors, or it might have been totally different.

Instrument

It is necessary to include the whole workspace among instruments. It either facilitated work, or provoked actions so as to overcome limitations such as distances or narrow vehicles (bad visibility), whereupon staff creatively organized temporary

Figure 10.8: BMC team leader, late April 1998.

open indoor workspaces. The constraints originating from the standard vehicle workspaces (See Figure 10.8) were criticized in the after-action evaluations (June 1998 answers to validation questions). At the same time it is remarkable how these vehicles, within their limitations, could be redesigned according to new technologies over some decades. The accounts and my photos tell about how standard IT artefacts were used for narrow vehicles, allowing some but little flexibility once they were installed. The large container test workspace (in HQ A, November 1997) meant new needs for control of attention and work in it. In addition the team there was dependent on an instrument which could solve the requirements for central control and coordination of the information resources in order to fulfil its coordination role within the whole HQ.

Preceding the development of the Actualities' Table (and among the causes behind it) were technologies for communication and rational control, used according to the standard procedures and practices. The contradictions between the rational reporting system and the efforts to actually use it and get output in time, probably stimulated the development of the table which became a less formal artefact but one that was appreciated in the work. The accounts and the evaluation tell about the links between actors that it offered and promoted, similar to the use of the flight progress paper strip (Hughes et al. 1992).

The most frequently used and important instruments, the mediating artefacts, were social rather than physical: language, procedures, supplemented by spreadsheets, rules, accounts of previous experiences. Printouts of documents were common, as Figure 10.9 illustrates.

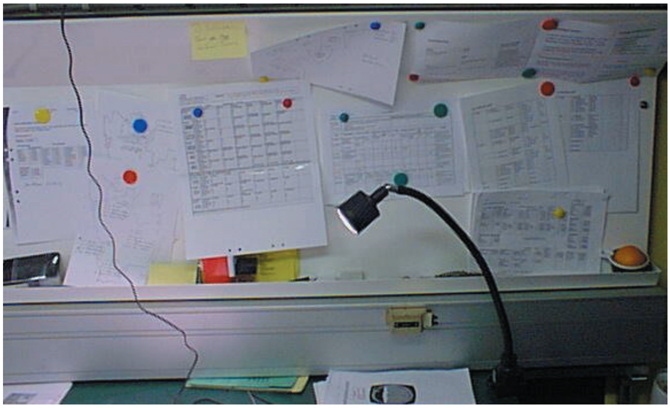

Figure 10.9: Printouts were taped onto walls in vehicles, April 1998.

Because of the resulting constraints and the sectioned organization, the actors in the HQ met in- and outside their 'cubicles'. They created tools for negotiation and sensemaking, or used tools in various ways: redesigned printouts, taped them onto walls for augmented visibility, faxed them. They drew models on the ground, put maps on the floor and so on. In order to keep up with demands, the army vision's "walkstations" certainly had been motivated. As substitutes, most among staff carried and guarded their own notebooks and some had mobile telephones, mixing high- and low-tech.

Rules

Most rules that were applied rested upon the military bureaucratic foundation. It stated that the central army authorities had the money and defined the content within the IS project framework. The failure of the bureaucracy to "deliver" a product was then turned into an "interim system", where, following the dominant common sense logic, command work was designed as office work aimed at a stable control process. Once the chain of exercises started, security reasons, for instance, generated many rules to obey and interpret to the best. They were first defined aside from work. Modern IT multiplies the risks and promotes rapid distribution of order as well as chaos.

The contracting of consultants was done according to the traditional centralized control with a certain division of power and roles along the chain of command, but did not prevent the table initiative. This initiative did not cost anything and thus was not discovered by the central authorities until it was brought up (autumn 1998), whereupon it was instinctively turned down (interviews). Another set of rules was present in the army, too. In short, anything that led to results was allowed. To design this set, much communication was needed. It is likely that what did not become visible (The Actualities' Table), did not bother those who were guardians of rules.

Community

Many belonged to more than one community, moved between them. Some had conflicing roles. Either they were precious experts in the command teams and had to do their job there, or had positions within the contextual bureaucratic structure. The bureaucracy worked for continued stability and order. It looked at the total and not the sub-optimized local efforts. The army and the HQ B interests were to make the final exercise a success. Actors had to use what the bureaucracy provided, constantly trying to achieve sufficient autonomy: money, authority, technology.

The various groups thus had a shared interest, which possibly facilitated the work. There were at least four groups of people involved in the activities. One was the army authorities and the command hierarchy, on the outskirts of which we can see superior command and at the lower end the most important individual in the organization that was studied, the division CO. Another group consisted of representatives from the computer and consulting industry, and the small systems development group (FENIX) reflecting the larger IS community. A third were staff with subgroups for IS and Actualities' Table development. A possible fourth group were those who used the artefacts. Possibly the incentive to make profit was stimulating the IS industry, but little of this was seen in the data.

These groups were each involved in parallel work because of the need for rapid solutions and the very constrained time schedule for delivery of the products contributing to the distributed work was the impossibility of controlling it all. Instead, the division of labour (see below) which was a "natural" consequence of the perspective on work and IS, had to rest upon trust between key actors. This does not mean that conflicts were masked or neglected, only that the commitment was strong enough to promote flexible cooperation within the tactical HQs, and to find prestige-free solutions to emergent difficulties.

Division of labour

Division of labour is necessary in the complex and specialized organization. The principles emanating from the superordinated bureaucracy governed the internal structure in the HQ. Consultants were contracted in order to complete the FENIX system in accordance with the tradition within the army where few have systems engineering competence. Security regulations produced within another defence agency led to yet another turn in the spiral of division of labour and specialization.

The division of labour between staff and the supporting battalion caused some frustration. Workspaces were designed and equipped by the latter, including the IS and communication systems infrastructure, rather than by those who had to work there. The reason was that work was the last "component" to be added in the HQ.

We saw an initial strict internal division of labour as regards to the standard tasks in the HQ and the systems development. This was supplemented by another division which grew from below, could only partially be defined in advance and admitted flexibility, and led to some redundancy. The overt examples on a flexible division of labour that produced redundancy and involved learning were project organization in temporary tasks and conscious creation of crossfunctional teams.

The Actualities' Table was just one out of several innovations aimed at efficient work, some exploiting new technologies. Initially, there was some confusion about what was really under way ("macro-commands, templates", documents) which led to a less than desirable involvement in the new AT design process and a design with flaws. Once the idea of the Table had been spread and rooted, and confirmed by the COS the division of labour was temporarily abandoned. The "normal way" of doing the job and the pressure to get ready before the last CPX dominated required much work and provided HQ B considerable autonomy.

10.6 Conclusions: Communities of Practice and Common Sense

The Actualities' Table grew from within the command work as part of the work itself, in a similar way as the calculation systems that Avdic (1999) studied. The table was a tool for informing, where affordance (Anderson and Sharrock, 1993) seems to have been achieved. It shortened the distance between report and action, which the central IS did not. It was thus promoted by the system of contradictions between situated work requirements and what was officially assumed, reified in the interim IS and in the workspaces. As an artefact and control support mechanism evolving within the work, it became practically invisible, however supporting integration within the Viable Systems, and requisite variety. The table was used by individuals from its early first stages in a distributed and parallel development process, which was to a large extent a reaction against the FENIX IS which required a

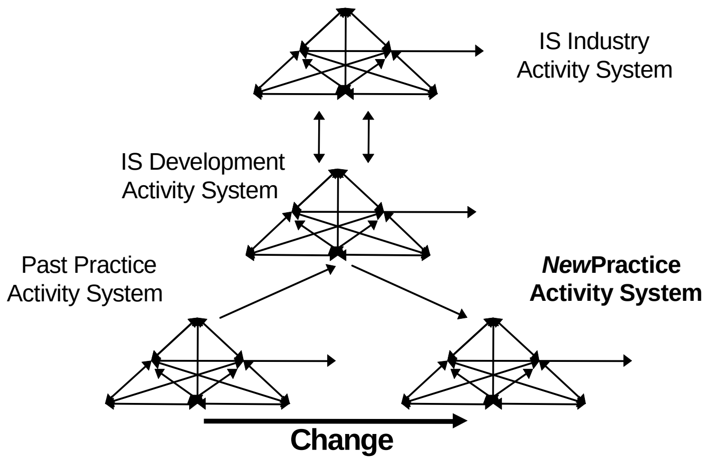

Figure 10.10: Information Systems Development and Change as Related Activity Systems.

lot of work in order to be usable. Some efforts, though not fully realized, were made at making the table a common resource and a team support asset. The basic design idea could not foresee the complications growing from the networked environment.

Again, Activity Theory can visualize the processes of systems and work development (Figure 10.10). During development of work and information systems, three or more activity systems interact. One is the system where the actual IS development is conducted, the meeting place between practitioners, systems developers, engineers, and possibly researchers. Another is the *past* activity system, practices which are about to be replaced by another tool set and constellation. A third is the *new organization* and its working processes.

Most important, a fourth *IS Industry Activity System* (upper schema) may influence what is done in the Development Activity System where representatives from practice (command workers) and consultants' firms (IS designers) met, supervised by the army authorities. Behind this approach is a traditional top-down change and control process, a recognized source of contradictions (Langefors, 1993). Consequently, as we saw, several contradictions evolved and some were avoided. What happened was that the on-location development of the new table was done within the lower systems, with little involvement if even insight from the others.

Three sets of 'common sense' were present. One was the perception of work as expressed by those who designed the table. Traditional artefacts were a safe way to continue in a complex environment. The other, what modern IT meant and could be—for example a database—was expressed by informants: just push a button and everything will be fine. The outcome is that what had been control-in-the-work might have become control-from-outside-the-work, from system-based rules, meaning less autonomy. The third is the FENIX structure, requiring much "IS work" in order to be operational before its output was satisfactory. The artillery officers in particular were troubled by the threshold to learn to use the new IS and to discover their own methods and routines.

The transformation and canalization of what was command work into the IS structure led to a kind of alienation from the traditional work (lower part of figure) where design and use of tables occurred. As my on-location evaluation indicated, much work was required in order to get output from the IS work in the interim system. The predefined and structured working methods did not meet the requirements from people who tried hard to work efficiently. Had the organization been permanent and/or the exercise continued for weeks or longer, the IS work probably had been reduced and easier to form. Now, the Actualities' Table became a smooth way to control the social world, where, in addition it admitted well-known practices. Figure 10.11 illustrates what became the actual work supported by a competing IS

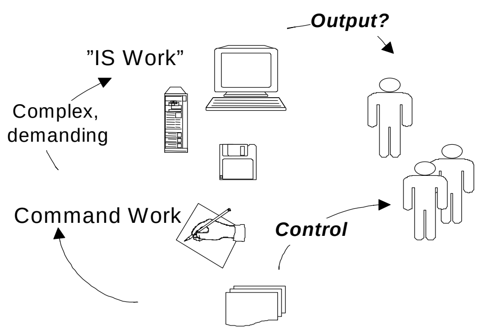

Figure 10.11: The two complementary and competing command work-related IS structures.

structure, built from other kinds of artefacts. On the other hand, it might be "normal" that organizations must be formed at short notice. The support systems ideally should be very easy to learn (as the original ATLE vision stated), or be well known, as those used in ordinary peace-time work (where we know that offices seldom move each day and have to be operational around the clock, and the environment is relatively stable).

The Actualities' Table combined with the communications system in reality became a new (and appreciated) IS, based upon other principles than the interim system. Its main components were the electronic messaging (email) system and the spreadsheets. A cluster of related “spreadsheet cousins” (including the BERRA system) grew together, now and then modified.

Probably the existence of the tables meant that actors did not have to learn about the whole potential in the FENIX IS and discover its capacity. Part of the necessary two-way transformation within the boundary management, where events are made intelligible and can be handled in an organized manner and ideas transformed into actions, could be done by other means. Possibly each technology and procedure that was invented was not technically efficient (fastest), but had greater social value: to be able to do something, and to combine various means and methods. The total work system shows similar problems as calculation systems: less than optimal solutions, unforeseen complexities, but shares their advantages. To use a phrase from Activity Theory, the zone of proximal development (Engeström, 1999) was where work satisfaction grew and meant moderate changes in the work instead of revolutionary ones.

There is a relation between the two cases. In the meeting actors got together, interpreted and invented (designed) what a real world object must be, how it should be labelled or redefined in order to be part of an orderly universe, institutionalized and manageable. Then actors engaged in coordinated action using their own artefacts, for example setting the Fighting or Battle Capacity (the 1 to 5 scale), capable of knowing its meaning in the continued work. The tables easily supported this transition from initiative to organized action, because they could be modified and re-interpreted as work went on. The work was done on and in the tables in a similar manner as Hughes et al. (1992) saw within ATC when the flight progress paper strips were used.

Concerning Activity Theory, it provided a schema that allowed a careful analysis but required iterations. Repeatedly social factors intervened in a far from machine-like manner. While helping to explore the new set of contradictions, Activity Theory had not the same shortcomings as when applied to the meeting analysis where a highly complex interpersonal action pattern evolved. However, it has to be emphasized that the social creation of what is “object” and “instrument” is present in this case, too, and what is “contradiction” (or “opportunity”) is socially defined.

PART V
Reflections

THE AIM OF THE FIELDWORK was to produce data for a rich description of what *command work* means and consists of, what technologies people use and with what result: a portrait of a cultural group. The data should allow a continued qualitative analysis, theory refinement and then formulation of principles for informed design of matching support technologies. This final part brings together the analysis and ends in conclusions from the whole study.

The division HQ studied was piloting the development of the new command concept during the study period, the implementation of several years' ongoing efforts to modernize the army. I have made portions of the knowledge-intensive command work visible and open for further investigation.

We looked at two cases: command work in a specific situation, a meeting, and the Actualities' Table, an artefact for resource overview and management that made data-insight-action converge. From both cases I have defined some issues for a higher-level analysis. In the final chapter I conclude the study and present proposals for continued research and the design of ISs (or rather computer artefacts) for support of command work.

Chapter 11
Closing the Field Work and the First Analysis

THE NEW HQ ORGANIZATION left its temporary character and successively formed its working routines during the spring of 1998, a thorough learning process about the workspace, people, and technologies. Learning was continuous throughout the exercises and included interaction between command levels, when staff managed the training of subordinate units. New knowledge, manifest in various actions and documents, was the foundation for continued work. During the exercises staff tried to overcome the frictions related to the new IS infrastructure, and created solutions to the new control requirements. Most actors seemed to be enthusiastic and especially during the last CPX enjoy this chance to demonstrate professionalism when watched by many.

The ethnography should lead to a holistic portrait of a *cultural group*, what its members *say, do* and *use* (Creswell, 1998). If *values* are included in culture (Hofstede et al., 1990), some inferences about them can be made. This chapter concludes the portrait and gives an analysis of central command work phenomena and concepts derived from what was said, done and used (Chapters 9 and 10).

11.1 The Cultural Group and a Story Line – A Portrait of the Division HQ

Because of the way the Swedish army is traditionally organized (a mobilization army and not a standing force), *convergence* as regards its relations to society as a whole (Caforio, 1998) has been the politically viable position, facilitating the integration of civilian experts (some being reservists) in its command structure. The compulsory service means that young people (both men and women) can be trained for positions where they use previous education and skills. This incorporated competence was beneficial for the whole group in the intense work during the series of exercises. In all, people knew each other well, were committed to their tasks, and also showed a generous attitude and openness toward my study. Emanating from the new CO, the general atmosphere was relaxed. I conclude that the internal power structure was well known and accepted.

A detailed total plan and schedule regulated the whole, from individuals' operations to principles for the movement of the HQ, and coordination with the communication infrastructure. The flexibility to adapt to new control directives, software versions, and try out new ways to do the job, was generally very high. The work involved experimentation with new ways to use IT and to find out how to design efficient working procedures and the organization. In some cases, there were minor conflicts or arguments over specific tasks, new routines and how to interpret the situation in the field. Actors were more flexible than the technical infrastructure, which confirmed the earlier study by Kahan et al. (1989), and demonstrated both loyalties to the given technologies and regulations, and an interest for innovations. Fighting capacity, survival, and protection guided the command thinking and use of technology, as was sustained autonomy and control capacity.

I conclude, based upon the demonstrated cooperative efforts to solve very complex IS-related issues that the motivation was high and that the commitment was stimulated by the autonomy the whole organization got when it was leading the formation of the new command organization. The dominant culture is one of power and autonomy, where control is a means, not an end. This culture "unfortunately" is accompanied by an objectively rational control culture, where control is an end rather than means.

Åselius (1999) discussed military culture and thinking when he described the changing conditions for the Swedish military during the Cold War period. The modern state-bureaucratic management culture, inspired from the McNamara period in the U.S., was introduced in Sweden 1970, driving the development of the new dominant control mechanisms and technologies. Officers then had to become domesticated administrators in a new kind of management bureaucracy, a process similar to the one when the nation-state evolved during the seventeenth century.

The surviving traditional warrior successively became archaic in this modern society. I could see how several traditions, part of the warriors' culture and inherited through the ages, converged during the exercises. Memories from the seventeenth and eighteenth centuries when Sweden was a regional superpower were present in the HQ's old Holy Communion vessels, because the HQ carried the traditions of an old army regiment. Cavalry traditions were probably (ibid.) together with the Swedish armour tradition embodied in HQ B, for many years being the only division HQ equipped with armoured command vehicles providing protection and mobility. Therefore, when this HQ got the chance to lead the modernization of the army command organization, it is understandable that the enthusiasm was great. Earlier (Chapter 4) I presented a story line (Strauss and Corbin, 1990) about the warrior "tribe" in the Bosnia operation. Here is the story line about the second tribe:

> *The tribe found itself in a cumbersome situation when appointed lead tribe in the army change process that had continued for a few years. The Army Elderly and the Supreme Council wanted to demonstrate professionalism and gain trust and respect in the international warriors' community and first promoted intense engineering and design work in order to produce state of the art command technologies. Soon it became evident that their efforts could not lead to any decisive result in time for a large gathering of several tribes for a contest. Our tribe then had to engage in an urgent process of design and development of new control artefacts. They found that the technologies chosen by the Elderly, even if they were accepted as "best practice", were no remedies. The tribe had to engage in a period of intense learning during practical exercises when they enjoyed freedom from the ordinary work, and could call upon its own experts in order to overcome difficulties. The warriors experienced the conflicts between old and new cultures but could successfully exploit very old rational forms for working procedures. These traditional pragmatic techniques were merely integrated with the modern engineering culture inherent in the new control technologies. Faced by the complexity some initiated a partly invisible evolutionary development process that later was threatened by interruption because it was not in line with the intentions of the Elderly. They experienced some problems in trying to get the attention they wanted from the Elderly when they expressed their needs, and sometimes felt as if they were positioned in a remote location. Eventually the tribe succeeded in overcoming resistance and was allowed to continue its struggle for autonomy within its domain, having demonstrated competence.*

11.2 In Retrospect, What is Command Work?

11.2.1 WORK – DESIGN OF SYMBOLS

We are now focusing on the centre of the conditional matrix (Strauss and Corbin, 1990), where interactions and action occur. In the modern knowledge-intensive organizations much work is invisible, difficult to observe and understand. Its complexity and character makes direct control difficult. This fluent work has to be detected and made visible by “informating techniques”. The ethnography informated the work and showed some of what happened, allowing analysis and interpretations.

A strong commander-centred perspective dominates modelling and descriptions of command work and easily masks other perspectives on what the work is. Unless a widened perspective on command work is introduced, much will remain inexplicable and surprising, and local expertise will easily be counted for less, reducing autonomy. Little autonomy means that few spontaneous responses can be initiated, but too much may throw the organization into pieces.

The two cases demonstrated different aspects of *design as social process*, the invention of mechanisms for bridging of the contradictions between qualitative and quantitative aspects of the social world of details and of matching control actions which provide variety. Both cases showed also how people could achieve much of what they wanted and how the common interests to do a good job paved the way for innovations. Consequently, neither case (or deign) was the fruit of conscious control. Rather they demonstrated the *dialectic of control*, the double-sided power relationship within which “subordinates can and do exercise power in social interactions to influence the activities of their superiors” (Nandan, 1997). Nandan stated that the dialectical nature of power relations in organizations is an important element to study within management control. Unfortunately “the importance of this ‘critical’ theme to a large extent remains unexplored in rational-functional theories of organisation and control” (printout, p. 6).

Knowledge-intensive work presupposes high levels of autonomy and self-management. The components (‘capital’) in the work are *symbolic* (being intellectual, relational, and artefactual) which means that they are highly mobile, and have to be constantly reproduced (Deetz, 1998). The belief in and attempts to use IT comes from its capacity to produce symbols that signify substance and knowledge. Because the command work studied occurred in peacetime, its symbolic character was still stronger but its output nevertheless had to be substantial. Its products were

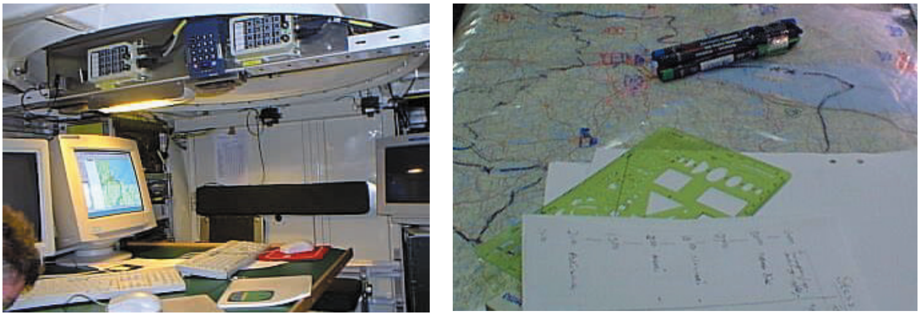

Figure 11.1: Symbols signifying substance and knowledge, in computer artefact and on traditional situation map.

mostly symbols, expressing knowledge, and had to be visible and credible for all involved. Figure 11.1 shows symbols on a computer screen and tools for production of symbols for the traditional map. I conclude that one driving force behind the intense personal interaction in command work is that only when acting and interacting are people acknowledged, only then can the work be visible and credible. Berger and Luckman (1966) gave another explanation. When in a crisis the members of a social group must intensify sozialization and integrative efforts in order to create an orderly sub-reality, using language to name the world, actually this is what boundary management is about. It is easy to see that the more troubles with supporting technologies and difficulties for humans to stay visible, the more personal interaction will occur, further reducing the possible advantages with the system, a vicious circle.

In knowledge-intensive work, shared values and strong culture provide control and coordination rather than strict control (Deetz, 1998). I conclude that it is necessary to recognize the variety of the social world that has to be acted upon and the dialectics of control, not to let an IS development process be dominated by a top-down control interest, method-driven and growing from less adequate models for organization and work.

I conclude that command work, through its character and purpose, is pragmatically evolving design work both stimulated by contradictions and checked by them. Moreover, it is knowledge-intensive, partly invisible and highly symbolic. It produces symbols and reproduces itself as a symbol for the army as well. To be credible, it has to be real and needs powerful tools.

11.2.2 INTERRELATED SOCIAL FACTORS AT WORK

The large system of contradictions (Chapter 2) affected what happened in the work. The common dichotomy between a system as required or desired by a client and what the designer and the industry envision and want to make available in the market (Langefors, 1993) was replaced by another dichotomy. This was the one between what central authorities required as regards their control efficiency (the use of resources and of actions at lower levels) and what symbolizes their control capacity, and what staff involved in the command work desire. The trade off is hard to strike between "powerful" technologies, and what can be used on a very basic level where people want to stay in control over their own work. The military culture of autonomy encourages initiatives in order to gain control over the enemy and the environment.

The outcome of the CPX suite was beneficial in various ways. Some technologies, for instance the communication systems, have to be tested thoroughly because only in practice can their limitations be discovered. People need to demonstrate professionalism and build trust that facilitates further independence. Given sufficient trust, all involved could profit by it and engage in efficient control actions, some being subtle and perhaps even invisible outside the dominant culture.

Clearly, issues of *autonomy* and *power* are central in command work, achieved with the help of *technology.* We have seen, too, that technologies caused troubles but at the same time were dire resources for battle capacity, communication and survival, given *knowledge* about how to use them. Figure 11.2 illustrates the relationships between categories at play in the social world, both constituting and

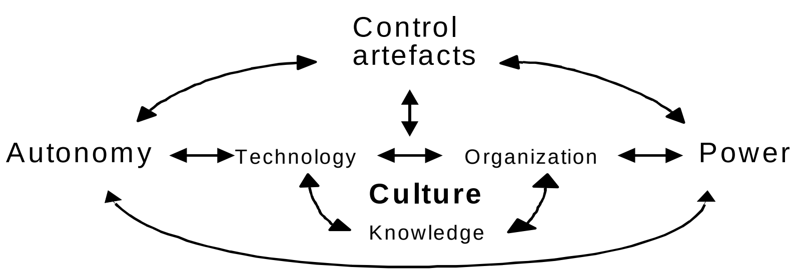

Figure 11.2: Interrelationships between social world categories .

forming the culture, what people do, say and use, while implying certain values:

The "core" of artefacts, organization and technology, underpinned by knowledge, supports control capacity which is the product of interrelated constructs:

autonomy, power and control artefacts. Once recognized, power also defines organization and knowledge, directs technology, and influences culture. The model says that technology is a prerequisite for control and organization and is socially interpreted. In addition, technology may be the mould for culture: what is it *possible* to say and do within the total IS architecture (see Chapters 3 and 8, theory and actual context). Because knowledge has to be externalized when used socially, it is dependent on available technology for representations.

Design is possible given certain resources and works with the central components in order to achieve the desired "external" control capacity, power, and autonomy belonging to the design goals. Social interaction, the use of language and naming were present: severe human-related constraints and disorder became "Personnel problem". A necessary bricolage became the "interim system" which *could* be designed and delivered. It became possible to test it and to make adjustments closer to the command work. Once this system existed, another kind of work evolved in order to avoid the separation of the social context by the instrument (the interim system) designed as to represent it and to regain autonomy and power.

11.3 The Cases, from Autonomy Defects to Action

One of my points of departure for the study was how Huguet et al. (1996) identified the need for *autonomy*, and how autonomy defects in an organization lead to either decisions *on constraints* (too severe constraints) or decisions *under constraints* (acceptable defects). Because we are now turning to autonomy and its relation to action, it is inevitable to consider also the issue of *power*, related to *rationality*.

Holmström (1995) and Juustila (1995) have both discussed power in the design process. For Holmström, design means translation of rationalities and is dependent upon power to proceed. Juustila pointed out the need to analyse the relationships between organizational culture, power and IT, often mutually conflicting.

The events that I have used for the cases were related to issues of rationality and power. Any evaluation of command work "live" without realizing what the institutional framework brings (resources and rewards, sanctions and rules) will misinterpret or neglect the strong tendency of actors to be innovative and use other rationalities when things go awry. Both cases originated in an autonomy defect, and were means to overcome it by re-allocating power. They exemplified "repair work" when breakdowns threatened or had occurred in the work. I present the cases in a simplified mode in Figure 11.3.

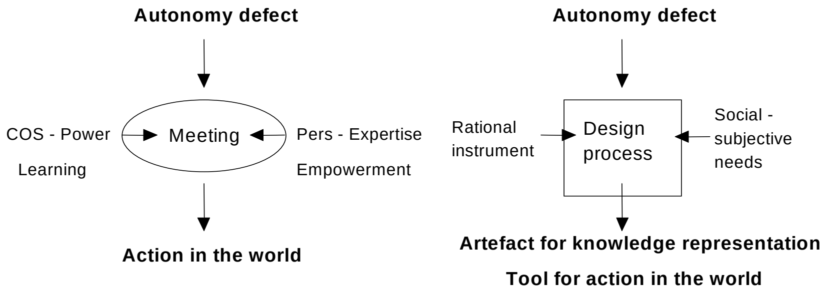

Figure 11.3: Overview of both cases, the meeting, and the Table.

The meeting used the organization's power structure as a lever for continued social action. The four actors interchangeably used the objective rationality of the bureaucracy and the social and the subjective rationalities. The outcome meant that they were integrated in a new reality. Following the perception of command work as design work, we realize that the meeting was a design process. During the course of the meeting, the actors (in theoretical terms) designed a solution that was acceptable and could be labelled and justified with the help of terms from the dominant "legal" rationality.

The design-in-work of a distributed structure of computer artefacts aimed at support of work processes and actions. It was the response to the evolving constraints from the interim IS architecture. Judged through social and subjective rationality, this MIS (FENIX) was partly a foreign technology which, given the level of personal skill, required much work for its own sake when instead the command work called for attention. In terms of knowledge-intensive and symbolic work (Deetz, 1998): too much work was required to produce the desired symbols and form them according to the needs.

The Actualities' Table allowed work with overtly rational symbols. Because it was designed by subgroups and could be used in smaller communities, it fulfilled the needs that came from social and subjective rationalities as well, gave actors more autonomy and admitted better control in the work. The Table offered opportunities to design an IS where knowledge was represented according to the actors' situation. The events indicate that the objective rational view of what is knowledge, equating it with *information as resource,* was unsatisfactory. Both cases confirm the statement by Ehn (1995) that in design work and in operations three kinds of rationality—objective, social and subjective—have to be united if a design will be successful and lead to any usable product.

In *cybernetic terms*, during the events preceding the meeting, augmented variety was first met by a richer informating and mediating mechanisms when staff visited field units (acting as *transducers*). Administrative routines and technologies then filtered part of the variety during the night. The control crisis, the external and the internal "cybernetic breakdowns", were resolved in the meeting. Variety was restored and a suitable formal solution designed.

The case of the Actualities Table is similar. The interim system did not keep up with the requirements for speed and adaptivity (variety) and was bypassed. The communication channels *attenuated* variety and additional activities were initiated. The use of email and the Actualities Table (spreadsheet technology) diminished the need to coordinate the systems centrally, admitting autonomy. The Table did not intervene between subsystems: the outcome was a maximum of viability and variety with a minimum of technology.

11.4 "Common Sense", Control, and Technology

Being an ethnographer and working sociologically, I have listened to the statement that the "object of sociology is to check up on common-sense beliefs" (Giddens, 1979, p. 249). Both cases demonstrated how new "control layers" (Beniger, 1986) were constantly invented in order to reach a satisfactory balance between contradictions and solutions to them, mostly in the form of new technologies. Giddens (ibid.) also stated that power is central, its utility being to transform the world:

> For the notion of human action logically implies that of power, understood as transformative capacity: 'action' only exists when an agent has the capability of intervening, or refraining from intervening, in a series of events so as to be able to influence their course. (p. 256)

There was much common sense involved in the thinking about control and the conception of technology. The notion of work, as presupposed in the technology, first was less adequate. The accounts and evaluations confirm the basic belief in the technologies, at the same time as it was evident that the accumulated complexity was difficult to master. Still, in spite of the standard components that were less compatible with the new telecommunications system, the interim IS was considered a considerable step forward (evaluation documents June 1998).

Having said this, the interim system still presupposed users' skill and competence above many practitioners' immediate capacity. The system was probably seen as an object in its own right rather than part of the work. Moreover work was hardly recognized by designers as knowledge-intensive symbolic design work that required a certain set of artefacts. Rather its components were substantial procedures based upon composite predefined standard products and a few tailored applications for certain tasks, for example production and editing of orders and a central repository for all messages and the decisions (actions) that they initiated. The added complexity from the actual symbolic command work simply meant that further simplifications were necessary to a level where more felt comfortable. At the same time they had to work still more with the procedures defined for the computer artefacts and then directing work.

The communication could be organized in totally new ways in spite of the use of compressed (zipped) files and the less user-friendly addressing functions and distribution lists in the email system. Seen separately, the communication systems promoted knowledge-intensive command work, but the communication itself became extremely complex to administer especially when the HQ moved and the infrastructure with servers and all recurrently was put on wheels to be restarted in new locations.

The design of the interim system was an emergency state and common sense dominated, headed by the standard IT options. Late did the developers/users realize the value of the Actualities' Table or see other solutions to what had been rapid responses to urgent requirements. For example, Person V strongly questioned the common sense about how information was *stored, saved* and *used* in the central interim system (catalogues, files) when instead store, save and use could be done in a spreadsheet. He had himself been one of the key persons involved in the design of the interim system but praised the Actualities' Table. Through it, use, save, and store became united in the work, as opposed to the given solution to the informing system in the interim system which separated and distributed these operations, augmenting the need for communication links.

When viewing command work as *design work*, technology and artefacts are made meaningful through the social context, in the same way as "information systems", "information", and "data", and shall support design, providing resources and solutions to control requirements. Technology must neither confuse nor conceal the knowledge that is represented in and mediated as symbols in messages. Moreover the informating, the mediating and the informing subsystems (Chapter 3) have to be designed according to their social roles and use, all being easily control-

Figure 11.4: Generators provided supply of electricity and autonomy.

led by those who rely on them. In command work, there must not be additional requirements for tedious retrieval or sensemaking work. When technically informed, additional knowledge must be obvious for those exposed to it. What count are building blocks expressing knowledge that can be interpreted, combined, and recombined into symbols that can be created and communicated at short notice.

An IS have to provide information "ready-at-hand" (Ehn, 1988) anytime because in real-world problem solving (the operational domain) sufficient information is not a finite entity, nor is there any finite time to reach solutions (Sage, 1987). It may be necessary to initiate action with no delay. Plans only indicate how to act under ideal conditions. The mutual dependence between knowledge and technology (mediating, for representations) is obvious. Instead of common sense, what is required is a well-grounded "epistemology of practice", including more than just an ideal and insufficient technical rationality (Miser and Quade, 1985).

Recurrently during the exercises (without enemy actions) the supply of electric power was threatened, usually with minor consequences. Figure 11.4 shows two of the larger mobile generators. In one situation shortfall of electricity (CPX early April) caused degradation of the FCP network. Due to technical problems in another situation during this exercise, two staff members in separate parts of the HQ could only communicate with the help of the telephone, when they had to make the logistics plan. During the conversation one of them used his small notebook making simplified overviews (Figure 11.5) of the tactical plan[1] according to the

1. I asked for and got the sketch during the next exercise, early May.

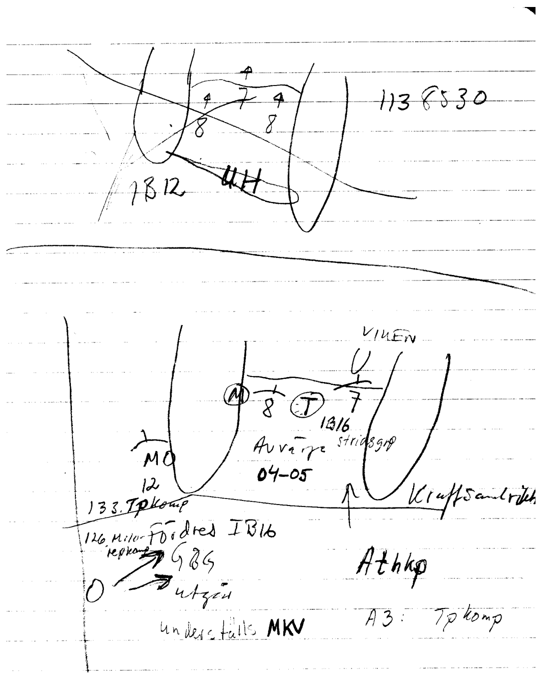

Figure 11.5: Sketch over tactical plan made during telephone conversation when other links did not function, approximately 2/3 scale.

sender's intentions, which illustrates that simple solutions can help. He said he could make sense of the communication thanks to his good knowledge of the actual terrain (the two curves are two lakes).

Some contradictions appear. Command work requires *simple, trustworthy* solutions, where recovery from breakdowns is a most basic capacity. The "common sense" about control technology for command purposes no doubt promotes efforts to develop large scale and *advanced solutions* (as in the ATLE vision). They have a considerable rhetorical power and symbolic value but can lead to "foreign" solutions, downplaying traditional knowledge and forgetting social values. The promised autonomy in reality becomes highly *conditioned*.

11.5 The Need for Bridges and Links, Social Boundary Objects

In the distributed command work and organization, gaps easily open, not only because of the division of labour (for example between Operations and Logistics).

When they threaten work, they have to be bridged. A *boundary object* is an object which is "both plastic enough to adapt to local needs and constraints of several parties employing them, yet robust enough to maintain a common identity across sites" (Star, 1989, p. 46). The meeting was a boundary object, although social, integrating people, authority, and knowledge. Commanders and liaison officers belong to another category of boundary objects, being able to move freely across boundaries between organizations. Grinter (1999) stated about designers/architects:

> They have evolved and standardized a set of practices that ensure that they get information and feedback essential for the design process. They have adopted technologies that allow them to share their work with all the interested parties readily. In addition to this, the organization has supported their collaborative activities by institutionalizing the role of architect. (p. 17)

Grinter's analysis is also applicable when it comes to *military commanders.* The meeting-case demonstrated how key persons, experts in their fields, were brought together and how a resolution was created between powerholders and experts (Figure 11.3). Not *any* persons had to meet, but *certain* individual experts. The meeting united three forms of rationality that hitherto had been separated by structure and technology and offered a chance to combine three interests: the technical control interest, the social (and practical) interest, and the subjective (aesthetic-expressive) interest, prerequisites in design for usability (Ehn, 1995).

Meetings belong to standard procedures but can be more about control of attention than the definition of something new. Such effects have occurred also during experiments with new command/control-room technologies at the National Defence College (Persson, 1998). When hierarchy becomes short-circuited things are opened up, power can be challenged and a transformation of rationalities enforced. Meetings then can become "fateful moments", problematic because individuals must launch themselves into something new, and decisions and actions have irreversible qualities (Giddens, 1991). The desired creativity and variety can end in enforced groupthinking.

The Actualities' Table served both as a communication medium and as a control artefact uniting different tasks in the work. Little effort was necessary to use it and it never had to travel outside its "community of practice" (or interpreters). Its data entered the rest of the HQ as well with regular and special reports but the table was an abstract, meagre representation of the world that could be dynamically updated directly in the work and then communicated. Considering the problems to correctly use the standard report template and the tedious work to aggregate reports, it is understandable that the table was appreciated, being a boundary object within and between functions.

Figures (i.e. numbers) are widely applicable symbols and easy to move around. Actors discussed, perhaps even wanted the table to be automatically updated via the central IS. However, as long as it remained in the small team where it was continuously created and used, it was likely that interpretation was simple, as compared to figures created or interpreted outside such a group, and then received in it. Also the advanced BERRA system had these properties. Related simpler tables (the Long-Term Forecast) among the self-designed tools contained both "fuzzy" figures and figures expressing qualitative and aggregated values on, for example, battle capacity. It is, however, inadequate to try to work with qualitative data, expressed in numeric symbols and well understood locally, and then distribute them or let algorithms "work with" them *as if they were quantitative data*. Even if more decimals may add credibility it is how people in the local team interpret them that is relevant. So, what seems to be blunt and lack precision and value, instead is what serves the local work because people communicate over the figures and know what they mean, avoiding abuse of them which is closer if they are used out of context.

Lastly, if local groups create self-help systems in order to get the boundary objects they need, these may become invisible mechanisms in the total work. Because they are out of the control of external agents, they may even become interpreted as anarchy, to be countered by legal actions. The paradox is that the Actualities' Table did not attract attention because it was not perceived as a computer artefact. It stayed out of sight from the dominating reality and rationality. If it had been discovered, it might well have become something else.

11.6 Information Systems Design Issues

11.6.1 Communication and Autonomy

Staff were distributed over the command organization and moved between work-spaces with the help of different technologies and attributes. Many individuals were experts, had to communicate widely, and were dependent on easy access and functionality of their communication systems. One aspect of the design and *use of artefacts* thus is that it must be possible to carry forward work between different persons and locations. The "enhanced" spreadsheet Actualities' Table (compared to its predecessor) admitted autonomy and variety when used, but for obvious reasons required that its users were well informed and knew how to interpret it.

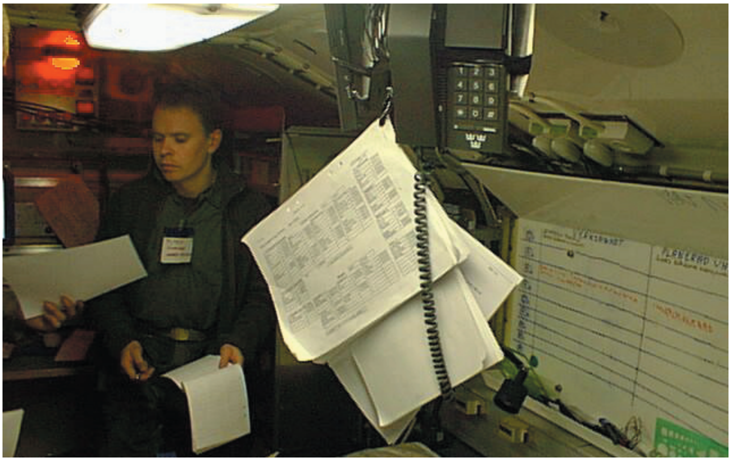

Figure 11.6: Early April, telephone list hanging in the middle of the workspace in a staff vehicle.

The design of communication technologies is strongly related to the military belief in uniformity and large integrated solutions, security being a central concern. From this situation distrust easily grows among social groups toward rules and formal authority. The uncertainty in dynamic knowledge-intensive work, whether beliefs and knowledge are valid, promotes more communication and meetings, which take time and may eventually also undercut the ability to remain viable.

The army vision prescribed that all information should be stored in a digital format but in the partly temporary platform various communication systems were used, often in combination. Transformation to digital format meant additional work. The PC as the common interface united several channels (email, fax, emulated other computer artefacts or media) but to type down telephone communication for central storage was difficult when the traffic was intense. The access to telephone books and email address lists were crucial for the work (Figure 11.6). The formats of standard email address lists caused some troubles. During an evening meeting near the end of the last CPX a group of officers complained about the difficulty to influence the distant designers of these lists and how the small presentation windows on monitors constrained what was seen, for example too few addressees. Certainly mail groups can be formed *before* actions and this difficulty can be compensated for, but the possibilities to collate them in a temporary force may be small.

Accepting the importance of communication as a means for sustaining an organization (Winograd and Flores, 1992) and for sensemaking (Weick, 1995), the definition of the computer as an *instrument for communication* makes more sense than using it primarily for control purposes. A focus on control (access, security, streamlining work) instead can constrain communication, limit creativity and commitment. By promoting communication and autonomy, instead creativity can thrive, and control is likely to be simpler (= not met by resistance) because of commitment and motivation, but of course complex enough. What rests is to handle the unavoidable process of divergence and convergence, which characterizes design (Löwgren and Stolterman, 1998).

11.6.2 VISIBILITY IN ARTEFACTS AND WORKSPACES

Visibility has various aspects. In the military, high visibility in the battlefield may mean certain death. Many efforts are aimed at making an opponent visible while at the same time protective camouflage is precious. Independently of which, what becomes visible can be acted upon with short delay. Both informating and informing are about visibility. Visibility augments the chance to name objects; names provide visibility. What is visible can be controlled because communication about it becomes easier and comparisons, preceding control actions, are simple. *Meetings* make work and people visible and allow mutual influence. They easily become “power markets”, for better or for worse. There are thus contradictions present in what some see as a blessing: being together with people to control them risking confrontation or to find common acceptable and legal solutions to social events.

The Actualities’ Table promoted overview and visibility, and in addition permanence through the use of written text. It could serve as a medium for control and comparisons. Permanence and visibility have another aspect. An external representation, recorded on some medium, becomes an artefact that can be used independently from its creator, thereby gaining autonomy from individual persons possible to and can be used both for control and communication deep into a large organization, but it is possible to violate as well.

The issue of visibility can be expanded to the whole workspace. Computer artefacts may reduce the face-to-face communication that often accompanies the distribution of paper, and decrease the mutual awareness of the actions among team members. In turn this may reduce helping behaviour and collaboration, which may compromise their function for reminding and coordination. People in the HQ expressed similar opinions. Isolation, sleep-deprivation and fear may cause breakdowns that may pass unnoticed. Berger and Luckman (1966) underlined the importance of intensified socialization processes in order to create “reality-resistance” (p. 168) when faced by marginal situations. Whittaker and Schwartz (1999) analysed the use of electronic planning media and traditional wall planning boards. Their explanation to why CSCW applications failed was that many applications imposed additional work on individual users or required changes in work practice without benefits for the users. Similar phenomena appeared in the command work when people tried to be loyal to the report application and other central resources. A category “IS-worker” evolved, distanced from the command work but occupied with the function of the central IS resources. They estimated that a traditional board was a valuable personal and group resource because it provided an ideal physical location for both arranged and opportunistic interactions. These activities were both social and situated in the context of relevant materials and information. It was also beneficial to be seen working on the board.

Similar wallboards were created in the HQ when paper printouts were taped onto vehicles (Figure 11.7), and workspaces were equipped with large maps and enlarged spreadsheets, usually projected from computers.

Figure 11.7: Printouts attached on the side of the truck where the IS section worked, having access to traffic and content of IS.

Whittaker and Schwartz concluded that future electronic GroupWare tools have to incorporate the benefits afforded by the material properties of the wallboard. GroupWare tools need to be public, promote commitment and conversation, be material when affording commitment and promoting reflective use of the tools. They need to replicate the dimensions of size and visibility when supporting ready access to complex information.

11.6.3 DESIGN, POWER AND RATIONALITY

An example of the rationality at play in command work is how Whitaker and Kuperman (1996) described two central but conflicting command foci, both being related to IT. One is the internal efficiency, order and controllability, the other is to obtain decisive advantages over an adversary. They stated that the confusion growing from these conflicting foci has been "exacerbated by their all being lumped together under the rubric of *information warfare (IW)*" (p. 3). Their view links to Richardson's (1991) ideas about the dichotomy between the *servomechanics thread* (focus at internal control, isolation from the environment), and the *cybernetics thread* (supporting regulatory structures designed to promote variety and maintain control, homeostasis and adaptability).

If IW becomes the "rational" label that makes the understandable confusion intelligible, then language is what creates something (next to) manageable. Depending on the priorities (to isolate or to manage variety), it is likely that each focus requires its proper control technologies. A "rational" way to achieve controllability of work in this confusion and thereby the desired power and autonomy is to look primarily at its technical aspects and to form it from an engineering perspective and then live with the social consequences. According to the same logic, even leadership can become engineering. The more systems engineering, the more "leadership engineering" is needed in order to manage the human factor.

To return to ISs, it is likely that few want to engage in an ISD process that is uncertain. One way to avoid uncertainty is to describe ISD as a rational engineering process supported by a *method*. If unreliable, a method cannot be the kind of product that is designed so as to be commercially usable. A method for design of IT, which declares objective rationality, becomes a strong design and a control instrument and to use it demonstrates rationality. The one who controls a method, a kind of technology, is consequently empowered.

Holmström (1995) convincingly analysed and discussed the role of methods in designers' work from a theoretical perspective. Both the designer and the customer want a reliable design process that leads to the specified product. For Holmström, the designer is a translator of rationalities, often relying on the dominant actor's (the customer) knowledge and power. There is a mutual interest between them: to achieve a satisfactory result. The designer has two choices: either accept a given strategy or find another that admits objective progress. When ISD explicitly seems efficient, but people continue to invent self-help solutions, the translation or integration of rationalities may have been unsatisfactory.

There is thus a contradiction between method and design object when the control object is a social process (like command work) but the design method is created for a technical control object, a machine or industrial process, where natural laws and empirical measurements provide a basis for control action. Moreover designers might work from a rationality that favours advanced technical artefacts instead of helping people to reduce the complexity of small things in work. We heard (Chapter 10) what Person R felt when he discovered what the "template" was. He assumed that its simple components were not attractive for ISD-professionals. Each kind of solution may have a profound impact for users of artefacts. It is not sufficient to claim that the human is positioned at the centre of design concerns, when at the same time what is "human" is given a technical profile, which can get far reaching consequences.

11.6.4 MIND, MATTER, AND DESIGN

In the command work there was a high level contradiction with implications for the design of IS and work. Being knowledge-intensive work, operations are about abstractions—ideas, signs and symbols—while logistics grows from down-to-earth facts and figures. Operations are ideal and correspond to *mind*, while logistics is rather about concrete resources, *matter.* The mind – matter dichotomy is operationalized in the interaction pattern between Operations (tactics) and Logistics. Procedure and artefacts are applied in order to negotiate reconciliation.

In the same way as Löwgren and Stolterman (1998) stated that IT is matter without properties or limits, the symbols and signs that are produced as representations in the knowledge-intensive work during exercises are abstractions with few built-in limitations. In peacetime training this does not matter. Many efforts are usually initiated to make exercises realistic but logistics seldom gets the impact it deserves. Instead the mind easily gets an attractive ultimate autonomy and power. The *symbolic* logistics-as-symbol has fewer limits than real logistics. In war, "matter" (i.e. resources, the organization, operations) generates frictions that must be dealt with.

The implication of this dichotomy is that the mind has a competitive advantage during short exercises when much must be done and participants can agree on rapid symbolic processes. Unfortunately tools and procedures can be designed detached from work, only for symbolic work. They may be less suitable if the matter (even people) is real, slowing down processes considerably, while the mind still tries to work with symbols without limits but with considerable elasticity. The point that Löwgren and Stolterman made was that the absence of limits in IT is more of an advantage than a problem. However, if the IT design stay at abstractions in the informing subsystem without considering their relations to the physical world which they represent and shall help to be controlled, the outcome may be fascinating but irrelevant symbols, representations of the world. Thus the challenge for IS designers is to try to acquire a relevant picture of what work means, how to maintain a clear link to the informated real world, and what kind of technologies that have social value (and what *this* means). Designers have to find ways how the interrelated subsystems can be kept together in ISD, checking the mind's tendencies to forget about matter when autonomy is threatened. Two crucial issues in the mobile office workspace illustrate the importance of matter: to design solutions to the need for reliable supply of electricity and how to do without this precious matter (Figures 11.4 and 11.5).

Turning to the context of the whole study, Logistics has had a weak position within the Swedish army (Åselius, 1999). I assume that officers-warriors could not or did not realize the need to include Logistics in their operational thinking and planning: the mind could remain comfortably autonomous, free from its body, the weak logistic base. Person S told how when designing his pinboard he tried to *unite* mind and matter in the design, to represent plans and constraints *on the same surface* in order to keep both aspects together. Perhaps the modern MSExcel application BERRA became a tool that augmented the possibility to make Logistics heard in command work where the mind easily dominates. It produced a credible, rational, and almost scientific output. I conclude that common sense ISD can either further add to the dichotomy, or integrate mind and matter, if designers expand their field of vision to include both mind and matter.

11.7 Representations and Knowledge

It is time to summarize ideas concerning *representations* of the world expressing knowledge. In command work, a great variety of representations and symbols have been used, both formalized and informal. The Actualities' Table and maps are two kinds, both satisfying demands for visibility, externalization, social use and value (for instance as boundary objects). Recalling cybernetics, externalizations become crossroads, junctions where variety can be augmented and attenuation countered. The 3x5 cards (Pagonis and Cruikshank, 1992) functioned as a channel (transducer) which did not attenuate the information/content, were synchronous with humans' lives, and probably transmitted trust. They allowed the necessary capacity to provide the variety that was needed.

Rice and Sammes (1989) pointed out the crucial importance of *rules for generation* and *interpretation* of them, rather than the representations (symbols) per se, which have to be simple, univocal, and indicate how they will be used (interpreted). It follows that users of knowledge must be involved both in the development of such rules and the symbols for knowledge representations (produced by technologies, the informing systems). The relevance of representations eventually comes from within the work. Larkin and Simon (1987) claimed for example that diagrams, even if widely used and objectively simple, have to be accompanied by people who can read them and know how to give them meaning. A representation must consist of both data structures and "programs" operating on them to make inferences (ibid.). "Programs" evidently are not only algorithms but also *heurithms* (Langefors, 1993), rules of thumb. A heurithm is an *open subsystem structure*, where people can realize the subsystems. It cannot be defined as an algorithm even if input and output can be formatted as if it were an algorithm. When heurithms are used like this, a cooperative mode of operations emerges involving people and computer artefacts.

The two informing systems for the command work built from computer artefacts, the FENIX IS and the Actualities' Table demonstrated two different, complementary and even contradictory approaches for the representation of the social world and action. One was the definition in advance where the world had to be categorized according to symbols and templates, later to be presented on the automated digital map across the whole organization. The underlying assumption was that this image should distribute, on command or automatically, the same knowledge about the situation all over the command organization. I call this the principle of *correspondence*. It is an attempt to make the representation look like reality, carrying the assumed knowledge without distortion.

This principle can have a strong rhetorical capacity, catching the attention, because of its reality-look. It highlights primarily the technical aspects of the informing components of the total IS (see Chapter 3) and makes what is knowledge unproblematic. Scaife and Rogers (1996), however, stated that the belief in graphical representations is more of common sense than supported by scientific evidence, leading to what they called the "resemblance fallacy" (p. 201): that spatial/iconic/figural qualities or animations facilitate cognitive operations. Instead persons have to *learn how to read* representations, even diagrams.

Recalling IS theory (Chapter 3) we saw that another perspective is that interpretation and sensemaking are social actions (Langefors, 1993; Smircich, 1982; Weick and Meader, 1993), transforming information and (assumed) knowledge. Both the Actualities' Table and Avdic's (1999) calculation systems were designed and given meaning by people using simple basic symbols (figures and letters) when making artefacts in their work. The design or layout of such artefacts, whether they are made for narrow spaces in vehicles (the pinboard) or intended to be used publicly (whiteboard), grows from the work. I call this applying a principle of *economical abstraction*. The design is open and allows for various kinds of use; besides it is simple to make. This principle is applied in accounting, but it should not be assumed that the rationality inherent in accounting must accompany the economic abstraction. It can work with heuristics.

Ideally, the economical abstraction should contain the agreed important aspects of the world, represent them in a recognized set of symbols that can easily be interpreted. A figure (number) can be an *exact measurement* that allows precise calculations, or be a *metaphor*, a *symbol* or a very *rough estimation*, such as when battle capacity is decided. By no means do figures enforce an economic rationality, but they *allow comparisons* and *provide overview*. The fieldwork data indicated that the Actualities' Table made the distance short between data, information and knowledge, reducing the need for intermediaries between actors. Because people designed the Table in their work, it probably *afforded* (Norman, 1988; Anderson and Sharrock, 1993) meaning and knowledge. The structure of the tables and similar representations was also a kind of "diagrammatic representation" which gave them a "computational efficiency" (Larkin and Simon, 1987), facilitating inferences. Not only a specific symbol but its *relations* to other symbols ("expressions") have a meaning in a context. Spatial relations, supporting inferences, can be enhanced in an external representation, such as how a certain table is structured, perhaps also in a correspondence representation. A similar situation evolved around the ATC flight progress paper strips (Hughes et al., 1992): when they were positioned in their rack altogether, operators could see, at a glance, the whole air situation, and then go deeper and monitor each strip when details were desired. The whole workspace has to be considered in design matters.

There is, however, a fundamental contradiction involved in the use of figures that may confuse how they are used. They are powerful, signify an objective rationality and can have a strong rhetoric capacity. They are convenient, are easy to store in tables and to use, but *require interpretation*. What is problematic is when figures are formed, the valuing, which can be based upon detailed measuring or heuristics (at best), perhaps inferred from knowledge. We can trace some of the contradictions between Logistics and Operations to this phenomenon. Logistics (relying on figures and accounting) easily promotes the use of figures as exact measurements which do not even need to have their meanings questioned and interpreted, because they already are *rational* and treated as true. Commanders try to overcome the literal meaning of figures, link them to social actions, and estimate the freedom of action. The Table was the logic successor of the old *contrerolle*, not because it worked with numbers and was a table but because it *allowed comparisons*, just as the tally-stick, between units, mind and matter, or successive versions of a representation. Other tables and matrices built from exact numbers/metrics accompanied it, for instance lists of personnel or spare parts with unique numbers. It is understandable that people want to augment precision by adding decimals to qualitative estimations, but futile.

To conclude: there are a few kinds of rhetoric, either the rhetoric of the correspondence or the rational economic involved in the representations we have heard about. An image, if it corresponds to the object in the world, appears an authentic, legitimate and convincing representation. If, in addition, it is the *only* one and looks as if it was updated and "running", short-circuiting the world and its representation, it may suppress different interpretations, reducing variety. Such representations can be strong allies to the mind and easily conquer matter which is about details. Economic abstractions connote rationality and logic, and may therefore be very hard to overturn; in addition they may be used for reliable social control. Both types can be used in conjunction with social interaction, language completing them. In the cases we saw how a social rationality could be applied when the tables were used and in the meeting. Once a representation is assumed to function autonomously, or has a capacity to do so and therefore easily is uncritically accepted, important social aspects may be forgotten or neglected.

11.8 Information as Resource or Knowledge?

11.8.1 INFORMATION SYSTEMS, THE ORGANIZATION AND WORK

When recalling the theoretical model of the total IS (Chapter 3), both cases originated from the failure to integrate the informating, the mediating, and the informating subsystems which led to a less than satisfactory (abstract) IS (image, knowledge). "Informating" had meant mainly formal reports from the social world, complemented with occasional personal communication, then mediated in the prescribed standard formats. “Informing” had been about what the technology allowed. The (abstract) IS easily became an outdated and irrelevant composition. Information about the crisis in the chain of command and an exhausted battalion commander had been achieved via a personal meeting. Aggregation of reports was ongoing and accompanied by frustration: much work, meagre outdated output, reduced variety.

Actors formed informating and informing systems that were based upon the variety in the operational social domain, inventing new ways to mediate data. Both the meeting and the Table satisfied the needs for the continuous reproduction and the production of symbols within the knowledge-intensive symbolic work (Deetz, 1998). The Actualities’ Table was an example of the kind of self-help system that Sorenson (1989) condemned (lacks focus, duplicates efforts, allows emphasis on details of a solution while broader issues are not considered). Sorenson’s perspective was the blessing of the command and control system built according to general laws induced from practice. His critique of local designs was that “they generally do not address, adequately, interface and integration issues that arise at other than local levels” (p. 13).

His perspective expressed that what actors do in their work is subordinate to the organization’s interests, and that local solutions in the work have little relevance. The fieldwork and the data, on the other hand, said other things. Not even the self-help system FENIX could provide what people needed or could achieve given the circumstances. Faced by it, people’s needs and their innovative capacity led to (almost) immediate results directly in the work on a most basic self-help level. Most important, probably, is that they felt that their knowledge was worth something, not only seen as counterproductive to ‘general laws’ governing the design of the organization. The greater the difficulties in making sense of the technology, the more innovations.

It is time to conceive the contradiction between central and local control, a function of power and autonomy, affecting many efforts to design usable ISs. It will be illustrated by a brief comparison of the three IS structures that influenced the command work, the original ATLE vision, the FENIX MIS, and the Actualities’ Table. They exemplify different design strategies. I illustrate them in Figure 11.8.

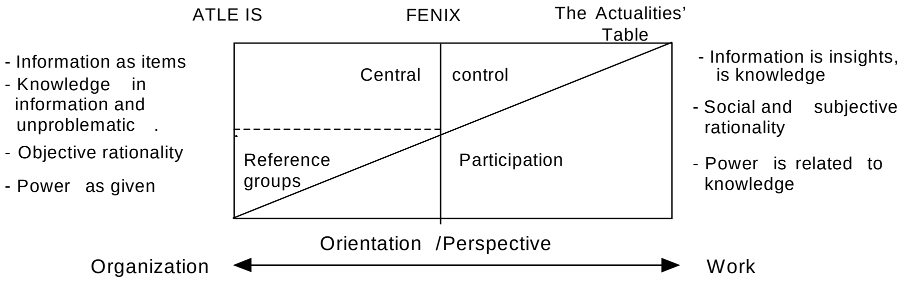

Figure 11.8: Comparison of the three examples of ISD as related to work, power, knowledge, and control.

The ATLE work (left side) was centrally controlled and coordinated. Reference groups were formed as to incorporate users in the process which was dominated by a perspective on information as resource, power and knowledge being unproblematic according to the dominant objective rationality. "Work" was defined centrally by directives about technology and the use of a certain method. The ATLE framework exemplified the IRM-strategy, which explicitly, according to the specification demands, was not to be applied. The VBS-strategy was a central army recommendation but in reality method and technology, resources and timeline were centrally controlled. In the FENIX development (centre), work had more influence because the system was designed partly in it, the developers/designers having greater autonomy, but adhered to the same rationality about work carried by its components. The unintentional but perhaps inevitable IRM-solution can be as constraining as the one that is intentional, and force the organization to initiate repair work.

Lastly, when the Actualities' Table was formed (right), it was an activity *in the work.* Only what was considered relevant became incorporated in the table that was a continuously redesigned application. The autonomy in the work was considerable. *The design was the work and command work means design*. The Table supported the knowledge-intensive work. It remained invisible within the bureaucracy, but relied upon its resources and legal power structure. Possibly it was what the mind needed, and could minimize the risk that matter was left behind, instead strengthening the relations between these entities.

11.8.2 UNDERSTANDING WORK, KNOWLEDGE AND POWER

What we can learn is that even what looks like a VBS strategy may for the people in the work imply a pure IRM-strategy. The conclusion is that we have to go to each and any group and look for what people do and then decide what kind of support strategy and solution that the group requires. The modern organization is an abstraction produced by the symbolic work. It is not a physical entity of its own but its effects are concrete. Command work continuously builds the organization, produces symbols representing the organization with its attributes, and symbols expressing knowledge (for example on the maps) that control or constitute the content in communication. If the command work is interrupted, the symbols fall apart. Therefore symbols expressing knowledge lose their meaning when detached from the work. The ethnography and the close analysis revealed that command work is not what it was believed to be. The control mechanisms within the symbolic peacetime military organization get a life of their own, not being designed for an organization which has to be viable.

> The strange thing is that we tend to live our lives by heuristics, and to try and control them by algorithms. (Beer, 1981, p 53)

A better "command world" can hardly be designed without development of a new consistent theoretical framework for work and ISD. However, traditional tools and techniques in work, being deceptively simple, also carry wisdom and can be used for redesign of work and implementation of modern computer artefacts.

The relations between knowledge and power (both defined by culture, values included) have to be kept in mind. If power and knowledge are seen as independent entities, both being unproblematic and "given", and the nature of information is an unresolved issue (knowledge or resource?), an organization can hardly function without disturbances. Likewise, if a symbol is taken out of its work context where it is constantly reproduced and reinterpreted (because that is what work is about), it loses its meaning. Any attempt to create an IS with these central issues "open" will fail. Ultimately the people who create this set of symbols through their work, themselves being part of it, have to believe in it. Relevant knowledge of what command work is and requires, reduces the risk that it will be defined, intentionally or by hazard, from a distance. A proper balance can then be struck between central control and what is better to decide locally. Another way to express this is to define where the limits and the focus for the engineering part of command work design (general laws?) should be, and then to find out how to provide support for the rest, the art.

Chapter 12
Design of Information Systems and Command Work — Discussion and Conclusions

THIS CHAPTER SUMMARIZES THE STUDY and what ISD for command work is about. The study demonstrates the contradictions between an organizational perspective and the work perspective on design, related first to different perspectives on work, and then on information, as resource or as knowledge. The subsequent dominant IS development strategies and methods meant more contradictions in the work, between common sense and work oriented design solutions, between mind and matter. The cases illustrate what characterizes knowledge-intensive and symbolic work and how social interaction and artefacts reconciled these and other contradictions. I open the chapter with a discussion of issues from the analysis in the previous chapter and present, for example, a model of command work that helps to explain why many efforts to implement IT lead to difficulties. Finally, I conclude about design and related topics from the whole study.

12.1 Discussion

In this section I discuss issues that define and characterize command work, how it can be described theoretically, and how this theory can inform ISD. I present ingredients to a theory for *command work* based upon the notion of *command work* as *design work*. Central concepts such as power, rationality and autonomy are brought together. I outline some of the relations between the symbolic components of work and the representations that the work deals with. Lastly, I present some design research topics.

12.1.1 CONFLICTING PERSPECTIVES ON WORK AND INFORMATION SYSTEMS

Several techniques, methods, and tools aim at the reconciliation of different perspectives and conflicts during IS design. Brooks (1995) stated that new methods, technologies or programming languages and the like are applied as "silver bullets" within engineering and design, although with limited success. Various researchers discuss problems related to the design and use of cooperative systems. Kensing and Blomberg (1998) confirmed Langefors' view on the value of active participation in the design process, and claimed that traditional design approaches make it difficult for users to see the links between their work and abstract technical descriptions of new systems. Clement and Halonen (1998) described a case which suggests that

> when work groups develop an application on their own, they will think of the application primarily as a tool for facilitating their own work activities and this version of the artefact can differ markedly from the IS professional's view of what a computer program should be, because the artefact is not that kind of an artefact for the work group (p. 1099).

These sources indicate that a new method does not suffice. Instead there is a more fundamental cause behind troubles including a faulty idea of what (command) work is, in addition weak in theory. My study suggests that an application of IT based upon "common sense" and taken-for-granted principles from management science (even if they are widely applicable) do not fit the requirements evolving from command work. Without a relevant perspective on what the work is, then failure is imminent. What matters is to start from the knowledge-perspective of work and design from that position. The challenge is to be true to some basic principles and to keep in mind why and for whom computer artefacts for command work are designed. Moreover, design has to frame the whole conglomerate of subsystems (the informating, mediating, informing and abstract ISs) *and* the workplace if it is to lead to functional products (see for example Rekimoto and Saitoh, 1999, about augmented surfaces in the work space; Streitz et al., 1999, about an 'interactive landscape').

Unless design efforts include workspace technology, work, and the total IS, one factor can neutralize the others. If a workspace does not admit teams to assemble and work together, the best competence can stay dispersed. Division of labour can negate workspaces intentionally designed (communication facilities) for groups.

During the series of CPXs I observed, and discussed workspace design with an informant (Person U). I concluded that managers appreciate open workspaces where people are visible and easy to control. The workspace and its technology were the managers' tools rather than the operators' who had slightly different preferences, to be aware of events and to cooperate. The same neutralizing occurs if IT and workstations are designed for individuals working normal office-hours when in reality several actors continuously rotate on the same workstation. The preferences of one person may not be the same as the others, passwords have to be shared, and a set of rules for sharing may be necessary.

Langefors' (1993) idea of a dichotomy between customers' interests (satisfy needs) and industry's (create a market, develop and sell products) has nuances. Ideally, today even commercial products mean comparatively cheap artefacts with high technical capacity. To keeping ISs upgraded and allocating investments is problematic for an organization like the army that is vitalized intermittently and piecemeal. Moreover if new software versions are acquired hardware usually has to follow and becomes outdated rapidly. Eventually the supposed mechanisms for social control become expensive and administration of them becomes cumbersome. In the military there is less of a customer – industry conflict about technical capacity, rather there is a *common interest* to develop advanced technology with unique capacities, because only the most reliable technology will do and help when survival on the battlefield presupposes being competitive in every aspect.

Both Sorenson (1989) and van Trees (1989) complained over the difficulties in getting the products the military needs and about the gap between research and command practice. Nevertheless there is still a strong belief that IT will sort things out because many problems are perceived as related to information management, IT being the 'silver bullet'. The troubles start when the customers who have difficulties in specifying what they want, try to evaluate technical concepts from industry. "Command work" is difficult to describe, but there is a belief in a process view and that it is possible to design easy-to-control procedures. There is a desire to get help to manage information overload, to get the right information at the right time (Whitaker and Kuperman, 1996; see Chapter 3) but the idea of what information and work are and what is needed is built on ideal assumptions rather than grounded in practice (Section 8.3). The office perspective on work, which is most consistent with what the technology promotes, leads to difficulties. A more relevant perspective seems to be that anomalies are the normal state, and that theories should start from them. Sage (1987), staying true to his *decisionmaking* paradigm in spite of evidence of the turbulence in the social world of command work, could as well have accepted *problemsolving*, far less formalizable but possibly a more relevant framework.

The effort to design and develop ISs often becomes overwhelming and new contradictions grow. People experience a loss of power and autonomy, and distrust grows. I interpret these as effects of perspectives on technology, on themselves, and work, that lead in the wrong direction. The appreciation of *internal control* is the dominating interest, but common sense about technology as an unproblematic means that more control becomes a trap. New controlling agents appear, and both controllers and those who are controlled often experience a *conditioned autonomy*.

Second, technology (especially information technology and systems) is seen as comprising stand-alone artefacts that somehow *produce* work, even knowledge, given the right instruction. This *detached view* on technology as add-on artefacts is supported by the technology itself and the industry, leading to an *object view* on information and knowledge. Humans then become operators who just have to "use" the systems in order to be informed. Sage (ibid.) stated that "to be informed" was connoted with rationality and had a value of its own, equated with receiving "information". What is missed are that humans actively interpret and define the world (often through technologies), what information and a suitable representation of knowledge mean, even what technology can "do" for them and what a relevant technology is. Part of the self-perspective supported by the military institution is probably that humans are capable of following an objective rationality, being logical. That is, the symbols that are produced in work must be read as logical and rational. It is, however, necessary to realize that internal rationality may be short-lived outside any organization, that reality is socially constructed, even being a symbolic universe (Berger and Luckman, 1966).

12.1.2 A Theory of Practice: Linking Power, Autonomy and Rationality

When faced by new situations in their heterogeneous organization and workgroups (and most groups *are* heterogeneous), staff organized work as individual or cooperative efforts in order to achieve either *more autonomy to build power* or to *exploit existing power* in turn promoting better control. Additional formal power could be achieved, for instance, through the bureaucracy (a control technology), as well as resources of any kind.

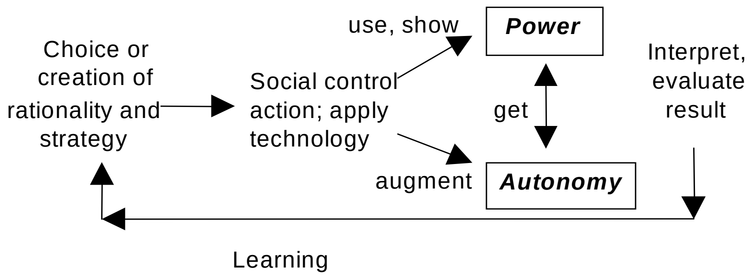

Figure 12.1: The "theory of practice": the pragmatic command work principles.

Figure 12.1 illustrates the "theory of practice", driven by the need to achieve social value. Technologies have several roles in command work when functional social actions are designed. People have different goals and follow a diversity of rationales in order to achieve sufficient variety. Change of strategies and reinterpretation of previous actions belong to the work, for example to manipulate matter in order to satisfy the mind (or to make mind accept matter). Actors, who are allowed to redefine knowledge, and to reinterpret symbols and representations have to invent legal ways out of dilemmas, reducing the risk that their actions become interpreted as evasion or lack of expertise. Ongoing evaluation then guides continued action through learning.

It is necessary to state that practitioners usually do not "choose between rationalities". Rather they assess a situation and then act (like Pers said when summarizing the meeting, opening of Chapter 9). In *theoretical terms,* people follow a s*ubstantive rational* or a *formal rational* point of view (Mommsen, 1980) or *integrate* objective, social, and subjective rationality (Ehn, 1995). The chosen, or rather *created*, pragmatic and uniting *rationality of practice* should support a satisfactory outcome, be a successful design. These theoretical rationalities correspond to distinct knowledge interests, together driving the process (ibid.).

In the meeting, both objective, social and subjective rationality were applied more or less consciously and integrated successfully. The formal/objective was present in the design of the control mechanism, the Actualities' Table, and reflected the technical control interest while the substantive rational aspects could be satisfied by the local amendments. Objective rationality dominated the FENIX systems development efforts, while social and subjective rationality grew from below as a default strategy in emergencies when pure technical control was insufficient. The conditioned autonomy was managed in various ways. Bureaucracy was either consciously and opportunistically used, or circumvented in order to reach the desired result, a legal and acceptable solution.

12.1.3 COMMAND WORK, A MODEL

With a relevant view on what command work is, it is likely that some design traps can be avoided. Nardi and Engeström (1999) defined four kinds of invisible work: work done in invisible places, routines or manual work, work done by invisible people, and crucial informal work processes. Lastly, conventions about what "real work" is may lead to negligence toward important but less glorious parts of it. Even the role of the whole workspace can be neglected, because ergonomic and physical conditions form what work becomes and where it is done. To conclude, work can occur everywhere and not only in the narrow mobile "cubicle". As the meeting demonstrated, decisive action may have to be initiated anywhere with short notice. It might even be beneficial if work is sometimes invisible outside a group.

The ethnographic approach that made work visible resulted in a model of command work, consisting of four related fields (Figure 12.2). Work occurs in all of

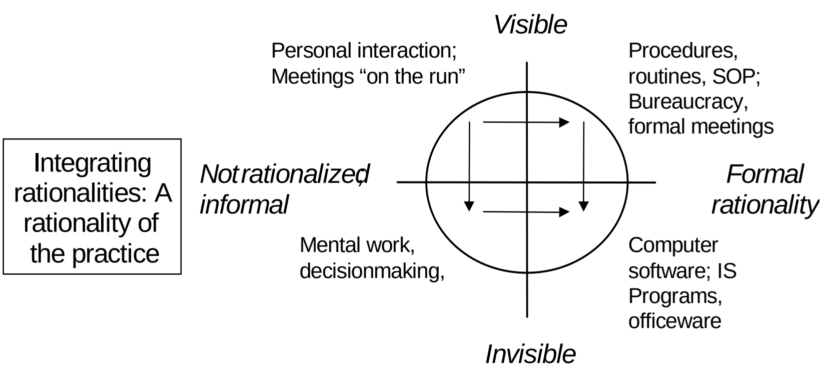

Figure 12.2: Model of Command Work, arrows indicate flow trends which have to be countered by work activities/operations.

these and moves back and forth, promoting transformations between the fields in order to be the boundary object that unites all activities and operations. This movement is what (theoretically) integrates various kinds of rationality into a "rationality of practice", in the work.

The visible upper sector is especially important when we discuss means for social control, because (1) what is not possible to see or detect, can hardly be controlled, and (2), control efforts (command work) must be made visible (informated about) in order to have any social effect. For instance, mental work by one person is hardly evident for the team, until substantial proof is produced: a plan, visible actions, a solution to a problem, a new concept or interpretation, preferably as external representations (Larkin and Simon, 1987). There is an ongoing quest for procedure and predictability, prerequisites for “rational” reliable control. Visibility is taken for granted and not questioned. Rather it is assumed that any visibility will do and will produce the desired effect. Common techniques are taken for granted, for instance what commercial hard- and software produces when *informing* is required. As regards visibility, *power* and *knowledge* are visible on uniforms. Badges and signs show (but do not guarantee) name, unit identity, rank and expertise, being attributes facilitating control and providing individuals with identities. In the same way as Hermann and Just (1995) stated, experts’ various types of competence have to be possible to exploit and demonstrate in any setting.

Independently of technology, actions in the knowledge-intensive symbolic work tend to become invisible, if certain precautions are not taken for visibilization (printers, monitors). Office technology or automation applied without considerations of the social context easily promotes invisible procedures. Caution is therefore necessary when “common sense” IS solutions are applied. One example is how, during the first CPX (HQ A) when a large container served as the Battle Management Centre workspace. The mainly electronic communication via workstations did not announce to the group what happened, in the way radio networks via loudspeakers previously had. New routines had to be initiated in order to orient personnel about evolving events. One informant said it was as if a blanket had been thrown over the room. He had to move around, go to the mapboard, and team managers had to organize briefings. The new Actualities’ Table remained mainly invisible because of confusing names on it and because it became an integrated part of work. The consciousness about its role came almost six months after the last exercise.

12.1.4 TOOLS FOR SYMBOLIC WORK AND THE RATIONALITY OF PRACTICE

Those who can “cruise” in the command work and can move between the different fields (Figure 12.2) belong to another type of boundary objects, and merit the title of *rationality brokers*. Like the designers/architects studied by Grinter (1999), they have to penetrate cross-organizational boundaries, carrying their tools with them. With the help of the tools they can define the real world as they want it to be seen, and communicate in order to get commitment to achieve unity of effort. Rationality brokers often have sufficient power and autonomy themselves, sufficient to be able to achieve changes and enforce solutions, or know how to get them. We can look at commanders and then see what kind of tools they have, how well the office technology fits their needs, and what suits them in their extremely mobile tasks. My observations and discussions during and after the fieldwork clearly demonstrated two things. Commanders want to and can move freely, and much is said between commanders that remain properties of individuals, partly invisible for the organization.

The *theory of practice* with its matching *rationality of practice* (work) was based upon the command work, and acknowledged the roles of social and subjective (and not only objectively rational) factors when designing technology. The accounts about one forerunner to the Actualities' Table (the pinboard) described that its use by artillery operators in a narrow armoured vehicle defined its physical format. Most important perhaps was that its design allowed the operators, on one board (or on the later one-sheet paper version) to represent and to capture an overview of plan, tactical activities, and the physical constraints (terrain, ammunition, action). The pinboard/table as a boundary object united mind and matter. Another example is how general Pagonis, Chief Logistician during the Gulf War (1990–91) continued to rely on (as he had done in his whole career) the simple 3x5 inch index cards as a manual IS and mediating system within the whole logistics organization (Pagonis and Cruikshank, 1992). About one thousand circulating cards constituted a simple, highly flexible IS that combined informating, mediating and informing qualities. They promoted high visibility of the persons involved in the communication, their power and their positions. They could be physically distributed in various ways, or faxed, and added to the variety in the communication media. In addition, in spite of their format, their capacity was "amazing":

> ... all the information needed by a decision maker can be placed on a 3x5 card…Three by five cards have reached me in hours or less when a paper had taken days. (p. 190)

In the Swedish HQ, most if not all officers had a small personal notebook in their pocket but few papers were smaller than the standard format (A4, close to 'letter' size), part of the office technology. Any printout, even if it was a short message, required an A 4-sheet. There was no paper artefact that easily could travel across the whole organization like these cards could, and function as the same kind of flexible and efficient boundary object.

Technologies and information artefacts must be suitable within heterogeneous groups (for instance low-tech/high-tech, in coalitions), and be designed for interpretation with little effort, have *computational efficiency* (Larkin and Simon, 1997), *affording* the meaning (Norman, 1988). Examples of design questions are:

- If a group has to move between different parts of the organization and the environment, what kinds of technologies help them to be boundary objects?
- What are the implications if both technology and design methodology have an inherent rationality, which is meaningful only in certain contexts?
- How to design tools that are usable not only in the peacetime environment where *mind can easily dominate over matter*, while in war *matter gets another weighting and must be dealt with*? And what if the tools themselves become matter that is circumvented because the mind needs something else?
- What kind of knowledge representation, symbols, make knowledge ready-at-hand for different groups and reduce the risk that biases dominate?
- What kind of tools can be used both in the boundary zone and in the core of the organization, supporting work that moves?

Technologies in the work have to make sense in a group, not being perceived as "foreign". Moreover, techniques for the transfer of work between groups are necessary, with or without people as work carriers and boundary objects, which means that external representations are needed.

12.1.5 PRINCIPLES FOR REPRESENTATIONS

When looking specifically at what "rationality brokers" often work with, *representations*, I defined (Chapter 11) two principles for externalization, the *economical abstraction* and the *correspondence*, leading to an emphasis either on diagrammatic and for instance tabular (spreadsheet) representations, or images which look like or are similar to (conventions about) reality. The traditional situation map (overlays providing additional military information), can be either corresponding (without overlays) or economical, diagrammatic (with overlays and symbols). Several sources use the idea of abstract mental constructs, whether they are called images, knowledge, or information which must be possible to *externalize*, *visibilize*, and *communicate*. "*Representativity*" is the first and most important criterion, achievable in various ways with the help of *actual data*. *Accuracy* can be a desired quality, which is demonstrated when *detailed control* is required, but perhaps irrelevant in other situations. Other characteristics are *openness* for use in various work processes and *overview*. If the aspects that are considered relevant and representative build a "representation", then its form can vary. I will start the discussion from Larkin's and Simon's (1987) and similar ideas.

When coupling the representation to the demand for control, to make it a *control artefact*, one thing especially stands out. The old principle embodied both in the *contrerolle* and the tally-stick is that *two versions* (of a register, a record) are necessary for a comparison, for efficient sensemaking and then control action. The practical implication is that it is difficult to compare two symbols, documents or images unless both are fully visible and have formats that allow a comparison, possible "at a glance". There must be a chance to *compare* two states (at least) of what is to be controlled (or indicators about this control object), the goal and one other.

Schmidt and Simone (1996) underlined that the format of an artefact is important for its use. Through writing, lists, table and matrices can be designed and reduce the cognitive load in tasks. The spatio-graphic format of an artefact can stipulate behaviour by reminding an actor of items to perform and directing attention to missing items ("the table abhors a vacuum", p. 179). To go one step further, Larkin and Simon (1987) described the advantages in using a *diagrammatic* (as opposed to a *sentential*) mode of externalized representation of a problem, which *highlights relations* between objects (data segments), supports a more *efficient computational process*, rapid perception and recognition of aspects in data. Information in a diagrammatic representation is indexed in two dimensions while the sentential information is a single sequence.

To put it differently, if a representation of knowledge can be designed so as to *articulate* the operational problem at hand, then this is better than a standard representation where problems may be implicit rather than explicit. In order to *afford* the problem, a representation must use not more but instead *better indexed* data segments (information). The usability of an external representations depends also on its relations to the internal (mental) ones people infer from it (Scaife and Rogers, 1996). Also the case of the ATC paper strips (Hughes et al., 1992) illustrates what principles that have social value. From the previous discussion and presentation of IS theory and the value of local solutions, it follows that representations should also be local, because the meaning of any representation grows from interpretations.

Returning to theory, the negligence as regards representations, the infological design problem (Langefors, 1974) is easy understandable if the theory applied makes the problem disappear and become engineering. The problems then reappear in the practice and the "system" may even remain unused. Nor is it satisfactory to pretend that the design problem is a purely theoretical one. Unless theory recognizes the practice than the effect is similar as if no theory was ever used. This study has led to a theory based on practice, and derived design suggestions from this.

Table 12.1 compares these two principles and their applicability in command work. The middle column describes the economic abstraction (including diagrammatic mode), the right is the correspondence principle of representation.

Table 12.1: Comparison between principles for representation of knowledge

Criteria - property	Economic abstraction	Correspondence
Precision - accuracy	Yes, but can be deceptive. Diagrammatic representation can originate in and simplify an image, enhance it.	Nuances and many stepwise refinement steps necessary when using symbols.
Overview-relations	If layout conscious, yes, following principles for diagrams.	Overview, but few explicit relations, requires additional work. Detailed image may limit field of view.
Attention management	Controllable - flexible.	Confusing – reduce variety through dominance?
Affordance	Incorporates context, “production program” for inferences (Larkin and Simon, 1987).	Explicit but relevant inferences may be difficult, ambiguity?
Interpretation	Few but distinct attributes. Explicit relations.	Pattern hard to discover, computational efficiency?
Compare “at a glance”	Possible to compare if layout careful (Larkin and Simon, 1987; Avdic, 1999; Anderson and Sharrock, 1993).	Changes or separate versions must be available at the same time and place and be distinguishable.
Communicable	Variety of media, narrow channels.	Transmission and explanation might need bandwidth.
Platform/media dependency	No (little).	Possibly only special technologies.
Use in workgroup	No restrictions, preferably large (public format).	Have to be large or distributed, may require advanced technologies.
Calculations in representation	Possible to embed; Spreadsheet technology.	Possible, may require complex technology.
Externalizable	Simple technology usable.	May be complex.
Interactivity	Possible.	Possible.
Format	One sheet.	May have to be large.

12.1.6 DESIGN OF REPRESENTATION LAYERS IN THE SYMBOLIC WORK

Through command work, people design and use organization, technology and symbols used for communication and representation of knowledge. The representations in command work express knowledge about the world and about how to change it, control actions. Military symbols for maps and representations are used according to agreements and must admit sufficient requisite variety.

The ideal common representation of the tactical situation, even if corresponding and identical in every HQ corner, is given meaning locally. This can deviate from the intended one unless a program (rules) for interpretation accompanies it. Depending on the situation, these rules can require much communication before acceptance. Altogether, representations exist as a layered structure which has the following structure (Figure 12.3):

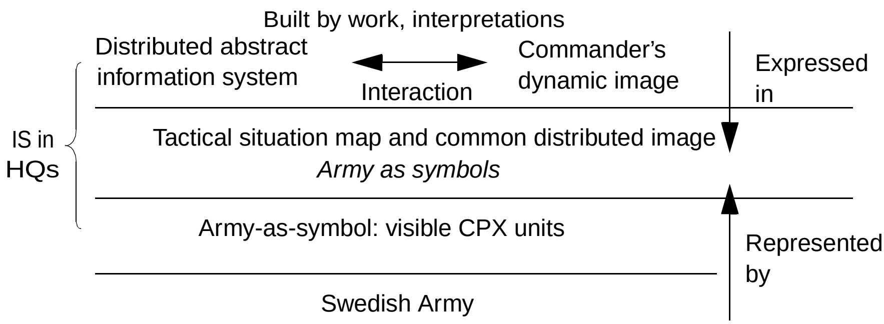

Figure 12.3: Layers of representation.

Work and technology together form a representation of the army (army-as-symbol) that by definition has to be interpreted as efficient and controllable, externalized and visible, consisting of real objects. It is controlled via an IS that contains another representation of the army-as-symbol, designed to be part of a control artefact: the *army as symbols*. There has to be a correspondence between the two representations (army-as-symbol, army-as-symbols), the former serving as the real army. Because of the need to serve as a credible and highly-controllable army symbol it is consciously designed to appear objectively rational.

The complexity of the external (real) army-as-symbol makes simplified internal representations both necessary and attractive, such that express order, completion and overview. One type is the situation map that gives a simplified, to some extent corresponding view from above. Then there is the common image, ideally possible to distribute automatically and carrying knowledge. The paradox is that the IS rep-

Figure 12.4: Joint planning session for review of a plan in an industry hall: the socially distributed IS was made visible in the work.

resenting and expressing knowledge about the operational domain, the army, is a social, distributed, abstract, multiformat system over the HQ where people have active roles, a distributed repository of historical data, which had both formalized and informal components. Now and then, in the command work (Figure 12.4), it was brought together in the workspace, in briefings and in command teams when people met, exchanged interpretations, informing each other. Often the map was a central artefact functioning as boundary object.

This system is often refined into or contains a correspondence representation that primarily serves as an "attention grabber" and reminder but in no way captures all: the army on the map or a representation with other technologies. Because of its correspondence (the tactical landscape) this externalized representation (within the HQ) gets a superficial quality (especially during exercises) and not only represents but actually *substitutes* for the real army or for the external army-as-symbol (during the fieldwork usually built from real objects). This internal representation of the highly virtual social world during exercises is easily controllable either with a click on the mouse or as wipe and redraw of an overlay on the map.

The CPX the actors, according to the (social) rationality of practice, created and populated the army-as-symbol. The complexity and dynamics from the enacted army-as-symbol made it more real, even if its matter was not very constraining and allowed the minds to move freely. The rationally designed (engineered) IS for the desired army-as-symbol (finite, ready, controllable) was less suited for the kind of design work (of symbols, more work, organization) that was necessary for the symbolic work in order to manage the boundaries of the organization. An *inner* environment evolved that required much work and self-help solutions in order to be manageable, drawing from the resources defined for the boundary management and the *external* environment. The matter in this environment did not allow the minds of the actors the same autonomy ("we are in the hands of technology").

To add a further twist to the previous discussion, the symbolic and knowledge-intensive command work produces the overriding symbol, the Swedish Army: a symbol for the nation, its autonomy, freedom and democratic values. How then can it be "expressed" in the products of the command work, withstanding the scrutiny of the mass media, being credible among those who created it? The army-as-symbol has to be highly visible, not inviting to any ambiguous interpretations. The symbol has to be *real* and *visible* which is easy enough, but what really matters is whether it is *interpreted* as a real or a virtual *army*. The most important question, whether this army would have been capable in a war is outside the scope of the study, but it was certainly possible to train and produce experiences from command work and control technology, as credible symbols.

12.1.7 Information Systems Design and the Conditional Matrix

In the first chapter I outlined the theoretical foundation for the study, cybernetics and the VSM (Beer, 1981), and the methodical and analytic framework, the conditional matrix (Strauss and Corbin, 1990). In this summary about ISD, I have the following conclusion. Design practices easily instrumentalize social actions, leading to breakdowns and needs for repair work. Kuutti and Bannon (1993) outlined, inspired by Activity Theory, a possible uniting theory for human-computer interaction (HCI). Their discussion links to my methodical and theoretical framework, the suggested new conceptualization of information system (Chapter 3), and what the cases have told. One of their concerns was how to establish a better connection between the *technical level* of ISD (how the communication between user and computer is arranged and, I claim, how users' communication is mediated), and the *organizational level*, where the organizational practice (work) to be supported occurs. Between these two levels there is what they called a *conceptual level* housing models of the object domain and of the system itself. This level has to be understood by users, experiencing and trying to make sense of the world and the system with the help of the technical level. Each level is a design domain within the total system, each containing an interface aspect. These aspects are the work processes (organizational level), the system and the object world models (conceptual level), and the actual HCI, how humans communicate (technical level). Figure 12.5 illustrates the design principles in a model derived from the conditional matrix (and thus translatable into the three-levelled Activity Theory structure). The boundary

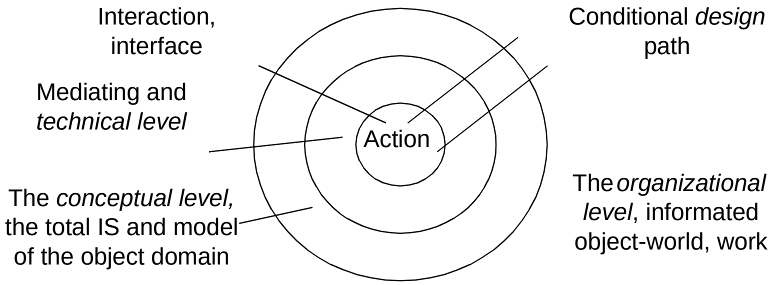

Figure 12.5: Conditional matrix, conditional design paths between levels have to be considered.

management in order to make the organization a viable system is conducted via (supported by) an IS that shall help actors achieve variety, to engage in design work (including the IS), create representations, and to communicate. The informing technical level shall admit also the control of the IS itself and make clear the different aspects of control involved in work (boundary management, design work). The conceptual total IS model presented in Chapter 3 will facilitate the understanding of both the object domain, the system, and their relations, connecting the organizational and the technical levels. If *conditional design paths* can be followed in ISD, where the conditions on each level are considered, then the connection between levels should be better. Instrumental solutions to social control requirements would be less frequent, transducers not reducing the variety, and the technical level making the world visible, contributing to informating it.

12.1.8 SUMMARY AND FUTURE INFORMATION SYSTEMS RESEARCH DIRECTIONS

The ethnography has informed the analysis and suggestions. The maps and matrices/spreadsheets as mainly diagrammatic representations are the most common visible artefacts in command work, often taped onto walls, boards, and tables. They merit study from the perspective of work as producing and working through symbols that represent and express knowledge about the world and how it can be controlled. Ideally, computers should be valuable, because they are artefacts that can manipulate symbols (Ehn, 1988) and hence can support symbolic work. The actual design work means to create an interface that *integrates* workspace and paper-based tools, whiteboards and computer artefacts, social and instrumental control interests, and contextual conditions with the actions in the work, augmenting the visibility of the work. However, it is necessary to systematize studies in greater detail in order to reach concrete solutions and to identify fruitful potential future research directions. The analysis has led to several research questions for command work ISs and computer artefacts, covering topics of knowledge representation, knowledge distribution, IS architecture, and design work, some of which are:

(1) Knowledge representations

- What principles are used for *making representations of knowledge in the work*, for example design of non-standard symbols and combination with standard symbol sets?
- Are there any and if so, what *differences* in producing and using representations of knowledge according to the *economic/diagrammatic* and the *correspondence principle* respectively? How to evaluate (measure) *computational efficiency* and *affordance ?*
- How do actors iteratively use different kinds of external (visible) and internal (invisible) representations (the interactivity between these representations)?

(2) Knowledge communication and distribution

- How should we design *interfaces for communication media* (telephone, email, fax) that afford both social context and function (usability) and their own technical function (access)?
- How can we keep track of the *social distribution of knowledge*, "who knows what and where" in a distributed workspace, and how to link knowledge-bearers and power-holders into networks with the help of new technologies, wearables ("walkstations") ?
- How can the *traditional map get augmented capacity* to support communication, calculations, and better computational efficiency?

(3) IS architecture

- How should we *integrate computer artefacts* and *simple technology* (such as the 3x5 card, maps) in order to *externalize* and *make visible* work and representations of knowledge?
- How should we design artefacts that fulfil criteria for *use in different rationalities*, the rationality of practice that move with the work?
- What does ISD mean if the architecture is defined as *integrated informating, mediating* and *informing subsystems*?

- How can we *integrate the IRM* and *the VBS approaches* in a way that optimizes the utility in work?
- How can we *enhance the usability of the traditional command workspace* by integrating, for instance, the ordinary map and computer artefacts, to turn the map into a computer of its own?

(4) Design Work

- What are the preconditions, both as regards *design tools* and *social factors*, for the active participation of people (workers) in ISD, in order to avoid detached design of stand-alone artefacts?
- How to *balance between engineering efforts* and *other design approaches* ("art") in ISD in order to *secure social acceptance of IS* and minimize potential resistance toward formalization?

12.2 Conclusions

This thesis is the outcome of a study that started with accounts from the war in Bosnia (Persson, 1997). The study continued as ethnographic fieldwork during command post exercises in Sweden. By producing an analytically informed ethnography, I have described command work, trying to make it intelligible to researchers and those who are actively involved in it. Rather than just searching for immediate technological and organizational solutions that would improve efficiency, I chose to study command work from within in order to discover (validate) theory, to find out how to inform ISD for the military. This thesis fits in the qualitative tradition of case studies. In this tradition, the analysis of individual cases and the relationships between them yield strong empirical results. From this kind of case analysis, I have formulated my conclusions.

The final conclusions start from the cases, the Meeting and the Table, and I will examine them first from the ethnographer's perspective, capturing what we can learn from them, and then shift position to the IS designer's position.

The study of the cases has resulted in a tentative answer to the superimposed research question (Chapter 1), why attempts to implement and use IT are often such uncertain enterprises. As long as there are contradictions between power and knowledge, when different realities are not integrated, difficulties will grow when command work is reformed, implying efforts to implement IT. This answer is concise and free from details, but there are many intricate consequences. The gap leads directly to conflicting perspectives on the organization's central concerns. The contradictions spill over to the actual work, and result in difficulties when designing the organization and its practices. What becomes central is how the need for internal order and controllability (coherent with the symbol signifying the Army) can be conjoined with its ability to face uncertainties in an unpredictable environment (a desired capacity in war).

Both cases originated in contradictions between design requirements from practice and from the systems-engineering community that had produced the infrastructure in the HQ. The "common sense ISD" had introduced a foreign element in the work and self-help initiatives evolved. The military action culture, the *rationality of practice*, is colonized by a strong control culture. Using the mind – matter dichotomy, the FENIX system did not admit autonomy to the mind and became matter that prevented rapid action. In turn this situation promoted innovation that eventually resulted in satisfactory autonomy for the mind.

We must realize that terms like "rationality" are constructs that enable us to talk about a phenomenon in the world. It is central to the understanding of social actions, how the social value of concepts shifts and leads to innovations, making durable definitions hard to strike at. The study demonstrates that because of the skills of the staff to balance between and integrate different rationalities, real-world problems can be solved. *Integration of rationalities* (and realities) was achieved in the meeting and in the Actualities' Table (Figures 12.1 and 12.2). The visible and social actions in work are labelled talk, discussions, negotiations, and quarrels.

Two fundamental insights are to recognize the role of *social power*, and what is *socially relevant* and *rational* may deviate from what is *scientifically* rational or *logical* elsewhere. Given authority or a certain social power, some actors become or are expected to act as *rationality brokers* during design of control actions and can reconcile contradictions. Representations of knowledge are re-negotiated when necessary and computer artefacts (including their output) are considered more or less relevant over time.

Command work is a kind of design work, working with and producing symbols. "Work" means to produce something useful, with effect, and thus is close to design. It presupposes direction and commitment. It should be possible to create symbols out of any technology (during the series of CPXs sudden loss of or reduced electric power from the mobile generators recurrently caused problems). Computer artefacts should be designed so as to support communication, to create tools for continued design, of meaningful symbols ("information") and of work. Originating in the idea of the Viable System Model and conducted during boundary management, the conception of command work as design work means that it is not an ordinary, repetitive and routine based activity. Even if some basic routines are used, they are combined and recombined in ways that give people the requisite variety they need, also when it comes to concepts. The cybernetic principles of variety and viability have to be supported all through the IS architecture and the work and support the organizational integration of the VSM subsystems intelligence and control, in the HQ of operations and logistics.

What does command work viewed as design work mean when it comes to ISD? Practice was reconstructed repeatedly if necessary. The temporary character of the organization augmented this tendency. Probably a VBS strategy is more relevant than an IRM approach because the control aspect has less weight as compared to communication, sensemaking and argumentation. In the mobile office in the woods people have to get in touch with each other. They have no use for complex interfaces to communication media or an infrastructure that cannot follow them in the workspace. They must have tools for their work.

The accounts and the cases demonstrated that much social control is achieved via systems engineering and organizational design. The products from these efforts give people little support for sensemaking or argumentation. A gap between requirements and resources for work easily opens and it has to be bridged by boundary objects such as social interaction or self-help systems. The suggestion, therefore, is to make a better distinction between what are engineering tasks (organization, communication links) and what has to be reached through command work as a rational social design enterprise. Now there is a melange between these design arenas.

ISD is primarily about contextuality, autonomy, the integration of interests, and finding the “zone of proximal development” (Kuutti, 1991). Design of ISs should be design *in work*, not design *detached from work*. If ISD is about *abstractions* (images, knowledge), less connoted to computer artefacts, then they can be designed by virtually anyone, provided they are aimed for local use, in the own group, following the logic of the infological equation (Langefors, 1993). All that is possible to do in advance is to facilitate such design and redesign, for instance through resources for communication, instead of detailed design of high-level working procedures. Then it must be possible to externalize these abstractions, make them visible and permanent. A different perspective means to create an infrastructure of technical subsystems that will produce data, including informating, mediating and informing (technical) subsystems, according to the common sense notion of information as *resource*.

I have presented a view of a socially complete IS that has four subsystems and corresponds to cybernetic base model (Beer, 1981) framing the whole study. ISD must not stay only at the informing subsystem but include the whole context where work occurs and artefacts are used, to be conducted in analogy with the conditional matrix (Strauss and Corbin, 1990). The design output must not be abstract because work does not only consist of invisible cognitive activities. Instead the whole sequence is about visibility, presupposing a conscious view on the meanings and relations between central concepts: information, knowledge, and representation.

Some key design concepts are starting positions for continued research on design for work (Section 12.1.7). First, *affordance of knowledge* is central, knowledge that is "ready-to-hand" (Ehn, 1988) even as a symbol (computational efficiency if a representation is used), and about artefacts for support of an efficient *social distribution of knowledge* (Anderson and Sharrock, 1993). Then, *design in the work* is a leading principle. What is part of the well proven tool set in command work has to be recognized and refined into an *epistemology of practice* (Miser and Quade, 1985). As regards the artefacts, the analysis has showed what principles are important for control (*visibility*, *comparisons* and *computational efficiency*). The crucial aspects of *communication* and *preservation of visibility* are next to be considered. The concrete work on "*calculation systems*" (Avdic, 1999) which shows that actual, high precision, and flexible tools can be built by practitioners, is worth closer study. In addition these tools seem to have a high social value because of their explanatory and persuasive power. Such tools already belong to the command work tradition. "Flexibility" also means to support work in *open processes* that can be formed according to the situation, and in designing of them, and help people maintain focus on orientation: to keep track of where they are in a set of open processes. *Externalization* comes next, adapted to where people are, as for example the 3x5 cards and the flight progress strips. Some of these criteria were present in both the Meeting and in the Actualities' Table.

I have presented a model of command work that promises to be useful for the design of computer artefacts for cooperation, *cooperative systems*, not only within the military. The modern command organization is one where the complexity promotes a far-reaching division of labour and dependence on experts' competence. The title of the thesis states that within this framework of organized command work, where control is implicit, it is vital to bring knowledge (experts) and power (formal authority) together if an army is to emerge, both as a symbol and as a full-scale construct. This convergence implies either to *empower the experts* in the modern command organization, that *those who have power learn*, or to create *efficient means for communication* between actors. Thereby it becomes possible to give priority to justified needs for *autonomy*, *commitment* and thereby for *survival*.

Postscript

IN THIS LAST SECTION I summarize and reflect over the impressions from the fieldwork and continue with comments on some central phenomena in command work and research. The thesis is the document from a long study on military command, conducted from an *information systems perspective*, its foundation being many years professional military experience. My perspective is narrow, because there are several ways to see information systems. Likewise, there are a multitude of ways of viewing military command. In order to find a perspective which could be followed in a consistent manner, in a qualitative study, I have performed the study as an ethnography. This kind of study is just one of many approaches in the vast area of information systems research, or specifically, to study what people do in a social environment, in their work. I have consciously avoided dealing with decisionmaking, psychological or cognitive topics, which of course can give additional insights into this complex area. My perspective highlights some of many aspects, but does not in any way exhaust the command domain.

> The "command workers" fought hard in their boundary zone to achieve efficiency, to conquer upcoming challenges and constraints, both originating from their own command work and work spaces, and from the environment. It is easy to understand that on some occasions little attention could be given the work itself, when survival in the demanding inner environment remained a prerequisite for any result. The enemy, although represented and mediated by innovative persons in a simulated environment, competed with upcoming frictions from within. All became an aggregated work load in the HQ. The people, this 'tribe of warriors', are worthy of admiration, and proved the capacity of humans who from the beginning were given a basic autonomy, understood how to make the most out of it, and succeeded in many respects. They may find themselves less supported by their own bureaucracy (maybe even enjoy the freedom from it) at the same time as they

> must be competent to generate resources from the same environment: by being "opportunistic assemblers of functional systems" (Hutchins, 1994, p. 172). I have discussed validity and whether the study was valid. When, after the exercises, I visited the staff in order to talk about some observations, I got the comment "Thanks for your interest, we are glad that someone cares about us". I read this as if the study has touched upon something relevant as regards change, introduction of new technologies, and the conditions for the command work.

Forty years ago research on organizations from a systems theoretical perspective was a fairly new field. Little was known about decentralized decision-making, the information and decision load that can be supported, and the effect of various communication structures and practices on alternative forms of organizations and their cohesiveness. Researchers hoped to enter into a (emphasis added) *"period of exciting systematic data collection"* (Ackoff cites Haire in Emery, 1969, p. 336). Ackoff's hope has still to be satisfied. Even if we can produce exciting data with the help of modern computer technology, informating social action, realizing that not all is relevant is an essential insight.

I intend the study to be a contribution to what commonly is called a "science of command," sometimes "...of command and control". My perspective led me to start from contradictions inherent in the military and I assume that this focus has directed the attention to relevant issues. From contradictions it was a very short path to examine some issues that are mostly taken for granted but not very well researched in that kind of research which is conducted within the military. Much research is directed at improvement of the internal control with the help of mechanisms such as management techniques, discipline, or leadership. My interpretation of such mechanisms is that they aim at making contradictions manageable. The harmonization which is achieved, completed by technical control attributes from within the bureaucracy (law, promotion, salary, punishment) often is satisfactory. People accept control as part of the military culture, the latter being part of the nation state institution. Evelyn Waugh (1952) formulated his main character's thoughts:

> Later in his military experience, when Guy had caught sight of that vast uniformed and bemedalled bureaucracy by whose power alone a man might stick his bayonet in another, and had felt something of its measureless obstructive strength, Guy came to appreciate the scope and speed of the Brigadier's achievement. (Men at Arms, p. 135)

Many contradictions can be hidden inside the organizations, but losses of lives belong to those which are most difficult to reconcile. If it cannot be satisfactory managed, there is a risk for loss of autonomy and with it, power. Few technologies will help restore such a situation.

Researchers' difficulties in getting access have been discussed by Caforio (1998). I interpret this partly as a lack of trust in the research community, perhaps originating in individual researchers' efforts to study the military. Through continued priority toward technical aspects or rational views on humans, the military will be less capable of building viable systems and instead fortify very specialized command units within protective cocoons. Traditional military culture within the nation-state has in many nation-states become a reservation for warriors. After all, machine-warfare, the modern Western Way of War, conducted by technical experts, is juxtaposed by situations where traditions and technologies become outdated. A totally different environment where even war has merely become invisible now faces what has been built according to seventeenth century blueprints.

In this study I have not intended to work from an economic perspective but rather to look at what people do when sparse resources are handled and controlled, to study work strategies, methods, and to see how control technologies were used. The study has indicated the very long tradition in creating powerful tools for social control over simple practices which involve counting, writing, and calculation. An outcome of this beginning are the modern management techniques including accounting, where detailed calculation and comparison of numbers are state of the art control. It is common practice that numbers are adjusted in order to fit the imperfections of the social world. Nevertheless these techniques have set the standards for control thinking. Thus, with the computer and modern information systems, still more precise control mechanisms are sought for. They are accompanied by a strong belief that information and knowledge can be objectified and stored ready to use somewhere, to be retrieved by the push of a button, at one's fingertips. There is just one item which is a prerequisite to making sense of all this so-called knowledge, human expertise. Unfortunately information technology can call for attention to more than command work. During the very first exercise, when HQ A pioneered the change process and tried to make sense of the interim IS, I heard a conversation:

- What is in our servers is a graveyard...

- An information graveyard.

The study suggests that it is necessary to make room for more autonomy instead of enforcing more control, and beware of intrusive technologies and blunt control behaviour from bureaucratic control mechanisms (implemented as new computer artefacts). On the one hand close monitoring is positive and necessary. Modern forces must be monitored in greater detail because they consist of *individual actors* whose *competence* is not easily replaceable, and when lost, affects the whole organization. There is also technology which has to be closely monitored and maintained. “Competence” is, of course, the organization’s concept for human expertise. In reality, any casualty also means sorrow and personal tragedies. This fact was understood from early on. During the crusades, the Assassins found out that a bureaucracy was a terrible enemy. They avoided, said Bartlett (1993), killing enemies who belonged to a crusading order because unlike “family member enemies”, one killed was soon followed by another identical competent male warrior. Thus, at the same time as the bureaucracy can be a terrible enemy (also for its own inhabitants), it has a vast potential to draw upon. Our warrior tribe which, unlike the Assassins (ibid.), had grown up *within* the bureaucracy could choose between two strategies, either the social or the formal rational, depending upon the situation. The modern warriors could choose to work socially within the bureaucracy, following its rules and exploiting them, or to find ways to circumvent bureaucracy, either outside or inside it, even using it as a pivot.

In either way, they were skilled in the use of technology, and could neutralize constraints and contradictions in many situations, reach autonomy and stay in power. The capacity to unite social and instrumental rationality was demonstrated in the first case, the meeting. Let us look at representations and control artefacts. I concluded that the old contre-rolle (also in its new shape, the spreadsheet) can be a reliable way of creating not only a virtual but also a credible and intentionally false reality. Such actions show that facts do not lie in the figures but in the minds of their creators and interpreters, the designers. Concerning the rationales to modernize, unlike in business administration there is not the same profit-driven need for an ongoing rationalization of the command organization. To be competitive in a market: resources must generally and necessary be handled economically. The imperative in command work comes from the need to reduce manpower, to protect those who cannot be replaced by machinery, in order to avoid losses and to simplify control and logistics. The use of technology is intimately linked to this need, to *gain power*, directly or indirectly (which presupposes calculations and planning), and *win autonomy*. A photography (Figure 1) from the end of the last exercise, can be read as an illustration of the last technology to rely on when nothing else was left.

Because humans are able to organize and in addition as individuals are different, contradictions and conflicts are part of the social fabric. A push in one direction is sooner or later checked by a move in another direction. During the series of exer-

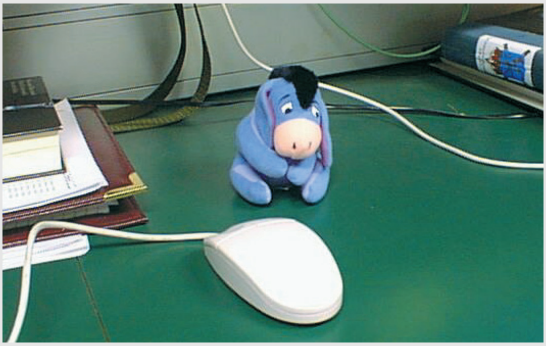

Fig 1: The Last Hope, the Ultimate Technology?

cises, the organization was even consciously filled to the brim in order to compensate for the less than optimal and ideal information system in the form of an interim solution. This led to more demanding control requirements. It was obvious that more men meant greater logistic demands and led to problems (evaluation report June 1998), but the risk for greater losses could be downplayed. In the background was a perspective on “control work” executed by means of certain technologies. These technologies occupy peoples’ minds, but when “work” turns out to be something else, technologies must follow. Therefore, there can also be a metaphor in the photo: *man versus technology*. We see a need for a new control layer (Beniger, 1986), where the same old basic work components (write, calculate, communicate) can be applied in new ways, allowing “heurithms” (Langefors, 1993), design of work and creation of a culture for the work. Knowledge is prerequisite.

Perhaps the study shows that research, too, must work within different rationalities and what is labelled as “science” depends on the situation. If this is so, I appreciate the training within the military, the best school possible to learn how to be a “rationality broker”. Researchers doing ethnography also need autonomy, have to be empowered and use technology. One difference between a researcher and a military ‘command worker’ is that the researcher has a different kind of bureaucracy to exploit when searching for resources, one where the allocation of power is less visible. This has advantages and disadvantages. Once inside the research community, it is easier to work autonomously, but one never knows exactly when rules are broken or what rules to break or obey (in order to get funds). In the military, autonomy may be very hard to achieve at least in subordinate positions, but most know the rules and where power is. It is easy to profit from this, perhaps first defining and renaming contraints, then circumventing or exploiting rules to one’s advantage.

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1. When considered beneficial for the understanding, titles of academic papers, reports, army and project documents and the like have been translated. These unofficial (in most cases) rubrics/descriptions in English have been confirmed with authors when possible and are bracketed by […]. Published books have not been translated except when the authors have been contacted and admitted translation. Military regulations, working papers, and documents are listed at the end of the references.

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