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Title of Paper

The Impact of GPS Support on the Performance of Municipal Crisis Management Teams

Topic(s)

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Topic 7: Modeling and Simulation

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ABSTRACT

This research investigates the impact of a geographical position system (GPS) support tool on command and control in a crisis management organization. The organizations of interest are Swedish municipal crisis management organizations and their crisis management teams. The goal is to investigate differences in the work processes of teams that have access to a GPS in its command post, compared to teams that do not.

We have tested:

1) Non-professionals, a total of 132 students, forming 22 groups.

2) Professionals, a total of 108 professionals, forming 18 Swedish municipal crisis management teams.

Results show that we get different performance and behaviours depending on the support and type of participants. The support tool helps the students and some of the professional users.

- Students - the support tool helps the students.
- Professionals - the support tool help command posts that consist of only emergency services personnel.
- Professionals - the support tool does not help command posts that consists of a mix of staff from local authorities and emergency services personnel.

The quantitatively analyzed behaviour patterns show that the C2 behaviour has a significant impact on the performance when using the GPS based support tool.

INTRODUCTION

Many municipalities involved in crisis management in Sweden today have made, or shall make, significant investments in different information and communication technologies. The goal of the investment is to increase performance and control of the organization's everyday accidents as well as during crisis, but the assumptions on gains often has not been empirically evaluated.

The two studies reported on in this paper utilize a micro-world simulation (Brehmer & Dörner, 1993; Brehmer, 2004) to study a global position system (GPS) concept on command and control teams. The goal is to identify differences, with regards to performance and communication, in the work processes of teams that have access to a GPS in its command post, compared to teams that do not. Study 1 tested 132 university students, forming 22 groups. Study 2 tested 108 professionals, forming 18 Swedish municipal crisis management teams.

The paper has five parts, Part one starts with this introduction and include *C2 and its modern extension C4ISTAR* and *Micro Worlds*. Part two *Two studies designed to explore GPS impact on performance and communication* describe the method for the studies as well as mapping of the GPS to the micro world and the C4ISTAR notion. Part three consist of the *Performance* result and part four of the *Communication* result. Part five conclude the paper with *Discussion* on the results.

C2 and its modern extensions C4ISTAR

C2 (command and control) in principle is the same as C4ISTAR (command, control, communications, computers, intelligence, surveillance, target acquisition and reconnaissance) – both are designed to frictionless and fast information transport needed for C2 purposes. The differences lie only in the factors involved. While C2 mainly focus on bringing the “order-information” from commanding level to tactical units and reconnaissance-data from tactical units to commanding level, C3 (communications) adds the communications technology, alternatively communication procedures between persons. C4 (computer) includes computers to direct, process, visualize and accelerate information streams. I (intelligence) and R (reconnaissance) bring in the processing of reconnaissance and intelligence data as new and important facets of modern leadership. TA (target acquisition) aims at the possibility to detail “effectors” for a special “target”. S (surveillance) can be seen as a continuous systemic function, covering the entire area of operations, from combining intelligence and reconnaissance data to sensor-reports with the communication network as a indispensable precondition for delay less and adequate reaction.

Micro worlds

Micro worlds are simulated environments where the system designers select important characteristics of the real system and create a small and well-controlled simulated system based on these characteristics (Granlund, 2002; Johansson, 2005; Woltjer, 2005). Micro worlds have, in the field of psychology, been viewed as tools to overcome the tension between laboratory research and field research (Dörner & Brehmer, 1993). The problems of laboratory research are the lack of relevance or external validity. The problem of field research is the lack of control and problems in finding causal interpretations of the results. The root of these problems lies in the inability to handle complexity, too little respectively too much complexity. Typical environments that can be simulated by using a micro-world are ecological, political, economical systems, military systems, and forest fire-fighting emergency management (Granlund, 2002).

The advantage of using a micro world is that the complex, dynamic and opaque characteristics generated by a proper micro world represent the cognitive task people encounter in real-life systems (Brehmer and Dörner, 1993; Dörner & Schaub, 1994; Granlund, 2002). Their complexity lies in that the participants need to weigh a number of contradicting goals and causes of actions that are coupled via processes within the system. The actions of the participants will form the systems state as well as the system it self, that change autonomously, and create dynamics to the world. Opaqueness refers to dimensions of the simulation that the participants cannot figure out. Dimensions they need to test in order to understand and control. Moreover, another important property of micro worlds is that they provide means to present a number of different problems for the participants, rather than a single, well-defined task (Granlund, 2002). Not to understand side effects of actions, adopt an ad hoc behavior as well as thematic vagabonding, and to have severe problem with delayed feedback are typical errors that participants make in micro worlds. Inability to understand regularities in the time-course and overlook checking the outcomes of the actions are others (Granlund, 2002).

The micro worlds characteristic, the ability to present a set of tasks and all possible errors make micro worlds stimulating for the participants that thus take their assignment seriously and, accordingly, are valuable to the researcher (Dörner and Schaub, 1994; Gray, 2002).

The micro world utilized in this research, C3Fire, is specifically designed for command and control studies (www.c3fire.org, Granlund, 2002; Granlund & Johansson, 2003). C3Fire generates a dynamic forest fire fighting task and has been used extensively in previous research on network based command and control (Artman and Wearn, 1999; Granlund, 2002, 2003; Johansson et al., 2003; Woltjer, 2005), on effects concerning information support systems (Granlund, 2004; Johansson et al., 2005; Granlund et al., 2010), on cultural differences in teamwork (Lindgren & Smith, 2006a, 2006b), and comes form a long tradition of micro world research of distributed decision making (Brehmer, 2005; Brehmer and Dörner, 1993).

METHOD

Study 1, participants

A total of 132 university students, forming 22 groups participated in the study.

Study 2, participants

A total of 108 professionals, forming 18 Swedish municipal crisis management teams participated in the study, 26 females, and 82 males.

The participants had computer experience. 46% work at the computer 4-8 hours per day. 46% work at the computer between 1-4 hours per day, 8% less than one hour per day, but none indicate that they are not daily users of a computer.

The participants are inexperienced when it comes to playing computer games. 82% do not play at all. 18% play 2-8 hours per week. No one played more than eight hours.

Experimental design

The study had a between-group design with one factor: (a) command teams using GPS, and (b) command teams using paper maps (Figure 1). The difference between the two conditions was the type of support the participants obtained in terms of information visualization and data sources, GIS or paper Maps.

In each team, three participants worked as commanders in a command post and three participants worked as ground chiefs on the simulated field (Figure 1). The commanders in the command post consisted of one commanding officer and two liaison officers. They worked on an operational level and commanded the ground chiefs. The commanders had no direct contact with the simulation and only controlled the simulated world by commanding the ground chiefs. The ground chiefs controlled three units (fire brigades) each in the simulation.

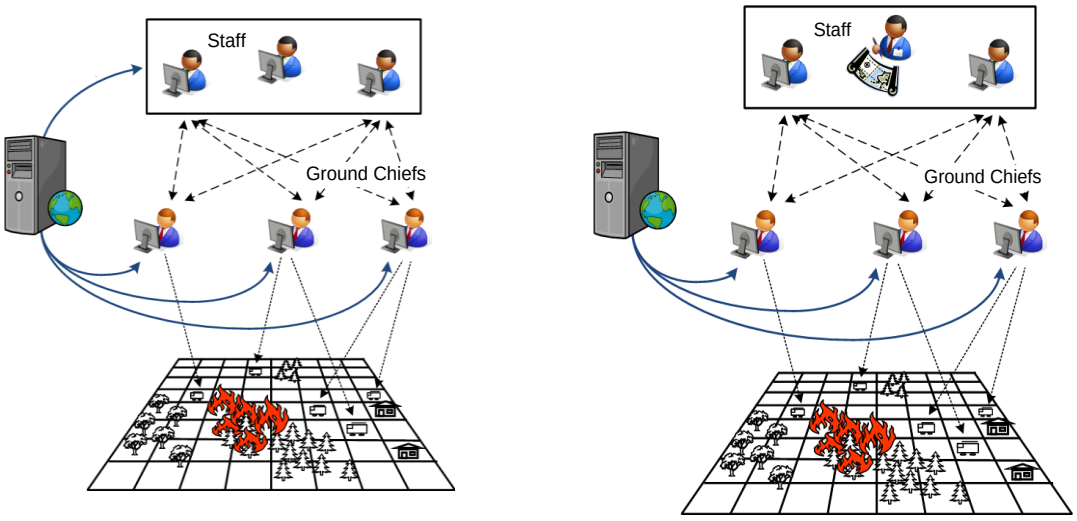

Figure 1. GIS condition and paper map condition

The GPS condition:

The teams in the GIS condition had, during the experiments, real-time data from the GPS available, as well as four digital map layers, but they faced the problem of handling the extra technological dimension the system represents.

The command post used three terminals. One terminal was equipped with the GPS. In the map layers, precise position data was displayed, in real time, for the 9 fire fighting units that the ground chiefs controlled. The user interface of the management support also displayed detailed information about each fire fighting unit's characteristics and actions. In addition to the GPS terminal, the command post had access to two liaison terminals for communication with the ground chiefs (Figure 1).

Each ground chief had access to one digital map layer, integrated with a tool for communication with the command post (Figure 1). The ground chiefs used the digital map to command their fire fighting units. Each fire fighting unit had a limited field of vision in the simulation, and reflected only the simulated reality in the immediate surrounding area of the vehicle. Each ground chief had thus three fields with valid information of the simulation. This information they passed on automatic to the command post, via the GPS. The command post had accordingly information about 9 fire fighting units.

The paper map condition:

The teams in the paper map condition had no management support and obtained their knowledge about the state of forest fires and fire fighting units by communicating via email, with each ground chief (Figure 1). Although this is less precise and a slower way to get data on the state of the simulation, the command post in this condition had the advantage of working with a familiar medium, a paper map.

The command post had access to a paper-based map equivalent to one of the four digital map layers. C3Fires coordinate system was on its axis. In addition to the paper map, the command post also had access to two liaison terminals for communication with the ground chiefs (Figure 1).

The ground chiefs was working under the same circumstances as in the GPS condition, meaning they had access to a digital map layer integrated with tools for communication with the command post (Figure 1). The ground chiefs used the digital map to command their fire fighting units. Each fire fighting unit had a limited field of view in the simulation, and reflected the simulated reality only in the immediate surrounding area of the vehicle. Each ground chief had thus three fields with valid information of the simulation. This information they

conveyed to the command post, via the email system. The command post had the information given to them by the ground chiefs.

Apparatus, GPS and micro world mapping to C4ISTAR

In the C3Fire micro world the participants' organization, resources and communication structures was set up in accordance with the research goal. The user interfaces and communication tools was individually set-up for all participants. For these studies a GPS module was connected to C3Fire. All events occurring in the world and all text messages were saved into a database for analyses and for instant replay of the simulations during the experiments.

As mentioned above micro worlds are simulated environments where important characteristics of the real system are selected as base for a small and well-controlled system. For these studies four characteristics of a GPS was picked out; unit position, unit state, view of sight and wind. In the C4ISTAR the GPS condition and the paper map condition have different features corresponding to the notions.

The **C2** (command and control) is not affected by the conditions; rather these are the notions on witch the conditions are supposed to have an impact.

The **C3** (communications) differ as in the paper map condition all communications is done by text messages via the liaison terminals. No information is exchanged between the command post and the ground chiefs in any other way than by the text messages. In the GPS condition the text message communications is severely extended by automatic, visual, real-time information on all four chosen GPS characteristics. The automatically transformed GPS data can be used by the team, command post and ground chiefs, as a way to communicate. The automatic communication has one direction, from tactical units to command level, not the other way around.

In **C4** (computers) the command post in the paper map condition has two liaison computers, but the GPS condition has two liaison computers and one computer exposing the GPS for the commanding officer.

The **I** (intelligence) and **R** (reconnaissance) seen here as the processing as **S** (surveillance) of intelligence and reconnaissance data, is not really affected by the conditions; rather they are like C2 seen as notions on witch the conditions are supposed to have an impact.

The **TA** (target acquisition) differ as in the paper map condition all detailing of effectors (fire fighting units) to a special target (forest fire) is made on the basis of textual information from tactical units manually transformed to a paper map by the commanding level. In the GPS condition the same detailing is made automatically by units positioning and view of sight in the GPS tool.

Experimental procedure

The experiment is performed in three steps, introduction to C3Fire and hands on training, five session cycles and a concluding debriefing (Figure 2). The experiments were conducted in the participating municipality's regular emergency management offices. This means that the entire computing environment was moved before each experiment.

When the participants arrive, they get an introduction to the task, instructions and perform an exercise simulation for learning how to use the system. During the simulation exercise, the participants learn to manage C3Fire. The exercise is followed by questions to the instructor and time for team talk. The training requires about 40 minutes.

After training, the team performs five session cycles (Figure 2). The number of simulation trials is limited to five as previous studies of Svenmarck & Brehmer (1991) showed that performance stabilizes after three to five performed trials. Partly because the teams need several attempts to develop distinctive strategies depending on condition, GPS or paper maps. The fifth and final trial will thus be the most important from an analytical point of view. The strategies is at this point most distinct. A reason not to continue with the trials is that the experiment as a total takes 6 hours to complete. With more trials fatigue may arise and have undesirable effects on the outcome.

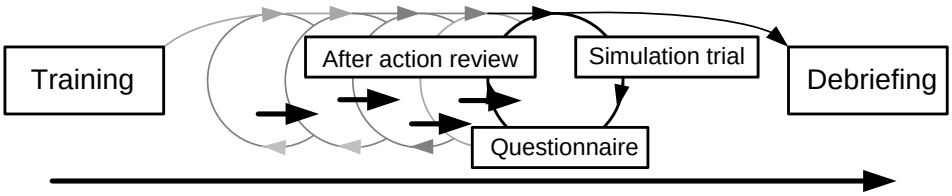

Figure 2. The experiment method with; training, five session cycles and a concluding debriefing.

Each session cycle consists of 20 minutes C3Fire simulation trials, 5 minutes for individual surveys and 20 minutes after action review. A session cycle takes about 50 minutes.

During the after action review, an evaluation and strategy talk, the participants watch a recording of their last trial. The recording replays not only the different firefighting unit's actions in the game, but also the total fires spreading. This gives the participants a greater understanding of the dynamics of the situation. They discuss their results together and make strategic plans for the next simulation session. This phase is intense and often takes as much time as the simulation. The after action review focuses on the participants awareness of the latest simulation in a joint reflection

After action review consists of an evaluation and strategy talk. During the after action review the participants look at a recording of their latest simulation trial. The recording shows the various units' actions during the game, and the total spread of the fire. The recording and the participants' discussion of events in the simulation gives them a greater understanding of the dynamics of the situation. They discuss their results together and make plans for the next simulation experiments. This phase is intense and often takes as much time as the simulation. After action review focuses on participants' awareness of the recent simulation through joint discussions.

The debriefing increase the participants' awareness of the learning processes they have gone through during the day's trials and is facilitated by the instructor. This differs from the after action review, which is controlled by the participants themselves. Debriefing extends the time scale and change the focus of learning in the direction of a collective awareness of the general principles of crisis management (Rego and Peter, xxxx).

RESULTS, PERFORMANCE

In this section the results of the teams' performance are described. For performance the most vital result is from the fifth trial, but the average result from each of the five simulation trials are visualized. The performance measure is a simple measure of the amount of burned out area at the end of each simulation. The measure gives an overview of the difference in the mean between the different types of teams. Generally one can say that a small amount BurnedOutArea is preferable to a large. The measure, however, says nothing about the type of surface, forest, field or house, which has been burning.

The results are from the study with students as participants and from the study with professionals. The results are presented with respect to the two conditions GPS and Paper Map. The latter study is presented partly with overall results and partly with results assigned to the two professional subgroups, RSCP and MCP.

Performance, students

For students the results showed, an over all significant difference, P=0,021 (N=132), between GPS and Paper Map over the five simulation trials (Johansson et al, 2006; Johansson et al, 2010). The groups with GPS support had a smaller amount of BurnedOutArea than the groups who used Paper Maps (Figure 3).

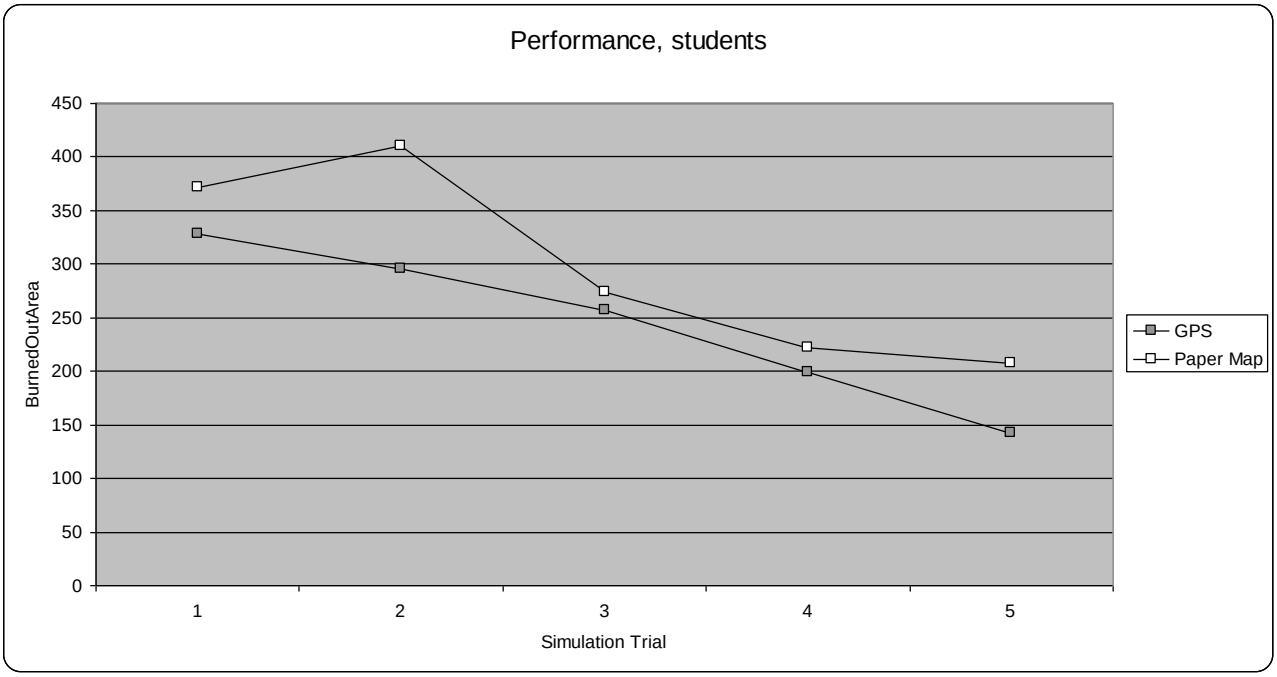

Figure 3. Students, Burned out area in end of trial, GPS vs Paper Map.

Performance, professionals

A different pattern emerges in the study with professionals as participants. There is no over all performance difference between GPS and Paper Map in the simulation trials and the trend of teams with GPS to have a smaller amount of burnt out area is wrecked in simulation trial 5 (Figure 4).

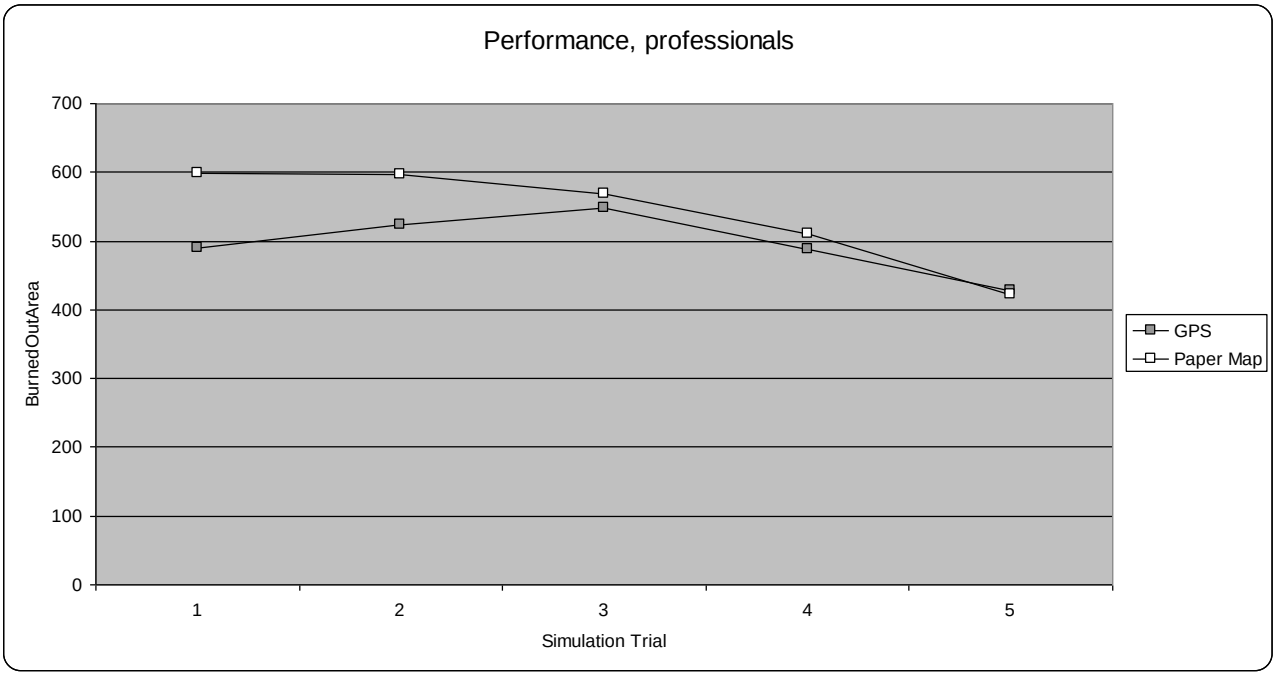

Figure 4. Professionals, Burned out area in end of each simulation trial, GPS vs Paper Map.

The student groups' performance is likely as the GPS offered more information, and in real time, than the paper map, and the task should reasonably be easier to solve with this information. Yet, our professionals contradict these results. Teams in the Paper Map condition perform as well as teams in the GPS condition.

One explanation is that our professionals are not a homogeneous group and therefore may have a diverse result on amount of BurnedOutArea that is not visualized with the mean covering all teams in each condition as in Figure 4. The teams' command post has a decisive influence on the outcome of each simulation trial. It is they who lead the entire operation. The command posts of this study could be sorted depending on profession as; command posts with only rescue service personnel, RSCP, and command posts with a mix of rescue service personnel and other municipal personnel, MCP.

RSCP, (Rescue Service Command Post) consists of a relatively homogeneous group of professionals with common education, training and with experience in commanding crisis events. MCP (Mixed Command Post) consists of a heterogeneous group of professionals varying from rescue service personnel to municipal personnel, heads of administrations as well as operational personnel with security responsibilities. MCP varies in terms of training and experience. Some of the participants are accustomed to command crisis events others are familiar with management, during normal conditions.

GPS condition, command posts with different professional disposition

The graph for RSCP and MCP in the GPS condition only, corresponding to fig, is shown in figure 5.

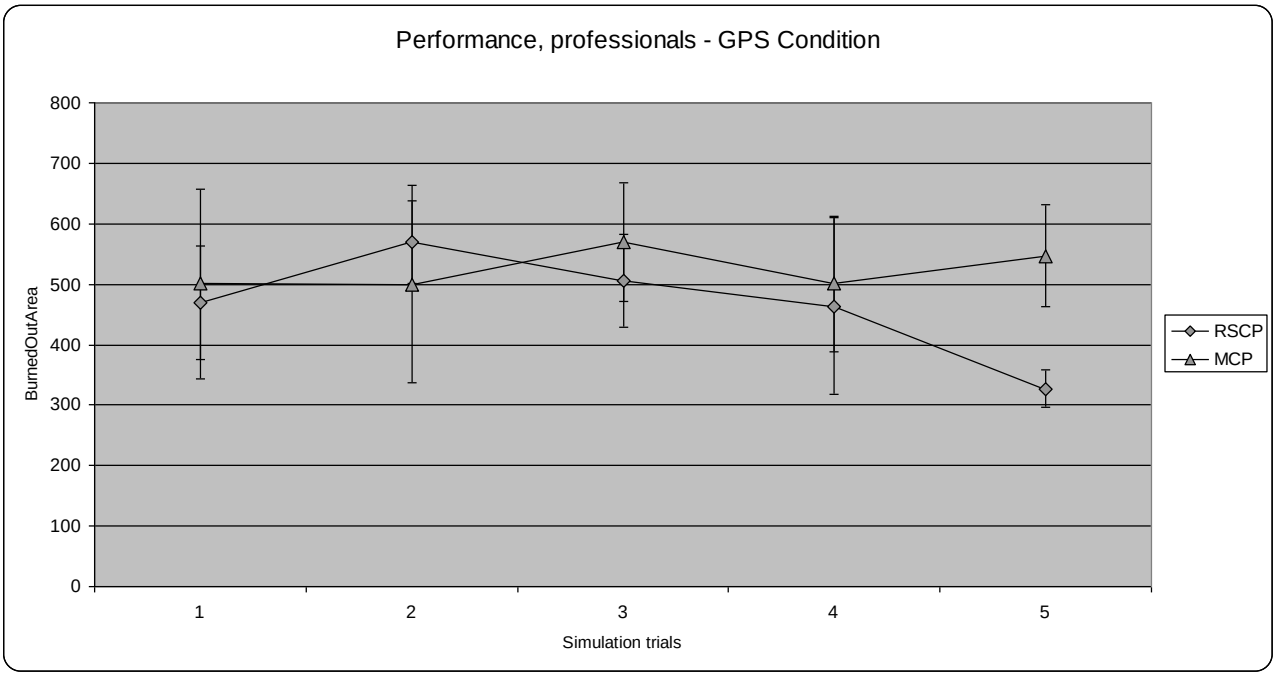

Figure 5. Professionals, Burned out area in end of each simulation trial, RSCP vs MCP in GPS condition.

There is a performance difference between the two types of command posts, RSCP and MCP, in simulation trial 5 of the GIS condition. RSCP have significantly less amount BurnedOutArea than MCP, $t(6) = 4.20$, $p < .006$. A value that is to be considered as an outlier is excluded from the calculation. Teams with command posts with only rescue service personnel, RSCP, have a positive learning curve through out the 5 trials, concerning the amount of BurnedOutArea. MCP has no learning curve. It is neutral with regards to the amount of BurnedOutArea (Granlund et al, 2010).

Paper Map condition, command posts with different professional disposition

The corresponding graph for RSCP and MCP in the Map condition is shown figure 6.

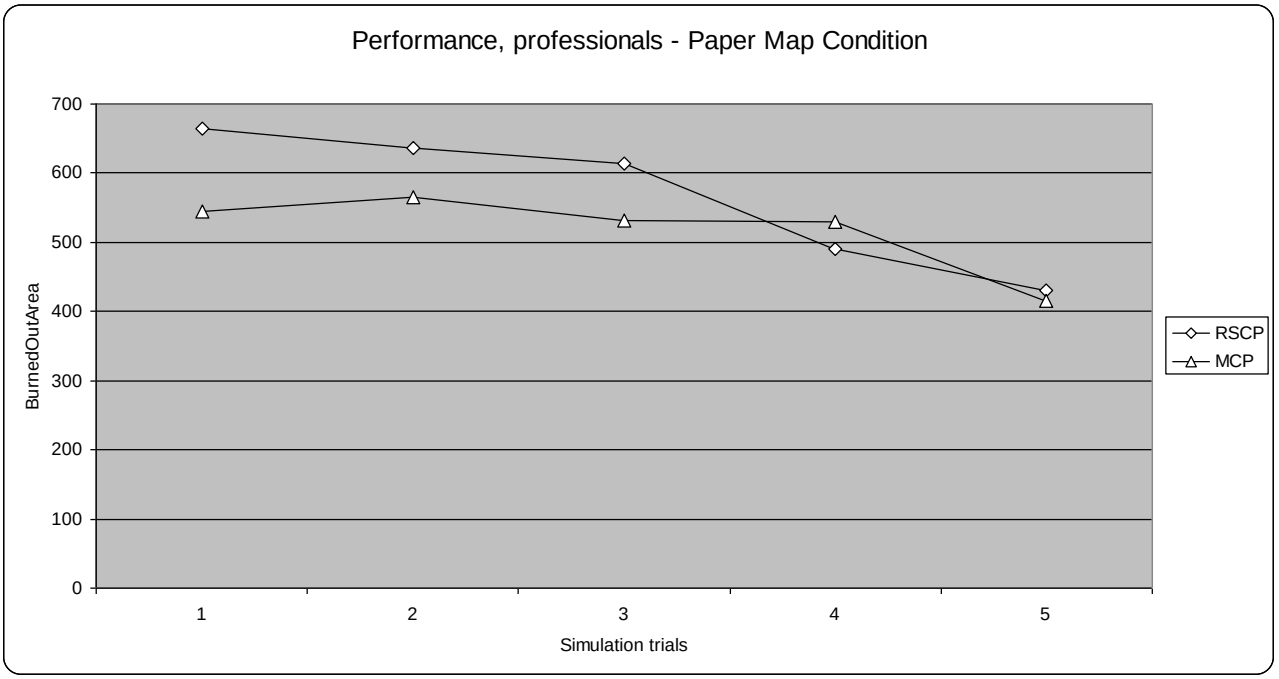

Figure 6. Professionals, Burned out area in end of each simulation trial, RSCP vs MCP in Paper Map condition.

There is no difference between the two types of command posts, RSCP and MCP, in simulation trial 5 in the Paper Map condition. Both RSCP teams and MCP teams has a positive learning curve. Also their learning curves are equal, meaning that both teams accomplish the task equally well independent of profession, with regards to amount BurnedOutArea.

Performance, summary

In the study with students as participant, teams in the GPS condition had consistently less BurnedOutArea than the teams who used paper maps (Figure 3). That is not the case in the study with professionals as participants when the overall result is considered. Overall, both conditions have the same amount of BurnedOutArea (Figure 4). When the results of the study with professional are assigned to the two professional subgroups, RSCP and MCP, the case is different. RSCP teams in the GPS condition have a consistently lower performance on the amount of BurnedOutArea than teams in the Paper Map condition (Figure 5). In this way, the results of RSCP teams are similar to the study with students. The results of MCP teams are not (Figure 5). Summary:

- Students with GPS support perform the task better than students with paper maps.
- Professionals with GPS support perform the task better than professionals with paper maps if the command post is rescue personnel only, ie subgroup RSCP.
- Professionals with GPS support perform the task less well than professionals with paper maps if the command post is a mix of municipal personnel and rescue service personnel, ie subgroup MCP.
- Professionals in the Paper map condition perform the task equally well independent of the command posts professional composition, ie subgroup RSCP or MCP.

RESULTS, COMMUNICATION CONTENT

In this section the content of the teams' communication are described. For this result only the fifth trial is analyzed. At the fifth trial the team has evolved their communication patterns as far as the experiment setting allow.

The results are from the study with students as participants and from the study with professionals. The results are presented with respect to the two conditions GPS and Paper Map. The latter study is presented partly with overall results and partly with results assigned to the two professional subgroups, RSCP and MCP.

Communication Content, Students

The results on communication content are from analyses of the text messages send between command post and ground chiefs in the fifth simulation trial of the experiments. At the fifth trial the teams have had opportunity to gain expertise, mutual understanding about the task and mutual communication strategies.

The text messages sent between the command post and the ground chiefs have been categorized in accordance with a coding scheme in to four main categories; Question, Information, Order, and Other. These four main categories are in turn divided into 11 sub categories (Table 1). The 11 sub categories are mostly self-explanatory. However, the distinction between the two different types of "Order" needs clarification. Mission order is an order with a high degree of freedom, for instance "fight the fire west of the town". Direct order is an order with a low degree of freedom and a high of degree precision, which leaves little room for own initiative, for instance "go to pos 54, 48". The categories are based on categories done by Svenmarck & Brehmer (1991), but they have been modified to fit the scenario used in this study.

Question		Information			Order		Other			
1	2	3	4	5	6	7	8	9	10	11
About Fire	About other persons activity	About Fire	About own activity	About other persons activity	Mission order	Direct order	Request for help	Request for clari-fication	Acknow-ledgment on info or order	Misc-ellaneous

Table 1. Communication categories.

The results of the classification for the 22 student teams can be seen in Figure 7. The communication show significant differences in category 1, 2, 3, 4, 5, 9 and 10. For category 6, 7, 8 and 11 there is no significant difference (Johansson et al, 2010).

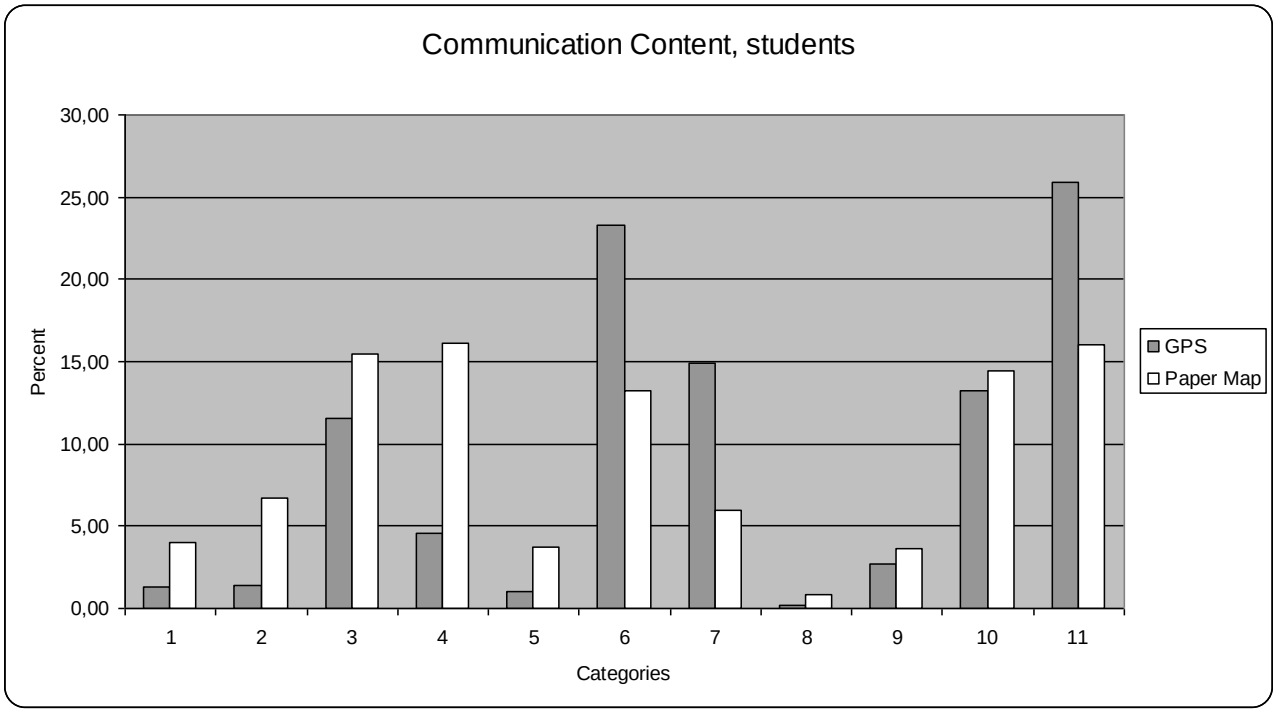

Figure 7. Students, Send mails in each category in percent, GPS vs Paper Map.

Order giving (mission orders category 6 and direct order category 7) is of special interest in this study as order giving is one of the means of the command post to manage the firefighting work on the simulated field. The students result shows no differences in order giving. There are no significant differences between GPS and Paper Map when it comes to mission order or direct order.

Within the Paper Map condition there is a difference between amount given mission orders and given direct orders. The command posts in the paper map condition have significantly fewer direct orders given than mission orders, $t(18)=3.46$, $p<.0028$ (Figure 8). Within the GPS condition no significant difference is found between the two, which means the amount given direct orders are larger in the GPS condition. This can be an effect of the GPS supports detailed representation of reality that could encourage the use of direct orders.

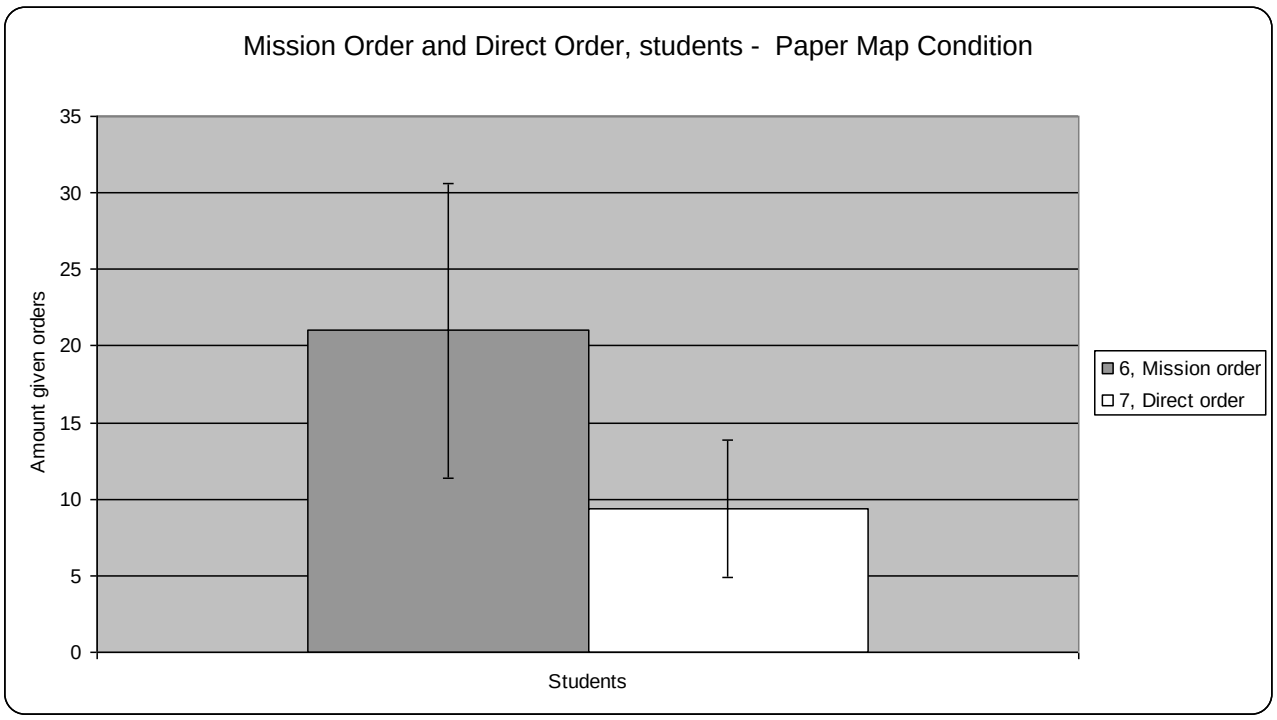

Figure 8. Students Paper Map condition, Given mission order (6) vs given direct order (7).

Communication Content, Professionals

The similarity between the GPS and the Paper Map sets of communication for the 18 teams of professionals can be seen in Figure 9. The communication show significant differences in category 4 only. For all other categories there are no significant differences (Granlund et al, 2010). Category 4 is "Information about own activity". The ground chiefs working on the simulated field in the Paper Map condition need to send information to their command post. The ground chiefs of the GPS condition does not have the same need as the GPS supply their command post automatically with information about their activity.

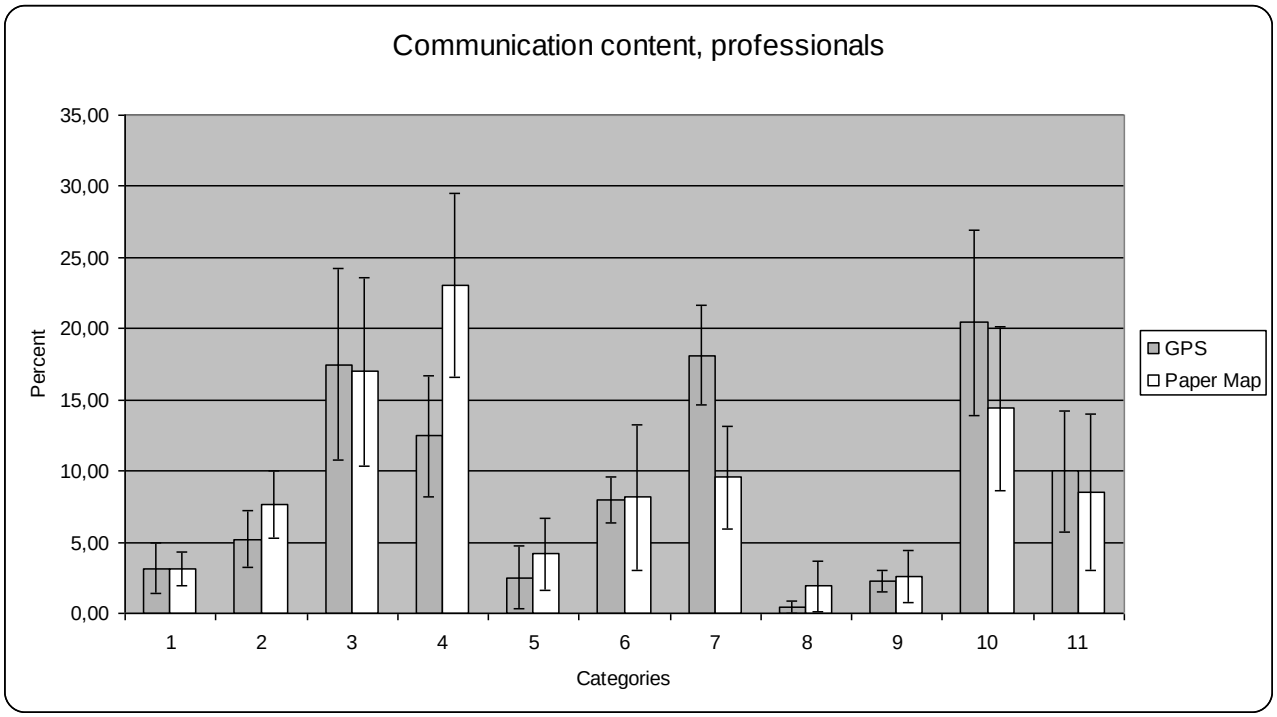

Figure 9. Professionals, Send mails in each category in percent, GPS vs Paper Map.

The Order categories (mission orders category 6 and direct order category 7) are interesting. There is no significant difference between the conditions regarding mission order or direct order. Looking within the GPS condition, though there is a difference. There are significantly less mission orders given than direct orders in the GPS condition, but not within the Paper Map condition (Figure 10). This can, as in the case for students, be an effect of the GPS supports detailed representation of reality that could encourage the command post to extended use of direct orders.

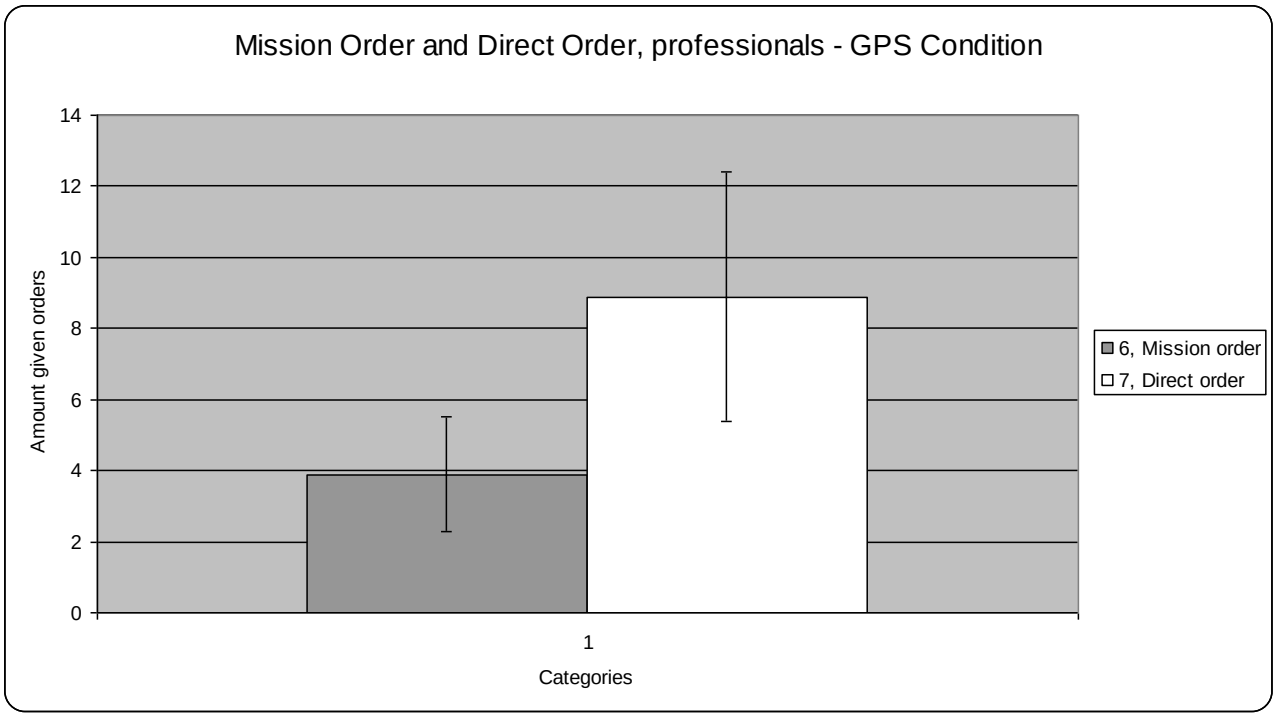

Figure 10. Direct order vs Mission orders

GPS condition, Order category for command posts with different professional disposition

Within the GPS condition command posts with only rescue service personnel, RSCP, and command posts with a mix of rescue service personnel and other municipal personnel, MCP have a diverse result regarding the ratio between mission order and direct order (Figure 11).

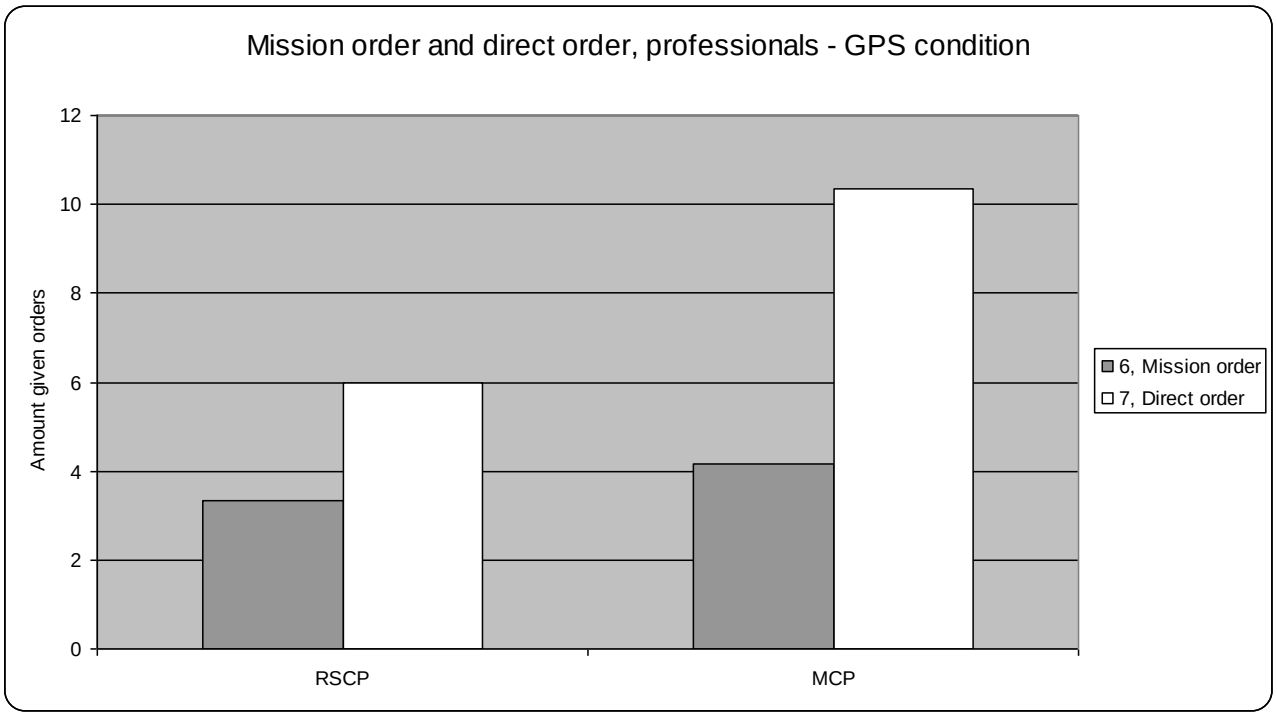

Figure 11. Direct order vs Mission orders within the GPS condition

RSCP teams have on average fewer given mission orders. The difference is not statistically significant. MCP teams have significantly, $t(10)=4.60$, $p<.001$, fewer mission orders given than direct orders in the GPS condition. The result can be interpreted as MCP generally gives more orders than RSCP during a simulation session, and the surplus consists of direct orders with a high degree of control.

Paper Map condition, Order category for command posts with different professional disposition

Within the Paper Map condition command posts with only rescue service personnel, RSCP, and command posts with a mix of rescue service personnel and other municipal personnel, MCP have a similar result regarding the ratio between given mission orders and direct orders (Figure 12).

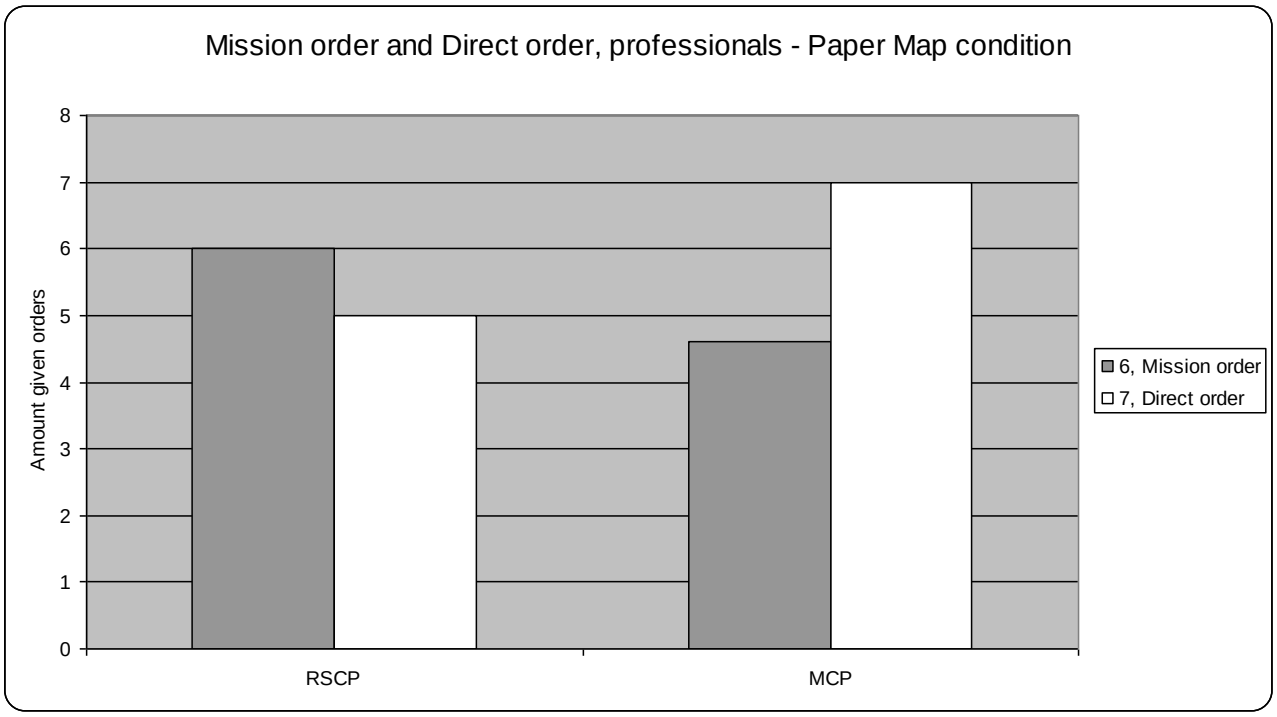

Figure 12. Direct order vs Mission orders within the GPS condition

For the special case of interest, Order (6, mission order and 7, direct order), not RSCP nor MCP show any significant differences between mission orders and direct orders. The result can be interpreted as RSCP and MCP in have the same behaviour regarding giving orders when the means for management is paper maps.

Communication Content, Summary

In the study with students as participants the teams showed significant differences in 7 of 11 categories between the GPS and the Paper Map conditions (Figure 8). They did not show any significant differences in the important categories mission order and direct order between conditions. Within conditions the Paper Map condition show significantly fewer direct orders given than mission orders. The GPS condition showed no significant difference between the two types of order.

In the study with professionals as participants only category 4 showed significant difference between the GPS and the Paper Map condition (Figure 9). Within conditions the GPS condition show significantly fewer mission orders given than direct orders. The Paper Map condition showed no significant difference between the two types of order. Summary:

- In the students result most categories show significant differences between the GPS and Paper Map conditions. The professionals have only one significant difference.
- Within the Paper Map condition students give fewer direct orders than mission orders. In the GPS condition they give as many mission orders as direct orders, ie the GPS support raises the amount given direct orders.
- Within the GPS condition professionals give fewer mission orders than direct orders. In the Paper Map condition they give as many mission orders as direct orders, ie the GPS support raises the amount given direct orders. This is the same effect as in the students result.
- The professional disposition within the GIS condition show that the direct orders are mainly sent by the MCP teams with command posts composed by a mix of municipal personnel and rescue service personnel. The RSCP teams, command posts with rescue service personnel only, show no difference between given mission order or direct order.
- The professional disposition within the Paper Map condition there are no significant difference between mission orders or direct orders, not for RSCP teams or for MCP teams.

DISCUSSION

In the paper map condition the C2 task was traditional. During the over all task of managing one or more forest fires in the simulated world, the communications was restricted to text messages send between command post and ground chiefs. The received intelligence was filtered by humans, ie the ground chiefs decide what information their command post need to know, in which resolution and degree of abstraction. The command post, in turn, had to harmonize contradictory reports of their men. The command post did not have any technological methods for surveillance. The command post needed to request surveillance information from their ground chiefs. Target acquisition was inaccurate.

In the GPS condition the communications had the basic text message ability as well as automated visual services with real-time unit position, unit state, view of sight and wind. This extra technological dimension had an impact on performance and communication content of the GPS condition.

Students

Given the above differences in the communication technology both the students and the professionals react differently depending on if they have the GPS or paper map condition.

The students clearly performed better with GPS and their communication was significantly differentiated in 7 out of eleven categories. From a game point of view the students manage to fully performance explore the benefits of the GPS in the C3Fire setting. Their usage is to a great extent based on the visual GPS-based information. The students communicated with significantly less messages in the categories, questions (category 1 and 2), information (category 3 - 5) as well as request for clarification (category 9) and acknowledgement on info or order (category 10). In the GPS condition the human to human communication between students highly depended on acceptance of the visual GPS communications abilities.

Professionals

The professionals did not as clearly increase their performance in the GPS condition as the students did. The professionals taken together as one over all group did not benefit at all. Both conditions performed equally well (Figure 4) and their communication content was similar in all but one category “Information about own activity”. The professional teams did not explore the benefits of the GPS to the same extent as the students.

What then was the difference between student approach and professional approach?

The student was a homogenous group of participants, with little or no experience of crisis management, with solid computer skills and high experience of playing computer games. They used the technological advantages of the GPS without experience based considerations, ie resource management, area prioritizing, goal management or synchronization. Student teams used all their resources, on first detected fire, with the one goal to close it out. They started to scout for fire before there were signs of fire in the scenario and first finder of target started to extinguish, they did not await each other.

The professionals, as opposed to the students, was a heterogeneous group of participants with a high experience of crisis management, solid computer skills but little experience of playing computer games. They solved the task as they should have done in their every day work. They used the technology with experience based consideration. The teams managed their recourses and felt uneasy about not having resources in reserve for preparedness purposes. The teams prioritized areas close to houses or other areas they perceived as valuable, ie they decoded the map. They had several goals, among them was to save prioritized areas, properties, electricity cables. They could as well decide that fires in the bush were unimportant at the moment and leave these to burn until handled later. The teams synchronized. They awaited order, did not start looking for fire until there was a sign in the scenario for a fire. Once fire was detected they often decided on an area on the field from which they operated.

The sub groups, RSCP and MCP

To fully understand the GPS impact on the group their over all performance must be divided into sub groups. The results of teams that had only rescue service personnel in their command post RSCP was separated from teams with a mix of municipal personnel and rescue service personnel, MCP, in both conditions.

For the performance result for the two subgroups in the paper map condition it is clear that both sub groups perform equally well and the communication shows no significant differences on the ratio between given mission order and direct order.

The GPS condition on the other hand has a clear impact on the two subgroups. RSCP clearly benefit of the GPS. RSCP perform of all four sub groups. Their ratio between given order is balanced; they give as many direct orders as mission orders. The MCP subgroup faces another situation. They are not able to benefit of the GPS communications technology. They perform worst of all four subgroups. Their ratio for given orders clearly show that they give significantly more direct orders than mission orders.

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