Information Quality TDDE46

Azeem Ahmad

Linköping University, Sweden

LINKÖPING UNIVERSITY

Objectives

- To learn what is information quality
- What are the factors associated with information quality
- Inspections, reviews and continuous delivery
- Recap of previous lectures

Lets build a dashboard

- Swedish police department hired you to build a dashboard for their software. They want to scan any car number plate on road and then the information should appear on dashboard. Your job is to not only design of dashboard but also the contents of information.

Factors that Affect Information Quality

- Relevant
- Accurate
- Updated
- Complete
- Well presented
- Not too much detail or not too little detail
- Reliability
- Objectivity – Bias

Information Quality

- Is a quality of contents in the system
- If the attributes that define quality of information are of good quality or of high value then the information is said to have good quality
- Is related with data input and data output

Information Quality

- If the data you put into your system is incorrect or of poor quality, then no matter how good your system is or how careful you are at setting up your queries, all you are going to get in return is poor quality, inaccurate information.

Information Quality vs Data Quality

- Information quality takes into account
  - not just data quality
  - but processing quality
  - (and reporting quality)

Data → *processing* → **Information**
Information → *intelligence* → **Knowledge**
Knowledge → *experience* → **Wisdom**

where things can go wrong

Food for thoughts

- Accurate suspect criminal history information has limited value if it is not secure and accessible when needed
- Inaccurate and incomplete suspect criminal history information has limited value even when there is secure and timely access to it

Factors that Affect Information Quality

- Relevant
- Accurate
- Updated
- Complete
- Well presented
- Not too much detail or not too little detail
- Reliability
- Objectivity – Bias

Factors - Relevance

- The information must be relevant in order to be useful.
- Teacher talking about his hobbies in the mathematic lectures
  - Could be fascinating but is it relevant?
- Car speedo-meter appearing red, when you pick your wife from workplace and she is angry!

Mars Climate Orbiter

- Purpose: to relay signals from the Mars Polar Lander once it reached the surface
- Disaster: smashed into the planet instead of reaching a safe orbit
- Why: Software bug – failure to convert English measures to metric values
- $165M

Factors - Accuracy

- If the collected data is inaccurate, the information, it will produce will also be inaccurate.
  - My SAAB car gas meter !
  - Weather forecast and prediction
  - Wrong price tag in shopping mall
  - Mistake when launching missiles or calculating medical dose for patients
  - Trusting 1177, for diagnosis, when you are telling your symptoms.

THERAC-25 Radiation Therapy

- THERAC-25, a computer controlled radiation-therapy machine
- 1986: two cancer patients at the East Texas Cancer Center in Tyler received fatal radiation overdoses
- Why: Software bug --- a race condition (i.e., miscoordination between concurrent tasks)

Factors – up to date

- If the collected data is not updated, the information, it will produce will also be not updated.
  - What is the average size of hard disks?
  - The aeroplane is checked by engineers (perhaps last year or yesterday)
  - Green light against your products that all test has been passed, but actually they passed last week and you did not run any test suite this week but you made so many changes.

Factors – Complete

- Information should be complete.
  - Pilot seeing a note on computer that “Everything is checked”!
  - If the part of patient history (allergies) is missing, wrong medicine can kill the patient

Shooting Down of Airbus 300

- 1988
- USS Vincennes shot down an Airbus 300
- Mistook the Airbus 300 for an F-14
- 290 people dead
- Why: Software bug --- cryptic and misleading output displayed by the tracking software

Factors – Well Presented

- Information should be presented in a way that is useful for users
  - New LADOK

	Product A								Product B								Product C								Product D							
Week Ending	New Sales	% Change vs prev week	Total Sales	% Change vs prev week	Market Share New	Share Change vs prev week	Market Share Total	Share Change vs prev week	New Sales	% Change vs prev week	Total Sales	% Change vs prev week	Market Share New	Share Change vs prev week	Market Share Total	Share Change vs prev week	New Sales	% Change vs prev week	Total Sales	% Change vs prev week	Market Share New	Share Change vs prev week	Market Share Total	Share Change vs prev week	New Sales	% Change vs prev week	Total Sales	% Change vs prev week	Market Share New	Share Change vs prev week	Market Share Total	Share Change vs prev week
1/2/2013	13,766	26.9%	47,931	23.3%	16.3%	0.4%	16.3%	-0.1%	16,474	22.9%	66,900	21.7%	15.0%	0.3%	16.6%	0.1%	11,103	18.1%	41,041	19.5%	1.6%	-0.1%	1.6%	0.0%	29,666	22.3%	71,409	22.2%	13.5%	-0.2%	12.7%	0.1%
1/9/2013	16,543	20.2%	50,525	5.6%	15.8%	-0.6%	16.0%	-0.2%	20,675	25.5%	71,833	7.4%	15.8%	0.7%	16.9%	0.3%	12,314	10.9%	41,157	0.3%	1.5%	-0.1%	1.6%	-0.1%	25,581	23.8%	75,818	6.2%	14.0%	0.5%	12.9%	0.2%
1/16/2013	14,944	-9.7%	46,176	-8.6%	13.4%	-0.3%	16.0%	0.0%	18,043	-12.7%	64,307	-10.5%	15.1%	-0.6%	16.5%	-0.3%	11,551	-6.2%	37,770	-8.2%	1.5%	0.0%	1.5%	0.0%	24,457	-4.4%	72,104	-4.9%	14.1%	0.1%	13.0%	0.1%
1/23/2013	14,180	-5.1%	44,156	-4.4%	15.4%	0.0%	16.1%	0.0%	17,035	-5.6%	61,152	-4.9%	14.8%	-0.3%	16.3%	-0.2%	10,720	-7.2%	35,662	-5.6%	1.4%	-0.1%	1.5%	-0.1%	23,584	-3.6%	69,904	-3.1%	13.9%	-0.2%	13.1%	0.1%
1/30/2013	14,590	2.9%	44,962	1.8%	16.0%	0.5%	16.2%	0.2%	17,037	0.0%	61,974	1.3%	14.9%	0.1%	16.3%	0.0%	10,833	1.1%	36,145	1.4%	1.5%	0.0%	1.5%	0.0%	24,186	2.5%	69,990	0.1%	13.9%	0.0%	12.9%	-0.2%
2/6/2013	15,672	7.4%	49,380	9.8%	15.6%	-0.4%	15.9%	-0.4%	18,802	10.4%	69,286	11.8%	15.3%	0.4%	16.6%	0.3%	12,405	14.5%	41,159	13.9%	1.4%	0.1%	1.6%	0.1%	26,335	8.9%	75,735	8.2%	14.1%	0.2%	12.8%	-0.1%
2/13/2013	15,629	-0.3%	46,811	-5.2%	16.2%	0.6%	16.3%	0.4%	17,677	-6.0%	64,067	-7.5%	15.0%	-0.3%	16.5%	-0.1%	11,346	-8.5%	37,360	-9.2%	1.3%	-0.1%	1.5%	-0.1%	25,389	-3.6%	73,045	-3.6%	14.0%	0.0%	13.1%	0.3%
2/20/2013	15,262	-2.4%	45,623	-2.5%	16.3%	0.1%	16.3%	0.0%	17,040	-3.6%	61,264	-4.4%	14.9%	-0.1%	16.3%	-0.2%	10,781	-5.0%	35,725	-4.4%	1.3%	0.0%	1.5%	0.0%	25,441	0.2%	71,843	-1.6%	14.3%	0.3%	13.1%	0.0%
2/27/2013	15,659	2.7%	47,178	3.4%	16.2%	-0.2%	16.4%	0.1%	17,772	4.3%	63,058	2.9%	15.0%	0.1%	16.2%	-0.1%	11,292	4.7%	37,441	4.8%	1.3%	0.0%	1.5%	0.0%	26,342	3.5%	73,728	2.6%	14.3%	0.0%	13.1%	-0.1%
3/6/2013	16,655	6.4%	50,764	7.6%	16.6%	0.5%	16.2%	-0.2%	19,700	10.8%	70,595	12.0%	15.7%	0.7%	16.6%	0.4%	12,351	9.4%	42,090	12.4%	1.4%	0.1%	1.6%	0.1%	27,865	5.8%	80,373	9.0%	14.5%	0.2%	13.1%	0.0%
3/13/2013	16,399	-1.5%	47,655	-6.1%	17.1%	0.4%	16.5%	0.3%	18,139	-7.9%	64,781	-8.2%	15.3%	-0.4%	16.6%	0.0%	11,398	-7.8%	37,958	-9.8%	1.4%	0.0%	1.5%	0.0%	27,408	-1.6%	75,939	-5.5%	14.9%	0.4%	13.2%	0.2%
3/20/2013	16,066	-2.0%	47,039	-1.3%	17.2%	0.1%	16.6%	0.1%	18,442	1.7%	63,497	2.0%	15.6%	0.3%	16.6%	0.0%	11,202	-1.7%	36,747	-3.2%	1.4%	0.0%	1.5%	0.0%	26,575	-3.0%	74,892	-0.6%	14.9%	0.0%	13.4%	0.2%
3/27/2013	15,294	-5.0%	46,242	-1.7%	16.6%	-0.6%	16.5%	-0.1%	17,866	-2.5%	62,445	-1.6%	15.6%	-0.2%	16.5%	-0.1%	10,721	-4.3%	36,588	-0.4%	1.4%	0.0%	1.5%	0.0%	26,955	1.4%	74,064	-1.1%	15.2%	0.3%	13.4%	0.0%
4/3/2013	16,866	8.8%	50,045	8.2%	17.0%	0.4%	16.6%	0.1%	18,602	3.4%	67,219	7.6%	16.3%	0.3%	16.4%	-0.1%	11,798	10.0%	40,106	9.6%	1.5%	0.1%	1.6%	0.0%	27,043	0.3%	79,818	6.4%	14.7%	-0.5%	13.2%	-0.2%
4/10/2013	15,305	-7.6%	47,943	-4.2%	16.3%	-0.7%	16.5%	-0.1%	17,458	-6.1%	64,249	-4.4%	15.2%	-0.2%	16.4%	0.1%	10,758	-8.7%	36,324	-9.4%	1.4%	-0.1%	1.5%	-0.1%	25,434	-5.9%	74,021	-6.1%	14.5%	-0.1%	13.0%	-0.2%
4/17/2013	15,764	3.0%	46,619	-2.8%	16.9%	0.6%	16.6%	0.1%	17,443	-0.1%	63,398	-1.3%	15.3%	0.1%	16.4%	0.0%	10,578	-1.7%	35,341	-2.7%	1.4%	0.0%	1.5%	0.0%	24,951	-1.9%	73,496	-0.7%	14.3%	-0.2%	13.1%	0.1%
4/24/2013	16,139	2.4%	47,265	1.4%	17.3%	0.3%	16.8%	0.2%	17,818	2.1%	62,423	-1.5%	15.7%	0.4%	16.4%	0.0%	10,487	-0.9%	34,756	-1.7%	1.4%	0.0%	1.5%	0.0%	25,869	3.7%	73,614	0.2%	14.8%	0.5%	13.2%	0.1%
5/1/2013	16,195	0.3%	48,886	3.5%	17.3%	0.0%	16.6%	-0.2%	17,426	-2.2%	65,171	4.4%	15.2%	-0.5%	16.5%	0.0%	10,866	3.6%	37,136	6.9%	1.4%	0.0%	1.5%	0.0%	26,217	1.3%	77,765	5.6%	14.7%	-0.1%	13.3%	0.1%
5/8/2013	16,790	3.7%	50,040	2.3%	17.1%	-0.2%	16.7%	0.1%	18,609	6.8%	66,961	2.9%	15.7%	0.5%	16.6%	0.2%	10,967	0.9%	37,423	0.8%	1.4%	0.0%	1.5%	0.0%	25,817	-1.5%	77,014	-1.0%	14.5%	-0.2%	13.2%	-0.1%
5/15/2013	16,018	-4.6%	48,937	-4.0%	17.2%	0.1%	17.0%	0.3%	17,440	-5.3%	62,964	-5.1%	15.2%	-0.4%	16.4%	-0.2%	10,036	-8.5%	34,199	-8.6%	1.4%	0.0%	1.4%	-0.1%	25,661	-0.6%	74,165	-3.7%	15.0%	0.5%	13.3%	0.1%
5/22/2013	16,706	4.3%	49,400	2.8%	17.2%	0.0%	17.0%	0.0%	17,355	-0.5%	63,588	1.2%	15.2%	0.0%	16.5%	0.1%	10,461	4.3%	35,730	4.5%	1.4%	0.0%	1.5%	0.0%	25,955	1.1%	76,249	2.9%	14.6%	-0.4%	13.3%	0.0%
5/29/2013	14,361	-14.0%	46,153	-6.6%	16.9%	-0.3%	16.9%	-0.1%	16,026	-7.7%	60,515	-4.4%	15.2%	0.0%	16.4%	-0.1%	9,321	-10.9%	32,690	-8.5%	1.4%	0.0%	1.4%	0.0%	22,997	-11.4%	72,038	-6.5%	14.6%	-0.1%	13.3%	0.0%
6/5/2013	17,090	19.0%	52,563	13.9%	17.2%	0.4%	16.9%	0.0%	18,395	14.8%	68,453	12.6%	15.3%	0.1%	16.5%	0.1%	11,439	22.7%	39,125	19.7%	1.5%	0.1%	1.5%	0.1%	26,443	15.0%	80,977	12.4%	14.2%	-0.4%	13.2%	-0.1%
6/12/2013	16,571	-3.0%	49,576	-5.7%	17.6%	0.4%	17.1%	0.3%	17,506	-4.8%	64,245	-6.1%	15.3%	0.0%	16.6%	0.1%	9,919	-13.3%	33,585	-14.2%	1.4%	-0.1%	1.4%	-0.1%	26,069	-1.4%	76,465	-5.6%	14.7%	0.6%	13.5%	0.3%
6/19/2013	16,073	-3.0%	49,064	-1.0%	17.2%	-0.4%	17.2%	0.0%	17,455	-0.3%	63,126	-1.7%	15.4%	0.1%	16.5%	-0.2%	10,206	2.9%	33,963	1.1%	1.4%	0.1%	1.4%	0.0%	25,480	-2.3%	76,062	-0.5%	14.6%	-0.2%	13.5%	0.0%
6/26/2013	16,292	1.4%	49,335	0.6%	17.7%	0.4%	17.3%	0.1%	17,466	0.1%	63,170	0.1%	15.5%	0.1%	16.5%	0.0%	9,562	-6.4%	33,591	-1.1%	1.4%	-0.1%	1.4%	0.0%	24,916	-2.2%	76,084	0.0%	14.2%	-0.3%	13.5%	0.1%
7/3/2013	16,607	1.9%	53,662	8.8%	17.5%	-0.2%	17.2%	-0.1%	18,501	5.9%	70,202	11.1%	15.8%	0.3%	16.6%	0.1%	10,831	13.4%	38,905	15.8%	1.5%	0.1%	1.5%	0.1%	25,143	4.9%	82,605	8.6%	14.5%	0.2%	13.2%	-0.3%
7/10/2013	16,919	1.9%	51,201	-4.6%	17.6%	0.1%	17.3%	0.1%	18,454	-0.3%	67,052	-4.5%	15.5%	-0.3%	16.8%	0.2%	10,252	-5.3%	34,457	-11.4%	1.4%	-0.1%	1.4%	-0.1%	26,005	-0.5%	77,745	-5.9%	14.3%	-0.1%	13.3%	0.1%
7/17/2013	16,401	-3.1%	49,970	-2.4%	17.2%	-0.4%	17.1%	-0.2%	18,398	-0.3%	65,442	-2.4%	15.5%	0.0%	16.5%	-0.3%	10,415	1.6%	34,774	0.9%	1.5%	0.1%	1.4%	0.0%	26,797	3.0%	79,598	2.4%	14.7%	0.4%	13.6%	0.2%

Factors – Detail Levels

- Too much details – information is overwhelming and difficult to extract the bits, you needed
- Too little – you will not understand the complete picture

Baking a cake

Too much detail	*Not enough detail*
Ingredients Not only telling you that you need flour, but telling you all of the different brands of flour and how the choice of each one would affect the rising of your cake.	Ingredients Telling you that you need flour but not the quantity you will need to weigh out.
Method Telling you exactly how many times you need to beat the eggs and for exactly how many seconds you need to fold in the flour.	Method Telling you to mix the ingredients together but not informing you of the correct order in which to combine them.
Cooking Telling you the exact amount of minutes that the cake should be baked for every type of oven that is currently for sale.	Cooking Telling you the temperature to cook the cake but not how long to leave it in the oven for.

Factors – Reliability

- Information should be reliable to be trusted

Information Quality Metrics

- Authority
  - Who did it? Credibility?
- Verifiability
  - Can it be verified?
- Validity
  - How accurate? Believable?
- Consistency
  - From different sources
- Availability
  - Access

Information Quality Metrics

- Does the IQ program, as implemented, respond to the purposes and goals defined in the beginning?
- Is any of the data that is shared inaccurate, and what can be done to minimize that occurrence?
- Is the agency's approach to information quality in line with its business purpose?

Inspection (Check TDDC88 Slides)

Goal

- Find defects (anomalies)
- Improve software development process

Inspection for Information Quality?

Is and is not

- It is systematic peer examination of software products/artifacts.
- It is not testing. Can be performed early on partially finished parts.

Several sources with proven history

- First introduced by Fagan at IBM (1976)
- Main book "Software Inspections" by Graham and Gilb (1993)
- IEEE Standard 1028 – 2008
- Several scientific studies show that defects are found using inspection, approx. 60-90% of total defects (Pfleeger & Atlee, 2010)

Who Participates in an Inspection (Check TDDC88 Slides)

Roles

Recorder

Reader

Author

Inspection leader
(Moderator)

Inspector

Who Participates in an Inspection (Check TDDC88 Slides)

Roles

Recorder

Reader

Author

Inspection leader
(Moderator)

Inspection leader

- Planning and organizing tasks
- Must be trained in the inspection process
- Ensure that inspection data is collected
- Issue inspection output

Inspector

Who Participates in an Inspection (Check TDDC88 Slides)

Who Participates in an Inspection (Check TDDC88 Slides)

Roles

Recorder

Reader

Author

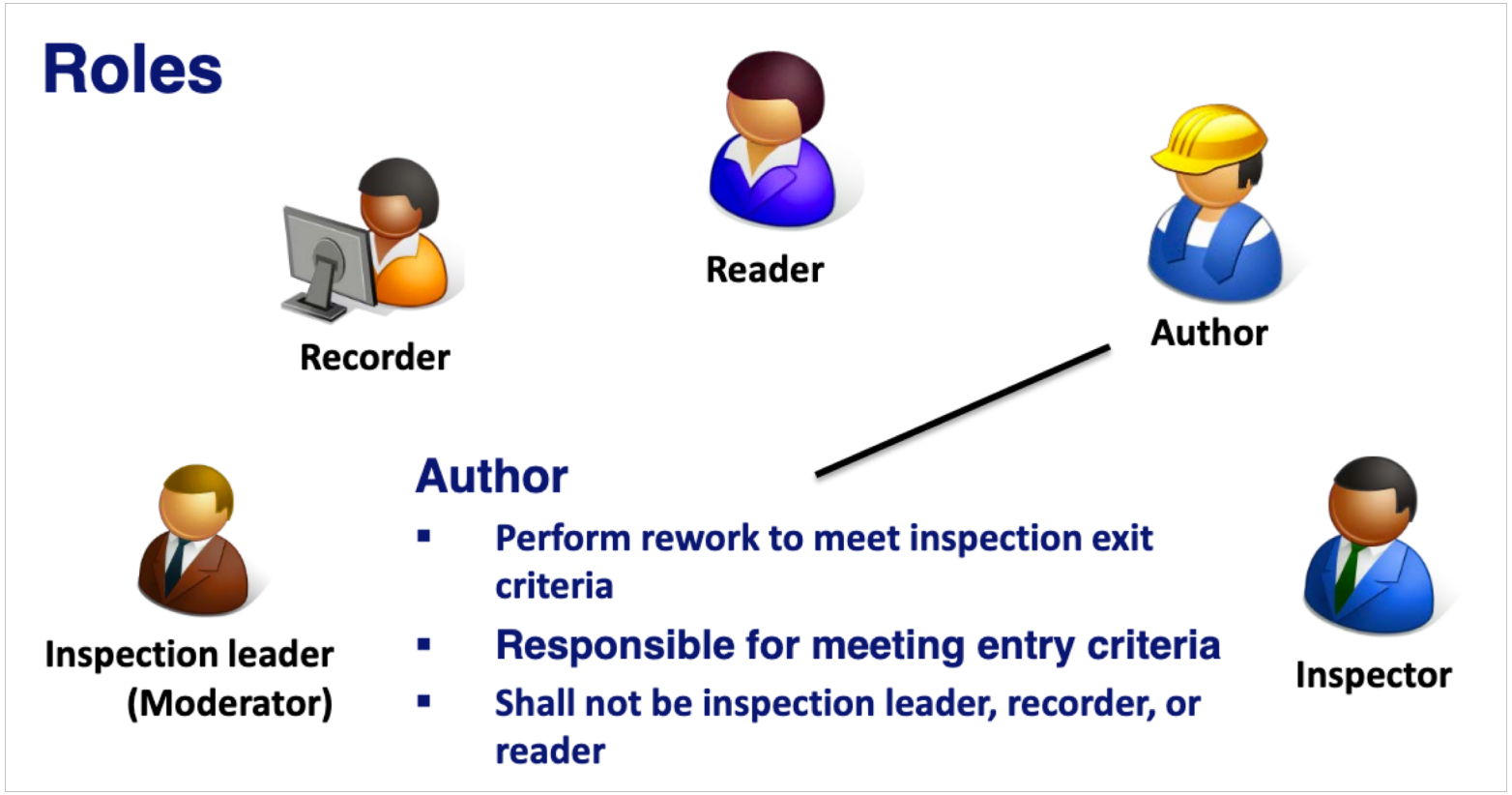
Inspection leader
(Moderator)

Reader

- Informs the software product to be inspected
- Highlight important apects

Inspector

Who Participates in an Inspection (Check TDDC88 Slides)



Who Participates in an Inspection (Check TDDC88 Slides)

Roles

Recorder

Reader

Author

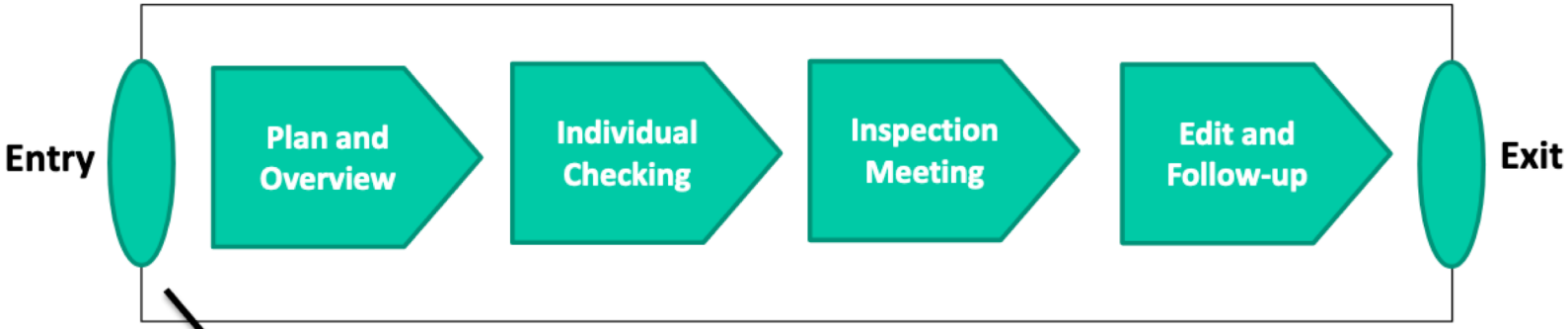
Inspection leader
(Moderator)

Inspector

- Identifies and describes defects
- Chosen due to expertice and different view points (e.g., design, requirements, testing)
- Can be assigned specifc topics (e.g., compliance to standards)
- All participants are inspectors

Inspector

Inspection Process (Check TDDC88 Slides)



Input (for entry)

- Objective statement
- Software products / artifacts (to be inspected)
- Inspection procedures
- Reporting forms
- Known defects
- Source documents

Author

Responsible for meeting entry criteria

Static Analysis

Specification ---
what bugs to look for?
(optional)

Static
Analysis Tool

Software
Under Check

Examines the source code,
without execution.

Warnings

Examine warnings
and fix bugs

Static Analysis

- Static Program Analysis analyses computer programs statically,i.e., without executing them (as opposed to dynamic analysis that does execute the programs wrt. some specific input):
  - Given a program P, determine the sign (positive, negative, or zero) of all of its variables.
    - Applications:
      - Check division by 0
      - Check for negative indices array

Static Analysis Tools

- Astree
  - Proves the absence of runtime errors and undefined behavior in C programs
  - Since 2001
  - Used in Airbus flights software
- Coverity
  - Looks for bugs in C, C++, Java, and C#
  - Used in NASA
- Java PathFinder
  - Finds bugs in mission-critical Java code.
  - Developed by NASA
  - Free
- …….

Dynamic Analysis

- On the first day of Christmas my true love gave to me
- a partridge in a pear tree.

- On the second day of Christmas my true love gave to me
- two turtle doves
- and a partridge in a pear tree.

- ...

- On the twelfth day of Christmas my true love gave to me
- twelve drummers drumming, eleven pipers piping, ten lords a-leaping,
- nine ladies dancing, eight maids a-milking, seven swans a-swimming,
- six geese a-laying, five gold rings;
- four calling birds, three french hens, two turtle doves
- and a partridge in a pear tree.

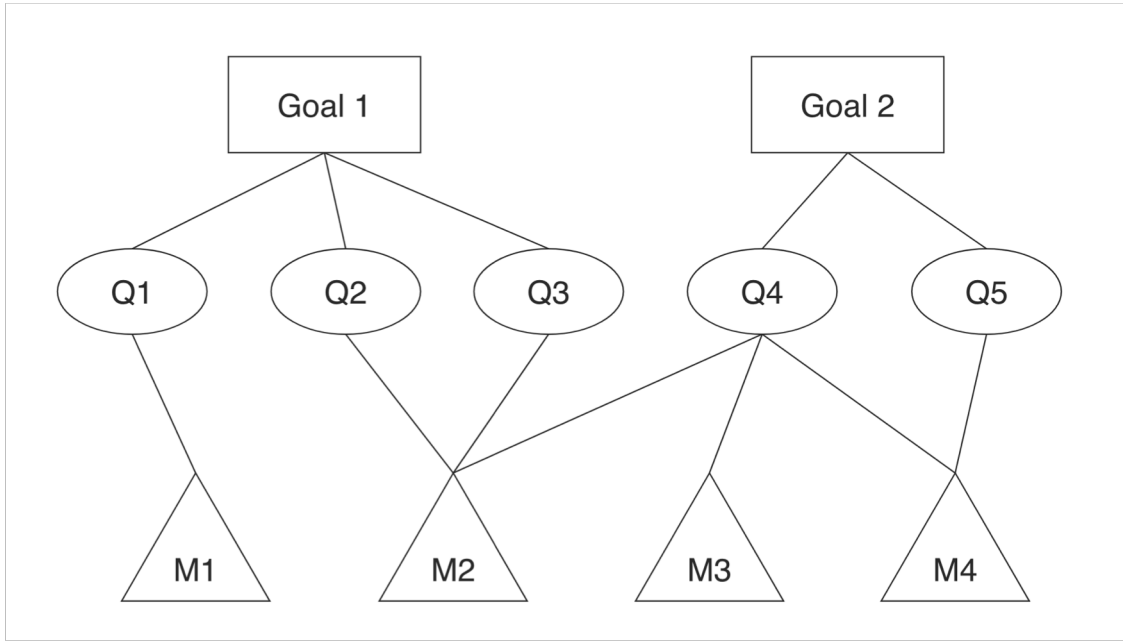
Summary - Lecture 1 - Quality factors in ISO 25010

Classification

- Product metrics:
  - Observable or computed properties of the product
  - Examples: Lines of code, number of pages
- Process metrics:
  - Properties of **how** you are developing the product
  - Examples: Cycle time for a change request, number of parallel activities
- Resource metrics:
  - Properties and volumes of the instruments you are using when developing the product
  - Examples: Years of education, amount of memory in testing environment

Summary - Lecture 2 - Metrics

Goal	Purpose Issue Object (process) Viewpoint	Improve the timeliness of change request processing from the project manager's viewpoint
Question	Q1	What is the current change request processing speed?
Metrics	M1 M2 M3	Average cycle time Standard deviation % cases outside of the upper limit
Question	Q2	Is the (documented) change request process actually performed?
Metrics	M4 M5	Subjective rating by the project manager % of exceptions identified during reviews
Question	Q3	What is the deviation of the actual change request processing time from the estimated one?
Metrics	M6 M7	$\frac{\text{Current average cycle time - Estimated average cycle time}}{\text{Current average cycle time}} * 100$ Subjective evaluation by the project manager
Question	Q4	Is the performance of the process improving?
Metrics	M8	$\frac{\text{Current average cycle time}}{\text{Baseline average cycle time}} * 100$
Question	Q5	Is the current performance satisfactory from the viewpoint of the project manager?
Metrics	M7	Subjective evaluation by the project manager
Question	Q6	Is the performance visibly improving?
Metrics	M8	$\frac{\text{Current average cycle time}}{\text{Baseline average cycle time}} * 100$



Summary - Lecture 3 – Goal Question Metrics

Software Engineering Method And Theory

- A common ground for software engineering
- Moving away from SE methods “fashion” industry.
- Founded in 2009 by:
  - Ivar Jacobson
  - Bertrand Meyer
  - Richard Soley
- OMG Standard under the name Essence
- The SEMAT Kernel – manifestation of the common ground

Summary - Lecture 4 – SEMAT

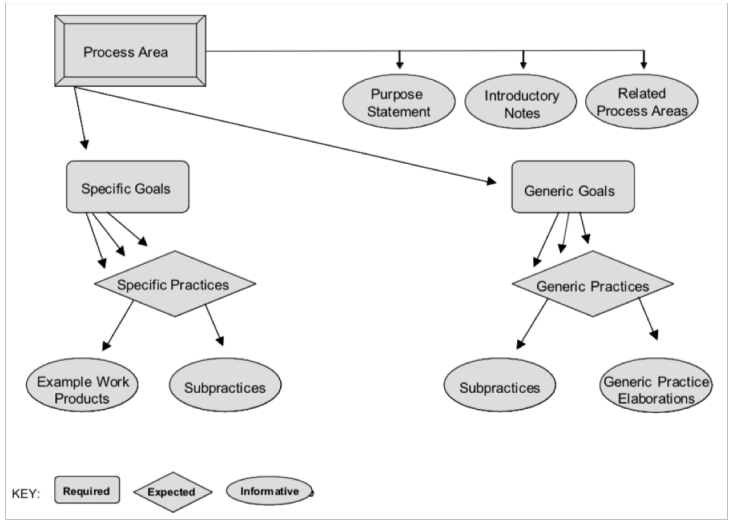
Process Areas (SE/SW/IPPD/SS)

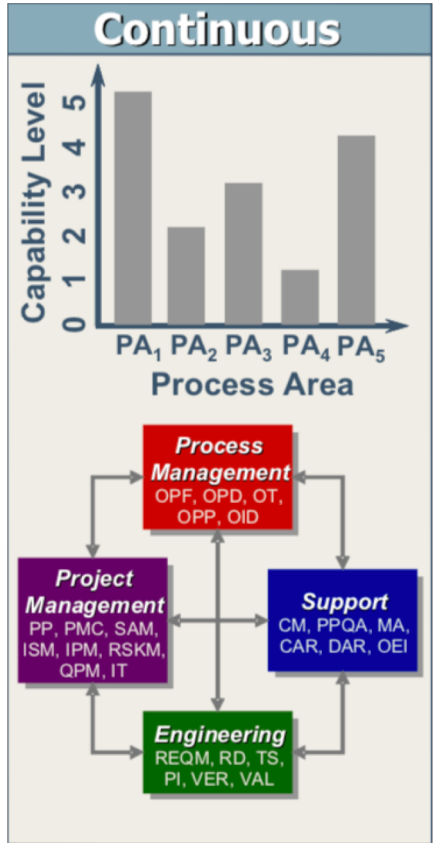
Organizational Innovation & Deployment (OID)
Causal Analysis and Resolution (CAR)

Organizational Process Performance (OPP)
Quantitative Project Management (QPM)

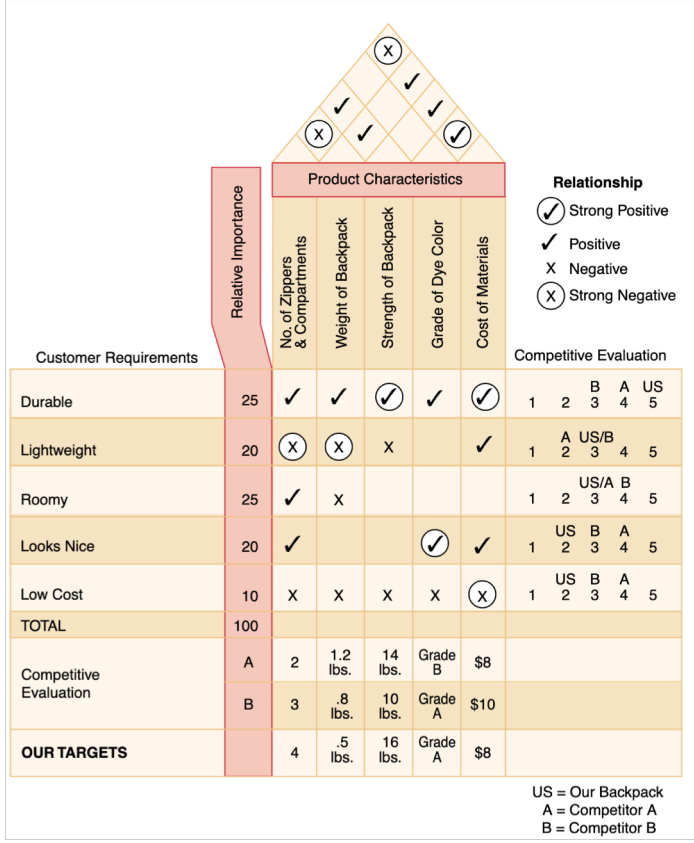
Requirements Development (RD)
Technical Solution (TS)
Product Integration (PI)
Verification (VER)
Validation (VAL)
Organizational Process Focus (OPF)
Organizational Process Definition (OPD)
Organizational Training (OT)
Integrated Project Management (IPM)
Risk Management (RSKM)
Decision Analysis and Resolution (DAR)
Organizational Environment for Integration (OEI)
Integrated Teaming (IT)
Integrated Supplier Management (ISM)

Requirements Management (REQM)
Project Planning (PP)
Project Monitoring and Control (PMC)
Measurement and Analysis (MA)
Process and Product Quality Assurance (PPQA)
Configuration Management (CM)
Supplier Agreement Management (SAM)





Summary - Lecture 5 – Evaluating & Improving Process



Summary - Lecture 7 – Software Quality Management

Thank You and Here it Ends !

LINKÖPING UNIVERSITY