INF5181: Process Improvement and Agile Methods in Systems Development

Lecture 10:

Learning from Experience

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Structure of Lecture 10

- Hours 1 & 2:
  - Lecture 9
- Hour 3:
  - Basic Concepts of Learning
  - Individual Learning (Skill Development)
  - Organisational Learning

Terminology

- <u>Data:</u>
  - Symbols organized according to syntactic rules (Syntax)
- <u>Information:</u>
  - Data interpreted in a certain context (Semantics)
- <u>Knowledge:</u>
  - Information, when related to the human mind in order to solve problems; i.e., it is human expertise stored in a person’s mind, gained through experience and interaction with a person’s environment (Pragmatics)

Terminology

- <u>Experience:</u>
  - The type of knowledge a person acquires by being involved;

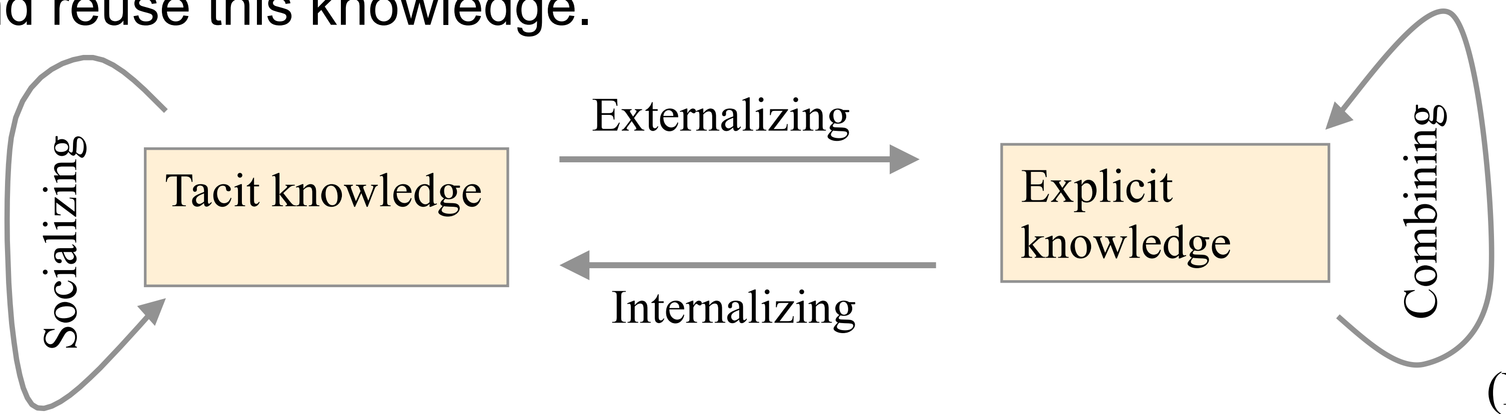
    → observation + emotion (with respect to the observed event) + conclusion (derived from the observed event and emotion)
- <u>Know-how:</u>
  - Procedural knowledge
- <u>Skill:</u>
  - Talent and/or ability to perform a task (thus, knowledge is a prerequisite of skill)

Terminology

- Knowledge Worker:
  - Knowledge workers contribute to company success mainly by gathering, organizing, and applying knowledge
- Knowledge Management (KM):
  - KM addresses the following tasks:
    - Acquiring new knowledge
    - Transforming it from tacit into explicit knowledge and back again
    - Systematically storing, disseminating, and evaluating it
    - Treating it as an asset and its infrastructure as a resource
    - Applying knowledge in new situations

Tacit (silent) versus Explicit Knowledge

- Tacit knowledge refers to knowledge that people use every day to perform tasks but which they find hard to express or do not even know about.
- Explicit knowledge is documented knowledge. Others may access and reuse this knowledge.

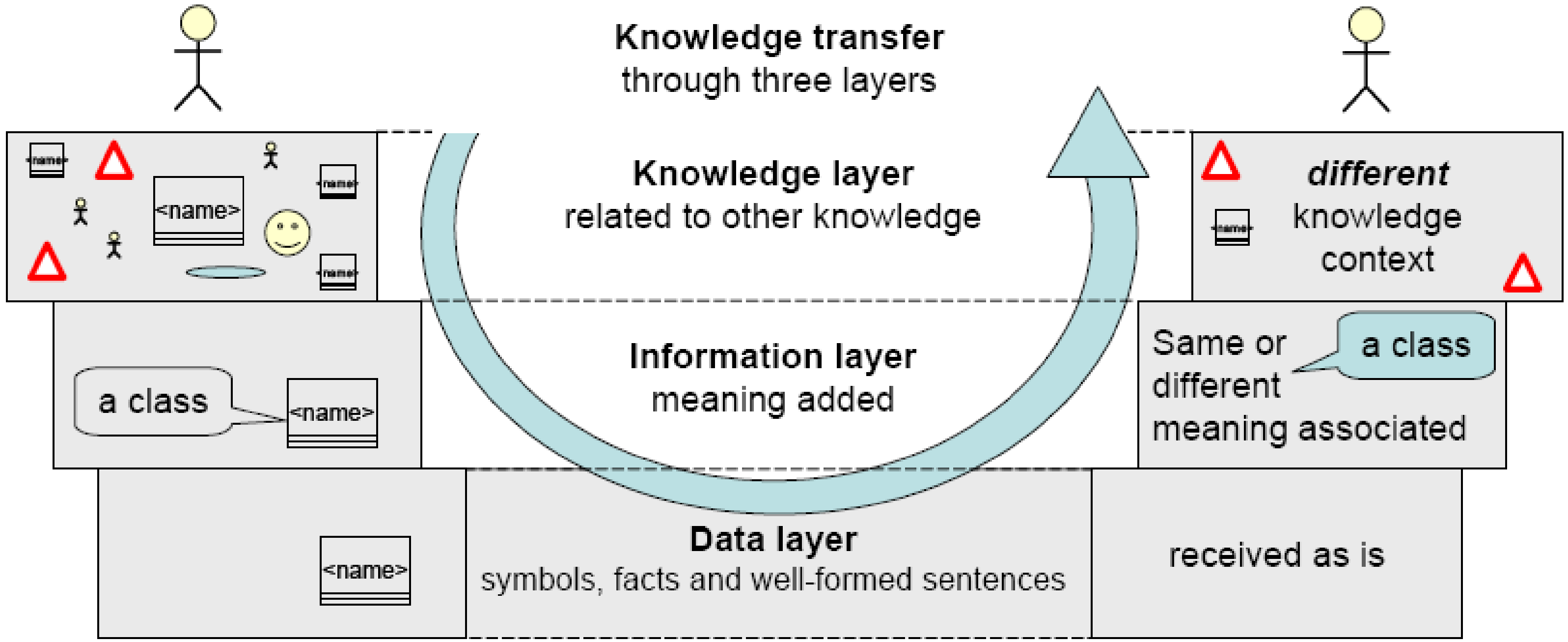


(Nonaka Model)

http://www.cyberartsweb.org/cpace/ht/thonglipfei/nonaka_seci.html

A Layered Model of Knowledge Transfer

Source: Kurt Schneider, Univ. Hannover



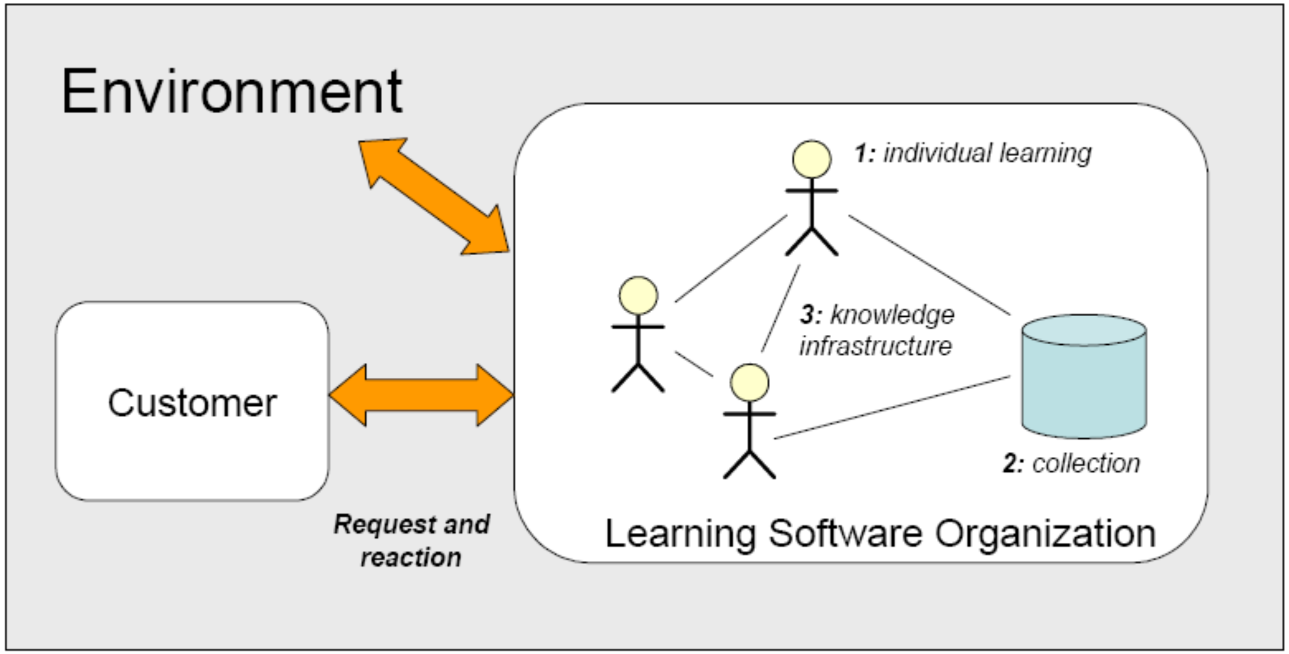
Question: What are pre-requisites for knowledge reuse?

Pre-Requisites for Knowledge Re-Use

- Experience must be “cleaned” and validated
- Knowledge must be
  - evaluated and organised (→ structured and linked)
  - transformed into readily usable material (→ conclusions)
- Several pieces of experience and knowledge could be
  - combined
  - reworked (“engineered”)
  - re-phrased (→ guidelines, recommendations)

Levels of Learning

- Individual
- Group
- Organization
- (Society)



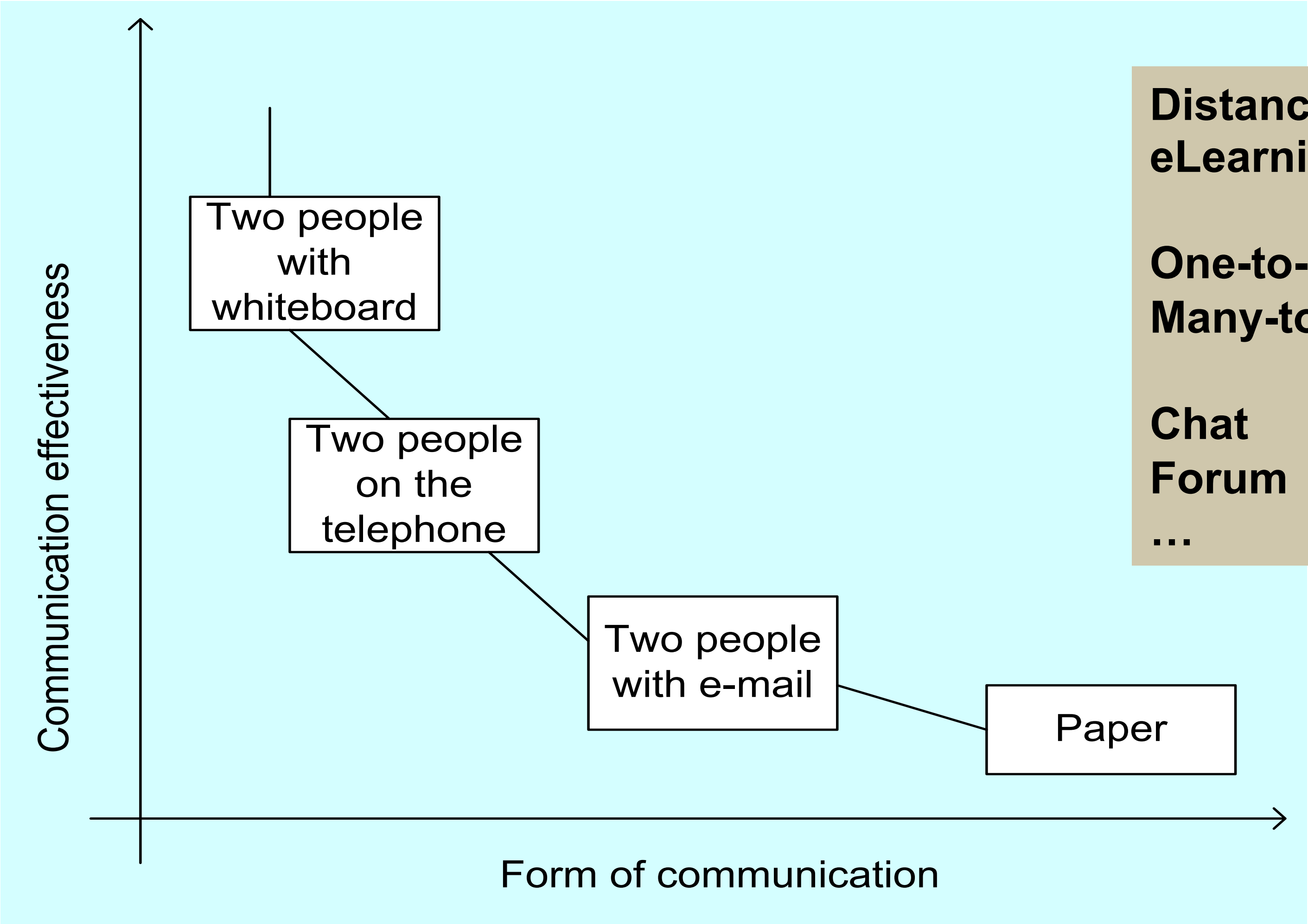
Source: Kurt Schneider, Univ. Hannover

Individual Learning

I hear and I forget.
I see and I remember.
I do and I understand.
Chinese Proverb

- Learning and competence development are important elements in process improvement work
- Relations between teacher(s) and learner(s):
  - One-to-one *(mentor arrangements, traditional master(guru)-student-relation in Asia)*
  - One-to-many *(traditional education)*
  - Many-to-many *(professional forum (e.g., conference), experience data bases)*
  - Many-to-one *(inexperienced project member)*
- Learning may activate:
  - Hearing, vision, smell, taste, movements
  - Different parts of the brain (emotions, intellect, creativity)
- Learning may be:
  - Active (participating), passive, “single loop”, “double loop”, …
- There exist many different learning theories
- There exist many different learning styles

Learning and Communication



Distance Learning
eLearning

One-to-many
Many-to-many

Chat
Forum
…

Organisational Learning

- Organisations may have different approaches to learning:
  - Develop own knowledge versus infusing extern knowledge
  - Planned (formalized, tested) versus ad-hoc competence development
  - Evolutionary versus revolutionary approach
  - Systematic versus ad-hoc experience transfer
  - Dedicated training courses versus "on-the-job-training"
  - Focus on what is most important in the value chain vs. treating everything as equally important
  - Focus on the individual versus the group
  - Focus on product versus process
  - …

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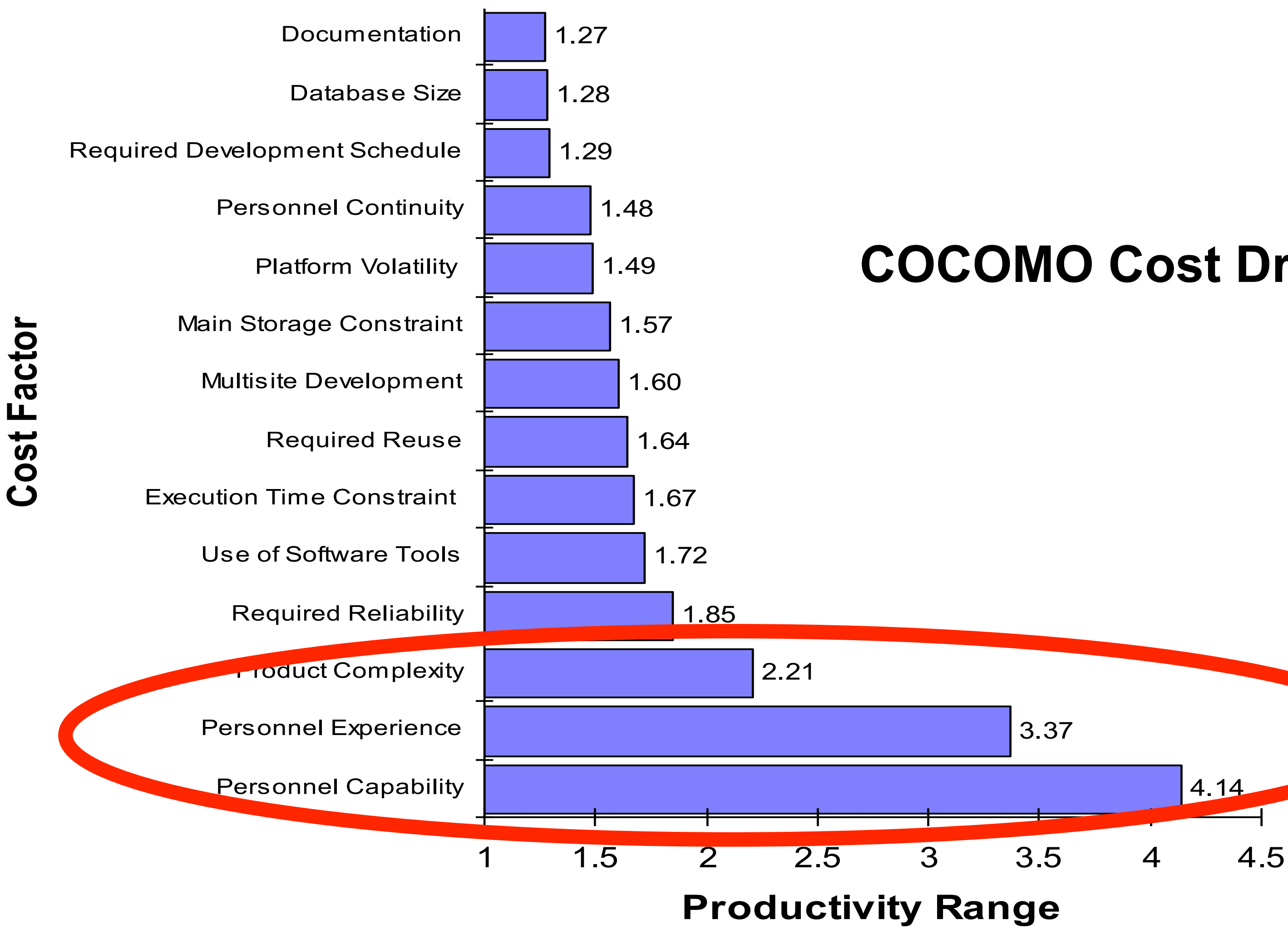
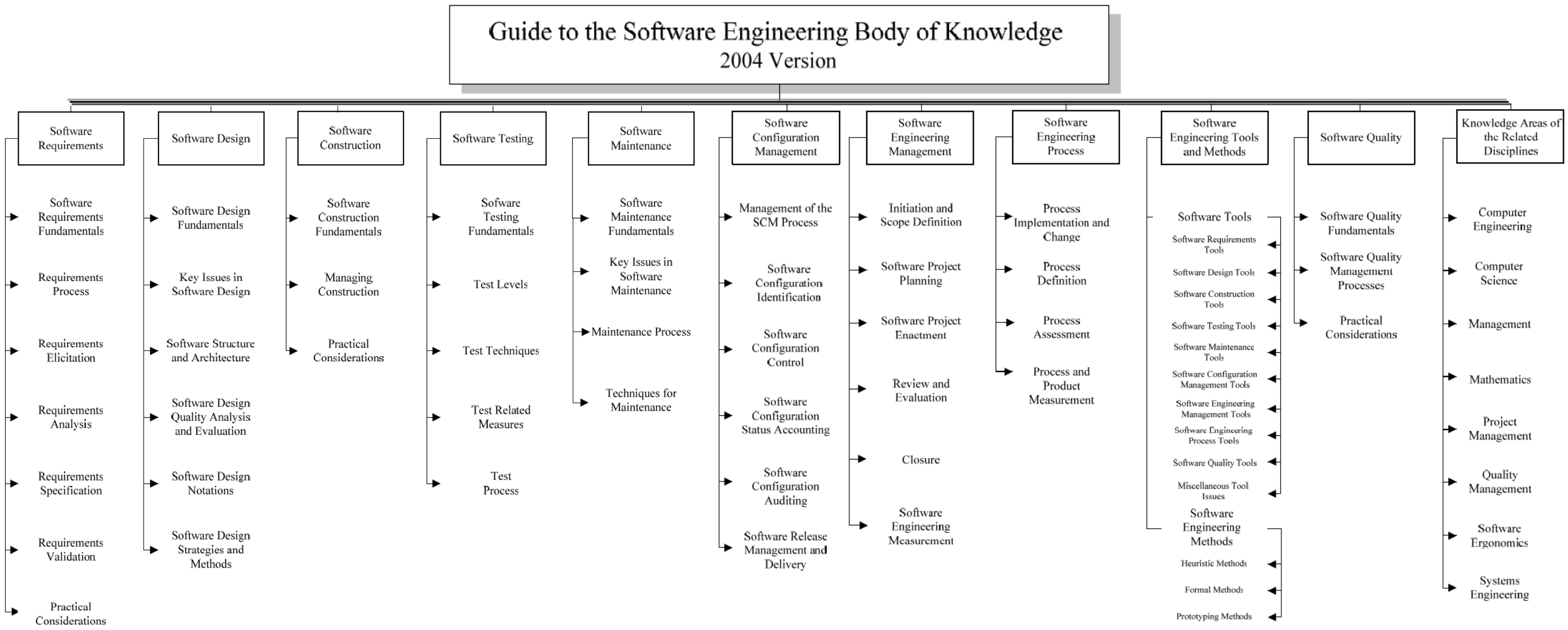
Impact of Skills & Experience on Cost



COCOMO Cost Drivers

SWEBOK Knowledge Categories www.swebok.org



IEEE, together with industry partners (Rational, SAP, Boeing etc...), have specified *Software Engineering Body of Knowledge* which is meant to be a standard for training and certification of software developers.

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Standard Skill Profiles for ICT Roles – Categories

Knowledge (Cognitive Competence)

- Declarative and tacit knowledge (breadth, kind)
  - *Application of knowledge*
- Understanding
  - *Comprehension*

Skills (Functional Competence)

- Range and Selectivity
  - Ability to *select* from a certain range of skills (and tools, methods, procedures…)
- Decision Taking based on:
  - *Analysis*
  - *Evaluation*
  - *Synthesis*

Wider Competences (Pers. Competences)

- Autonomy/Responsibility
  - *Autonomy*
  - *Responsibility*
  - *Context* (Ability to operate within context)
- Learning Competence
  - *Learning to learn*
- Social Competence
  - *Communication*
  - *Cooperation* (including Role)
- Professional Competence
  - *Problem Solving*
  - Training (and briefing) others (*Transfer of Knowledge*)

Competence Profile – Roles

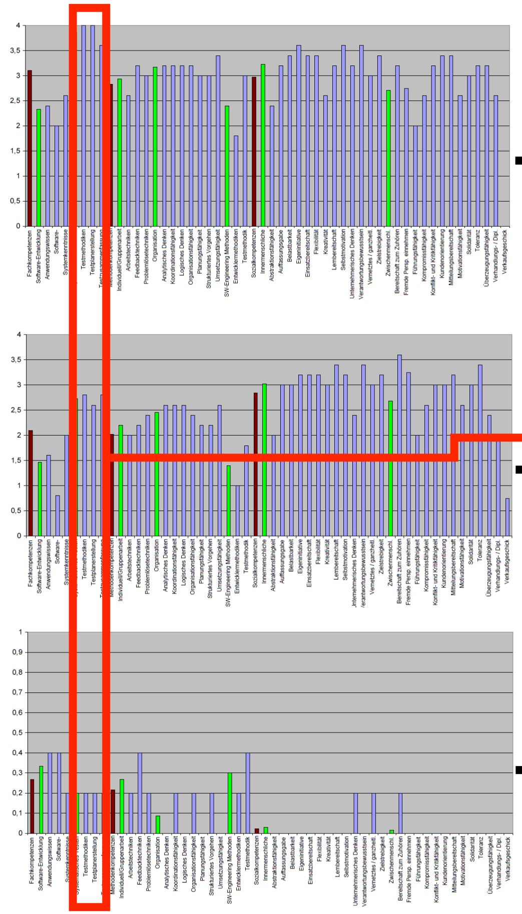
	Skill areas	Product Manager	Project Responsible	Project Manager	Developer	Configuration Manager	Test Responsible	Release Responsible	Change Responsible
Software Engineering									
	Software Requirements	4	3	3	2	1	3	3	2
	Software Design	2	2	3	3	2	2	2	2
	Software Construction	2	2	2	2	3	2	4	2
	Software Testing	2	2	2	3	1	4	3	3
	Software Maintenance	3	2	3	3	3	2	3	4
	Software Configuration Management	2	2	2	3	4	2	4	3
	Software Engineering Management	4	3	3	1	1	1	2	2
	Software Engineering Processes	3	3	3	2	1	1	2	1
	Software Engineering Tools and Metho	1	2	2	2	2	2	2	2
	Software Quality	4	3	3	2	2	3	3	2
Specific areas	…								
Social areas	…								
Domain specific areas …									

Individual Gap Analysis

Skills GAP analysis					
Name: <name>		Current status	Personal wish	GAP	**Action**
Software Engineerin					
	Software Requirements	2	3	1	Attend 3-day course
	Software Design	3	4	1	Attend course, go to 2 conferences
	Software Construction	2	2	0	
	Software Testing	2	2	0	
	Software Maintenance	1	1	0	
	Software Configuration Management	3	**2**	**-1**	
	Software Engineering Management	2	2	0	
	Software Engineering Processes	2	2	0	
	Software Engineering Tools and Metho	3	3	0	
	Software Quality	1	3	2	Attend course, participate in QA-audits
Social	…				
Specific areas	…				
Domain specific areas …					

Gap Analysis – Example: QUALISEM-People

- Required Skills
- Current Skills
- Training preference



Tester (5 Fragebögen)			
Kompetenz-bereich	Einzelkompetenz	Differenz IST vs. SOLL > 1: ● > 2: ⬤ > 3: ⬤	Persönlicher Weiterbildungs-wunsch > 30% ● > 40% ⬤ > 50% ⬤
Fachkompetenz: SW-Entwicklung			
	Anwendungswissen	⬤	●
	Software-Entwicklungsprozess (OO-Entwicklungsprozess)	●	●
Fachkompetenz: Systematisches Testen			
	Testmethodiken	●	
	Testplanerstellung	●	
	Testzusammenfassung	●	
Methodenkompetenzen: Individuell / Gruppenar-beit			
	Feedbacktechniken	●	●
Methodenkompetenzen: Organisation			
	Logisches Denken	●	
	Strukturiertes Vorgehen	●	
Methodenkompetenzen: SW-Engineering Metho-den			
	Testmethodik	⬤	●
Sozialkompetenzen: innermenschlich			
	Abstraktionsfähigkeit	●	

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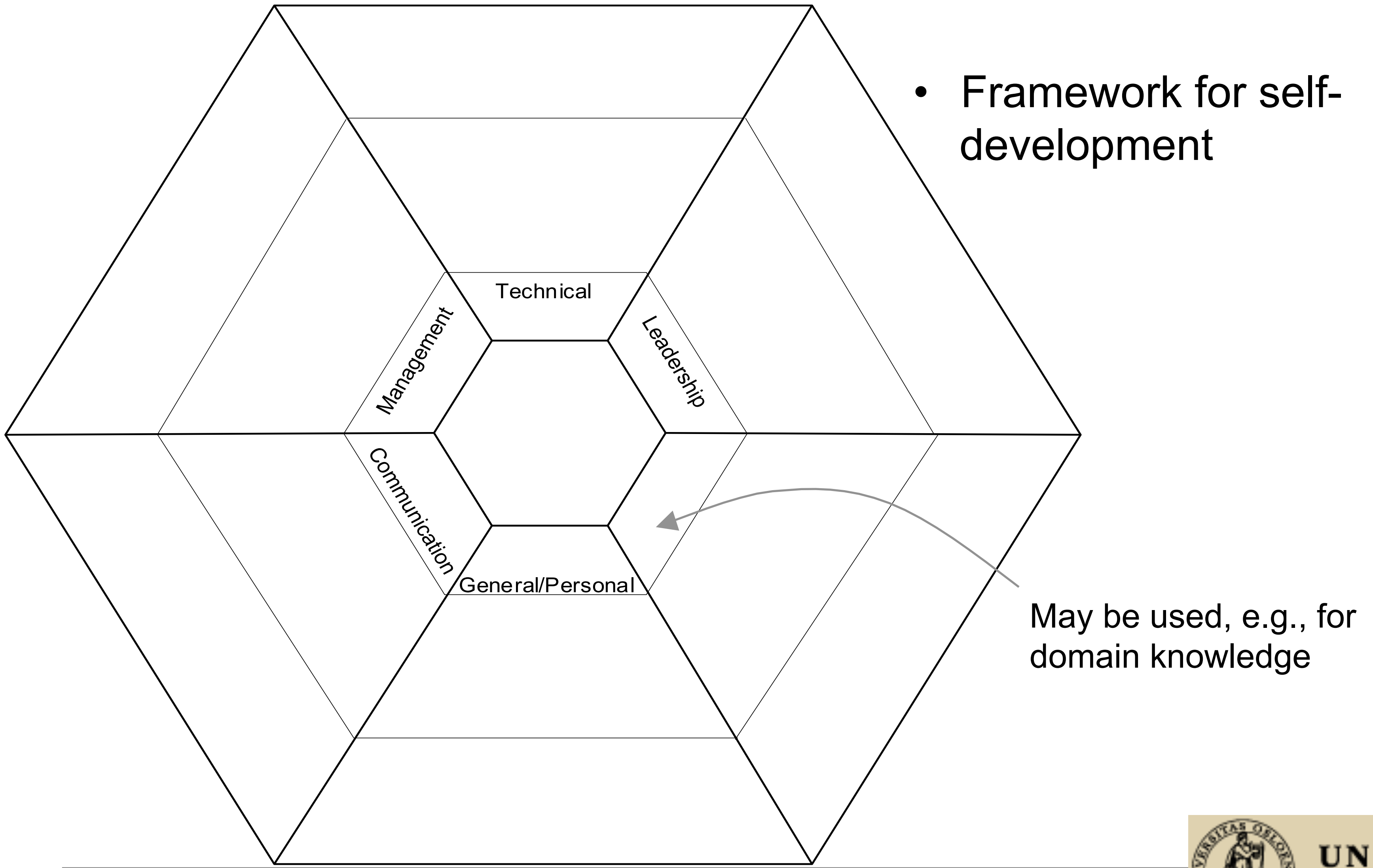
QUALISEM-People – Steps

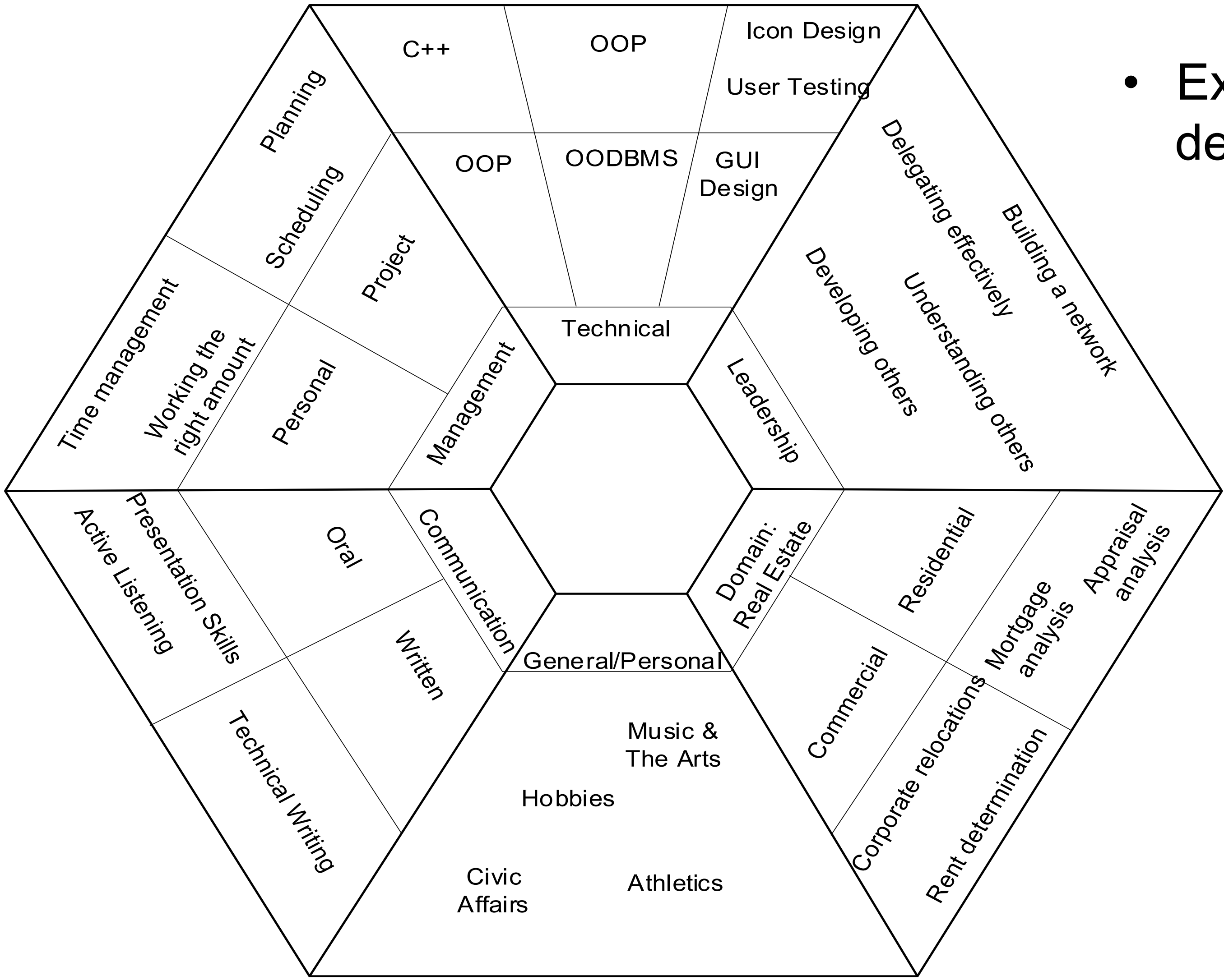
1. Selection of an adequate set of standard profiles, specific roles and employees within the company.
2. Tailoring of the standard profiles in order to meet customer needs and to fit in with the specific company context.
3. Definition of the target profiles based on a role-based questionnaire in which either the employees or company managers rate desired performance levels in relation to the specific skill competences. In completing the questionnaire it is also important to take into account the future needs of an organization or department, as well as new methods that may be applied.
4. Assessment and documentation of the actual competences are developed on the basis of a role-based questionnaire in which the employees rate their performance level in relation to the specific competence areas of their role.
5. Elicitation of qualification preferences based upon the questionnaire ratings of the employees.
6. Comparison and aggregation of the data from stages 3 and 4 resulting in a skills gaps analysis. Aggregation of data relating to qualification preferences from stage 5. Balancing of the skill gaps and qualification preferences.
7. Stakeholder workshop - the objective of which is to prioritize the skill gaps and identify the preferred ways in which to provide training for them.

Hohmann’s Self-Development Framework



- Framework for self-development

Hohmann's Self-Development Framework



- Example of a self-development framework

Skill Levels (Hohmann)

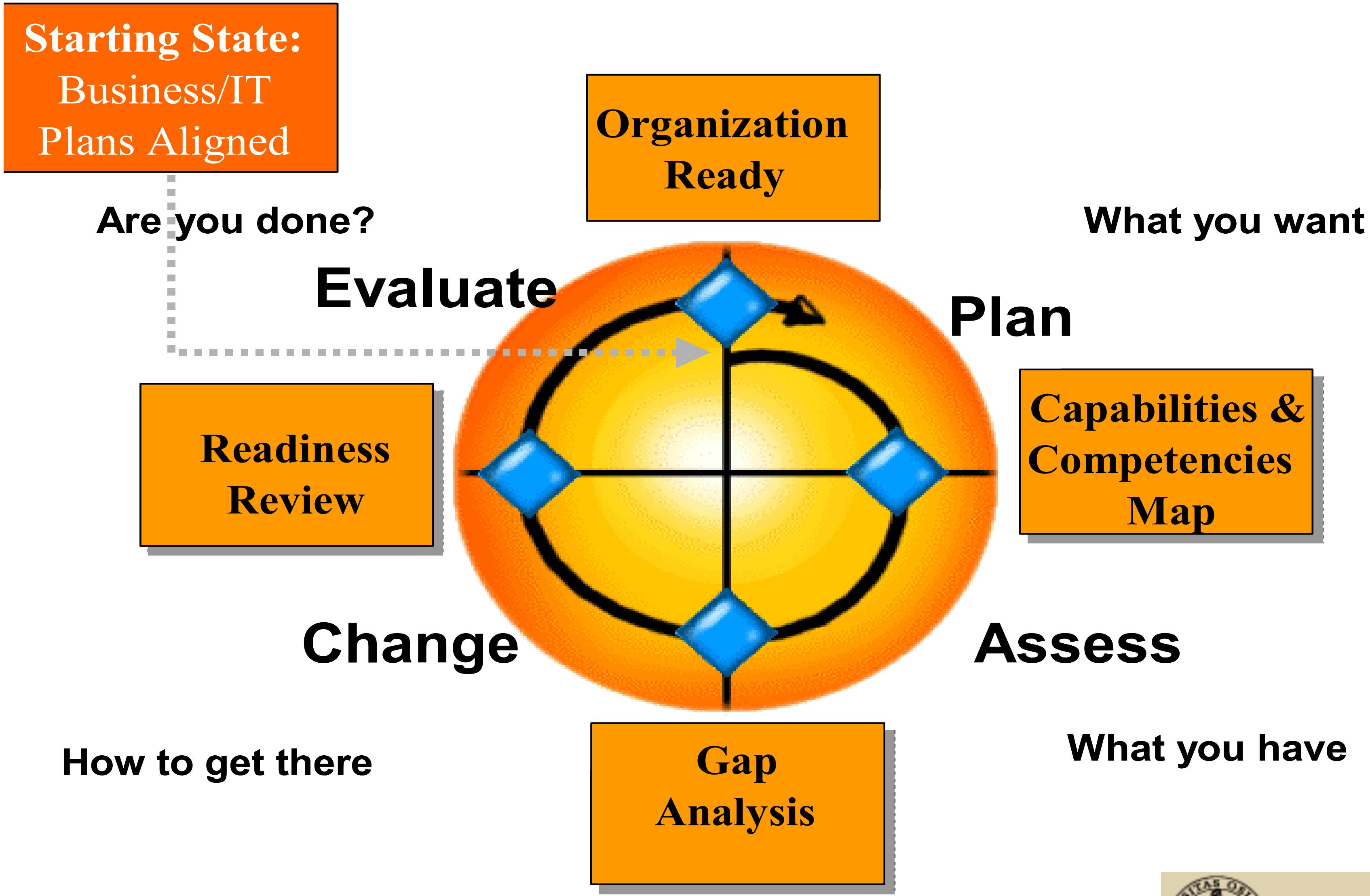
- Innocent
  - You are not even aware of the domain.
- Aware
  - You are introduced to the domain.
- Apprentice
  - You have some training within the domain and have some experience → the start of *library of cognitive plans*.
- Practitioner
  - You have accomplished relatively complicated tasks within the domain → rather developed *library of cognitive plans*.
- Journeyman
  - You work daily within the domain and start to find your own tailored methods → well developed *library of cognitive plans*.
- Master
  - You master a wide range of tasks within the area and adjust intuitively the method to your needs → you have a wide and sophisticated *library of cognitive plans*.
- Expert
  - You are an distinguished expert and publish/share your knowledge actively → externalizing your *library of cognitive plans*.

Microsoft Readiness Framework (MRF)

- In the context of Microsoft Readiness Framework, ***readiness*** means the state achieved by either an individual or an organization as a result of activities geared toward “getting ready for” new technology, including “getting ready to” plan, build, manage or operate that technology.

- Organizational readiness
  - Leadership
  - Culture
  - Process
  - **Skills**
  - Hardware
  - Software
- Individual readiness
  - **Knowledge**
  - **Skills**

MRF Process



Starting State:
Business/IT
Plans Aligned
Are you done?
Organization
Ready
What you want
Evaluate
Plan
Readiness
Review
Capabilities &
Competencies
Map
Change
Assess
How to get there
Gap
Analysis
What you have

Microsoft Skills

- "Skills, like hardware, are assets. They have value, require an investment, and depreciate over time. Like any asset, they need to be constantly examined and re-evaluated. A skills management system is vital to an organization's ability to develop its human capital.

A skills management system has three primary components:

- Competency Management – organizations must think about development of their intellectual capital from a competency management perspective. What skills are important to the organization? What job roles are important?
- Assessment Management – how do companies assess whether their employees have the required knowledge and skills? If companies cannot make this assessment, they cannot measure the return on investment in hiring, training, and career development.
- Learning Management System – an organization can measure the difference between competencies and assessment or, assess where the competencies don't meet the requirements and then implement a personalized learning plan that will provide development (closing of the skills gaps) for each employee."

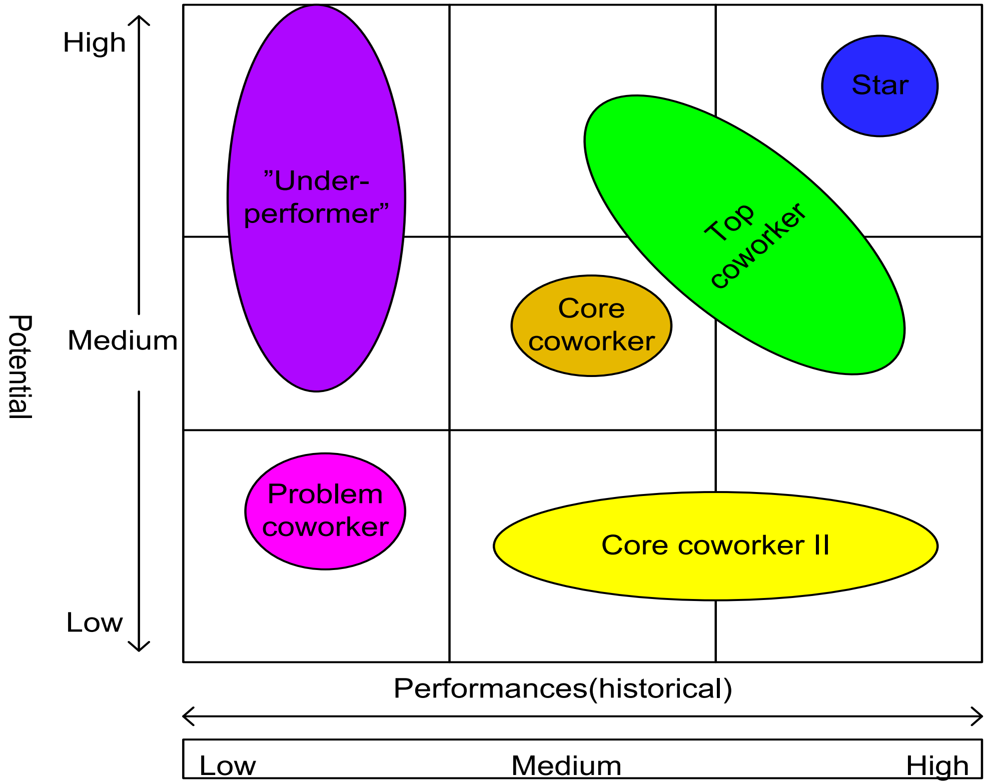
Microsoft Skill Levels

Skill Level Rating	Simple Description	Description
0	No Experience	Not applicable.
1	Familiar	Familiarity: Skill in formative stages, individual has limited knowledge. Not able to function independently in this area.
2	Intermediate	Working knowledge: Good understanding of skill area, is able to apply it with reasonable effectiveness. Functions fairly independently in this area, but periodically seeks guidance from others.
3	Experienced	Strong working knowledge: Strong understanding of skill area, is able to apply it very effectively in position. Seldom needs others' assistance in this area.
4	Expert	Expert: Has highly detailed, thorough understanding of this area and is able to apply it with tremendous effectiveness in this position. Often sought out for advice when others are unable to solve a problem related to this skill area.

Categorizing Workforce

Ref.: Eduviva (www.eduviva.no)

Portfolio analysis of existing human resources may be a useful tool for uncovering gaps in competencies and elaborating training and career plans.



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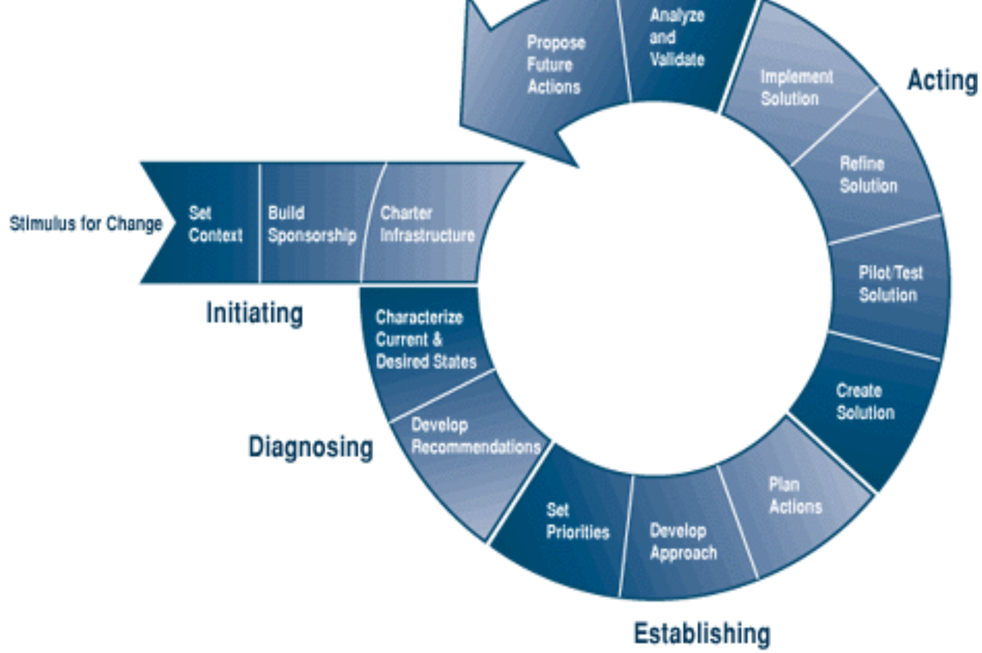
Continuous Improvement (a cyclic process)

General procedure:

- Initiate an improvement program
- Define goals
- Analyze the current situation
- Plan changes
- Implement changes
- Check the effect of the changes
- Analyze the current situation, adjust goals, ... etc, etc

IDEAL Process (SEI)



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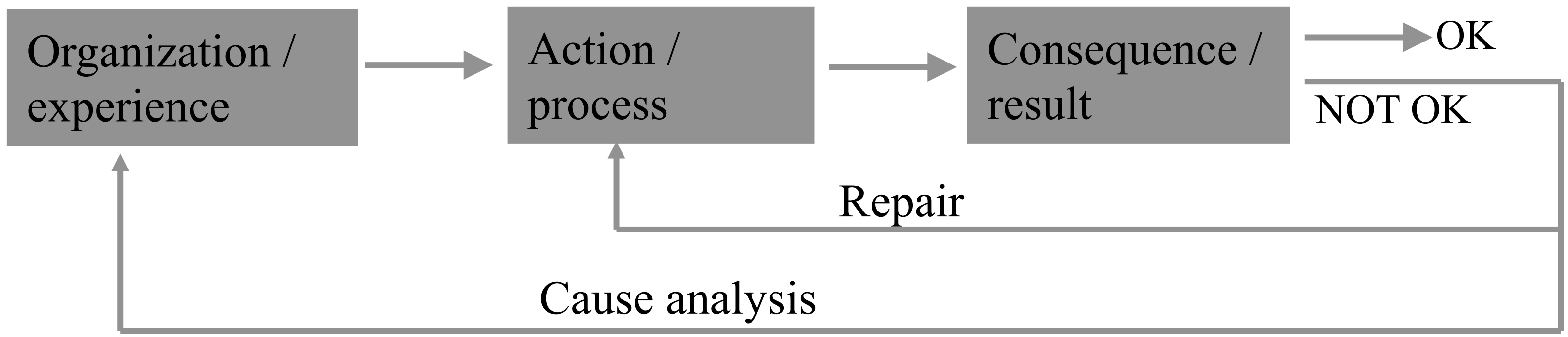
The Core of any Systematic Approach to SPI: PDCA Cycle

- **PLAN** what you want to accomplish over a period of time and what you might do, or need to do, to get there
- **DO** what you planned to do
- **CHECK** the results of what you did to see if the objective was achieved
- **ACT** on the information – standardize or plan for further improvement

[Deming, Sheward]

Learning in Single- and Double Loops



- We get a better product when we correct a fault, but if we don’t eliminate the root-cause of the defect there is always a risk that the same fault is injected over and over again.
- By seeking the cause of the fault, we are able to
  - Remove systematic faults once and for all
  - Get the opportunity to improve the process which caused the fault(s)
  - Nurture innovation

Organizational learning: A theory of action perspective
Chris Argyris & Donald A. Schön, 1978

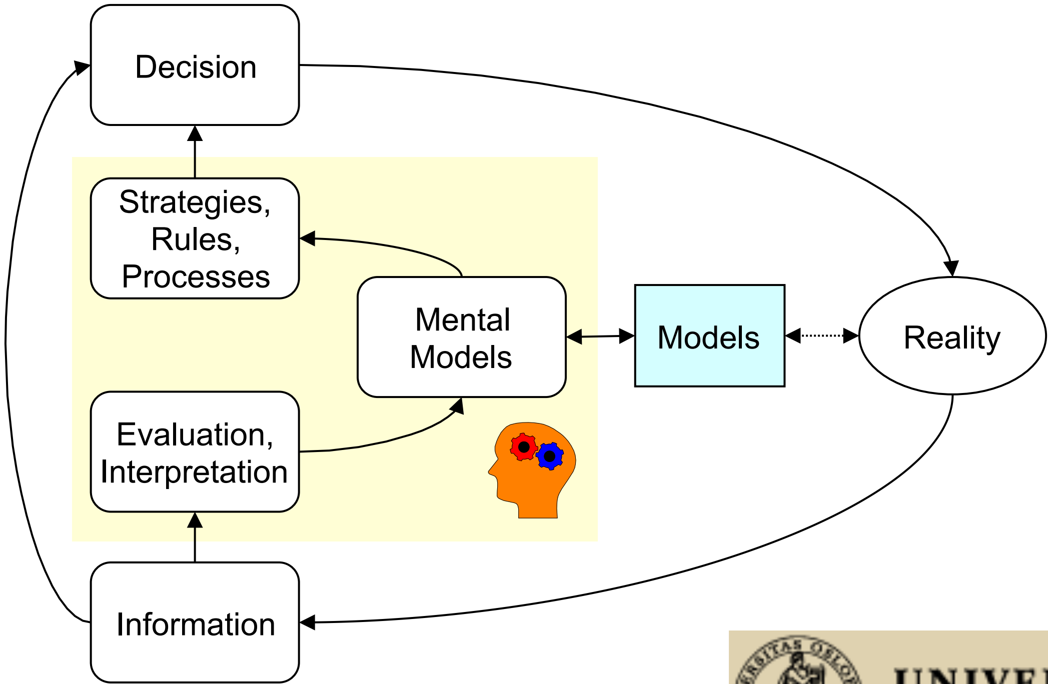
Learning of Managers & Engineers

- Tasks:
  - Understand: processes, root-causes of mistakes (lack of success)
  - Plan: development projects, implementation of improvement suggestions
  - Control: development projects, implementation of improvement suggestions
  - Improve: identify improvement potential, development of improvement suggestions

- Prerequisite:
  - Ability to learn

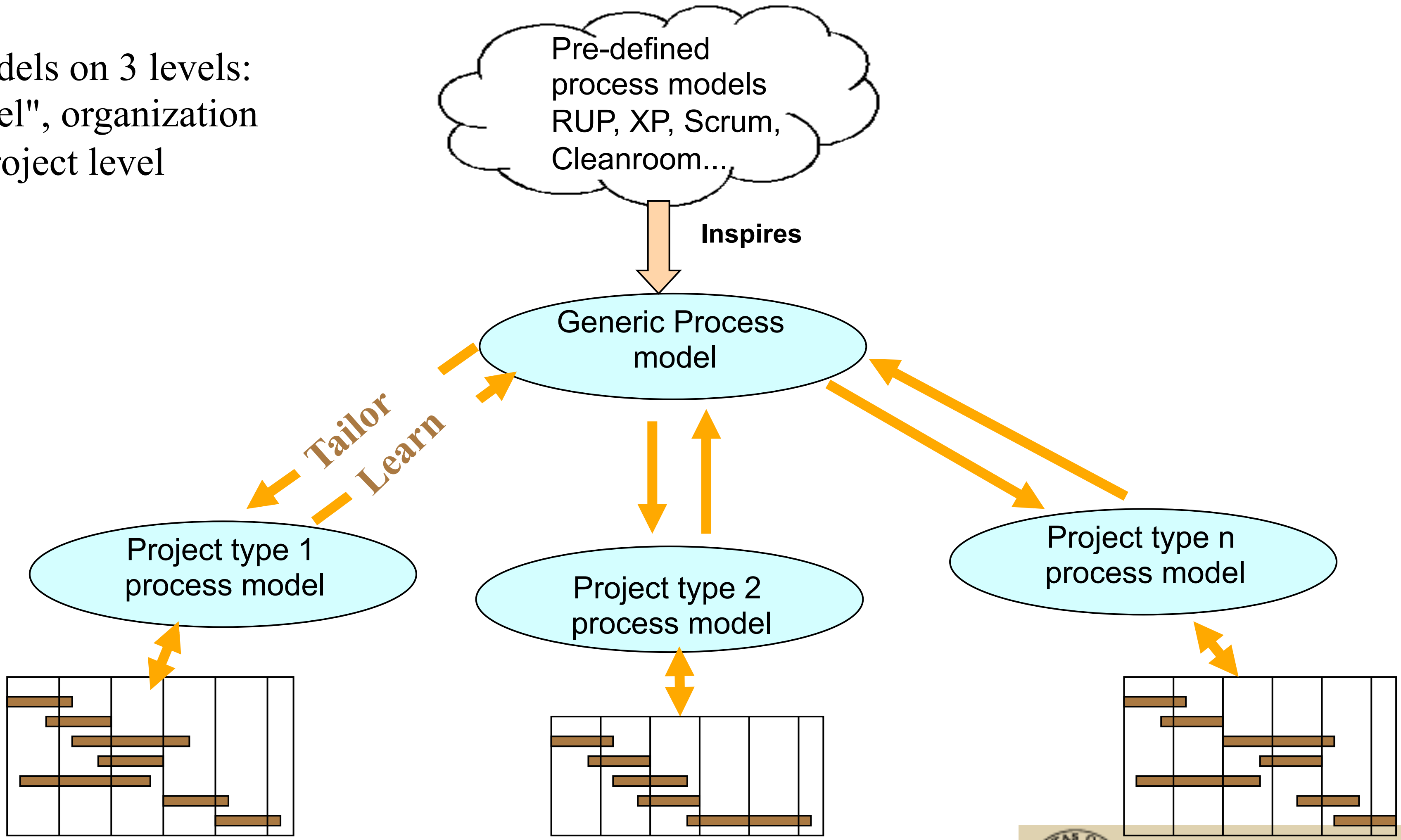
- Types of learning:
  - „Single-Loop“
  - „Double-Loop“

Model-based learning

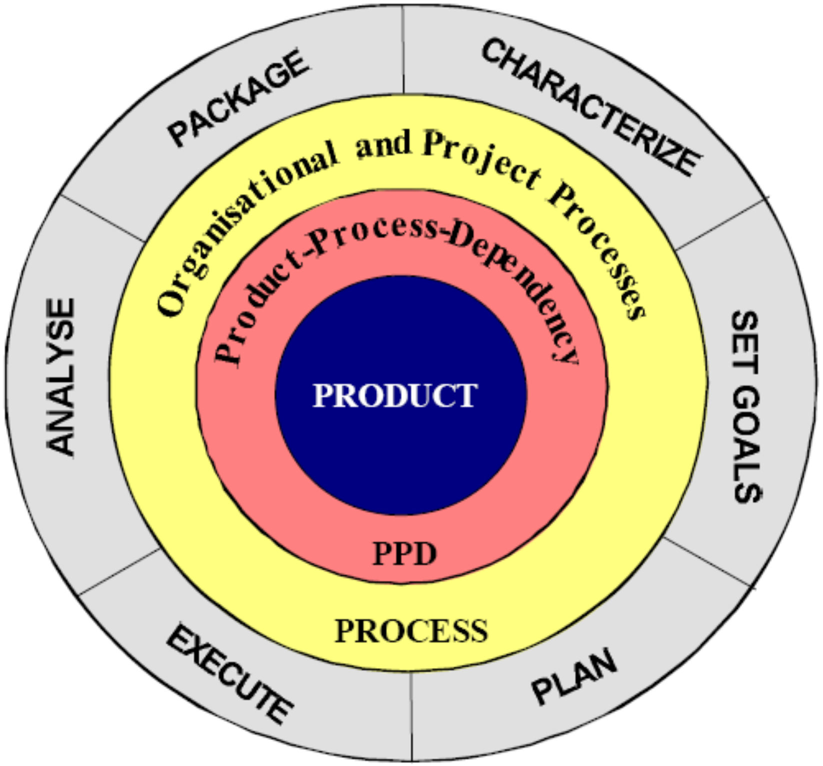


Learning from Process and Experience

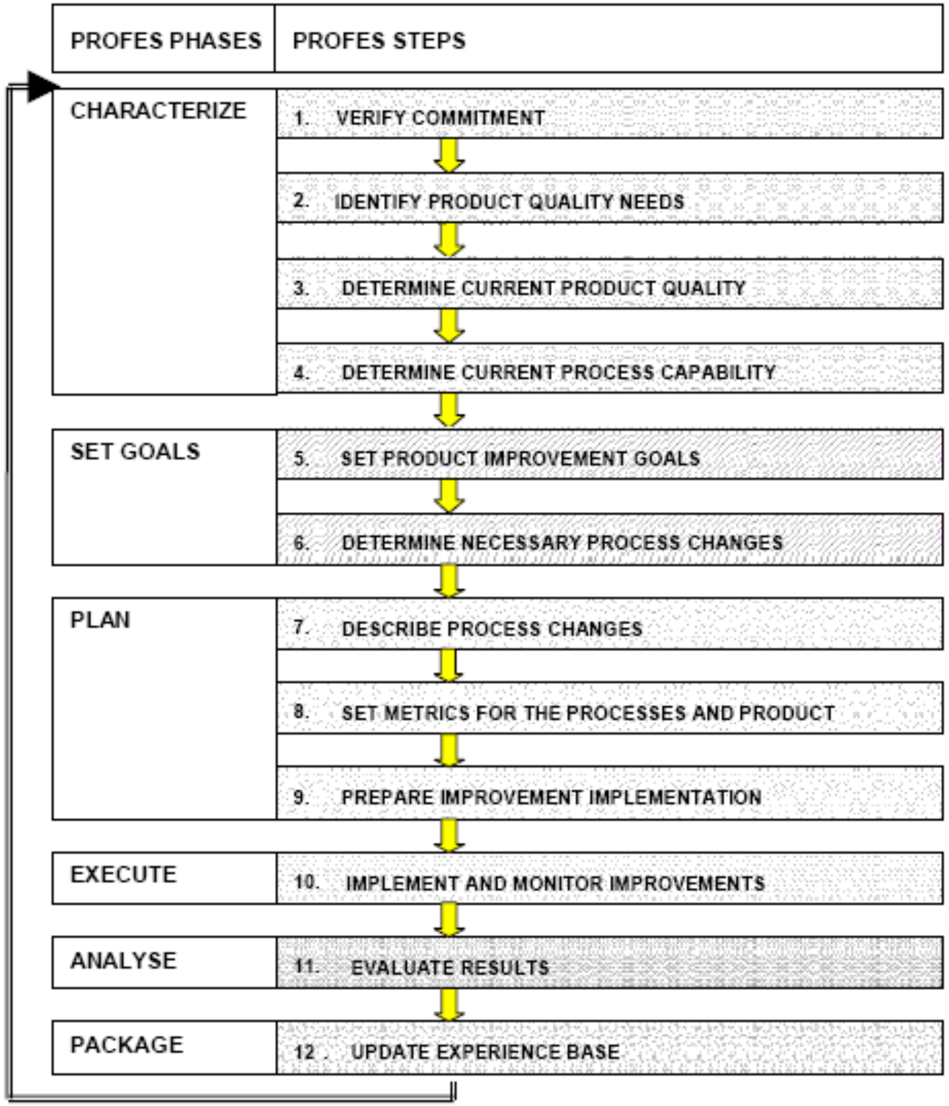
Process models on 3 levels: "Global level", organization level and project level



PROFES



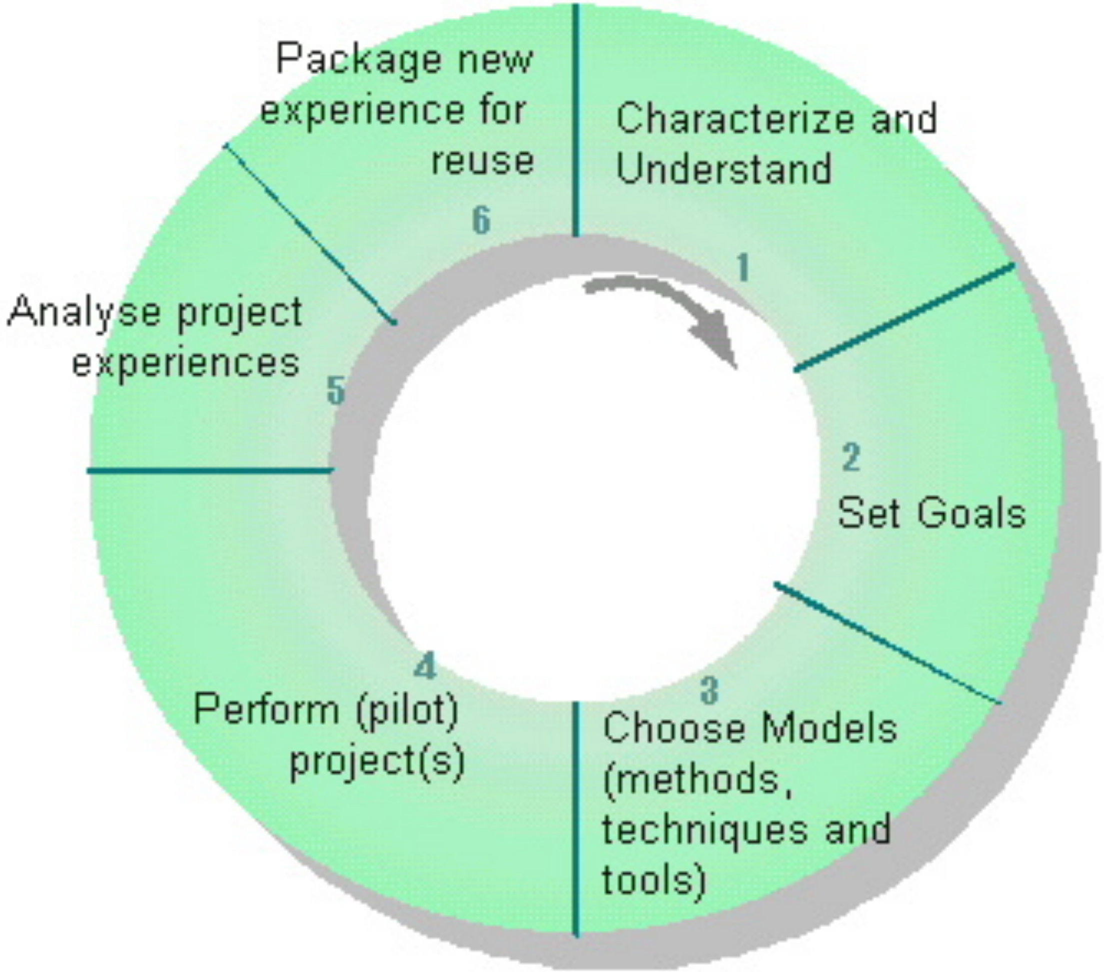
The PROFES improvement cycle



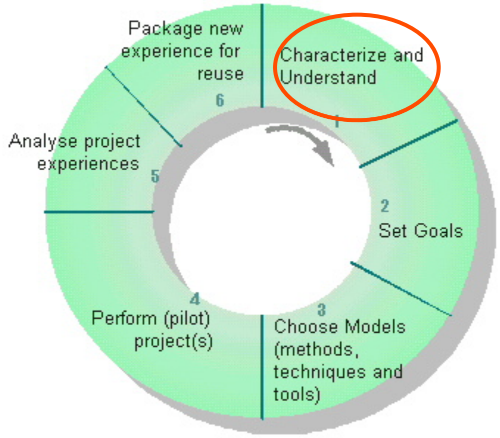
Phases and steps of the PROFES improvement methodology

Process Improvement Processes – QIP

QIP – Quality Improvement Paradigm, Victor Basili, University of Maryland



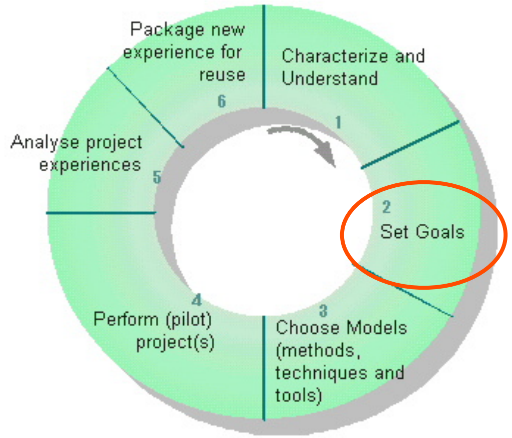
1. Characterize



- Characterize the organization. Identify characteristics and locate the organization in the improvement circle.
- Identify particular problematic areas. Are the customers satisfied? Are the collaborators satisfied? Are there any signs of weakness in the process?
- Look ahead. Do you think the characteristics will change during the next period? Are we headed for new markets that will demand other requirements than we are familiar with?
- Exploit knowledge that resulted from the last run of the Quality Improvement Paradigm (if available)

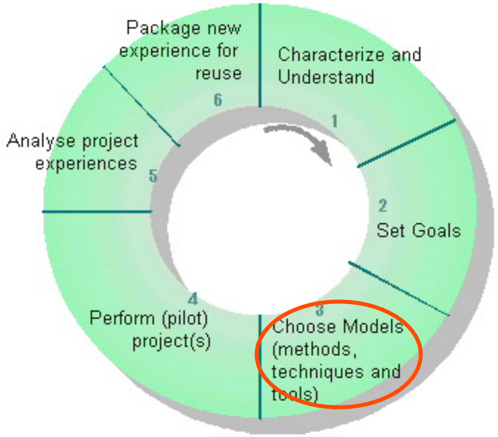
- NOTE: This step should be carried out very carefully in the first run of the QIP. It is recommended to make semi-structured interviews (e.g., via CMMI assessments) of various roles in order to identify pros and cons. Analyze, if available, data from past projects.

2. Set Goals



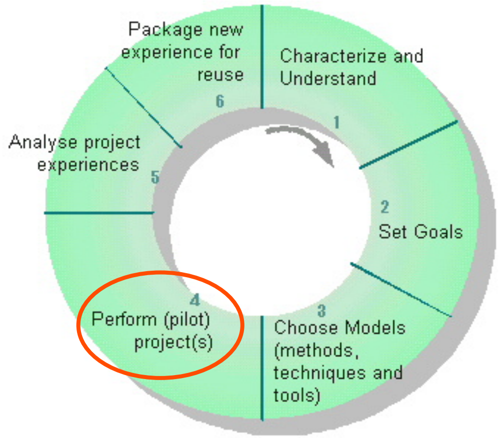
- Set goals for the next period.
  - What company-wide improvement goals exist?
  - What goals with respect to market and business strategy exist?
  - Align to strategic business goals!
- The goals should be broken down into concrete improvement goals (→ GQM plan).
  - Define the goals so that it is possible to verify them later on.
- Use the knowledge about what is important for the organization- in particular the experience/knowledge from the last run of the QIP (unless it is the first run).

3. Choose Models



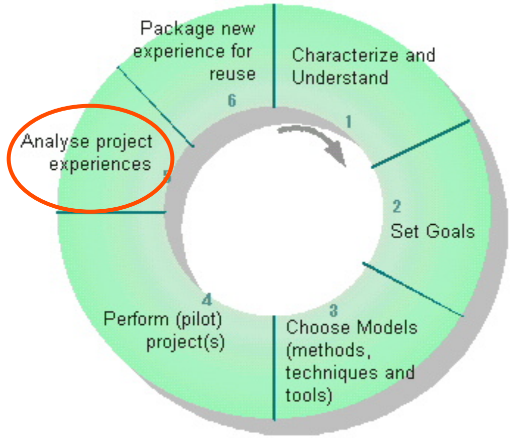
- Decide what efforts are necessary in order to reach the set goals
- Prioritize (urgency, impact, risk, …)
- Make explicit what new methods/models/knowledge will be tested
- If necessary, choose the tool support to be used
- Make a risk analysis in order to make the right decision about the scope of the improvement effort (company, department, (pilot) project)
- Complete the improvement plan (→ Measurement Plan)

4. Perform Projects



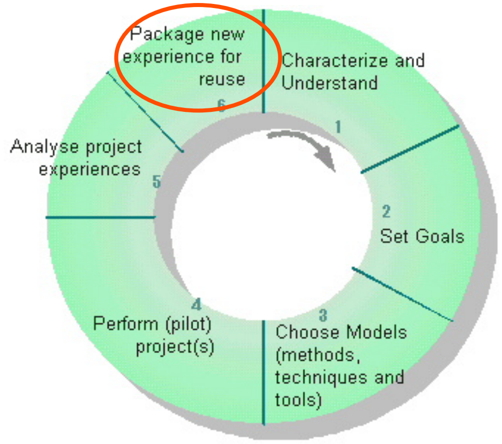
- This involves the testing of the new models/methods and tools in a certain number of projects (or pilot-projects)
- For each (pilot) project:
  - Characterize the project
  - Agree what process model to use in the project
  - Use the measurement plan
  - Coordinate the process activities, the measurement plan and the project plan
  - Collect data, analyze and provide feedback during the project. Learning meetings!
  - At the end of the project, analyze the results and document the experiences

5. Analyze



- Collect the (analysis) results from all (pilot) projects
- Conduct the analysis with regards to the organization
  - How do the recent results relate to what we have seen earlier/elsewhere in the organisation?
- Document the results

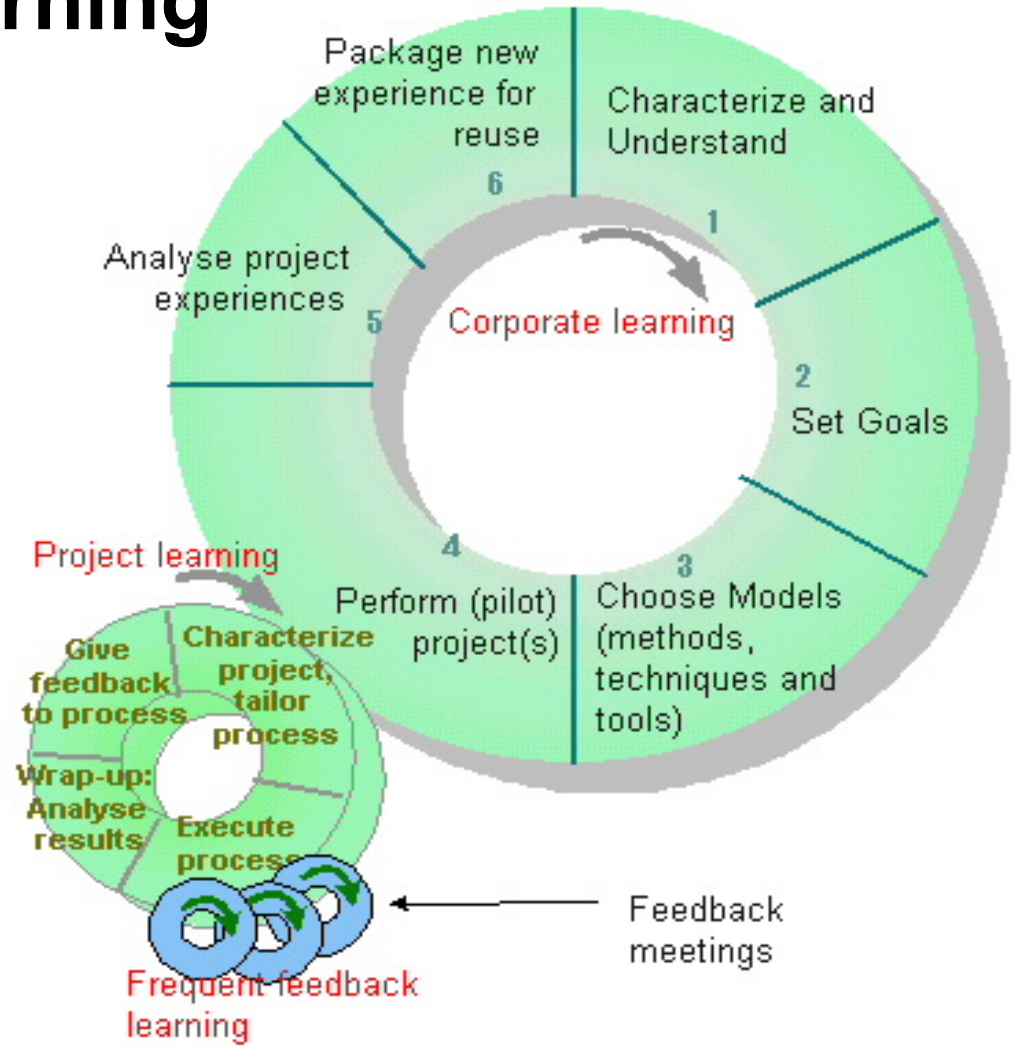
6. Package Experience



- This is about how to make a good process available to future projects.

- Document (package) the results from the projects so that the experiences may be reused (i.e., are understandable and transferable).
  - For instance, this may involve updating a process model and linking quality models to it.

QIP – Focus on Learning



QIP – Also included: project level and local feedback meetings.

→ Learning on three levels!

Learning Meetings

- Conduct learning meetings (or reflection meetings)
  – Schedule the meetings at the end of main activities (milestones, iterations, etc.)
  – Gather the project group at the occurrence of particular events (”de-briefings”)
- In the learning meetings discuss the following:
  – What was supposed to happen (the plan)?
  – What happened actually?
  – Why were there deviations?
  – What did we learn?
  – How can we prevent this to happen again?

Evaluation Meetings

- Use Post Mortem Analysis (PMA) as described in "*Postmortem reviews: purpose and approaches in software engineering*" [file *post-mortems.pdf* in reading materials]
- Evaluation meeting:
  - What can be considered to be successful parts of the project and should be repeated?
  - What went OK, but could have been done better?
  - Which faults were made that should be avoided in the future?
  - Identify the causes to both good and bad experiences

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Bring the Experience Back to the Process

- Do this closely together with the PMA
- If you have a well-defined standard process, the experiences should lead to changes.
- Discuss suggestions for how to change the standard process with the organization itself – then carry out the changes that were decided!
- Institutionalizing: do not underestimate the job of changing the way other people work!

"It is easier to dissolve an organization than to change it"

Tom Peters

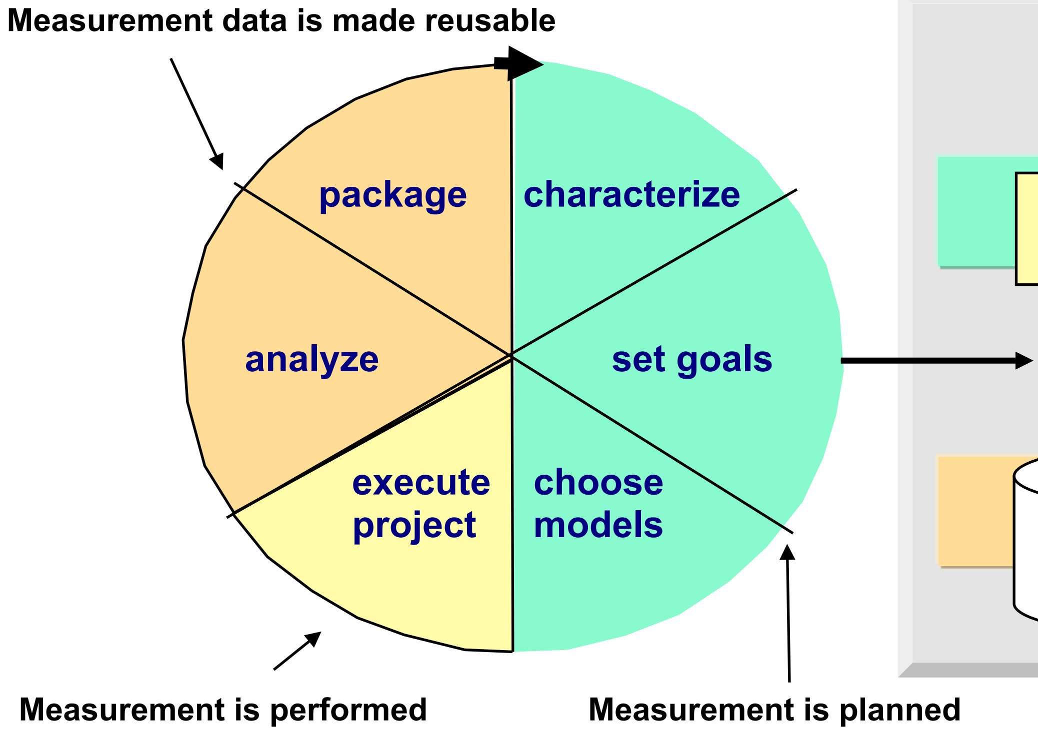
QIP and Learning Organizations

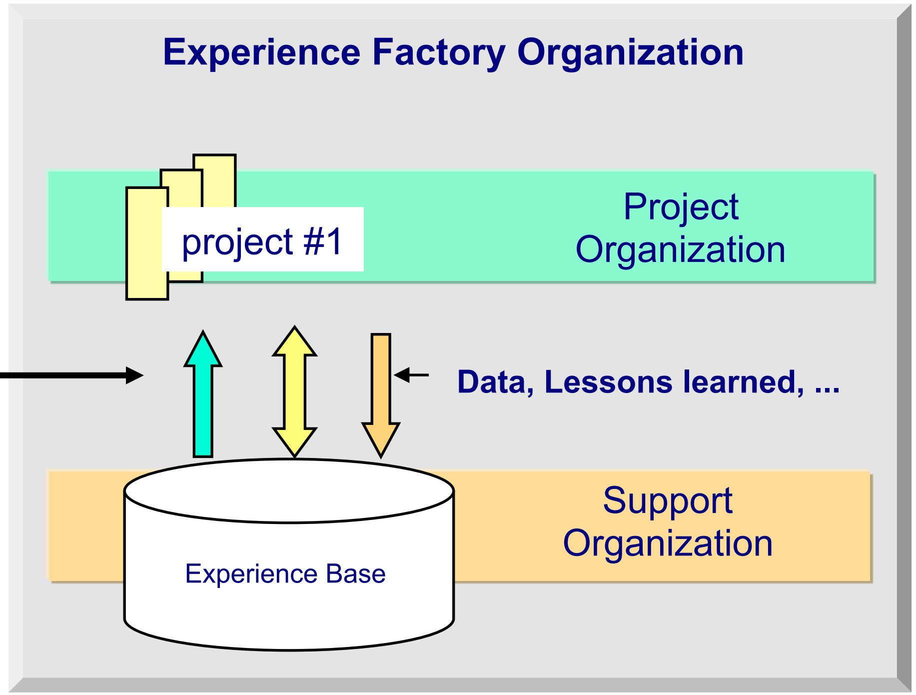
QIP

(Basili, Rombach, 1988)

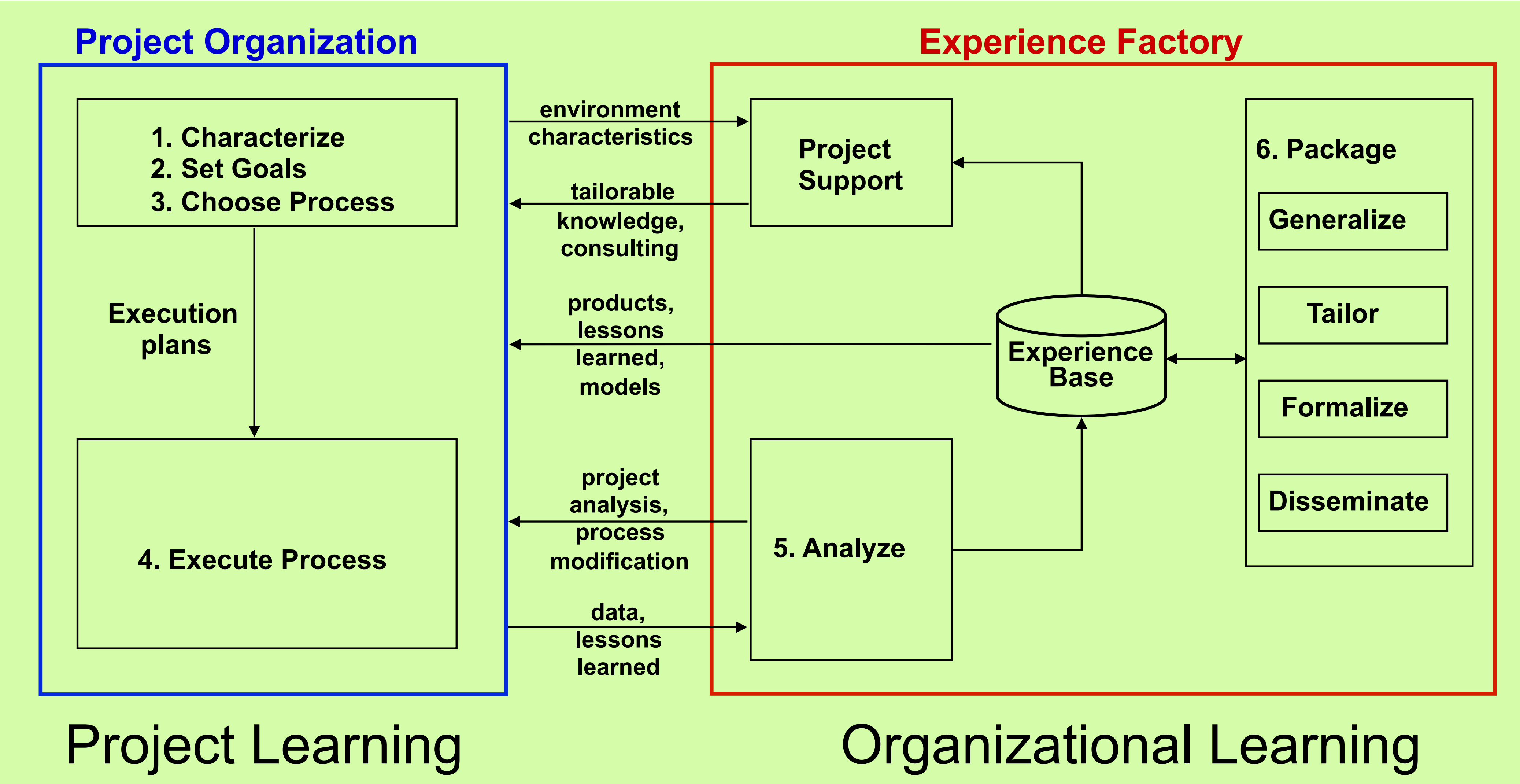
Experience Factory Organization

(Basili, Rombach, 1988)





The Experience Factory Organization



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The Experience Factory Organization – A New Paradigm

Project Organization **Problem Solving**	**Experience Factory** **Experience Packaging**
Decomposition of a problem into simpler ones	Synthesis of different solutions and re-definition of the problem
Instantiation	Generalization, Formalization
Design/Implementation process	Analysis/Synthesis process
Validation and Verification	Experimentation
Product Delivery within Schedule and Cost	**Experience / Recommendations Delivery to Project**

SEL: An Example Experience Factory Structure

PO

DEVELOPERS
(SOURCE OF EXPERIENCE)

STAFF	275-300 developers
TYPICAL PROJECT SIZE	100-300 KSLOC
ACTIVE PROJECTS	6-10 (at any given time)
PROJECT STAFF SIZE	5-25 people
TOTAL PROJECTS (1976-1994)	120

NASA + CSC

Development measures for each project →

← Refinements to development process

EF

PROCESS ANALYSTS
(PACKAGE EXPERIENCE FOR REUSE)

STAFF	10-15 Analysts
FUNCTION	• Set goals/questions/metrics - Design studies/experiments • Analysis/Research • Refine software process - Produce reports/findings
PRODUCTS (1976-1994)	300 reports/documents

NASA + CSC + U of MD

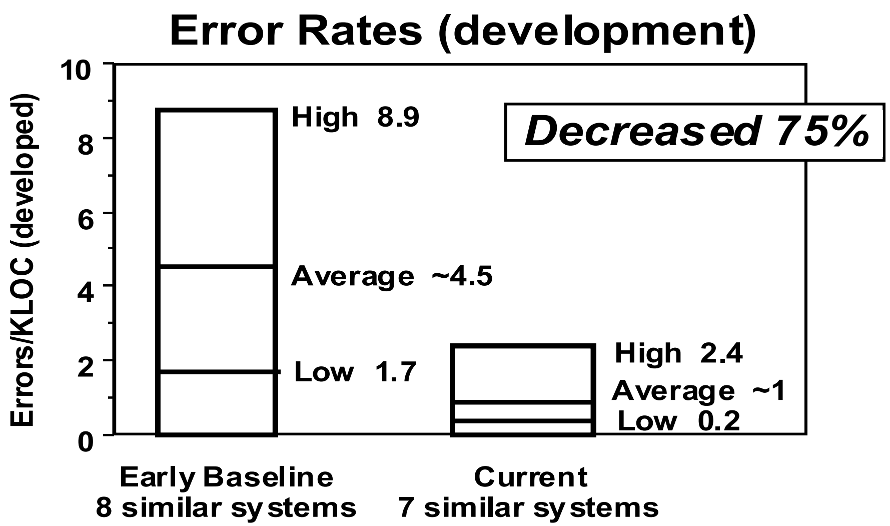
DATA BASE SUPPORT
(MAINTAIN/QA EXPERIENCE INFORMATION)

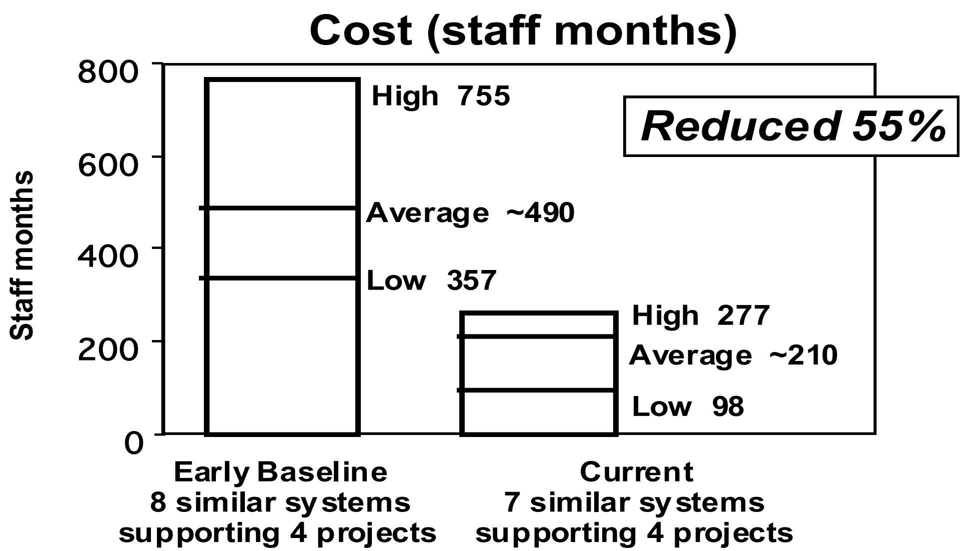
STAFF	3-6 support staff
FUNCTION	• Process forms/data • QA all data • Record/archive data • Maintain SEL data base • Operate SEL library

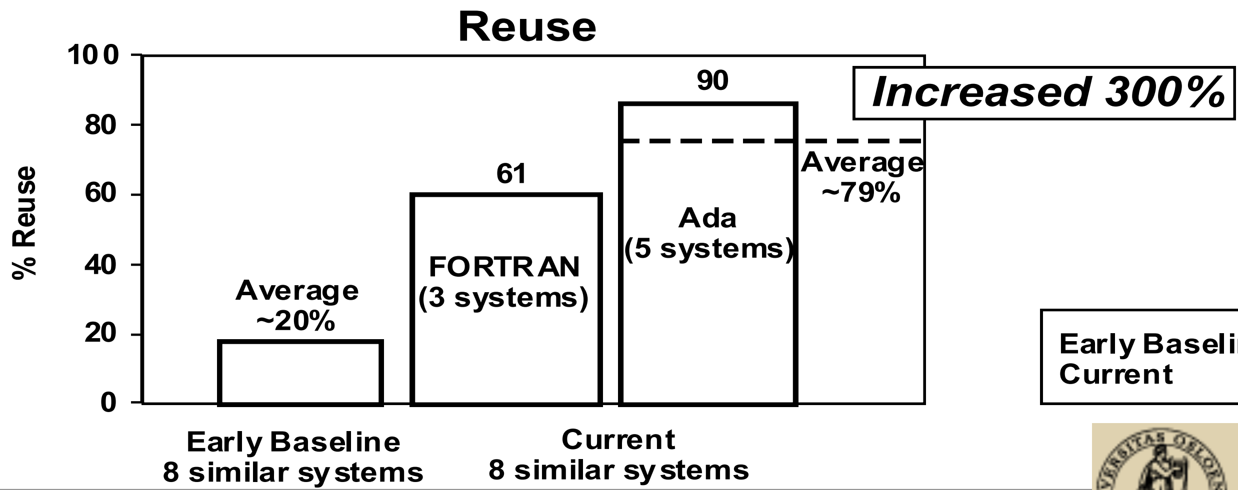
SEL DATA BASE	160 MB
FORMS LIBRARY	220,000
REPORTS LIBRARY	• SEL reports • Project documents • Reference papers

NASA + CSC

Using Baselines to Demonstrate Improvement: 1987 vs 1991







Early Baseline = 1985-1989
Current = 1990-1993

IEEE39

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Using Baselines to Show Improvement: 1987 vs 1991 vs 1995

Continuous Improvement in the SEL

Decreased **Development Defect rates**	by **75%** (87 - 91) **37%** (91 - 95)
Reduced **Cost**	by **55%** (87 - 91) **42%** (91 - 95)
Improved **Reuse**	by **300%** (87 - 91) **8%** (91 - 95)
Increased **Functionality**	five-fold (76 - 92)

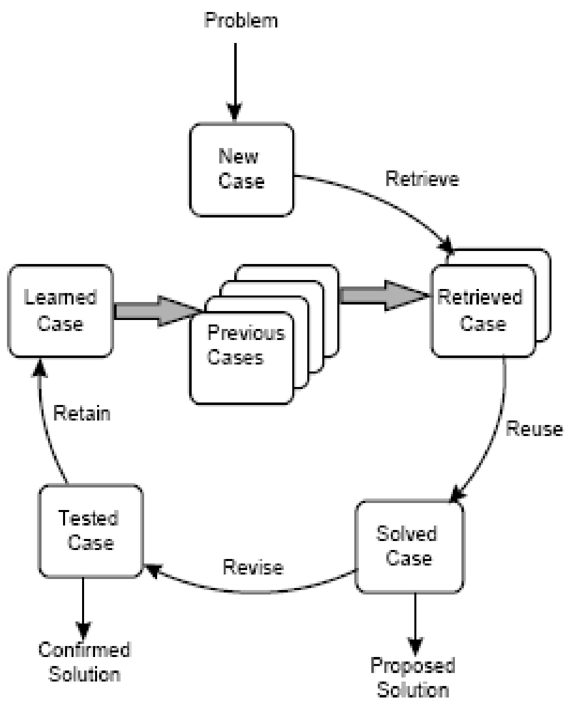
CSC officially assessed as CMM level 5 and ISO certified (1998), starting with SEL organizational elements and activities

Fraunhofer Center for Experimental Software Engineering - 1998

CeBASE Center for Empirically-based Software Engineering - 2000

BUT: Experience Factory dissolved within NASA after 2000!

How to find similar projects in the EB?



The CBR cycle (adapted from Aamodt & Plaza 1994)

Case-Based Reasoning (CBR):

- Involves (a) matching the current problem against ones that have already been encountered in the past and (b) adapting the solutions of the past problems to the current context.
- It can be represented as a cyclical process that is divided into the four following sub-processes as depicted in the Figure (Aamodt & Plaza 1994):
  - retrieve the most similar cases from the case base
  - reuse the case to solve the problem
  - revise the proposed solution – if necessary
  - retain the solution for future problem solving

Effort Estimation Model – Example (1)

Case-Based Reasoning (CBR) Example:

$$Effort = f(System\_Size)$$

Attributes	New Case	Retrieved Case 1	Retrieved Case 2
Project Category	Real Time	Real Time	Simulator
Language	C++	C++	C++
Team Size	10	10	9
System Size	150	200	175
Effort	?	1000	950
Similarity		90%	~50%

Possibilities to predict effort:

- adapted effort based on 1 project
- average effort of 2 projects
- weighted average effort of 2 projects

Possible adaptation rule:

$$Predicted\_Effort = \frac{150}{200} * 1000 = 750$$

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Effort Estimation Model – Example (2)

Case-Based Reasoning (CBR) Example:

$$Effort = f(System\_Size)$$

Attributes	New Case	Retrieved Case 1	Retrieved Case 2
Project Category	Real Time	Real Time	Simulator
Language	C++	C++	C++
Team Size	10	10	9
System Size	150	200	175
Effort	?	1000	950
Similarity		90%	~50%

Possibilities to predict effort:

- adapted effort based on 1 project
- average effort of 2 projects
- weighted average effort of 2 projects

Possible adaptation rule:

$$Predicted\_Effort = \frac{1}{2}\left(\frac{150}{200} * 1000 + \frac{150}{175} * 950\right) \approx 782$$

Effort Estimation Model – Example (3)

Case-Based Reasoning (CBR) Example:

$$Effort = f(System\_Size)$$

Attributes	New Case	Retrieved Case 1	Retrieved Case 2
Project Category	Real Time	Real Time	Simulator
Language	C++	C++	C++
Team Size	10	10	9
System Size	150	200	175
Effort	?	1000	950
Similarity		90%	~50%

Possibilities to predict effort:

- adapted effort based on 1 project
- average effort of 2 projects
- weighted average effort of 2 projects

Possible adaptation rule:

$$Predicted\_Effort = \frac{150}{200} * 1000 * \frac{9}{14} + \frac{150}{175} * 950 * \frac{5}{14} \approx 773$$

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Effort Estimation Model – Similarity (1)

Case-Based Reasoning (CBR) Example:

Distance Measure (Euclidean Distance) → Similarity = 1 – Distance

$$distance(P_i, P_j) = \sqrt{\frac{\sum_{k=1}^{n} \delta(P_{ik}, P_{jk})}{n}}$$

$$\delta(P_{ik}, P_{jk}) = \begin{cases} \left(\frac{|P_{ik} - P_{jk}|}{max_k - min_k}\right)^2 & if\ k\ continuous \\ 0, & if\ k\ categorical\ AND\ P_{ik} = P_{jk} \\ 1, & if\ k\ categorical\ AND\ P_{ik} \neq P_{jk} \end{cases}$$

$P_{.,k}$	$P_{new,k}$	$P_{1,k}$	$\delta(P_{new,k}, P_{1,k})$
Project Category	Real Time	Real Time	0
Language	C++	C++	0
Team Size	10	10	0
System Size	150	200	$0.04 = (50/250)^2$

⇒ ***distance***$(P_{new}, P_1) = 0.1$

Assume that smallest system in DB has 100 KLOC and largest system has 350 KLOC →
max – min = 250 KLOC

Effort Estimation Model – Similarity (2)

Case-Based Reasoning (CBR) Example:

Distance Measure (Euclidean Distance) → Similarity = 1 – Distance

$$distance(P_i, P_j) = \sqrt{\frac{\sum_{k=1}^{n} \delta(P_{ik}, P_{jk})}{n}}$$

$$\delta(P_{ik}, P_{jk}) = \begin{cases} \left(\frac{|P_{ik} - P_{jk}|}{max_k - min_k} \right)^2 & if\ k\ continuous \\ 0,\ if\ k\ categorical\ \ AND\ \ P_{ik} = P_{jk} \\ 1,\ if\ k\ categorical\ \ AND\ \ P_{ik} \neq P_{jk} \end{cases}$$

$P_{.k}$	$P_{new,k}$	$P_{2,k}$	$\delta(P_{new,k}, P_{2,k})$
Project Category	Real Time	Simulator	1
Language	C++	C++	0
Team Size	10	9	$0.01=(1/10)^2$
System Size	150	200	$0.01=(25/250)^2$

⇒ ***distance*(P$_{new}$, P$_2$) ≈ 0.5**

Assume that smallest system in DB has 100 KLOC and largest system has 350 KLOC →
max – min = 250 KLOC

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EF Discussion

- What are potential obstacles for a functioning EF?
- What could be done to overcome the obstacles?

Research done by SINTEF/NTNU

Torgeir Dingsøyr, Emil Røyrvik: An Empirical Study of an Informal Knowledge Repository in a Medium-Sized Software Consulting Company, ICSE 2003

- Focus: Knowledge Management in mid-sized companies
- 3 KM tools investigated in case studies:
  - Electronic Project Guide: Description of common processes and work roles in project work, with templates, checklists and examples.
  - Well of Experience: A knowledge repository ("collective yellow stickers"). Contains everything from bugfixes to telephone numbers.
  - Skills Manager: An overview of the skill levels of all employees on about 250 different skills that are considered important for the company.

Next Lecture

- Topic:
  - Process Assessment, Process Improvement Frameworks, Course Review
- For you to do:
  - Work on project report (final)
  - Remember:
    - Final project report is due on December 6th at 19:59 (submission is mandatory – delay will NOT be accepted!).
    - Please submit electronically to dietmarp@ifi.uio.no
    - Only PDF format will be accepted!