# QUALITY IMPROVEMENT THROUGH HUMAN-CENTERED MANAGEMENT OF THE SOFTWARE DEVELOPMENT PROCESS

Angelika Mittelmann, VOEST-ALPINE STAHL LINZ GmbH, Austria

**Summary:**
This paper deals with improving the software development process not by introducing any additional technical issue but by managing the human resources in an adequate manner. The concept of organizational learning (OL) is introduced as a means for turning from occasional training initiatives into "life-long" learning of all persons involved in software development. A managerial framework with effective OL-methods is presented. With help of four typical problem scenarios the practical usage of this framework is shown.

*Angelika Mittelmann, Dipl.-Ing., Dr., VOEST-ALPINE STAHL LINZ GmbH, Dept. SPO, P.O. Box 3, A-4031 Linz,*
*phone: +43 6585 9159, fax: +43 6980 6161, email: artm@eunet.at*

## 1 Introduction

During the pioneer phase of Computer Science software development was considered as industrial arts. People producing these works of art "software" were honored as "software-heroes" because they enabled organizations to automate process steps which could otherwise only be completed in time with an army of employees. Problems being solved with aid of computers and software were coming to be more complex and the methods as well as the tools of the software engineers were filed out. The focal point was and still is to perform all activities in an optimal manner in order to guarantee high quality software products.

The individual as the concerned and involved person in the software development process is not yet respected. This is one main reason why often is complained of the long lasting and expensive software production which could be hardly overcome at all. Since 1968 this fact is also known as the "software crisis" (Naur, 1968; Chroust, 1992). In order to afford relief herein the European Union introduced programs like ESSI resp. PIE and ESPITI which aim at effectively improving the software development process in Europe. Newly undertaken investigations of the European Software Institute (ESI) on the success of these programs show, that "Europe has not learnt enough - yet. But it is learning to learn." (Ibáñez, 1996). The step from occasional training initiatives to "life-long" learning of all persons involved in software development is still lacking.

## 2 The Managerial Framework Based on OL

In the following a managerial framework is presented where the concept of organizational learning plays the key role. The reason is that OL starts with the individual as the most important part of every organization.

## 2.1 Organizational Learning Basics

OL is the process of heightening and changing the organizational value and knowledge base, the improvement of the problem solving and task accomplishment as well as the change of the common relations of and for the members of an organization (Probst, 1994). This means in practice, that using OL-methods leads to the introduction and continuous improvement of the learning process not only of every individual but also of a software development team, an organizational unit or a whole corporation. Their usage stimulates the individual learning ability and the creativity of a group, supports team building as well as personal and organization development (see also Fig. 3). Indirectly they help creating an organizational culture in which continuous learning is an integral part of the culture, which in turn results in reaching the needed software process and product quality.

As mentioned above OL is based on individual learning processes. But organizations are also able to learn independently from individuals but not independently from all organization members. This is the reason why it is not sufficient to consider the learning process of individuals but also the learning process of groups, within the whole organization, and between organizations as well. As OL depends on a multitude of learning individuals it is essential to understand organizations as *distributed knowledge systems* (Scheurer, 1998). Besides of the private knowledge, not available for the organization, there are three subsets of organizational knowledge (see Fig. 1) to be distinguished: first of all the *common knowledge* (knowledge kernel) of the organization (e.g. forms, abbreviations), second the *available knowledge* (loosely coupled knowledge isles of groups within the organization), and third the *achievable knowledge* (meta-knowledge found in catalogues or knowledge on how to use databases).

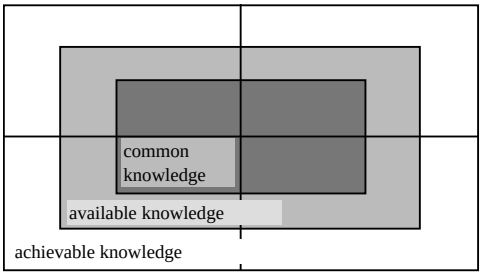


**Fig. 1: Subsets of organizational knowledge**

With regard to OL basically two different types of learning (Argyris, 1994) might be distinguished (see Fig. 2). *Single Loop Learning* concerns processes in which problems are identified and solved without questioning the underlying rules and standards. *Double Loop Learning* relates to fundamental changes of rules and standards within the organization. Fulmer therefore speaks of *Shock Learning* (Fulmer, 1994).

| | *Single Loop Learning* | *Double Loop Learning* |
|---|---|---|
| *Charateristics* | • based on repetition<br>• routine<br>• learning within existing structures | • based on cognitive processes<br>• no routine<br>• goal is the change of rules and structures |
| *Results* | • changes at the level of behaviour and task accomplishment<br>• ad-hoc problem solving | • changes of mental models<br>• development of new structures, cultures, and strategies |

**Fig. 2: Types of Learning**

## 2.2 The OL Framework

The OL framework (Mittelmann, 1998a) is a structured set of OL-methods supporting all aspects of human resource management. The structure represents a rough cyclic process model to be used in business process management (see Fig. 3) in general:

- Methods for *diagnosis*: assess your project and organization environment
- Methods for *representation*: depict the results of your diagnosis
- Methods for *creativity support*: support the creativity of your employees
- Methods for *learning assistance*: establish the learning willingness and ability of your employees
- Methods for *personell development*: support the development of your employees in a goal-oriented way
- Methods for *team development*: develop the capability of your teams
- Methods for *organization development*: enlarge the development process to your whole organization
- Methods for *conflict solving*: solve the conflicts within your organization in a constructive manner and make use of methods for diagnosis for this purpose (here the cycle restarts)

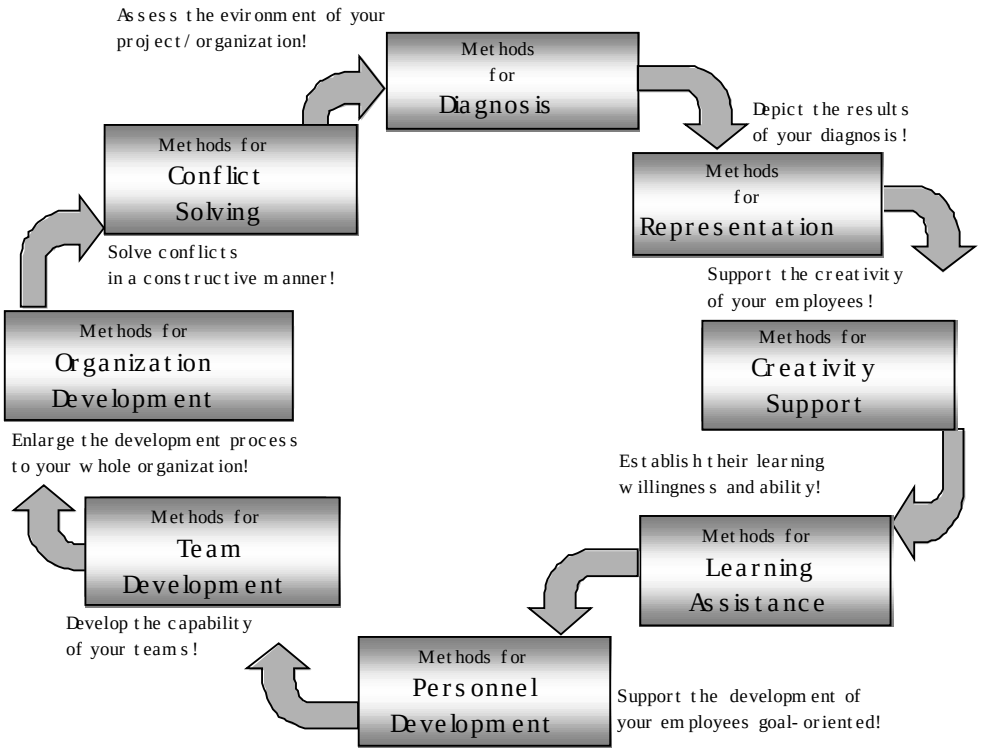


**Fig. 3: OL framework**

## 2.3 Some OL-Methods for Use in the Software Development Process

In this section some OL-methods out of the OL framework will be shortly described (what they are, how and why to use). Most of them belong to the team building section of the OL framework because effective team building is a critical success factor for high quality software development processes and products.

### 2.3.1 Association-Pair-Building

This method (Mittelmann, 1998a, 1998b) belongs to the creativity support section of the OL framework. Technical terms are associated to everyday-life terms which enables a better and quicker understanding. This method aims at a homogeneous understanding of technical terms within a team. Indepth-thinking, learning, and understanding processes are initiated.

The group is divided into two subgroups. One group selects up to five terms out of their current or future working area, the other searches for up to five everyday-life terms. The subgroups should undertake their search independently. After having found their terms the subgroups come together and try to find meaningful association-pairs between one technical term and one everyday-life term. It is essential to give reasons for the pair building.

### 2.3.2 Collage Technique

This method (Baumgartner, 1995) is part of the diagnosis section of the OL framework. By creating pictures using the collage technique the participants are led to evaluate their current or future situation in the relationship-triangle "me-group/department-organization". This method aims at making clear the common feelings and differences in order to take this knowledge into account in the future.

Every participant creates a collage representing the current situation or the situation after two to five years. Mainly picture material should be used, sparingly citations, headlines and the like. The impressions, fantasies and associations coming up looking at the pictures are exchanged in small groups. The creator of the picture just listens to the comments. After this discussion he adds what he wants to express with the picture. After the presentations in the small groups the most important items are summed up, the mutualities and differences are worked out and presented. The participants get to know how the other participants think of the current and future situation. An extrinsic picture arises through interpretation of the original picture which may be very valuable and instructive for the author of the picture.

### 2.3.3 Community Building

This method (Jordan, 1994) is in the team development section of the OL framework. A group of employees with simular working assets meet regularly in order to exchange working experiences.

This method aims at converting implicit working experience into explicit common knowledge for all group members. They discuss in depth how they do their work, what problems they are confronted with and how they solve them. They are encouraged by their managers to help each other to improve their business.

### 2.3.4 Encouraging Informal Group Relationships

This method (Jordan, 1994) is also part of the team development section of the OL framework. Encouraging informal group relationships includes all activities which help to develop team climate as well as close relationships between all team members. It aims at better getting to know each other and improving the quality of teamwork. The range of the activities starts with coffee breaks and ends with the organization of sportive or cultural events. It is essential to keep strictly the principal of voluntariness.

### 2.3.5 Knowledge Map and Yellow Pages

These two methods (Seemann, 1996) belong to the representation (of knowledge) section of the OL framework. They are tools for knowledge management at the group and organizational level.

A *Knowledge Map* is a structured representation of the knowledge of individuals and the organization units made accessable to all members of the organization. The explicit knowledge of employees or departments is institutionalized and made public in a Knowledge Map. Each employee has the possibility to put in his or her knowledge. The management is responsible for an organizational culture that allows and supports employees to put in their knowledge voluntarely. The main goal is a guide of knowledge that allows access to valueable knowledge to be looked up at any time it is needed.

*Yellow Pages* (compare yellow pages of telephone books) might be the first step to a Knowledge Map and give access to knowledge sources of an organization. Employees with excellent knowledge in special topics or competence are registered and can be contacted on demand. These employees have to be ready to share their knowledge with other colleagues. The main goal is to document access points to special knowledge sources within an organization.

### 2.3.6 Participative Development of Metrics

This method is part of the diagnosis section of the OL framework. It can be described in terms of a process model (Mittelmann, 1996; Mittelmann, 1997; Mittelmann, 1998b). The first phase of this model includes the development of a goals tree according to the team's working area. In the second phase the software development process is devided into meaningful subprocesses resp. activities if not yet available in the organization. The third step deals with the development of entity templates according to the goals in the goals tree. An entity template is a form which includes the parts: process, product, and resource in which the appropriate subprocesses or activities, their products and needed resources are filled in. In the fourth step the "goal/question/metric" method is used to identify out of questions the wanted metrics. In the next step a measurment plan is worked out based on the results of the entity templates. In the last step, which could end up in the first step again after a reasonable period of time, the measurement plan is realized. All team members are involved in all the above mentioned steps.

### 2.3.7 Project Prototyping

This method (Seemann, 1996) is in the team development section of the OL framework. Project Prototyping is a co-operation supporting method. It aims at developing common sense within a team about the goals of the project and the activities to be done in order to reach the goals. The team meets regularly to check their common understanding of the project effectiveness and goal achievement. All results of these meetings are documented. The development of a shared vision and improved system thinking are supported.

### 2.3.8 Systemical Portrait

This method (Mittelmann, 1998a, 1998b) is a member of the team development section of the OL framework. A "Systemical Portrait" visualizes all relevant environments of an individual with respect to his working area. This method aims at acquainting members of a newly formed team efficiently with one another. For this purpose every team member writes his name within a circle (name-circle) in the middle of a flip chart and places all his relevant environments (also written in circles) around the name-circle in the center. All outer circles are linked to the name-circle by lines. Above each line the team members writes his most important question or term in regard of his working area. Afterwards the person is given feedback to his systemical portrait by one or two persons who he had chosen as his feedback partner at the beginning. At the end the feedback partners present all Systemical Portraits to the audience.

### 2.3.9 Team Sessions

This method (Mittelmann, 1998a, 1998b) is in the team development section of the OL framework. The issue of a Team Session is always a practical topic or a statement, but not relations, expectations or believes of team members. The main goal is to achieve a documented basis for future decisions or organizational changes. For this purpose all employees are invited to a Team Session. Ready in time before the session the employees receive the necessary information. During the session all ideas of the employees are collected, structured and afterwards documented in a final report of the Team Session. This method helps to achieve a holistic picture of the topic in question, improves informal communication as well as co-operation. Receiving information of all employees leads to a better base for decision making.

### 2.3.10 The Ideal Organization

This method (Baumgartner, 1995; Mittelmann, 1998a, 1998b) is part of the diagnosis section of the OL framework. This method is an imaginative exercise which helps to identify ideas, wishes, and suggestions of the team members. Every team member plays by turns the role of the "king of the organization". Every command is allowed and the *king* is assured that his commands will be followed without any discussion. The *king* commands and the others try to find out how they feel when imagining realizing his commands. The *king* also writes down his feelings. At the end all suggestions are summed up.

## 2.4 Typical Problems and Their Path of Solution Using the OL Framework

The most effective way of using the OL framework is to combine several OL methods to method sets according to the general environment, the structure as well as the culture of the organization in question. In the following method sets for four typical problem scenes in the software development business are discussed (Mittelmann, 1998a). The chosen scenes are:

- Scene 1: Starting a new software development project
- Scene 2: Communication problems with users
- Scene 3: Experts conflict
- Scene 4: Introducing a new technology

Fig. 4 depicts an overview which method belongs to which scene resp. method set.

| | *Scene 1* | *Scene 2* | *Scene 3* | *Scene 4* |
|---|---|---|---|---|
| **Association-Pair-Building** | X | X | | |
| **Collage Technique** | | X | | |
| **Community Building** | | | | X |
| **Encouraging Informal Group Relationships** | X | X | X | X |
| **Knowledge Map and Yellow Pages** | | | | X |
| **Participative Development of Metrics** | | | | X |
| **Project Prototyping** | X | | | |
| **Systemical Portrait** | X | X | | |
| **Team Sessions** | | | X | |
| **The Ideal Organization** | | X | | |

**Fig. 4: OL method sets**

In the following sections every scene is outlined and the consequences on the quality of the software development process and products using the method sets are discussed.

### 2.4.1 Scene 1: Starting a New Software Development Project

Starting a new software development project is always minted with uncertainty. People normally do not know each other, the real task is only roughly clear. At this time it is essential to get quickly the team working together. If the team consists of members who know each other only sketchily the method *Systemical Portrait* could be used in order to acquaint the team members efficiently to each other. The result is a better understanding between the team members and a good base for communication. The next step is to gain a common understanding of the problem to be solved. For supporting this step and all following project activities the method *Project Prototyping* might be used. The successful use of this method leads to goal-oriented working attitudes during the whole project life time. The imagination of the team members stays at a realistic level. One well-known problem at the beginning of a software development project is that every team member has a slightly different understanding of the technical terms used in the task descriptions. To overcome this problem the method *Association-Pair-Building* might be used. During the whole project life time it is necessary to keep people talking to each other about all subjects that might be interesting to them. If people talk to each other they also work better with one another. For this reason the use of the method *Encouraging Informal Group Relationships* may be worth considering.

### 2.4.2 Scene 2: Communication Problems with Users

Although cooperative software development is a widely accepted and used concept communication problems or even conflicts with key users are very likely to arise. To find out quickly the causes of the problems one could start with a workshop where the method *Systemical Portrait* may be used to familiarize the key users with the software developer staff and afterwards the *Collage Technique* may be used for diagnosing purposes. If the identified problem is found in misunderstandings of key terms, the method *Association-Pair-Building* might be used. If the problem is more of structural nature the method *The Ideal Organization* may be used to gather improvement ideas of all team members. Again it is essential that these two groups of people keep talking to each other. For this reason the method *Encouraging Informal Group Relationships* should be used. Following these steps leads to a better understanding between the interested parties, which in turn results in better software products. It is more likely that the users get a product what they need and wanted.

### 2.4.3 Scene 3: Experts Conflict

During software development sometimes people quarrel which solution is the best suited for the given technical problem. If this quarrels cannot be solved in a reasonable period of time the project manager has to intervene by talking to every conflict party. This might also be done with aid of a *Team Session*. For avoiding this situation in the future the project manager is well advised using the method *Encouraging Informal Group Relationships*.

### 2.4.4 Scene 4: Introducing a New Technology

Introducing a new technology (e. g. object-orientation) to the software development process is an often discussed problem area. In order to get to know up from the beginning the impacts of the new technology on the software development process and products the method *Participative Development of Metrics* might be used to develop an appropriate metrics system for the project. Process improvement efforts can be better managed if well-suited metrics are used. In order to disseminate the essence of the new technology *Community Building* could be used.

An even more explicit know-how transfer can be reached by introducing the methods *Knowledge Map* and *Yellow Pages*. All this activities can be accompanied by the method *Encouraging Informal Group Relationships*. If people are offered opportunities to talk to each other informally they will often talk about subjects very new to them. This means they will also share experiences with the new technology used.

## 3 Conclusions

Our experience in many software development projects convinced us that managing the human resources in an adaquate manner is a critical success factor in this business. That is the reason why we introduced the OL framework as a rough process model for managerial purposes. Some typical software development project scenes were described in order to show the practical usage of this framework. At the end we would like to emphasis that it is not sufficient to use it occasionally because human resource management is a never ending job. Every investment into people will turn into profit sooner or later.

## 4 References


Argyris, C.: *On Organizational Learning*. Blackwell, Oxford 1994.

Baumgartner, I. et al.: *OE-Prozesse: die Prinzipien systemischer Organisationsentwicklung; ein Handbuch für Beratende, Gestaltende, Betroffene, Neugierige und OE-Entdeckende*. 3. Auflage, Paul Haupt Verlag, Bern/Stuttgart/Wien 1995.

Chroust, G.: *Modelle der Software-Entwicklung: Aufbau und Interpretation von Vorgehensmodellen*. Oldenbourg Verlag, München 1992.

Fulmer, R. M.: *A Model for Changing the Way Organizations Learn*. In: Planning Review, May/June 1994, p 20-24.

Ibáñez, M.; Kugler, H.-J.; Rementaria, S.: *Has Europe learnt enough?* In: Journal of Systems Architecture 42 (1996), p 583-590.

Jordan, B.: *A Learning Organization in the Making*. Xerox Parc Research Learning Center, Palo Alto 1994.

Mittelmann, A. et al.: *Das ami-Vorgehensmodell in der Praxis*. Wirtschaftsinformatik, 48 (1996) 6, S. 601-607.

Mittelmann, A.: *The Implementation of a Measurement Plan in an Industrial Environment*. In: Lehner F. (Ed.): Software Metrics: research and practice in software measurement. Gabler Edition Wissenschaft, Wiesbaden 1997, p 211-228.

Mittelmann, A.: *Der Einsatz von Methoden des "Organisationalen Lernens" in den Software-Lebenszyklus-Prozessen*. Dissertation, Johannes-Kepler-Universität, Linz 1998a.

Mittelmann, A. et. al.: *Geschäftsprozesse mit menschlichem Antlitz: Methoden des Organisationalen Lernens anwenden*. Vol. 1 "Wissens- und Prozeßmanagement" eds. Gappmaier, M. and Heinrich, L. J., Trauner Universitätsverlag, Linz 1998b.

Naur, P.; Randall, B. (Eds.): *Software Engineering*. Proceedings NATO Working Conference, 7.-11. October, Garmisch 1968.

Probst, G. J. B.; Büchel, B. S. T.: *Organisationales Lernen*. Gabler, Wiesbaden 1994.

Scheurer, St.; Zahn, M.: *Organisationales Lernen - von den theoretischen Grundlagen zur praktischen Umsetzung*. In: zfo 3/1998, p 174-180.

Seemann, P.: *Real-World Knowledge Management: What's Working for Hoffmann-LaRoche*. Center for Business Innovation, Ernst & Young LLP, CBI310, Zürich 1996.

# 5 Abbreviations

| | |
|---|---|
| ESI | European Software Institute |
| ESPITI | European Software Process Improvement Training Initiative |
| ESSI | European System and Software Initiative |
| OD | Organization Development |
| OL | Organizational Learning |
| PIE | Process Improvement Experiment |