TEAM LEARNING CAPABILITY - A STRATEGY TO MASTER COMPLEXITY AND TO ACHIEVE FLEXIBILITY

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The conclusions in this paper are based on experience from the development of training programs in industrial international organizations as well as on experience from the development of a number of new undergraduate university curricula. The main theme is that there is an entirely new situation for many organizations today, The winners are the most flexible and adaptable actors, rather than the biggest and most experienced ones as has often been the case in the past. This has implications on the organization of training programs and continuing education for engineers in industry.

1 Introduction

The most important new factors [1] to be considered in industrial development today are:

Increased complexity. So many entirely different aspects have to be taken into account that a co-operating team of highly skilled and experienced persons have to develop a shared understanding as a basis for their design decisions.

Increased flexibility. Quite often the conditions will change during a development project. The reason for the change may be availability new technology, or a new situation on the market due to moves by competitors. There will not be time available for the propagation of responsibility and decisions in a hierarchical structure; each team has to understand by itself when, how, and why to react upon the changes occurring.

2 Background

2.1 Experience background

The conclusions reported in this paper are based on the following experiences:

- introduction of a project organized curriculum at Lulea University of Technology in the seventies
- use of problem based learning, PBL, within the Faculty for Health Sciences, Linkopings Universitet
- use of PBL in the IT Program at Linkopings Universitet
- field studies in some industrial system development projects since 1985
- development of a new training program [2] for industrial control system designers
- development of three engineering programs at the new Campus Norrkoping, Linkopings Universitet.
- competence and organization development in industry based on the PBL method.

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2.2 Problem Based Learning (PBL)

The Problem Based Learning, (PBL), [3] strategy, originally from Mc Master University in Canada, is becoming more and more spread at universities around the world. Project organised curricula [4] have been used widely since the seventies in particular in the engineering fields. A combination of the two approaches [5] has been used for industrial training where learning was integrated with the ordinary tasks in order to implement a learning organisation.

PBL has been used as the general model for all the undergraduate programs within the Faculty of Health Sciences at Linköpings Universitet, since 1986. The PBL model used within the Faculty of Health Sciences has almost as it is in 1995 been inherited by the new Information Technology Program within the School of Engineering at Linköpings Universitet. We have also experiences from implementing PBL in the industrial context, for example in product development, management development, and in technical courses.

PBL is built on a view of learning that says that one's own activity is important for the learning. The learning is subject integrated and based upon realistic cases/situations. The method makes it possible to integrate learning into daily work activities.

The characteristics of PBL:

- the learning and the work with the problems are based on realistic cases/situations.
- self-directed learning, one's own activity and responsibility for the learning
- work in a tutorial group.

The problem solving phases are: brain storming in order to make the collected experience of the group explicitly visible and available, the development of a structure or ordering of this material, formulation of the problem(s) to solve, definition of the learning needs, collection of the knowledge or information required, applying the skills and knowledge to the case, and evaluation.

The tutorial group is the hub of the learning process. The group consists of 5-8 persons. They work under the guidance of a tutor. The group is handling the cases/situations that the education/development work is build upon. The work in the tutorial group means to locate, identify and formulate problems. The group members also plan and solve the problems and they document the solutions. To support the work in the tutorial group there can be lectures, exercises, work related to a ongoing project, skill training, resource sessions, individual work, invited resources persons, supervision etc.

2.3 Experiences from our industrial training activities

We claim that development of a team learning capability within the organization is a strategy both to master the complexity and to achieve better flexibility. We will report how this team learning capability can be introduced and supported

In the development of industrial training programs it has very clearly been stated from the industrial side, that the requirements on the engineers today is quite different from what has been assumed in the past. The problems facing the development engineers in industry today are, in general, such that what is required is:

- **Ability to learn new things** rather than to memorize and repeat static knowledge
- **Ability to communicate and to co-operate** rather than individual brilliance
- **Ability to understand totality** rather than having a narrow deep knowledge
- **Ability to act and ask questions** rather than ability to follow detailed instructions.

Moreover, the attitudes and the behavior patterns of the individuals have to change. The conversion from the old model with the individual inventor-type design engineer able to find the smart solution to the difficult problem by himself, to a model where responsibility and capability reside in a co-operative multidisciplinary team. Such a conversion will not take place automatically just on request. A group process and the evolution of a shared understanding can enable the changes needed in attitudes and behavior.

2.4 Peter M. Senge's five disciplines

At the Learning Center, Sloan School of Management, MIT, research on learning in industrial development organisations has been conducted for many years. Senge [6] defines a learning organisation as a community where the members continuously are improving their ability to produce the results they want, where new views and ideas may evolve, and where people all the time are learning how to learn together. He claims that organisations can learn only by means of the learning that is taking place in the teams within the organisation. A learning organisation is aiming at more than the sum of the individual objectives. "*It is impossible to create a learning organisation unless you have people at all levels developing the skill to learn how to learn*".

We have used Peter M. Senge's five disciplines: Systems Thinking, Personal Mastery, Mental Models, Building Shared Visions, and Team Learning, and we have added a 6th one, Technology. Technology is the discipline of exploiting new components and technologies, of using tools and support systems for the ordinary task. The discipline has impact on the individual work but also as an important leverage for the cooperation and communication within the organization as well as towards activities in the outside world. In particular the use of information technology (databases, WWW, E-mail, word and document processors, etc.) is one of the most important means for increased flexibility and efficiency ever introduced.

2.5 Implementation strategy

Training and education can be of different characters such as learning and memorizing facts, getting acquainted with a new tool and achieving skills in its use, knowledge about concepts and relations, or deeper understanding of how different areas and paradigms are related. As a consequence of what has been learned, the attitudes and the behavior of the persons may change, and this is in general the effect desired. The understanding must be put into some real world context. Change of behavior will follow only if the new understanding is applied to the working context. In general this cannot be done as an individual effort, but in a group process with interaction. The group where the interaction takes place can be a project team, a unit in the line oriented organization, or a group composed with the learning aspect in focus. Such a group is often an instrument for interaction horizontally in the organization.

It is also necessary to establish vertical interaction. In order to build and propagate a new set of corporate goals and values, to agree upon new roles, new responsibilities and authorities, all vertical levels in the organization have to be involved. Quite often it

happens that just the upper levels of a company participate in the development of a new strategy, and the rest of the organization is not concerned or even aware of any intended change. In order to reach any effect at all, the different levels must develop the strategy together. If the goals are shared the implementation is much easier.

2.6 To develop team learning capability

Team learning capability within the organization is a strategy both to master the complexity and to achieve better flexibility. The teams, rather than their individual members, will have the capability to find answers to questions about what, why, and how. Moreover, all real change must be based on changes in the attitudes and of the behavior of the individuals. Learning in terms of getting new knowledge and skills can be the first steps, but the change of behavior takes place only after a deeper process where the new facts have to be confronted with previous values and synthesized to new patterns. This deeper process normally requires a group of persons, a tutorial or training group, even if the objectives are supported by efforts at the organizational and technical levels.

The PBL method enables a work integrated competence development. The tutorial group can either be an existing team like a project group, or a cross functional group where one main objective is to support the co-operation and the sharing of knowledge and experiences between the units. Using the PBL method in the industrial context makes it possible to develop the cases continuously as the project proceeds. This is one way to be flexible and to work process oriented with development work. The tutorial group and work with real cases in the PBL method are an efficient ways to integrate the knowledge from external sources into daily work and thereby support changes in attitudes and behavior. The PBL method enables the team members to develop a shared understanding and capability to learn together.

2.7 Cross functional teams

A very important requirement is on the holistic view, the ability to see relations between different aspects, different subsystems, different technologies, different nations and markets, different business areas, etc. Today there are narrow specialists in all the areas, but few who have had the reason, or the opportunity, to go outside their restricted area of responsibility. A very efficient way to relax the existing boundaries is to create cross functional teams or project groups wherever possible. The groups should be ‘cross’ in as many respects as possible: different business areas, different technologies, different markets and nations, different sites, different ages, and different backgrounds. It is necessary for a group to meet physically at least the first time to get acquainted, but after that much of the communication can be via telecommunication and computer networks in case the group is distributed geographically.

2.8 Running next-next generation projects

A means to monitor the development of technology, the look-ahead necessary for understanding the possibilities and the pitfalls associated with new technology, can be to have projects formally organized, where the objective is to develop products based on technology beyond what will be used in the next product generation. However, these products will be of experimental character, feasibility studies, rather than intended for production or for real customer use. The result of running formal next-next generation projects is that man-time will be allocated with the same priority as for the ongoing short term activities, and that the technology monitoring really will take place and be put in the right context.

3 Conclusions and future work

Our experience from using the team learning strategy in training and development work is so far very promising and we will continue the development of this strategy.

Traditionally system development models have been based upon the idea that knowledge and understanding can be handed over as documents to other persons or groups. At the end of each phase of the development process, the documents are delivered to the next phase. 'Document' can mean requirement specifications, system design specifications, drawings and blueprints, circuit diagrams, program code, etc. The transfer of understanding from one person to another or from one group to the other, is based on the assumption that all information not explicitly stated in the document is stable in time and shared by all writers and readers of the document. Today, as we have a very dynamic technological and organizational environment and a global market and economy, these assumptions are in general not true.

In a research project just about to start, we are aiming at finding an embryo of a new system development model, based on team understanding rather than on the delivery of documents. The approach will be similar to the work presented in this paper. We will investigate how a shared understanding can bee achieved and supported. We will try to find the limits of what can be described in system definition languages. System modeling and visualization will be used as a means to build templates for shared visions and understanding of system behavior and architecture.

4 References

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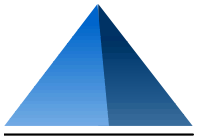

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