

# LEARNING TO CHANGE - A NETWORK APPROACH TO ENGINEERING MANAGEMENT DEVELOPMENT

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## 1 Introduction

Engineering Management is with a brief definition the management of technical development processes. Engineering is today essentially seen as a linear process view and the rationale is that development work should be controlled and administrated to reduce costs, cut lead times, and secure quality. Successful innovation requires a different rationale in product development whilst also securing sustainable working conditions. Such rationale should be focused on creativity, integration and the individual. Thus, management of product development needs further exploration. Industrial product development is characterized by constantly new prerequisites why new engineering management models need to be developed with the perspective of a dynamic context.

This paper will present a research approach that aims at forming new knowledge and develop engineering management models promoting innovation and sustainability – a *learning network* with a group of enterprises. A learning network is a way to maintain a direct link to the industrial experience, while also developing managerial models. There are thus dual objectives: to promote problem solving on the local and to create more generic models. The paper will present the learning network approach and how it can be utilized for organizational change and for modelling of development work.

## 2 Background

The learning network is part of an *Engineering Management research program* lead by an interdisciplinary research group, representing engineering design, organization and management, and organization psychology. Several pre-studies in collaboration with Swedish manufacturing companies have identified research issues and methods for joint efforts between academia and industry in developing the area of engineering management. Starting in the wide and often unspecified description of urgent company issues, conclusions have been drawn of what major challenges industrial product development holds, and research issues have been structured to guide further research, see Figure 1. Results from these studies have been reported earlier in [1] as well as at ICED 03 [2].

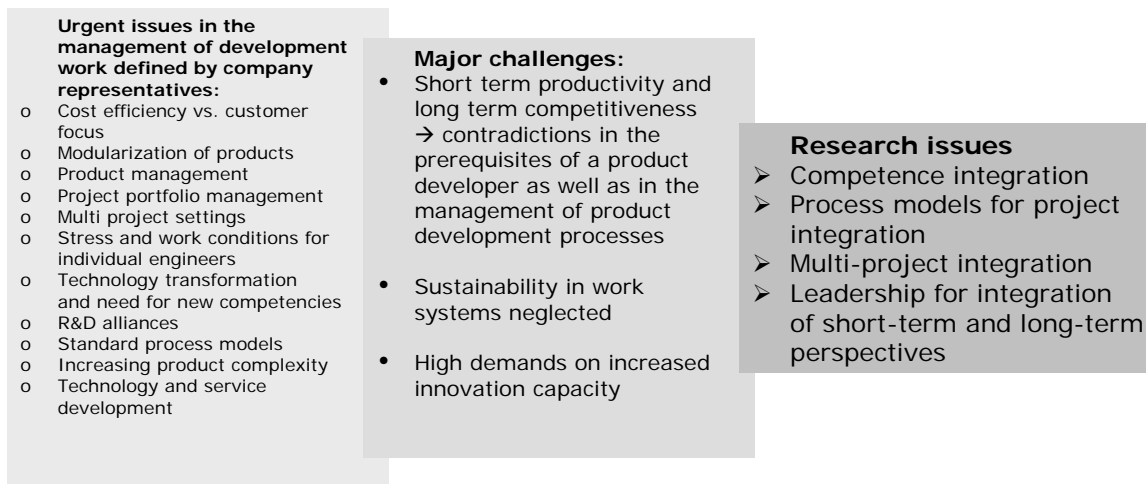


Figure 1. Research issues in engineering management.

Identified shortcomings challenge established ways of operating and managing product development. New approaches for example to work procedures, project management, collaboration between partners in development work, and strategies in product development are needed. In parallel, an increased awareness of such aspects is required in industrial product development as new theoretical contributions alone will hardly have an impact on product development performance.

Besides developing engineering management models, a capacity to implement and adjust to new ways of working are thus needed [3], [4]. There is no reason to believe, that the speed of change will decrease, nor is it likely to find *the* organization or *the* work procedure that will function for all situations. Thus, companies need to develop a capacity to change continuously in order to be flexible and dynamic in their ways of working also in product development.

The Engineering Management program is constituted by several sub-projects, all concerning issues on how to manage and organize product development in order to strengthen innovative and sustainable work systems, see Figure 2. Concurrently, each project addresses a specific phenomenon and includes urgent research questions related to competitiveness.



Figure 2. Projects within the Engineering Management program.

### 3 Main objectives in Engineering Management

The Engineering Management program assumes that work systems that are both innovative and sustainable is of major importance to success in product development enterprises. In the

following these major conceptions for the research and for collaboration with industry is briefly explained.

### 3.1 Innovation

Innovation is not a single event, but a series of activities. Allen [5] state that innovation emerges from two streams of activity, i.e. the development of technological knowledge and a developing set of market needs. Either technology development or the market is thus, the one driver behind innovation, but interaction between the two creates innovations. It is important to stress that innovation is not only the individual problem solving, but the process from new ideas to products on a market [Utterback].

To describe the innovation as a *process* of activities is common in literature on innovation, *encompassing product development activities* and stressing that innovation takes an idea to a business. Trott [6] enlarges the picture of innovation as a process requiring a mindful management. He states that the development of new ideas is dependent on an organizational ability to hold creative individuals, the needs on the market and the scientific and technological knowledge base within the company and in society as a whole. Other researchers support the picture as innovation management to hold several parameters summarized in company culture, management principals, organizational aspects and the individual capacity to create new ideas and develop new knowledge, [7], [8], [9].

### 3.2 Sustainable work systems

If remedies to monotony and boredom in work has been the focus in a number of studies as the problem has involved large number of people on the operational level, issues of stress and burn out have lately become more in focus. Such problems afflict different occupational categories, mainly people in the service sector, people within health care and social services and to an increasing extent also engineers, financial experts, media and computer people – people in the fast lane. Psychological pressure is not only devastating to the health of the employees, but also to work quality and organizational performance.

A number of initiatives have been taken in order to make the work more challenging and developing: empowerment, management by objectives, job enrichment, etc. Unfortunately it seems to become just too much. One can formulate the hypothesis, that we presently are plastering an obsolete system and with the best of intentions increase work intensity. With increasing competition, also economic deliberations come into the picture. With the old rationale we might find ourselves whipping a dead horse, while a new thinking is required. The alternative would then be a sustainable work system, which is work system that is both competitive and regenerates human energy [10]. The character of such a system is hardly specified yet and is one of the major issues in this project.

## 4 Research in progress: the method is the result

With a Learning Network approach, several effects are gained. Not only is a practice related learning taking place, but also organizational change occurs in tune with learning. Further, knowledge, models and theories can be generated and tested. The Learning Network project will in the following be presented with some preliminary observations.

## 4.1 Action Learning

The Learning Network approach has emerged out of the British action learning tradition once promoted by Reginald Revans. Since then, action learning has been used in a vast number of contexts for promoting both learning and change – in individuals and in organizations. The action learning approach can be understood against the background of David Kolb’s work on experiential learning.

Kolb [11] created a model of a “experiential learning cycle”, see Figure 3. New solutions and concepts that give changes in e.g. a work procedure can be produced from the reflection upon own experience. Forslin and Thulestedt [12] and Forslin and Fredholm [13] started early to apply these theories and principles with groups of companies as a research approach.

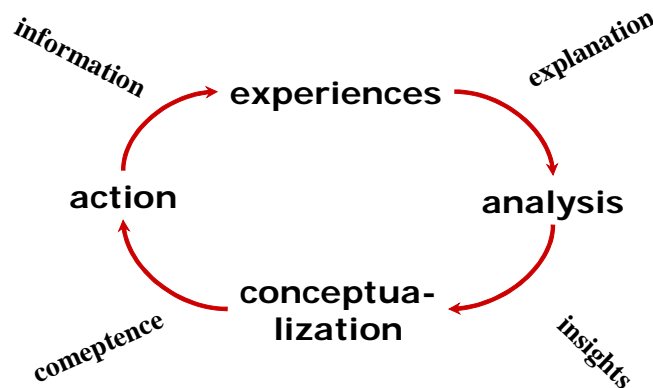


Figure 3. The cycle of experiential learning, modified from (Kolb 1984).

Practitioners are often stuck in the acting-experiencing loop and need support to take the further steps of actually learning from their experience and to start to think about their practice in a more conceptual way. Researchers on the other hand are skillful in analyzing and conceptual thinking, but often lack direct experience from the industrial reality. By working together in a net work a supplementary relationship between theory and practice develops for mutual benefit. Consequently, the member of the network is the major resource.

There is a vast literature on learning in organizations, e.g. [14]. From research on knowledge management, e.g. [15], and organizational learning, e.g. [16], the important conclusion is drawn that organizations can learn only if individuals learn. Porras and Robertson [17] also stress the importance of individual learning in changes as realization of a change is connected to change in “behavior on the job”. Behavior on the job in turn, is of course not only dependant on learning but also factors such as company structure, organization of people, culture, management principles, physical settings, work procedures and applied tools in a company. This promotes the action learning approach in change work as it causes individual learning.

As the participating companies in the net work are venturing into a change process that will compete with other internal commitments, it was seen as useful to provide a model for the change process to create a figure to relate one’s progress with. A model formulated by Kotter [18] was chosen. It is a pragmatic down to earth approach in eight steps:

1. Create a sense of urgency
2. Create a guiding coalition

3. Develop a vision and a strategy
4. Implement the vision of change
5. Create space for action on a broad base
6. Create short term results
7. Consolidate and conduct further changes
8. Anchor new ways of working (etc.) in the culture of the company (ibid.)

The project as such is a test of Kotters model, selected because of the non prescriptive but guiding ideology behind the model.

## 4.2 The Learning Network

The Learning Network project is a longitudinal action research project spanning over 2.5 years. As a research study it has at least a twofold objective: to develop knowledge in interaction with the companies, on how to conduct change in a product development organization and to develop management model ensuring innovative and sustainable work systems.

The start up of a network is preceded by a work on finding interesting companies, interested members and defining the assignment. This is an important part as the company members must be the problem owners and take the full responsibility to conduct changes and learn new behaviors or define new procedures in product development. The network constitutes two types of actors: company members in charge of the local project and researchers answering for the learning process and making research out of the experiences, see Figure 4. In this study, participating company members represent three companies.

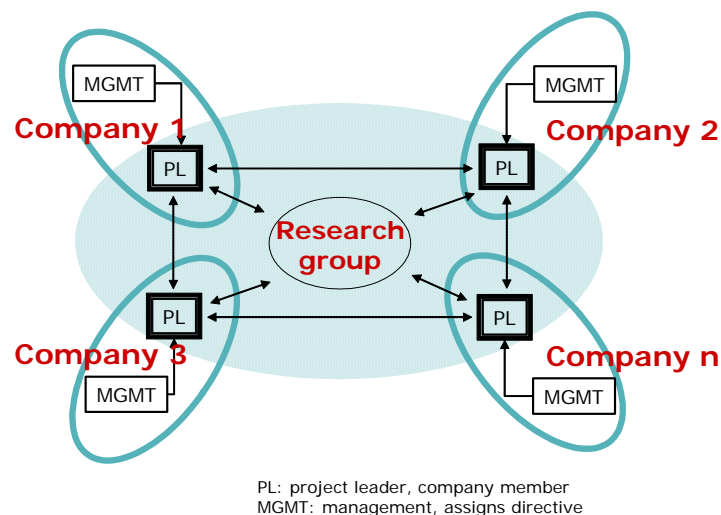


Figure 4. An illustration of the network members and their interrelations.

Apart from the local projects the major activity in the Learning Network are the regular one day meetings arranged by the researchers and involving all companies. In this approach, meetings with companies will be held by a six-seven weeks interval. Each meeting includes several recurring points. Each company present their work conducted at the company since last meeting and defines assignments for the following working period. The researchers present their reflection upon company specific efforts and conditions and give input by

sharing knowledge and presenting theories and models relevant for the assignments company members work on. In addition, at each meeting, company members are encouraged to reflect upon meetings as well as their activities in the companies.

The eight step procedure by Kotter (see 3.1) is applied in the Learning Network. The model is efficient as a guide to analyze specific change activities and evaluate whether certain measures have been taken or not.

For each meeting notes are taken and a continuous documentation of the work is done. The research group analyzes each meeting and feeds back these analyses to the company members in written and oral form. By introducing theories in the subject areas the company members are engaged in, existing models can be questioned and analyzed from an industrial perspective in order to form a basis for development of new Engineering Management models.

### 4.3 Current progress analysis

Results in the paper have been based on analysis of activities and work during the first quarter of this project. So far the results concern the progress of companies, while new models will be follows later in the project. Also, preliminary conclusions from experiences of the Learning Network approach can be drawn.

The companies in the Learning network differ in size, in products and regarding the assignment they bring into the learning network. However, more striking and important to the success of the network activities is that they identify the same need to question traditional working procedures within their product development and that they experience a need for change to stay competitive. Also important is that all the company projects have a formal internal commissioner and that the company members have support from their organizations. Each company participating in the learning network is represented by two or three persons involved in the learning network activities. A description of the participating companies and their state of art when joining the network is given in Table 1. The subject areas focused by the different companies and the assignments they bring into the Learning network can be summarized as follows:

Product management: organizational changes to strengthen the relation between business development and product development

Creativity in projects: developing means to evaluate the creative potential in project work, especially regarding different phases in the product development process

Technology transformation: measures to strengthen the development organization in the company when shifting technology focus from mechanics to mechatronics

These subject areas are however provisionally as it is part of the process to develop and in some cases reformulate the assignments.

Table 1. The table presents the participating companies by their state-of-art and assignment when initializing the Learning Network.

Subject area	Technology transformation	Product management	Creativity in projects
Company description	Company A has about 600 employees and is a member of a world wide company group with about 40 000 employees. They sell security solutions basically realized by mechanical products. Of growing importance are their mechatronical solutions as they aim to stay world leading and see opportunities to apply new technologies in products.	Company B has about 60 000 employees and operate within the telecom industry. They have lived through a deep crisis with a major reduction of employees including the development organization. The company has a tradition of being highly innovative, leading the technology development, however, after crisis defined strategies to become more business oriented than ever before.	Company C has about 5000 employees, developing and manufacturing milking systems. They are competitive today even though not leading the technological development within their branch. Lately a technology and product success has been realized, which affect the company to lever their ambitions of being innovative.
Assignment	When entering the network the vice president of the company has given the two company members authority to take part and an assignment to find solution on how to transform a development organization from mechanics focused to mechatronics focused. In many aspects they are traditional company with a strong manufacturing organization and business logic related to an efficient manufacturing.	The company members in the network as an assignment from cooperate staff to change the product management organization and to develop routines for a continuous improvement of common work procedures in product life cycle management. In focus in the network is the implementation of new routines for a common work procedure.	The company members in the network is assigned to increase cost efficiency in the development organization, in specific they define their task to find solutions for estimating innovativeness in the product development process.

At the present five meetings have been conducted in the Learning network. Each meeting has been embodied by problem analysis, starting in the actual situation of each company, a theoretical input from researchers and discussions on change procedures, as described in 3.4 *The learning network*. The theoretical input has been chosen according to the overarching issues in the research approach as follows:

Innovation management

Product development processes and knowledge creation in development work

Creativity

Change procedures

As a result from meeting activities and the work under way in the companies, a more nuanced problem definition has evolved. A more insightful problem definition and consequently, a clearer assignment for change is a result so far. Also the main objectives of the Engineering Management program and the Learning Network should be lifted up, so as to relate local projects to these. Table 2 gives a short presentation of the description of the current change activities and problem definitions.

Table 2. Current change activities and problem definitions in the Learning Network companies.

Company A	<p>Software and electronics challenge traditional product solutions.</p> <p>The potential to innovate is not a problem, read problem solving/ technology development. However, there is a less clear approach to implement new technologies, meaning to develop business solutions and launch new products on the market.</p> <p>A shift in technology focus requires a competence integration perspective. Regarding company A, also an urgent need to redefine the position of the development organization in the company has been highlighted during the Learning network activities this far. Company A is a traditional company with a strong manufacturing rationale that needs to be questioned.</p>
Company B	<p>Product management is re-organized to strengthen business development in a former technology pushing company. In parallel, work procedures for managing certain aspects in the <i>product life cycle development</i> is developed.</p> <p>Complex products require coordination in work procedures. A process management is obtained by the new work procedure.</p> <p>Company B is well underway in changing product establishing the new work procedure. A special attention should be paid to in what way new work procedures affect the strong history of being an innovative company.</p>
Company C	<p>There exists a strong demand to reduce costs in R&amp;D. At the same time the company has showed to be highly innovative in certain product areas.</p> <p>A means to increase innovativeness is to be able to measure it in a project setting.</p> <p>Company C has identified an objective; however is still confused concerning means to realize these. Innovativeness is strongly dependant on creativity and creative capacity is suggested to be utilized as a parameter. Still, a deeper analysis of what parameters that affect creativity in projects are urged for.</p>

## 5 Conclusions

Even though the Learning Network is only quarter ways through the running project some experiences regarding the applied research approach and its effects can be presented.

The goals for a company to take part in an action research approach as the Learning Network is to:

- gain theoretical insights and new knowledge,
- share experiences,
- have time and space for reflection,
- gain motivation to overcome organizational barriers for change,
- get support in process management.

Our experiences from the application of action research are that the key solution to fulfill these goals has been the procedure of regular meetings with demand on work within each company in between the meetings. Discussing new theories and existing models related to the issues each company is working and exchanging experiences between company-members have been important in these meetings. Company-members are in general overloaded with work and experience a difficulty to make time for reflection in their work place. Regular



meetings have provided this basic condition for deeper learning. As the research group facilitates meetings with demands on problem identification, explanation of context specific matters in each company and drive company members to define a task from time to time, the process management have been achieved. The research group have acted process managers, however, with a great emphasis on that change is conducted by the company members. Researcher only act outside the companies.

Another experience is that there is a strong satisfaction in addressing the entire problem area of Engineering Management in its full complexity. Heavy emphasis on short-term activities in daily business is put a side for a long term perspectives on new working ways. In the same time, prescriptions are abandoned and each company develops their individual solution.

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