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Integrated Competence Development

A Concept for Company and University Coordinated Research

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Abstract

A framework for competence development involving universities and company in tight co-operation is being developed at Volvo Aero. A process oriented view and a concept for learning organisations are key factors for the company's competence profile and thereby it's competitiveness.

Experience from ongoing co-operation programs is presented. The objective is to transfer scientific knowledge into technical knowledge and at the same time stimulate university education and research.

The concept is based on PhD students and professors associated to both organisations and working in multi disciplinary teams. As a result, the level of interaction and communication between the university and the company have been significantly enhanced.

Advantages and disadvantages of this tight coupling between university and company are discussed.

1 Background and Introduction

Strategies and methods for efficient product development are popular issues in today's industry. Integrated Product Development (IPD), Concurrent Engineering (CE) and Integrated Product/ Process Teams (IPPT) are only some of the labels frequently mentioned. IPD (e.g. Conaway, 1995) will be used in this article for convenience. The fundamental ideas are the same in all concepts and the explicit techniques used all aims at obtaining an efficient and enthusiastic work environment where the right things are done in the right way and in the right time.

The title 'Integrated competence development' reflects on the apparent similarities between the concept to be described for competence development and the issues addressed in IPD. No unified definition of what is included in IPD exists although the concept (CE) is becoming firmly established (Couchman and Badham, 1996). Typical features are;

- identified customers with early and tight involvement
- tight communication with suppliers and partners
- use of structured support methods (e.g. QFD, DFM, FMEA)
- parallel activities
- cross-disciplinary teams
- efficient and intensive use of digital simulation tools (CAD, FEM, CFD, MSA)
- emphasise target definitions, objectives, aims, etc.

These features hold true not only in efficient product development but also in the concept of competence development at Volvo Aero in Trollhättan.

1.1 General driving forces in a competitive environment

The business environment is rapidly changing and companies have to be able to meet new situations faster and more often to stay competitive. Wheelwright and Clark (1992) identified the driving forces for industrial development as:

- Intense international competition
- Fragmented, demanding markets
- Diverse and rapidly changing technologies (which increases the variety of possible solutions)

To meet these tougher business situations the companies can either emphasise on

- rapid adaptation to new circumstances or
- more focused business strategy (by liaison, globalisation, outsourcing)

Both alternatives are frequently used, but in this paper the former will be in focus, i.e. when companies want to develop competence for a competitive organization.

In figure 1, an alternative description on how the company's complex situation forms the requirement on it's organisation and individual co-workers is illustrated.

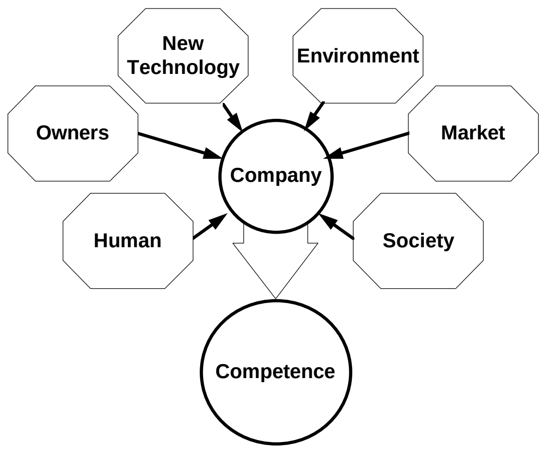

Figure 1: Companies situation sets the scene for competence requirements

Except for the previously mentioned requirements, a company has environmental and social responsibilities which adds requirements to the list. New technologies not only increases the variety of possible solutions but also provides new methods and tools for efficient work. The intuitive area is perhaps the information technology area, where new ways of communicating are supported and more sophisticated simulations can be performed using computer aided tools. However, these technology improvements also requires employees to be educated and new organisational forms to be developed.

1.2 New and future requirements on competence

Statham and Kleiner (1996) identifies two major premises for efficient development projects;

- use up-front planning and
- cross disciplinary communication

These must be emphasised to reduce the number of late and expensive problems.

When developing competence, the same idea holds true; plan your forthcoming need for competence to avoid late problems with lacking competence. In this work, new tools and methods are being used for project and process planning of competence development.

Competence improvements have to be carried out continuously on several levels;

- development and implementation of new methods
- new and improved methodologies
- development and adoption new technologies
- develop organisations and management techniques

Capbility to synthesise increasingly complex situations is a vital competence. Most work activities have become more theoretical, and *theoretical knowledge* is definitely a core competence. This also increases the need for knowledge about higher education in most companies.

Social competencies (communication, flexibility, creativity, adaptable to continuously changing circumstances, express in oral and writing in several languages, management skills, holistic and critical thinking) are increasingly important since more intense communication is required both within the company and between the company and customers/suppliers/partners.

Since the industrial environment is quite turbulent and future changes can be expected the following questions are raised;

- How to prepare students for life-long learning?
- How to educate for continuous re-education?
- How many times must an average co-worker re-educate?

2 Methods

2.1 Process based competence development

Volk (1992) concluded from a technology development project at Northrop Corporation (USA) that technological improvements (regarding advanced, automated computational tools) themselves will not improve productivity. Increased awareness and control of processes are required to develop and introduce new and improved technological systems.

One way to obtain a good overview of organisational activities, used and developed at Volvo Aero since late 80:th (Loinder, 1996) is to use process mapping to describe activities (Rise & Wiklund, 1993). Customer needs and inputs are identified as well as the products from each process. The *process* is defined as the series of activities required to develop the product based on input from customer needs. The process is directed by management processes and supported by support processes, as illustrated in figure 2.

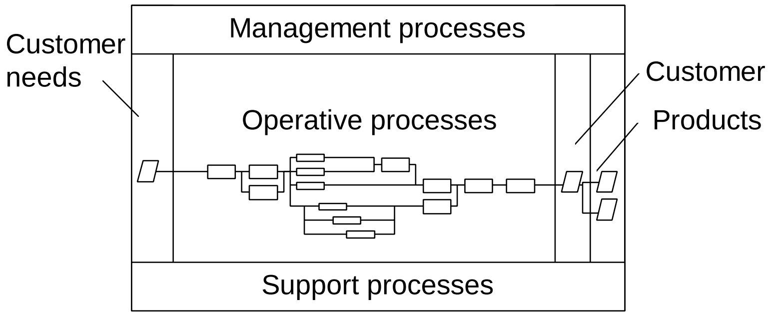

Figure 2: Illustration of process mapping, describing work at VAC

Describing work in processes, using process mapping, is helpful when identifying critical competencies in new or excising processes. Thus, the problem of obtaining an overview over the competence situation can be addressed.

The market environment sets the scene and through a careful strategy analysis the product plan is formulated. The product plan sets the requirements on the business plan and the technology plan, respectively. Finally, as the technology requirements are identified, the requirements on forthcoming competence needs can be foreseen and formulated in a competence development plan. The resulting plan is used for personnel and organisational development strategies. In this way competence requirements can be foreseen and planned for in a structured manner. Strategic tools used for this development at Volvo Aero are found in Roussel et al (1992).

The competence development forms at Volvo Aero ranges from short course modules to post doctoral education. The different levels where universities and the company co-operate are shown in figure 3.

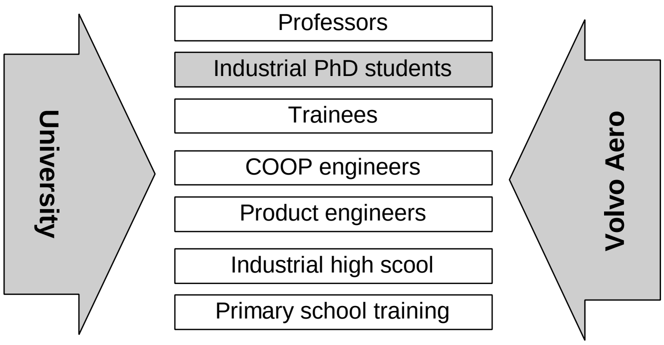

Figure 3: The different levels of competence development at Volvo Aero and co-operation with universities.

2.2 Learning processes

Organisations need to rapidly adopt to new circumstances and learn how to do things in new and different ways (Dodgson, 1993). As the competitiveness of the company increasingly depends on such capability, the process of organisational learning has been highlighted. Not only has the company to learn from their mistakes, but also consciously and continuously improve current processes and methods. As the need for a specific competence has been identified, the delicate task is to develop and implement this competence into the organisation. Argyris and Schon (1978) describe this as single-loop learning (learning from mistakes), double-loop learning (improve current processes) and deuterio-learning (understand and develop the process of learning itself). Dodgson concludes that an interdisciplinary perspective will have a particular value for studying learning organisations.

Competence follows the individual and therefore the individual co-worker carries the company's competence. To achieve a organisational capability, this has to be done by developing individuals such that these contribute to the organisational competence requirement.

Lunde (1996) studied the effects on co-operation and work culture of a re-organisation. It was found that a re-organisation can be useful when developing competence within a company by identifying the work culture supporting critical processes.

2.3 The process of technology development

It is useful to divide the development efforts into product- and process developments to meet the requirement of an effective product and an effective company, respectively. Each is divided into base development phase, demo phase and prototype phase as shown in figure 4.

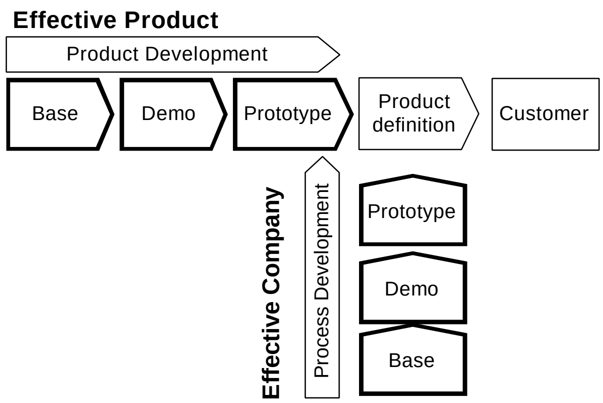

Figure 4: Process vs. product development

Project planning can be used to identify expected and forthcoming technology requirements. (Isaksson & Elfström, 1996). New and improved technologies identified can be assessed (upon risk) and an appropriate form of technology development can be initiated. Structured methods (like QFD) are valuable when identifying and assessing these alternatives.

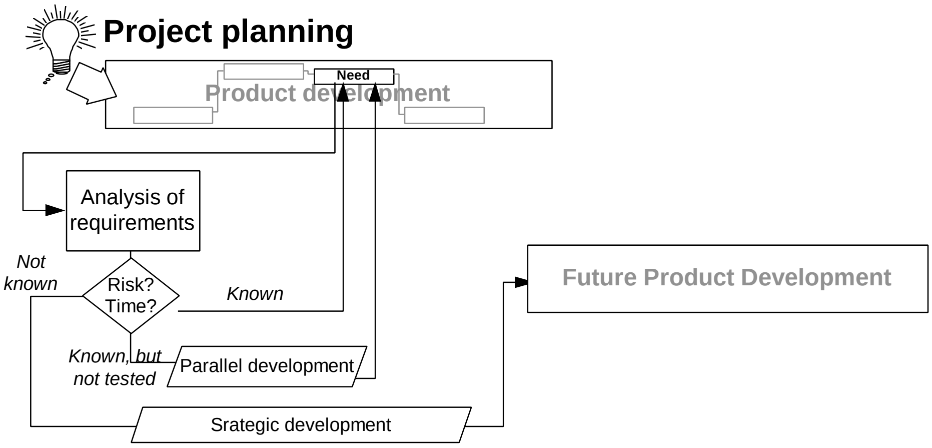

Figure 5: Assessment of technology requirements

The same method can be used for strategic competence development. As the technology development is planned future needs of competence are identified which forms input to the competence development plan (see also figure 3).

3 A concept for Company and University co-ordinated research

Volvo Aero uses several methods to co-ordinate competence development in an industrial environment. Co-operation within the Volvo Aero group or within the Volvo company, together with partners and suppliers, and co-operation with universities in different forms. Here, the university co-operation projects involving doctoral students will be discussed, and one of them presented in more detail.

3.1 General doctoral student models

Co-operation between universities is most often used in base and demo phases of process development, while universities seldom takes part in the core development phases of product development. Research oriented projects and demonstrator projects are often more suitable for university involvement. New methods, techniques and ideas developed at universities often needs an implementation phase before they are productive. The problem discussed often addresses questions important for new engineers, presently under education at the universities. Thus, both the company and the university benefits from this co-operation. Se figure 6.

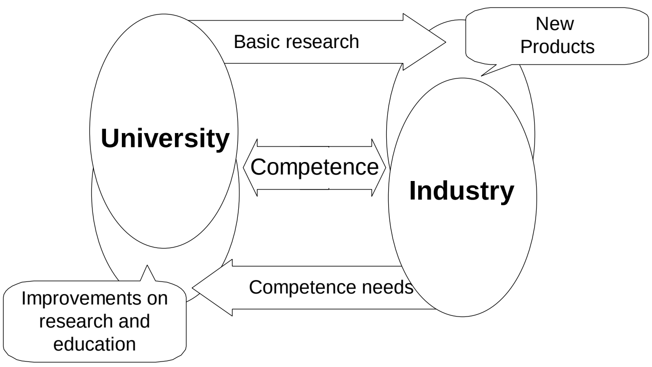

Figure 6: Mutual benefit (company and university) from co-operation

These research projects can be realised in several different ways. At VAC we have four different models for involving PhD students;

- Industrial PhD students employed by and doing research at the company
- Industrial PhD students employed by the company and doing research at the university
- PhD students employed by the university, but doing the research at the company
- PhD students employed by- and doing research at the university

3.2 The model for co-ordinated research

The model presented is based on experiences and research in joint projects between Luleå university of technology and Volvo Aero. The philosophy of the project is to obtain the same positive and pro-active activity as in successful product development teams. Tight coupling between the university and company in both organisation and task creates a group with a common goal, where all parts can se benefits. The key characteristics, mainly considering the organisation of PhD students are described below;

- PhD students employed by the university, but doing the research at the company
- Government financial support
- Position at operative department, utilising the technology of interest
- Insight in the daily work at the company
- Involved, to some extent, in the university department work
- Involved, to some extent, in the product development project
- Steering group with members from university and company
- Reference group, consisting of company specialists in the area
- Examiner and supervisor at the university
- Supervisor at the company
- Reporting to government, university and company in different forms
- Information and implementation through the government program, the university and direct into the company
- Information to other interested parties through publications, seminars, lectures, and courses

The technology development projects are managed following the same principles as in an IPD project. This means parallel work, cross disciplinary teams and communication, and use of structured support tools (se figure 7). The project steering group consists of seven persons out of which three persons from the university and four from the company. They all represent different interests of the project (customer, supervisor, expert etc.). The entire group meets twice a year, while the company group has four additional meetings a year.

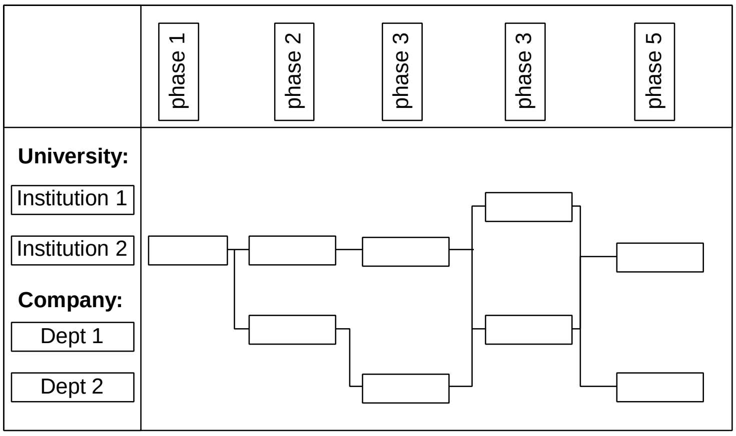

Figure 7: A process schema used for planning of activities and showing the relations and responsibilities of the work packages

4 Results and conclusions

4.1 General observations

The general observations presented are based on several years of research co-operation between Volvo Aero and various Swedish universities.

1. Observed difficulties to establish an efficient form of co-operation

   Universities and companies have by definition different aims of their work and thereby different roles. Universities works on a longer base while companies have to consider short return of their investments and make profit. The academic culture differs from the company culture and this can often lead to mis-understandings and mis-interpretations in meetings and agreements. Especially if the parts only meets occasionally, and does not have a tight communication. Together with a relatively low research competence in industry and low industrial competence at universities, conditions for efficient co-operation are lacking.

2. Continuous change of universities

   Swedish universities are currently undergoing several changes. In industrial terms, they are developing a customer oriented view, with less free founding and competition to get students. Quality questions and educational lead times are frequent issues of discussions. More research activities are wanted in collaboration with industry. The development of new, regional universities has forced universities to focus on different areas. Small and local universities specialise on regional specialities, young universities on applied research while the old and well established universities are strongest in classical areas of science. This simplified relation is illustrated in figure 8, where the university profiles are related to typical stages in industrial development.

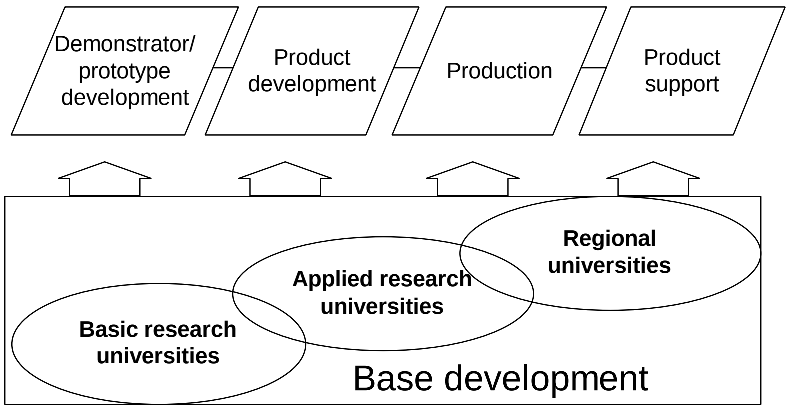

Figure 8: Types of universities involved in different industrial stages

4.1.1 Conclusions based on general observations

To improve the efficiency for university and company co-ordinated research, the following considerations are vital to deal with

- Obtain an understanding for each roles, culture and language
- Search for equal competence level at both the university and the company in order to get a good dialogue in communication and adaptation of knowledge
- Build cross functional networks
- Increase the amount of research educated co-workers in the companies
- Improve industrial involvement and increase the number of industrially experienced people at the universities
- Develop co-operation forms involving industrial based PhD students

4.2 Advantages and disadvantages with the co-ordinated research model

The model for co-ordinated research has influenced the working methods at both the university and the company. Both parts have developed a better understanding for each others expectations and the close coupling has improved communication, something that is vital in technology transfer. Some advantages are summed below;

- High degree of influence on both company and university
- Good forum for co-operation (mixed steering group)
- Fast implementation of new technology
- Fast feedback for university education and research
- High degree of relevancy in research (continuous involvement)
- Industrial PhD student is free to focus on research activities
- Easy access to the company's education for university co-workers
- Easy access to university education for company co-workers
- Real industrial experience during doctoral education
- Direct and simultaneous insight in company and university

However, there are some disadvantages especially for the research student namely;

- Weaker academic environment in companies
- Courses at a distance
- Implementation issues can disturb the research activities

- Less objective position

5 Discussion

The perhaps most important recommendation is to not only agree upon the research objectives and goals, but also to understand each others perspective and expectations. As a help in doing so, an illustration of the research perspective has been developed and used in the discussion. Companies expectations on projects are often to find applicable solutions to a problem on an industrial level whereas researchers at the university aims at developing their field from a scientific point of view. Generally, scientists wants a narrow scope to fulfil expectations and industry people a much wider scope. The difference between project expectations is illustrated in figure 9.

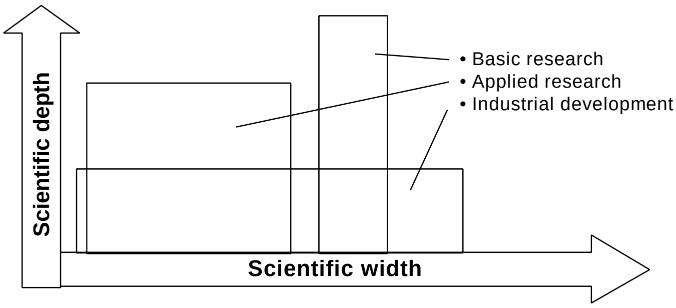

Figure 9: Different levels of technology projects

Initially, this might seem like a contradiction in defining objectives that satisfies both aspects. However, the scientific research perspective is beneficial for the broader industrial expectations as well. This is illustrated in figure 10. Typically, a scientific development effort strives for a deeper and more complete understanding of a specific problem or phenomenon. To achieve this, a solid understanding is needed in a wider area. This knowledge rests on a scientifically solid base and does not directly contribute to new scientific results.

For the industrial problem in the same field this basic scientific knowledge might be very useful. It is often not known to a broader community outside the scientific discipline. *A scientific peak effort within a narrow area gives a broader knowledge which contributes to the solution of industrial problems in a much wider sense.*

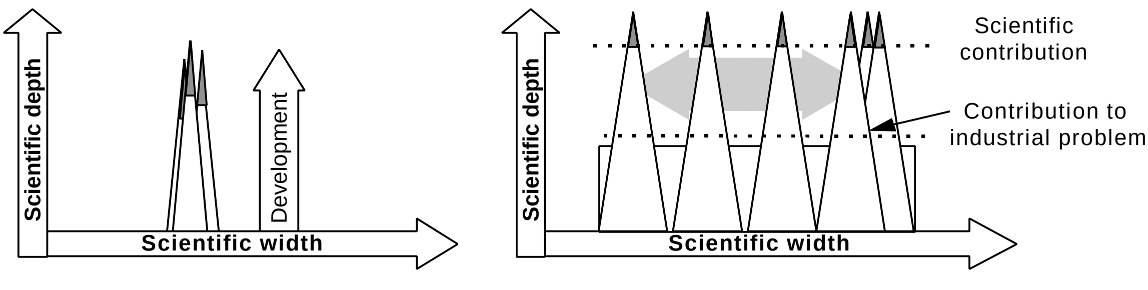

Figure 10: Scientific development vs. industrial development. The scientific study gives a wider result on an industrial level than what is scientifically interesting.

On the other hand, applied scientific research directly linked to industrial activities guarantees relevant research topics.

A few scientific (narrow) efforts defined within the industrial problem can cover the broad scope of a project on an industrial level, and still produce relevant and scientifically interesting results.

6 Acknowledgement

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