

## Dynamic Learning Organisations Supporting Knowledge Creation for Competitive and Integrated Product Design

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### Abstract

This paper shows that learning strategies and a structured approach to turn organisations into learning organisms have a major influence on the success of engineering programs in general, and on integrated design activities in particular. It points out the important relationship between dynamic learning organisations and the successful integrated development of complex mechatronic products using the topical and typical example of safety engineering in automotive development. It points out the key properties of learning organisations and reports about a way in which they have been successfully applied to the showcase example in close collaboration with a car manufacturing company.

### Keywords:

Learning Organisations, Competitive Design, Mechatronics, Certified Innovation Manager, EU Certificates

## 1 INTRODUCTION AND METHODOLOGY

Designing and modelling of mechatronic systems have acquired key roles in assuring and increasing the quality, efficiency and efficacy of the product development process. This trend poses several challenges not only on engineering tools and on engineering education and formation, but also to a very large extent on organisations. The importance of continuously fertilizing the organisation with new knowledge about requirements, trends and experiences linked to the products and the concerned development methods and tools is still often underestimated.

This paper reports on experiences gained in applying principles of dynamic learning organisations to product development organisations in the automotive sector.

The original project was called ORGANIC (2005 – 2007, [9]). Based on different European studies about innovation management where members of the partnership and leading industry have been involved we developed a modern learning organisation based innovation management strategy. A company becomes an ORGANISM where through continuous learning spirals the knowledge grows and the core competences increase continuously. In collaboration with innovation leading companies the project developed an example base which is being exchanged and used in different working task forces since 2006. This is also reflected in the way the qualification and certification of the Innovation Manager job role has been transported to industry.

Meanwhile the European Union finances a project called EU Certificates Campus (2008 – 2010) where such key areas of knowledge are transported in form of online short courses, together with recognised certificates for innovation management.

Chapter 2 of this paper presents an approach to identifying and modelling a learning strategy for a particular development organisation. Chapter 3 shows how the analysis of core competences serves as a key to putting in place a learning organisation.

An issue that is particularly relevant for development teams is that they are increasingly distributed. Chapter 4 reports about experiences gained in designing and establishing a learning organisation in automotive safety engineering.

Chapter 5 deals with the important issue of how dynamic learning organisations can assure the sustainability of continuous innovation. Modelling and implementation strategies of dynamic learning principles are the subject of chapter 6. Chapter 7 concludes and gives an outlook on further research and development.

## 2 MODELLING A LEARNING STRATEGY

ORGANIC analyzed 20 competence areas that are considered keys to turning an enterprise into a learning organisation:

1. Building Basic Understanding
  - **Core Competencies and Customer Relationship Management Skills**
  - Innovation and EU Policies Know-how
  - Introducing Innovation Management Principles
  - Knowledge Management Competencies
  - Market Research Skills
  - Regional Innovation Strategies Involvement
  - Human Force Skills Management
2. Building Communication Skills
  - e-Challenges in Innovation
  - Innovation Skills for Reporting and Presentation Skills
3. Building Management Skills
  - Corporate Wide Innovation Management
  - Innovation Aspects in Project Management
  - **Innovation Process Management Process**
4. Building Team-Learning and Teamworking
  - Cross Cultural Success Factors
  - Innovation Aspects in Conflict Management

- Innovation Aspects in Motivation Building
- Innovation Aspects in Team Communication
- **Innovation Skills for Distributed Team Management**

#### 5. Building Personal Skills

- Cross Cultural Skills
- Knowledge about Personal Characteristics
- Learning Culture Establishment

Each of these competence areas has been treated with equal importance, and best practices have been collected. After running through all the proposed steps the architectural design of a learning organisation tailored to the company-specific needs has been established.

The three highlighted areas in the above listing will be explained by examples in the following sections of the paper.

### 3 CORE COMPETENCE ANALYSIS

One of the key success principles is that organisations understand that they are part of a learning chain. The innovation ideas of customers influence their own innovation tracks. The closer one gets to such key partners the more dynamic the learning cycles will flow.

#### 3.1 Step 1: Identify Core Competences

A core competence is a field of knowledge of the firm

- where they are stronger than other competitors;
- where they created already a critical mass of competence;
- where with one knowledge item/function many customers can be served (Re-usability);
- where since years dynamically knowledge is extended, newly created and exploited.

#### 3.2 Step 2: Identify Key Customers for Learning

Once an organisation identified the core competence fields the next step is to identify which customers are those who most dynamically contribute ideas to this core competence.

A key learning customer is identified as a firm which

- regularly gives inputs to new functions, ideas, plans for increasing the identified core competence;
- has its own known innovation leadership and can help putting new structures into place;
- is willing to get in closer collaborative partnerships for services and products in the future.

#### 3.3 Step 3: Enable a Social Learning Strategy

Once the key customer and the core competence are identified the organisation creates supportive social learning spaces to further enrich the communication and empower the dynamic feedback flow to the core competence.

#### 3.4 Example: Automotive Safety Engineering

Figure 1 illustrates the example of Automotive Systems [7] where core functions of e.g. a control system are the same in all variant projects. The company then decides to develop all base functions just once and maintain parameter sets which allow applying the same 80% (ready-to-use) functionality by parameter sets to many different customers. The company then learns continuously new functions and decides whether to include them in the base.

This leads in the long run to stable systems working for many customers and focussing the learning on core

functions which they can supply better and quicker than any of the competitors.

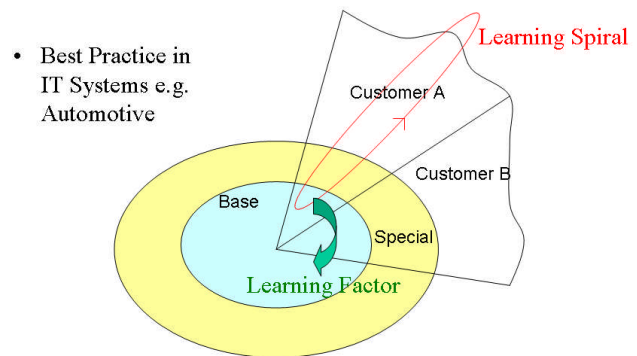


Figure 1: Example – Base Development Strategy in Automotive Systems Development

Figure 2 illustrates the example of a leading automotive supplier which identified using the analysis that e.g. Customer B would drive the innovation in the mechatronics functions while currently the base knowledge for safety design is created with the idea motor Customer A.

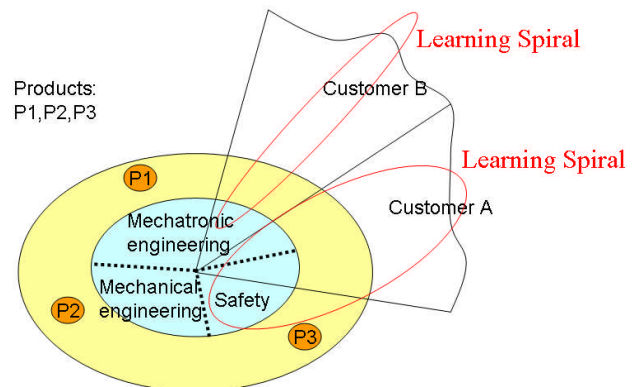


Figure 2: Example – Core Knowledge Strategy in Competitive Development

Based on the specific team structures are built to further increase this learning spiral.

#### 3.5 Benefits

Imagine that one either does 30 parallel projects (30 times the effort, 30 different results, 30 maintenance teams, etc.) or instead that one creates one core competence team that provides one solution adapted (by parameters and configuration options) to 30 variants of customers.

One can focus knowledge, resources, and concentrate on customers that are contributing further to the core knowledge.

### 4 SKILLED DISTRIBUTED LEARNING TEAMS

Another key success principle is that organisations are able to model and support the learning spiral (see the learning spiral in Figures 1,2,3) in form of a role based distributed team [1], [2], [3] [4]. This way they learn a so called learning cooperation pattern which can be re-used to dynamically run these learning/innovation partnerships.

We continue with the example presented in section 3.4, pointing out how the core competence for safety design further developed. The company analysed the currently involved roles and the current information flows in the safety related learning cycle.

#### 4.1 Step 4: Analyse Current Team Roles

Figure 3 illustrates the current levels of roles involved in the safety concept, safety design and safety implementation.

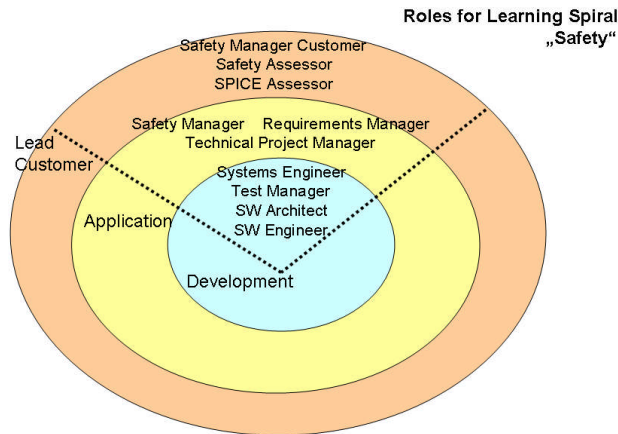


Figure 3: Example – Safety Learning Cycle in Figure 3 – Actual Roles

#### 4.2 Step 5: Analyse Current Information Flows

Figure 4 shows the current information flow which showed that there is a bottleneck with the safety manager.

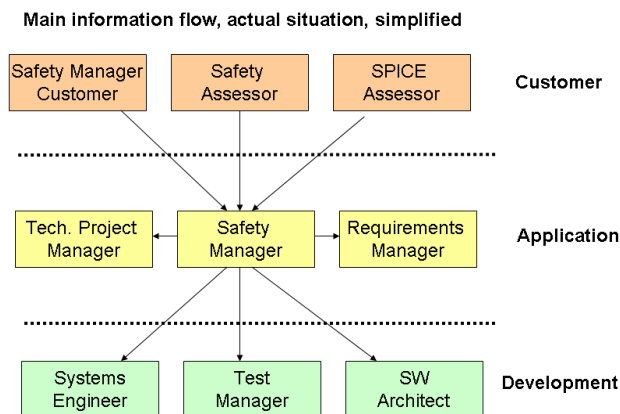


Figure 4: Example – Safety Learning Cycle in Figure 2 – Actual Flows of Information

#### 4.3 Step 6: Improve towards a learning team

The results of such an analysis are shown in Figure 5. The learning organisation would decide to create a joint learning time to unleash the power of knowledge exchange and collaboration.

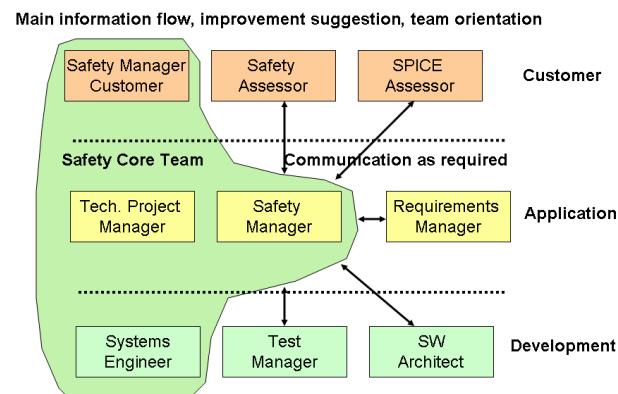


Figure 5: Example – Safety Learning Cycle in Figure 2 – Social Team Learning

#### 4.4 Distributed Innovation – Learning Teams

A distributed innovation/learning team

- involves roles from different levels (customer, product, core competence);
- does not have bottlenecks;
- enables teamwork and feedback loops to create ideas, solutions, knowledge;
- distributes and shares information to the team members.

#### 4.5 Benefits

The learning effect on the core knowledge (safety design in that example) is multiplied by bringing key players together in a learning team. Much information and time is lost when bottlenecks serve in the middle. Also, remember, we need to further increase the dynamics around the learning cycle and the faster it turns the more we learn together on e.g. safety design.

### 5 DYNAMIC FEEDBACK LOOP BASED ORGANISATIONAL PROCESSES

In most traditional innovation management courses the content relates to patents, supporting new patents, creating idea databases and following up on the ideas, supporting innovative staff, etc. Learning organisations add to this traditional picture the organisational strategy of a continuous learning organism around features which keep the organisation alive and leading for a long time.

Therefore another key success principle of learning organisations is the ability to create innovation processes around the learning dynamics of the organisation [1], [3], [7], [9].

Feedback loop based innovation / learning processes

- must represent continuous feedback loops;
- are created based on the learning cycles;
- support the continuous increase of core competence knowledge;
- create critical mass of knowledge to be re-usable in many projects and services.

#### 5.1 Step 7: Create an Innovation Process based on the Learning Cycles

Figure 6 illustrates a feedback loop process that has been designed around the safety core team.

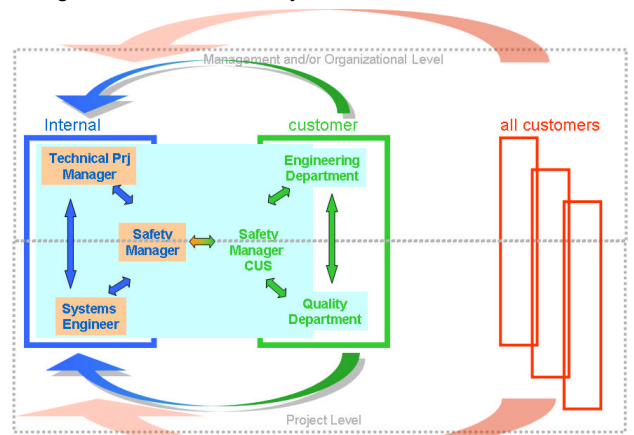


Figure 6: Example – Safety Learning Cycle in Figure 3 – Feedback Loop Processes

Customer and project roles collaborate closely, gather key knowledge prepared and stored by the internal team,

and continuously refining the knowledge based on planned feedback loops.

## 5.2 Benefits

If one executes many projects that each contributes core knowledge stored only in the respective project space, the knowledge will stay in each single project and eventually (if a staff member moves to another project) be shared.

When certain knowledge has been declared as core knowledge that projects share and a base structure (product, service, knowledge, requirements tree, etc.) is built for all projects in the centre, all knowledge flows together and the feedback loop process is a strategic process in the firm.

## 6 MODELLING AND IMPLEMENTATION STRATEGIES

### 6.1 Strategies for the Learning Organisation

The established framework for designing a learning organisation has the 20 competence areas listed in Chapter 2. Each area has its own success principles. By running through all 20 areas an architectural design for a learning organisation can be created.

The qualification and certification in these 20 areas, including the ways to implement the according principles, has been established as the job role “EU Certified Innovation Manager” [11] by the European Certification and Qualification Association (ECQA) [12]. The certificate is currently issued by iSQI (International SW Quality Institute).

Implementing learning organisations aspects in integrated design teams is one of the major subjects in the development of a competence profile, training courses, and certification of Integrated Design Engineers in our recently launched project “iDesigner” [13][14].

### 6.2 Strategies for ISO 15504/SPICE

Knowledge about these innovation principles is important for process quality—in the automotive industry typically SPICE [10]—assessors to provide improvement recommendations which help organisations to win from SPICE investments.

- To know the core competence in functionality in a product segment will help to install the requirements and test traceability for core functionality once, and then repeat to use it from there. This obviously multiplies the return on investment.
- If the understanding of customer, system, and software requirements is demanded, then such learning teams are the basis for such a good communication.
- Innovation is based on a continuous learning cycle involving the customer and core competencies which can be multiplied into many product segments and projects.

### 6.3 Strategies for Industry Task Forces

Cross company learning teams on core areas of SPICE have been created in SOQRATES 2003 [15], where up to now above 20 German leading companies collaborate. Figure 7 we illustrates the collaborative innovation learning model applied in SOQRATES.

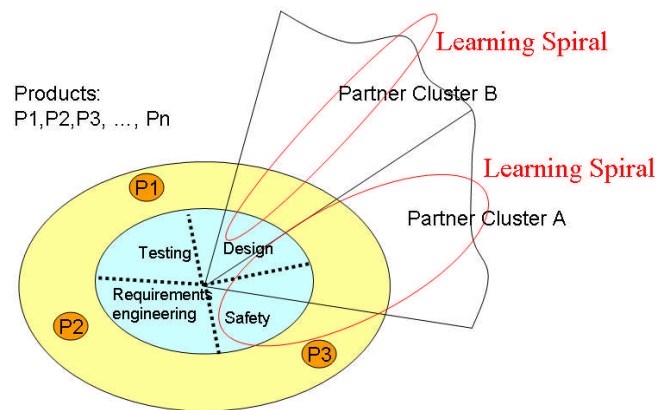


Figure 7: Example – Core Competencies Architecture for Cross Company Task Forces Model

Clusters of companies are formed who can contribute key knowledge to a SPICE core competence. Companies can only join on a win-win principle where they give (be a key player to one of the knowledge fields) and take (can access core knowledge elaborated by another cluster team).

Still it is exclusive to be a member of the group because existing members must agree the integration of new members. Thus the core group contributors are no competitors, they exchange and learn from each other, and get together better than their competitors on the market.

Using the same innovation learning strategy cross company learning teams on core areas of SPICE have been created also in Austria in S<sup>2</sup>QI 2005, where up to now above 10 leading Austrian firms collaborate.

### 6.4 European Networking

Since 1994 an annual European Improvement and Innovation Conference has been organized. The partnerships in the previously mentioned EU projects are actively contributing to the EuroSPI<sup>2</sup> (European Systems and Software Process Improvement and Innovation) initiative, which has built a pool of approximately 500 experience reports. EuroSPI<sup>2</sup> 2009 will take place in Madrid, Spain, in September 2009 [16].

## 7 SUMMARY

This paper suggests an organisational approach to tackling the increasing system complexity of designing mechanical and mechatronic products using the example of safety engineering in automotive powertrain development.

Departing from a framework of 20 competence areas, each having its own success principles, the architectural design of a learning organisation is created. The advantages have been pointed out on the basis of the concrete experiences of a car manufacturer who has successfully applied the proposed transformation to their own organisation.

The authors are deeply involved in several research, training and consulting activities in implementing learning organizations for the development and the production of complex mechanical, and often mechatronic products. This context enables them to carry out research further, as well as to validate and fertilize it in real practical environments. Their major common activities are currently in the area of the definition of the skills required for different job roles in order to be able to support a learning organisation in integrated engineering.

## 8 ACKNOWLEDGEMENTS

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