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# APPROACH FOR IMPLEMENTING NON-LINEAR DISTRIBUTED INNOVATION MANAGEMENT METHODOLOGIES IN COLLABORATIVE INDUSTRIAL NETWORKS

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*Linear innovation management methodologies have been developed in engineering and business. Nevertheless the usage rate in industry is rather low. The authors state that not enough research has been conducted in order to understand the problem of systematically governing creative innovation processes in collaborative enterprise networks. Non-linear models to govern innovation processes are needed. Systems integration and networking models, which are viewed as 5th generation model, highlight the implementation as a non linear process of both explicit and tacit knowledge flows among a network of firms and their suppliers and customers. These non-linear structures can be a facilitator for design, distributed innovation process supporting creativity. The authors propose an approach which includes the necessary steps to implement an innovation methodology in industrial settings.*

## 1. INTRODUCTION

Innovation management is becoming a key issue in research and academia. Currently authors claim that there is a big dilemma companies face when competing in the global market. Among others Christensen (1997) published some useful explanations why large companies fail. One of the main problems is that companies become blindsided by disruptive innovations because they focus too closely on their most profitable customers and business and the necessary incremental improvements (Christensen, Raynor 2003). These incremental improvements become more and more virtual for large companies so virtual teams need to collaborate in distributed teams (Zedtwitz, 2003)

Indeed a recent study shows that companies claim not to have the right methodologies and information systems to work within distributed virtual teams (Fischer, 2003). Information systems have been rated as insufficient to meet the complexity in collaborative networks. Additionally most approaches still consider innovation management as a linear process which is surely not the case. The authors claim in this paper that methodologies supporting the non-linear innovation activities are needed.

It is an accepted hypothesis that "structuring and governing" the non-linear innovation process and its complexity is a key success factor. On the other hand some authors claim that creativity cannot be structured as people want. Some authors consider this as an antithesis. If people want to create disruptive innovations they need to change their mind-set (Christensen, 1997). Nevertheless, an innovation failure rate of 99% (Gassmann, 2002) is a substantial problem for the industry. Consequently, approaches, which provide structure and governance while taking creativity into account, have to be developed.

This paper starts with a description of state of the art methodologies for managing innovation from the engineering and business perspective to introduce the research problem in chapter two. It compares existing approaches in order to identify similarities and contradictions between these viewpoints. A representative selection of methodologies will be exposed. In chapter three the issue of Distributed Innovation Management and the role of virtual teams in this context are illustrated. A methodology for Distributed Innovation Management in collaborative networks is highlighted. Eventually, the authors propose an approach for implementing innovation management methodologies in distributed industrial settings under the major restrictions of trust, structure, governance, and creativity of the innovation process itself. Recommendations for implementing innovation methodologies, regarding the practical industrial requirements, conclude the paper.

## 2. EVOLUTION TOWARDS NON-LINEAR METHODOLOGIES FOR MANAGING INNOVATION PROCESSES

Innovation has become a strategic management issue by identifying innovation as an important success factor for industrial and service-oriented companies. The life-cycle of knowledge and innovation is continuously decreasing so that companies have to get more dynamic and responsive to stay competitive in the market (Vahs and Burmester, 2002). In the last decades a broad number of methodologies and approaches for innovation management were developed. These methodologies have different topics and structures depending on their origin and focus. They are either business oriented focusing on the management oriented point of view or engineering oriented focusing on product development from a technological point of view. Each of these approaches make the communication and strategic alignment difficult.

In **Figure 1** recent methodologies that form the business oriented point of view are shown. Their focus is on creation, identification and structured evaluation and improvement of innovative ideas and their development until market entry. Some methodologies are also covering the product development on an abstract level. The sketched approaches have a linear innovation process model background.

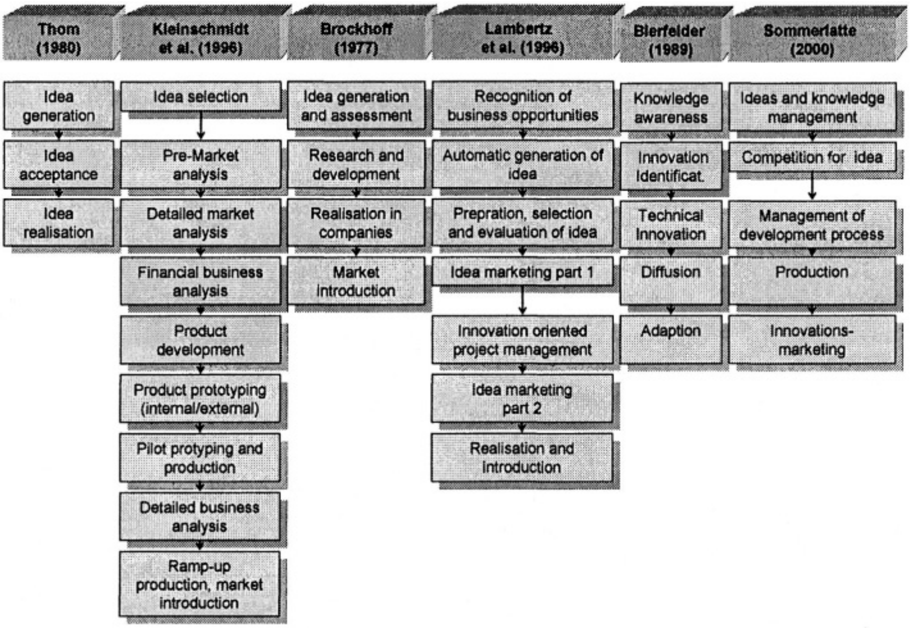


Figure 1: Linear business oriented innovation methodologies

All engineering domains have designed their own innovation and so developed methodologies. Figure 2 gives an overview over a selection of methodologies developed for mechanical engineering. All the approaches start on a given task. In a structured way they cover the conceptualisation and design of the recent product supporting the identification of the optimal methods and technologies for their implementation. Abstract models for the description of new products or systems foster the identification of innovative solutions to fulfil the given task. After the identification and evaluation of the abstract functional and structural models the main elements are mapped to be available or new technologies, which are abstracted as solution elements. Software, electronics, pharmaceutical, chemical or construction oriented engineering methodologies follow the same basic concepts like depicted in **Figure 2** for mechanical engineering.

**Yet, actual innovation processes deviate significantly from these structured methodological approaches as shown in**

**Figure 1** and **Figure 2**. As already stated, innovation is a very creative process. Innovation methodologies challenge the task to provide a creative environment and to lead the idea to a product. Another hurdle for a straightforward methodology is the circumstance that innovation is a distributed process in time and location (organisational and geographical) especially in virtual organisations.

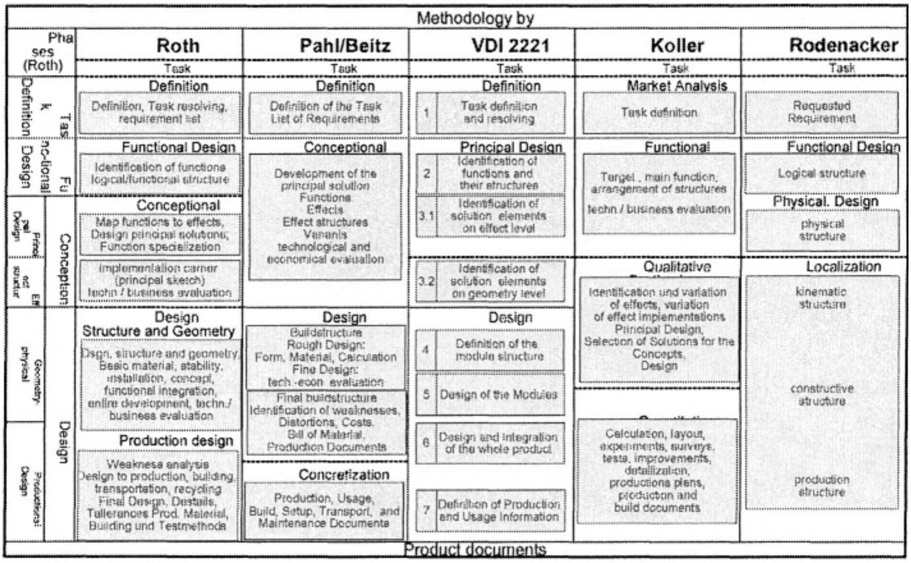


Figure 2: Linear development methodologies for mechanical engineering

It is proven by the developers of innovation and product development methodologies that a structured non-linear approach to innovation and development leads to an optimal sourcing of ideas and effective processes (Segarra, 1999). Enterprises are facing the challenge to make these methodologies work inside their virtual organisation structures. The current discussion in economics of innovation and management of innovation literature indicates linear models for innovation management will become obsolete. Consequently Pavitt (2003), Rothwell (2000), Dogson (1994) and others have put forward more than a decade ago non-linear innovation models, such as the systems integration and networking model or 5th generation model that conceives implementation as a non linear process of both explicit and tacit knowledge flows among a network of firms and their suppliers and customers.

The authors adopt the idea of non-linear innovation processes and introduce requirements and an approach for a flexible technological infrastructure. The distributed innovation management approach provides the flexibility to support the application of different innovation methodologies to offer the ideal basis for innovation.

# 3. ARCHITECTURE, REQUIREMENTS AND APPROACH FOR DISTRIBUTED INNOVATION MANAGEMENT

The current trend of virtualisation, collaboration in virtual distributed teams and the corresponding opportunities of the internet put the subject back to the focus of R&D management (Zedtwitz and Gassmann, 2002). The authors suggest a non-linear methodology framework and a supporting IT-infrastructure that can be embodied by optimal innovation management. The next chapter provides a method for selection and implementation of the best suited innovation management for the industrial setting which is applied on the infrastructure.

### 3.1 Proposal for a methodology framework for Distributed Innovation Management

The general approach was developed in co-operation with the industry (Eschenbaecher, Cocquebert, 1999). The extension of the basic ideas can be conceived as a result of the new opportunities provided by internet-based web-portals. These provide support for different concepts of collaboration (compare Thoben et al, 2003):

- Co-ordination by using
    - Transparent structure of responsibilities, defined control mechanisms, power structures, structuring and governing phase model, definition of organisational forms of virtual teams, steering committee as project controlling and external support by consultants or non-team members.
- Communication by using
    - Portal structure to save, open and revise documents, e-mail, calendar, news editor, quick links, status window, category definition
- Cooperation with
    - Subscription opportunity,
    - Web-browser user interface (24 hours availability)

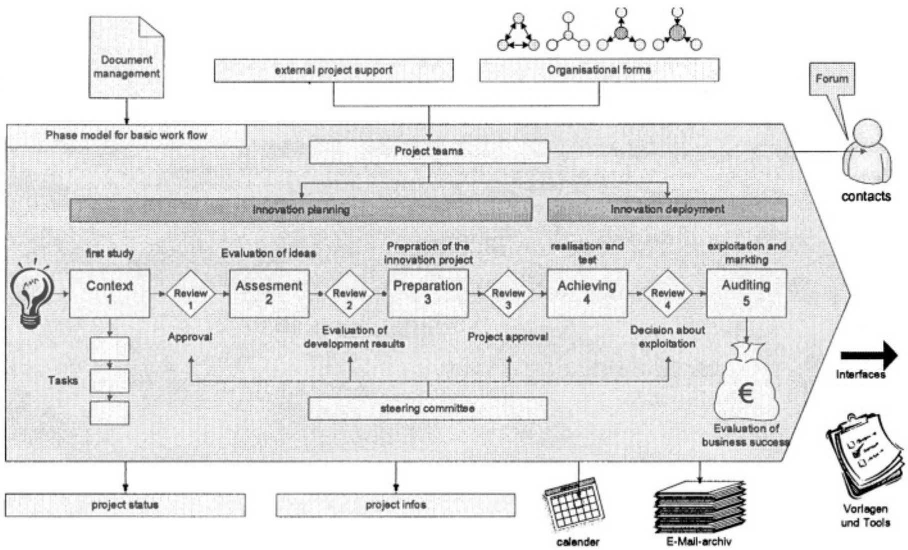


Figure 3: Methodology for non-linear Distributed Innovation Management (Eschenbaecher, 2004)

The methodology framework is visualised in **Figure 3**. The user process and the users, which collaboratively conduct the innovation process, are in the center of the framework. The model splits the innovation process into specific, discrete phases. Each phase is concluded by a review that delivers one of the two following results:

- Entering the next phase is cleared by accepting the previous' phases results, or
- The previous phases' results are rejected forcing the process back into the previous phase for improvement.

These iterative recursions separate the model from traditional, linear innovation models. Hence, this model is a non-linear one. Within the phase's context, assessment, preparation, achieving and auditing many parallel activities take place.

Every phase is finished by a review organised by an independent group of experts deciding whether the activities should be continued or not. This can be an internal management board, reviewers of a funding body or a steering committee of a distributed team. Furthermore the innovation process is separated in the two main stages innovation planning and innovation introduction. These areas are governed by project teams which co-ordinate the project. This methodology shows that conducting a distributed innovation management activity within a network makes a substantial effort in co-ordination, co-operation and communication necessary. The authors propose that the optimal selection and strategic implementation of innovation methodologies describing necessary efforts and suggest an approach for application of innovation methodology in organisations.

### 3.3 System architecture and requirements for Distributed Innovation Management

Distributed innovation management is characterised by innovation-related activities across distributed players as part of virtual or extended organisations, supply chains and even specific innovation consortia. Innovation management can be distinguished between distributed, collaborative, project and individual innovation covering the whole organisation (Hahn Eschenbaecher, 2004). This facilitates enhancing innovation across supply chains by reducing the enterprise-centric perspective of individual organisations and seeking a more dynamic network-centred perspective that engages enterprises other than closest suppliers and customers.

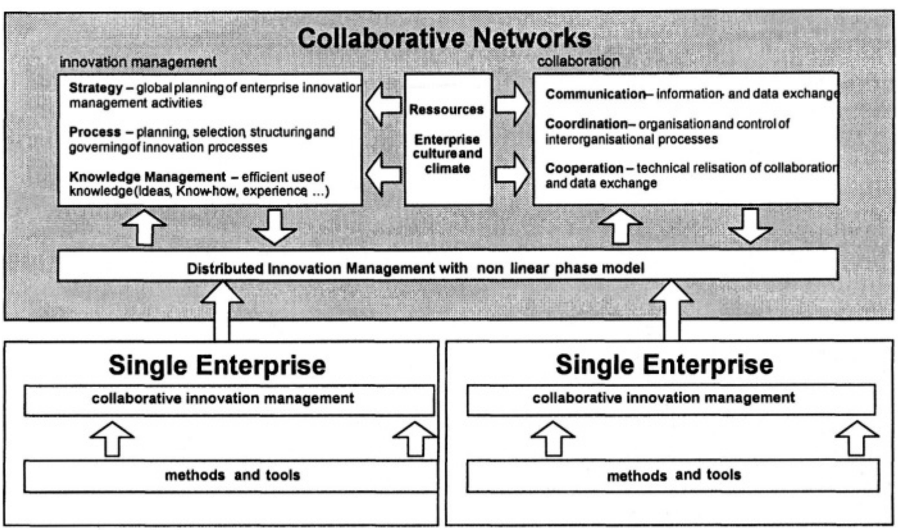


Figure 4: Exemplary system architecture for distributed innovation management (Eschenbaecher 2004)

The tools required for distributed innovation are in their infancy (Bafoutsou, Mentzas, 2002). A principal design feature will be that these tools must support structured and governed collaboration, to allow any individual to easily access the information they are looking for.

The requirements for a distributed innovation management infrastructure are based on two major components. The first component is a phase model. This phase model needs to be dynamic and follows a non-linear process. The second aspect relates to the concept of collaboration. The hypothesis is that more and more companies need to become involved in collaborating networks. This will have consequences for their innovation management approaches. Collaboration clearly means that companies need to share information (communication aspect), they need to have suitable co-ordination mechanisms in place (co-ordination aspect) and they should have a good technical cooperation infrastructure (at least a common platform or maybe in the future an integrated plug-and play interoperable infrastructure).

Figure 4 summarises an exemplarily system infrastructure in collaborative networks. Single enterprises using a collaborative innovation environment are synthesised in a common distributed innovation management system. If such teams have to collaborate in networks they do not only need methods and tools but also a common innovation strategy and an aligned understanding of the collaboration mechanisms.

Document management has been perceived as a central aspect for distributed innovation management. The experience in practical settings showed that too much time is used in innovation projects just to identify information. This gets even more dramatic if several distributed partners have to collaborate.

## 4. IMPLEMENTATION OF DISTRIBUTED INNOVATION MANAGEMENT CONCEPTS IN INDUSTRY

The authors suggest an approach for the implementation of non-linear innovation strategies in organisations implementation process that takes the actual situation, structure, and stakeholders into account. Generally the integrated methodology covers the organisational implementation and the supporting IT infrastructure.

The process comprises seven tasks that are incorporated in four main phases. These are visualised in Figure 5. The four phases are requirements, design, implementation and usage of the innovation methodology in the organisational structure.

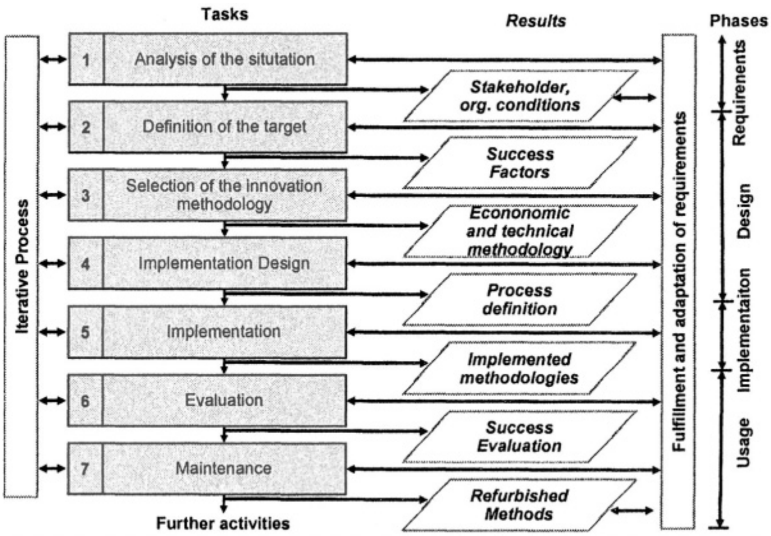


Figure 5: Proposed implementation process for innovation methodologies

## 4.1. Requirement Phase

In the requirement phase the as-is situation in the organisation is analysed. Basis for this survey are the business processes, organisational structures working situation, knowledge management (skills etc.) and technological and market position of the organisation. Additionally, a survey on the existing IT environment beyond the proposed infrastructure provides the status quo for the implementation of an IT infrastructure to support innovation management. This is extended by a survey on the stakeholders influencing the individual worker, organisational units and strategies.

Derived from the strategy of the organisation the success factors related to innovation are identified. This success factors help to evaluate the design of the distributed innovation management approach.

## 4.2. Design Phase

Based on this analysis the aims for the innovation management in the organisation are sketched. The business key success factors are the driver for the target definition for the organisation. They reflect the strengths and weaknesses of the organisation and provide a guideline for the innovation strategies. The target definitions for the innovation management cover for example *Areas of innovation (product oriented, technological, production oriented, services), Organisational implementation, Conditions (Time, Costs, ...), Agility, Trust and Governance.*

Based on the targeted definitions and the identified success factors the different methodologies and technologies are selected and designed. Therefore the innovation management implementations process branches into two parallel sub-processes, which cover organisational and infrastructural topics. In the organisational branch the optimal innovation methodology is identified. This goes parallel with the planning of supporting technologies. The technology has to support the selected methodology and the methodology selection has to take the supportive technological infrastructure into account. The available methodologies and technologies are benchmarked by the identified success factors.

The design of the organisational and technological implementation is at least as important as the right selection of the methodology and technologies are. This is crucial for the costs, time, dissemination and acceptance of the methodology. The implementation can either be top-down by providing the infrastructure and processes definitions or bottom-up by a gradual change of the personal involvement into the innovation process or mixed approaches.

### 4.3. Implementation Phase

In this phase the innovation methodology and supportive infrastructure are developed and implemented. It is important to spend attention on the organisational as on the technological aspects. The implementation process should be structured into dedicated short steps and should provide feedback cycles to adapt the designed innovation management approach. Here feedback questionnaires and rounds and the control of progress on the identified process factors are useful tools.

### 4.4. Usage Phase

After the implementation of the appropriate innovation management methodology and supportive technological environment the achieved results have to be controlled and improved. Especially in changing organisational environments like virtual organisation an ongoing adoption and improvement of the innovation management is required.

## 5. CONCLUSIONS

The previously highlighted methods of innovation management enhance the traditional concept of simple invention by provisions for successfully implementing the inventions as/ into new products, services, and production methods. Existing methodologies and technologies for distributed Innovation Management are facing the fact that innovation starts with a distributed and creative process. Nevertheless most of the approaches are based on linear approaches which do not seem appropriate. Indeed the players in the innovation process are driven by external influences and different stakeholders in daily business.

Distributed Innovation Management in collaborative networks creates new requirements for both the innovation methodology itself and an approach for implementing a distributed approach into a network. In this paper a generic infrastructure is introduced which can support a variety of innovation methodologies.

Consequently, this is followed by a methodology for the selection and implementation of innovation management by selection of the proper methodologies and supportive IT-infrastructure in parallel. The innovation methodology takes into account existing innovation management methodologies and is based on a generic requirement specification for supportive infrastructures.

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