Application of Design Elements for an Engineering Community in a Multi-sector Engineering Company

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ABSTRACT

The efficient and effective engineering of industrial plants has a high impact on the success of numerous companies. Core of engineering activities is to accurately cover the requirements of the customer and design and build a perfectly fitting solution. Due to the one-time character of these projects, time and money can be saved by a reuse of knowledge from former projects as well as a strong methodology to execute these complex projects. The need for an efficient exchange of knowledge and further development of engineering methods (e.g. resource planning, training concepts, cross-country collaboration) has been recognized by many companies on a top level. At the same time there is currently no consistent approach, how to involve the experience of a broad engineering community in the development and implementation of efficient methods. This work describes an approach which closes the gap between a grown "community of practice" and a top-down initiative for the development of engineering methods and structured knowledge exchange. It ensures the deep involvement of experienced engineers from a vivid community for exchange and feedback. Three formerly described design principles (stakeholders, infrastructure, content and activities) of a community-based initiative have been applied to in a multi-sector engineering company.

1. INTRODUCTION

The competitiveness of plant engineering companies is highly determined by the ability to exactly gather the requirements of the customer and engineer a perfectly fitting solution since engineering defines costs for purchasing components as well as installing the plant. For that reason, engineering is a key success factor in the value chain. Due to high complexity in engineering projects, the use of adequate methods is an important lever to reduce time and costs as well as to improve quality. Those methods are, e.g., efficient resource planning, training concepts, cross-country collaboration. [1]

The implementation and further development of these methods affects the daily work of engineers and therefore requires their intensive involvement as a whole community. Currently there is no consistent approach how to build and manage a broad engineering community with focus on exchange and further development of engineering methods. This also includes a sustained integration from strategic to operative level.

A suitable solution is seen in the combination of a grown "community of practice" and a top-down structured, strategic initiative as an enterprise network. As a first approach, three key design principles (stakeholders, infrastructure, content and activities) were developed and discussed in a former paper [2]. These principles are an extract from the 7-S framework developed by Waterman, Peters and Philips and serve as an orientation for establishing such an engineering community [3]. This work focuses on the results of a comprehensive application of these three principles in a multi-sector engineering company.

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2. THEORETICAL BACKGROUND

The following sections provide a deeper understanding of plant engineering business and its current challenges as well as a literature review on the research fields "communities of practice", enterprise networks, and strategic initiatives.

2.1. ENGINEERING OF INDUSTRIAL PLANTS

In this paper plant engineering is seen in the context of EPC (Engineering, Procurement, and Construction) business. The engineering part in projects (e.g. a complex automation system) consists of all technical related activities, processes and tools for the realization of a customer-specific solution [4]. The process to realize an industrial plant is characterized by the involvement of numerous different players (e.g. customer, engineering service provider, component supplier) and a large number of domains. For that reason, along the whole process there is a large number of interfaces where all involved parties have to collaborate efficiently (see figure 1). At the same time, everyone who is involved in that process has to provide specific knowledge and experience from similar projects.

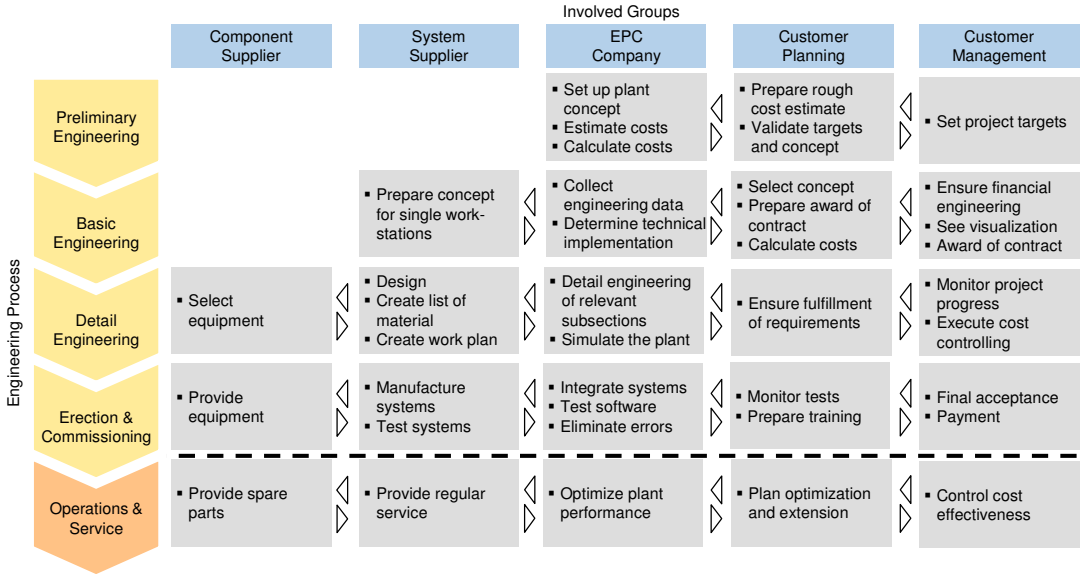

Figure 1. Simplified plant engineering process, on the basis of [5].

A survey among engineering top management was conducted in 2012 and 16 statements on the topics engineering approach, knowledge, synergies and employees were evaluated. Figure 2 shows that statements related to engineering methods and establishing an engineering community are among the five top rated.

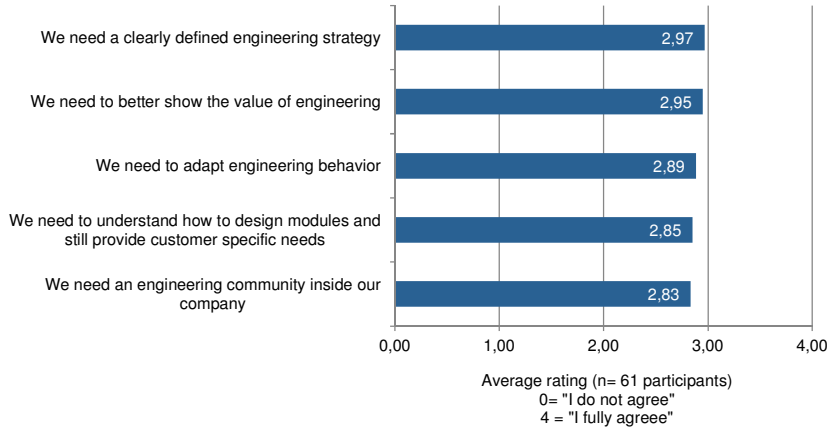

Figure 2. Top five plant engineering challenges.

2.2. COMMUNITIES OF PRACTICE, NETWORKS AND INITIATIVES

Three fields of research have been identified to provide the theoretical background for community-based knowledge exchange, collaboration, and target-oriented development. Only by considering all of these fields it is possible to elaborate an integrated community approach with focus on the exchange and development of engineering methods.

Communities of Practice

The term "Communities of Practice (CoP)" was originally used by Lave and Wenger when they analyzed and described the learning of groups in different cultures. The results were published in the book "Situated Learning" [6]. With the spread of web technologies and the formation of virtual groups in the internet the term "Communities of Practice" has been transferred to the virtual world and now describes the collaboration of people in virtual communities.

In this context, a large number of literatures were published in the past years, so a comprehensive overview cannot be provided here. Dubé, Bourhuis, and Jacob for example issued a typology of virtual communities of practice, while the work of Zboralski focuses on the benefits of CoPs [7][8]. For supporting the use of communities, Wenger and Snyder provided instructions for managers. [9]

Enterprise networks

Enterprise networks describe another kind of collaboration, which happens within or across companies. There are different definitions in the literature; the three following definitions point that out.

According to Wagner, enterprise networks serve as a knowledge pool. By the use of internal capabilities companies extend the knowledge base and create the basis for successful innovations [10]. Another definition focuses on the cooperation of companies based on clear agreements. Thereby, operational tasks are merged, while each partner remains independent [11]. Sydow defines enterprise networks as coordinated collaboration between several independent companies [12]. It is fundamental for the existence of the networks, that companies subordinate individual targets [12].

Strategic initiatives

Strategic initiatives are an important way to implement new approaches into a company. Menz et al. define strategic initiatives as specific and temporary measures which have significant influence on the strategic development of the company and which provide a possibility to define new targets [13]. Mueller-Stewens and Lechner define the management of initiatives as part of the enterprise strategy [14]. Strategic initiatives or strategic programs are coordinated measures to influence the development of a company. According to Gilbert, the focus of initiatives is located in fundamental and promising opportunities of the company to achieve clearly defined results within a given period [15].

3. PROBLEM STATEMENT AND APPROACH

To improve the efficiency of plant engineering companies, the exchange and further development of engineering methods is a key success factor. Since the experience of the involved engineers is crucial, a broad community has to be integrated. Currently there is no consistent approach how to involve a broad engineering community, set strategic focus for the further development, and efficiently share results and best practices.

A suitable solution is seen in the combination of a virtual community of practice and a strategic initiative to an enterprise network while considering the characteristics of a project-related plant engineering business and its employees. Such an approach can only be implemented by achieving a strong integration from strategic to operative level combined with a solid organizational basis.

4. APPLICATION OF DESIGN PRINCIPLES IN A MULTISECTOR ENGINEERING COMPANY

In an earlier work three key design principles for such an engineering community have been derived from similar approaches. In a research project these three principles (content & activities, stakeholders, and infrastructure) have been applied to the setup of a company-wide engineering community. [2]

The targets of the community are

- Establishing a common engineering understanding,
- Enabling (best) practice sharing, and
- Supporting (global) collaboration by developing a framework of proven practices, methods and processes.

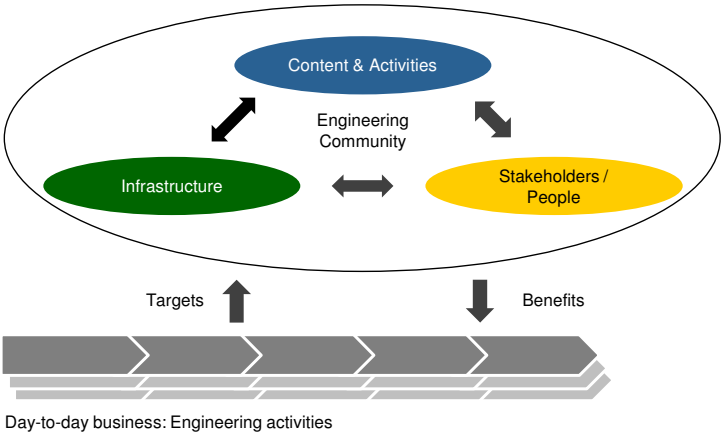

Figure 3. Design principles for an engineering community [2].

The following sections provide an overview about results from the application of these principles in a practical example. The focus of this example is to build a company-wide engineering community to collect, share and further improve engineering methods. When implementing this engineering community, aspects from virtual communities of practice, strategic initiatives, and enterprise networks were considered.

4.1. STAKEHOLDERS

Motivated employees are a key success factor for a community. Therefore, in an earlier work a stakeholder model consisting of three dimensions has been developed. It consists of the dimension of the community (internal or across companies), the participation in activities, and the position of a stakeholder in the company. [2]

In the underlying example, the focus was set on establishing an internal community. Therefore, three stakeholder groups were defined based on the position of a stakeholder in the company (see table 1). These groups were composed for several reasons:

- Preferences in communication
- Knowledge and experience
- Expectations from the community

Table 1. Stakeholder groups.

Group	**Description**
Engineering Heads	Engineering Heads are the highest authority in charge of engineering in a company. In a multi-business company there are numerous Engineering Heads, each with responsibility for a single Business Units.
Engineering Group Leaders	Engineering Group Leaders represent lower and medium management level in an engineering organization. They are, for example, responsible for staffing and multi-project management.
Engineering Work Level	Engineering Work Level represents the large majority of engineers dealing with day-to-day engineering projects. That means solving technical issues, integrating subsystems, and coordinating administrative tasks (schedules, costs) during project execution.

Not all groups are able or willing to participate at the same extend. To consider that and to structure the work within the community, different roles have been defined. By implementing these roles, each member can decide on its own how to contribute. This allows a tailored participation in the community.

Moreover, participation in the community is voluntary and therefore requires a good relation between effort and benefits. This can be ensured by providing different roles. Table 2 shows an overview of roles as well as a description of the related tasks and expected efforts.

Table 2. Roles in the community.

Role	Description of tasks	Expected effort
Advocate	• Verification and confirmation, that the topic has a significant business impact • Feedback and approval of content	• 1 Meeting per year (Engineering Council) • Some topic related conversations
Contributor	• Involved in topic, interacting with innovation project • Contributing experience, examples, good practices	
Work Group Member	• Participating in the work group • Discussion of topics, content, approach • Feedback on content (1st approval level)	• Regular meetings (3-6 per year) • Topic related conversation incl. request for feedback or comments
Supporter	• Acting as interview / sparring partner • Sharing experience, requirements, practices	• "On demand": Interview, phone call or invitation to a topic specific workshop (3-4 h)
Participants	• Participation in events of the community, but no active involvement in work groups • Possible lead-users of results from work groups	• Attendance at events • Distribute news from the community
Central Team	• Moderation of work group • Management of innovation projects • Elaboration, documentation and provision of content (methods, guidelines, policies, etc.)	• Work packages, work steps and desired deliverables to be defined in the project plan

A significant proportion of the work to develop engineering methods takes place in project-like work groups. These work groups are the basis for collecting, structuring and further developing best practices and require strong contribution of experts from work level (as Work Group Member or Supporter).

In order to reduce work load of the experts (customer projects are usually more important that internal projects) and thereby allow a concentration on the actual topic, a central team to perform a major proportion of project work was established. It is sponsored by management and responsible for management, moderation and documentation. This structured approach is no typical element of a virtual community of practice, but part of a strategic enterprise initiative.

4.2. CONTENT AND ACTIVITIES

The participants are integrated in the community in two different ways. A topic specific motivation is in place for "Engineering Group Leaders" and "Engineering Work Level". A prompt work on methodical day-to-day problems or the willingness to share experience makes participants willing to contribute. For that reason, experience exchange events are conducted with a focus on providing a platform for direct exchange and to attract people for collaboration in work groups.

The stakeholder group „Engineering Heads" is especially involved in setting the strategic direction of the community as well as promoting the work of the community. Therefore, known deficits in engineering businesses are discussed and upcoming challenges in engineering are raised. This takes place in the Engineering Council and leads to

a guidance function for the community. In addition to that, "Engineering Heads" are a key to distribute the results of the community, to motivate the employees for active participation, and to gain attention at central management.

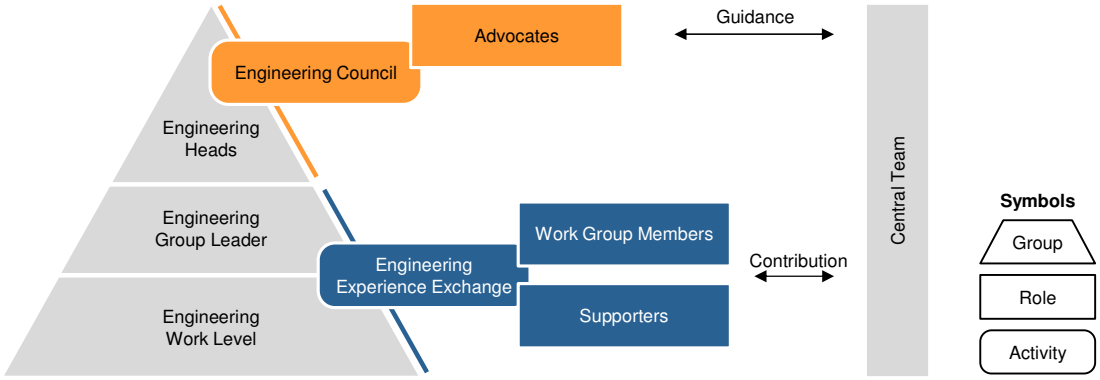

Figure 4. Groups, roles and related activities.

In the underlying example at the multi-sector engineering company topics like standardization, modularization, or engineering training have been raised by management. Special experience events were conducted and several work groups have been established in order to integrate the whole community. To widely spread the achieved results, a publication of guidelines and best practices takes place.

Table 3. Communication concept.

Media	Bi-directional communication	Timeliness	Marketing function	Ease of implementation	Personal contact	Ranking
Website	-	+	+	+	-	1
Wiki	+	+	-	-	-	2
Newsletter	-	+	+	+	-	1
Face-to-face events	+	-	+	-	+	1
Online-Meeting	+	-	-	+	-	2
Discussion Board	+	+	-	-	-	2
Blog	-	+	-	+	-	2
Flyer	-	+	+	+	-	1

To support the work of the community, a detailed communication concept has been elaborated. Based on the requirements of the different stakeholder groups different types of media were analyzed and rated. Table 3 shows an overview of the assessment and a ranking as result. The four types of media ranked with "1" have been selected and successfully implemented.

4.3. INFRASTRUCTURE

An adequate infrastructure is essential for efficient work in the community. Therefore, communication, collaboration and establishing the community must be supported by using adequate IT-tools. These tools are widely spread in virtual communities of practice, but must be fitted to the boundary conditions. Since one single system cannot fulfill all requirements, three different tools were integrated (figure 5). In addition to that, a good usability of the platforms must ensure the acceptance of the users.

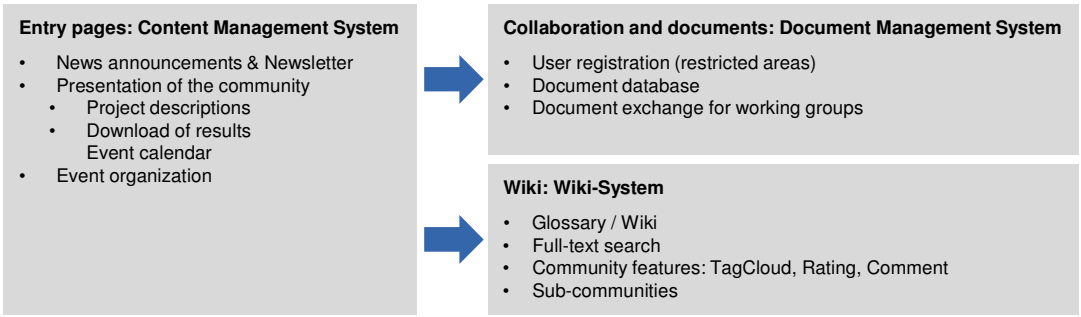

Figure 5. System landscape for the engineering community.

Communication

The communication part of the community has been established using a content management system. This enables a consistent appearance of the community to the interested stakeholders by providing newsletters, announcements, project descriptions, event organization, etc.

Collaboration

To support an efficient collaboration within the community a document management system has been implemented. This provides the possibility to easily share documents, but also to collaborate in restricted user groups when creating new methods or guidelines. Moreover, the system is also used for best practice sharing by uploading and characterizing useful documents.

Community

The virtual community itself is supported by a wiki system. Based on a wiki system, users can easily contribute, rate, and comment on the entries of other people. It also provides the opportunity to establish new sub-communities and to support networking of the participants.

5. EVALUATION

A good indicator of interest in the community is seen in the number of direct participants in the community. This includes the number of participants in experience exchange workshops, the number of engineering heads involved in the Engineering Council, and members of the different work groups.

Table 4. Direct participantion in community events.

Direct participants	**2011**	**2012**	**2013**
Participants in Experience Exchange Events	81	154	205
Participants in Engineering Council	-	-	11
Number of Work Groups	-	1	3
Number of Work Groups Members	-	8	32

Table 4 shows a constant rise of direct participation in the engineering community. This especially applies to the number of participants at the experience exchange events as well as the members of the established work groups on important engineering topics.

6. SUMMARY

By implementing the engineering community according to the three design principles (stakeholders, content and activities, infrastructure) a constant growth of the community was achieved. The community now consists of elements from communities of practice to bring together experts with different backgrounds but also considers the setup of strategic initiatives. This allows a strong focus on methodical engineering topics and ensures strategic direction. Moreover, it is the basis for a sustainable development of engineering while creating a clear differentiation to technical, subject-specific communities.

The elaborated stakeholder concept together with different roles for participation in the community allows a continuous optimization of communication and a satisfaction of the stakeholders' demands. The integration of people from all levels and a regular feedback provides the opportunity to continuously enhance tasks and processes of the community.

Further potential is especially seen in a quicker integration of engineers in order to provide a fast solution of major methodical issues. An increased use of social web technologies has been tested, but first results show major challenges in discussing those complex issues using this media. Therefore, in a first step an improved process with focus on structuring engineering challenges will be prepared and a quick integration of experts based on a dedicated expert network will take place. In a second step, this process will be redesigned using a larger proportion of social web tools.

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