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Abstract

Purpose – Companies create company-specific production systems (XPS) by tailoring generic concepts to fit their unique situation. However, little is known about how an XPS is created. This paper aims to provide insights into the creation of an XPS.

Design/methodology/approach – A retrospective case study was conducted in a Norwegian multinational company over the period 1991–2006, using archival data and interviews.

Findings – The development of the XPS did not start with a master plan. Instead, dispersed existing initiatives were built upon, along with an external search for novel ideas. Widespread experimentation took place, only later to be combined into a coherent approach. Once established, the XPS was disseminated internally and further refined. The CEO orchestrated the experimentation by facilitating the adaptation and combination of different concepts and by allocating resources to institutionalize the XPS in the global network.

Originality – This paper is the first to study how an XPS is created. Our study contributes with novel empirical insights, and it highlights the role of top management in facilitating experimentation and step-by-step organizational learning.

Keywords Company-specific production systems (XPS), Toyota Production System (TPS) Sociotechnical systems (STS), Organizational learning.

Introduction

Netland (2013) introduced the term "company-specific production system" (XPS) to describe how companies create standardized improvement programmes that are adapted to their own strategies and environments. An XPS is described as an "own-best-way approach to the one-best-way paradigm" of operations management: a strategic and long-term programme, shared within the global production network, creating a common platform for improvement. The central idea of an XPS is to combine and adapt existing organization concepts to fit the unique situation of the company. However, neither Netland (2013; 2014; 2017; Netland and Aspelund, 2014) nor subsequent empirical research on XPS (Boscari *et al.*, 2016; Osterman and Fundin, 2018; 2020) offer any analysis of how an XPS comes into being. The same holds for the closely related notion of "corporate lean programmes" (Powell and Coughlan, 2020a). Hence, the extant literature offers little managerial advice on how to create an XPS, limiting the practical applicability of the XPS approach.

This article responds to these shortcomings by asking:

How is a company-specific production system (XPS) created?

A retrospective case study was conducted in a Norwegian multinational, covering the XPS development from the initial phase when the company realized a need to focus on production performance, to the final implementation and institutionalization of the XPS in the company's global network.

The findings indicate that the company managed to create a long-lasting improvement programme "meant to sustain the emphasis and focus […] over a long time" (Netland, 2014, p. 131). The creation process did not follow a master plan. There was no systematic evaluation of the company's uniqueness, and most concepts were tried out based on emerging, mostly unrelated, initiatives in the organization. Furthermore, incorporating

and adapting the concepts were done through experimentation by different stakeholders. Experimentation led to a widespread learning process in different parts and levels of the company, lasting for 14 years. After the incubation phase, the learning was orchestrated by the CEO, enabling the organization to adapt and combine the concepts, and ultimately to integrate a final XPS.

This paper is, to the best of our knowledge, the first to study how an XPS is created. Our study contributes novel empirical insights, and it highlights how the process of creating an XPS is one of experimentation and step-by-step organizational learning. Correspondingly, the role of the top manager is one of orchestrating learning by facilitating local experimentation and ensuring that lessons learned are codified and disseminated.

Creating an XPS

Within the existing literature, an XPS is thought to have three main characteristics. However, beyond some general assessments in Netland's work, how these characteristics matter for the creation process has barely been addressed.

First, an XPS is a long-term, strategic programme (Netland and Aspelund, 2014). In contrast to temporary improvement projects, an XPS is supposed to be *infinite* – that is, it is intended to "sustain the emphasis and focus across the global operations networks over a long time" (Netland, 2014, p. 131). Therefore, the creation of the XPS is done centrally in the organization, where the "headquarters offer a shared system for the global production network" (Netland, 2014, p. 128). The XPS is also supposed to be supported by top management and to bring consistency and durability to improvements in all plants within the company. However, the XPS literature does not offer any analysis of the content of the top-management support, although it is considered crucial for the

programme's success (Netland, 2013; 2014). Similarly, studies of lean-inspired transformation recognize top-management support as a vital factor for the success of such transformations, but they have rarely detailed the content of this support (Holmemo and Ingvaldsen, 2016; Marodin and Saurin, 2013; Netland *et al.*, 2019). Therefore, top-management support for the creation of an XPS needs to be examined empirically.

Second, an XPS combines proven principles from different organizational concepts. Although "lean" appears to be the dominant source of inspiration for XPS design, Netland pointed out that industry-specific characteristics mean that particular lean elements may not be appropriate in a certain industry, whereas "non-lean principles" may be suitable (2013, pp. 1092–1093). Despite this conceptual understanding, Netland (2014) empirically found that few XPS contain unique, non-lean principles.

Third, in an XPS, concepts are adapted to a company's strategies and environments. Not all principles suit all companies due to differences in production set-up, plant size, technology, organizational culture, and other contingency factors (Hekneby *et al.*, 2021; Sousa and Voss, 2008). Netland (2014, p. 129) addressed the issue by giving an example of a batch producer of aluminium selecting a production principle of "optimized flow" instead of "just-in-time", because the former is more suitable for a process industry. The adaptation of the concept is here related to the production set-up (Hayes and Wheelwright, 1979). Moreover, with reference to Sousa and Voss (2008), Netland implied that a more extensive contingency view should be taken when analysing uniqueness. However, the XPS literature gives no precise description either of which variables should be examined or of how the tailoring process proceeds.

The creation of an XPS might resemble how the original Toyota Production System (TPS) concept was created, even though the latter often serves as the main inspiration for the

former. The TPS was also built on pre-existing concepts, primarily those associated with US mass production and with unique Japanese influences, which were combined and adapted to fit challenges facing Toyota from the 1930s onwards (Benders, 1998; Fujimoto, 1999; Holweg, 2007). The evolution of TPS reveals an extensive and prolonged process of experimentation and organizational learning. Its results and insights were synthesized into a "production system" only at a relatively late stage of development.

Research Design

Presentation of case company

Our study examines Elkem ASA, a Norwegian multinational company. Elkem is one of Norway's oldest industrial companies, with over 100 years of experience within the electrochemical process industry. Elkem started out as an engineering company selling the Söderberg electrode to the global market. From 1950, Elkem gradually became a producer of aluminium, ferroalloys, and later silicon materials, changing the company's focus from technology and engineering to running large-scale production (Sogner, 2014). Today (2020), Elkem consists of three business divisions – silicones, silicon products, and carbon solutions – and has 31 plants around the world. Elkem's main production can be classified as a highly automated process production with large volumes of standardized products. Most of the plants are organized around a single main material flow, which diverges mostly in the final phases of the value stream.

With its origins in Norway, Elkem has adopted values from the Scandinavian working life tradition, which is characterized by extensive worker participation and collaborative industrial relations (Ingvaldsen, 2013). With its global expansion, including factories in China, Brazil and South Africa, the company is exposed to a wide array of national cultures and social institutions.

In 1990, Elkem was on the brink of bankruptcy. Net income had dropped to an annual deficit of 700 million NOK and the company's debt was more than 6 billion NOK. Elkem also struggled with safety and workplace conditions, due to outdated production facilities and a lack of strategy for future growth and investments. Indeed, the consensus among central Norwegian officials in 1990 was that Elkem belonged to a dying industry and that its prospects of survival were poor.

Today, Elkem is a world-leading company within the electrochemical industry and is considered one of the most successful fully integrated silicone manufacturers in the world. It has become a global leader in silicon and micro silica, a leading manufacturer of special alloys for the steel industry, and a world-leading supplier of carbon materials and specialized carbon products. Elkem currently has 6,370 employees worldwide and its revenues amount to more than 25 billion NOK (2019). Workplace conditions are considered to be of world-class standard, with a rate of only 2.1 injuries per million working hours in 2019.

Within Elkem's top-management team, the evolution and success of Elkem are often traced back to the company's strategic initiative in the 1990s that involved developing the Elkem Business System (EBS), the company's own XPS (Sogner, 2014):

> *We are confident that it was the right choice to develop and implement EBS because we have seen the results of our improvement in the company's KPIs [key performance indicators]. Increased production volume, uptime, silicon quality, sales volume and, of course, safety.* (Top managers, Elkem top-management team, 2017)

Hence, according to Elkem, the creation of the XPS was an important contribution to the company's turnaround and business success in the period 1990–2020.

Data collection

A retrospective case study (Yin, 2014) was conducted in 2019 and 2020 to capture data on how the EBS was created. We used purposive sampling to identify the most central people involved in the XPS creation process. Data were collected from four main sources:

- Interviews with the top managers working in Elkem from 1991 to 2006, including the CEO, HR director, the EBS director, and several other managers involved in the creation process.
- Interviews with today's top-management team at Elkem, including the CEO, HR director, division directors, EBS director, and central actors related to the EBS. The interviews were followed up with several emails to further investigate the themes emerging from our analysis.
- Four workshops with central actors related to the creation of the EBS.
- Archival data from EBS educational material from 1990 to 2020, combined with observations and participation at the EBS University in September 2017.

In total, 21 interviews were conducted, using a semi-structured approach. Each interview lasted between 1.5 and 2 hours. Interviews were structured around seven main topics (see Table I). Questions were developed based on the main topics in the XPS literature: (1) the strategic dimension, including support from top management; (2) concepts in use; (3) how concepts were selected, adjusted, and tailored to the company.

Table I. Interview guide

Main topic and question	**Elaborative questions**
Introduction Describe your background and relation to Elkem and Elkem Business System.	Background? Formal position? Experiences with EBS?
Creation Overall, describe how the EBS was created in Elkem.	Time frame? Main events?

Concepts Which concepts were used in the creation process?	Origin of the concepts? History of introduction?
Tailoring process How were the concepts adapted to the company?	Evaluating company needs? How concepts were implemented? Impact on the organization?
Top management Describe the role of top management in the process.	Precise description of top management support? Importance for the creation process?
Important events or persons Are there any important events or persons in the creation process that should be mentioned?	Concepts? Events? Persons?
Closure Is there something important information regarding the creation process not addressed?	What is forgotten? Who should be contacted for further information?

Data analysis

All interviews were transcribed and, together with the archival data, sorted according to the timeline. Elkem created its XPS over a period of 14 years, with different individuals bringing in different ideas and concepts. The data were analysed based on Langley's (1999) suggestion to use "temporal bracketing" to understand organizational change processes. If there is a certain continuity in activities within a period, temporal bracketing might be used to facilitate the examination of how actions in one period change the context of action in subsequent periods (Langley, 1999, p. 703). This strategy led us to cluster our data in four main, successive phases (see Figure 1). We then analysed the data within each phase with respect to three main themes from the literature on XPS:

- Which concepts contributed to the XPS?
- How were concepts combined and adapted to company-specific conditions and needs?
- How did top managers support the creation of the XPS?

This strategy of data analysis allowed us to build a "process model" (Cloutier and Langley, 2020) of XPS creation – that is, a reconstruction highlighting the main events and activities, and how they relate. Hence, we could understand how concepts were selected, combined, and adapted, as well as top management's role in the overall process. The findings were brought back to and validated by key respondents (Yin, 2014).

Findings

Introduction and time phases

To describe the creation process, it seems reasonable to set the starting point as 1991, because it was then that a new CEO entered the company, later to become the main sponsor of the business system. The XPS emerged in a series of new ideas and experimentation over a 14-year period. In 1999, the experimentation ended in consolidation and a formal decision to establish the EBS. The final content of the EBS was established in 2006, bringing a vital concept of critical process management to the final principles and the written material that contributed to the institutionalization of the XPS.

The creation process can be structured into four main phases. Even if there is some overlap, each phase represents a different stage in the development (see Figure 1). We have labelled these four phases as:

1) *Crisis*: the first period mostly stemmed from desperation and a strong focus on survival.
2) *Inspiration and experimentation*: in this period, Elkem was introduced to several new ideas and concepts, inspiring and changing the focus of top management. Elkem started to experiment with the different concepts in the different plants and divisions, resulting in significant, yet distributed, organizational learning.

3) *Consolidation*: in 1999, Elkem integrated and combined the different concepts, and formally established the EBS.
4) *Institutionalization*: the final content of the XPS was implemented, and a plan for institutionalization was developed.

In the following subsections, we present each phase in detail. Table II presents an overview of the main findings.

Figure 1. Creation phases of Elkem Business System

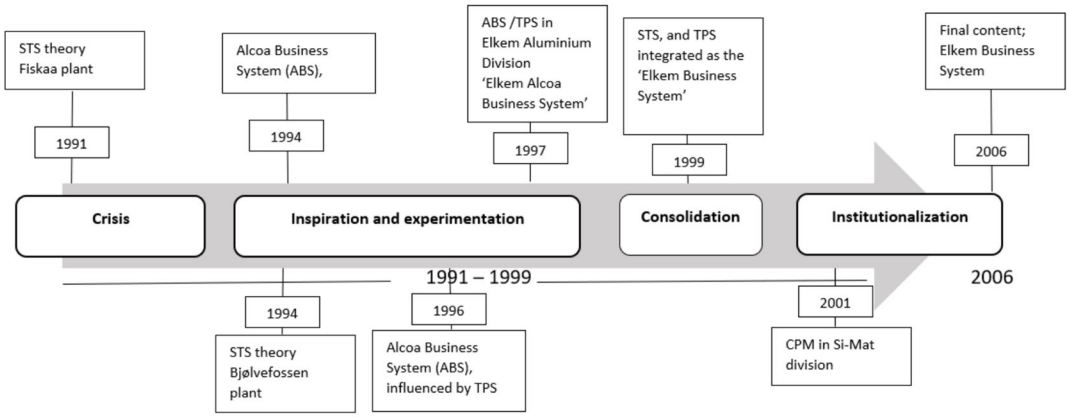


Table II. Key findings

XPS variables	Phase 1: Crisis	Phase 2: Inspiration and experimentation	Phase 3: Consolidation	Phase 4: Institutionalisation
Concepts used	STS at Fiskaa plant, 1991	Alcoa Business System (ABS), influenced by TPS, 1994 STS at Bjølvefossen plant, 1994 ABS/TPS in Elkem Aluminium Division, 1997 STS on management team in 14 Elkem plants, named the Elkem Management Forum, 1996	STS and TPS combined in the Elkem Business System, 1999	Critical Process Management (CPM) integrated into Elkem Business System, 2006

How were the concepts adjusted and combined to meet the company's unique needs?	STS was introduced through a national action-research program. No explicit adjustment, pragmatic use.	The inspiration to learn more about TPS was based on a strong belief in ABS as a "rescue package". TPS was neither tailored due to an extensive analysis of contextual variables nor picked accordingly. But initiated by several stakeholders, allowing different parts of the organisation to experiment with the concepts	Converting written material from Elkem Alcoa Business System to Elkem Business System	The CPM concept was selected based on an evaluation of the environment in the upstream process in the electrochemical industry, and it was implemented accordingly
How did top managers support the creation of the XPS?	No role. Unaware of the ongoing STS process in Fiskaa plant	Sponsor – creating belief in ABS as a rescue package; allocating resources for experimentation. Orchestrator – handling the process of experimentation and learning, adjusting concepts to the company`s needs; handling resistance.	Orchestrator – combining the different concepts, making a formal decision to create the Elkem Business System (EBS).	Allocating resources for institutionalisation

Phase 1: Crisis

The first phase of the XPS creation process mostly related to handling a fundamental crisis in the company. There was no formal decision to create an overall production system; rather, a cost reduction programme was the management's focus. However, one plant began experimenting with a totally different concept, which became a pillar for the XPS.

Concepts in use

In 1991, Elkem consisted of 25 wholly and partially owned production units in Norway, Iceland and North America, with approximately 5,000 employees, of whom two thirds were in Norway (Aslaksen, 1999). The globalized economic market had developed significantly, with newcomers (China and Russia) flooding the western European market with low-price products of acceptable quality (Aslaksen, 1999). In the home market, the

Norwegian government introduced new power regulations, which forced Elkem to pay more for hydroelectric power and led the company to realize that it was unable to utilize its production equipment and human resources to the standards required to be globally competitive (Aslaksen, 1999). These contextual elements were to become decisive in the emergence of the XPS over the following years.

When a new CEO was appointed in 1991, the company was on the verge of bankruptcy. The company had to cut costs, and extensive staffing reduction programme was implemented in the early 1990s. The firm relied heavily on consultancies to implement cost reduction programmes, to initiate employee reduction, and to sell off assets.

In parallel, a quite different concept had already been introduced to Elkem in 1990 by an action researcher. Working for the Norwegian government to promote modern organizational design, she was the first to introduce the sociotechnical systems approach (STS) (Trist, 1981), which was combined with Norwegian work-life norms of broad worker participation in organizational development (Emery and Thorsrud, 1976; Ingvaldsen, 2013). The "Fiskaa plant project" in Kristiansand marked the start of a long-term collaboration that was to have a decisive impact on the development of Elkem's final XPS. This project was not part of the ongoing cost reduction programme; rather, it aimed to develop a participatory work organization and to enhance the internal capacity for organic change in order to increase productivity and improve the quality of work-life (Aslaksen, 1999). The project required employees to participate in all activities, and there was a clear link between the project and the factory's long-term strategy. The project started with a gap analysis and the broad involvement of the organization. Trade union representatives, operators, chairmen, representatives from operations and maintenance, top management, and various staff members participated. Several groups (task forces)

were established, and they were given responsibility for coordinating the improvement work between the meetings to ensure active participation throughout the organization.

Two significant lessons emerged from the project. First, the project demonstrated that an alternative work design might be superior. Changes involved using semi-autonomous teams and decentralized decision-making for operators (Aslaksen, 1999). This contributed to internal discussion and configuration, which related to empowerment in the EBS. Several organizational alternatives were constantly discussed and tested throughout the 1990s. Second, the project showed that when developing an organization and implementing a participatory work design, the set of principles or fixed solutions is not sufficient on its own. Because they challenge the plants' existing power structures, the ideas had to be made operational and tested in practice, and arenas for learning (i.e., cross-functional teams) across the organization had to be created (Aslaksen, 1999). This knowledge of empowerment and practical experimentation was later used to tailor different concepts to suit the company's uniqueness, ultimately becoming the EBS.

Tailoring concepts to meet the company's needs

The cost-cutting programme was based on the fundamental need for company survival, whereas the STS project was initiated with funding from the Norwegian government. In fact, the Fiskaa project was not on the radar of the top manager until 1994.

Data indicate that the STS concept was not initially tailored to suit the company's needs. The concept was introduced by the Norwegian government as part of its Industrial Sector Programme. Responding to the main challenges facing the processing industries in Norway, the programme aimed to create a more flexible work organizations, utilize the competence of the workforce, and improve the work environment (Aslaksen, 1999). Instead of deploying cost reduction actions directed by top management, all parts of the plant's organization were involved in establishing targets and actions (Aslaksen, 1999).

An important task within this process was to involve the shop floor in using new sensor technology in the production line (Aslaksen, 1999). The knowledge of empowerment was later used to tailor the concept of TPS in Elkem's aluminium division.

The Fiskaa plant was invited to participate in the programme in 1990. In return, the plant had to demonstrate interest among both the employers and the employees in working towards increased participation and sharing of their experience with other plants in the Industrial Sector Programme. Therefore, the STS concept was selected on the recommendation of an external programme rather than as a result of an evaluation of whether it was a "perfect fit".

Top-manager support

The CEO of Elkem seemed to have little knowledge of the STS initiative at the Fiskaa plant until 1994, when he met the action researcher.

Phase 2: Inspiration and experimentation

In this phase, new concepts inspired the main stakeholders in Elkem to change the focus from cost reduction to product quality in order to re-establish trust in Elkem as a profitable company. In addition, widespread experimentation with different concepts for improving production performance was initiated across the global network. This fuelled significant learning within the company.

Concepts used

In the 1990s, Elkem jointly owned two plants with Alcoa (Lista and Mosjøen). In 1994, through collaboration with Alcoa, Elkem's recently appointed CEO was introduced to Alcoa's XPS, the Alcoa Business System (ABS) (Kolesar, 1993). As early as 1980, Alcoa

had begun sending managers and other technical personnel to Japan to learn how improvement work should be carried out. The new CEO received direct information from Alcoa about their exploration of TPS principles in the process industry, and in 1994 Elkem sent its first manager to Alcoa to be trained. He returned with a training programme and a clear concept of improvement work in the processing industry. The training programme created considerable enthusiasm and faith among the managers in Elkem. In retrospect, the CEO acknowledges that an important reason why the ideas from Alcoa became inspirational was that Elkem's stakeholders at the time felt a strong sense of urgency. Even top management was not convinced that the company could be rescued, and there was a lot of negative publicity about Elkem and the wider industry in which it operated:

> *To be completely honest, the reason that [EBS] became a success was that it came out of desperation. Even top management was not convinced that the company could be salvaged.* (Former CEO of Elkem interviewed in 2019)

The training programme was, therefore, considered a "rescue package", and, in 1995, Elkem started the process of creating its own training programme, in addition to sending more people over to Alcoa to learn about TPS and the basic principles of ABS.

Tailoring concepts to meet the company's needs

In the ABS, Alcoa had already begun adapting TPS principles to processing industries. Elkem's decision to adopt the TPS principles was not based on a precise description of contextual variables or an assessment of a "perfect fit" between these variables and the company. Rather, the TPS principles were introduced based on a strong belief that the ABS could work as a "rescue package" at a time of urgent need.

The inspiration provided by this new concept might have been related to a broader shift in focus that was taking place among manufacturers in this period (Voss, 1995). Shifting away from cost-cutting activities, the new focus was on *production performance*. Taking inspiration from the CEO in Alcoa, Elkem adopted the slogan "it's all about getting the processes under control". This slogan (and its variants) captured the new focus in Elkem and its move away from a fundamental low-cost strategy and towards a strategy of high-quality products:

> *It should be understood that this was not about cost and downsizing, but to get the process under control. That was the real breakthrough and it had much more economic effect than cost reduction.* (Former CEO of Elkem interviewed in 2019)

Alongside the new interest in applying the TPS, further experiments with the STS concept were initiated. Here, we discuss three important experiments that took place in this phase.

Experiment 1. In 1994, the action researcher was commissioned for a new project at the Bjølvefossen plant by the plant manager. Following the same structure as the Fiskaa project, Bjølvefossen began by establishing an innovation team, representing a vertical structure of the plant and called the extended management team (EMT). Top management, middle managers, division managers, engineers, operators, and the four unions were represented in the EMT. First, a gap analysis was conducted, which involved analysing external and internal contextual elements, and this was followed by the development of a long-term vision for the plant: "becoming a competitive and profitable melting plant for strategic customers" (Aslaksen, 1999, p. 100). Four task forces were then established, each being responsible for actions and competence development in the plant in relation to four areas: market situation, production, technology, and

organizational aspects. For example, the technology task force introduced the use of new monitoring technology by production operators. Plans for new technological solutions were developed, training was integrated into day-to-day operations, and the strategic choices were made with broad involvement by the entire organization. The task forces reported back to follow-up conferences, at which actions and results were shared and discussed in relation to the next integration phase.

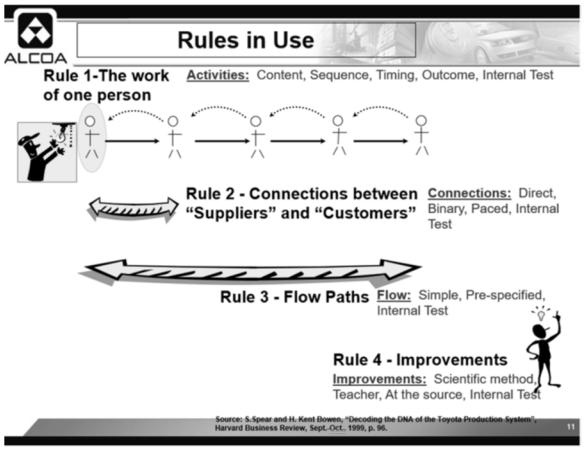
An interesting adjustment was made in the Bjølvefossen project that related to the political context of the plant. Between the second and the third follow-up conferences, the heads of the four unions had a strong sense of being held as "hostages" in the process by Elkem's management (Aslaksen, 1999). They wanted to discuss this with their members and shop stewards. The third conference was then used to bring all the unions together, and the plant manager presented the project in detail, thereby involving the unions by enabling them to contribute to further development. The outcome was that the union heads received a reinforced mandate to continue participating in the project, and the shop stewards were given more information about and involvement in the project (Aslaksen, 1999).

Experiment 2. Alongside the Bjølvefossen project, TPS principles were tried out in Elkem's aluminium division. Led by the division manager, this project had its own trajectory parallel with the rest of Elkem's organization. Together with several highly skilled operators in the two Norwegian plants, the aluminium division became a key arena for experimenting with TPS knowledge from Alcoa and adapting the concept to Norwegian conditions by removing supervisors from the shop floor and creating semi-autonomous teams. This was not part of the programme at Alcoa, where a more traditional work structure on the shop floor was preferred. This adaptation was made during the experimentation, leading to important organizational changes that appear similar to those

associated with the STS concept. Notably, in this division STS had never been introduced as a concept in itself. Rather ideas of "flat hierarchies" and "semi-autonomous teams" entered the division via their broad acceptance as good practices in the Norwegian work-life culture (Ingvaldsen, 2013) and due to the influence of the parallel projects taking place in the Fiskaa and Bjølvefossen plants.

Elkem's aluminium division produced raw aluminium, mainly electrochemically and often referred to as the "upstream process"; in addition, it also completed and processed raw material for specific customer products (the "downstream process"). Alcoa, in its collaboration with Toyota, developed two types of improvement programmes for its main processes: (1) critical process management, which focused mainly on the upstream process; and (2) ABS, which was based on TPS approaches to creating flow efficiency and waste reduction in the downstream processes. In 1998, the aluminium division established an internal training group consisting of local operators and specialists from Alcoa's headquarters. They became responsible for the experimentation and developed the first written material and training programme, which was based on Alcoa's principles. This training programme was named the Elkem Aluminium Business System (EABS) and was the precursor to the EBS. The materials described some basic principles that were eventually to constitute the basis for all improvement work in the two Norwegian plants. The training programme, in its "Rules in Use", described the relationship between an operator's standardized work process and the rest of the value chain (see Figure 2). Operator activity was to be defined in standard operational processes (SOP). The Rules in Use then defined how this operation was integrated in the value stream, creating flow between all the work processes and finally executing continuous improvement at every stage. Rules in Use, originally developed in the aluminium division in 1998, remain part of the training in Elkem's global university programmes today.

Figure 2. Alcoa's 'Rules in Use'



Initiated by the training group, the principles were implemented in the two Norwegian factories and combined with STS ideas. Central to these experiments was a young and talented operator, later to become the first head of the global XPS Centre in Elkem. For many years, he had been a full-time union representative for the Norwegian Chemical Workers' Association and had been heavily exposed to the STS concept and ideas of industrial democracy in the 1960s and 1970s (Emery and Thorsrud, 1976). He had also worked with team-based improvement work and Total Quality Management projects in other organizations and was able to use many similar methods in the new context. In 1998, he and his team started to train production operators to establish self-managed work teams. An important task in combining TPS and STS was to prepare the organization to eliminate the position of the shift supervisor. The company had found that when TPS principles were introduced, operators started to suggest improvements; however, there were significant variations in the rate of actual improvements between the different shifts. This could, according to the training group, be traced back to the shift managers. As one former shift manager explained:

> *We were used as a communication channel to communicate the problems in the system. Several managers did not take the problems further and then nothing was*

done about the problems. We then realized that the problem was the managers.

(Former shift manager Elkem plant, 2018)

Distributing the supervisors' responsibilities and tasks down to the teams required considerable effort to develop team roles and standardize the work processes (i.e., the SOPs). The ambition was to create semi-autonomous teams, guided by clear plans, defined roles, and standardized operations. In addition, the support chain and assistance functions were reshaped to meet the needs of the teams, operating only during the day. In parallel, the company implemented tools, such as 5S, Standardized Work, Visual Workplace, and Morning Meeting, which were combined with improvement teams led by shop-floor operators. During 1998 and 1999, the team-based organization was consolidated at the plants. All shift supervisors were removed, and the production line formally shifted to a team-based operating mode.

The results of the improvement initiative in Elkem's aluminium division from 1997 to 1999 is presented as a formidable production performance success by Elkem's top management today. It is argued that the processes led to significant increases in product quality and a doubling of production in the same period, resulting in significantly higher profits. This also contributed to the factories in Alcoa having, for the first time, no absences due to injuries over the course of a year; furthermore, the number of employees was reduced from 1,700 to 750 across the two factories. Perhaps the most important message was that new business areas were created in the downstream processes, securing jobs for those who had become redundant during the improvement phase.

Experiment 3. The STS concept was also tested in a third project led by the action researcher and directed at the global network. In 1996, the local plants in the global network had limited interrelated cooperation, there was a significant "top-down"

relationship between the corporate management team (CMT) and local plants, and the relationship between the main union and the CMT was strained because of the cost-cutting programme, resulting in a law suit in 1994 related to the downsizing process in one plant (Aslaksen, 1999). Given this situation, the Elkem Management Forum (EMF) was established with two main goals:

1. To create arenas for dialogue, reflection, and learning between the CMT and the plant management teams.
2. To initiate plant improvement processes to enhance global production performance.

The EMF's participants were all top managers at the plants, in total numbering 100 people in 17 management teams spread over 14 locations. The EMT project followed the same structure as the projects at Fiskaa and Bjølvefossen. It started by addressing the company vision, then the STS methodology was introduced as a tool to analyse and develop the organization, after which Elkem's approach to strategic plant development was introduced. This was probably the first time that the STS concept was introduced to all Elkem's managers. The first session ended with the preparation of development activities that were to be conducted at each plant and presented in the next session. As at Bjølvefossen and Fiskaa, several actions were initiated across the global network between the sessions, contributing to enhanced production performance using TPS and STS practices. The EMF was evaluated and, in 1998, Elkem's CMT decided to continue the project, initiating a third module of the EMT.

The experimentation phase primarily dealt with tailoring the ideas from earlier phases. We discovered no formal decisions or discussion about evaluating different concepts that could best fit the company at that time. On the contrary, decisions were made by different stakeholders, based on the *belief* that Alcoa's concept could realize the idea of getting the

processes under control and create arenas for dialogue and learning. For example, a team of Alcoa specialists was brought in to the aluminium division to conduct an initial analysis of the performance of the Norwegian plants. This "plant ABS performance audit" resulted in a presentation to the Elkem aluminium plant managers, who were immediately impressed with the analysis and the action plans for the production lines. This demonstration enhanced the willingness to implement the TPS concept, but there was no understanding or decision that the concept should be tailored to Norwegian conditions or combined with STS.

Top-manager support

Based on the data relating to the CEO in this and the following phases, he can be characterized as a strong "sponsor", a description used in Alcoa to address top managers' necessary support in the development of the ABS (Kolesar, 1993). As mentioned above, there was a significant amount of desperation among the managers in Elkem in this period. The CEO played an important role in creating faith and optimism, gradually managing to change the perspective from short-term costs to long-term improved plant performance (Aslaksen, 1999). This sponsor approach became important for internal stakeholders as well as for external investors and owners, allowing the CEO to create the final XPS.

The CEO can also be described as an "orchestrator" who coordinated the learning processes that were taking place. He did not have a master plan for an XPS; rather, he had a strong belief that the concepts and the new organizational structures introduced to him in this phase would save the company. Importantly, he allowed for experimentation. In an interview, the former CEO emphasized that he was himself immersed in a learning process in this phase and that the ideas that were developed were not from him, but from many different people across Elkem's global network.

We could not have developed the Elkem Business System if [CEO name] had not been there. He was the main architect and sponsor of the business system. (Former operator and EBS coordinator in Elkem)

Without the CEO – no Elkem Business System. (Former union leader, Norwegian Chemical Workers' Association)

One particular event seems to have been important for the CEO in this phase. He met the action researcher for the first time in 1994 at a seminar led by the HR department. After being informed about the Bjølvefossen project, his first response was:

If this concept is so fantastic, why isn't there a "forest of trees growing" in the entire company? (Action researcher, quoting the CEO)

The action researcher then presented the knowledge from the two projects, emphasizing the need for a holistic organizational development in which both technological and human resources would be developed to improve production performance. The CEO gradually came to appreciate the STS concept and decided to hire the action researcher in 1998 as head of the HR department.

The CEO visited the 30 plants across the world twice each year from 1994 to 2000 (amounting to more than one visit per week to a company plant for six years). In the early years of these visits, he began with a formal presentation of the TPS principles that stressed the importance of getting the processes under control. Later, from approximately 1996, he started to join the teams on the shop floor, participating in and observing continuous improvement, and experimenting with new organizational forms. In his interview, the CEO claimed that this became important for him because it enabled him to understand how TPS and STS could be combined at the shop-floor level. Key to this was the idea of restructuring the shop-floor organization into semi-structured teams, removing the foremen from the shop floor, and defining the role of middle managers and technical

personnel as a “help chain” whose aim was to support the value-creating process at the shop-floor level (Lean Forum, 2012).

> *The ideas [about self-managed teams] did not come from TPS and Alcoa. We developed them entirely on our own. This was brand new in our industry and we developed this completely ourselves.* (Former CEO of Elkem)

To support the new ideas that were redefining management in the company, the CEO decided to shut down administration buildings located outside the plant’s production areas. From 1996, plants were instructed to move central administration into the factory area, to further strengthen the understanding of managers as being a “help chain”. Plant managers and indirect staff were integrated into the production environment, forcing the managers to directly participate in the “quest for process stabilisation” (Lean Forum, 2012). The CEO also decided to relocate all plant board meetings to the factories. The first meeting took place in a meeting room, while all others occurred on the production floor.

Most interviewees claimed that the CEO was vital to creating the XPS, particularly in relation to the way he dealt with resistance from middle managers (Lean Forum, 2012). The CEO was described as persistent and firm in convincing the global management team and technical personnel that this was the only right way, and in imparting the message that “either you are with us or you are out”. The CEO confirmed this and claimed that such persistence was possible because of the strong support from the workers’ union.

Phase 3: Consolidation

Several meetings were held in 1999 to consolidate the final XPS. One event, in particular, seems to have been vital. The results of the experimentation were presented to the management team in a meeting in Mosjøen in 1999. The meeting was part of the ongoing

Experiment 3, described in the previous section, and it gathered the entire management team from all Elkem's plants. At this meeting, the CEO, together with the other managers, formally decided that the Elkem Aluminium Business System should be renamed the Elkem Business System (EBS) and that it should be implemented not only in production but also across all parts of the global company (logistics, R&D, supply chain, etc.). This marked the formal "birth" of Elkem's global business system and the intention to implement it across the entire organization.

One organizational initiative was vital for the consolidation: the conversion of written material from the EABS to the EBS. The EABS programme had developed a substantial number of documents. These included brochures on core values, representing the principles for production performance in Alcoa (Figure 3): "Make to use", "Elimination of waste", and "Empowered people". One important change was made in this meeting, reflecting the combination and adaptation of STS and TPS: "Processes in control and capable" was added as a central value. "Empowered people" was also regarded as a strong value describing desired management behaviour, due to its fundamental recognition of employee involvement and participation as the basis for all leadership in the EBS. Today, this value is placed in the centre to further emphasize the importance of the people dimension in the EBS (Figure 4).

Figure 3. Values of the 'Elkem Aluminium Business System'

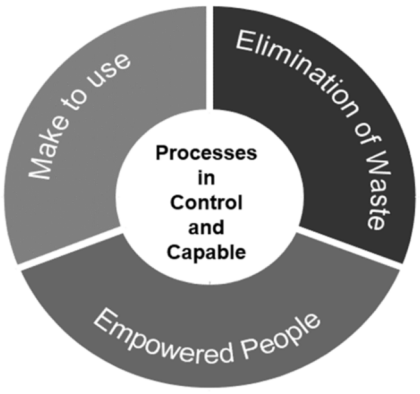


Figure 4. Values of the 'Elkem Business System' (revised)

Phase 4: Institutionalization

Concepts used

As mentioned above, Alcoa had an additional training programme within its global network that was to be integrated into the EBS. This was called critical process management (CPM), a programme that is highly compatible with TPS principles since it addresses the ultimate question of how processes can be stabilized and improved (Shah and Ward, 2007). What distinguished Alcoa's second training programme was probably the level of detail of the parameters that were measured, the attempted standardization of the upstream processes, and the more extensive use of mathematics and statistical analysis to define deviations in each period. Metallurgical upstream processes have an extensive number of variables that influence the output. For example, characteristics of the raw material, such as the moisture level, the diameter, and dust density, crucially influence the process and, consequently, the final product. To ensure stable production, these variables must first be defined, then constantly measured and monitored. Central to this is the organization's ability to ensure that the variables are identical every time (to stabilize them) and then to develop and improve the process (to make it capable).

CPM training does not seem to have received a strong focus during the early years of the EABS and EBS. But in 2001, the silicon material division in Elkem started to implement it more extensively. Despite being exposed to TPS and STS concepts over a long period, the silicon material division was still struggling to get the furnaces under control. Division managers then started hiring specialists to further develop the knowledge within the division. Finally, in 2006, both training programmes were merged into Elkem's global business system. This marked the beginning of the final concept of the EBS.

CPM knowledge, including a renewed focus on the maintenance and stability of machinery, was to have a decisive impact on Elkem's production and on the legitimacy of the final EBS. When the knowledge was established in the upstream processes, it had major consequences both for the furnaces and for production. The quality of the production increased considerably, and fewer resources were required, but, perhaps most importantly, the operators and engineers experienced the furnaces becoming more stable and less unpredictable. This directly affected working conditions on the shifts, which gradually became calmer and more controlled, with fewer "fire alarms" and other interruptions, ensuring that work could be continuous for longer periods.

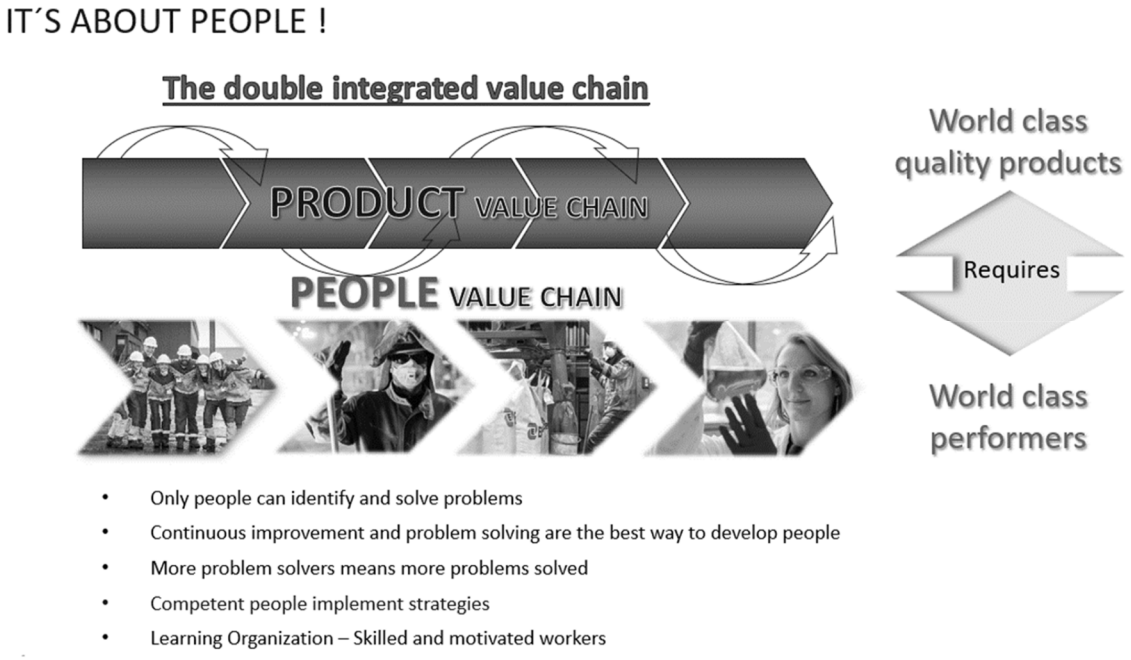
Tailoring concepts to meet the company's needs

The CPM concept was selected and implemented based on a precise evaluation of the technological environment in the upstream processes in the electrochemical industry. The silicon material division realized that the TPS and STS principles were insufficient to fulfil the ambition of getting control of the furnace processes, so they sought a complementary concept suitable for the upstream processes. This seems to have been the first time since the cost reduction programme that a concept was tailored to address a precise and identified need in Elkem.

Top-manager support

The CEO was not actively involved in implementing CPM in the silicon material division. The division manager was the main architect of this process. More importantly, however, in 1998 the CEO had appointed the former action researcher as the company's HR director. In close cooperation with her, the CEO allocated resources to institutionalize the EBS. First, a global "university" was established, securing a basic understanding of the concept in all parts of the organization. The university was based on a vital principle: it should have an equal mix of operators, managers, and technical personnel to ensure that understanding and knowledge were transferred to all organizational levels. Second, an EBS department was established, which was given the responsibility to coordinate all future activities of the EBS. Third, a global assessment programme was implemented to ensure necessary local adaptation to the concept. Fourth, a global management training programme was established. Finally, several XPS coaches were appointed to the different divisions; these coaches were responsible for international training and coordination between the XPS department and the different divisions. The institutionalization of the EBS remains a vital part of Elkem's global strategy today, and the company continues to distribute the content of the EBS to former and new plants across its global network (Authors, 2020). The 14-year learning process of integrating the STS concept with TPS is visually presented in the training material, which opens with the EBS logo: "The double integrated value chain" (Figure 5).

Figure 5. The EBS 'Double integrated value chain'



Discussion

Apart from studies on the development of the TPS, our research is the first to document and analyse the creation process of an XPS. The TPS has become a template for other companies to follow. However, our study makes clear that creating an XPS involves much more than simply copying the TPS and replacing "Toyota" with the company name. Even if the first phase at Elkem is disregarded, it still took almost a decade to develop and refine the system, and to create mechanisms to disseminate EBS knowledge at various levels within the company. While it is beyond the scope of this paper to develop a design theory for an XPS, several observations can be made that would be relevant input for such a theory. It is particularly worth emphasizing how the design process is managed: we term this process "orchestrated learning", by which we mean planning and structuring an extensive goal-directed experimental learning process.

The findings show that the creation of an XPS cannot be modelled as a linear process of strategic choice, in which the organization evaluates its external and internal environments, decides on a (combination of) concept(s), and then implements that. Rather, we interpret the creation of an XPS as a multi-level process of organizational learning. Framing the creation as a learning process helps us to be aware of activities and tensions that are easily overlooked when emphasis is put on selecting and implementing "best practices" (Powell and Coughlan, 2020b, p. 924).

First, we propose that creating an XPS involves combining "learning from the experience of others" with "learning from direct experience" (Levitt and March, 1988). Others' experiences enter as commodified organization concepts (Benders *et al.*, 2019), but also through direct linkages with suppliers, customers, or other actors in the same industry (dos Santos *et al.*, 2020; Powell & Coughlan, 2020b). The building blocks may be diverse: in the case of Elkem, some elements were international in origin, such as the ABS; others were national, such as the sociotechnical ideas promoted in the 1990s by the Norwegian government. We find that external knowledge was rarely simply adopted at Elkem; rather, it was tried out on a small, experimental scale, so that the company generated its own experience. As such, external knowledge seemed to trigger internal knowledge generation, rather than substituting for it.

Second, we propose that creating an XPS involves striking a balance between, on the one hand, searching out and generating new experience, and, on the other hand, consolidating experimental knowledge into a coherent approach to be further disseminated across the units (Argote *et al.*, 2020). In the case of Elkem, there was an alternation between local experiments and central efforts to revise the XPS content. Hence, the evolving XPS concept, with its associated departments, values, and practices, served as a repository for the organization's accumulated experience. By codifying the lessons learned, the XPS

practices functioned analogously to how an SOP should function in a learning shop-floor environment (Adler and Cole, 1993; Spear, 2004). Furthermore, by explicating values and normative commitments, the XPS retained knowledge by infusing it with a deeper, cultural meaning (Authors, 2020). Key personnel transferred knowledge by changing positions or working through parallel organization structures like the EMF. Although a "final" XPS eventually emerged from the convergences of the learning processes, it remained flexible enough to incorporate new insights, as shown by the example of CPM.

The learning dynamics in the case company are similar to accounts of how the original TPS evolved (Benders, 1998; Fujimoto, 1999) and even to how some companies transfer and adapt their management practices when expanding internationally (Ansari *et al.*, 2014; Jonsson and Foss, 2011). It also shows a "creative accumulation" pattern of organizational learning (Ingvaldsen and Engesbak, 2020), where new concepts and new insights come to supplement the old ones, rather than replacing them.

As Netland *et al.* (2019) argued, "lean leadership" must be specified in order to be meaningful. Likewise, the role of the top manager in creating an XPS and disseminating knowledge about it should be clearly outlined. In the case of Elkem, the top manager can be considered the conductor of the orchestrated learning processes. His active role started in the second phase. He inspired staff members to experiment with ideas that originated both from within and from outside the company. New initiatives were allowed to flourish in the organization, and at one point some of these were consolidated into the final XPS. Furthermore, top management allocated significant resources to secure institutionalization, and they created units to maintain, develop, and disseminate the XPS. This indicates a key awareness of the challenges of sustaining organizational change (Buchanan *et al.*, 2005).

Finally, it is worth commenting on the terms XPS and "corporate lean programme", with the latter appearing to have superseded XPS (Netland, 2017; Netland and Ferdows, 2014; Powell and Coughlan, 2020a). Netland (2013) pointed out the importance of adapting to industry-specific conditions and, in line with that, looking to "non-lean principles" (pp. 1092–1093). In our case, the latter come to the fore. More generally, the more the production processes in an industry differ from convergent repetitive manufacturing, the more important it is to look beyond lean (Hekneby *et al.*, 2021). The term "corporate lean program" does not acknowledge this, nor does it emphasize the importance of developing one's own system. In line with our position that developing an XPS is more than simply copying another XPS, and that an XPS requires an extensive orchestrated learning process, replacing XPS by corporate lean risks throwing away the baby with the bathwater.

Limitations and future research

Netland (2013) emphasized that production processes in a processing industry differ from the convergent repetitive manufacturing used by car manufacturers, arguing that contingent factors matter for the suitability of elements of the TPS and other systems and concepts for this sector (see also Hekneby *et al.*, 2021). A possible critique of the EBS, or of our account of its development, is that the company's strategic market positioning does not appear to have played a role, and hence that it was not company specific. Therefore, the EBS may be relevant for its competitors as well. Nevertheless, the EBS may still generate a competitive advantage for Elkem: it may be relatively straightforward to imitate another company's XPS, but it is much harder to get it to work internally by instructing and educating staff at all organizational levels.

An avenue for future research would be to investigate whether XPS development in other companies follows a pattern of similar phases. In our case study, experimentation largely preceded evaluation and consolidation; in other contexts, there might be stronger elements of a grand design and less room for incorporating learning from local experiments.

Future research could also explore the role of middle managers in an orchestrated learning process and their interactions with top managers in that process. Although our study has primarily been concerned with the top management, middle managers' role must be adapted accordingly for XPS programmes to be successful (Netland *et al.*, 2019).

Conclusion and Practical Implications

Creating an XPS is a process of step-by-step organizational learning. Organizations would be wise to build on established concepts, create internal arenas for experimentation, and incorporate the lessons learned into a final production system to be disseminated and institutionalized across the company.

What are the implications of this study for managers wanting to establish an XPS? First, they should appreciate that the process requires significant time, attention, support, and dedication. The duration of the EBS development process also implies that there must be consistency in top-management support. This may be easily endangered when there are changes in top-management positions. Second, top managers should stimulate the organization to pick up new ideas and actively build a network for external learning. Third, top managers should allow the organization to experiment with different concepts before the final content of the XPS is consolidated. Furthermore, they should support interaction between key persons and transfer of experimental knowledge vertically and

horizontally in the organization. Finally, top managers need to realize the importance of allocating resources for institutionalization of the XPS. The creation process is an opportunity for building shared norms in the organization.

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Declaration of Conflicting Interests

No potential conflict of interest is reported by the authors.

Endnote

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