Development Projects in SMEs

Bjørnar Henriksen, Carl Røstad, Moritz Stietencron

Development Projects in SMEs

From Project Organization to Dynamic Resource Planning

Bjørnar Henriksen[1], Carl Christian Røstad[1], and Moritz von Stietencron[2]

[1] SINTEF Technology and Society, 7465 Trondheim, Norway
{bjornar.henriksen, carl.c.rostad}@sintef.no
[2] BIBA - Bremer Institut für Produktion und Logistik GmbH
at the University of Bremen, Bremen, Germany
sti@biba.uni-bremen.de

Abstract. Innovations and rapid product introduction are keywords for competitiveness in many industries. In larger companies with R&D departments these have often been organized as projects with dedicated resources. However, in smaller companies the project organization has been challenging, as their ability to dedicate resources from e.g. operational activities is more difficult. This is more and more evident in industries where the requirements of rapid product and process development is more demanding. In several research projects, we have investigated different approaches and enablers for a more dynamic way to meet the development requirements. Keywords for these projects have been modularity, inter-organizational collaboration, product-/and process intelligence, and process integration. In this paper, we have a particular focus on how development projects could be integrated in the operations planning, where these development activities become a part of the operations when resources (personnel and equipment) need to be "co-utilized" from production.

Keywords: Product development, flexibility, operational planning

1 Introduction

Most manufacturing companies are aware of the need for innovations and continuous development. However, with limited resources and a day-to-day business (production) to take care of it is very often difficult to combine these activities, that to a large extent compete for the limited resources, such as operators, machines/equipment/raw materials. The R&D manager or project manager could have advanced project plans and very good intentions, but will often loose the battle for key resources when there is a short-term production requirement from customers. This challenge is particularly true for small and medium sized companies in competitive markets.

Customization is one of the potentially most important competitive advantages for manufacturers in high cost countries such as Norway, especially when it is combined with innovations and frequent product introductions. However, this is challenging as design and development should be combined with efficient production processes. Mass

adfa, p. 1, 2011.

customization and modularized design/production would normally be key elements in a strategy to meet such challenges. Modularization could also be a path for more efficient development processes as modules could be developed separately, thus creating less internal competition for resources. Modularization also goes "hand in hand" with outsourcing and more network-oriented business models [1]. This aspect has been the focus for the Norwegian R&D-project "Innovativ Kraft", where a network of manufacturing companies aim to share test facilities, experts and other capabilities. There have been developed several tools to facilitate such collaboration. This paper is also based on two other research projects "LIP" (Live Innovation Performance) and the EC-funded project LINCOLN[1], where the latter focuses on bringing live data to the design process while LIP focuses on organization, processes and technology for smoother collaboration between development tasks and operations.

Section 2 presents theoretical perspectives on product development and operations. Section 3 presents the R&D-projects, while Section 4 discuss more in detail how project and production could be integrated through operations planning and ICT-enablers.

2 Theoretical Perspectives

There has been a common understanding of *project* as a very suitable way to deal with a planned set of interrelated tasks to be executed over a fixed period and within certain cost and other limitations. Traditionally the project was considered a success if it delivered on time, within budget at the predefined quality. This is the famous project-triangle (time, cost, quality) [2]. This is a natural consequence of e.g. the PMI definition, where a project is seen as a unique task: "Projects are different from other ongoing operations in an organization, because unlike operations, projects have a definite beginning and an end - they have a limited duration"

Today it is more and more accepted that we need a broader set of criteria [3] (see also [4–6]). The project must also be seen in a relation to the basic organization, to assess, to which extent the project contributes to the company’s strategic goals [7]. The term "governance" is now often used to describe a transition from the traditional hierarchical management into a management structure and principles, where common values enables the sharing of responsibilities between different bodies and collaboration to achieve the goals. When we look at the relationship between the basic organization and the project, it is just new forms of governance we want [8].

Foster [9] defines “lean” as “a productive system whose focus is on optimizing processes through the philosophy of continual improvement” [9]. Lean contains a range of methodologies and tools (e.g. A3) to involve people, capture and address issues and improvement areas. One crucial insight is that most costs are assigned when a product is designed. Lean Product Development (LPD) comprises:

- driving waste out of the product development process
- improving the ways projects are executed
- visualizing the product development process

[1] http://www.lincolnproject.eu/ (accessed March 15th, 2017)

As a consequence, product development activities should be carried out concurrently, not sequentially, by cross-functional teams [2]. At the system engineering level, requirements are reviewed with marketing and customer representatives to eliminate costly requirements. *Concurrent engineering* could be a key to collaborate in projects and mobilize knowledge from different parts of the organization [2]. Concurrent engineering is the term that is applied to the engineering design philosophy of cross-functional cooperation in order to create products that are better, cheaper and more quickly brought to market. In this way, the development projects not only get a better strategic foundation, but also input of the more operational effects. In concurrent engineering product design and production processes are developed simultaneously by cross-functional teams. The reason for this is the need to capture and integrate different aspects and the voice of the customer throughout the development process [10]. Concurrent engineering has the following four characteristics [11]:

- increased role of manufacturing process design in product design decisions
- formation of cross-functional teams to accomplish the development process
- focus on the customer during the development process
- use of lead time as a source of competitive advantage

Concurrent engineering significantly modifies the sequential development (waterfall method) process and instead opts to use what has been termed an iterative or integrated development method. A significant part of concurrent engineering is that the individual employee is given much more say in the overall design process due to the collaborative nature of concurrent engineering. Giving the designer ownership plays a large role in the productivity of the employee and quality of the product that is being produced. This stems from the fact that people given a sense of gratification and ownership over their work tend to work harder and design a more robust product, as opposed to an employee that are assigned a task with little say in the general product [10]. There is a motivation for teamwork since the overall success relies on the ability of employees to effectively work together.

One of the ideas in lean product development is the notion of set-based concurrent engineering: considering a solution as the intersection of a number of feasible parts, rather than iterating on a bunch of individual "point-based" solutions. Thus, concurrent engineering is enabled by a modular product design, where resources and knowledge related to the different modules are involved concurrently at different stages of product development. *Modularity* allows part of the product to be made in volume as standard modules while product distinctiveness is achieved through combinations or modifications of modules. Modularization could bridge the advantages of: (1) standardization and rationalization, (2) customization and flexibility, and (3) reducing complexity [10].

To develop a modular product platform is a comprehensive process. It is both time-consuming and costly, and for many businesses it is a completely new way of working. Often you have to plan even further ahead than you otherwise would have done, and are thus vulnerable to radical changes in the market. If the product does not yield expected/projected results, you risk being left with an even greater economic loss than would be experienced by conventional products [12]. Figure 1 gives an overview of the involvement of different stakeholder groups in a set based concurrent engineering approach.

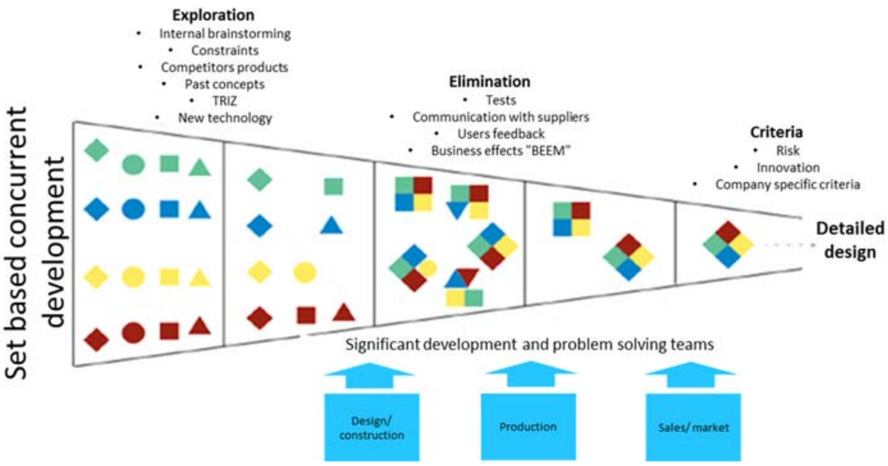

Fig 1 Involving people from different functions through set based concurrent engineering

Module-based design is when you make a product platform consisting of modules connected together via common interfaces. To take full advantage of modularization all modules should be planned in relation to replacement due to development. A good example of this is Sony's Walkman, where a good product platform with opportunities for replacement of various modules without changing the whole product, was designed. This requires time and resources for initial planning and design, but in the long run this will enable reduced development costs because they do not have to change the entire product [13]. Modularization also impacts the whole lifecycle of products as modularization enables real-life up-, side- and downgrades of products based on their use real-life in the lifecycle itself ensuring the continued use of the products [14, 15]. This is now further enabled by the possibilities of IoT, Industrie 4.0 and the low cost of sensors, computing power and data-handling and transfer. This will impact the logistics and supply-chains as well as the requirements for information systems as these now must handle not only sourcing products and services, but also customized upgrades. Thus, modularization together with the ICT-developments the later years, yields new business-areas and creation of new service-concepts.

Material requirements planning (MRP) is a production planning, scheduling, and inventory control system used to manage manufacturing processes. Most MRP systems are software-based, but it is possible to conduct MRP by hand as well. An MRP system is intended to simultaneously meet three objectives: (1) ensure materials are available for production and products are available for delivery to customers, (2) maintain the lowest possible material and product levels in store, (3) plan manufacturing activities, delivery schedules and purchasing activities. A major drawback of MRP was that it failed to account for capacity in its calculations. This means it will give results that are impossible to implement due to manpower, machine or supplier capacity constraints. However this has largely been dealt with by MRP II. Generally, MRP II refers to a system with integrated financials. An MRP II system can include finite or infinite capacity planning but also include financials. In MRP II fluctuations in forecast data are taken into account by including simulation of the master production schedule, thus creating a long-term control [16]. A further extension to purchasing, to marketing and to finance (integration of all the functions of the company), resulted in what we normally recognizes as ERP. Demand driven MRP (DDMRP) is a multi-echelon formal planning and execution technique [17].

The motivation for *Dynamic Product Development* (DPD) is that concepts must be changed continuously is that projects are not isolated from the world. Things happen all the time and concepts must simply be changed to be kept up to date. DPD has a different mind-set and is the product concept developed as long as a project runs and not just before engineering starts [18]. In this way DPD could be considered as a way to integrate projects to operations. Feedback is in DPD based on management participation for immediate and qualitative information, which facilitates control and guidance in real time, reducing unwanted surprises to low levels. Frequent solution iteration is in DPD important. The focus on qualitative data represent contrast to the recent *Industrie 4.0* paradigm, which is much more focused on quantitative data, and enabling technologies such as IoT and automated (dynamic) processes.

3 The projects

This paper is based on three projects, I-Kraft (Innovativ Kraft), LIP (Live Innovation Performance) and EU-LINCOLN. The aim for all three projects is to find new resource-efficient and dynamic ways to innovate in especially SMEs. The projects are linked to concrete product development cases in a number of industrial partners. The objects of the I-Kraft project are to create mechanisms for collaboration within a network of industrial companies. SINTEF, BIBA and Inventas are R&D-partners in all three projects.

Where LINCOLN aims to bring "live" data to product development, the objective of the LIP-project is to create the concrete processes and technology enablers for the manufacturing companies to work more dynamically with innovations, improvements and operations. The reference for this paper is the three above projects, but the main focus is on the solutions for integration of innovation, improvement and operations which are explored in the LIP project.

4 Enablers for integrating operations and development

4.1 Resource planning

Even in the larger industrial companies[2] in our projects we experiences that key resources are bottlenecks in product development. These key resources could be technical experts and foremen from production, but also managers responsible for product development. What we experience is that even if a company has a R&D manager/department) and top management well motivated for innovations and focused product development, their availability become unpredictable. Order processing is the priority and

[2] >100 mill. EUR turnover

even the managers have to take their turn on the shop floor. As a result, the general picture is that "fine-tuned" project plans have almost no value, and even smaller projects are in general delayed for months.

An initial Value Stream Mapping (Figure 2) showed a potential for increasing efficiency in production. Even though the VSM seems close to industrial "standards", the value-added time should be increased, and waste reduced. We learned that much could be addressed to the production planning, scheduling and the priority of orders.

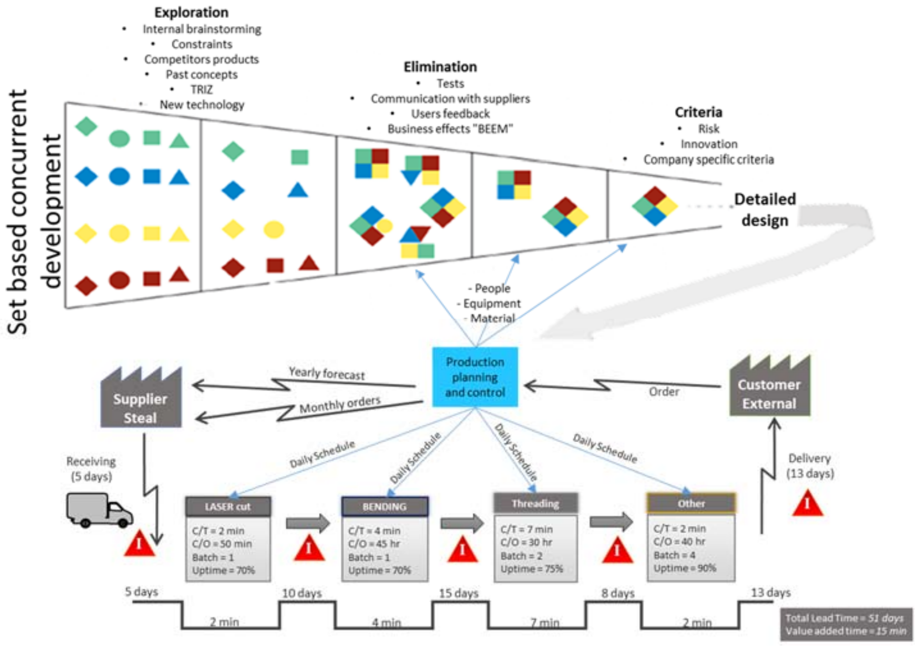

Fig 2 Integrated resource planning – production and development

The case companies investigated could to some extent be considered doing DPD, as managers and key resources are very flexible. However, this flexibility seems to go only one way as the development projects almost always have to be set aside in favor of day-to-day business. However, as we see from the VSP, there are room for more value added time, time-and resources that could be made available for development projects. Our focus have been how to capture the "waste" and find practical ways to convert it to projects or value creation at a longer horizon through:

- more robust production planning: horizon, capacity etc in MRP
- performance measurement, related to production planning and projects
- waste reduction, bottleneck planning

More discipline in order processing and prioritizing, e.g. using replanning and use of unnecessary overtime as indicators. The other important element in resource planning is to integrate projects and development in the production planning through capacity adjustments and/or making project deliverables as elements in production planning.

4.2 Enabling ICT

The case company in Figure 2 has - over a three-year period - implemented an ERP-system, but met a classical problem of misfit to the real life of the company. Not all modules have been implemented and parts of the organization and processes have been omitted from the ERP-solution. Projects and the project module are such an example. The ICT solution just doesn't fit the processes in the company and therefore has not been implemented. The approach in the I-Kraft project has been to improve the production planning and the data quality in the MRP-system, focusing on bottlenecks and reducing need for rescheduling. The aim is to free resources that could be scheduled for development projects.

The project has tested several tools and solutions and one of them is a very simple app that can be used on all platforms and is sky-based. The rationale for this specific test was to see how easy one can actually track and communicate tasks and activities in internal development projects. Findings and previous experience from such internal development projects in this setting indicates that you can't use larger/complex project management systems as these requires too much management and updating, thus immediately lose their validity as development work starts. The experience so far is very good as this is so easy to use that everyone can join. Both the development teams (including external companies involved) and operators in the production use and apply this simple app on their smartphones. We have also moved some information from mailboxes to the lists that are established and they are therefore accessible to everyone. The lists in the simple app have limited functionality, but this seems to be the big advantage when you have to limit yourself and it does not grow in size so you can not keep it up to date. We think this way of working is especially good for smaller projects with autonomous teams without appointed and dedicated project managers.

IoT also represents a window of opportunities for making both production and projects more dynamic. Smart products and smart processes could process messages and knowledge to operations and development projects, making them both more dynamic and robust. These opportunities and constraints are focus in LIP and LINCOLN, where important issues are related to data quality, filtering and presentation of key data.

5 Conclusion

In modern production customization and flexibility is more and more important as well as continuous improvement and development. In this dynamic context we see that the traditional demarcation between operations and projects are more and more erased. What we need, is to find ways to plan and use common resources and capabilities. In three projects, we have studied challenges in development projects and seen how project plans and milestones have had to be changed as priorities have been on day-to-day business and operations. A more robust and efficient production planning could free resources to development tasks. We also believe that simple ICT tools such as "to do lists" could be more fruitful for creating this dynamics, than big ERP-systems, in particular in SME's. There are still much research to be done in our projects and elsewhere to verify the above, and to give strong recommendations.

Acknowledgements. The research leading to these results has received funding from the Research Council of Norway within the projects "Innovativ Kraft" (project no. 235708) and "Live Innovation Performance" (project no. 25666) as well as the European Union's Horizon 2020 research and innovation programme under grant agreement No *727982*. The contents of this paper reflect only the authors' view and the Commission is not responsible for any use that may be made of the information it contains.

References

1. Henriksen B, Røstad CC, Naume C (2016) Modularization Fact-Based Design to Increase "the Room to Maneuver." 6th International Conference on Information Systems, Logistics and Supply Chain ILS Conference 2016, June 1 – 4, Bordeaux, France (in Press)
2. PMI Project definition. http://www.pmstudy.com/about-PMP/project.html. Accessed 15 Mar 2017
3. Jugdev K, Müller R (2005) A retrospective look at our evolving understanding of project success. Project Management Journal 36(4):19–31.
4. Atkinson R (1999) Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. International journal of project management 17:337–342.
5. Pinto JK, Slevin DP (1988) Project success: definitions and measurement techniques. Project Management Journal 19(1):67–71.
6. Wateridge J (1998) How can IS/IT projects be measured for success? International journal of project management 16:59–63.
7. Lim CS, Mohamed MZ (1999) Criteria of project success: an exploratory re-examination. International journal of project management 17:243–248.
8. Andersen ES (2010) Prosjektet som en temporær organisasjon. MAGMA no 2
9. Foster ST, Ganguly KK (2007) Managing quality: Integrating the supply chain. Pearson Prentice Hall Upper Saddle River, New Jersey
10. Jo HH, Parsaei HR, Sullivan WG (1993) Principles of concurrent engineering. In: Concurrent engineering. Springer, pp 3–23
11. Smith RP (1997) The historical roots of concurrent engineering fundamentals. IEEE Transactions on Engineering Management 44:67–78.
12. Rosenblatt A, Watson GF (1991) Concurrent engineering. IEEE SPECTRUM 28:22–22.
13. Ericsson A, Erixon G (1999) Controlling design variants: modular product platforms. Society of Manufacturing Engineers
14. Sanchez R, Mahoney JT (1996) Modularity, flexibility, and knowledge management in product and organization design. Strategic management journal 17:63–76.
15. Mehrsai A, Henriksen B, Røstad CC, Hribernik KA, Thoben K-D (2014) Make-to-XGrade for the Design and Manufacturing of Flexible, Adaptive, and Reactive Products. Procedia CIRP 21:199–205.
16. Waldner J-B (1992) CIM: principles of computer-integrated manufacturing. John Wiley & Sons
17. Ptak C, Smith C (2011) Orlicky's Material Requirements Planning 3/E. McGraw Hill Professional
18. Ottosson S (2004) Dynamic product development—DPD. Technovation 24:207–217.