Enterprise-wide Value Stream Mapping: From Dysfunctional Organization to Cross-Functional, Collaborative Learning and Improvement

D. J. Powell[1,2], C. P. F. Bartolome[2]
[1]SINTEF Manufacturing AS, Horten, Norway
[2]Norwegian University of Science and Technology, Trondheim, Norway
(daryl.powell@sintef.no)

Abstract - **A value stream is defined as the set of all the specific actions required to bring a product through the three critical management tasks of any business: the problem-solving task, the information management task, and the physical transformation task. However, a headlong rush into adopting lean tools and techniques on the shop floor has resulted in the improvement of the information management and physical transformation tasks only, and has led many organizations towards a state of static process optimization rather than one of sustained lean growth. In this paper, we draw on practical insights from a multiple-firm action research initiative in two companies to present an alternative method for value stream mapping that also incorporates the problem-solving task. This technique has allowed the organizations to achieve not only sustainable improvement in operational performance, but also significant growth in people productivity. What emerged was a product-centric approach to cross-functional learning and improvement, which has implications for both lean theory and practice.**

Keywords - **Lean Production, Value Stream Management, Continuous Improvement**

I. INTRODUCTION

Lean Production was popularized as an alternative approach to production management in the 1990s. In *The Machine that Changed the World* [1], the Lean Production paradigm was presented as five parts of an holistic system: *Dealing with the customer, designing the car, running the factory, coordinating the supply chain* and *managing the enterprise*. This means that Lean Production is a system. One cannot simply cherry-pick parts of it, but must rather build the integrated system of product-, process-, people-, and partner (supplier) development. However, Lean Production has in many instances simply been reduced to something just for factory operations and shop floor management.

Though many companies the world over look towards lean thinking and practice to find a way to engage employees in continuous improvement, [2] suggests that, unfortunately, there is usually something missing in these efforts. A typical *lean implementation* often begins with a value stream mapping (VSM) exercise – to analyze the process of converting raw materials to finished goods – to "lean out" the process from the bottom up. Though these efforts often lead to quick wins, they are by no means sustainable, and things often have a habit of returning quickly to the status quo. We suggest a primary reason for this is that companies attempting to replicate Toyota Motor Company's success often limit their efforts solely to the implementation of shop floor best practices.

As such, VSM has become one of the default tools for organizations embarking on a lean journey. Spawning from what is referred to as Big Picture Mapping or Material and Information Flow Mapping at Toyota, VSM was popularized in the book *Learning to See* [3], which unfortunately covers only the "door-to-door" production flow inside a plant. Though this is perhaps a good level at which to begin a "mapping and lean implementation effort", many companies neglect to scale up their efforts in order to see value streams across the entire enterprise, focusing simply on *value analysis* (to solve delivery problems in the existing production system) and disregarding *value engineering* (solving deeper engineering problems to improve the designs of existing and future products to better fit both the capabilities of the production system (e.g. design for assembly, design for manufacturing) and the needs of the customer) [4]. For example, more recently, [5] highlighted the Toyota Product Development System (TPDS) as the key to Toyota's success, suggesting that an overemphasis on Toyota Production System (TPS) alone has resulted in many failed lean transformations in the West. [5] presents TPS as an "*efficient duplication system*" and indicates that it is in fact a combination of the Shusa (Chief Engineer) System, the concept paper, and the Obeya management system in the product development process that is the real secret behind the success of Toyota – through deeply understanding the needs of the customer and thereby creating constancy of purpose and cross-functional clarity and alignment throughout the enterprise.

[6] reframes the original lean ideal as a *Lean Strategy*, consisting four integral parts: *Higher customer satisfaction, better products, improved production processes* and *tighter supplier integration.* [7] also presents a Lean Product-Process Development (PPD) model as five core elements: *Understanding customers and context* (creating the right product), *process excellence* (delivering with speed and precision), *exceptional people* (high-performance teams and team members), *capturing and applying know-how* (creating the learning organization), and *product excellence* (pursuing product perfection). These two works are significant as other previous models and frameworks for Lean Production have unfortunately overlooked the significance of the product dimension (for example, [8]

978-1-5386-7220-4/20/$31.00 ©2020 IEEE

presents Toyota's 4Ps as *philosophy, process, people & partners,* and *problem-solving*). One disadvantage, however, is that [7] is very much framed as a product development system, where in fact it essentially consists of all of the elements described as the complete Lean Production system in [1].

In this paper, based on the practical insights from a multiple-firm action research initiative, we present an alternative, product-centric approach to the traditional form of VSM with its process focus. The enterprise-wide approach to VSM encompasses the organization in its entirety, with the aim of fostering end-to-end, cross-functional collaboration, learning and improvement rather than static process optimization *per se*.

II. VALUE STREAM MAPPING

A value stream can be defined as "*the set of all of the specific actions required to bring a specific product (whether a good, service or, increasingly, a combination of the two) through the three critical management tasks of any business: the problem-solving task running from concept through detailed design and engineering to product launch, the information management task running from order-taking through detailed scheduling and inventory, and the physical transformation task proceeding from raw materials to a finished product in the hands of the customer*" [9 p.19]. Developing the capability to see, understand, manage, and improve value streams as they cut across the different functions (often starting from traditional, functionally organized enterprises) is therefore fundamental for realizing the true promise of lean thinking and practice.

As such, VSM has become one of the default tools for organizations embarking on a lean journey and a core requirement for effective *Lean Management*. However, traditional VSM efforts often fail to cut across such functional borders, typically covering only the "door-to-door" material- and information flows inside a plant [3], or indeed focusing specifically on one business process at a time, for example product development [7]. This results in lost opportunities for organizations to improve the many issues that can be found at the interfaces between functions – for example between Research and Development and Engineering, Engineering and Production / Supply Chain, Production / Supply Chain and Sales, and Production / Supply Chain and Customer Support. Thus, a major weakness that we observe in this traditional approach to VSM is that many companies neglect to scale up their efforts in learning to see value streams in their entirety, i.e. scaling efforts from what [9] define as the *information management* and *physical transformation tasks* to also include the *problem-solving task*, as well as capturing additional important information once the product has indeed found its way into the hands of the customer, what we shall refer to as the *maintenance and end-of-life tasks*. This effort requires input and collaboration spanning the entire organization to encourage and assimilate learning and improvement across the entire organization, rather than simply realizing static process optimization in isolated business functions.

While VSM is a powerful tool for improving manufacturing / production workflows [10], we advocate that it is even more powerful when used to visualize entire value stream "work systems", uncovering organizational disconnects and unnecessarily complicating business processes and practices, that are otherwise unknown to other functions / stakeholders and which make for a dysfunctional organization. This is particularly relevant for engineer-to-order (ETO) manufacturers that exhibit project-based production systems, and do not typically possess highly linear material and information flows [11].

Therefore, in the following sections, we develop and present an alternative approach to VSM as a collaborative, enterprise-wide initiative to see, understand, manage, and improve value streams in their entirety.

III. RESEARCH DESIGN

Given the practical nature of the research, we adopt a multiple-firm action research design [12] for our enquiry into the development and application of a product-centric VSM approach at the enterprise level. Action research can be considered as a reflective process of progressive problem solving led by individuals working with others in teams or as part of a community of practice to improve the way they address issues and solve problems [13]. As such, the authors have led a "reflective problem-solving process" with an ETO manufacturer. We take insight into the lean transformation activities of two firms within a multinational corporation providing hi-tech. solutions to the maritime industry, having actively participated in both the development of the tool and the subsequent mapping exercises that took place.

IV. THE NEED TO ADVANCE BEYOND TRADITIONAL VSM

[11] suggests that swim lane diagrams are a visual management tool that can be used to visualize value streams in ETO and take into account non-linear and returning material and information flows, as an alternative to traditional value stream maps. As such, a brown-paper mapping technique was developed to visualize enterprise workflows using swim-lanes. This was subsequently used by the cross-functional teams to identify improvement opportunities within and between the organizational functions that constitute product-centric value streams.

TABLE I
Research sites

Company	Location	Size (No. employees)
1	Canada	45
2	UK	20

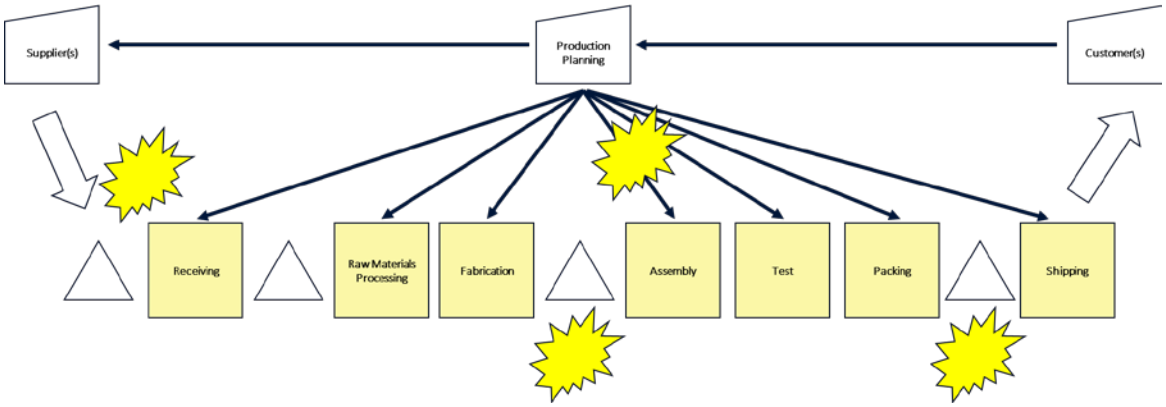

Fig. 1. Current-state value stream map.

We studied the adoption of this tool at two firms, after they experienced that the results of the lean implementation had begun to stagnate after just three years (2015-2017). For example, the cost of poor quality had reduced by 60-80%, and on time delivery had also improved to a similar degree. But the companies were yet to realize the true promise of Lean Production.

Although VSM had been used from the outset, this had previously focused only on the door-to-door material and information flow using a traditional VSM format. To advance the lean transformation, the companies recognized that something more than shop floor process mapping and isolated improvement were required. The swim-lane mapping technique was adopted to map product-centric value streams, encompassing all business functions throughout the enterprise. The major differences between traditional VSM and the enterprise-wide VSM approach are described in the next section.

V. ENTERPRISE-WIDE VSM

A traditional, current-state value stream map can be seen in Figure 1. Notice the linearity of the door-to-door material and information flows, as well as the 'kaizen bursts' (improvement suggestions arising from the mapping exercise). From such a current-state map, one would typically continue to develop a future-state map (see Figure 2). Notice here the grouping of two cells – what we may call the fabrication cell and the assembly and test cell. The idea of course is to create continuous flow where we can and pull where we cannot. As such, in the illustration, the two cells are decoupled by an intermediate supermarket. Notice also that the assembly process has become the single pacemaker process, utilizing a pull system upstream and continuous flow downstream. This of course generates satisfactory results – increasing efficiency in the duplication process and maybe also favorably impacting the cost-of-goods-sold (COGS) on the balance sheet.

However, when we begin to adopt an organization-wide view, we quickly begin to see that there are in fact many more improvement opportunities that can be realized, some of which automatically influence the decisions and requirements that are otherwise later needed in the shop floor operations.

Figure 3 represents a simplified *enterprise-wide value stream map*. Regardless of the efforts made in improving the duplication process (here labelled Production / Supply Chain) through *value analysis*, what we in fact discovered during the action research at the two participating firms was that there is much greater potential to be realized in re-focusing the improvement efforts to include other areas of the business as well, in order to contribute towards collaborative learning and strategic improvement through *value engineering* (greater value creation) – by engaging with Product Management, R&D / Engineering, Sales and Marketing, and even Customer Support; functions which together with Production / Supply Chain constitute the product-centric value stream (and in particular the interfaces between such functions).

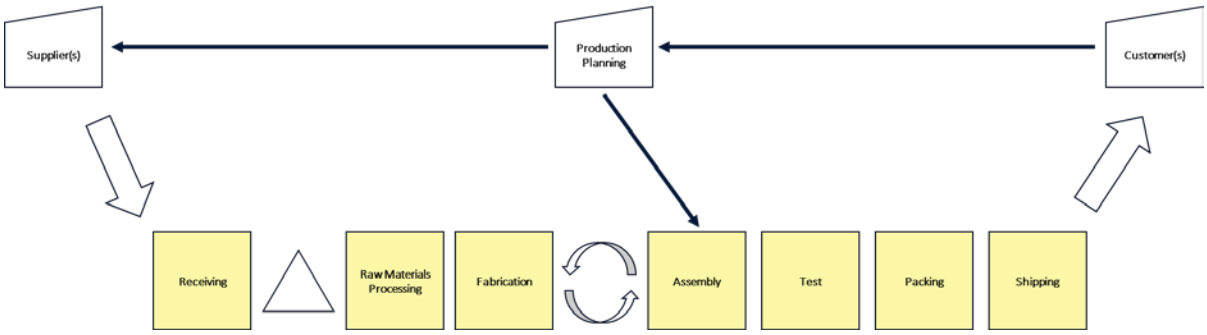

Fig. 2. Future-state value stream map.

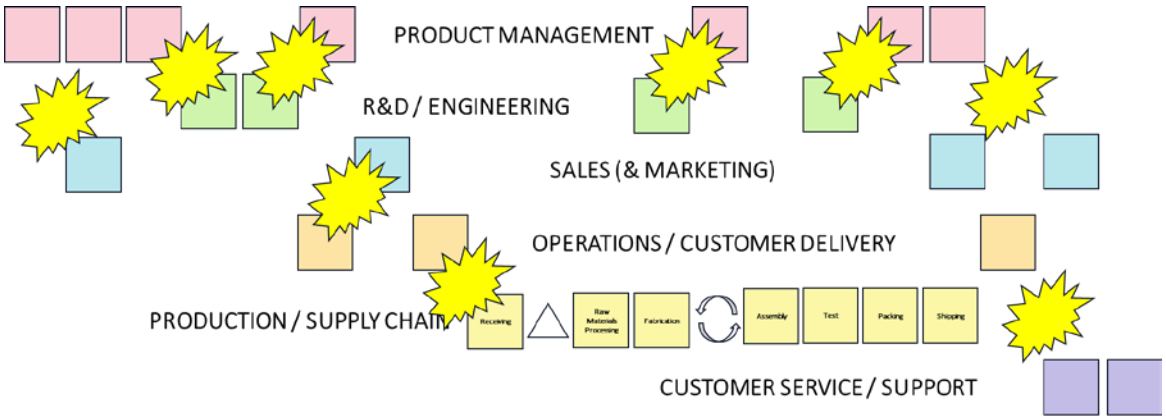

Fig. 3. Enterprise-wide value stream map.

VI. RESULTS

Following the adoption of the enterprise-wide VSM approach and subsequent engagement of the entire enterprise in continuous product- and process improvement, both participating firms witnessed a significant increase in people productivity over the next two years (2018-2019). In fact, because of the collaborative learning and improvement which emerged from the enterprise-wide VSM, the companies were able to launch several new product lines, subsequently observing growth in people productivity on the scale of 200% and 400% respectively.

VII. DISCUSSION

As [1] suggests, lean is about doing more with less – solving more of the customers problems with less resources. The two firms that participated in this action research initiative were able to realize just that – sustained lean growth. This type of growth is very much the opposite of the otherwise static optimization that one tends to realize by simply adopting a process-centric shop floor perspective during a traditional VSM initiative.

Rather than settling for the adoption of the popular "door-to-door" production process flow perspective of VSM, representatives from all business functions at the two firms (Product Management, Research and Development / Engineering, Operations, Supply Chain, Sales and Customer Support) became engaged in mapping entire "product-centric" value streams as holistic work systems – first in order to develop learning capabilities and second to further exploit the learning for strategic improvement.

The investigation also revealed that the physical transformation task and associated information management task that constitute the Production / Supply Chain function were in fact currently the most streamlined and effective "tasks" within the entire enterprise (not surprising due to the previous three years of lean implementation efforts).

However, more importantly, during the process of "learning to see" the enterprise as a complete work system, the most significant improvement opportunities appeared to be found at the interfaces between different functions (e.g. between Product Management and Supply Chain; Sales and Engineering; Customer Support and Operations), or indeed within functions other than Production / Supply Chain. This highlights the potential for adopting a more holistic approach to VSM, what we refer to as enterprise-wide VSM.

VIII. CONCLUSION

VSM is a practical and highly effective way to learn to see and resolve disconnects, redundancies and gaps in how work gets done [10]. Unfortunately, however, there has been an all-to-common focus on applying VSM as a tool for static process optimization only. By definition, a value stream map should cover all three tasks described in [9], otherwise the result is a high-resolution process map and at best a business process reengineering exercise. This is unfortunate, as [1] initially presented Lean Production as an holistic system consisting of five core parts: *Dealing with the customer, designing the car, running the factory, coordinating the supply chain* and *managing the enterprise*.

Lean has more recently been described as a learning system rather than a production system [14, 15]. As such, in this paper, we present swim lane mapping as an alternative form of VSM which can be used to engage all stakeholders in cross-functional, collaborative learning and improvement. We call the approach "enterprise-wide VSM", and like [11], we also see the potential for such a mapping technique in the ETO manufacturing domain in particular.

This article presents the yet unexploited potential for enterprise-wide VSM as a tool to foster cross-functional, collaborative value stream management – allowing all functional "silos" in an enterprise to firstly learn-to-see and secondly learn-to-learn – by seeing, understanding, and improving value streams in their entirety. We used

enterprise-wide VSM to visualize product-centric value streams as complete systems of work, rather than simply focusing on the physical transformation and information management tasks in isolation. We suggest that such a tool can be used by researchers and practitioners to promote organizational learning and improvement, particularly in ETO / project-based production environments.

ACKNOWLEDGMENT

The authors would like to acknowledge the support of the Research Council of Norway for the research program *SFI Manufacturing* and the research project *Lean Digital*.

REFERENCES

[1] J. P. Womack, D. T. Jones, and D. Roos, *The Machine that Changed the World*. New York: Harper Perennial, 1990.

[2] J. K. Liker and M. Hoseus, *Toyota Culture: The Heart and Soul of the Toyota Way*. New York: McGraw-Hill, 2008.

[3] M. Rother and J. Shook, *Learning to See*. Cambridge: Lean Enterprise Institute, 2003.

[4] M. Ballé, N. Chartier, P. Coignet, S. Olivencia, D. Powell, and E. Reke, *The Lean Sensei. Go. See. Challenge.* Boston, MA: Lean Enterprise Institute, Inc., 2019.

[5] T. Sakai, *The Secret Behind the Success of Toyota*. London: Amazon, 2018.

[6] M. Ballé, D. Jones, J. Chaize, and O. Fiume, *The Lean Strategy: using lean to create competitive advantage, unleash innovation, and deliver sustainable growth*. New York: McGraw Hill Professional, 2017.

[7] J. M. Morgan and J. K. Liker, *Designing the Future*. New York: McGraw Hill, 2018.

[8] J. K. Liker, *The Toyota Way: 14 Management Principles From the World's Greatest Manufacturer*. New York: McGraw-Hill, 2004.

[9] J. P. Womack and D. T. Jones, *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. New York: Simon and Schuster, 1996.

[10] K. Martin and M. Osterling, *Value stream mapping: how to visualize work and align leadership for organizational transformation*. New York: McGraw-Hill 2014.

[11] D. J. Powell and A. van der Stoel, "Lean Engineer-to-Order Manufacturing," in *The Routledge Companion to Lean Management*, D. J. Powell and T. H. Netland Eds. New York: Routledge, 2017.

[12] P. Coughlan and D. Coghlan, "Action Research," in *Research Methods for Operations Management*, C. Karlsson Ed. Abingdon: Routledge, 2016, sec. Action Research, pp. 233-267.

[13] E. T. Stringer, *Action research*. Thousand Oaks: Sage publications, 2013.

[14] D. J. Powell and P. Coughlan, "Rethinking lean supplier development as a learning system," *International Journal of Operations & Production Management,* 2020.

[15] M. Ballé, J. Chaize, and D. Jones, "Lean as a learning system: What do organizations need to do to get the transformational benefits from Toyota's method?," *Development and Learning in Organizations: An International Journal,* 2019.