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Lessons from *seru* production on manufacturing competitively in a high cost environment

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ABSTRACT

High capital and labor costs, coupled with high rates of technological and competitive change, present challenges for manufacturers in developed countries, often spurring them to offshore production to low cost sources. However, the electronics industry provides an exception to this trend, where dynamic, high cost conditions have given rise to a new production system – *seru* – a cellular assembly approach. *Seru* evolved as an alternative to lean systems approaches, manifesting important differentiated system design choices that appear to offer promise for manufacturing in dynamic, high-cost markets. This paper reports the results of in-depth, longitudinal case studies of two electronics giants who have implemented *seru*. The case studies describe *seru's* fundamental extensions to, and departures from, lean production, agile production, and group technology-based cellular manufacturing. We explain how Sony and Canon have applied *seru* to improve productivity, quality, and flexibility in ways that have enabled them to remain competitive. In addition, our findings elaborate the theory of swift, even flow, with implications for future research of trade-offs related to production efficiency, responsiveness, and competitiveness in high-cost, technologically dynamic markets.

1. Introduction

The past three decades have witnessed waves of offshoring by manufacturers in developed countries pursuing low-cost sources of production. Companies like Canon and Sony provide exceptions to the popular offshoring trend. Recognizing that their markets required responsiveness that extended supply chains could not provide, these companies pioneered a production system known as *seru* that has made it possible to manufacture competitively and profitably in Japan. Sony, for example, kept more than half of total production in Japan, offshoring substantially less than other Japanese global electronics companies (Nikkei Monozukuri, 2005). Producing locally has then strengthened their capacity to innovate. In ensuing years, hundreds of Japanese companies, especially electronics makers, have adopted *seru*, touting impressive benefits (Economic Research Institute, 1997). The *seru* experience provides a useful lens for understanding how manufacturing can be competitive in a high-cost economy.

The *seru* production system (Yin et al., 2008; Stecke et al., 2012; Liu et al., 2014) is a type of cellular manufacturing that is distinguished first by the cells being configurable rather than fixed; and second by its use of cells for assembly, packaging, and testing rather than fabrication alone. *Seru* is defined by its prioritization of responsiveness over cost reduction in setting the firm's operations strategy.

In this paper, we analyze the case histories of Canon and Sony, examining the factors leading to the development of *seru* systems and their successful implementations. We make use of several paradigmatic and theoretical lenses to aid understanding of these factors, including lean and agile manufacturing paradigms, cellular manufacturing concepts, and the Theory of Swift, Even Flow (TSEF,

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Schmenner and Swink, 1998). Our analysis yields a set of testable propositions that describe how and why manufacturing under *seru* can be profitable in a high-cost environment, and it identifies structural factors that may be transferable to other industries and contexts. The case studies describe *seru's* fundamental extensions to, and departures from, lean production, and explain how these companies have applied *seru* to improve productivity, quality, and flexibility in ways that have enabled them to remain competitive. Our findings also offer an elaboration of the theory of swift, even flow, along with interesting implications for future research of trade-offs related to lean and agile manufacturing approaches, and for competitiveness in high-cost locations and technologically dynamic markets.

The following sections of this paper provide a literature review, followed by Canon and Sony case analyses. We conclude by discussing how the TSEF enhances our understanding of *seru*, how our observations of the *seru* phenomenon help to elaborate the theory, and how *seru* compares to lean and agile production systems. At a higher level, our effort to build and deploy theory around *seru* emphasizes the principles of theory development summarized by Schmenner and Swink (1998) almost two decades ago. In addition, our analysis describes a possible path forward for manufacturers and policy makers who seek profitable ways to revive or preserve domestic manufacturing in high cost countries.

2. Literature review

Seru was developed to cope with high demand volatility and short product life cycles. Innovative manufacturing firms face the challenge of being *flexible* enough to handle significant process and environment variabilities, yet *efficient* enough to produce at a competitive cost. A considerable literature suggests that efficient production is best achieved through lean manufacturing, which typically seeks to reduce buffers and to eliminate demand volatility. Indeed, Krafcik (1988) coined the term *lean* as a contrast to buffered production, and researchers summarizing related literature conclude that lean assumes as an operating condition that the production schedule will be level (Narasimhan et al., 2006; Shah and Ward, 2007). In contrast, the agile production literature promotes flexibilities of many types, with the aim of creating a broadly responsive production system. Some operations-management scholars suggest that a combination of agility and leanness can permit some degree of responsiveness while maintaining the efficiency targeted by lean (Browning and Heath, 2009; Kumar et al., 2011; Mackelprang and Nair, 2010). While some argue that leanness serves as an antecedent to agility (Narasimhan et al., 2006), others maintain that lean and agile involve conflicting structures and policies which make their simultaneous deployment challenging (Hallgren and Olhager, 2009; Richards, 1996).

Interestingly, *seru* was explicitly developed as an alternative to the Toyota Production System (the precursor to lean). The developer of the *seru* concept—an expert in the Toyota Production System—concluded that implementing the Toyota Production System would not be appropriate in an innovative industry where the primary objective is to respond to demand volatility and fast product development cycles. Rather than adding agility to leanness—as suggested in the extant literature (as summarized by Narasimhan et al., 2006)—*seru* begins with the objective of responsiveness: *Seru*'s originators sought to achieve a smooth flow of a wide variety of products and volumes while using resources frugally. *Seru* exemplifies high, but strictly targeted, responsiveness (recalling the rigid-flexibility model developed by Collins et al., 1998) that explicitly chooses practices not typically associated with leanness. Thus, *seru's* agility is more limited than what is suggested in the agility literature, and its agility does not emerge from lean.

In a related work, Schmenner and Swink (1998) propose the Theory of Swift, Even Flow (TSEF), which explains how a process becomes more productive as its material and information flows increase in speed and evenness. To motivate the theory, they distinguish between *descriptive frameworks* and *theories*. Lean, agile, and cellular manufacturing are frameworks—descriptive or normative—rather than theories. As such, they provide limited insight into trade-offs in production systems. We show that the success of *seru* can be explained by an elaborated version of the TSEF. The TSEF also aids in understanding how cellular manufacturing under *seru* differs from group-technology models emphasized in the literature, and how these differences contribute to differences in performance.

2.1. A review of lean and agile manufacturing

The literature on lean and agile manufacturing is summarized by Narasimhan et al. (2006) and Shah and Ward (2007). Shah and Ward (2007: 791) define lean as "an integrated socio-technical system whose main objective is to eliminate waste by concurrently minimizing or reducing supplier, customer, or internal variability." This generally accepted definition makes clear that lean begins from the objective of eliminating waste, with reduction of variability as a primary facilitator (Narasimhan et al., 2006). In contrast, the primary objective of agile manufacturing is to develop *responsiveness,* through developing operating flexibilities such as product customization, rapid product changeovers, and efficient production scaling (Shewchuk, 1998; Goldman and Preiss, 1991). Such flexibilities conventionally reflect a production system's ability to change status within an existing configuration of pre-established parameters. In addition, Bernardes and Hanna (2009) suggest that agility adds to flexibility the ability of the operating system to rapidly reconfigure in accordance with new parameters.

Hopp and Spearman (2001) observe that, in a production system, capacity utilization, work in process, and variability should always be in balance. If, for example, variability in the system increases, either work in process must increase or capacity utilization must decrease. de Treville and Antonakis (2006) employ this understanding of "factory physics" to define lean as a system that has as its objective to reduce waste in the forms of unused capacity and in-process inventory, thus forcing it to reduce system variability. This factory-physics definition is useful to our purposes because it allows us to consider the possibility that a system could be designed to use buffers to permit variability deemed to be strategically valuable, thus creating a contrast between responsiveness (where buffers are allowed in the pursuit of strategically valuable, variable demand) and a strictly lean approach (where buffers are always to be minimized).

In their discussion of manufacturing paradigms, Narasimhan et al. (2006) emphasize the importance of distinguishing *performance* from *practices*. From the above discussion, it is clear that lean and agile performance objectives differ substantially. Researchers observe, however, that lean and agile practices overlap considerably. Practices strongly associated with lean, such as minimizing setups (and setup time), cross-training, reducing process lead times, and forging close relationships with suppliers, are also commonly associated with agile (Narasimhan et al., 2006). In addition, agile typically involves use of small-scale facilities, modularity, advanced manufacturing technologies, multi-purpose equipment, and information systems to link workers, functions, customers, and suppliers (Bottani, 2010; Brown and Bessant, 2003; Cao and Dowlatshahi, 2005; Nagel and Bhargava, 1994; Prince and Kay, 2003; Richards, 1996). While research studies identify trade-offs between operations strategies that prioritize responsiveness/

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