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The genealogy of lean production

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Abstract

Lean production not only successfully challenged the accepted mass production practices in the automotive industry, significantly shifting the trade-off between productivity and quality, but it also led to a rethinking of a wide range of manufacturing and service operations beyond the high-volume repetitive manufacturing environment. The book 'The machine that changed the World' that introduced the term 'lean production' in 1990 has become one of the most widely cited references in operations management over the last decade. Despite the fact that the just-in-time (JIT) manufacturing concept had been known for almost a decade prior, the book played a key role in disseminating the concept outside of Japan. While the technical aspects of lean production have been widely discussed, this paper sets out to investigate the evolution of the research at the MIT International Motor Vehicle Program (IMVP) that led to the conception of the term 'lean production'. Furthermore, the paper investigates why – despite the pre-existing knowledge of JIT – the program was so influential in promoting the lean production concept. Based on iterating series of interviews with the key authors, contributors and researchers of the time, this paper presents an historical account of the research that led to the formulation and dissemination of one of the most influential manufacturing paradigms of recent times.

Keywords: Lean manufacturing; Measurement/methodology; Productivity

1. Thrust and motivation for this study

The initial stimulus for undertaking a study into the history of lean production was personal interest: having joined the International Motor Vehicle Program (IMVP) at MIT as a Sloan Industry Center Fellow in 2002, I was well aware of the long history and the impact the program had through its publication of 'The Machine that Changed the World' (Womack et al., 1990). At the time the program had been running for almost a quarter of a century, and it soon transpired that – while the 'Machine' book was one of the most cited works in Operations Management (Lewis and Slack, 2003) – surprisingly little documentation was available with regards to the development of the assembly plant methodology and other key contributions that laid the foundation for the book, other than in anecdotal form. A second motivation for the underlying study came from my graduate students posing the simple yet logical question as to why the book by Womack et al. in 1990 had been so influential, given that major studies on just-in-time (JIT) manufacturing and the Toyota Production System (TPS) had been published by Schonberger, Hall, and Monden almost a decade earlier (cf. Schonberger, 1982a; cf. Hall, 1983a; Monden, 1983). As I could not provide a satisfactory answer to this legitimate question, I set out to inquire.

In a first step, I questioned the IMVP researchers who contributed to the 'discovery' of the lean production paradigm from 1979 onwards. These interviews soon highlighted a fascinating story on the organisational settings and occurrences that in retrospect might seem like logical occurrences, but in fact

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were often merely fortunate coincidences. For example, the role of the Japanese transplant operations in shaping the research agenda has been widely understated in my view. In a second stage, in order to provide a more balanced perspective, I put the same question to early writers on just-in-time manufacturing and the Toyota Production System, namely Richard Schonberger, Robert 'Doc' Hall, Yasuhiro Monden, John Bicheno and Nick Oliver. The idea was to triangulate the previous account with a less MIT-centric view of the events at the time, and to complement the historic accounts given by the IMVP researchers (selected quotes from these interviews will be presented throughout this paper, marked with an asterisk *). In addition, I consulted Takahiro Fujimoto, Koichi Shimokawa and Kazuo Wada on the evolution of production systems in Japan in order to give an accurate account of the early documents on TPS and JIT, and their availability outside Toyota. Additional secondary material was sought from the archives at the Toyota Automobile Museum and the Imperial War Museum at Duxford. Finally, I reviewed the unpublished dissertations and working papers of the IMVP researchers in order to document the evolution of thought and methodology over time.

The paper is structured as follows: in Section 2, the evolution of the Toyota Production System and its formal documentation is briefly reviewed to set the wider context, Section 3 describes the establishment of the International Motor Vehicle Program, and Section 4 reviews the development of the assembly plant benchmarking methodology that provided the basis for the 'Machine that Changed the World'. Section 5 discusses the complementing role of the U.S. transplant operations in the knowledge transfer from Japan to the Western world, before discussing the reasons behind the 'Machine' book's success by opposing the authors' and external experts' views. Section 7 briefly outlines the research at IMVP after 1990, before concluding in Section 8.

2. A brief history of time: the Toyota Production System

The evolution of production systems in the motor industry has been comprehensively covered (Hounshell, 1984; Boyer et al., 1998), as has the story of the Toyota Production System, which fuelled one of the greatest corporate success stories (Cusumano, 1985; Ohno, 1988; Fujimoto, 1999). Of interest for this study is determined at which point the production system was formally documented in the public domain, or in other words, at what point could the outside world have taken notice of the developments at Toyota.

The foundation of the Toyota Motor Company dates back to 1918, when the entrepreneur Sakichi Toyoda established his spinning and weaving business based on his advanced automatic loom. He sold the patents to the Platts Brothers in 1929 for £100,000, and it is said that these funds provided the foundation for his son, Kiichiro, to realize his vision of manufacturing automobiles. While Wada's recent analysis casts some doubt over its historical accuracy (Wada, 2004), the romantic version is that Sakichi told his son on his deathbed: 'I served our country with the loom. I want you to serve it with the automobile' (Ohno, 1988 p. 79). At the time the Japanese market was dominated by the local subsidiaries of Ford and General Motors (GM) which had been established in the 1920s, and starting Toyoda's automotive business was fraught with financial difficulties and ownership struggles after Sakichi's death in 1930. Nevertheless, Kiichiro prevailed – helped by the newly released Japanese automotive manufacturing law in 1930 – and began designing his Model AA by making considerable use of Ford and GM components (Cusumano, 1985). The company was relabelled 'Toyota' to simplify the pronunciation and give it an auspicious meaning in Japanese. Truck and car production started in 1935 and 1936, respectively, and in 1937 the Toyota Motor Company was formally formed. World War II disrupted production, and the post-war economic hardship resulted in growing inventories of unsold cars, leading to financial difficulties at Toyota. Resultant severe labour disputes in 1950 forced a split of the Toyota Motor Manufacturing and Toyota Motor Sales divisions, as well as the resignation of Kiichiro from the company.

His cousin Eiji Toyoda became managing director of the manufacturing arm and – in what in retrospect bears considerable irony – was sent to the United States in 1950 to study American manufacturing methods. Going abroad to study competitors was not unusual; pre-war a Toyota delegation had visited the Focke-Wulff aircraft works in Germany, where they observed the 'Produktionstakt' concept, which later developed into what we now know as 'takt time'. Eiji Toyoda was determined to implement mass production techniques at Toyota, yet capital constraints and the low volumes in the Japanese market did not justify the large batch sizes common at Ford and GM. Toyota's first plant in Kariya was thus used both for prototype development and production, and had a capacity of 150 units per month. The first high-volume car plant, Motomachi, was not opened until 1959.

While the simple and flexible equipment that Kiichiro had purchased in the 1930s would enable many of the concepts essential to TPS, the individual