

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 that gave the crucial impulse towards developing the Toyota Production System capable of

- Source: Holweg, M. (2007). The genealogy of lean production. *Journal of operations management*, 25(2), 420-437. Pages 421 to 423.

economically producing large variety in small volumes, was Taiichi Ohno (A^ん no Taiichi). Ohno had joined Toyota Spinning and Weaving in 1932 after graduating as mechanical engineer, and only in 1943 joined the automotive business after the weaving and spinning business had been dissolved. Ohno did not have any experience in manufacturing automobiles, and it has been argued that his 'common-sense approach' without any preconceptions has been instrumental in developing the fundamentally different just-in-time philosophy (Cusumano,1985). Analysing the Western production systems, he argued that they had two logical flaws. First, he reasoned that producing components in large batches resulted in large inventories, which took up costly capital and warehouse space and resulted in a high number of defects. The second flaw was the inability to accommodate consumer preferences for product diversity. Henry Ford himself learnt this lesson in the 1920s, when sales of the Model T dropped, as customers preferred buying second-hand Chevrolets, which offered choice in colour and optional equipment. It took Ford 1 year to introduce the Model A, while Alfred Sloan was introducing a product and brand portfolio at GM, offering 'a car for every purse and purpose' (Sloan, 1963; Hounshell, 1984). Ohno believed that GM had not abandoned Ford's mass production system, since the objective was still to use standard components enabling large batch sizes, thus minimizing changeovers. In his view, the management of Western vehicle manufacturers were (and arguably still are) striving for large scale production and economies of scale, as outlined in the 'Maxcy-Silberston curve' (cf. Maxcy and Silberston, 1959).

From 1948 onwards, Ohno gradually extended his concept of small-lot production throughout Toyota from the engine machining shop he was managing (for a complete timeline see Ohno, 1988). His main focus was to reduce cost by eliminating waste, a notion that developed out of his experience with the automatic loom that stopped once the thread broke, in order not to waste any material or machine time. He referred to the loom as 'a textbook in front of my eyes' (Cusumano, 1985), and this 'jidoka' or 'autonomous machine' concept would become an integral part of the Toyota Production System. Ohno also visited the U.S. automobile factories in 1956, and incorporated ideas he developed during these visits, most notably the 'Kanban supermarket' to control material replenishment. In his book, Ohno describes the two pillars of TPS as automation, based on Sakichi's loom, and JIT, which he claims came from Kiichiro who once stated that 'in a comprehensive industry such as automobile manufacturing, the best way to work would be to have all the parts for assembly at the side of the line just in time for their user' (Ohno, 1988, p.75). In order for this system to work, it was necessary to produce and receive components and parts in small lot sizes, which was uneconomical according to traditional thinking. Ohno had to modify the machine changeover procedures to produce a growing variety in smaller lot sizes. This was helped by the fact that much of the machinery Kiichiro had bought was simple, general purpose equipment that was easy to modify and adapt. Change-over reduction was further advanced by Shigeo Shingo, who was hired as external consultant in 1955 and developed the single-minute exchange of dies (SMED) system (Shingo, 1983).

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The result was an ability to produce a considerable variety of automobiles in comparatively low volumes at a competitive cost, altering the conventional logic of mass production. In retrospect these changes were revolutionary, yet these were largely necessary adaptations to the economic circumstances at the time (cf. Cusumano, 1985) that required low volumes and great variety. By 1950, the entire Japanese auto industry was producing an annual output equivalent to less than 3 days' of the U.S. car production at the time. Toyota gradually found ways to combine the advantages of small-lot production with economies of scale in manufacturing and procurement, but counter to common perception, this implementation took considerable time. While one might be tempted to argue that Ohno had 'invented' a new production concept by 1948, it was in fact a continuously iterating learning cycle that spanned decades. Thus, more than anything, it is this 'dynamic learning capability' that is at the heart of the success of TPS. As Fujimoto concludes in his seminal review of the evolution of the Toyota Production System:

'Toyota's production organization [. . .] adopted various elements of the Ford system selectively and in unbundled forms, and hybridized them with their ingenious system and original ideas. It also learnt from experiences with other industries (e.g. textiles). It is thus a myth that the Toyota Production System was a pure invention of genius Japanese automobile practitioners. However, we should not underestimate the entrepreneurial imagination of Toyota's production managers (e.g. Kiichiro Toyoda, Taiichi Ohno, and Eiji Toyoda), who integrated elements of the Ford system in a domestic environment quite different from that of the United States. Thus, the Toyota-style system has been neither purely original nor totally imitative. It is essentially a hybrid.' (Fujimoto, 1999, p. 50).

Astonishingly, TPS was not formally documented until 1965 when Kanban systems were rolled out to the suppliers; there had simply not been a need to do so. As Robert Hall comments, 'Toyota instructs implicitly. They cannot tell you in words what they are doing, not even in Japanese'. As a result, the development of TPS was largely unnoticed – albeit not kept as a secret – and according to Ohno only started attracting attention during the first oil crisis in 1973.

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