Reflections on “The Machine that Changed the world”

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Mass Production v. The Toyota Production System

In order to understand why the American Auto Industry was so interested in Japanese car production, you first have to look at the history of US automobile manufacturing. Many people attribute the first automobile to Henry Ford’s Ford motor company but this is incorrect. The US automobile goes as far back as 1893 with Duryea Motor Wagon Company.

The cars built at the turn of the 20th century were nothing like the cars we see today or even the cars Henry Ford became famous for. Many of the vehicles made before the founding of the Ford Motor Company were made using craft manufacturing methods. These vehicles were made to order, slowly built, complex and unreliable modes of transportation and due to the high cost of craft manufacturing, these vehicles were typically only available to more well off families.

This all changed when Henry Ford founded the Ford Motor Company in the early 1900s. Ford was a pioneer in automobile manufacturing due to his incorporating of mass production style manufacturing in the building of his automobiles. While craft automobile manufactures were building cars one by one, Ford was rapidly producing car parts to be incorporated into a final assembly line of vehicles which all used identical and interchangeable parts and for a few years even incorporated the same exterior color; black.

Mass production and the assembly line resulted in a massive increase in efficiency for manufactures but it didn’t come without a cost. Car were not customizable and the new process’ mundane and repetitive work took its toll on assembly line employees. Assembly lines also made quality assurance difficult since stopping the line for one single defect carried the cost of slowing production for all vehicles still under construction further down the line. The ultimate cost of poor quality assurance became apparent in vehicles that had to be repaired after they left the line or even after they were sold and problems were discovered by unsatisfied customers.

Japan also produced vehicles but their vehicles did not see the same initial success as vehicles from the American automobile companies that took root in Japan. This all changed once Toyota’s Eiji Toyoda and and Taichii Ohno studied the American manufacturing model to come up with a model of their own that was better suited for Japan and especially Japanese work culture. Toyoda and Ohno called this manufacturing the “Toyota Production System.”

These manufacturing methods were different in a few major ways. The biggest way was probably in the mission of the production model. The mission of American style mass production was to build as many vehicles as fast as possible while the mission of TPSs was to eliminate mistakes and flaws in manufacturing. Toyoda and Ohno realized

that manufacturing would never be perfect and they hypothesized that eliminating mistakes would create a more efficient system than one that simply makes as much as possible and fixes mistakes in the end. The TPS also pioneered the “just in time” manufacturing process where required parts are ordered when they're needed rather than being ordered in bulk and stored like the TPS’ counterpart production model required. This allowed Toyota to become extremely efficient in regards to making sure they had no excess parts and that they required a minimum amount of warehouse space.

The Toyota Production System’s differences proved themselves against the American mass production methods in regard to efficiency and quality. It was widely known that Japanese manufacturing quality was better their American counterparts and that the American automobile companies were interested in learning Toyota’s secret to increased quality and customer satisfaction. This was a factor of TPS’ just in time manufacturing, its principal of eliminating mistakes and how it empowers employees to fix problems.

The assembly line worker played a different role in the Japanese assembly line when compared to traditional American and European mass production assembly lines. Assembly line workers were encouraged to halt production and find then fix the root cause of problems when they noticed them. This led to an increase in worker satisfaction and productivity as well the production lines overall quality. Since the cause of any given assembly line problem would be addressed immediately, problems would occur only a few times before their root causes were identified and resolved, after which the problem would never again affect vehicles coming off the assembly line. As problems were resolved, the assembly line evolved into a more and more perfect assembly line, free of mistakes. By design, a TPS inspired line would build quality into the lines products by eventually reaching a state where it only built products that were effectively mistake free after all the opportunities for mistakes in the production have been resolved. Mistakes fixed in the mass production model often had to be fixed in much more complex environments. Often times a small mistake would have to be fixed in a completed car which could result in a minor or even major disassembly and reassembly of the vehicle. Alternatively, the TPS allowed these mistakes to be fixed right when they were spotted by assembly line workers which resulted in minimum re-work.

The American mass production alternative was to build as many vehicles as fast as possible while testing and fixing them after they’ve come off the line. Compared to the TPS, this was an extremely inefficient and costly alternative.

Relating it to Software

I think the TPS principals are very relatable to much of the process used in software production and quality today. I think the most powerful principal that can be incorporated into software engineering is to fix mistakes as you find them. Agile methodologies like SCRUM help to accomplish this well by breaking large software projects down into small iterations. With small iterations, once a problem is discovered

team leaders can go back to the drawing board and design and implement a fix for that problem before it grows into a larger issue that needs to be fixed after the project is completed. Implementing this principal as opposed to the waterfall method could improve a software engineering teams quality and efficiency immensely just like it improved Toyotas quality and efficiency.

Increased empowerment among team members is another principal of the TPS that I think could significantly improve software quality among a software engineering team. Often times software engineering features are split among members which results in not every bit of code getting reviewed by every member and on occasion some code may not get peer reviewed at all. With that in mind, its important to empower team members to point out when they notice bad software patterns or code smells that way those mistakes can be fixed before they reach the software equivalent of the end of the assembly line and instead need to be fixed when the problem has become much more complex.

I think these aspects of the TPS and software engineering methodology were demonstrated well through the courses incorporation of peer reviews in our project timelines. Often times peer reviews resulted in constructive feedback which led students to go back and revise designs and code before it morphed into large challenges in the projects end. Without this, our projects that were becoming increasingly complex over the course of the semester could have easily become unmanageable. The incorporation of design patterns also helped demonstrate the power of using tried and true techniques free of mistakes. The standard design patterns we were directed to use have been battle tested and revised through decades of study and millions of software projects so we could be sure they were likely iterated on over and over and are free of major error. They also gave us a common language to communicate in which is a powerful tool to have in regard to effective and efficient communication in teams.

The Read Beads Experiment

Dr. Edward Deming's Read Beads Experiment is a great example if ones looking to identify the inefficiencies in the traditional mass production model. Deming takes it one step further though by letting us observe the effect the mass production model has on workers when it makes them feel disempowered. Deming's read beads experiment is basically a small simulation of what could be considered one step of a mass production style assembly line. Like many mass production lines, the subject/employee is asked to complete one simple and usually mundane task over and over again. Deming makes it interesting by making this task inherently inefficient and by adding performance metrics on top of that. Nearly every subject fails to meet performance quotas but their failures are due to the process being flawed rather than the employee being unskilled or unmotivated. The subject isn’t given the empowerment they would be given in a TPS based system, so they're not allowed to recommend more effective ways of accomplishing the task. Instead, they're fired and replaced only to have their

replacement also fired and replaced after they also fail to meet quota. This is a great representation of the high employment turnover seen in early 1900s mass production assembly lines.

From the outsiders perspective, it was clear that those involved in the experiment were being treated unfairly by management by being given an impossible task and being expected to perform. Good employees were let go and inefficient processes continued to cost the subjects time, patience and if it wasn't an experiment, money.

Deming's experiment showed us when to use the the TPS as opposed to how to use it. The experiment exhibited many properties fixable by the major principals that make up the core of the TPS; employee empowerment and fixing mistakes. Subjects should have been empowered to stop the task and point out the reoccurring problem resulting from the mistake in the design of the bead retention mechanism. If that had happened, the subjects could have discovered the root problem and fixed the real issue, the doomed bead retention paddle. If the subjects in the read beads experiment could have been able to follow these two principals of the TPS then the bead sorting task may been a success and may have seen much lower rates of subject turnover.

References

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