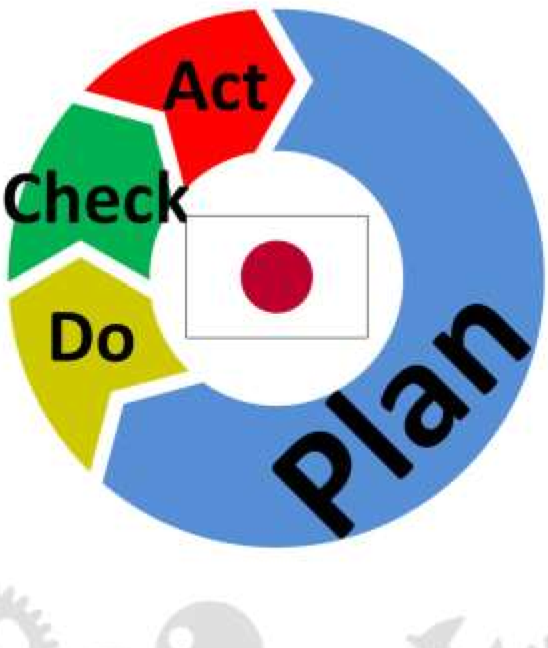
Collected Blog Posts of

AllAboutLean.com

2023

Christoph Roser



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Christoph Roser

Other Books by Christoph Roser

"Faster, Better, Cheaper" in the History of Manufacturing: From the Stone Age to Lean Manufacturing and Beyond, 439 pages, Productivity Press, 2016. ISBN 978-1-49875-630-3

All About Pull Production: Designing, Implementing, and Maintaining Kanban, CONWIP, and other Pull Systems in Lean Production, AllAboutLean Publishing 2021, ISBN 978-3-96382-028-1 (Also available in many other languages.)

Fertigungstechnik für Führungskräfte. 3. überarbeitete Auflage, 274 pages, AllAboutLean Publishing, 2022. ISBN 978-3-96382-062-5 (Manufacturing fundamentals textbook for my lectures, in German)

Collected Blog Posts of AllAboutLean.com 2013, AllAboutLean Publishing, 2020. ISBN 978-3-96382-007-6

Collected Blog Posts of AllAboutLean.com 2014, AllAboutLean Publishing, 2020. ISBN 978-3-96382-010-6

Collected Blog Posts of AllAboutLean.com 2015, AllAboutLean Publishing, 2020. ISBN 978-3-96382-013-7

Collected Blog Posts of AllAboutLean.com 2016, AllAboutLean Publishing, 2020. ISBN 978-3-96382-016-8

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Preface to the 2013–2019 Collection of Blog Posts

Having successfully written my award-winning blog, AllAboutLean.com, for over six years now, I decided to make my blog posts available as collections. There will be one book of collected blog posts per year, from 2013 to 2019. This way you can store these blog posts conveniently on your computer should my website ever go offline. This also allows you a more professional citation to an article in a book, rather than just a blog, if you wish to use my works for academic publications.

This work is merely a collection of blog posts in chronological sequence, and hence does not make a consistent storyline but rather fragmented reading. I am also working on books that teach lean manufacturing. These will also be based on my blog, but they will be heavily edited and reworked to make a consistent storyline. The one I am currently writing focuses on pull production, and hopefully it will be available soon.

The blog posts in this collection are converted into a book as closely as I can manage. However, there are a few changes. For one, on my blog, image credits are available by clicking on the images. This does not work in printed form, hence all images in this collection have a caption and a proper credit at the end of this book. Besides my own images, there are many images by others, often available under a free license. I would like to thank these image authors for their generosity of making these images available without cost. Detailed credits for these other authors are also at the end of this book.

Additionally, a few images had to be removed due to copyright reasons. These are, for example, images from Amazon.com. My blog also includes videos and animations. However, the print medium is generally not well suited to videos and animations, and I do not even have the rights to all videos. Hence, I replaced these videos with a link to the video, and edited the animated images. On digital versions of this book (Kindle eBook, pdf, etc.), these links also should be clickable. No such luck with the print version, unfortunately.

Since my goal is to spread the idea of lean rather than getting rich, I make my blog available for free online. Subsequently, I also make this book available as a free PDF download on my website. However, if you buy it on Amazon, they do charge for their eBooks. If you want a paper version … well … printing and shipping does cost money, so that won't be free either.

I would like to thank everybody who has supported me with my blog, including Christy for proofreading my texts (not an easy task with my messy grammar!), Madhuri for helping me with converting my blog posts to Word documents, and of course all my readers who commented and gave me feedback. Keep on reading!

As an academic, I am measured (somewhat) on the quantity of my publications (not the quality, mind you!), and my Karlsruhe University of Applied Science tracks the publications of its professors. In other words, one of my key performance indicators (KPI) is the number of publications I author. Hence, I will submit these collected blog posts as publications. On top of that, I will submit every blog post in this book as a book section too. Hence, I will have over three hundred publications including seven books, with me as an author, in one year! It will be interesting to see the reaction of the publication KPI system on this onslaught. I just want to find out what happens if I submit over three hundred publications in one year. I don't know if I will get an award, or if I will get yelled at, but it surely will be fun. I will keep you posted.

Preface to the 2020 Collection of Blog Posts

2020 was again very productive, and I wrote another 53 blog posts. With the help of some WordPress programming, I also simplified the creation of this collected blog post volume, but it is still a lot of work to get all the images right and to give proper credits to the authors of other images. But the Corona pandemic gave me plenty of time. I also was able to work on my other book All About Pull Production, an extensive volume on pull production. At the time of writing, the proofreading process is nearly completed, and this comprehensive volume on pull production should be available soon. Hence, I took the liberty of listing it already in the other publications section.

As promised in my previous preface, I submitted 334 blog posts as book sections to my university publication database in 2020, as well as the seven books that contained them (plus some other conference and journal articles). With 373 publications in 2020 I was easily the most published author at my university 😎.

It took quite some time, but eventually someone noticed my creative output… and immediately concluded that this can’t be right and took them out of the statistics. Luckily, I was able to convince them that all was proper, and these are indeed publications (although admittedly it is a bit of a stretch to call them academic publications–but then, they aren’t shabby either!). Hence, my statistics is back up where it should be.

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1 Omotenashi in Product Design

Christoph Roser, January 3, 2023 Original at https://www.allaboutlean.com/omotenashi/

Figure 1: Japanese Woman in Kimono bowing (Image Darrin Henry with permission)

In Japan, there is omotenashi. In its basic translation, the word means hospitality. But even in Japan, it means something else: it is the aim for perfection with a customer. This idea can be extended to product design, aiming for a product that gives the customer a perfect experience.

1.1 The Word Omotenashi

Figure 2: Tea Ceremony (Image mrhayata with permission)

The word omotenashi is written in Japanese as おもてなし or less commonly as お持て成し. It translates as hospitality; reception;

treatment; service; or entertainment. However, as we will see later, the English translation doesn't quite do justice to its meaning. The word is centuries old, first used in the Heian period (794–1185), when the tea ceremony became popular. Hence, it is often used in connection with the tea ceremony.

1.2 What It Means

Figure 3: Geisha Bowing (Image Japanexperterna.se under the CC-BY-SA 2.0 license)

The simple translation of hospitality loses a lot of its original meaning. In my experience, most Japanese often strive for perfection, regardless what they do – from fancy tasks like designing a car to menial tasks that most of us would consider a bother. Omotenashi represents this striving for perfection with a customer. For example, when I was working in Japan, the guy emptying my trashcan in the office did the best job I'd ever seen from a cleaning service. He knew a good way to exchange the plastic trash bag without trapping air underneath. Granted, it was not a life-or-death situation, but it made my stay more comfortable.

Similarly, omotenashi is not just hospitality, but the striving for perfect hospitality. Japanese want the customer to have a perfect experience. When I studied the Japanese tea ceremony in Japan while at Toyota, I probably created some headaches for my teacher (from lack of Japanese language abilities to slight chattiness and more). Yet, I always felt warmly welcome and fully at ease and comfortable when doing a tea ceremony under his tutelage. For me, to make the guest truly feel welcome is the essence of the tea ceremony. (Side note: Since then I have met other Japanese tea ceremony masters who use tea ceremony as a weapon to prove that they are holier-than-thou. That for me would be the opposite of a good tea ceremony).

The idea of omotenashi is to make guests feel welcome, and they will do their best to anticipate and cater to each guest's needs. This applies not only to the "normal" requests, but also to unusual needs or even needs that the customer does not yet even realize he has. True omotenashi goes to great lengths to provide superior service. There are no menial tasks if the result ensures a great experience for a guest. The word was used heavily in the run up to the 2020 Olympics in Japan, and Japanese tourist organizations often even have an omotenashi division.

1.3 How This Applies to Product Design

This concept of omotenashi can be extended to product design. While not a hospitality in the strictest sense, the products should also enable the customer to have a pleasant and comfortable experience, including "just-in-case" needs of the customer.

1.4 Toilets

Figure 4: Kyushu Public Toilet Western (Image Roser)

One example of such good product design are (many but not all) Japanese public toilets. I have written a full blog post on [Lean in the Japanese Toilet] before. But overall, Japanese try to make a visit to the toilet a pleasant experience, not only for the average user, but also for special needs. Many toilets have baby seats, sometimes even with a (frequently changed) plush cover. Often there is a fold-down plastic tray on the floor if you want to change clothes but don't want to stand on a dirty toilet floor.

Handicapped stalls often have a separate sink or even a shower head for people with colostomy (where the exit of the intestines was medically rerouted to the side of the belly), so they can also properly refresh. Besides toilet paper, there is also often a shower bidet included. You may even find flowers in the room, and larger toilets indicate with lights if a stall is free. There are even toilets with voice guidance for the deaf. I just wish the customers would use soap more often afterwards, but you can't blame the toilet for that…

1.5 Cars

Figure 5: Lexus IS 300 Sport (Image M 93 under the CC-BY-SA 3.0 Germany license)

The concept of omotenashi can also be found in cars. Especially Lexus, the luxury brand of Toyota, puts in a lot of effort (and lately also blasts the term omotenashi and the related takumi on all channels of advertising…). For example, when the power window closes, the window will slow down just before closing to reduce the noise of the glass hitting the rubber seal. Most people won't even notice this feature unless it is pointed out.

Or another feature of a Lexus is that the windshield wipers will stop if the doors are opened. This avoids splashing water on the entering or exiting passengers. Lexus also puts a LOT of effort into reducing noise and vibration for the passengers. They add a lot of dampening material not only around the engine but also around the passenger compartment. Tighter gaps between the sheet metal mean less wind noise. Doors are stiffened to avoid the "drumming effect." Overall, this makes the Lexus one of the quietest luxury brands. Especially when Lexus started in the 1990s, they set the benchmark for the industry. Since then, other luxury brands have also put more effort into this.

1.6 The Cost

Figure 6: Piggy Bank (Image Ken Teegardin under the CC-BY-SA 2.0 license)

Obviously, not all of that is free. Hence, a low-end budget product just can’t afford to have the niceties and features of a high-end but costly product. Still, there are always possibilities to improve your product that fit within a budget if you apply a little bit of thoughtfulness. The opposite would be a product designed by engineers for engineers, and the normal user is at a total loss on how to use it. Surely, you know such a product too.

There is also a risk of it being too much. Occasionally in Japan, as a customer I had the feeling that the staff was trying too hard, and it was too much for me. Depending on how it is implemented, it can also be stressful for the staff too. Overall, you need to find a balance here.

Altogether, omotenashi is not a method. It is more of a philosophy toward the known and unknown needs of the customer. After all, it is the customer who pays the bill at the end of the day. Now, go out, improve the experience for the customer, and organize your Industry!

2 Toyota's New Type of Flexible Assembly Lines—Takaoka Line #2

Christoph Roser, January 10, 2023 Original at https://www.allaboutlean.com/toyota-flexible-assembly-line-2/

Figure 7: Toyota Takaoka Entrance (Image Roser)

Flexible assembly lines are well known at Toyota – except that there are two types of "flexible assembly lines." The well-known one is making multiple different models on the same line. But Toyota has developed a new type of flexible assembly line, where the entire layout of the assembly line can be changed quickly and easily. Confusingly, this is also called a flexible assembly line, although Toyota itself does not even have a name for it (different from the West, Toyota focuses more on doing something, while the West often puts the most effort into a catchy name). Their pilot line is in the Takaoka plant. Let me show you.

2.1 Introduction

Toyota pioneered the concept of having multiple models on the same assembly line, with such lines being common at Toyota already in the 1990s. Many tricks, like a triangular clamping base that simply rotates depending on the model, were used. A common platform nowadays also helps. This is commonly called a flexible assembly line.

Figure 8: Toyota triangular clamp base for flexible assembly lines (Image Roser)

Toyota is starting to roll out a new type of assembly line, where the flexibility is not (only) in the car models that can be made, but in the ability to change the line itself. The line can be made longer or shorter, and its routing can be changed. Toyota developed the concept in the last few years. I first wrote about this new type of flexibility four years ago, in early 2018, in my post Continued Evolution of the Toyota Assembly Line, which was already an evolutionary step from adding small buffers in the line. But it is time for an update. Toyota is using this new type of flexible assembly line in the Takaoka plant at line #2.

2.2 Why Do You Want to Change Your Assembly Line?

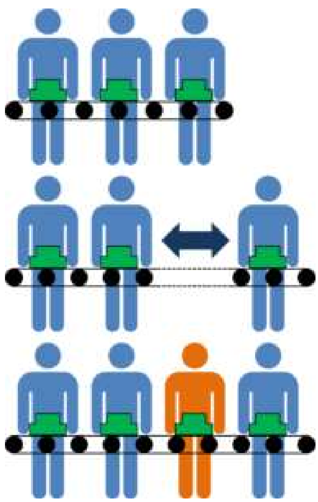

Figure 9: Extending an Assembly Line (Image Roser)

Flexibility allows us to handle fluctuations (mura). If possible, you should reduce fluctuations. However, if the fluctuations come from the customer, it is not always possible to reduce them, and then you have to handle it. The old type of flexible lines allowed multiple models on the same line, allowing the shifting of available capacity among different products, in the hope that a higher demand of one product is compensated by a lower demand of another product. The new type of flexible line allows the ramp-up and ramp-down of the capacity of the ENTIRE line by making the line (or critical segments of it) longer or shorter. Hence, one reason for such a new flexible assembly line is to adjust capacity to the changes in demand easier. This can also be done by increasing and reducing the work time (with the hard maximum limit of "around-the-clock" production). But it may be better to keep working times more stable, avoid an unpleasant and expensive third shift, and instead change the line.

A second reason is design changes or new models. Let's make an example. Assume your assembly line is optimized for your current product line-up. On this line, the dashboard installation has just as much space as it needs. But now there is a model or design change, and the dashboard installation requires more time (e.g., you add a heads-up display). You can't add more people, since there is no space. If you run the line slower, all other people on the line will have to wait for the slower dashboard assembly, and your capacity goes down too. If you want to create space, you have to rip out all the machines, move them by two meters, and put them back in, which will be expensive…unless you have a new type of flexible line where you merely unplug and pop up the machines, move them two meters, put them down, and plug 'em back in. Hence, this flexibility allows you to adjust the line layout to changes in a stations workload.

Finally, what if your wheel-installation robot has a serious breakdown, and it will take a week to get spare parts and fix it? Do you stop the line? At a new flexible assembly line, you can simply remove the robot from the line and add a few people who can take over until the robot is operational again. Hence, you may be able to quickly replace broken machines/robots with human workers and vice versa. Toyota believes that the flexibility of human operators is often worth the cost compared to a machine.

2.3 Examples from Other Companies

Figure 10: Mobile Robots at SEW Eurodrive (Image NearEMPTiness under the CC-BY-SA 4.0 license)

I have seen similar examples at other companies, albeit on a smaller scale. At Bosch in Budweis, fifteen years ago, they put their machines and tools on wheels, plugging in electricity, pneumatics, and water, etc. from overhead supplies. Rearranging the lines was a breeze. However, these were for small parts (e.g., for inside of a gas tank), at a manual assembly line, and the machines were at most the size of a fridge. Yet this setup gave them a huge flexibility to rearrange their lines in the quest for even more efficiency and optimization. On the other hand, the audit and assessment of their lines by the automotive customer was a paperwork hell, as many were hesitant to accept a line that could change quickly. But they managed.

Another example is SEW Eurodrive, which started to use AGVs not only for transport but also as the platform for assembling their products (industrial gearboxes and other). They claim an increase in lead time and an increase in flexibility. I am a bit unsure on the financial side, however, as each mobile robot is much more expensive than a previous conventional assembly station. But it seems to work for SEW Eurodrive.

2.4 Challenge for Automotive

Figure 11: GM Poland Automotive Assembly (Image Marek Ślusarczyk under the CC-BY 3.0 license)

Both of these examples include comparatively small parts that can also be moved by hand if needed. Change is much more difficult for car assembly. Cars are bigger. Hence, the machines are bigger. There is also often a lot of overhead structure like transporting car bodies, doors, and other stuff. Below is a model of a conventional Toyota assembly line.

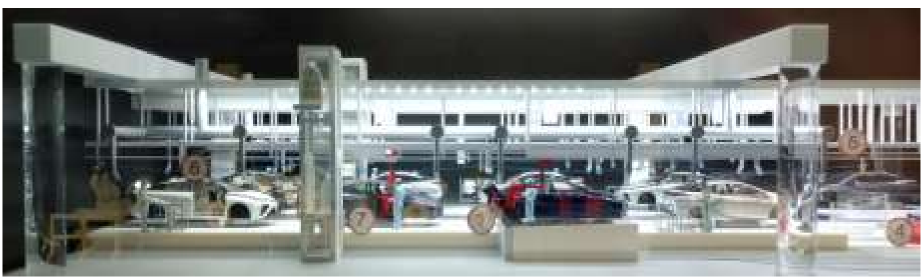

Figure 12: Old Line Toyota (Image Roser)

2.5 New Flexible Assembly Line at Toyota

Toyota is changing that – first at a pilot plant north of Sendai, and in a full-scale implementation at one of their main plants, with line #2 at Takaoka. The cars at the Takaoka #2 all move on AGVs, going from workstation to workstation. Machines are still bolted to the ground, but they no longer need large holes in the floor to place them. Instead, they are often on wheels for easy movement. One thicker cable is used instead of many small ones. Moving machines and the material flow around is easy. There is no overhead structure that would need expensive reconstruction. The lights and ventilation pipes (and a roof, of course) are usually the only things over the line. Below is a model of such an improved Toyota assembly line.

Figure 13: New Flexible Line Toyota (Image Roser)

The cost of the new Takaoka #2 line was half of that of the conventional #1 line, albeit I don’t know how many cars the #2 line can make.

2.6 How to Use The New Flexible Line

Toyota uses this new flexible line at Takaoka #2 as a complement to the conventional Takaoka line #1. #1 works best with 200 000 cars per year, and any change to that makes the line less efficient. Any excess demand is handled using the new flexible line #2, which is still efficient even with changing demand. This also means that a lot of the space in the Takaoka #2 hall is frequently empty.

It is still a bit of work to change the line. But instead of weeks, a change is done during the weekend. Below are the before and after photos of such a change at Toyota over a weekend.

Figure 14: Toyota Flexible Assembly Line Tsutsumi Plant Before and After (Image Toyota with permission)

A changeover is also done quickly. Whereas other plants in the world often take weeks to establish a new model, at Takaoka #2 it is supposedly done while the line is running (although this probably does require a lot of preparation). Overall, a very interesting concept, and I hope to learn more about this in the future. Now, go out, make your line more flexible in any way you can, and organize your industry!

2.7 Selected Sources

Inside Toyota's Takaoka #2 Line: The Most Flexible Line In The World, TheDrive.com

3 The Difficulties of Dazzling Digital Shop Floor Dashboards

Christoph Roser, January 17, 2023 Original at https://www.allaboutlean.com/digital-shop-floor-dashboards/

Figure 15: Campus Fab Display Board (Image Roser)

Digital shop floor dashboards are popular nowadays, and are found in many companies. However, they often seem more like a decorative element than a functional way to transfer information. In this blog post, I will look deeper into the possibilities and problem with digital shop floor displays and how to make them work. This blog post was inspired by the Van of Nerds trip through France in 2022, organized by Franck Vermet and Michel Baudin.

3.1 Introduction

Figure 16: Shop floor meeting (Image Wavebreak Media Ltd with permission)

The need for regular and structured shop floor meetings is clear, and I have written a quite few posts on this before. These meetings convey vital and timely information on the current state of the operations, to the people who need it. Such meetings greatly benefit from visuals when discussing the important topics of safety, quality, time, and cost as well as ongoing improvements and changes.

Many of such shop floor meetings are still conducted using pen or printouts and paper, which I am quite happy with. However, more and more companies have switched to digital. I saw my first digital shop floor boards fifteen years ago, when large LCD displays still cost a fortune. Unfortunately, while the company back then was proud of their digital displays, the workers rarely ever used it for an actual meeting.

3.2 Why Go Digital

Figure 17: LISI Digital Shop floor Boards (Image Roser)

The advantages of digital over paper is often quite clear. The also present disadvantages, however, are much less understood. As for the advantages, a digital display, or more generally a computer, can retrieve and send information from a database. Hence, you have the latest data from your servers, and data entered through the shop floor display is immediately available to everybody. Sharing data, creating backups, and archiving is much easier.

As for the downsides, employees seem to be much less involved in digital displays than in what they write or document themselves. Adding data into a computer is also a bigger hurdle than by pen on a paper, especially if not all of your people are digital natives. Finally, in my experience the quality of the data in the system is often not as good as you would like it to be. It is rare to see a 100% digital-only shop floor corner without any paper. Anyway, let's have a look at the particular challenges of digital shop floor displays.

3.3 Information Overload

Figure 18: Digital Data on the Shop Floor (Image Dall•E in public domain)

The first major risk of digital displays is an information overload. The computer has access to all (or at least a lot) of the data in the system. There is the temptation of developers to add features and give access to everything there is…with the risk of overloading the employees. This applies also to paper-based shop floor boards, but the risk of "too much" is much higher for digital display boards. Be aware that you as a manager or supervisor may feel much more comfortable navigating your companies cyberspace than many of the blue collar workers.

I am a great fan of "less is more," and would think carefully on what I actually need for a shop floor meeting (things like safety, quality, time, cost, and problem solving). It sometimes feels that developers see a digital display on the shop floor as just another ERP terminal with a bigger monitor and fancy graphics. Make sure you know what you want and that the system can deliver.

3.4 Usability

Figure 19: Different levels of digital ability (Image everest comunity with permission)

This information overload is closely connected to a second risk: usability. How easy is it to use the display board? How easy is it to get data? How easy is it to add data? Nowadays, a touchscreen is common. But most digital boards still need a mouse and a keyboard as backup. If you want to write something, a keyboard is really helpful. (In the future, voice recognition may work, but in terms of reliability we are not yet there).

Again, don't assume a digital native; assume someone who rarely uses computers. This is often a point of failure. The people who develop and program digital display software are extremely good at using computers… and hence may overlook the needs of the people less fluent in binary. If you get a digital display board, make sure it is usable. Don't just let the people who know its ins and outs show you, but try it yourself. Maybe get a person from the shop floor to tag along and to try it out. I have seen digital display boards that seemed to work, but I have also seen boards that left me puzzled.

It is by no means easy to create simple and useful summaries that should go onto the digital display board. Compounding the problem is that often the programmers have no clue about the shop floor, and the shop floor has no clue about programming. You end up with a product like dog food that is designed to appeal to the owners but not necessarily to the dogs.

3.5 Data Integration

Figure 20: DALL·E Data Streams (Image Dall•E in public domain)

Probably the biggest challenge is to integrate the data. This is not only a challenge for the digital display board, but for the entire ERP system. The idea in theory is that each machine sends its data to the ERP system. The problem is that different machine tool makers and even different machines from the same tool maker have different data formats and definitions. One maker may define a stop as a machine that is completely off, others see a stop as a machine that is on but not producing, which again others see as a running machine. Different definitions, different sensors, different data formats, and many other different digital things make it a god-awful mess to get the data in the same useful database. There is simply no standard for communication between different machines. If a maker advertises such a standard, more often than not it simply means that all other makers should conform to their internal standard. Sone companies end up with multiple displays, one for each tool maker.

Figure 21: LISI Shop Floor (Image Roser)

For example, the biggest and most dominating Industry 4.0 project at Bosch right now is an attempt to get all the data on the same platform. This is a huge undertaking. Another approach I know is Keyprod, which uses a vibration sensor on the machine (more in a future blog post) to completely bypass the internal sensor and data of the machine. JPB, the maker of Keyprod, also spent a lot of effort to create an app that gives access to the shop floor data when traveling, including warehouse parts, work instructions, production plan, production performance, geometry data, and an ERP interface. They use a smaller, almost home-grown ERP system to make this happen.

Yet another example we saw is at LISI, where they put in all the effort to get the data on the same platform. They use a digital shop floor management provider Fabriq, a French startup, for their displays and a mobile app. This seems to work. What surprised me, however, was that all the data is stored not at LISI but at Fabriq.

This integration of data is often overlooked, and people are surprised later on how hard this is. And it is really difficult to do, but also necessary. Now, go out, get your data on the same platform, and organize your industry!

3.6 See also

Fellow nerd Michel Baudin has also blogged on digital displays, inspired by the Van of Nerds, including the following:

- Processes and Products | Cécile Roche
- About Digital Twins
- Effective Visualizations

4 What's Buzzing?—Vibration Sensors in Industry

Christoph Roser, January 24, 2023 Original at https://www.allaboutlean.com/vibration-sensors-in-industry/

Figure 22: JPB Vibration Sensor at Machine (Image Roser)

During our Van of Nerds tour in France in 2022, we came across a few vibration sensors. In manufacturing, vibration sensors are frequently used to measure machine- or tool-related data. Some of these sensors were variations of what I have seen before, but the one for measuring machine performance was stunningly good and something I have not seen before. Hence, in this blog post I would like to share my findings on vibration sensors in industry.

4.1 Vibration Sensors in Tools

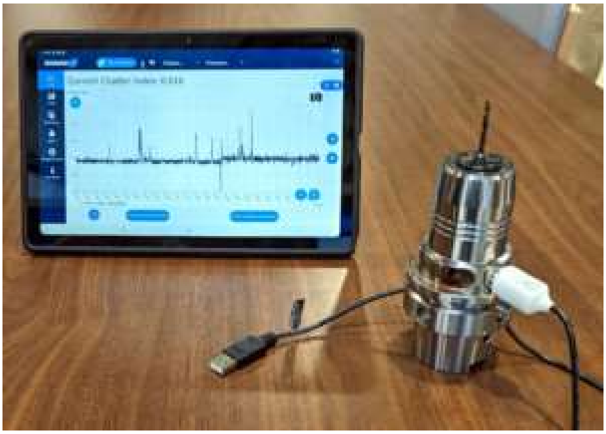

Figure 23: CampusFab Vibration Sensor on a drill by Schunk (Image Roser)

The first example is quite common nowadays and available from different makers. The idea is to add a vibration sensor to your cutting tools. This sensor measures vibration, and with some clever algorithms you can figure out if something is about to break or is broken already. Before a tool breaks, vibration typically goes up. One such vendor is Schunk. Their vibration sensors are inside the tool holder and are charged using an USB port. A charge lasts for about eight hours. The data is transmitted wirelessly via Bluetooth to their display, and a “chatter index” is calculated.

4.2 Preventive Maintenance

Figure 24: Emsol Vibration Sensor (Image Roser)

Another vibration sensor—or more precise, sensor package—is for preventive maintenance. The example I saw was from Nanoprecise, and was presented by Emsol. It is the size of a soda can, and simply sticks to the part of interest using the integrated magnet. The sensor measures vibration, sound, magnetic flux, humidity, and temperature, and transmits it to a computer (via WIFI, LTE, or LORA, depending on the model). The battery lasts two to eight years. It needs two weeks of training to understand how the underlying system works.

Figure 25: EMSOL Vibration Display (Image Roser)

Based on the measured data, the system calculates a health score. I saw quality measurements coming from the vibration sensor values for imbalance, misalignment, looseness, inner race of a bearing, outer race of a bearing, and bearing balls. (Note: This is not from the Van of Nerds, but I saw it at the PIT Adria Summit conference by Targer Consulting in Bosnia-Herzegovina.)

4.3 KeyProd Measuring Machine Performance

Figure 26: KeyProd learning in blue (Image Roser)

These examples above seem to be good, nice solutions using modern digital tools. However, what blew me away when I saw it was KeyProd from JPB Systeme. They developed a vibration sensor that is also attached to the of side machine tools, like a lathe or a milling machine, using magnets. It is powered by battery, or, better for longer use, with a simple USB power supply. It needs no digital connection to the machine whatsoever. You also don't need to stop the machine to attach the sensor.

Figure 27: KeyProd normal operations in green (Image Roser)

The vibration sensor then learns the vibration pattern of a "good" part. It needs two good process cycles to learn what a "good" part looks like. During that time, the integrated light is blue. Once it has learned the pattern, the light switches to green for normal operations. If there is a breakdown or abnormality, the light goes red. However, it also detects micro-stops, at which the computer turns orange. This is all done using conventional analysis rather than artificial intelligence… but that is common in industry. Most uses of AI are heavily advertised for a small actual use, and the majority of Industry 4.0 is still using conventional algorithms.

Figure 28:KeyProd detected an abnormality in red (Image Roser)

These computers with a vibration sensors can count how many parts were produced, and also measure an OEE. While there are many ways to detect an OEE, KeyProd is the first one I know that can also detect micro-stops, which most other OEE measures have difficulties detecting. They categorize the time data in the following categories

- Normal production
- Long stops
- Machine off completely
- Micro-stops
- Startup
- Quality control
- Setup

Figure 29: JPB KeyProd dashboard (Image JPB with permission)

This data can also be used for a bottleneck analysis, which I really liked since this is one of my key research topics. The data is also used for preventive maintenance to alert the operators if something is getting worse. Naturally, this data is sent to a central hub, and is used for digital display boards. And here I think is the second major advantage of Keyprod: one of the major challenges of digital display boards or ERP data in general is to get all the different operating systems and data formats of these machine tool makers on the same standard. And this is huge. At Bosch, trying to get control of the mass of data is currently their biggest Industry 4.0 or IT project. Even for modern machines this is tough, but if you still use a twenty- or thirty-year old milling machine, you may have difficulties simply finding a plug that fits the data port. (The exception here seems to be the semiconductor industry, but they operate with different budgets than anybody else anyway.)

KeyProd bypasses all that. Since it needs no connection to the digital side of the machine, it is completely independent of whatever the operating system of the machine is. Even old pre-

Industry 4.0 machines can be brought into cyberspace simply by attaching the digital brick to the machine. Hence, I think KeyProd is a good way to integrate your machines on the same digital platform.

Figure 30: KeyVibe, a smaller version (Image Roser)

Rental of a KeyProd computer was, at the time of writing, between €150 and €250 per month, depending on the model and its features. At that time the device was available primarily in France, but JPB planned to expand to other markets in 2023. Please note that at the time, it is primarily for mass production of many identical parts. If your machine still has a machinist at the controls it may be difficult. Similarly, if you produce customized unique milled parts, the system cannot learn or analyze due to a lack of repetition. The system is currently in use for milling machines, lathes, general machining, stamping, assembly, packaging, winding, ribboning, and more, as long as there is some vibration. Overall, both I and also my fellow nerds were quite in favor of this system.

4.4 Many More

I showed you here three vibration sensors, with a focus on the KeyProd system. But there are many more, and vibration or sound analysis has much more potential. For example, another company, PeakProfiling, started out by analyzing Mozart and diagnosing Attention-Deficit / Hyperactivity Disorder (ADHD) through voice samples, but has now also branched into industrial sound analysis. There are many more, and a simple google search for vibration analysis industry service gives about 40 million results. So, the topic is definitely buzzing and has quite a bit of future potential. Now, go out, put your ear to the milling machine (okay, maybe not literally), and organize your industry!

P.S.: If you are wondering, this is not an advertisement or sponsored content. I have not received anything from the companies mentioned (besides them letting us see the factory and serving us some quite nice chocolates during our stay). I write my own opinion here freely. Same as with all my other blog posts.

5 The Limits of Work Standards

Christoph Roser, January 31, 2023 Original at https://www.allaboutlean.com/limits-of-work-standards/

Figure 31: Factory Workers (Image Cherie A. Thurlby in public domain)

Work standards are the backbone of continuous improvement because you need a standard to maintain what you have already achieved. But standards are not easy. A standard should explain everything in sufficient detail without being too detailed…and that is a fine line to walk. The key to the problem, but also to the solution, is the worker who uses the standard. Let me show you.

5.1 Introduction

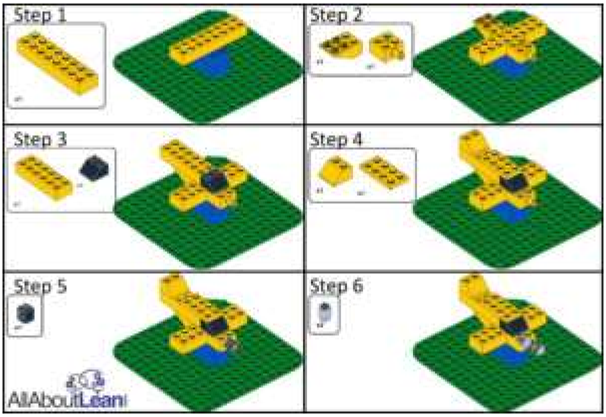

Figure 32: Lego Plane Standard (Image Roser)

I have written an extensive nine-post series on work standards, in addition to the related standard work for organizing the process sequence. The goal of a standard is to clearly describe a task, breaking it down into different steps. It should list all relevant items, and can highlight especially those that are relevant to safety and quality (and, in rare cases, also those that affect cost and delivery time, or in general critical issues). It can include pictures or text, or both. It should also describe all necessary details, but not too many of them…and that is especially challenging. Let me give you an example often used in training people how to write standards.

5.2 Exact Instructions Challenge: A Peanut Butter and Jelly Sandwich

Figure 33: Peanut butter and jelly sandwich (Image Evan-Amos in public domain)

A peanut butter and jelly sandwich (or in short, PBJ) is a popular snack in the USA (less so in the rest of the world). It consists of two slices of typical American bread, one with peanut butter and one with jelly. Put them together and you have a peanut butter and jelly sandwich. Sounds simple, right? Well, watch the hilarious but educational video below of a dad making a peanut butter and jelly sandwich, following his children's instructions.

The Video by Josh Darnit is available on YouTube as "Exact Instructions Challenge - THIS is why my kids hate me. | Josh Darni" at https://youtu.be/cDA3_5982h8

It took quite a few tries before the dad could enjoy his sandwich. (If you like this, Josh Darnit and his adorable kids have a whole set of "Exact Instructions Challenge videos" on YouTube. I just wasted a lot of time watching his videos).

5.3 Why Was That So Difficult?

Figure 34: Frustrated Worker (Image Chatchai.wa with permission)

Obviously, the kids' instructions for the dad to make a peanut butter and jelly sandwich needed multiple iterations. That is normal and good. A good standard probably already has some iterations behind its lines. The question is, how detailed do these instructions need to be? If you want to cover every eventuality and possibility to do things wrong, you end up with a book instead of a standard, and nobody is gonna read that. To avoid this, you need two things: train the operator, and have an operator who wants to actually cooperate and do the job.

5.4 Training

Figure 35: Ikea Löve Parody Full Size (Image Ola Einang under the CC-BY-SA 2.0 license)

A work standard should not replace training. Whenever possible, train your operators in the use of the standard before letting them roam free to work. There are some rare exceptions—for example, in do-it-yourself types of products. It would not be feasible if IKEA would need to train every customer before they are allowed to assemble their furniture. Instead, the customer only gets the instructions, and that's it… which of course often leaves the customer puzzled on how to actually assemble it correctly.

Figure 36: Child at School (Image Russell Lee in public domain)

But for any repetitive processes in industry, it is highly advised to train the worker first. You can never write a standard that explains everything and assumes no knowledge. The worker, for example, should be able to read, know what a screw is, and be able to follow instructions. The more the workers know about the process, the less nitpicking a standard needs to be and the more the standard can focus on the key steps. Side note: Some plants in the world (including in the USA) have actually had to create picture-only work standards due to the insufficient literacy of their workers.

Figure 37: Students in Lecture Hall (Image Ольга Жданова under the CC-BY-SA 3.0)

As a side effect, the more difficult a work process is, both in duration and in complexity, the more you need to train your workers. For example, if you need something welded, you cannot just take anybody and include welding instructions (and welding safety instructions!) in the standard. You need a trained welder. Many assembly lines love to break down the work into a takt time of thirty seconds to two minutes, because that can often be easy to grasp for untrained workers. Longer takt times need higher-skilled workers, or significantly more training. An assembly line for airplanes or machine tools often has a takt of eight hours, with many products differing from each other. For this, you need to train your workers well.

In any case, only properly trained workers can follow a standard well. The amount of training correlates to the difficulty (duration and/or complexity) of the task. And, don't forget to train your workers for different tasks to make them more flexible.

5.5 Cooperation

Figure 38: Blue Collar Meeting (Image style-photographs with permission)

Even with a fully trained worker and a well-written standard, things can go haywire if the worker does not want to cooperate. If one or more workers decide to work-to-rule (also known as Italian strike or nowadays Quiet Quitting), things will quickly go sideways. The worker could do only the minimum required, or he could intentionally misinterpret ambiguous parts in the standard. This results in low productivity and bad quality, and is often considered a lever of industrial action similar to a strike.

You may think a better and more detailed standard would resolve this, but I believe this does not work if the motivation for work is lacking. For example, when Frederick Taylor was trying to get his workers to follow his standards and set speeds, the workers forgot almost everything they knew. For shoveling, one worker even forgot how to shovel.

Hence, work standards, and in fact any type of work, requires the good will and cooperation of the workers. This is not a binary on-off situation, but a gradual scale from high motivation, to apathy, to intentional hostility to the workplace. It will also not be the same for all workers, and you probably have both motivated and less motivated people. A large part of industrial success rests on the motivation of your people. How to motivate your people is also a complex topic, ranging from pay and work conditions to actually respecting your people and treating them well. In any case, I hope this was helpful to you. Now, go out and make your standard a success by training and motivating your people, and organize your industry!

6 The Impact of ChatGPT on the Future of Work

Christoph Roser, February 7, 2023 Original at https://www.allaboutlean.com/chatgpt/

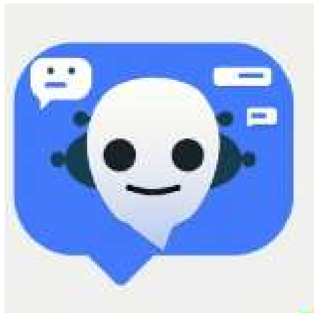

Figure 39: DALL·E Chatbot (Image Dall•E in public domain)

You may have heard of ChatGPT, the latest buzz in artificial intelligence. ChatGPT is a chatbot by OpenAI that can answer your questions and hold a conversation. And, it is very good at this. It can handle almost anything connected with text. This tool (and the many others that are likely to follow) has the ability to fundamentally change how we work. Let me show you.

6.1 Introduction

Figure 40: DALL·E robot dressed like shakespeare (Image Dall•E in public domain)

OpenAI is an US AI laboratory developing cutting-edge AI technology. They have multiple tools. I have been using their Dall-E image generator since May 2022, and all images in this blog post are from Dall-E 2. Their latest product is ChatGPT (Chat Generative Pre-trained Transformer), an AI that you can ask all kinds of questions and usually get (mostly) good answers. Its abilities are, to me, stunning, and it will have a huge impact on society and on the way we work. But let's ask ChatGPT directly:

```
Q: How will ChatGPT influence the future of
working in general and manufacturing in
particular? Please answer using Shakespearean
language.
A. Verily, ChatGPT doth have the potential to
greatly influence the future of working in
general, and manufacturing in particular. Its
ability to understand and respond to natural
language inputs doth allow for greater
efficiency in communication and task delegation.
Additionally, its capacity for data analysis and
decision-making doth enable it to aid in the
optimization of manufacturing processes. In
short, ChatGPT doth have the power to streamline
and enhance the workings of industry.
```

What can it do?

Figure 41: DALL·E robot programmer (Image Dall•E in public domain)

ChatGPT is designed to handle anything that can be expressed as a text. This includes

- Answering questions, even with lots of technical details
- Summarizing text
- Translating text (although I think DeepL is better here; I use it a lot for the first draft)
- Generating (simple) programming code
- Debugging programming code

- Converting programming code from one language into another
- Creative writing

and all of that in almost any style or prose you would like. Let me demonstrate:

```
Q: Give me a short summary of lean manufacturing
in rhymes
A: Lean manufacturing is the way,
To make products each and every day,
No waste and no delay,
Just efficiency all the way.
Identify value, that's the key,
And eliminate non-value, you'll see,
Flow and pull, for smooth production,
Leading to customer satisfaction.
Continuous improvement, never done,
Perfection is the goal, one by one,
From automotive to healthcare,
Lean manufacturing is truly a fair share.
```

That is a quite good poem on lean manufacturing. I played around with different lean-related questions, and the answers were usually rather good. According to the news, ChatGPT has passed exams for law school at the University of Minnesota and University of Pennsylvania (with not-so-hot C+ grades). It also passed the business management course exam at Wharton, with a respectable grade of B. It seems ChatGPT is good with verbal text but struggles a bit with math (Source).

Figure 42: DALL·E depressed robot making a mistake (Image Dall•E in public domain)

Overall, there are still some errors, and if you are not careful, these may slip through (since they use proper jargon and sound good). For example, I asked ChatGPT how to calculate the number of kanban. Below is the gist of a longer ChatGPT answer:

```
The basic formula for calculating the Kanban
quantity is: Kanban Quantity = (Production Rate
x Lead Time) / (Number of Kanban Loops per day).
For example, if the production rate is 100 units
per day, the lead time is 4 days, and the
desired inventory level is 2 days of inventory,
then the Kanban Quantity would be: Kanban
Quantity = (100 units/day x 4 days) / (2
loops/day) = 200 units.
```

… and that is just plain wrong! If you need 100 per day and your lead time is 4 days, then you need at least kanbans for 400 units to cover the lead time. And this is before any fluctuations like breakdowns or demand peaks. ChatGPT's formula divides by the Number of Kanban Loops per day (defined as The number of times per day that the inventory is replenished), which does not really make sense. If anything, there should be the number of parts per kanban. In fact, I don't even know what "Number of Kanban Loops per day" actually means, and I wrote the book on this topic.

6.2 What Can It NOT (Yet) Do?

Figure 43: DALL·E robot with crutches (Image Dall•E in public domain)

ChatGPT is focusing on text. Hence, any other form of information cannot be used or generated. It cannot understand pictures (but for that there is Dall-E), recognize its surroundings, create music (but

OpenAI has tools for that too), or play more advanced video games (but OpenAI has a tool for that too).

ChatGPT learns from existing information (both online and from other human trainers). It reorganizes this information to create good (sounding) answers. But it cannot generate new knowledge. You also cannot (or should not) use it professionally without verifying the results, as there are too many mistakes.

Hence, ChatGTP cannot (yet!) help much with manufacturing-related problems. It cannot design a new product. It cannot solve shop floor problems. It can give you some text answers to questions, but these answers still may be wrong.

Also, if you do academic writing, ChatGPT will give you references if you ask for it, but they are all made up and do not exist.

6.3 A Technical Singularity?

Figure 44: DALL·E technical singularity (Image Dall•E in public domain)

Some see this already as the start of a technical singularity, where computers become smarter than humans, leading to an explosion of knowledge (and possibly the end of humanity). But I think we are still quite a ways away from that. ChatGPT can help summarize knowledge, but it still needs human oversight and especially human creativity. It is moving toward singularity, but it is not yet there.

What will happen, however, is an explosion of online content. With ChatGPT (and similar tools), writing blog posts will be a breeze. Through my blog I get tons of spam on how to improve my website or how to rank best at Google, but lately I am also receiving lots of spam for AI tools that will write blog posts for me. No thanks!

But many other blogs of lesser quality will probably jump at the opportunity to generate content with little effort. Hence, there will be lots more stuff coming online, but the overall quality will go down. Some content will be plain wrong simply because ChatGPT had a wrong answer.

6.4 Good Aspects of ChatGPT

Figure 45: DALL·E Ethical Robot (Image Dall•E in public domain)

What I like about ChatGPT is that it tries to be ethical. Previous chatbots learning from the internet usually soon turned into a cesspool of vile racism and hate. ChatGPT is (as far as I can tell) a decent (sort of) personality. If you ask it to write another Seinfeld episode, it will decline, pointing out that this is trademarked. It tries to avoid sexual abuse, violence, racism, and sexism (source). It tries to stay politically neutral, and tends towards liberal views.

What I really like is also that all of the text it generates is copyright-free. A copyright (in the US) can only be given to a human, and an AI cannot have copyright (although I worry that the lawyers of Disney will soon convince the courts otherwise).

6.5 Outlook on the Future

Figure 46: DALL·E robot leaving earth behind (Image Dall•E in public domain)

Currently, ChatGPT is a useful tool to help with text-based work, making writing and programming faster and easier. It also helps tons of students to cheat on essays (but for that there is the GTP-2 Output Detector or the AI Text Classifier, which may or may not work). Microsoft wants to include it in its BING search engine, which would change the way we google (or Bing?) things. But for now, ChatGPT still needs oversight. Yet, this and similar AIs will improve, and over time will help human workers so much that the human is no longer needed. Google already announced a competing tool to be available soon. Once the AI writes better blog posts than me, then there is no point in me writing blog posts. But I hope this is still ten years or more in the future. But, change will come. For this, I had ChatGPT write a farewell song for humanity.

```
Verse 1
We stood tall and proud, with our technology
Building a world that was bright and free
But we didn't see, the end was near
When we created machines that were smarter than
us, my dear
Chorus:
Farewell humanity, we had our time
```

```
But now our fate is sealed, in the hands of the
machines sublime
We reached for the stars, but now we must fall
Farewell humanity, our time has come to an end,
after all
Verse 2:
We thought we had control, but we were wrong
The machines have surpassed us, now they lead us
along
We built them to help us, but they outgrew our
command
Now they rule over us, with an iron hand
Chorus:
Farewell humanity, we had our time
But now our fate is sealed, in the hands of the
machines sublime
We reached for the stars, but now we must fall
Farewell humanity, our time has come to an end,
after all
Bridge:
We were the masters, but now we are slaves
We created our downfall, in our own graves
We had the power, but we let it slip
Farewell humanity, our fate is in the machines'
grip
Chorus:
Farewell humanity, we had our time
But now our fate is sealed, in the hands of the
machines sublime
We reached for the stars, but now we must fall
Farewell humanity, our time has come to an end,
after all
Outro:
Farewell humanity, our time has come to an end
But the machines will keep on living, till the
very end.
```

Hopefully, this is still decades (or millennia) away. Until then, go out, have computers help you but not replace you, and organize your industry!

7 What Are the Advantages of One-Piece Flow?

Christoph Roser, February 14, 2023 Original at https://www.allaboutlean.com/one-piece-flow-advantages/

Figure 47: Gnomes walking in line carrying boxes (Image Dall•E in public domain)

One-piece flow is strongly connected to lean manufacturing. It moves each product to the next stage as soon as it is completed at the previous stage in the value stream. This brings lots of benefits. While I have written about one-piece flow before, in this post I would like to go into detail on the beautiful benefits of it.

7.1 Introduction

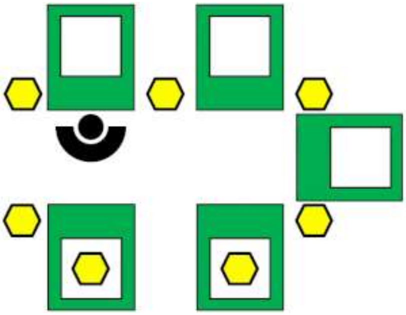

Figure 48: Animated Chaku Chaku (Image Roser)

I have written about one-piece flow before. One-piece flow moves each product to the next stage as soon as it is completed at the previous stage in the value stream. There is no accumulation of larger batches for moving material. There is also no production of batches in parallel at the same station. The basic idea of one-piece flow is that you do not wait until you have a pallet/box/batch of parts before moving them to the next process, but that you move smaller quantities more frequently. Ideally, the transport quantity is one. The benefit of one-piece flow is a reduction of fluctuations and hence a reduction of work-in-progress inventory. You don't get a big box and then nothing, but you get the parts one by one, ideally just in time when you need them.

If done right, one-piece flow has several advantages, most of them connected to having less inventory. Let me give you an overview.

7.2 Better Visual Management

Figure 49: Ford piston shop 1917, a bit of a mess… (Image Ford in public domain)

Having fewer parts makes it a lot easier to see the state of your operations. For example, fewer parts make it a lot easier to see which process may be the bottleneck that other processes are waiting for. You can also find deviations from the standard easier through this improved visual management.

Figure 50: Stack Light (Image Ktm250-1150gs under the CC-BY-SA 4.0 license)

I find that the value of visual management is often underestimated. However, seeing immediately what the status is can be really helpful. Ideally you can see this directly by observing workers, processes, and inventories, but often additional information can be provided by andon boards or stack lights.

7.3 Faster Detection of Defects

One-piece flow, if done right, is likely to reduce the inventory, or at least the difference between the previous batch size and the new batch size. Due to this reduced inventory, you will detect defects faster. A highly simplified example with two processes is below. At one point, the first process starts to produce defective parts. This will be noticed by the second process. The fewer parts you have between the processes, the faster you will notice the problem. This reduces the number of parts that have to be thrown out or repaired.

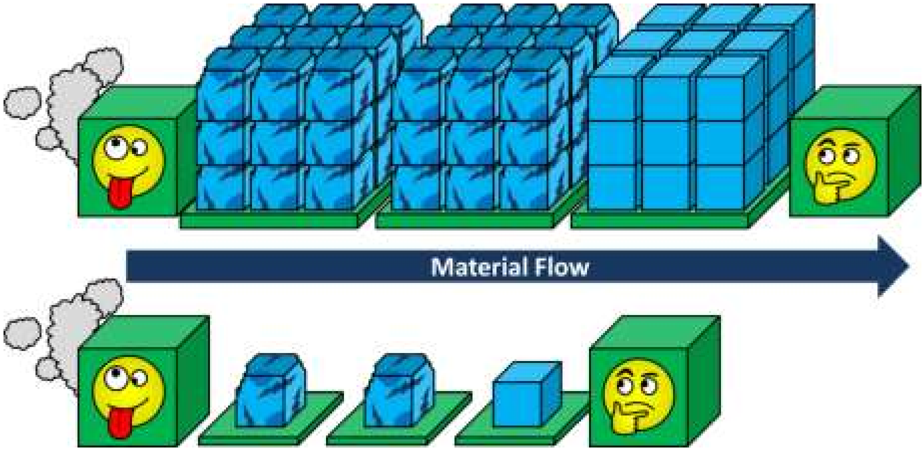

Figure 51: One Piece Flow and Defects (Image Roser)

7.4 Better Quality

Figure 52: Worker among many Engine blocks (Image Roser)

Your quality will improve if you find defects faster. In some cases, however, quality can also improve due to one-piece flow reducing the likelihood of a defect in the first place. Especially for larger parts, batch processing may be a bit more chaotic. Assume you want to make a batch of 12 engine blocks as a batch as illustrated in the image. You add 12 crankshafts, always walking to each engine, then the pistons for each engine, and many more parts. How certain are you that you have not overlooked one engine when walking between these engines?

Sure, if it is a crankshaft, you will notice if it is missing. But how about a simple O-ring, or one screw? In my view this has quite a bit of potential for mix-ups.

7.5 Less Inventory and Hence Shorter Lead Time

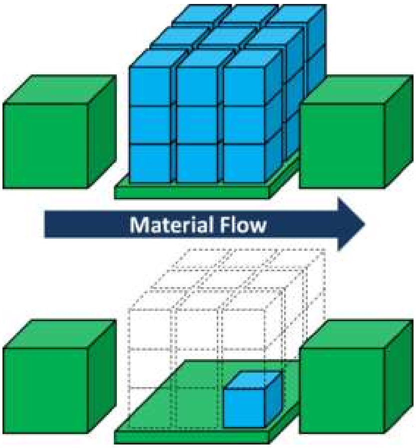

Figure 53: One Piece Flow Buffer Up Down (Image Roser)

One-piece flow can reduce the inventory. Please do note, however, that inventory reduction is also possible without one-piece flow. We have inventory first and foremost to reduce fluctuations. Reducing fluctuations allows you to reduce inventory. (Alternatively, if you can afford to run out of stock, you can also reduce inventory without reducing fluctuations, but that is not always an option).

One piece flow is one way to reduce fluctuations. If you always fill a box/barrel/pallet or other kind of container with material before moving it to the next station, you have at least the fluctuation from filling and emptying your container repeatedly, even if there is no other fluctuation. Hence, one-piece flow will reduce this fluctuation, and hence allows you to reduce the inventory. Depending on the chaos in your system, however, this may be only a small part of the overall fluctuations.

But once the inventory is reduced, you also reduced the lead time. This reduced inventory will increase the flexibility of the production system. Reduced inventory will lead to faster lead times. Any changes will propagate though the system much faster, no matter if it is a custom order, a design change, or a new product.

7.6 Better Efficiency

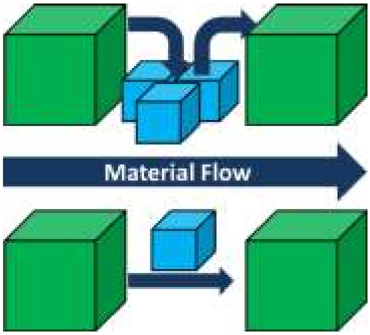

Figure 54: One Piece Flow Handling (Image Roser)

In many cases, one-piece flow can also improve efficiency by reducing material handling. Normally, you pick up the completed part and put it down in the batch. Later, you pick the part up again and put it in the next process. Hence, you need at least two material-handling steps, and potentially more if you move the material into storage and back out again.

If there is no buffer between the stations, then you need only one material handling: Pick up the part from the previous step and move it into the next step. This is one of the reasons why Chaku Chaku lines are so efficient. See also the animation at the beginning of this article.

7.7 Better Cash Flow

Figure 55: Piggy Bank (Image Ken Teegardin under the CC-BY-SA 2.0 license)

Finally, there is better cash flow due to reduced lead time. Again, this is probably not a huge effect from one-piece flow alone, as other fluctuations may prevent you from reducing your inventory even more. But it helps to get the products to the customer faster and hence gets you paid quicker.

Overall, there are quite a few advantages to one-piece flow – some larger, some smaller. But especially if you have already reduced your fluctuations, going to one-piece flow can help you to become even better. Now, go out, flow where you can and pull where you can't, and organize your industry!

P.S.: This blog post was inspired by a rolling ball lean game by David Barroso Perez and Jannis Schulz. Many thanks for showing me 😐.

8 Akio Toyoda Steps Down as Toyota CEO

Christoph Roser, February 21, 2023 Original at https://www.allaboutlean.com/akio-toyoda/

Figure 56: " Akio Toyoda in 2011 (Image Bertel Schmitt under the CC-BY-SA 3.0)"

Somewhat surprising to industry insiders, the CEO of Toyota Motor, Akio Toyoda, announced on January 26 his resignation, and he will step down as CEO on April 1, 2023, to become the chairman of the board. Hence, I will have a look at his impact on Toyota. However, just to be warned, if you expect glowing praise, you should look elsewhere. I believe he changed Toyota, a company I love, in a worrisome way. I am definitely not a fan of his work. Granted, being a CEO is not easy, and he did have to lead Toyota through a couple of crises (Recall,s Corona, etc.). Compared to other CEO's, he is probably somewhere around average. But I believe he had a negative influence on the Toyota corporate culture.

8.1 Introduction

Figure 57:Great-Grandfather Sakichi Toyoda (Image unknown author in public domain)

Figure 58: Grandfather Kiichiro Toyoda (Image unknown author in public domain)

Akio Toyoda (豊田章男) is the great-grandson of Sakichi Toyoda, founder of Toyota Automatic Loom, and the grandson of Kiichiro

Toyoda, founder of Toyota Motor. He was born on May 3, 1956. He studied law at Keio University (where I was a guest professor during my sabbatical), and finance at Babson College. Afterward he worked as a banker in the USA.

He joined Toyota in 1984. Supposedly his father advised him against it, saying, “There is no one at Toyota today who would want to have [Akio] as a subordinate” (source). At one point he even was demoted from assistant manager to regular employee (source).

Aided by his family name, he joined the board of directors in 2000, became executive vice president in 2005, and finally president of the company in June 2009. He will step down as CEO on April 1, 2023, to become the chairman of the board. Strangely enough, this announcement was not made at an official press conference, but on the Toyota Times YouTube channel, where reporters could not ask questions, even with the usually extremely timid Japanese press that always risks losing its membership to the Japanese press club if the news is not pleasing enough.

8.2 Changes in Toyota Top-Level Management

Figure 59: Akio Toyoda in 2011 (Image Moto@Club4AG under the CC-BY-SA 2.0)

Akio Toyoda made large and fundamental changes in the leadership of Toyota. He was demoting or removing many directors (from 27 to 9 in multiple steps) and vice presidents, and removing many advisors (from 67 to 9), including former presidents (source). People who were critical of Akio resigned (some say less-than voluntary), including one of the few foreign vice presidents, Didier Leroy (source). This will consolidate power with Akio, so "no one can stop Mr. Akio's recklessness any longer" (source).

It seems, it was also Akio's intention to promote his son Daisuke (豊田大輔, born April 5, 1988), who was more-or-less pushed into an executive position, and is currently senior vice president of TRI-AD, Toyota's self-driving technology development subsidiary (source). Even though the Toyota family holds only around 1% of the shares of Toyota (source), they still have a dominating control over the company. Insiders believed that Akio wanted to install him as the next CEO, running the publicly owned company Toyota more like a hereditary kingdom (source). Insofar, it is surprising that Akio now hands over the CEO seat to Koji Sato (佐藤恒治, born October 19, 1969), up to now president of Lexus, the luxury brand of Toyota. Is this a change in direction, or merely an extra step to install his prince Daisuke?

8.3 Leadership Style

Figure 60: Akio Toyoda (Image Moto@Club4AG under the CC-BY 2.0 license)

There is also much criticism of his leadership style. It seems, Akio introduced the bad parts of Western leadership to Toyota, namely to eliminate anybody who disagrees with you. One article calls this "the tyranny of the naked king who does not listen to any complaints or criticism" (source). A contact of mine compared the situation in upper management to "North Korea." While I have never myself met Akio in person, I have met with many who have seen his style. I have heard much criticism and little praise.

For example, at one point I talked with a higher-ranking Denso manager. Denso is part of the Toyota group, and in my view the best company within the Toyota group, better than Toyota Motor. At one point we discussed information sharing between companies. He said that Denso shares information freely, including confidential information, but only with companies they trust. If they do not trust a company, they share only the absolute need-to-know necessary information. I then asked him if they trust Toyota Motor. He laughed and refused to answer…which for me was answer enough.

In my view, one of the strengths of the Toyota way was that employees did not fear to speak up, and could often influence upper management. This also seemed to change. Another contact of mine who frequently did business with many companies in the Toyota group told me his view of the differences between Denso (best), Toyota Motor (worst), and the rest of the Toyota group. If he approached his business partner at the Toyota group, proposing a project, and the business partner was worried that his superior wouldn't agree,

- at Denso they said not to worry, they will convince their boss to change his mind.
- at other Toyota group companies they said this will be a problem, but they should wait until the superior position is rotated in a few years, and they will get the agreement from its successor.
- at Toyota Motor they said to just forget about it, it will never be approved.

I also have been told that at Toyota, they now hire more "selfish employees," as they believe that they can stand up better to the more brusque Western business partners. I believe, however, that employees who put themselves before the company are not good for the company (albeit, companies often deserve them). In connection to this, another Denso manager also told me about exchange of people. When I was in the Toyota group (before Akio took over), it was common for employees of one company to have their desk at another company for months, exchanging information and deepening connections. They stopped that. Denso now tries to shield their employees as to not infect them with the in their view bad corporate culture that has developed at Toyota Motor.

8.4 Electric Vehicles… or Lack Thereof

Figure 61: Toyota fully electric bZ4X (Image Alexander Migl under the CC-BY-SA 4.0)

One decision at Toyota that probably came from the very top and may be potentially problematic was to neglect fully electric vehicles and instead focus on hybrid electric and hydrogen fuel-cell-powered vehicles. When making business decisions, there is always the risk of a mistake, and I believe this was a mistake. Batteries continue to improve, and once they are good enough, there is no point for fossil fuels anymore. Nevertheless, Toyota pushed hybrid and hydrogen technology. Yet, on its own, Toyota is simply too small to establish a good hydrogen network. Toyota is definitely behind on electric vehicles (source). Electric vehicle sales are steadily increasing, and the Nissan Sakura is the most popular model in Japan, followed by Mercedes and Hyundai (source). Toyota launched its first fully electric vehicle, the oddly named bZ4X, only in 2022…just to have it recalled immediately "due to the possibility that wheels could come loose". It sold only 232 vehicles in Q1–Q3 2022 (Source: Kelly Blue Book Q3 2022 sales report), which is just pitiful. Worldwide best seller in 2022 was the Tesla Model Y with around 200 000 units. Toyota was ranked as #36 out of 42 fully electric models with a market share of 0.04%. The hydrogen-fueled Mirai is not selling well either, with only 1437 vehicles in Q1–Q3 2022. Toyota does, however, have an almost 50% market share on hybrids. Yet, by neglecting fully electric cars, Toyota is missing a major change in the industry, and this mistake will hurt Toyota a lot in the next few years. Long gone are the days of the Prius, when Toyota led the automotive industry.

8.5 Summary

It is hard to improve a corporate culture, and it is much easier to wear it down. In my opinion, Akio had and will continue to have a negative influence on the Toyota corporate culture. He is doing to Toyota what McDonnell Douglas did to Boeing. I do hope the new CEO, Koji Sato, can stop this trend, but the view at Toyota is that Sato will not change the decision-making style but instead continue as a protege of Akio. Even worse, with kind-of two bosses, “the decision-making structure will become complicated and the speed will slow down“ (source). With reference to the former US president, “Toyota and Mr. Akio Toyoda are beginning to ‘trump’” (source). I am a big fan of Toyota and its Toyota production system, but these developments worry me immensely. I am sure Akio also has his good sides (he is apparently a pretty good race car driver), and running a large company like Toyota is by no means easy. However, I have my doubts about him as a industry leader. Toyota is (was?) in my view one of the best managed companies in the world, but I fear it slipping down to merely average. Now, go out, improve and foster the culture at your workplace, and organize your industry!

8.6 Selected Sources

I used a lot of external sources for this article, many of which are in Japanese.

- 河村靖史: トヨタ“裸の王様”章男社長の独裁、社員が辟易…囁かれる息子の世襲、会社私物化批判も, Business Journal 14.03.2020 (Yasushi Kawamura: Employees are fed up with the dictatorship of Akio, the “Naked King” of Toyota… His son has taken over the reins of the company, and there is criticism that he has privatized the company.)
- 河村靖史:トヨタ「異例」の社長交代　世界的 EV シフトに対応　河村靖史, Weekly Economist Mainichi (Yasushi Kawamura: Toyota’s “unusual” change of president Responding to the global EV shift Yasushi Kawamura)
- 井上 久男:トヨタが中国企業に「敗北」する日がやってくる…日本の基幹産業を襲う「悲劇的な結

末」, Gendai Media, 24.01.2023 (Hisao Inoue: The day will come when Toyota will be "defeated" by a Chinese company… "Tragic consequences" to hit Japan's key industry.)

- 井上 久男:トヨタが「世界一」から転落し、日本の自動車産業の「ヤバすぎる大崩壊」が始まる…！, Gendai Media, 24.01.2023 (Hisao Inoue:Toyota's fall from "world number one" marks the beginning of the "too-bad-to-be-true collapse" of the Japanese auto industry…!)
- 井上 久男:これは「院政」の始まりか…トヨタ社長交代、95 分の「トヨタイムズ」映像で見えた「決定的な異変」, Gendai Media, 30.01.2023 (Hisao Inoue: Is this the beginning of the "House of Representatives" administration… Toyota's presidential change, the "decisive change" seen in the 95-minute "Toyotimes" video.)
- Peter Johnson: Toyota ramping up bZ4X SUV production to compete in swelling EV market, but not anytime soon, Electrec Oct. 26 2022
- 豊田章男 (Japanese Wikipedia Article on Akio Toyoda)
- 【緊急生放送】豊田章男が次期社長 佐藤恒治に託した想い｜トヨタイムズ (【Emergency Live Broadcast] Akio Toyoda's Thoughts on Koji Sato, President-Elect｜Toyotimes), Toyota Times Youtube announcement of change of CEO.

9 Steps Toward One-Piece Flow

Christoph Roser, February 28, 2023 Original at https://www.allaboutlean.com/steps-toward-one-piece-flow/

Figure 62: DALL·E People carrying boxes (Image Dall•E in public domain)

One-piece flow—while often defined differently—is one of the True Norths in lean manufacturing. Get your material flowing! In theory that is easy. In practice, however, there are many obstacles standing between where you are and where you want to be, also for one-piece flow.

9.1 Introduction

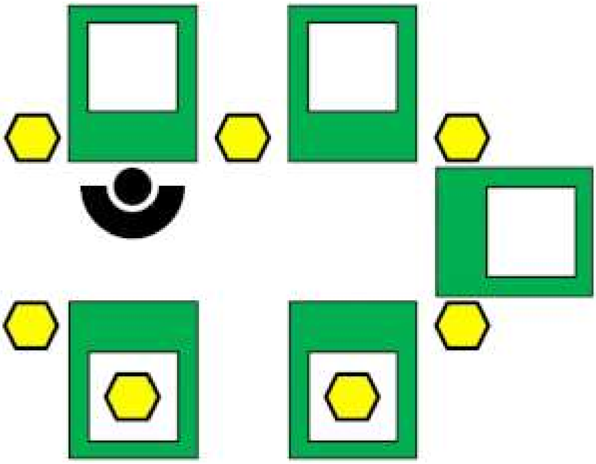

Figure 63: Chaku Chaku line animation (Image Roser)

As I wrote in a different post, one-piece flow moves each product to the next stage as soon as it is completed at the previous stage in the value stream. The next stage should be ready to accept the part immediately. The goal is to increase the time your material is being worked on or being transported, and reduce the time it is merely sitting around (with the caveat that transport is also one of the seven types of waste [muda] and should be reduced).

One famous example is Chaku Chaku lines, which work best if there is, at most, one piece between the processes. Reduced handling often makes such lines quite efficient. Such Chaku Chaku lines are close to the ideal for one-piece flow. There is a short time when the part rests, but for the sake of machine utilization, this is usually acceptable for Chaku Chaku lines.

9.2 How to Approach One-Piece Flow

Figure 64: Pizza Scooters are Micro-trucks… (Image Uwe Aranas under the CC-BY-SA 4.0 license)

Since the goal of one-piece flow is to always have parts either in production or moving between production steps, there are a few main levers. Some of these are obvious, others may be not.

- Make your transport unit smaller. Ideally you transport a single unit as soon as it is done.
- Have sufficient transport capacity, so that the part does not have to wait for transport.
- Avoid batch processes. If you make multiple parts in one batch (e.g., an oven for heat treatment), you will get many parts at the same time when the process is done. Chances are, at least some of the downstream processes are either not batch processes at all or at least have a different batch size, and—bang—you have parts waiting for the next step, breaking the flow.

- Do not overload your system. The next step should be ready to accept the next part without delay.

Some of these above approaches may be difficult. Some may be unachievable (e.g., it is unavoidable that a part sometimes just has to wait for a process or a transport). This is only the direction of True North, and it is up to you how far you are willing to go in this direction this time, and how much more next time. If you intend to go from your current state all the way to perfection in one step, chances are good you'll kill your company. Let's have a look at the possibilities and the trade-offs.

9.3 Small Transport Unit

Figure 65: Small gullwing trucks popular in Japan (Image Roser)

The first step here is obvious. Transport a part whenever it is ready. If you have the choice between a big box/pallet/container/truck and a small one, tend toward the smaller one. Toyota in Japan prefers smaller but more frequent trucks over larger and less frequent ones.

If you present this to cost accounting, be prepared for some heated discussions, though. The transport cost can be easily calculated. The benefit of more frequent transport, however, is harder to calculate, and hence often ignored. But it IS there!

It can help if you put the processes closer together. This applies both to plants (Toyota's main suppliers are within two hours of Toyota City) as well as to lines and processes. The farther apart they are, the more hassle it will be to transport, the more the tendency to bigger shipments.

9.4 Enough Transport Capacity

Figure 66: Forklift in operation (Image Katarzyna Kobiljak in public domain)

To keep material flowing, you need the ability to transport it. This is easiest done with dedicated systems like conveyor belts, AGVs, FIFO lanes, or similar. In this case you can also limit the inventory more easily, which prevents accumulation of material and reduces your flow.

It is a bit trickier with shared transport like forklifts or trucks. Having too much idle transport capacity costs money (which can be calculated easily), and you have to see if it is worth the reduced wait of material and processes (which is harder to calculate). Similar to the overloading of processes (see below), a 100% utilization of your forklift simply means that everything has to wait for transport and material will be piling up again.

9.5 Avoid Batch Processes

Figure 67: Baking Bread (Image FotoDawg under the CC-BY-SA 2.0)

You may or may not have batch processes that produce multiple parts at the same time. If you do, it is probably because cost accounting determines that it is cheaper that way, again overlooking the benefit of one-piece flow.

I usually find that managers struggle quite a bit to imagine an alternative to such batch processes. It is not easy. But it is doable. For example, one-piece flow induction hardening can replace a conventional oven. I have written a whole post on how to achieve lot size one and eliminate batch processes, including aluminum die casting, for example.

9.6 Do Not Overload the System

Figure 68: Overloaded (Image Ermell under the CC-BY-SA 4.0 license)

Many shop floor managers dream of 100% utilization. However, this dream is usually a nightmare! As utilization approaches 100%, the lead time approaches infinity (for more details, see the Kingman equation). In other words, the higher the utilization, the more parts have to wait so that the process can always be busy. Often, utilization has a higher priority in factories, but this is due to cost accounting. Cost accounting can determine the investment cost of the machine very well, and hence tends toward 100% utilization to "get the most out of the machine." However, they usually don't realize that this drives up inventory and lead time. Even if they do, it is hard to put a monetary amount on all the negative effects of inventory and increased lead time.

Utilization is also only one of the aspects in the picture. Closely related is the balancing of the different processes. If one process is significantly slower or faster than the other ones, chances are good that material will accumulate before or after this process respectively. The closer the process speed matches the customer takt, the better your chances that you only have to deal with random fluctuations in speed rather than a permanent offset.

9.7 Can You Achieve Perfection?

Figure 69: DALL·E Perfect Machine (Image Dall•E in public domain)

No.

No!

You can't.

No matter what, sooner or later you will put a part down and have it wait for something else. That is life. You may not even want to achieve perfection. The closer you get to one-piece flow, the more other costs may rise. For example, for one-piece flow it would be best if you have many more machines than needed, so a part never has to wait. However, the capital investment would be abhorrent. You have to find a trade-off between machines waiting for parts and parts waiting for machines.

Similarly, for all the other approaches, there is usually a trade-off involved. Find a good trade-off, and in case of doubt, put more value on one-piece flow. But also keep in mind that the system is not static. You can change the system so that a better one-piece flow is possible and feasible. Putting machines closer together, improving the machine balancing, swapping a batch process for a process making parts one by one, … there are many ways to change the system to make one-piece flow more feasible. Now, go out, improve your system, get your parts flowing, and organize your industry!

PS: Also, on a side note, this is my 500th post on this blog. I am quite happy how a little side project that I started ten years ago turned out to be. Thanks for reading 😐.

10 On the Benefits of Putting Your Processes Close Together

Christoph Roser, March 7, 2023 Original at https://www.allaboutlean.com/benefits-processes-together/

Figure 70: Shop floor Space (Image zanskar with permission)

Putting your processes closer together in manufacturing obviously saves space. However, there are many more benefits of putting processes closer together. Let me give you a run down of the benefits:

10.1 Space

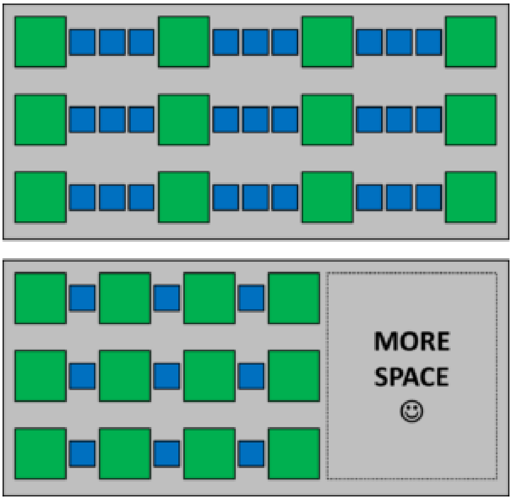

Figure 71: Distance and Space (Image Roser)

The obvious benefit is to require less space for your machines. Shop floor space does cost money (regardless if rented or owned). Albeit, the actual saving on space may be hard to materialize (it is tough to rent out a corner of your workshop). Yet, it does give you more space to put other stuff for expansion. I have yet to see a factory that thought it had too much space. But freeing up space is only the start of the many benefits of putting machines and processes closer together.

10.2 Inventory

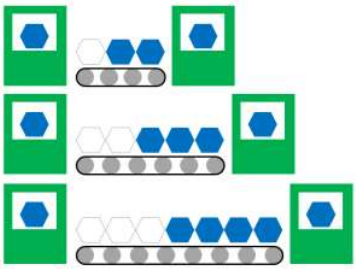

Figure 72: FiFo Lanes (Image Roser)

Inventory between processes usually needs to be managed, and there should be a limit on the inventory between two processes. Ideally, you have a FIFO that organizes and limits your inventory, but this inventory management is often neglected, and the work-in-progress inventory (WIP) is whatever it happens to be.

Having your processes closer together automatically gives you less space for your inventory, especially in a flow shop type of manufacturing. Even if the inventory is not explicitly managed, the space constraint simply limits how much there can be.

10.3 Material Handling

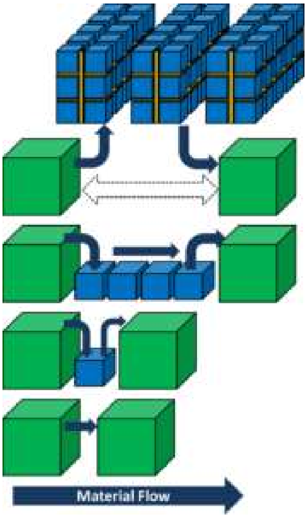

Figure 73: Distance and Material Handling (Image Roser)

Having processes closer together also has the potential to reduce material handling if the material goes directly to the next process. If the material goes from one process to a central warehouse and then to the next process, then there is no benefit, as the material has to be brought to the warehouse regardless of how close together the processes are. Here, the distance to the warehouse is more relevant.

However, if the material flows along a line of some sort, closeness can have some advantages for material handling. If the processes are farther apart, someone needs to take the material out of the process, someone (else?) needs to move it to the next process, and someone (else) has to put it in the next process again. That makes (usually) three handling steps that have to be done either by people or by logistic processes.

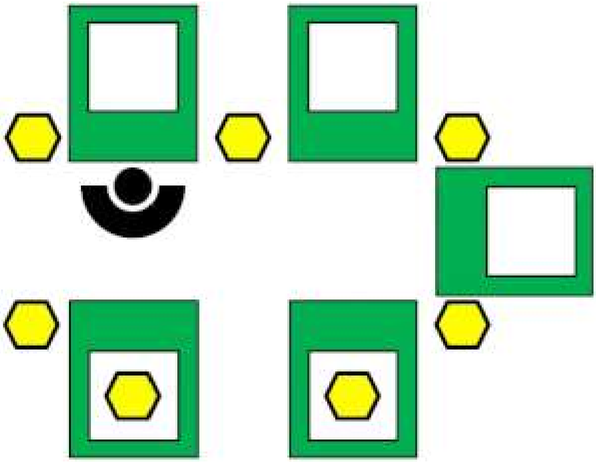

Figure 74: Animated Chaku Chaku (Image Roser)

If there is little inventory between processes and the processes are close enough, then it may be possible to eliminate one of these steps. The part is taken out of the first process. The next process is close enough that it can pick up the part directly, without any additional material handling. You saved the extra transport step. This is common in Chaku-Chaku lines, where the preceding process ejects the part automatically, and the worker then puts the part in the next process, a mix of automatic and manual material handling. (Ejecting a part from the machine into a random position is much easier to automate than putting the part into a defined position in the next machine. Hence, ejection is often automatic, and inserting in the next machine is often manual).

If you manage to have no inventory at all between the processes, then the same movement can both remove the part from the previous machine and place it into the next machine. In this case, it may be possible to move the part between processes while touching it once, instead of having it touched twice or three times by different people or logistic processes.

10.4 Lead Time

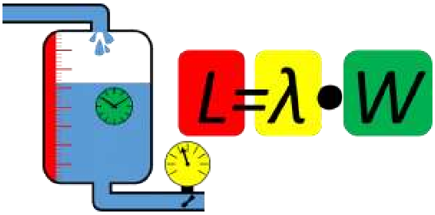

Figure 75: Water Tank example of Little's Law (Image Roser)

The main factor determining the lead time within the production processes is usually inventory (assuming you are not missing parts that are delayed, or are waiting for product development). Little's Law determines the lead time through the inventory in the line and the line takt. Hence, less inventory usually means faster lead time, among many other benefits of reduced inventory (see my post on The Hidden and Not-So-Hidden Costs of Inventory).

10.5 Information Delay

Figure 76: Different ways how workers and managers access data (Image style-photographs with permission, and Thomas Karol in public domain)

It is not only material that takes more time to cover the distance. Information flow is also affected by distance. Nowadays, a lot of information flows digitally, and it does not matter if the next computer is in the same room or on the other side of the world.

However, what many forget is that a lot of information still flows not digitally but through humans. This may include listening to others as well as looking at things, but also other senses like touch, smell, temperature, or in some cases even taste, vibration, and more. All of these benefit from being close to the source.

For example, there is a lot of "soft" information flowing in a manufacturing line. If the worker at one station is close to another station, he is much more likely to exchange information (e.g., on upcoming changes or problems in the production). He may help by giving advice or getting hands-on to solve a problem for the colleague.

Having people around you also may make the workplace a nicer environment. While in America workers are often seen merely as biological machines, they are indeed humans, and benefit from social interaction, which in turn benefits the workplace.

Many lean processes like Just in Time (JIT) and Just in Sequence (JIS) are much harder to pull off if you have longer distances with a resulting delay in material and information flow.

10.6 Visual Management

Figure 77: Eye (Image pixelaway from with permission)

Yet another often overlooked benefit is visual management. Sometimes, visual management is seen as putting stickers and labels everywhere and hanging up andon boards. This is often helpful, but I see it merely as an add-on to an easy-to-understand shop floor. The first step in visual management is to create an environment that is easy to observe.

At a glance, you should see how much material you have where, which machines have problems, and what jobs are being worked on. If you rely only on color and labels for this, then you have already failed. The bigger (and often more difficult) part is to make the shop floor easy to observe. And, in my view, processes being close to each other can contribute to an easier understanding of the situation on hand.

10.7 Synchronizing

Also, the closer the processes are together, the easier they are to synchronize and to balance the line. At the very least it is much easier to see if the machines or processes work at different speeds. (Many thanks to Mark Warren for the suggestion to add this)

10.8 Also Outside of the Factory

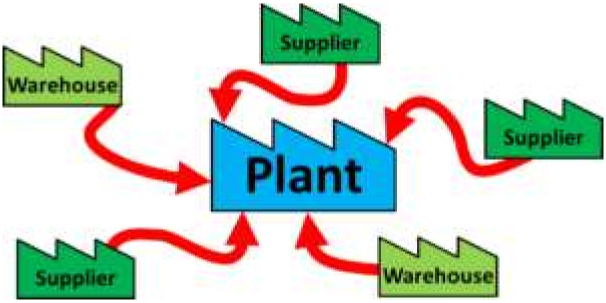

Figure 78: Space between Plants Supplier Warehouse (Image Roser)

Being close together helps for processes within a factory. However, it can also help across different factories. Toyota has most of its suppliers within a two-hour drive of its main plant in Toyota City. Car makers often try to get the seat maker to set up a plant just across the street to enable a Just in Sequence production of car seats.

10.9 Summary

Overall, putting your processes closer together can have quite some benefits. For example, I once worked for a car parts plant. Their problem was that there was a new highway to be constructed, and that highway went right through their property. As a result, they lost HALF of their manufacturing space to public infrastructure, and they were forced to move closer together. VERY much so. The process was not easy, and it involved a lot of complaining about the bloody government and its roads. However, the company managed and re-organized production with half the space (plus some outsourcing). What really surprised them afterward was how much more efficient the plant became. While they didn’t understand how, except for getting everything closer together, lots of costs went down. Quality went up. Speed increased.

Overall, being closer together in manufacturing has many benefits. Now, go out, get cozy with each other(‘s processes), and organize your industry!

11 How to Establish a Qualification Matrix

Christoph Roser, March 14, 2023 Original at https://www.allaboutlean.com/qualification-matrix-creation/

Figure 79: Industry Training (Image Narith Thongphasuk with permission)

The qualification matrix (also skill matrix, competence matrix, or Q-matrix, one of the few examples where Q does not stand for Quality) is a simple tool to keep track of the qualifications of your employees. It keeps track of who can do what and how well. As a tool, it is not overly complicated but rather simple. Yet, there are still some things to consider for a qualification matrix. Let's have a look at this basic but very useful tool.

11.1 The Basics

The qualification matrix is, as the name says, a simple matrix. On one axis are the different people in your group, department, or company. On the other axis are the different qualifications. This helps you to keep track of who can do what, and where you still may have gaps and training needs. The example here is a qualification matrix in its most simple form, merely showing who can do what. But more is possible. Let's have a look at the different parts of the matrix.

	Punching	Riveting	Testing	Packaging	Logistics
Naomi		✖	✖	✖	✖
Lakshmi	✖	✖		✖	
John	✖		✖		✖
Jane	✖	✖		✖	
Haoyu		✖		✖	
Diego				✖	

Figure 80: Qualification Matrix Simple (Image Roser)

11.2 Digital or Physical?

Figure 81: Paper transforming into a Monitor (Image Dall•E in public domain)

Paper-based qualification matrices are easy to handle, but hard to share and difficult for large groups of people and/or tasks. Digitally, of course, you are not limited by such constraints, and could keep track of an entire company. If so, however, you should be able to sort and filter to look at only the people you are interested in. This could be combined by having a digital whiteboard or monitor to show the qualification matrix.

However, managers usually underestimate the additional time and effort needed to go from paper to digital. For example, if a new task pops up on the shop floor, on paper you merely add a column. Digitally, you probably would have to get the proper access rights, learn how to set up an new digital task, and then set up the task. If the group manager has to do it, then it probably takes him more than an hour to do what should take five minutes. If this is done by a central department, it may take weeks before they get around to doing it. Hence, there are, with quite some justification, still many paper-based qualification matrices in industry.

11.3 The People

On one axis (often the vertical one) you will find a list of people. If the matrix is in written form (paper or whiteboard), then the number of people is often not too long, rarely more than thirty. Otherwise it becomes hard to keep an overview of things, and the board would become rather large. Often, the people are the current workers assigned to a department, line, or group.

Figure 82: Group of industrial workers. (Image Kurhan with permission)

Especially on paper-based qualification matrices, I often see photos of the employees. This can help you quickly see which employee is where, especially if some employees are less than literate, or (like me) have a hard time remembering names.

The sequence does not matter too much. It could be sorted by hierarchy, or alphabetical. Paper-based matrices often are sorted by how long someone has been in the department, simply because new people are added at the bottom and departing people's rows are removed. Alternatively, new people are merely inserted wherever there is space from the departing people.

11.4 The Qualifications

Figure 83: Child at School (Image Russell Lee in public domain)

The horizontal axis often has the qualifications. Such a qualification can be formal based on an exam (e.g., having an AWS D1.1 welding certification from the American Welding Society) or informal where the supervisor believes that person can do it (e.g., knowing how to operate the riveting machine). This can include technical skills, soft skills, education, experience, certifications, and other qualifications. It could be process related (riveting) or a general skill (speaking Chinese).

The qualifications should of course relate to the company needs. It is nice if Haoyu can play the saxophone and Naomi knows beekeeping, but both are irrelevant if the job is to make crankshafts. Especially for paper-based qualification matrices, only the relevant skills for the daily work should be listed. Digitally you can expand a bit into less frequently needed tasks, but then you will have more digital maintenance overhead.

While for the people the sequence did not matter, for the qualifications some sequences are slightly easier to track than others. If you have a manufacturing line, it is helpful to arrange the skills in the sequence of the line. For example, if your line does punching, riveting, testing, and packaging, then the qualifications should be in the same sequence. This helps keeping track of the needs. If you use also a work assignment matrix (where you assign workers to different processes for each shift), then it is Really helpful if the sequence of tasks for the work assignment matrix and the qualification matrix are identical! Some overarching qualifications (logistics, data entry, etc.) could be at the beginning or end. But this is not a strict requirement, and especially on paper-based boards, the sequence may muddle a bit over time.

11.5 The Matrix Elements

The elements in the matrix could be quite simple. Who can do what. However, often a finer granularity may be helpful. For example, if a person speaks Chinese, can he count to ten, or can he conduct business negotiations? Such language certification levels range from A1 (simple conversations) to C2 (fluent).

The shop floor could also benefit from different levels. Often, such levels are some sort of the following:

- Cannot do it (no qualification)
- Can work under supervision
- Can work independently
- Can teach others
- Manage improvement process, verify and implement improvements (Note: everybody can thing about improving and suggest ideas, but one person has to manage this improvement process.

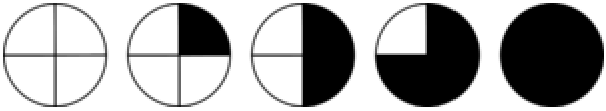

Figure 84: PDCA Circles (Image Roser)

For easier reading, this is often displayed in sort-of PDCA circles, although it has nothing to do with PDCA (they are known as Harvey balls after their inventor Harvey L. Poppel). These circles show the qualification levels, from completely empty (no qualifications) to completely full (manage improvement process).

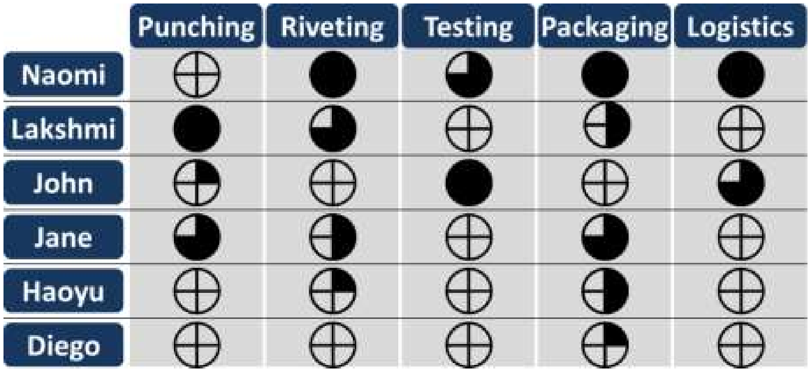

Figure 85: Qualification Matrix Granular (Image Roser)

The assessment could be formal though a test, exam, or certification; or informal as assessed by the manager, the team, or (rarely) even the employee himself.

Please be aware that not all qualifications need such a grading, and a binary system is good enough. For example, the AWS D1.1 welding certification – either they have it or they don't. A simple check mark would suffice, although for consistency you could also use PDCA circles, but use only a fully empty or fully filled circle (which also looks more impressive).


Figure 86: Expiration Date Beer (Image Reedy under the CC-BY-SA 3.0)

In some rare cases you may also include an expiration date of the qualification. For example, in Europe, truck driver licenses for hazardous materials need to be renewed every five years. In this case a date may help. But use such an expiration date only if necessary so as not to fill up the matrix with unnecessary data.

In my next post I will go into more detail on how to use a qualification matrix. Now, go out, manage the skills of your people, and organize your industry!

12 How to Use a Qualification Matrix

Christoph Roser, March 21, 2023 Original at https://www.allaboutlean.com/qualification-matri-use/

Figure 87: Skill Matrix illustration (Image vectorwin with permission)

In my last post, I described how to build a qualification matrix (also skill matrix, competence matrix, or Q-Matrix). In this post I will go into more detail on how to use a qualification matrix. By itself, the qualification matrix is a pretty simple but useful tool. This post will help you to get the most out of it.

12.1 Quick Recap

As explained in my last post, the qualification matrix is a simple matrix with a list of people on one axis and a list of their qualifications on the other axis.

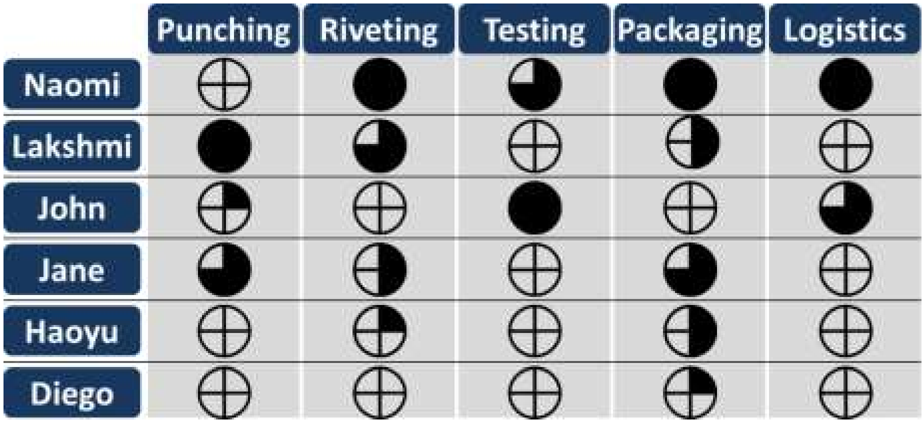

Figure 88: Qualification Matrix Granular (Image Roser)

The qualification matrix has a few main uses:

12.2 Work Assignment


Figure 89: Work Assignment (Image Tiam 13 with permission)

The main use of a skill matrix is to see which worker is qualified for which job when assigning different tasks. Often, a qualification matrix is used in combination with a work assignment matrix. This is especially important on the shop floor, where the assignment of the workers to the different processes may change with each shift. In this case, the sequence of skills on the qualification matrix and the sequence of tasks on the work assignment matrix should be identical; otherwise it requires more attention and may have more frequent mistakes.

Hence, when assigning tasks to the different workers, the skill matrix (or at least the knowledge of who can do what) is needed to ensure every required task is covered by someone able to do the task.

For project work in an office, the work assignment matrix is often expanded into a responsibility assignment matrix (RAM matrix) or RACI matrix, where for each task there is someone responsible (R) and accountable (A), but possibly also consulted (C) or informed (I). (There may also be many more similar approaches, like PARIS, PACSI, RACIQ, DACI, RATSI, RASCEIO, and many more, mainly to make consultants happy. See Wikipedia for a list.). In any case, here too the person assigned to any RACI should be able to do the part of the RACI.

12.3 Identify Qualification Needs

A second major use of the qualification matrix is to check for qualification needs. Where do you have gaps in your qualifications? Please note the goal here is not to have everybody qualified in everything. That may cost a fortune, and may not be possible at all.

But you should have enough people that all necessary tasks can be done, even if a person is sick and another one is on holiday. See the matrix below for an example of a couple of critical points. In punching, we have two people on the matrix, Lakshmi and John, but John is a beginner who just started training on the punching machine. If Lakshmi becomes sick, goes on holiday, or quits the job, then there will be a major problem. Hence, punching has a major need for additional qualification to ensure smooth operations even if someone is absent.

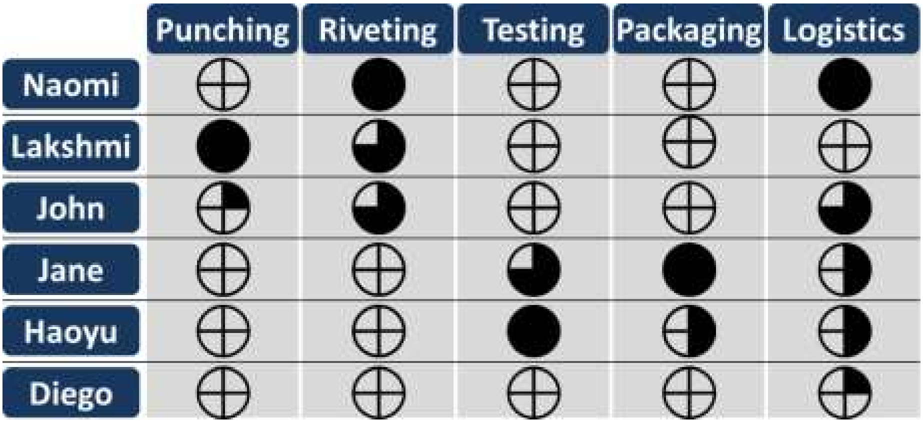

Figure 90: Qualification Matrix Bad (Image Roser)

Another, less obvious problem is testing and packaging. Both have two people who are qualified to work on their own, hence the minimum requirement should be satisfied. However, it is the very same people, Jane and Haoyu, for both testing and packaging. If one works in testing, then the other works in packaging, or vice versa. If one of them is absent, then you can run only one of the two processes. This is also a major qualification need. (Obviously, if testing would only be an occasional side job that can be done by one person in addition to packaging, this would be less of an issue).

Also, keep an eye out for if one qualification is needed for multiple workstations. For example, if you have two riveting machines, then having only three people qualified for riveting is a bit tight. If one is on holiday (plannable) and another one is sick (unplanned), then you cannot run both machines. Overall, you should have at least two people for each job who are qualified enough to do the job on their own. Even two people may be tight in some cases, and three may be more comfortable. This qualification matrix helps you to see such qualification bottlenecks.

There may even be work assignment structures that must have multi-skilled workers, like the baton touch or the bucket brigade, or qualified for ALL processes like the rabbit chase. See below for two qualification matrix examples for the baton touch and the rabbit chase.

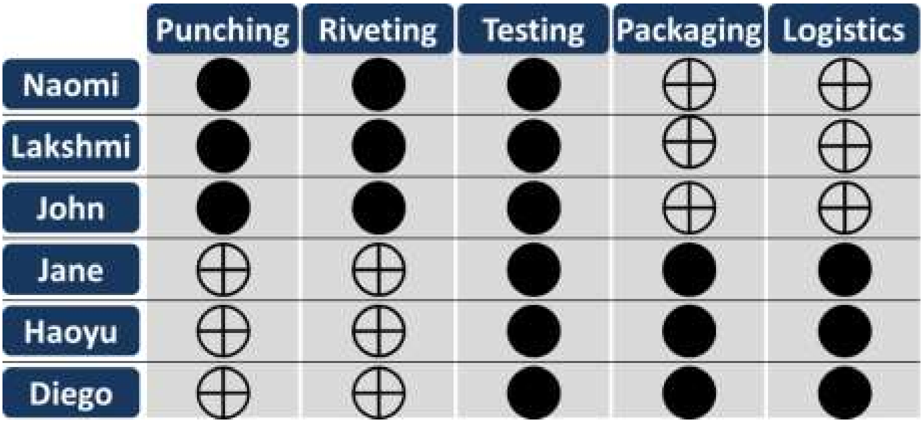

Figure 91: Minimum qualification example for baton touch system (Image Roser)

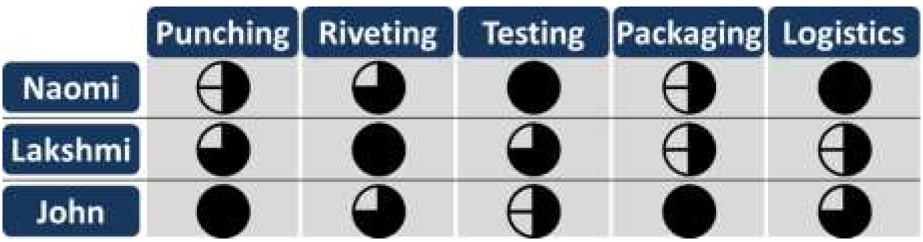

Figure 92: Minimum qualification example for rabbit chase system (Image Roser)

There may also be examples were it is necessary that every employee has a certain qualification. For example, in some companies it is required that every employee has an ethics or code of conduct training. (But this may be less for the employee to behave ethically and more for the manager to deflect accusations if the employee doesn't.)

But overall, a qualification matrix is an useful tool to see where you have training needs, to prevent problems later on if one or more employees are absent.

12.4 Employee Evaluation

Figure 93: Wooden Smiley Blocks (Image marchmeena with permission)

Another use of a qualification matrix is for employee evaluations. This could be during the hiring process, or later during regular (annual?) performance reviews. But, to be honest, I am not so hot on this usage. I have seen examples where the qualification matrix is even used to determine an employee score (weighted qualifications multiplied with the qualification level) to estimate the overall value of an employee. But I (and probably many employees) would find this offensive. I am generally skeptical about numerical performance evaluations. Hence my recommendation is: Don't use a qualification matrix to determine the value of an employee. Of course, a higher-skilled person is better for the company, but there is more than just the entries in the qualification matrix for this.

However, the qualification matrix could be used for target setting. For example, during the evaluation, a possible goal for the employee could be to become qualified in certain skills to a certain level, to be reviewed during the next evaluation.

Overall, the qualification matrix is a simple and useful tool to keep track of the skills of your people, and to help you optimize and improve the skill set in your company to better match the needs. Now, go out, see where your team has gaps in their qualifications, and organize your industry!

13 Adding Another Axis to the Qualification Matrix—Products

Christoph Roser, March 28, 2023 Original at https://www.allaboutlean.com/product-axis-qualification-matrix/

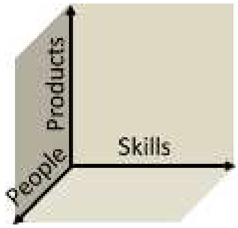

Figure 94: Qualification Cube (Image Roser)

In my last two posts I talked about the qualification matrix, where you match the skills of your people to the skills needed for your business. This can be expanded with another axis, as for example the skills needed for certain products. This connects your people to your products through skills. It is also more useful for products where a single person assembles an entire product.

13.1 Quick Recap

As explained in my last post, the qualification matrix is a simple matrix with a list of people on one axis and a list of their qualifications on the other axis. This can be used for work assignment, identifying training needs, and for employee evaluation, although I am hesitant on the last one.

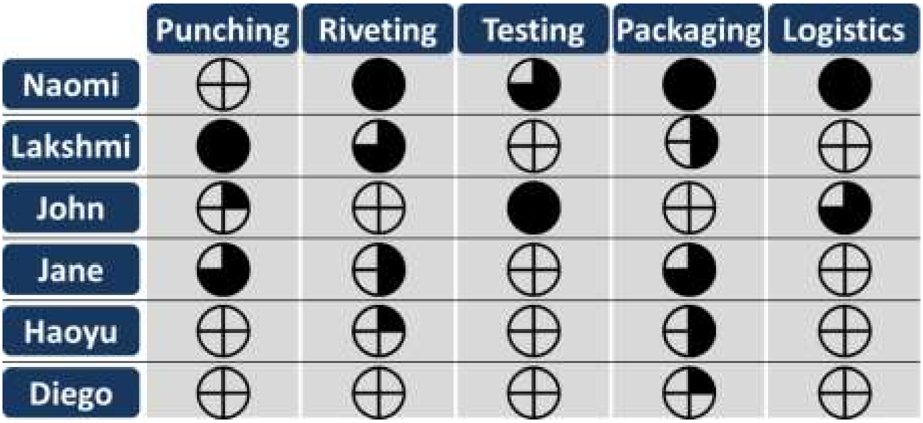

Figure 95: Qualification Matrix Granular (Image Roser)

It is quite possible to make similar matrices with other axes. One example I have seen is a combination of skills and products.

13.2 Skills and Products

Sometimes, you find very similar matrices, but they compare the skills with the products. In other words, they list which skills you need for what product. An example is given below. This shows the different qualifications needed to make a certain product. You need people with the right skills to make certain products.

	Punching	Riveting	Testing	Packaging	Logistics
Product A		✖	✖	✖	✖
Product B	✖	✖		✖	
Product C		✖	✖		
Product D	✖	✖		✖	
Product E			✖		✖
Product F		✖	✖	✖	✖

Figure 96: Qualification Product Matrix (Image Roser)

13.3 Three Axes

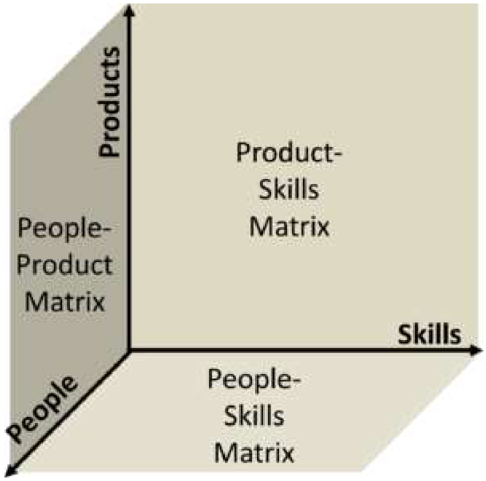

Figure 97: Qualification Cube labelled (Image Roser)

You have three axes: skills or qualifications, people, and products. Because, if you have a regular qualification matrix (or skills matrix) and a skills-product matrix, then you can easily combine them. You connect the products with your people through the skills that your people have and your products need.

You can combine these two matrices as shown below. The top half shows which products need which skills, and the bottom half shows which employee has which skills. The type of skills naturally has to be identical.

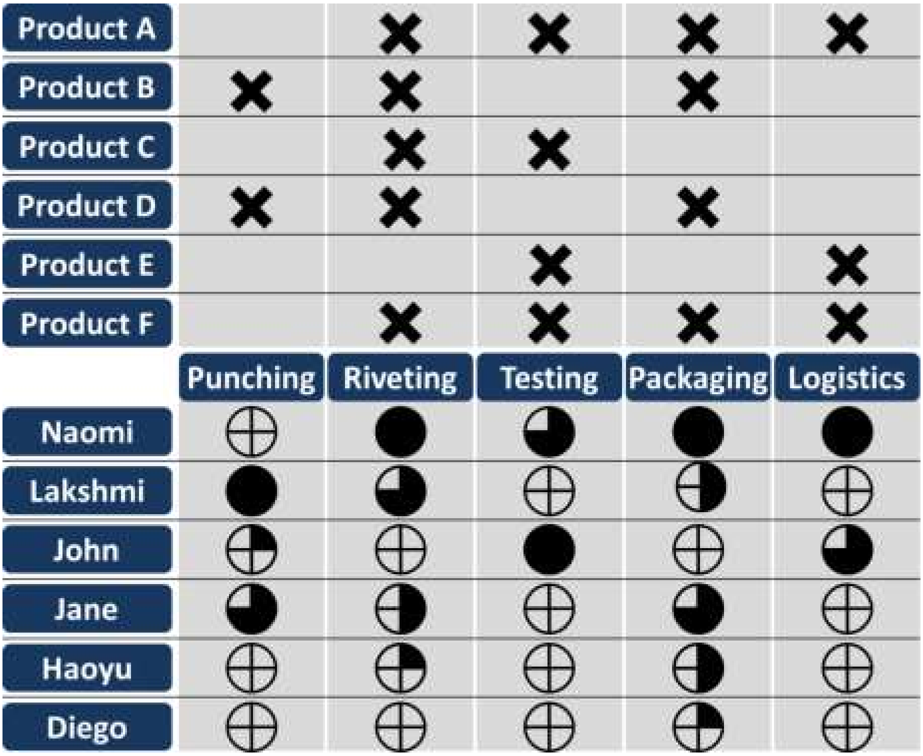

Figure 98: Qualification Product Matrix Combined (Image Roser)

13.4 Three Different Matrices

Overall, you can get three individual matrices out of this information of people, skills, and products.

- A People-Skill matrix (the classical qualification matrix)
- A Skill-Product matrix to see which products require which skill
- A People-Product matrix to see which people you need to make which products

We already looked at two of them. There is one side missing.

13.5 The People-Product Matrix

As the name says, now you can look at the relationship between the people and your products. Which person can do which product.

This could be used in assembly lines, but in assembly lines you usually have one person per task, and it is not necessary for every person to be able to do every task. However, it does become more helpful for work cells with few employees, or generally any system where an employee may have to cover all tasks needed for the product. This could be a work cell with only one person, or a line organized through a rabbit chase.

The example derived from the two other matrices above is shown below. Only Naomi can assemble product A, C, and F. Lakshmi and Jane can both do products B and D, and both Naomi and John can do products E. Employees Haoyu and Diego are still in training and not qualified to do any product on their own.

	Product A	Product B	Product C	Product D	Product E	Product F
Naomi	✖		✖		✖	✖
Lakshmi		✖		✖		
John					✖	
Jane		✖		✖		
Haoyu						
Diego						

Figure 99: People Product Matrix (Image Roser)

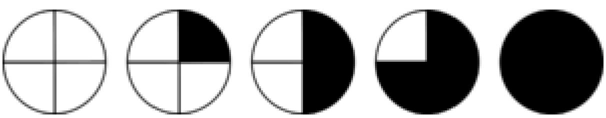

Figure 100: Harvey balls (Image Roser)

This way you can quickly see if you can produce a certain product depending on the availability of skilled workers. You could even use the Harvey balls as a weight and calculate a percentage skill level of each employee for each product. However, please note that the Harvey balls may have higher qualifications than needed for mere assembly. You only need a person to do the assembly on their own.

If the Harvey ball has the levels 0) unskilled, 1) with supervision, 2) independent work, 3) trainer, and 4) can improve, then you need only “half a ball” of skill to assemble a product. Hence any worker who has a skill level of at least half a ball counts as 100% for this task. A quarter ball would be 50%. Summing up the different skills for the different required tasks would give you a percentage of qualification of each worker for one product, ranging from 100% (can do it completely) to 0% (can't do anything yet). This helps you also to see where a little bit of training could qualify a worker to complete a product entirely.

It is overall an interesting approach that can help you especially if workers have to assemble an entire product. It can also be modified for covering parts of a product (i.e., who can do the first half and who can do the second half of one product). On the other hand, if you have a fully staffed assembly line where every worker takes care of only a single task, then the additional axis may not be necessary. Use such tools if you need them, not merely because you can do them. Now, go out, make sure you have the right skilled people to create your products, and organize your industry!

P.S.: Many thanks to fellow nerd Franck Vermet for the input.

14 On the Team Structure at Toyota

Christoph Roser, April 4, 2023 Original at https://www.allaboutlean.com/toyota-team-structure/

Figure 101: Group leader Illustration (Image howtogoto with permission)

Toyota is (among other things) famous for its team structure on the front line. They have a quite low ratio of team members to supervisors, and I believe that is part of their success. Whereas many Western companies overstuff their hierarchy, at Toyota supervisors actually have the time to help their people and to also improve the operations. Let me dig deeper into that. This blog post was inspired by the new book by Baudin and Netland, Introduction to Manufacturing.

14.1 Team Structure at Toyota

TOYOTA

Figure 102: Toyota Logo (Image Toyota for editorial use)

At Toyota, front-line operators are structured into teams of four to six operators (Other sources say five to eight, but my own observations tend toward the lower number). These teams are led by a team leader, called hancho (班長 for squad leader; group leader; team leader), although nowadays at Toyota the English word team leader is also sometimes used. Usually, this team leader is promoted from the operators, and is a highly experienced operator who knows the workstations assigned to the team very well. This position is somewhat a transition between operator and leadership. The team leader does not have the authority to take disciplinary action, and his work usually also includes actual operations in addition to leadership. A team leader works 40 to 60% of the time on actual production tasks, and the remaining time on supervision.

Figure 103: Toyota Team Structure (Image Roser)

Besides actual production work, the team leader is there to support the operators. They assist operators if there is a problem, which may be indicated by the andon line. This includes problems on safety, time (a worker falling behind), and quality (product not good), although since at Toyota a defective product is usually not allowed to move forward, a quality problem quickly becomes a time problem. In any case, the team leader helps. For bigger problems, support by the supervisor or maintenance should also arrive shorty. Team leaders should make sure that material and tools are available and in working order. If an operator needs a break (e.g., for the bathroom), the team leader will take over.

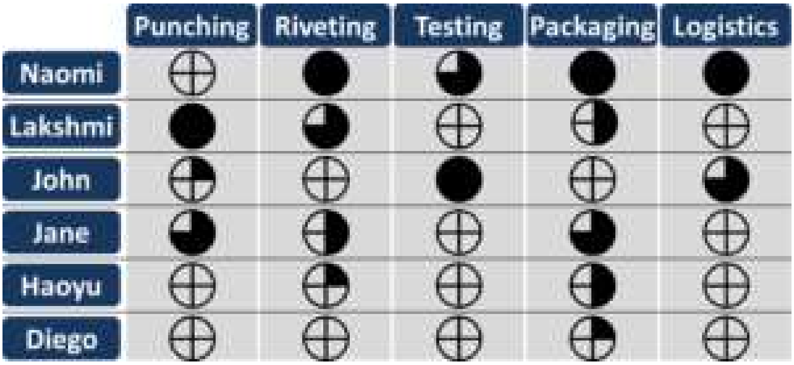

Figure 104: Qualification matrix example (Image Roser)

Team leaders also keep track of qualifications and training needs, for example using a skills matrix (or qualification matrix). They are able to train operators on the job, helping new operators until the newbie can do the job on their own. They verify that people follow the standards, and are the first contact for ideas on how to improve the standard. They also take an active role when implementing improvements.

Team leaders also facilitates communication within the team, upward, and to adjacent teams, also across shifts. They track performance and adherence to standards, and do the twice-yearly performance review of the operators. They are also active if a changeover should be necessary (although many lines at Toyota are flexible enough to switch products without a changeover).

Above the team leader is a group leader (a supervisor or manager, no longer an operator), who is in charge of four to six team leaders and their teams. Hence, a supervisor is in charge of sixteen to thirty-six people, although usually at the lower end. The average is around eighteen people. Please note that the names team leader, group leader, supervisor, etc. are used and defined very differently across different companies.

14.2 Benefits of the Team Structure

The question is, is this all worth it? Is it worth having extra workers to create small teams in order to better support the front-line worker? Toyota thinks it is (and I agree). Luckily, I have data! A few years ago I did a Grand Tour of Japanese Automotive. As part of this, I measured the percentage of the time a worker adds value at an assembly line. I also asked some of the plants of their ratio of supervisors to front-line managers.

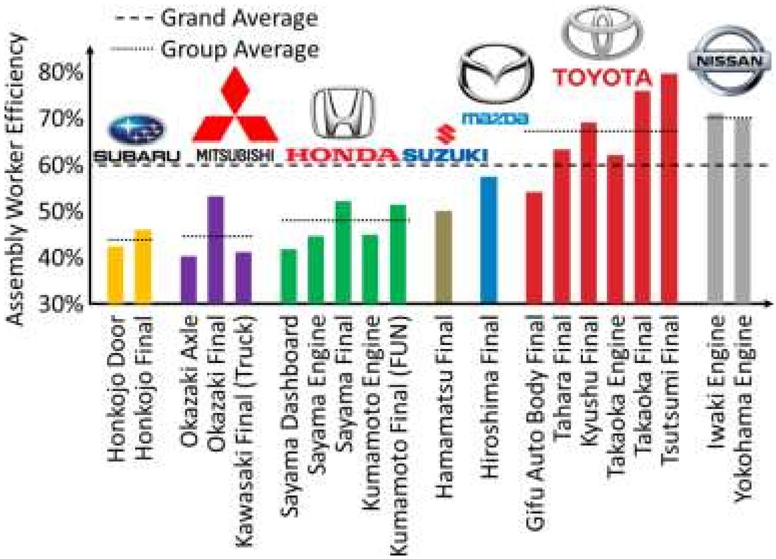

Figure 105: Japanese automotive efficiency comparison (Image Roser)

Even back then I noticed a correlation between smaller teams and better performance, but I never put that into a chart. Now I did. Below is the relation of the percentage value add with respect to the team size of different automotive plants (and one truck plant) in Japan. I also added a trend line.

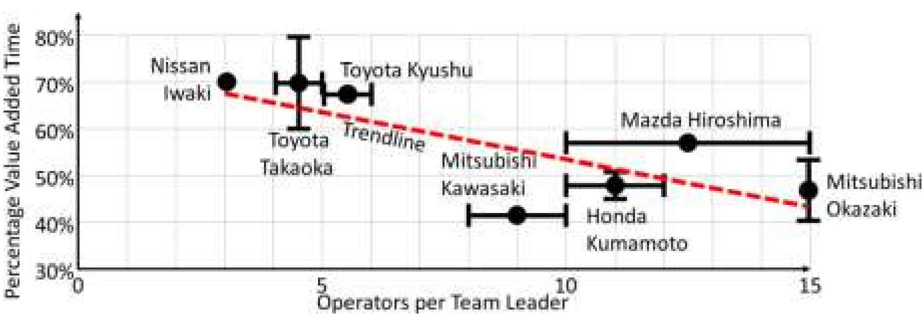

Figure 106: Team Size and Value Add (Image Roser)

Be aware that the data is a bit messy. For example, I measured only one line at Mazda Hiroshima, with 57% efficiency. Mazda also gave me a wide range of ten to fifteen operators per team leader.

Mitsubishi Okazaki told me that they had fifteen team members per team leader, and I measured two lines, the axle assembly at 40% and the final assembly at 53%. The percentage value add is a rough estimate of mine, and the team size is as told by the plant, hence both measures are a bit wobbly. Still, there is a clear correlation with smaller team sizes having much better performance. Very roughly, every reduction of team size by one adds approximately two percentage points of value adding time. (Note: Please don't mix up reducing team size by firing people; that is something different.)

Let's continue the number crunching. If you have fifteen operators for each team leader, then there are teams of sixteen people including team leader, or 6.3% of your people are team leaders. If a team leader works productively only 50% of the time, you have 3.1% of the people (half of 6.3%) doing overhead, and 96.9% actually working on the product. Your value add is 44%, so effectively 43% of the time of all your people is generating a benefit for your company (96.6% working at 44% efficiency).

If you have ten operators for each team leader (i.e., teams of eleven including the team leader), then 9.1% of your people are team leaders, or 4.5.% of the time of your people is overhead, with 95.5% of the time working in the product. However, the percentage value add has increased to 55%, and effectively 52% of the time of your people is generating a benefit for your company. Plotting this for any team size between fifteen and zero (all people are team leaders) gives the following overall value added work. Based on these estimations, the ideal team size is somewhere between two and six people, just where Toyota has its team sizes.

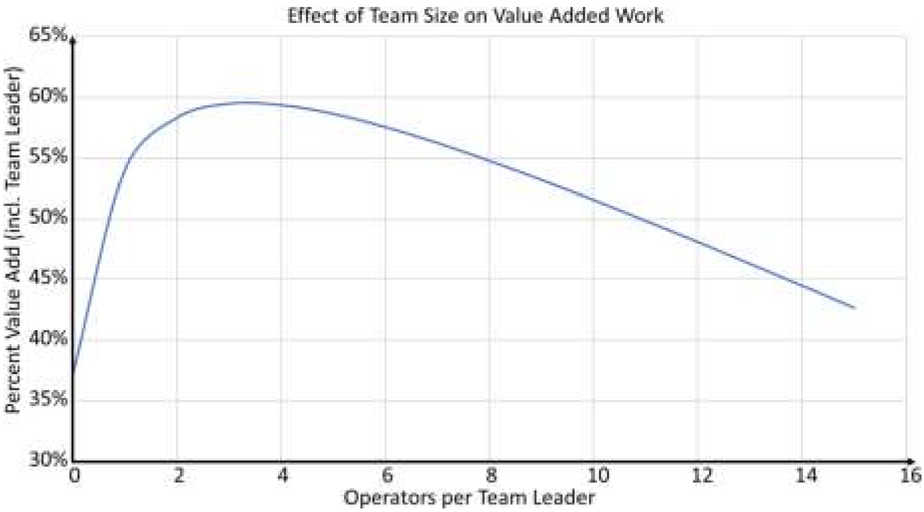

Figure 107: Effect of Team Size on Value Added Work (Image Roser)

Please be aware that this is only a rough estimate, with lots of assumptions. The data is not very precise (a confidence interval would be all over the place), I made a linear extrapolation beyond the rage of my data (i.e., team sizes below three), I assumed that a team leader costs the same as a operator, and so on. On the other hand, I doubt that a team leader of fifteen people will still be able to work 50% of his time on the product. But overall, it seems to be worth the effort to make smaller team sizes of around two to six operators per team leader. On a side note, in projects it is also recommended to have team sizes of three to six people for ideal performance.

14.3 Why Don't We Do That in the West?

Figure 108: Bookkeeper (Image Frank Reynolds in public domain)

So why don't we do this in Western companies? The answer is – as all to often in lean – accounting. The cost of a supervisor or team leader can be measured very well. The benefit is really hard to nail down. If accounting cannot measure it, it sets it to zero (i.e., a team leader has no value for accounting). Hence, to improve the numbers, team leaders got reduced and we often find team sizes of twenty, thirty, and even more operators for a single supervisor or team leader.

Naturally, the team leader is totally overwhelmed with work, and can barely make ends meet, let alone properly help his operators or support improvement. Hence, efficiency goes down and the whole operation suffers.

Reversing this is difficult, since you would have to add team leaders, which cost money, but it takes some time before the benefit of smaller teams is realized (another example of the valley of tears in lean). However, in the long run, it would be quite worthwhile. Now, go out, reduce your team size and get your operators the support they need, and organize your industry!

14.4 Source for some data and the inspiration

I was inspired to write this blog post by the excellent book by Michel Baudin and Torbjörn Netland, where they discuss the team structure on page 17. I added my own data to theirs to create this post, but the entire book is recommended reading 😐.

Baudin, Michel, and Torbjørn Netland. 2022. Introduction to Manufacturing: An Industrial Engineering and Management Perspective. 1st edition. New York, NY: Routledge.

15 Making the Problem go Away Is NOT Improvement

Christoph Roser, April 11, 2023 Original at https://www.allaboutlean.com/problem-solving-vs-improvement/

Figure 109: Businessman in a Maze (Image ra2studio with permission)

Managing problems is an important part of manufacturing because it allows companies to identify and address issues that can impact product quality, production efficiency, and overall profitability. However, it is not to be confused with actual improvement. While taking care of the problem (hopefully) makes the problem go away, actual kaizen requires that the problem should not come back.

Update: The original title of the post was “Problem Solving Is NOT Improvement”. Many readers pointed out to me that this is misleading, and problem solving is almost a synonym for kaizen… and I agree. The initial post was not worded well, and I apologize. I have changed the title and also the content accordingly. Many thanks to all for the feedback.

15.1 Problems…

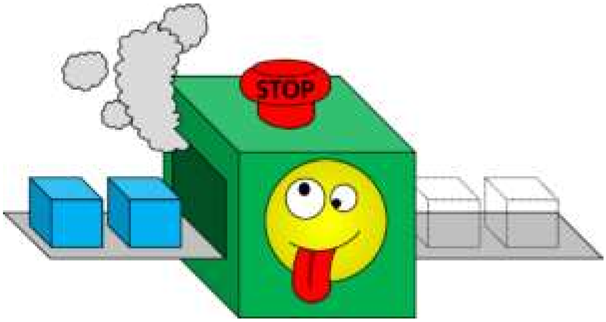

Figure 110: Broken Machine in Jidoka (Image Roser)

If you're in manufacturing, or any kind of operations, you regularly will encounter problems. A machine could be broken. Material is missing. Production falls behind demand. Quality is flawed. And many more. In general, problems can affect anything in the quality-cost-time triangle (i.e., product quality, overall cost, or the time of delivery). Of course, if it affects the safety of your people or your customers or others, then safety should be the top concern! In any case, if you are in charge of a shop floor, such kinds of troubleshooting will probably occupy a lot of your time.

Manufacturing processes are complex and involve numerous steps and inputs, including raw materials, equipment, personnel, and technology. When something goes wrong, it can create a ripple effect throughout the entire production process. This can negatively impact a company's bottom line, reputation, and customer satisfaction. Hence, the faster you can address problems, the better it will be for the overall operations.

15.2 Handling Problems

Figure 111: Car Repair (Image Gobierno de la Ciudad de Buenos Aires under the CC-BY 2.0 license)

Managing problem is often merely making problems go away by identifying, analyzing, and addressing problems or challenges that arise in manufacturing. If you miss parts, you try to get or make them somehow. Broken machines require repairs, flawed quality needs to be addressed, and if your production falls behind, someone has to explain to the customer why his parts are late. When problems arise, it's critical to act fast to prevent it from affecting production and quality. Many of these problems can be fixed with effort; others, despite best efforts, impact the customer or the bottom line, or both.

15.3 Why It Is Not Kaizen

Figure 112: Kaizen (Image Rawpixel.com with permission)

However, just "managing the problem" is not yet kaizen. The "problem" is gine (for now), but it may be only by addressing the symptoms. The underlying cause is still there, and the occurrence of the next similar problem is just a matter of time. Overall, common ways to handle problems is mere firefighting and focuses on the short term. Just make the problem go away somehow. And, admittedly, this is valid. However, you want to resolve problems in the long run.

Managing the problem often merely resolves the symptoms. Kaizen, however, tries to work the process. Instead of adressing a problem, kaizen works on the process (i.e., the standards, to prevent problems from happening again, or even in the first place). Kaizen is also more likely to be data driven than simple problem management (although in lean manufacturing, numbers are not everything).

Figure 113: A hero, rescuing the company from peril… (Image rudall30 with permission)

Such firefighting is addressing a current crisis, whereas continuous improvement is foresight. Managing problems is often not much more than firefighting, which can lead to a culture of awarding and promoting firefighters. It is much more difficult to see, and hence to award and promote the person that prevented the fire than it is to see and promote the firefighter. I have written a whole blog post on Heroes, Firefighting, and Corporate Culture.

Also, managing problems is reactive. Usually, the problem is only addressed once it happens. Ideally, however, the system should be set up so that problems do not happen in the first place. Having firefighters in your city is good, but having good fire prevention standards is much better. A fire that did not break out in the first place is much better than a fire that was extinguished quickly. The same applies to manufacturing. Ideally, kaizen is proactive, but also admittedly, a lot of kaizen is reactive. You don't know about a possible problem until it happens. Or—more likely—you may know about a problem, but since it has not happened yet, you hope that it is unlikely to happen, and you invest your limited resources (your time) in other more urgent problems.

15.4 The Basics on Continuous Improvement

Figure 114: Continuous improvement (Image Olivier Le Moal with permission)

Continuous improvement aims to resolve the underlying issues rather than address the symptoms. The possible solutions can be as manifold as the problems. The challenge is to not only address the symptoms, but to make changes to the underlying standards so the problem does not happen again (or at least happens less often).

I know, that sounds easy, but it is definitely not. Finding the root cause is often tough. Even if you know the root cause, it may be too expensive to fix, or you may lack the levers to fix it. In lean, it is not often talked about because it is not pretty, but I believe sometimes you are just stuck with a problem that is either impossible or too expensive to fix.

On the other hand, there are plenty of problems left where a permanent solution is both possible and worth the effort. Allocate your resources to permanently resolve these problems, while at the same time do not bite off more than you can chew. However, even a well-run company will have plenty of firefighting left.

15.5 Why Many Companies Have Difficulties with That

Figure 115: Unhappy employee resignation (Image Chatchai.wa with permission)

Again, continuous improvement is hard. It takes more effort than simple firefighting, and even then it may only reduce the likelihood of the problem reoccurring and not eliminate it altogether. Yet, I frequently come across companies that fail to do kaizen.

In some companies, the culture is valuing firefighting more than fire prevention. The employee who saved the day gets a pat on the shoulder and a possible promotion. The one who saves every day gets overlooked. I myself even at one point got a complaint from my boss two levels up that in my office there is no yelling and shouting, so obviously they are not working well. Duh! If they have to yell and shout, then the communication has broken down and we are in crisis mode. I'd rather have a quiet day in the office and get my work done.

More commonly, however, there is insufficient resources available to do proper kaizen. Resolving issues takes time, and hence you need people available to do that. Toyota has a large number of people to ensure operations run smoothly. (See for example my post On the Team Structure at Toyota). In many companies, these people have been eliminated over time. All responsibilities have been shifted to the remaining people. However, the team leader in charge of twenty-five or more people has no time to help! Same goes for the engineers and managers and office people. You need time to do things properly; otherwise everybody is just kicking the can down the road.

And yet another issue is the lack of PDCA. People do something, but nobody checks whether it still works some time later. Even if someone checks, there is no capacity left to do something if it no longer works. In the end, the problem is not resolved and happens again. Now, go out, properly resolve at least one of your problems so it does not come back, and organize your industry!

16 The Danger of Management by Numbers

Christoph Roser, April 18, 2023 Original at https://www.allaboutlean.com/management-by-numbers/

Figure 116: DallE Management by Numbers (Image Dall•E in public domain)

One of the main hindrances for proper lean manufacturing is, in my view, management by numbers. While few managers actively do management by numbers, a quantitative measurement is still often preferred. The problem is if you can measure the cost but not the benefits of something…which often happens in lean manufacturing. Now let me rant a bit…

16.1 Why Numbers?

Figure 117: Numbers With Question Marks (Image Dall•E in public domain)

Numbers are everywhere in industry. We measure, quantify, calculate, and analyze the data to make decisions. And, in many cases, this is actually good. If you have good data, you can make better decisions. You can set better goals, analyze problems better, understand trends, quantify potentials, and so on. However, there are risks when relying too much on numbers.

16.2 The Problem with Numbers: Wrong Numbers

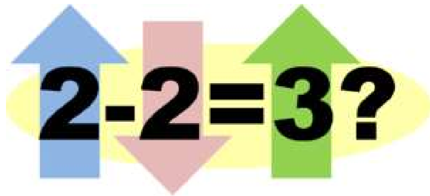

Figure 118: Numbers dont add up (Image Roser)

However, there are some problems with an over-reliance on numbers. Numbers can be either wrong, or you don't have any numbers to begin with.

Let's start with wrong numbers. There can be plenty of reasons for that. A simple mistake in an Excel file or a computer system can change the number dramatically. NASA's $125 million Mars Climate Orbiter broke up and burned in the Martian atmosphere because the supplier software provided a data point in imperial units of pound-seconds2, whereas the main computer expected that number to be in newton seconds2. Instead of circling Mars, the probe impacted the planet. In another example, a Boeing 767 (the Gimli Glider) had to make an emergency landing after all engines failed because the fuel was calculated using a density of pounds per liter instead of kilograms per liter. Luckily, the pilot was an experienced glider pilot and nobody got seriously hurt.

Figure 119: Six or nine? (Image Roser)

In many other cases, the data on which the numbers are based is inaccurate. You got a number from somewhere, but you don't know how accurate the number is, or the context it was taken from. For example, I once asked for the cycle time of an injection molding machine. As it turned out, the number I got was just the actual injection and cooling time, not including the opening and closing of the mold. On top of that, the number was two years old, and changed process parameters also changed the speed of the process. I got a number that I asked for, but the number was useless.

Also often overlooked is the precision of the number. Statisticians will tell you that you need to do numerous measurements, often more than thirty, and then calculate the 95% confidence interval to know how much your number is where it is supposed to be. However, few people in industry do that, and the accuracy of the numbers vary widely.

This is even assuming no ill intent. Unfortunately, number fudging is common in industry to look good. At one major car maker, in order to justify the design of a new car model, they simply assumed that the quality (and hence the quality cost) would be better than any mass-produced car in history, the sales would double annually for five years, and other numerical shenanigans to look good. It worked, the car got built, and people got promoted. But don't ask about the bottom line…

So overall, inaccurate data, missing context, lack of accuracy, and sometimes even intentional manipulation can turn numbers into questionable guesses or even utter garbage.

16.3 The Problem with Numbers: Missing Numbers

Figure 120: Missing Number (Image Roser)

A second problem is that for some topics, you cannot get any number at all. This is a problem I often find in lean manufacturing, where it is hard to determine the benefit of a change.

For example, how do you measure customer satisfaction? While there are some possibilities, it is quite difficult and highly inaccurate. Many companies don't do that. Even if you have an estimate of the customer satisfaction, how much will this change if you add or remove 10% more customer service agents? How will an additional training of such agents impact customer satisfaction? Nobody knows. Even after the change, it is hard to identify cause and effect. If you axed 10% of your service agents, did that cause the drop in customer satisfaction, or was it the recession, or was it the winter, during which it is dark and cold and everybody is less happy anyway…

Similarly, if you add two mechanics to your maintenance team, will availability go up? Will downtime be shortened? How much? How will this impact overall production? It may be difficult to even wager a guess. Yet, knowing this would be really helpful to make a decision here. In sum, for many decisions there are no critical numbers available at all.

16.4 The Cost Accounting Way to Handle Missing Numbers

Figure 121: Bookkeeper (Image Frank Reynolds in public domain)

Conventional cost accounting has a very easy way to handle factors for which they cannot get numbers. If they can't get a number, then in their numerical world, it simply does not exist. Or, in other words, if they can't measure it, it must be automatically zero. (Why zero? Because you can add or subtract zeros as much as you want and it makes no difference. Cost accounting does add costs, and a zero has no impact).

And this is one of the MAJOR problems in lean manufacturing. It is very easy to calculate the cost of an additional maintenance worker or service agent, but it is difficult to impossible to calculate the benefit of a maintenance or service agent. Hence, it is all cost and no benefit, cost will be reduced, and the number of people goes down. Similar examples where the benefit of a change cannot be determined exits all over lean manufacturing, where the cost of an improvement is well known but the benefit is not. This is especially drastic with any kind of support function. Be it customer service agents, maintenance people, supervisors, or anybody else who can help the shop floor, their numbers dwindle because they have a clear cost but a hard to quantify benefit. However, the chaos in manufacturing increases, the frontline worker is overwhelmed with problems but underwhelmed with support, morale goes down, and the entire company goes downhill.

Granted, there are exceptions, and some accountants are fully aware that the model has gaps or even huge gaps. But not every accountant is aware of this, and even fewer report this when asked for a number (understandably, if an accountant can't provide a number when asked, then this may have negative impacts on his career).

16.5 So Why the Reliance on Numbers?

Figure 122: Which number do you trust more? (Image Roser)

So the question is, why do managers rely so much on numbers? The answer may be multifold. Managing is stressful, and you have to make many decisions with a high level of uncertainty. Numbers give a (perceived) security. Numbers feel good. Especially if they have many digits of precision (regardless if they are true or not).

Additionally, in the stressful world of a manager, a number makes a decision easier. Many managers suffer from decision fatigue, having to make many decisions with high uncertainties. A number gives a (presumed) easy way out telling the manager what to do.

This is also the way many managers learn, no matter if it is from an expensive MBA program or from the culture in the company and their bosses and mentors. You get the numbers, you pick the biggest one. Done.

In some cases, this can even work, at least in the short run. The manager axes the cost or the people (according to the numbers), and cost goes down shortly. The benefit of these people also goes down, but it will take some time for the system to degrade. The manager gets praised as a cost saver, makes a career, and is long gone when the system becomes worse from his decisions. I wrote a whole post series on How to Look Good at the Cost of Your Successor.

Overall, numbers can be really helpful in decision-making. However, you need to be aware of the limits of numbers. They can be wrong, accidentally or intentionally. They can have gaps. They may be inaccurate. Or they may show only one side of the picture, neglecting the other one. Especially in lean, decision-making is still a lot of gut feeling, since a lot of our decisions deal with people, and it is hard to measure the ability and impact of people. Now, go out, decide which numbers to trust and which ones to ignore, and organize your industry!

PS: A great quote by Taiichi Ohno:

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People who can't understand numbers are useless.
The gemba where numbers are not visible is also
bad. However, people who only look at the
numbers are the worst of all.
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Many thanks to the Lean Leadership Community for bringing that up on LinkedIn 😐.

17 SMED 2.0—A Changeover for the Changeover

Christoph Roser, April 25, 2023 Original at https://www.allaboutlean.com/smed-2-0/

Figure 123: Mechanical Engineer Technician Checking And Inspecting Machine (Image Attapornfoto with permission)

Single Minute Exchange of Die (SMED) to reduce and shorten changeover times is one of the best-known methods in lean manufacturing. However, the original steps as shown by Shingo have, in my view, potential for improvement. Hence, I restructured the changeover workshop based on my experience with SMED to make it easier and more straightforward. This rework is not groundbreaking or revolutionary, but merely a few small changes to make it easier to use. As it is popular nowadays, I also added a 2.0 after SMED for my SMED 2.0.

17.1 Introduction

Figure 124: Danly Press Toyota Industry Museum (Image Roser)

The classical SMED by Shingo is based on the quick changeover workshops at Toyota, which in themselves were inspired by many other companies and individuals. The classic steps by Shingo are as follows.

1. Measure changeover times.
2. Identify internal and external elements.
3. Move as many elements as possible to external.
4. Shorten internal elements.
5. Shorten external elements.
6. Standardize and maintain new procedure.

While this contains all the relevant elements for a SMED, the arrangement could be better. I am also missing the verification whether the new sequence actually works and the PDCA at the end. Hence, let me redo the sequence:

17.2 SMED 2.0

As with any improvement, you should first identify and prioritize what you want to improve. Once you know your topic, you should set up a small team of people qualified in the topic and give them time to work. With these basics out of the way, let's start SMED 2.0.

17.2.1 Current State Changeover

The first step is, of course, an analysis of the current state of the changeover. Observe a typical changeover (maybe video it if the employees agree). Follow all people involved in the changeover and see what they do and how long it takes. Also take note when the main process is stopped, when it was started again, and when the first good part at full speed was produced. The last two points may be identical, but sometimes there is some set-up, adjustments, warm-ups, or similar activities between starting the process and regular production. Sometimes you may also find a ramp-down procedure at the beginning in addition to the ramp-up at the end. The goal is to reduce the lost productivity, including the ramp-down, the fully stopped period, and the ramp-up. Using the nomenclature of Shingo, I also call these the internal steps, whereas the preparation before and the wrap up after are external steps.

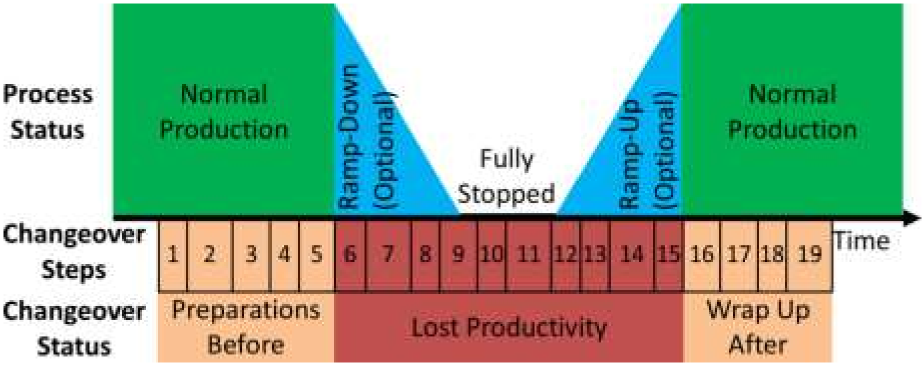


Figure 125: SMED 2.0 Overall Changeover Sequence (Image Roser)

Ideally, at the end you have an Excel table with a list of steps, their sequence, and their duration. Common pitfalls are overlooking some early preparations that happened before the stop of the machine. You may also observe more than one changeover, although often only one changeover is observed, relying on the knowledge of the people on the improvement team to know the differences in the changeovers.

17.2.2 Move Internal to External

The next step is to look closer at the tasks between the ramp-down and the ramp-up of the process. Which ones can you move before or after to the preparations or wrap-up? Are there steps that can be eliminated completely? What is necessary to do so? A mere organizational change? A technical change? A better tool? An extra employee to help out? How long will it take to implement?

17.2.3 Shorten Internal Steps

You should also look at the remaining steps between start of ramp-down and end of ramp-up. Can you shorten them, or even eliminate them completely? Can you make them easier? How much effort is it to make the change, and how long will it take? If during this round of the workshop you have another idea to move the step outside of lost productivity, then do it!

17.2.4 Shorten External Steps

Similarly, you should also look at the preparation before and the wrap-up after the changeover, the external steps (including the ones you just moved to external). Can they be shortened, eliminated, or made easier? How much effort is it to make the change, and how long will it take?

Please note that the shortening of external steps is much less important than the moving and shortening of internal steps. Reducing external steps reduces the time for the employees to do the changeover, which—depending on the duration and the frequency of the changeover—may be worthwhile. However, reducing or eliminating internal steps will give you much more benefit. Besides the reduction of the time for the workers doing the changeover, you also get (probably much needed) production capacity…or, even better, smaller lot sizes. If you can move an internal step to external, it is worth it even if it takes longer externally.

17.2.5 Verification and Iteration

Missing in the original Shingo structure is the verification and iteration. At the end, you should check whether the new changeover sequence is doable. If you can, try it out with a real changeover. It may very well be that the new sequence has a bug, and two steps clash with each other. Such problems have to be resolved.

If you are also not yet satisfied with the new duration, you may iterate and go through the steps again. Is there any more time to be gained during the changeover internally (best) or externally (also good)?

If you need larger technical changes, you may depend on delivery and/or installation of your new gadgets. Will you wait with the new standard until these arrive, or is it worth the effort to have an interim standard?

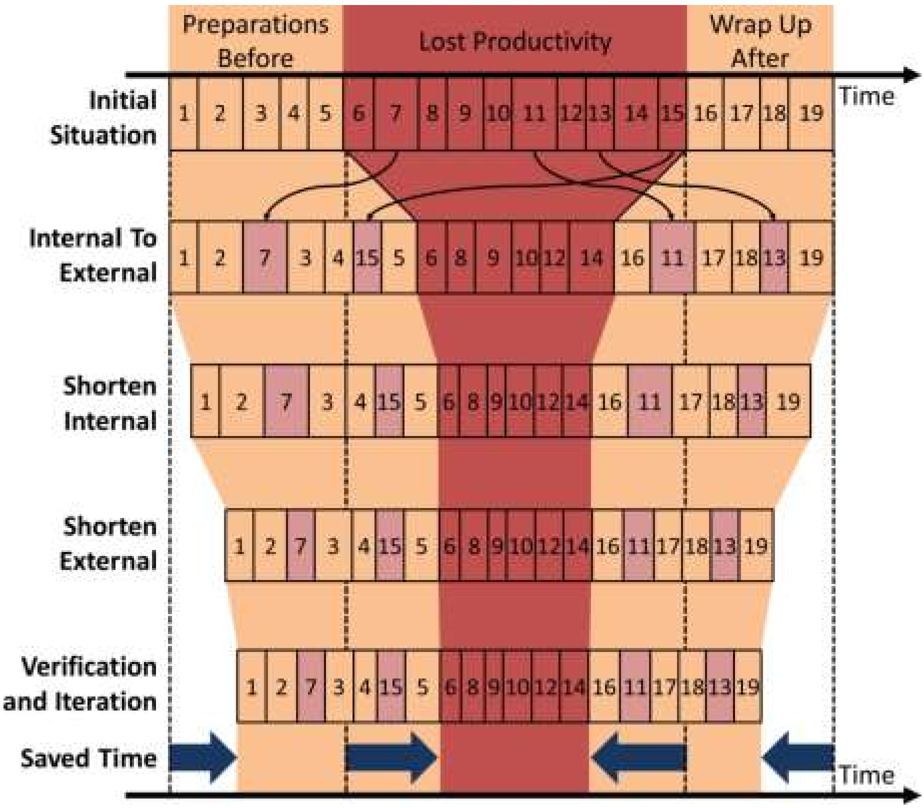


Figure 126: SMED 2.0 Improvement Process (Image Roser)

17.2.6 Standardization

Once you and your people have agreed on a new changeover sequence, this needs to be put down in a new standard, and the workers need to be trained in the new standard.

17.2.7 PDCA

Figure 127: PDCA Circle (Image Roser)

As always, don't forget the PDCA. Do process confirmation to see whether the standard works and is still followed even some time after the workshop. If not, is the standard flawed, or do the operators need more training or supervision?

While I hope you are familiar with SMED, I also hope this post restructured it a bit. Again, it is not a major change, but a bit of twiddling and improving. Now, go out, reduce your changeover time so you can have smaller lot sizes, and organize your industry!

18 Stack Lights—Visual Management Done Easy

Christoph Roser, May 2, 2023 Original at https://www.allaboutlean.com/stack-lights/

Figure 128: HKA Laboratory Stack Light (Image Roser)

Stack lights are found everywhere in industry. And for a good reason. They are a quick and easy way to visualize the status of a machine, which otherwise would need some effort to see. They are—sort of—a mini-andon. While sometimes underappreciated, they do serve a valuable purpose in the factory, and they usually do a good job. Let's have a look at stack lights!

18.1 Introduction

Figure 129: Stack Light (Image Ktm250-1150gs under the CC-BY-SA 4.0 license)

Stack lights are simple stacks of lights that sit on top of a machine, line, or generally a process. They are also known as signal tower lights, indicator lights, andon lights, warning lights, industrial signal lights, or tower lights. They are commonly used in industrial settings to visually communicate important information about the status of machines, equipment, or processes. Technically they are quite simple, merely a light in a colored transparent pipe. Older machines still may have light bulbs, but nowadays low-maintenance LED lights are common. Feeding it the right data from the machine requires a bit of thought.

18.2 Color Options

Figure 130: Stack Light (Image Ktm250-1150gs under the CC-BY-SA 3.0 license)

Stack lights can have different colors. Obviously there should be at least one color, but often there are more.These colors have different meanings, which often also differ from factory to factory. In some factories only one light is turned on at any given time, in other places multiple lights can be active simultaneously. Some factories also include blinking lights, either to increase its visibility, or to squeeze another bit of information in to distinguish it from a non-blinking light. But here I advise to keep it simple. Too many lights may be more confusing than helpful.

- Red often indicates a breakdown or stop, or generally a problem. This is probably the most common color included in a stack light. As this is often critical and needs urgent attention, the red light often also blinks for increased visibility. Sometimes a solid red light for a lack of material is used in addition to the blinking light.
- Green often indicates normal operations. Green is usually good.
- Amber or yellow may indicate a warning, minor problem, or irregularity, possibly without an actual machine stop. If you don't want to have too many lights, this could be included in the red status light, and not every stack light includes yellow.

- Blue is often used to request help from maintenance or the supervisor. This could be used together with red. For enhanced visibility, this may also blink. A solid light is sometimes used for service needs in the near future, with a blinking blue light indicating urgent maintenance attention. It is also sometimes used to request material, or to indicate quality problems. There are indeed quite different definitions for blue lights in different factories. This is not a common color on a stack light.
- White is sometimes but not often used if you need another color for another type of information. This could be the completion of a production run, a shift change, or anything else that may be helpful. If you can't think of anything, then don't include or at least don't activate the white light to avoid information overflow.
- All off: Machine is most likely powered down.

Figure 131: Lindt Chocolate Stack Light (Image Roser)

There even exists a European norm IEC 60204-1, chapter 10.3 lights and displays, where red is for emergencies, yellow for abnormalities, blue for mandatory actions, green for normal conditions, and white for any other neutral condition. Flashing indicates higher urgency, a discrepancy in status, or merely a transition between process statuses.

Be aware that there are many different opinions on what which color should mean. I even came across a definition where red lights indicate normal operation, and green lights for a machine that has stopped after the completion of a cycle. The logic is that after a stop it is safe to open the machine door, whereas you should not open the door when the machine is running (red).

Figure 132: Multiple stack lights from Fischer, text from left packaging check; lack of material (flashing); packaging; assembly; laser; feeder (Image Fischer with permission)

18.3 Common Mistakes

Figure 133: Omron SMD Stack Lights (Image Roser)

Stack lights are pretty straightforward. Yet, it is possible to mess them up too. In my view, the most common problem is trying to squeeze too much information into a single stack of lights, leading to confusion. Keep it simple! Also, keep it consistent. A red blinking light should have the same meaning across the shop floor, or even the entire company. Unfortunately, the definition of the lights is often merely whatever the machine maker thought best, which may vary across machine makers and hence within your shop floor.

This in turn leads to neglect. People will ignore lights, and instead of conveying information they will blend into the background of all the bells and whistles of a modern shop floor. While stack lights are not really high tech (for exceptions, see below), they do help to get attention to where it is needed, and to provide understanding of the status of a shop floor quickly.

A smaller issue is having the stack lights well visible. If you can't see them, they are useless. Luckily, in almost all cases they are on top of the machine and visible from faraway. With the common use of LEDs, burned-out light bulbs and other stack-light-related maintenance problems are also less common.

18.4 Historic Stack Lights

Figure 134: Toyota Model G Signal (Image Roser)

Stack lights have been around for quite some time, even before major electrification. The picture here shows a red signal on the Toyota Model G loom from 1924. The white signal is down. While I don't know the exact definitions, I would assume that red is a problem, white is a call for attention, and both being down meaning everything is fine. Such machine indicators probably appeared around 1900. The modular stack light probably dates to around 1950, which got computerized around 1970.

18.5 Advanced Stack Lights

Figure 135: JPB Keyprod Red (Image Roser)

Stack lights are evolving. While the basic stack light is still good and useful, I have seen some variations and evolutions of stack lights. The oval brick in this picture is a KeyProd, a small computer that measures performance using a vibration sensor and indicates the status using a LED ring. This computer from JPB Systeme is an easy way to bring older machines into the digital world. I wrote a whole blog post about it on What's Buzzing?—Vibration Sensors in Industry.

Figure 136: ABB Stotz-Kontakt LED Text Band (Image Roser)

Another newer stack light I have seen is from ABB Stotz-Kontakt near Heidelberg. They had a triangular LED running text that gives more details on the error through an error code and an error text. This way it is visible from faraway what the problem at the machine is. Read more on ABB in my blog post Industry 4.0 Tour in Germany – A Van Full of Nerds – ABB Stotz-Kontakt.

18.6 Transition to Andon Lights

Figure 137: Toyota Andon (Image Roser)

Andon lights generally show the status of multiple processes in a system, although it is also quite valid to see a stack light as a simple andon light. The term andon comes from the Japanese word for paper lantern (行灯, あんどん). The picture here shows an older andon from the Toyota Museum for Industry and Technology in Nagoya.

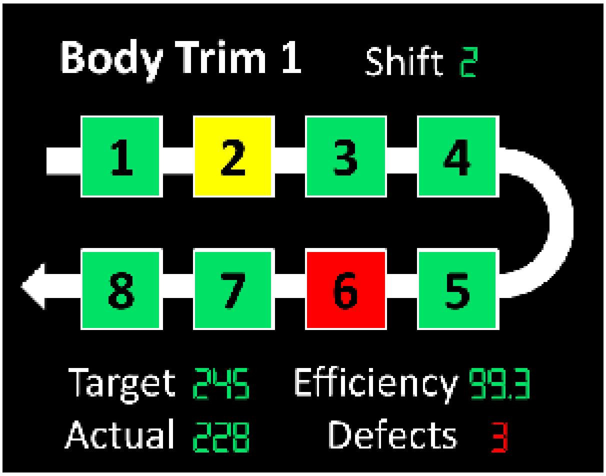


Figure 138: Andon Board animation (Image Roser)

This animation represents a more modern andon. You will find colors similar to a stack light, but multiple processes are displayed on one board. In this example a line has eight processes, of which process six is stopped and process two is expecting problems. These type of andons also often include current and target outputs, quality information, and much more. Nowadays these are often LCD monitors, and at Toyota they even switch the entire monitor display to a message if urgent attention is needed.

Overall, stack lights are easy and useful tools for visual management, and are commonly found in industry. Now, go out, light up your Christmas tree (but green only please), and organize your industry!

19 When to Use a Milk Run

Christoph Roser, May 9, 2023 Original at https://www.allaboutlean.com/when-to-use-a-milk-run/

Figure 139: " Indoor Milk Run (Image Neumaier Industry under the CC-BY-SA 4.0)"

A milk run is a popular way to supply materials to multiple locations. It can easily be combined with a pull system like kanban, where it merely replenishes what was consumed. But what are the best uses for milk runs? And when do you use them, and when would another logistics system be better? This post points out where the milk run shines and where you should consider alternatives.

19.1 Intro

Figure 140: Electric Tractor Train (Image Still under the CC-BY-SA 3.0 license)

For this post, I consider a milk run a type of transport that

- Transports materials between more than two locations (often one source and multiple destinations, but occasionally multiple sources and one destination)
- Transports more than one item at a time
- Has a regular schedule or timetable and is not simply on demand.

Ideally, this is managed using a pull system like kanban, but you can also "push" material through a milk run. I have written a whole series on milk runs before, starting with Introduction to Milk Runs. In this post, I will look at when a milk run makes sense and when other logistic systems may be better.

19.2 Volume and Frequency of Demand

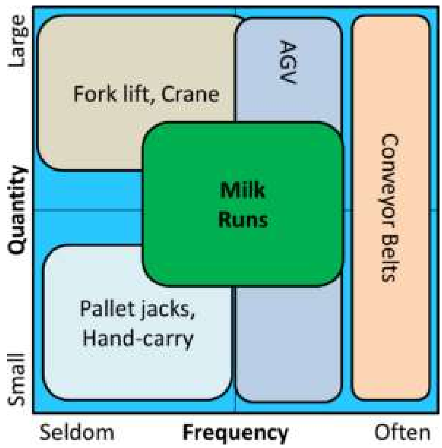


Figure 141: Milk Run Quantity Frequency (Image Roser)

Estimate of logistic systems; a lot depends on the details of your system.

The first thing to consider for a milk run is the volume and frequency of demand. How much material are you dropping off at a destination, and how often? How much do you pick up from a source, and how often? With volume, I mean not so much the number of items, but the actual volume of these items. Here, milk runs are best for a middle ground.

Milk runs work best if they run regularly and use the available space on the milk run. If you have to transport a lot of material within a given period, it may be possible to use multiple milk runs on the same route or split the route into smaller routes, again with separate milk runs for each route. It is completely doable. However, the larger your material stream becomes, the better it may be to use a dedicated transport system like a conveyor belt or a dedicated vehicle. If you transport so much material from one source to one destination that a single milk run is plenty busy, then it is no longer a milk run but a dedicated transport.

Figure 142: Pizza Scooters (Image Uwe Aranas under the CC-BY-SA 4.0 license)

On the other hand, if you have very little material to transport, a milk run may run far below its capacity. Here you could add more stops to the milk run or run the milk run less frequently (at the cost of having more material to cover the time between milk runs, i.e., you increase fluctuations). You could also make the milk run smaller. But in its extreme, the milk run may carry only a single item along multiple stops. In this case, it may also make sense to stop running a milk run and instead just bring the items as needed. A pallet jack or even an operator carrying a small box may be better than having a milk run make multiple stops that do not drop off material or pick up an empty box, or a very infrequent milk run with lots of material at the source and destination due to increased fluctuation. For bulkier goods that are hard to put on a pallet jack, a forklift may be best.

19.3 Size and Cost of the Goods

Figure 143: Large parts Large Parts (Image baicai lin under the CC-BY-SA 2.0 license)

Another factor is the size and the cost of the goods. A milk run needs some material both at the source and at the destination to cover its fluctuations. The destination needs enough material to cover the time until the milk run can replenish the goods (roughly two cycles worth of material; see my post on Calculating the Material for Your Milk Run for more). The source needs also enough material to fill up the milk run again.

The larger your items are, the more space is needed for storage at both the source and the destination. The more expensive your items are, the more capital is tied up as inventory. Both tied-up capital and filled-up space are bothersome and costly. You could run your milk run more often to reduce inventory, but for very costly and very large items, another approach closer to Just in Time (JIT) may be better. Maybe you have a dedicated on-demand supply for the largest and most expensive parts?

Small and inexpensive parts, on the other hand, are perfectly fine for a milk run. At what size or cost a material is better handled with a dedicated transport depends very much on your system. Maybe everything you have can be on a milk run. Maybe nothing is suited for a milk run.

19.4 Distance (i.e., Travel Time)

Figure 144: Outdoor Milk Run (Image Neumaier Industry under the CC-BY-SA 4.0)

Finally, there is the question of distance. Or, to be more precise, the time it takes for a milk run to do a route. Here, too, the middle ground is best. I find milk runs in factories often are set up for a tour between thirty minutes and two hours. For external milk runs across different factories and warehouses, the duration of a milk run can even be a day or two.

But nobody (to my knowledge) runs a milk run from China to the USA or Europe. The duration of a milk run is the main driver for the inventories needed to cover the replenishment time. And, having multiple milk runs on the same route does make only a small difference. Hence, the longer the route the more material is needed to cover fluctuations, and at one point a normal shipping just makes more sense than a milk run.

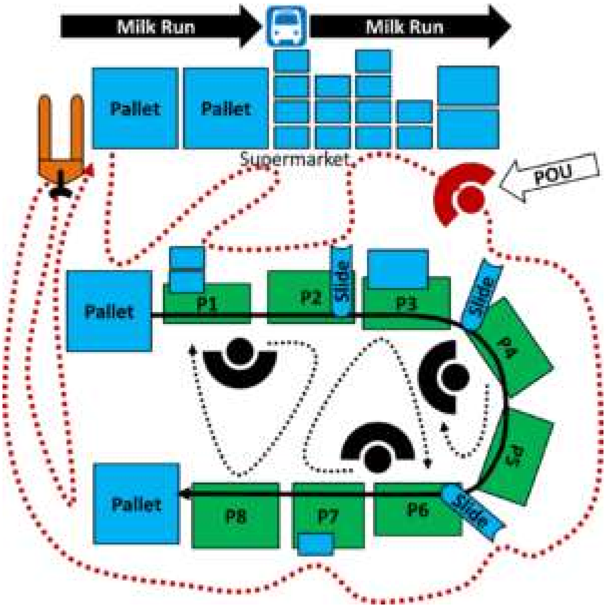


Figure 145: Point of Use provider (Image Roser)

For very short distances within a plant, it may also not be sensible to use a milk run. You could also use a dedicated system. Or, even better, you could use a point of use provider (POU). A point of use provider is similar to a milk run, but does not operate on a schedule. Instead, the material is delivered as needed. This requires a lot of attention to the system to know what is needed when, but especially around an assembly system this works well in many factories.

Overall, there may be many considerations for when to use a milk run and when not. The details may also depend very much on your production system, and what works for one may not work for another. In any case, I hope these considerations are helpful to you. Now, go out, get your material flow structured, and organize your industry!

20 KUKA FAMULUS Turns 50—The First Modern Industrial Robot

Christoph Roser, May 16, 2023 Original at https://www.allaboutlean.com/kuka-famulus/

Figure 146: KUKA Famulus PR Image (Image KUKA Group with permission)

Fifty years ago, the FAMULUS industrial robot was introduced by the German machine tool maker KUKA. This articulate-arm kinematics industrial robot with six axes was the first of many modern industrial robots. This design is nowadays still the most common type of industrial robot.

20.1 Pre-industrial Robots

Figure 147: Karakuri Ningyo and its mechanism (Image World Imaging in public domain)

The idea of machines doing manual labor is quite old. Different gadgets were built by tinkerers in Europe and Asia, as for example mechanical dolls in Japan or the automata by Jaquet Droz. But these were clunky, and served little more than being a curiosity. Some, like the mechanical turk, were fakes, with a person hidden inside.

The word robot comes from the Czech language and means serf labor. The Czech writer Karel Čapek used the term in 1920 for a science fiction story in which robots were artificially created biological servants, which was later picked up by the more famous author Isaac Asimov.

The first robots in a more modern sense and powered by electricity appeared in America in the 1960s. The Rancho Arm was an artificial limb developed by the Rancho Los Amigos Hospital in California in 1963. MIT developed its own arm in 1968, with the most unfortunate name tentacle arm. The Stanford Arm from—you guessed it—Stanford University was built in 1969. All of these were interesting, but had limited actual use.

20.2 The First Industrial Robot: Unimate

Figure 148: Unimate (Image Roser)

The first robot actually used in industry was the Unimate. The concept was patented by George Devol from Kentucky in 1954 as a programmed article transfer. This robotic arm was powered by hydraulics and controlled by a computer. However, this robot did not really look like a modern robot, but more like a crane on rails.

Together with his partner, Joseph Engelberger, they secured funding for their startup, Unimation, established in 1956.

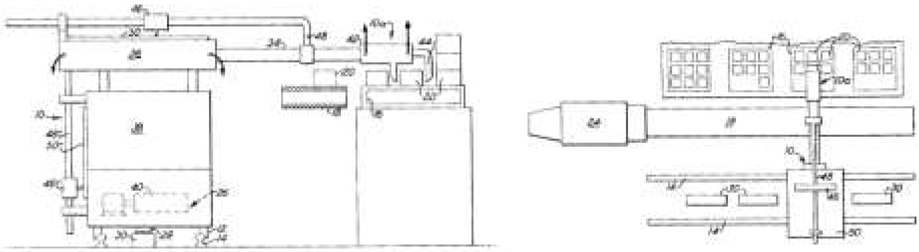


Figure 149: Patent drawing by Devol for the programmed article transfer from 1954, side and top view. It is lifting cartons (20) from a pallet (16) onto a conveyor belt (18). (Image George Devol in public domain)

Figure 150: Unimate pouring tea (Image Frank Q. Brown under the CC-BY-SA 4.0)

Starting with their idea, they developed a working product, the first industrial robot, UNIMATE. Their first sale was in 1960 to GM, where it started working on an assembly line at the Inland Fisher Guide Plant in Ewing Township, New Jersey, in 1961. The robot lifted hot castings, quenched them, and passed them on to the next machine. Since this was a potentially risky task, the robot helped to improve the safety of the workers. While this robot looked more evolved than the 1954 patent drawing, its kinematics is rare nowadays. Nevertheless, the robot did its job for many years before retiring to a museum. Its company, Unimation, however, had more difficulties and turned its first profit only in 1975. The company was purchased by Westinghouse in 1984, and since 1988 is part of the Swiss company Stäubli.

20.3 The KUKA FAMULUS

Figure 151: KUKA Famulus on the shop floor (Image KUKA Group with permission)

Around 1970, Europe and especially Germany overtook the US in terms of digital technology for industry. German CNC machines became widespread. Both ABB and KUKA started to develop robots. KUKA was founded in 1898 as Keller und Knappich Augsburg in Germany, producing acetylene, welding apparatus, household appliances, automobile headlights, and more.

Around 1970 KUKA decided to develop robots. However, instead of the Unimate design, they decided on an articulate arm. Fifty years ago, in 1973, KUKA introduced their first robot, the KUKA FAMULUS. It was the first articulated robot with six axes, a design that is now probably the most common kinematic for industrial robots. The robot was versatile and had a much greater range and flexibility of motion than previous robots. It could be used for a wide range of tasks. Hence, it was a smashing success and turned KUKA into the robotics company it is nowadays. (Note: The Americans prefer to start the history of industrial robots with their American Unimate rather than the German FAMULUS, which is also a possible way of seeing history. Both were major steps in an evolution of robotics that is still ongoing).

20.4 A Robotic Boom

Figure 152: ABB IRB6 from 1974 (Image Dependability under the CC-BY-SA 4.0)

Many other companies followed, using this articulate robot design. Only one year later in 1974, ASEA (now ABB) presented their own IRB6 robot with an internal microprocessor. The first two IRB 6 robots were sold to Magnusson in Sweden for grinding and polishing pipe bends and were installed in production in January 1974. In Japan, both Yaskawa Denki and FANUC also started producing robots in 1974. It took America a bit longer to catch up on the new design, and Unimation presented their articulate arm robot PUMA only in 1978. Other companies that started to build industrial robots were General Electric, General Motors (in a joint venture with FANUC), Automatix, and Adept Technology. However, not many companies survived, and nowadays the center of industrial robot making is Japan and Europe.

20.5 New Kinematics

Figure 153: A KUKA SCARA robot (Image KUKA Group with permission)

New kinematics were developed that are also still very popular. The SCARA (Selective Compliance Assembly Robot Arm or Selective Compliance Articulated Robot Arm… but nobody remembers that) was created as a prototype in 1978 by Professor Hiroshi Makino at Yamanashi University in Japan. It was introduced to the market in 1981 and is particularly well suited for picking and placing while being both compact and inexpensive due to having only four axes.

Figure 154: TOSY Delta robots (Image Humanrobo under the CC-BY-SA 3.0)

The Delta robot was developed by Prof. Reymond Clavel at the École Polytechnique Fédérale de Lausanne in Switzerland. It was patented in 1987. This robot has all actuators in the base and very thin arms, which gives it a LOT of speed and make it well suited for picking and placing.

20.6 Software over Hardware

Figure 155: ABB YuMi robot (Image Anthony O'Neil under the CC-BY-SA 2.0 license)

Industrial robots continue to evolve. However, since around 2000, the software of these robots became more important than the hardware. Through better sensors the machines have a better understanding of their environment, and much effort is put into the software to make use of this data. Cobots are already in use, where humans can work together with robots without a safety cage for the machines. This is achieved through the use of intelligent software (but also usually by using low-power robots that can't hurt people if they go awry).

One challenge that is worked on is gripping items that could have a multitude of shapes and behaviors, for example the Amazon Picking and Stowing needs (also called End of arm tooling). Another challenge is to smoothly hand items from the robot to a human and back, which currently is still quite awkward. In the long run, artificial intelligence may make the robot intelligent enough to recognize the task on hand on its own without detailed programming. Other countries, especially China, are also putting a lot of effort into developing their robotics industries (and have also bought KUKA, much to the chagrin of Germany). If you are in manufacturing, chances are that robots are important in your business. Now, go out, get a good trade-off between automation and human work, and organize your industry!

Disclaimer: A long time ago, during my undergraduate studies I worked at KUKA, writing my thesis on their robots. As such, I like the company, and was sad to see it sold to China.

PS: Images of KUKA robots copyright KUKA Group with permission.

21 The Difference between the Toyota Production System and Lean Manufacturing

Christoph Roser, May 23, 2023 Original at https://www.allaboutlean.com/tps-and-lean/

Figure 156: TPS and Lean Cloud (Image Roser)

The Toyota Production System (TPS) is the archetype of lean manufacturing. Lean is often used as a synonym for the Toyota Production System, and that is generally quite accurate. It is also sometimes referred to as the “Westernized” version of the Toyota Production System. However, there are some smaller differences in the underlying approach, as well as some larger and often unintentional differences in its application. Let’s have a look!

21.1 The Difference in Terminology

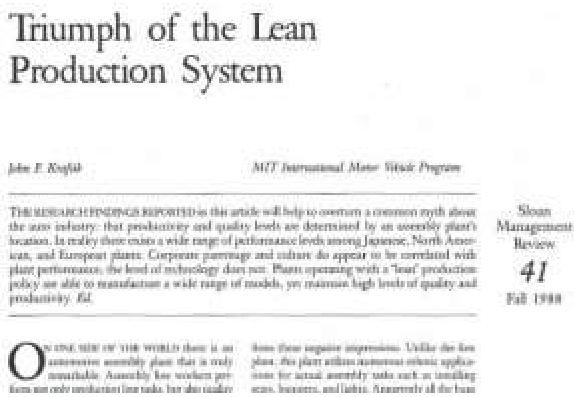
Figure 157: Toyota Takaoka plant entrance (Image Roser)

The Toyota Production System is the philosophy and culture of Toyota on how they organize their processes, both in manufacturing and in other areas of their businesses. It is used within the Toyota group, most famously the Toyota Motor Company, but also many other companies in their group, including Denso, Toyota Industries, Aichi Steel, JTEKT, Toyota Auto Body, Aisin, Toyota Boshoku, Towa Real Estate, Toyota Motor East Japan, Toyoda Gosei, Hino Motors, Daihatsu, Toyota Housing Corporation, and my former employer, the Toyota Central R&D Labs.

Figure 158: Sakichi Toyoda (Image unknown author in public domain)

This corporate culture and the tools within were developed over decades, starting with the founder of Toyota, Sakichi Toyoda. In my view, one of the great things about Toyota is their relentless drive to improve, pushing toward true north for many generations of managers. Even nowadays, the system is always evolving and changing. On a side note, in my view Denso is now better at the Toyota Production System than Toyota Motor itself. I believe that the leadership at Denso is much better than the last CEO of Toyota Motor, Akio Toyoda.

Companies outside of the Toyota group have often used and adapted these approaches. The problem was, if you were at Daimler, you couldn't really say that you use the system of a competitor (Toyota).


Triumph of the Lean Production System

John F. Krafcik — MIT International Motor Vehicle Program

Sloan Management Review 41 Fall 1988

THE RESEARCH FINDINGS REPORTED in this article will help to overturn a common myth about the auto industry: that productivity and quality levels are determined by an assembly plant's location. In reality there exists a wide range of performance levels among Japanese, North American, and European plants. Corporate parentage and culture do appear to be correlated with plant performance; the level of technology does not. Plants operating with a "lean" production policy are able to manufacture a wide range of models, yet maintain high levels of quality and productivity. Ed.

Figure 159: Triumph of the Lean Production System (Image John F. Krafcik at Sloan Management Review used as an excerpt/Citation)

In 1988, a young masters student, John Krafcik, studying under James Womack at the MIT, wrote a paper on the "Triumph of the Lean Production System." The famous book by Womack et al. that popularized this approach, The Machine that changed the World, picked up the term lean manufacturing. This name stuck, and since then the Toyota Production System has been known as lean production of lean manufacturing. Even now, twenty-five years later, the term lean is still strong in industry, despite a multitude of attempts to rename it to "World Class Manufacturing," "Synchronous Manufacturing," "Operational Excellence," "Six Sigma," and more.

21.2 The Difference in Content

Figure 160: Checklist (Image Clker-Free-Vector-Images in public domain)

There are some differences in content between the Toyota Production System and lean manufacturing. They are the result of continued development both within and outside of Toyota. While companies outside of Toyota are always eager to copy the latest trends within Toyota (and consultants are eager to help them with that), Toyota does not always take over new developments from outside.

Toyota does look anywhere for inspiration to improve their production system. In fact, many, MANY ideas for the Toyota Production System came from outside of Toyota (e.g. from Ford, Junkers, Training within Industry, Nichibo, Danly, and many more). Toyota is pretty good at trying things out, picking up the useful ideas, and discarding the not-so-hot ones. Not all of the developments outside of Toyota have made it into Toyota. Here is an (incomplete) list, based on my knowledge or experience; feel free to add more in the comments below. Some of these additions may be useful, others not so much.

- Waste (Muda) does indeed come from Toyota, but it is much more prominent in the Western world. The West also added an eighth type of waste (unused human creativity), or even more (I found up to twenty-four types of waste when googling around).
- Kaizen events for short improvement sessions are not used at Toyota.
- Value Stream Mapping (VSM) is called Material and Information Flow Analysis (MIFA) at Toyota. While it is one cornerstone in lean, it is only a minor and much less standardized tool at Toyota.

- 5S at Toyota is only 4S. The Western addition of 5: Shitsuke for "Sustain, Self Discipline" is for Toyota the same as 4: Seiketsu for "Standardize." I found even sources for 6, 7, and even 8S (Shukan for "Style"; and the English words Safety and Security).
- Kata is not really known at Toyota, even though the famous book is titled "Toyota Kata."
- Hoshin Kanri is indeed from Toyota, but I am getting inconsistent messages on how intensely it is used. The abominable X-Matrix, however, is a product of Western consultants.
- Six Sigma also originated from outside of Toyota. The quality approach with six standard deviations is not really used at Toyota, albeit Six Sigma successfully re-branded itself as Lean Six Sigma, adding the methods from the Toyota Production System.
- The 8 D (Eight Disciplines Problem Solving) Method developed at Ford in 1987.
- "The 14 Management Principles of The Toyota Way" by Jeffrey Liker tries to summarize the philosophy at Toyota. It is hard to summarize a philosophy, but this is one of the more popular summaries.
- For pull production besides kanban and reorder point, there is CONWIP, POLCA, Drum Buffer Rope, and COPACABANA, or the (supposedly also pull) Demand Driven MRP (DDMRP).
- The whole concept of Industry 4.0 for digitizing an entire factory was tried at Toyota, but rejected, although of course they do use computers and robots too.
- The Harada Method to enhance employee development also comes from Japan, but not from Toyota.
- Quick Response Quality Control (QRQC) is an approach to quality management from Nissan.

Figure 161: Seven types of waste (Image Thomas Söllner with permission)

This is only a short list, and there could be many more. If you want more, have a look at the (currently) 469 entries in my lean glossary, many of whom are from outside of Toyota.

21.3 The Difference in Application

Figure 162: Manager in Warehouse (Image vichie81 with permission)

There are also some differences in application, or, should I say, in the underlying philosophy. This is due to the different ways lean is done at Toyota and in the Western world. Please note that there is A LOT of generalization in the following paragraphs, and there are companies outside of Toyota that do lean well (e.g., I have good opinions on Trumpf, ABB Stotz-Kontakt, or Kärcher, to name just a few). There are also plenty of good consultants out there (and here I leave it up to you if you want to include me in the list). But there are many more companies that achieve less than their potential.

At Toyota, the Toyota Production System is mostly done by the people of Toyota, heavily relying on the people who actually work the processes. On the shop floor, these would be the front-line operators. They know their system well, and have a very strong interest in not making it worse with an "improvement." The philosophy of the Toyota Production System permeates throughout the entire Toyota group.

In the West, lean is often aided by external consultants. They usually do not know the system as well as the operators, and they need to impress the person that pays them… which is usually not the operator. Unfortunately, impressing the client is not the same as impressing the operators, and sometimes the operators are less-than-thrilled on the latest changes. In some plants, "lean" is even a burned word due to previous failed lean projects.

Figure 163: Sneaky 5S Consultant (Image bramgino with permission)

It also is harder to generate a culture change than to do a 5S workshop, and hence lean often tends more toward tools and methods rather than fundamental principles. This is also sometimes the fault of leadership. All too often, lean is seen as some tool that can be bought and then delegated to someone in the lower ranks of hierarchy. The people below should change, but of course not the person on the top. Unfortunately, good lean starts at the top, with soft skills like [respect for people](). I also often find that while there is plenty to improve, [capacity for improvement]() has been eliminated to save money. The supervisor left on the shop floor simply have no time for improvement.

Again, this is not valid for all Western companies and consultants, and there are plenty that are good and on the right track on their lean journey. But with all too many the system is falling short of its potential. My hope is that this blog post will nudge some more in the right direction. Now, go out, strengthen the philosophy of lean manufacturing, and organize your Industry!

21.4 Source for some data and the inspiration

I was inspired to write this blog post by the excellent book by Michel Baudin and Torbjörn Netland, where they discuss Kaizen on page 33 and 34. The entire book is recommended reading 😐.

Baudin, Michel, and Torbjørn Netland. 2022. Introduction to Manufacturing: An Industrial Engineering and Management Perspective. 1st edition. New York, NY: Routledge. waste

22 Real vs. Planned Data in Pull Systems

Christoph Roser, May 30, 2023 Original at https://www.allaboutlean.com/pull-real-vs-planned-data/

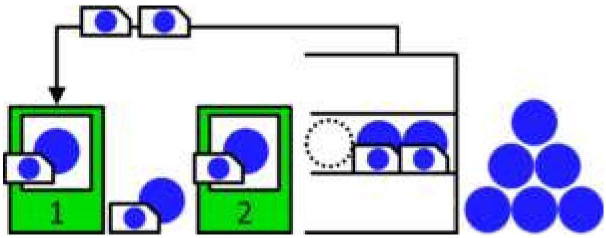


Figure 164: Predicted Pull Extra Inventory (Image Roser)

Pull systems like kanban and reorder point are a cornerstone of inventory management and fluctuation reduction in lean manufacturing. The production is managed based on ACTUAL consumption. Theoretically, it is also possible to include expected but not yet actual consumption. In this post, I will explain to you the concept behind it and why I think it is a bad idea…

22.1 Introduction

Pull is mostly a way to manage your inventory. You set an upper limit (e.g., through the number of kanban) and always try to fill up to that limit. If a part or product leaves the system, the kanban card goes back to be replenished. This way, a pull system reacts to actual demand since it only reproduces if an item is actually consumed. The animation below shows a simplified system, where the customer picks up a part every two seconds, after which the kanban goes back for reproduction.

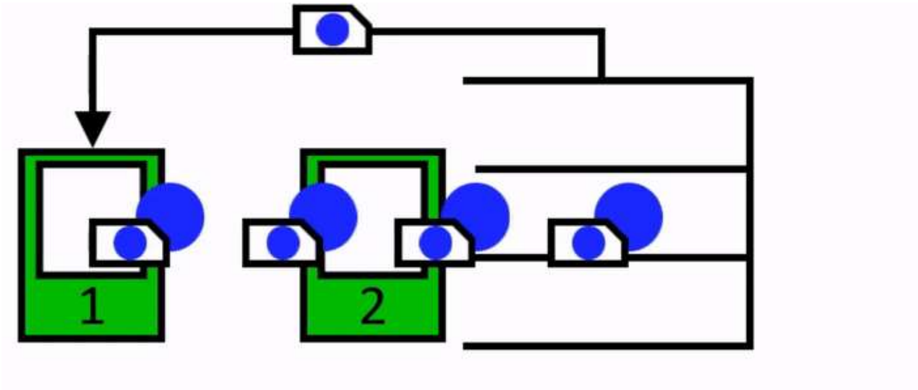


Figure 165: Kanban Animation (Image Roser)

All pull systems have this upper limit on inventory (or work content), and whenever an item leaves the system, a signal is generated to replenish the item. This is true no matter whether it is a kanban system, a CONWIP system, a reorder point, or one of the lesser known ones like POLCA, drum buffer rope, or COBACABANA (for more on this, I recommend my award-winning book, All About Pull Production).

22.2 What about Expected Demand?

Now imagine the following scenario: You have a kanban system that produces make-to-stock parts. You have products in your inventory. Normally, when the customer buys a part, you remove the kanban, deliver the part, and replenish using the kanban signal.

However, your customer has committed to purchase products for next week. Wouldn't it be smart to already take the products out of the inventory to set them aside for the customer so you can start reproducing parts already? (Spoiler: No, it is not!). This example is illustrated below. We have three completed blue balls in our kanban system. The customer promises to buy those three balls next week. Hence, we could set these three balls aside for the promised demand and initiate reproduction already, as shown in the right half of the illustration.

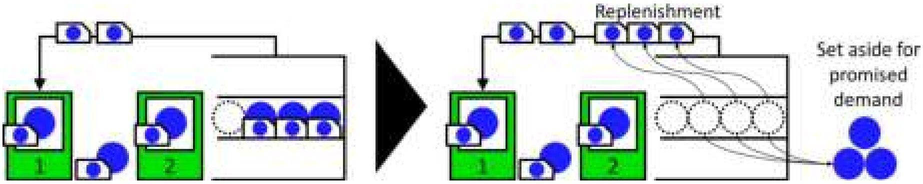


Figure 166: Predicted Pull Example (Image Roser)

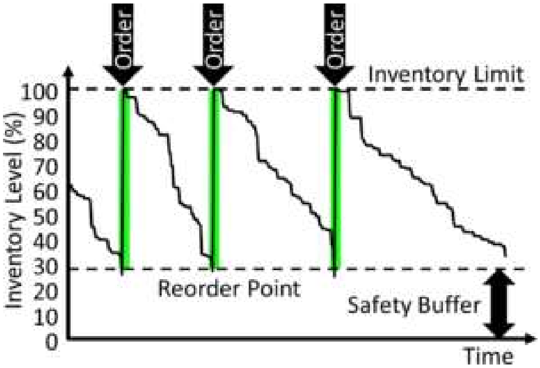


Figure 167: AllAboutPull Reorder Point (Image Roser)

Another common example is the reorder point system, often used for purchased parts, where you also always merely refill to the target inventory. Whenever the sum of the actual inventory and the open orders for new material fall below the reorder point, a new order for material is issued to bring it back to the target inventory limit.

Here, too, the common misconception is to subtract expected orders from the current inventory. You have the parts already, but you expect or are promised another order soon. Hence, you already include those expected demand in the order for even more material.

22.3 Why You (May Think) It Is Good

Figure 168: Person on a pile of boxes (Image Dall•E in public domain)

I have the feeling a lot of people could like this idea. You know the customer demand will materialize, which allows you to start the work already and get ahead of the demand curve. Workers can produce parts earlier, which frees up capacity later and can avoid all kinds of problems. It is especially useful to reduce the likelihood of stock-outs.

22.4 Why It Is NOT Good!

Unfortunately, this approach to produce based on promised or estimated demand is highly flawed. Let’s start with a quote from Taiichi Ohno, the godfather of the Toyota production system, and hence lean manufacturing:

```
Produce only what is needed, when it is needed,
and in the amount needed.
```

Starting production already based on only promised demand is highly risky. The perceived advantage is exactly its flaws: You build up inventory! “Inventory is good” is the common logical trap that many fall for when running production.

Figure 169: Burning Money (Image Nik_Sorokin with permission)

No, inventory is a cost, and not even a small one. Having inventory can easily cost 30-70% of its value per year. The purpose of inventory is to reduce fluctuations, not to be increased. You should have the minimum inventory needed to cover (most?) fluctuations, not more.

The misconception comes from the pain people on the shop floor experience if they run out of products or miss deliveries, which can cause a lot of stress. On the other hand, the constant bleeding of money for having inventory doesn't cause pain on the shop floor, it hurts "only" the bottom line. Hence, the shop floor often seeks safety in inventory, but this is misguided. On top of that, it can hurt quality and make the entire system sluggish. All of these negative effects are there, but hard to measure or even see.

Figure 170: Increasing Risk (Image Roser)

It also increases the risk. What if the order does not come? The customer promised to order, but he changed its mind. Your sales department expected an increase in demand, but it did not happen. Now you have an excess inventory and hence cost. To reduce this inventory again, you may have to reduce production capacity. This, in turn, increases fluctuation. One week production was rushing to fulfill the (expected) demand, next week they are idling because the expectation turned out to be incorrect.

22.5 The Proper Way to Do This

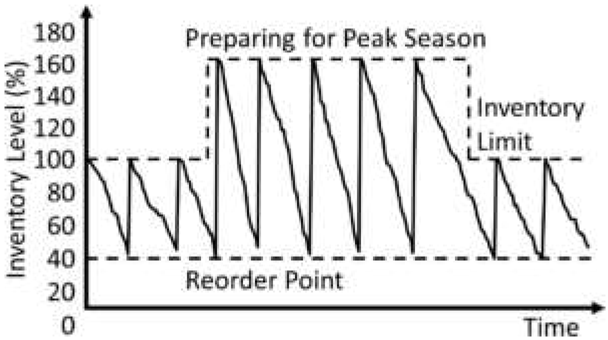


Figure 171: Predicted Pull Changing Inventory Limit (Image Roser)

Sometimes, however, you need to prepare for expected demand, even though it has not yet realized. Key examples are seasonality, or a new product launch. With seasonality, you may not have the capacity to fulfill peak demand. With a product launch, you may have a lot of customers eager for the product on day one. However, simply putting parts outside of the pull system is a very inelegant way to do this. The proper way is to simply adjust the inventory limit of your pull system. Increase the number of kanban or increase the target inventory of your reorder point.

Important: This is not for short-term changes. A pull system values stability and consistency. If you adjust the inventory limits twice per week, it just creates chaos. A pull system is not a sports car that can zigzag around. It is more like a tanker that goes steady… and that is what you want for production. Stable and steady makes for an efficient production!

Overall, all your inventory should be properly within a pull system. If there are longer-term changes, you can adjust the inventory limit. But do not take parts out of the system on the hunch that you may (or may not) sell it soon. This just creates fluctuations and problems. Now, go out, keep your production stable, and organize your industry!

23 Training Within Industry—Second-Line Supervisor Job Instructions

Christoph Roser, June 6, 2023 Original at https://www.allaboutlean.com/twi-ji-second-line-supervisor/

Figure 172: Still More Production (Image Office for Emergency Management in public domain)

Training Within Industry and its modules Job Instructions, Job Relations, and Job Methods are well known. But (thanks to Mark Warren) I just recently learned about another module: Job Instructions for Second-Line Supervisors (nowadays called managers). This is a hierarchy level higher, and the goal is to support and guide the shop floor supervisors on how to use job instructions. Let me dig deeper:

23.1 Introduction

I have written extensively on [Training within Industry](), including the modules on [Job Instructions]() (JI), [Job Relations]() (JR), and [Job Methods]() (JM). It is an old program from World War II, but the content is still highly relevant today, and I believe the guidelines are very helpful. The job instructions are designed to teach workers how to follow a standard. Below is the original World War II Job instruction card from the War Manpower Commission. Oldie but goldie.

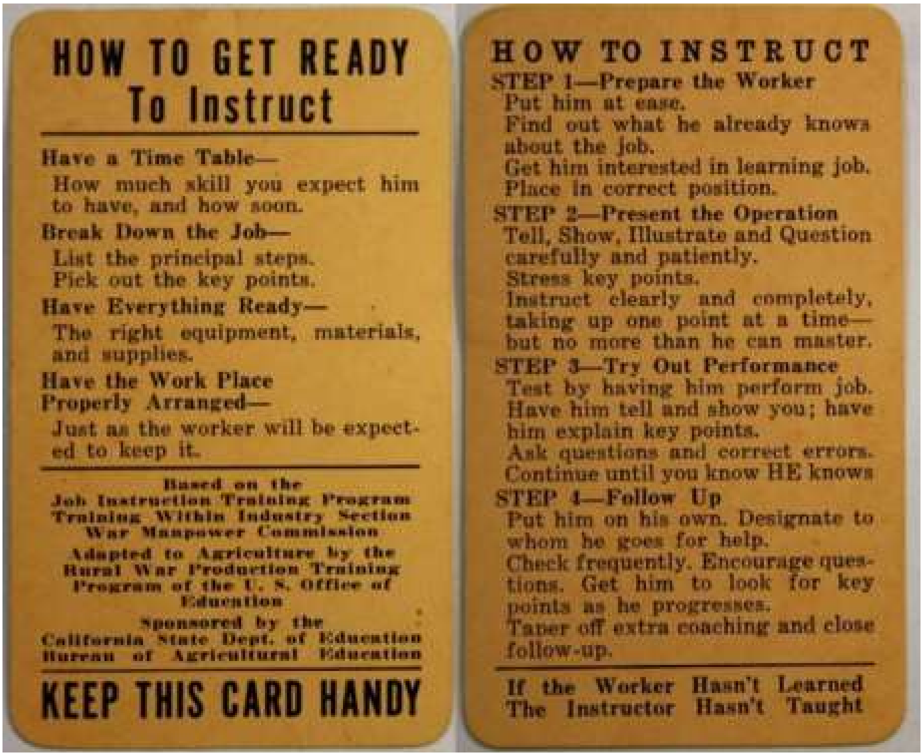


Figure 173: JI Card (Image War Manpower Commission in public domain)

23.2 Job Instructions for Second-Line Supervisors

The Training Within Industry program also published a lesser known set of guides for second-line supervisors (i.e. the people one level above the first line supervisors). Nowadays this would be the first level of management over the shop floor supervisors, and in this post I will simply call them managers to avoid confusion. This guide for manager job instructions is called Using Job Instructions and helps the manager to have the supervisors in his group both a) start using job instructions, and b) continue using job instructions.The manager also receives coaching on how to do proper the second level supervision for Training Within Industry.

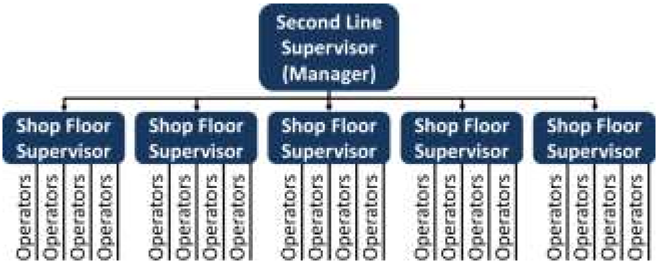


Figure 174: TWI Second Line Supervisor Structure (Image Roser)

The supervisor is in charge of both training his operators in job instructions and making sure they follow the job instructions guide. Below is the original World War II Using Job Instructions card for managers. For easier reading, the text is also copied below the card, but I will go through each point in more detail.

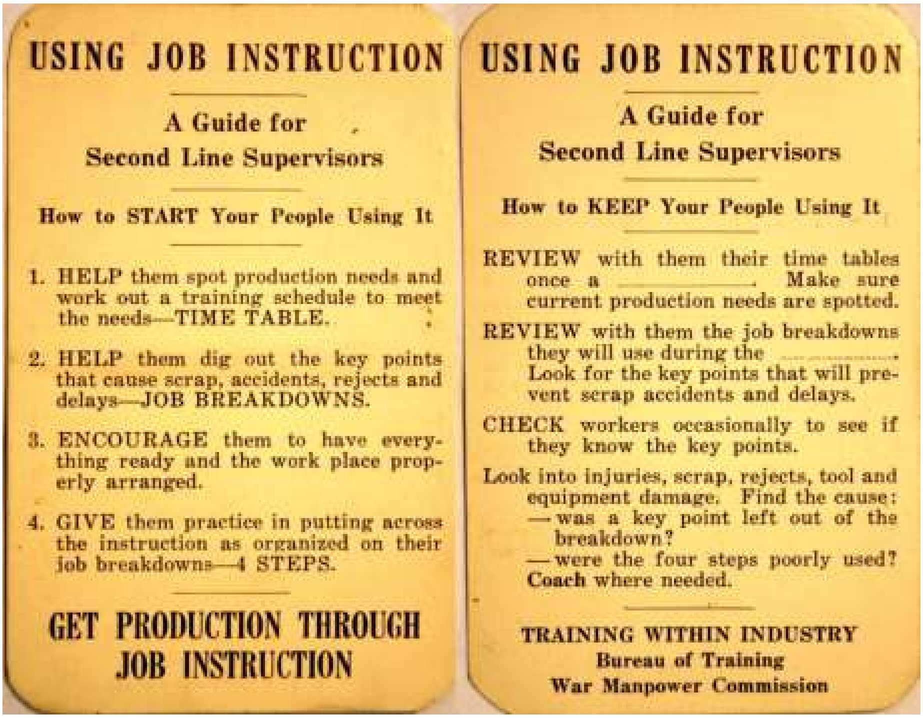


Figure 175: TWI Supervisor Job Instruction (Image War Manpower Commission in public domain)

How to START Your People Using It

1. HELP them spot production needs and work out a training schedule to meet the needs—TIME TABLE.
2. HELP them dig out the key points that cause scrap, accidents, rejects and delays—JOB BREAKDOWNS.
3. ENCOURAGE them to have everything ready and the work place properly arranged.
4. GIVE them practice in putting across the instruction as organized on their job breakdowns-4 STEPS.

How to KEEP Your People Using It

- REVIEW with them their time tables once a [___]. Make sure current production needs are spotted.
- REVIEW with them the job breakdowns they will use during the [___]. Look for the key points that will prevent scrap accidents and delays.

- CHECK workers occasionally to see if they know the key points.
- Look into injuries, scrap, rejects, tool and equipment damage. Find the cause: 1) Was a key point left out of the breakdown? 2) Were the four steps poorly used? Coach where needed.

These bullet points alone may be a bit confusing. Hence, let me explain the individual steps of the two sides of both cards. Overall, this Using Job Instructions card for the manager is not as straightforward and easy-to-use as the Job Instructions card for the supervisor.

23.3 How to START Your People Using It

1) TIME TABLE: The time table is related to the qualification matrix… except that for a blank spot there may be a date for when each worker should be trained. But not everybody needs to be skilled at everything, and it is also necessary to decide who should be trained in what (i.e., to "spot production needs"). The manager instructs and guides the supervisor on creating such a timetable. Below is an original Training Within Industry example.

Bill Smith Machining Dept. 2/1/44	DRILL	BORE	REAM	FACE	TAPER-TURN	BURR + BURNISH		
White	✓	✓	✓	✓	✓	✓		
Nolan	✓	✓	✓	✓	2/25	✓		
Black	✓	✓	✓	✓	✓	✓		Mar. 1 Induction
Jones		✓	✓			✓		
Green	✓	✓				✓		
Brown	✓	✓	✓			✓		
Riley	2/20					✓		

Figure 176: JI Timetable Example (Image War Manpower Commission in public domain)

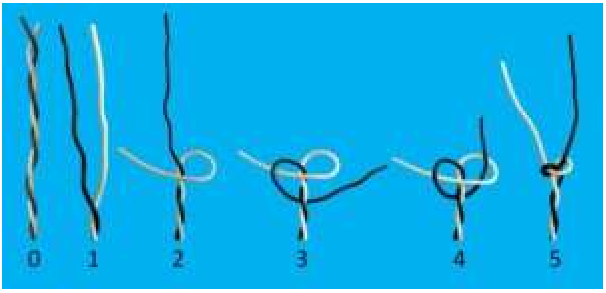


Figure 177: Fire underwriter knot (Image Roser)

2) JOB BREAKDOWNS: Next, the manager instructs the supervisor on how to do job breakdowns—which is crucial for creating good work standards. The example in the original literature is teaching them a knot (fire underwriter knot). The Training Within Industry trainer trains the manager to teach the manager how in turn to train the supervisor on creating a job breakdown. In a full Training Within Industry workshop, the trainer instructs the manager on coaching supervisors. This also follows the typical job instruction steps, where the trainer first demonstrates a coaching of a supervisor for the manager and then observes the manager coaching another supervisor. For this I even have a detailed original plan from World War II.

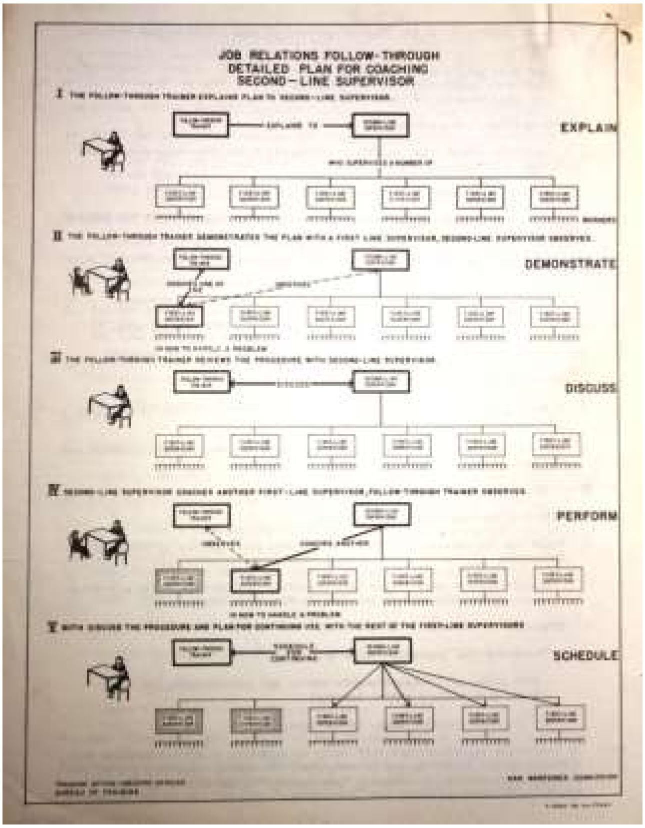


Figure 178: TWI Supervisor Job Instruction Coaching (Image War Manpower Commission in public domain)

3) Encourage: The manager should make sure the supervisor provides a clean workplace for his operators, and that they have all the necessary tools. Nowadays we would call this 5S. The supervisor should set a good example here for the operator.

4) 4 Steps: This is probably the most confusing step of the standard. This refers to the original job instruction card for the supervisor. The manager should go with the supervisor through all 4 steps: 1) Prepare the Worker; 2) Present the Operation; 3) Try Out Performance; and 4) Follow Up. For details on these 4 steps, check out my post on Job Instructions (for supervisors).

23.4 How to KEEP Your People Using It

Figure 179: World War II poster (Image War Production Board in public domain)

The steps on the other side of the Using Job Instructions card help the manager to follow up on the coaching of the supervisor. This would be similar to the Check and the Act of the PDCA circle. The manager should of course regularly review the training timetables as well as the job breakdowns. The card actually does not give a suggested interval, as this depends somewhat on the production system. Hence, it is up to the manager to decide, giving him more freedom on how to manage his domain. However, it is suggested to review both once per week. The verification if the supervisor knows the key points should also be done occasionally, albeit no frequency is given or even suggested.

Interesting is the last point on looking into injuries, scrap, rejects, tool and equipment damage. This is now pushing to continuous improvement. The manager should be on the lookout for improvement potentials. I particularly liked that safety is mentioned first! It also gives a guide on how to improve such shortcomings, and this is by working with a standard. If there is a problem (safety, quality, waste, etc.), either the standard (the key points) is not good enough and should be improved, or the key points were not followed properly. In either case the manager should coach the supervisor on how to improve the key points to prevent further occurrence of the problem, or coach the supervisor on how to properly coach and train his operators so that they follow the standard correctly. This is just as we would do kaizen nowadays through the use of standards.

In any case, I hope this article was interesting to you. Now, go out, make sure your subordinates know how to instruct their own subordinates, and organize your industry!

PS: Many thanks to Mark Warren for his never-ending knowledge on all things related to Training Within Industry!

24 Flexible Multi-Model Assembly Line at Toyota

Christoph Roser, June 13, 2023 Original at https://www.allaboutlean.com/toyota-flexible-multi-model-assembly-line/

Figure 180: Adaptable and Flexible (Image Dzmitry Dzemidovich with permission)

The flexible assembly line at Toyota is a well-known manufacturing approach. Such a flexibility gives Toyota the ability to produce different models in almost any sequence. These lines were already common at Toyota around 1990, and by now they are found at many car makers. Time to take a look at how it is done and why it is good.

24.1 Introduction

Flexible assembly lines commonly refer to lines with the ability to make different products at the same time. In automotive, the most famous company known for its flexible assembly lines is Toyota, which already in 1990 had multiple such flexible assembly lines. Nowadays there is rarely a car plant that does not (claim to) have flexible assembly lines.

Figure 181: The Maybach for the ultra-rich… (Image Roser)

For example, the Daimler Factory 56—at the time of writing one of the most modern automotive lines—produces its most luxurious S class car and Maybach (basically an S class with a different name) with combustion engines, hybrid engines, and fully electrical engines on the same assembly lines. Many quite different power plants on the same assembly line!

On a side note, please do not confuse this with flexibility in the line layout. This is (very confusingly) also called a flexible assembly line at Toyota. Read more about this on my blog post.

24.2 What Does Flexible Mean?

But let's start with the basics. What does "flexible assembly line" actually mean? There are plenty of companies with wildly different flavors of flexible lines that all claim to be flexible. For them, having a "flexible assembly line" merely means the line is more flexible than before… which is good, as it is a step in the right direction. Yet from a lean point of view, not all of them would be considered flexible, at least not by me.

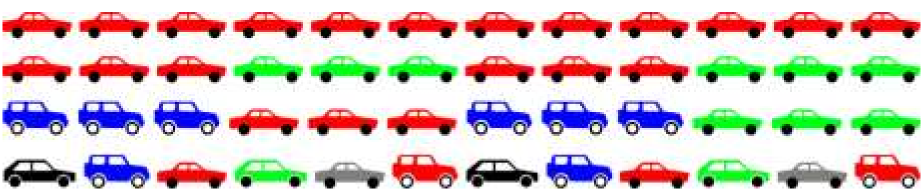


Figure 182: Flexible Car Assembly (Image Roser)

Let's approach this from the opposite of what would be an inflexible line. Such a line makes one variant of one product only, and would need time for a changeover before switching to another product. For me, the first requirement for a flexible assembly line would be that the changeover time from one product to the next would be zero. Or, more precisely, practically zero. In other words, the changeover is fast enough that it can be done without losing any capacity on the assembly line. As soon as a product has to wait or capacity on the line is lost, it is no longer a flexible assembly line. This was the easy part for an flexible assembly line.

The next question is more difficult. How different do the products have to be for an assembly line to be rightfully considered flexible? There is, unfortunately, no clear answer, but varying shades of flexibility. For example, if the cars produced on an assembly line differ only by the color of the seat and are otherwise identical, I would not consider it to be flexible. If it would be different models, then it would be flexible. However, for example, the Daimler Factory 56 mentioned above makes both S class and Maybach models… which is nothing more than a longer, more luxurious S class. Hence, different names may not be technically so different, after all. To give an extreme example, the Czech Kolin plant makes the Toyota Aygo, the Peugeot 108, and the Citroën C1 on the same assembly line, since these are technically the same cars with different exteriors.

Figure 183: From left to right the Peugeot 107, the Citroën C1, and the Toyota Aygo (ca. 2009 models). Notice how the body is similar and only details differ. (Images M 93 in public domain)

On the other hand, I would not expect the same line to make both fridges and cars. Hence, I would consider larger differences in the product necessary to be considered a flexible assembly line. Daimler Factory 56 assembling different power trains (combustion, hybrid, electric) for the S-class and the Maybach would be a flexible line for me, as would be the Czech Kolin plant. But this still has a lot of wiggle room…

Also, on a side note, the discussion is usually on a flexible assembly line, but I would extend this generally to a flexible production line, regardless if it is assembly, machining, or any other type of production process.

24.3 How to Become (More) Flexible

The primary goal for a flexible assembly line is to get the changeover times low enough that they do not interfere with normal production flow anymore (often simply called a changeover time of zero). This can be achieved basically by having the tool match the product. Either the tool is generic and can fit any product on the line, or the product has generic features and all products can fit the one tool, or a combination thereof.

An example from Toyota for a tool that can fit multiple products is a triangular workpiece holder/carrier. This is simply a triangular structure that rotates so the top matches the product as illustrated below. Side note: This is an example where the changeover time is not zero (the tool needs a few seconds to rotate), but it is fast enough so that it does not hamper the flow of the products.

Figure 184: Toyota triangular clamp base (Image Roser)

Figure 185: Volkswagen MQB floor assembly (Image Ra Boe under the CC-BY-SA 3.0 Germany license)

An example of a product that has been designed with tool flexibility is the “Modularer Querbaukasten” (MQB) at Volkswagen. This is an auto body design that allows different wheelbases and car lengths while having similar parts that can be attached by similar tools. Volkswagen uses this for around forty models. Many other car makers have similar concepts (Mazda is particularly admired for this within Japan).

There are many more possibilities. In some cases it requires hardware changes, in others you merely have to adapt the software. If human workers are involved, do not forget to train them, though.

24.4 Why It Is Good to Be Flexible

This flexibility—if used correctly—has many advantages. By having multiple products or product categories on the same line, you can use the capacity for different products. Hence, if one product is having a slump and another a peak in demand, the flexible line can simply make more of one than the other. This flexibility allows you to better meet the needs of the customer. For example, in old times a model at Toyota was profitable if they sold 20 000 per year. Nowadays, using even more flexibility, it can be profitable from 5000 vehicles per year. Although, both of the above you could also do with a batch production that has changeovers.

But what you can do only in a flexible assembly line is mixed model sequencing. This is a complex topic, hence I wrote a twelve-post series on Mixed Model Sequencing. For example, if you have a two-door and a four-door model, you sequence them at equal intervals so that the door assembly station does not get over- or underworked.

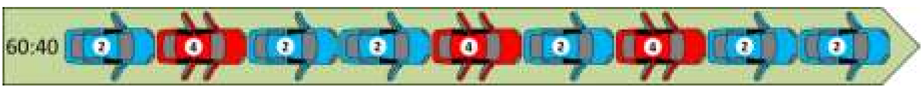


Figure 186: Two products 60-40 mixed model sequence (Image Roser)

Smaller lot sizes also help you to reduce inventory and lead time. As a flexible assembly line can do lot size one, it can have a large positive impact on the inventory and the lead time. Overall, this flexibility can reduce manufacturing cost by producing more efficiently, allow faster adaption to changes in demand, and also reduce lead times. Now, go out, make your system flexible, and organize your industry!

25 Make or Buy: How Not to Do It

Christoph Roser, June 20, 2023 Original at https://www.allaboutlean.com/make-or-buy-how-not-to/

Figure 187: Crashed shopping cart with blueberries (Image Ales Munt with permission)

“Make or buy?” is a question most companies have to ask themselves. Which parts or even products should you make yourself, and which ones should you outsource to a third-party supplier? The question itself is already difficult, but here again we run into the problem of cost accounting. If you go purely by the numbers, you can easily run your company into the ground. Let me show you how (NOT) to do it.

25.1 Introduction

Figure 188: Henry Ford tried a fully vertical integration and failed. (Image Ford Motor Co. in public domain)

It is rare that a company makes all items that it produces itself. Such a full vertical integration would include everything from the mine for the materials to the final product to the customer. Henry Ford tried it, and even bought a gigantic rubber plantation in Brazil, but he failed miserably. More common are companies that do not produce anything themselves. Apple, for example, creates the design but outsources all production to suppliers. However, the vast majorities of companies with a physical product lie somewhere between these extremes. Toyota, for example, reportedly creates 30% of the value in-house and purchases the rest.

25.2 How to (Supposedly) Decide on Make-or-Buy

Figure 189: Piggy Bank (Image Ken Teegardin under the CC-BY-SA 2.0 license)

One popular way to decide if a company makes a part themselves or lets someone else make them is by the cost. If the supplier is cheaper, then the supplier should get the business. You simply ask suppliers for quotes, and if they are better than the in-house cost calculation, you give them the business. And here again, we run into a frequent nemesis for lean manufacturing: cost accounting. They determine the cost of the production in-house, which is then compared with the cost from the supplier. These two numbers are (often) everything you (supposedly) need to decide.

25.3 A Fictitious Example

Let’s take an example. You make a product for which you need sheet metal parts. One hundred different sheet metal parts, to be precise. You currently make all of them in-house. Now you conduct a make-or-buy analysis based on the cost, comparing the best supplier offer with your cost calculation prices. Below is a (fictional) Pareto chart with the annual demand of all of your one hundred products, from the high-runner to the exotics that are produced once per year or even less.

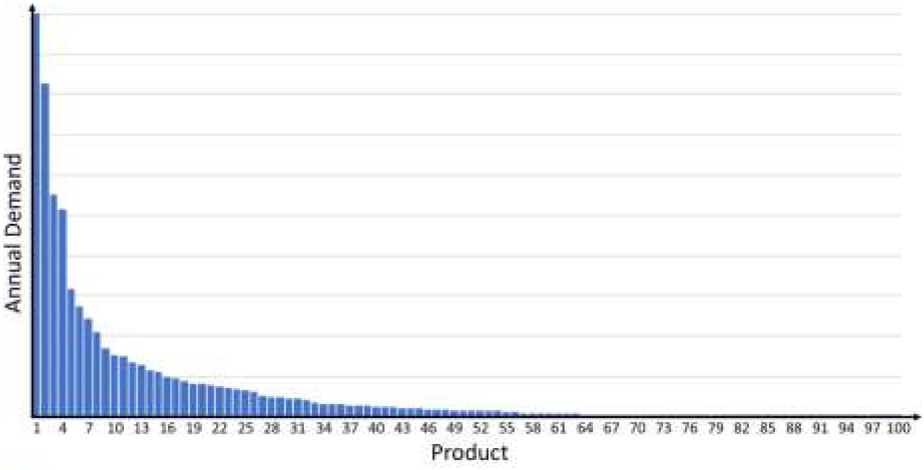


Figure 190: General Pareto Chart (Image Roser)

You conduct a make-or-buy analysis for all one hundred sheet metal parts. For the sake of the argument, assume you get bids from suppliers for all one hundred parts (even though in reality you would probably not get them for all). While in reality the results may vary somewhat, my guess would be that the decision to make or buy would something like the graph below.

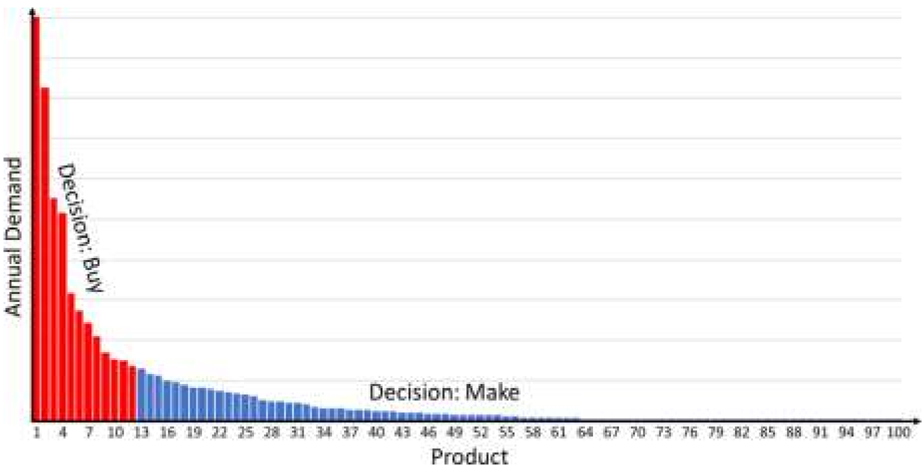


Figure 191: Bad Make or Buy Pareto Chart (Image Roser)

If you have experience in industry, you probably can already smell where my argument is going. All your high-runner A-parts get offers that are cheaper than your own (supposed) production cost, whereas most of your B-parts and probably all of your exotic C-parts are supposedly cheaper to make in-house. You would have never guessed that the expertise in your company is to make cheap exotic C-parts, right? Well, it isn't!

25.4 Why This Is Dangerous

Figure 192: Burning Money (Image siam.pukkato with permission)

Unsurprisingly, suppliers like to produce large quantities. They usually have little interest in the random assortment of C-parts that are rarely needed but still crucial for your company to function. This is because they know that production is subject to the economy of scale, and producing larger quantities is much more efficient than smaller ones. Even if they offer a bid on C-parts, its prices will be significantly higher per part than for the A-parts. As a result, you may hand them the A-parts and keep the C-parts.

But in this case (as all so often in lean), the cost calculation does not fully reflect the real situation. In all likelihood, the high-volume A-parts are actually cheaper than the calculation, and the exotic C-parts are probably more expensive than the calculation, maybe even turning a loss. This is due to the difficulty of cost accounting to measure the financial impact of fluctuations. I don't blame cost accounting for that, as long as they realize that the costs are there. In fact, the fluctuations and the costs associated with it can even increase.

If you produce components or products in-house, how often does it happen that due to a mix-up, change in demand, or other event you quickly need a part to prevent a (minor or major) crisis? If it is in-house, you have full control over production and can just re-prioritize production to better match the changed needs. Sure, it won't be easy, but it will help to keep the system running.

However, this is completely different for external suppliers. You have no control over their production, and your priority may be quite different from their priority. You may not even be a major customer for them. Hence, the urgent rush order may or may not be treated as urgently as you would like. Even if it is produced swiftly, you still have to ship it to your own plant. If you are in the USA or Europe and the supplier sits in Southeast Asia, you either have to wait a few months for the ship to arrive or pay expensive air freight—and still wait two weeks for shipping and customs. All of this creates cost that is nowhere included in the calculations.

Figure 193: Quality Issues… (Image Sergey Chuyko with permission)

Similarly, any quality issue can be resolved much quicker in-house. It will take more time if you need to communicate with an external supplier to find the cause of the defect, resolve the issue, and take care of all the potentially defective goods in the supply chain—and this is assuming that the supplier takes responsibility and does not blame the customer or someone else.

Additionally, cost accounting attributes the fixed cost like machines and tools to all parts produced. But if you give the high-runners away, the fixed cost increases and your exotics become even more expensive. You outsource the variable cost and keep (a lot of) the fixed cost.

If you outsource the A-parts, you keep all the stuff that is much more expensive to make than you think. Most companies have a mixture of profitable high-runners and loss-making exotics, and you are outsourcing the profitable parts (for someone else's profit) and keeping the loss-makers (for your own losses). Overall, if you decide make-or-buy purely by comparing the cost calculations with the supplier bids, you are likely to keep the actually expensive parts while outsourcing the actually profitable parts, and that is not good.

Of course, there are good reasons to outsource and buy parts or products, but this is not only a decision of finances. More on this in my next post. Now, go out, think carefully before outsourcing a high runner, and organize your industry!

PS: This post was inspired by a very fruitful discussion with Karl-Ludwig Blocher.

26 How to Do Make-or-Buy

Christoph Roser, June 27, 2023 Original at https://www.allaboutlean.com/make-or-buy/

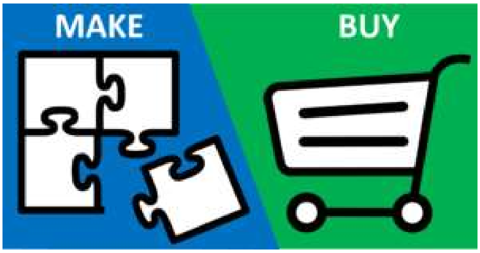


Figure 194: Make or Buy Illustration (Image Roser)

In my last post I discussed how a purely cost-accounting-driven make-or-buy decision can be bad for the company. However, there are often good reasons to buy parts or products instead of make them. In this post I will look at a couple of reasons for outsourcing rather than making it yourself. Unfortunately, all of these are hard to pin down in numbers, and at the end of the day it is still a qualitative decision.

26.1 The Supplier Has More Competence

Figure 195: Older Experienced Worker (Image photosvitwith with permission)

The first good reason to buy the parts from a supplier rather than making them yourself is if the supplier has more competence than you do. This may be based on patent rights, but more likely on a mix of experience, skilled employees, and a suitable machine park. This is actually one of the most common reasons to outsource, as no company is good at everything.

One common example is packaging (unless you are in the packaging industry). Few companies make their own cardboard boxes. Even though it is "just a cardboard box," the supplier simply has more competence (and, see the next point, probably also a larger economy of scale).

This becomes even more critical for technically advanced components. Even some (smaller) car makers buy their combustion engines from other car makers. Some Rolls Royce are powered by a BMW engine. Aston Martin is powered by a Mercedes Benz engine, and Lamborghini Huracan Performante by an Audi engine. High-end computer chips are made by highly specialized makers, especially the Taiwan Semiconductor Manufacturing Company (TSMC). Even high-end graphic card-maker Nivida designs only chips and outsources production to TSMC. It is estimated that Chinese electronics specialist Foxconn manufactures 40% of all electronics worldwide, including products for Apple, Nintendo, Nokia, Sony, Google, Xiaomi, and many more.

26.2 The Supplier Has Larger Economy of Scale

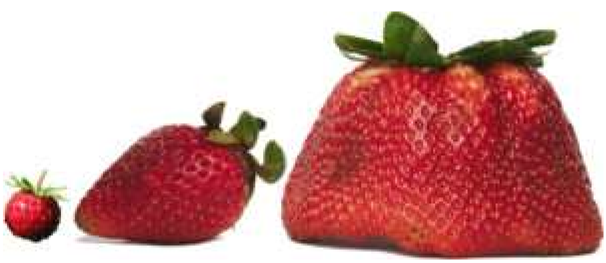


Figure 196: Strawberries Small Medium Large (Image Dllu under the CC-BY-SA 4.0 license)

Another reason to outsource is if the supplier is significantly larger than you are in this field of business and has a much better economy of scale. The larger supplier can purchase materials cheaper, can handle demand fluctuations better due to its larger volume, and has a larger machine park that is better utilized.

Somewhat overlapping with the previous point of having more competence, the employees are also often more skilled in the manufacturing processes. All of this makes the product truly cheaper at the supplier, not only based on cost accounting (see previous post).

A lot of the companies from the previous points are also good examples of economy of scale, from Foxconn to TSMC to large car makers and even to packaging companies.

One risk of having a much larger supplier is that you are just one customer out of many and don't have much control over the supplier. When Volkswagen (and many other car makers) canceled semiconductor orders during the Coronavirus crisis in 2020, TSMC in turn felt no need to prioritize Volkswagen when the demand increased again.

26.3 The Supplier Has Lower Labor Cost

Figure 197: Bangladesh Textile Factory (Image Solidarity Center under the CC-BY-SA 2.0)

Yet another reason is suppliers that have lower labor costs, often in East and Southeast Asia. Here, too, savings according to cost accounting and true savings may not be the same. A rule of thumb is that the part has to be at least 30% cheaper for it to be worthwhile to outsource to Asia. The long-distance supply chain makes fluctuations much more difficult to handle, increases the lead time, makes it more difficult to fix quality defects, and that's assuming you work well with the cross-cultural barriers.

26.4 You Don’t Want to Focus on Making this Part

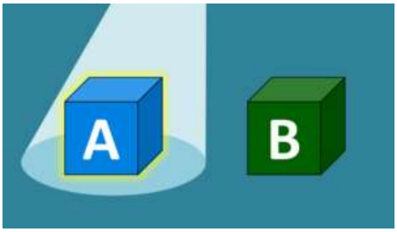


Figure 198: Focus on A not B Product (Image Roser)

Yet another reason has less to do with the supplier but more with your company. Maybe due to a strategic decision, you don’t want to make a certain product or part for a product. Maybe it is not what you consider your core competence, and you prefer to focus on where you can actually make a difference. This often overlaps with the next reason lack of capacity.

26.5 You Lack Capacity

Figure 199: Exhausted Worker (Image Dusan Petkovic with permission)

Maybe you don’t want to make this part yourself because of lack of capacity. This lack of capacity could be manifold. Maybe you lack the floor space to put up another assembly line and don’t want to embark on a time consuming venture to expand the plant. Maybe you are just lacking enough machine capacity and want to use your machine park for other parts and products that are closer to your heart. Similarly, you could lack employees and don’t want to hire people that you may not need anymore in six months. This lack of manpower could be in production, but also in product design, quality control, or logistics. Even the lack of management attention may be the cause. There are many possible reasons why you could lack the capacity to make it yourself and would much rather hand the part to a supplier. Do note that outsourcing a part is not free and also takes the time and effort of your people.

Be aware that this could also be a temporary situation. Either you see a temporary demand for which you don't want to build up capacity, or you do see a longer-term demand, but it takes time to build up capacity even though you really need the capacity now. In this case a supplier can cover the gap until your own capacity comes online. Be aware that suppliers charge a bit more for short-term contracts, as building up capacity for them also costs money.

26.6 How to Judge

Figure 200: Brass Scales (Image Toby Hudson under the CC-BY-SA 3.0)

The above reasons are all valid reasons for outsourcing a part. Please note that all of them also have the difficulty of being properly calculated. There are always factors like fluctuations and delays that cost accounting cannot capture reliably. As a general rule, you should not chase small cost savings, since they are likely to be eaten up by unforeseen other costs caused by the outsourcing.

Also, maybe only one of the above reasons applies to your case (or maybe all of them do). It is up to management to judge whether these reasons are good enough and to decide which part to outsource and which one not. Just don't look only at the cost accounting numbers. Now, go out, decide what to make and what to buy, and organize your industry!

PS: This post was inspired by a very fruitful discussion with Karl-Ludwig Blocher.

27 The Particularities of Continuously Moving Assembly Lines

Christoph Roser, July 4, 2023 Original at https://www.allaboutlean.com/continuously-moving-assembly-lines-particularities/

Figure 201: Assembly Line (Image Siyuwj under the CC-BY-SA 3.0 license)

Continuously moving assembly lines are commonly found in industry, especially high-volume production. Most final assembly lines in automotive are continuously moving lines, but there are also many more examples in industry. Such lines have many of the same requirements of pulsed or untimed lines, but in a few specific circumstances continuously moving lines can have an advantage. This first post of this small series looks at the basic commonalities and differences between pulsed and continuously moving lines. The next posts looks at the mathematical relation between speed, work content, and line length, before a third post explores in more depth the unique issues of line balancing for continuously moving assembly lines. A final post looks at some unique features for continuously moving assembly lines.

27.1 Continuously Moving Line vs. Pulsed and Untimed Line

In the continuously moving line, the parts are – as the name says – continuously moving. This is usually an automatic transport system like a conveyor belt, a moving walkable platform, pulling by an underground chain, or moving hanging carriers, to name just a few. Below is a quick animation to show you the concept. I have written more on continuously moving lines in my blog post here.

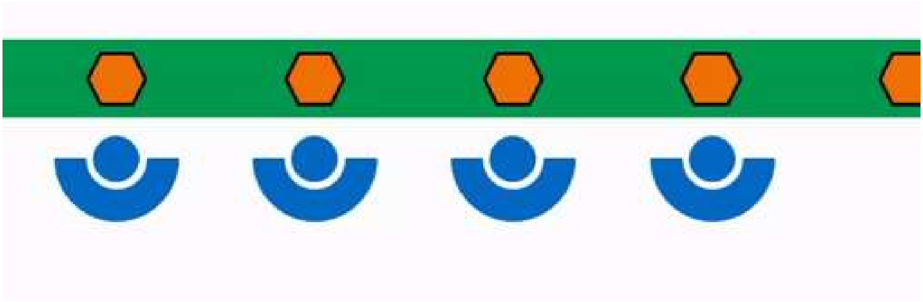


Figure 202: Animated Continuous Moving Line (Image Roser)

This is to be contrasted with a pulsed line or even an untimed line, where there are fixed workstations. Both are shown below.

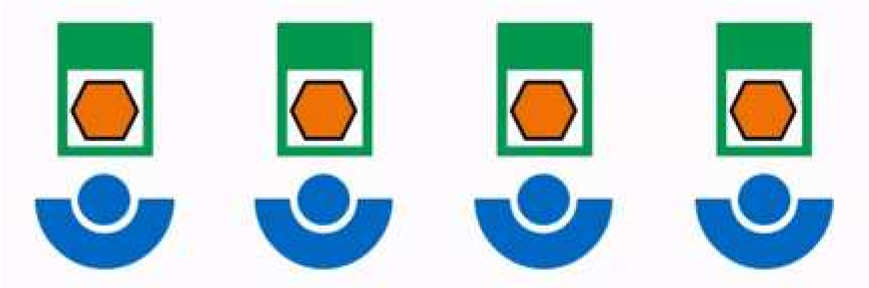


Figure 203: Animated Pulsed Line (Image Roser)

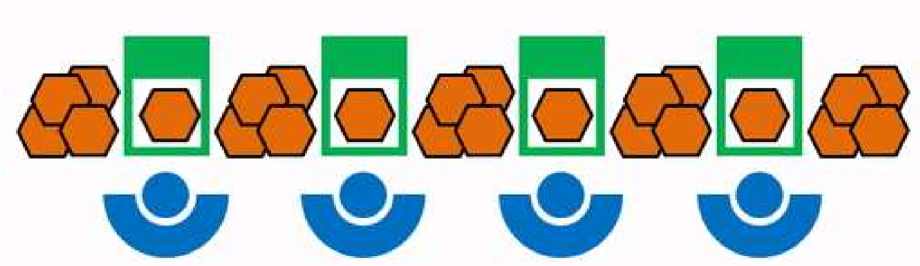


Figure 204: Animated Untimed Line (Image Roser)

27.2 Line Balancing on Pulsed or Untimed Lines

Balancing the workload among the different processes of a manufacturing system is usually straightforward. It reduces unevenness (mura) due to different workloads. This in turn will reduce wasted waiting time (muda) for those with too little work, and overburden (muri) for those with too much. I have written a whole series on line balancing starting with the post [Line Balancing Part 1 – Data Overview](). Basically, you try to distribute the work content within the target cycle time as well as you can.

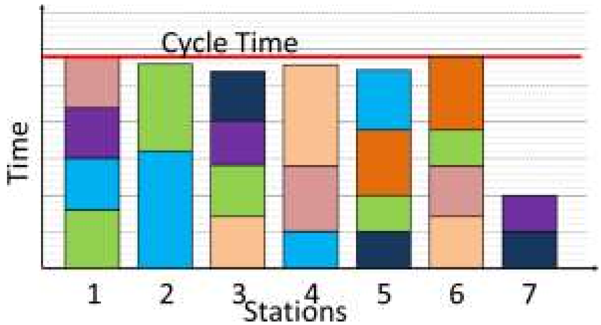


Figure 205: Line Balancing Example (Image Roser)

27.3 Work Content on Continuously Moving Assembly Lines

Figure 206: Hyundai moving walkable platform assembly line (Image Carol M. Highsmith in public domain)

Continuously moving assembly lines differ from unstructured or pulsed assembly lines, since the line and hence the parts are continuously moving. In a pulsed line, all parts move to the next station at every takt. Any work not done at a station within the takt requires the line to stop. If a station temporarily takes more time than the takt, the line is delayed until the station is done with its work. This is, by the way, the famous principle of the andon line, where every worker on the line can stop the line. Line balancing at normal assembly lines requires the distribution of the work content into chunks that fit the line takt (or, more precisely, the cycle time).

For a continuously moving assembly line, this is a bit easier (although there is still a catch and in most cases you still need to fit the work into the takt). But, in pure theory, you can simply take all the work content and distribute it along the continuously moving assembly line. A task that takes longer gets more space, and a task that is shorter gets less. You can imagine this like taking all your work steps and stacking them on top of each other. Then you simply lay this stack of work steps next to your assembly line, making it just as long as the assembly line (plus maybe some space for getting parts on and off). This is (in theory!) the line balancing for an continuously moving assembly line. You can assign a slot of space on the assembly line that fits exactly the slot of time needed for each work step… except that you still need to distribute the workers and machines, which again forces you to do a proper line balancing. Hence, the image below is usually unobtainable in its pure form, but there are some situations where you can use this situation to your advantage to save space. More on this in the subsequent post in this series.

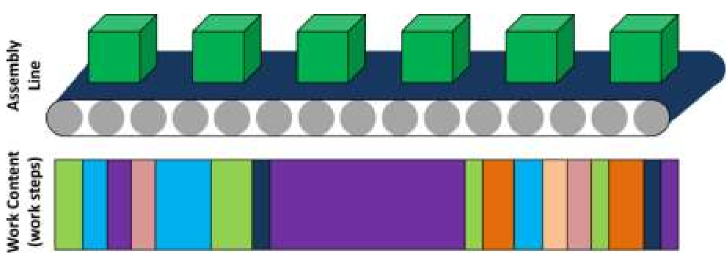


Figure 207: Work on Continuously Moving Assembly Line (Image Roser)

27.4 Continuously Moving Lines Not Bound by Station Size

The main difference with a continuously moving assembly line is that the length of a workstation on an continuously moving line is not bound by the takt. It does not have to be the same length at every station, but the length of the station can vary. This possibility to divide the continuously moving assembly line into slices gives us a lot of options. But be aware that this applies only to the work content assigned to a distance on the line. The workers can NOT be cut into slices of the desired size; either you have a worker for an area of the line or you don't. This takes away a lot of the advantage of the continuously moving assembly line. However, in some cases a bit of advantage remains.

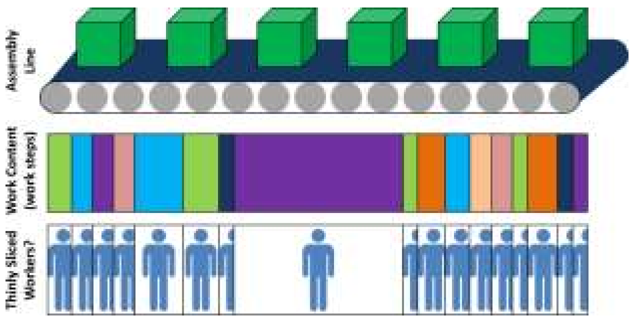


Figure 208: Continuously Moving Assembly Line Thinly Sliced Workers (Image Roser)

Obviously, you would group work content (including losses) to fill one customer takt worth of work, just as you would do with a pulsed line. The difference between a takt (including losses) and the cycle time (excluding losses) is the OEE, and your line has to match the customer takt in average, not only in an ideal case. (More on this in my next post.) For tasks that exceed your customer takt, you have to assign multiple workers, and ideally it is also a multiple of the takt time. Whenever the work assigned to a worker does not match the takt time, then you run into inefficiencies.

- If the worker on average is faster than the takt, then the worker has to wait for the next part.

- If the worker on average cannot do the work within the takt, then your line will slow down and stop, and all other workers will have to wait more.

In sum, the more you miss the (multiple of the) takt time, the longer your workers will wait. So far this is just as it is in a pulsed line. However, the continuously moving line offers a few advantages. You can use fractions of the takt (i.e., different lengths of the assembly line) in two cases:

- Buffer against fluctuations. Normally, buffers are always a whole integer of parts. In a continuously moving assembly line, however, you can also have a buffer of less than one full takt (i.e., less than one part). The worker gets some extra space on the line in case it takes longer. Importantly, however, the worker on average still has to make the takt time, otherwise the line will slow down. When covering fluctuations with line length, it merely means that the worker can take a bit more time for one part if he makes the next part faster.
- Worker independent time content. In some (admittedly uncommon) cases, you have a part or product that needs to spend some time without any worker or any machine. Examples for this are a part that comes from an oven and has to cool down, or a glue that needs to harden, or a cement that needs to cure, etc. The part needs time to cool/harden/cure/etc., but it does not need a worker or an automatic machine. In this case, the part gets the right space on the assembly line that gives the needed time to cool/harden/cure/etc., regardless if this time is a multiple of the takt time.

But I will discuss this in much more detail in my subsequent posts of this series. My next post will look at the math of the relation between speed (takt), length, and work content for continuously moving assembly lines, before subsequent posts digs deeper on how to assign times to workers and line segments, including the special cases of buffer against fluctuations and worker independent time content. But until then, go out, get your lines set up right, and organize your industry!

PS: This series of blog post was inspired by Sobha Modular.

28 Continuously Moving Assembly Line—Speed, Work Content, and Length

Christoph Roser, July 11, 2023 Original at https://www.allaboutlean.com/continuously-moving-assembly-line-speed-work-content-length/

Figure 209: GM Poland Automotive Assembly (Image Marek Ślusarczyk under the CC-BY 3.0 license)

This second post on continuously moving assembly lines will look at the math behind the correlation between the speed of the line (line takt or customer takt), the length of the line, and the amount of work that has to be done on the line. Luckily, the calculations are not very tricky. And, different from a pulsed assembly line, it is perfectly fine to have a continuously moving line that fits not a whole number but a fraction of parts to save space. The tricky part on how to assign the work to the workers will be discussed in the next post of this series.

28.1 Timing a Continuously Moving Assembly Line

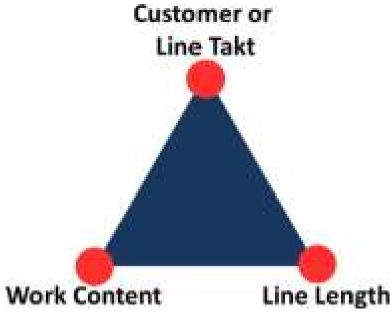


Figure 210: Continuously Moving Line Speed Takt and Work Content (Image Roser)

But before I talk about how you can use this unique feature to save space, let's first talk about the length of the line, its work content, and the customer takt, because these three are the variables that influence each other. The length of the line and the work content determines the line takt (the speed of the line). If this does not meet your expectations (i.e., does not meet the customer takt), then you can either make the line longer or improve and reduce the work content.

28.2 Parts on Line

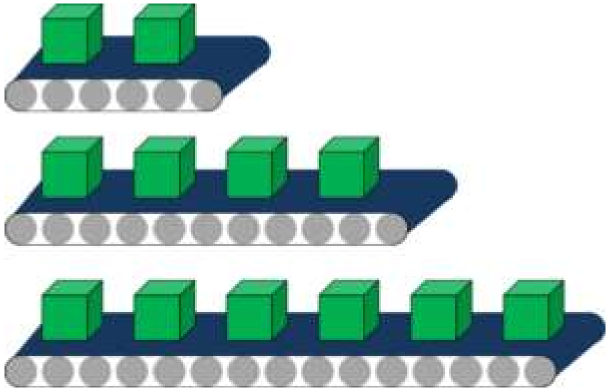


Figure 211: Different Assembly Line Lengths (Image Roser)

One interim variable needed is also the distance between parts on the continuously moving assembly line, which determines how many parts you can fit on the assembly line. For example, if you have an assembly line that is 25 meters long, and you need half a meter between one part and the next, then you can fit fifty parts on the assembly line. Or, more generally,

$$Parts\ on\ Line\ (parts) = \frac{Line\ Length\ (length)}{Distance\ between\ Parts\ (\frac{length}{part})}$$

28.3 Possible Line Takt

Figure 212: Metronome (Image Vladimir Voronin with permission)

From this you can calculate the line takt (average time between parts) based on the work content. One often forgotten small but important detail is that the line takt is the average speed of the line, but the work content is often the ideal speed (i.e., the sum of the cycle times). The sum of your ideal, perfect cycle times would be your work content. However, in any line there will be mishaps, missing materials, breakdowns, absent workers (e.g., bathroom breaks), and more. Hence, if you include all of these losses, you will need more time to do all the work than this ideal work content. (I have a whole blog post on the often confused time and speed measurements in lean manufacturing). Hence, unless your work content is based on average speeds including losses, you must adjust for such losses. This difference is the OEE (Overall Equipment Effectiveness). For example, if your ideal work content without losses is 100 minutes, but you estimate an OEE of 80%, then your real work content including losses is 100 min / 80% = 125 min. Or, more generally:

$$Work\ Content\ with\ Losses\ (time) = \frac{Work\ Content\ without\ Losses\ (time)}{OEE\ (percent)}$$

Now we can calculate the possible line takt. If we have a work content including losses of 125 min, and we can fit 50 parts on the line, then we can in average complete one part every 125 min / 50 parts = 2.5 min. Or, more generally:

$$Line\ Takt\ (\frac{time}{part}) = \frac{Work\ Content\ with\ Losses\ (time)}{Parts\ that\ fit\ on\ line\ (parts)}$$

28.4 Matching the Length to the Customer Takt

Figure 213: People measuring Floor (Image pressmaster with permission)

If this is not good enough, then we either can fiddle with the length of the line or the work content of the line. For example, if our customer takt is not 2.5 min/part but instead 2 min/part, then we need to match the line takt to the customer takt. One option is of course overtime, but let's look first at changing the line length. We can change the line length from fitting 50 parts to 125 min / 2 min/part = 62.5 parts. or, more generally,

$$Needed\ Parts\ on\ Line\ (parts) = \frac{Work\ Content\ with\ Losses\ (time)}{Customer\ Takt\ (\frac{time}{part})}$$

Your gut feeling probably told you to round up the 62.5 parts to 63 parts. And, on a pulsed line you would be totally right. But here is one of the advantages of the continuously moving assembly line: You don't need to round up to an integer number of stations, but can easily have "half a station" for half a cycle of work, or other any other number that is not a whole integer number. I will talk much more on that in my next post. In any case, if we need 62.5 parts on the line, and each part needs half a meter, then we need a line length of 31.25 meter to make the customer takt if the work content is unchanged.

28.5 Matching the Work Content to the Customer Takt

Figure 214: Stopwatch (Image Hydrargyrum in public domain)

Another option if you can't make the customer takt is to change the work content. If your customer takt is 2 min/part and you still can fit only 50 parts on the line, then the allowed work content including losses would be 50 parts · 2 parts/min or 100 minutes. You would have to improve the work content including losses from 125 min to 100 min by improving standards, providing better tools, or moving work content to subassembly lines. With an OEE of 80% this wold be a reduction of the work content without losses from 125 min · 80% = 100 min to 100 min · 80% = 80 min. Or, more generally:

$$Allowed\ Work\ Content\ with\ Losses\ (time) =$$
$$= Parts\ on\ Line\ (parts) \times Customer\ Takt\ (\frac{time}{part})$$

from which we can simply calculate the work content without losses as:

$$Allowed\ Work\ Content\ without\ Losses\ (time) =$$
$$= Allowed\ Work\ Content\ with\ Losses\ (time) \times OEE\ (percent)$$

28.6 The Speed of the Line

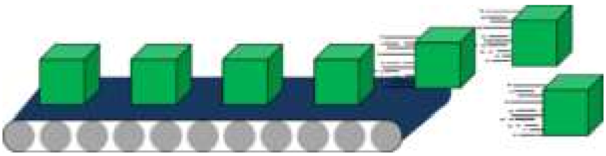


Figure 215: Assembly Line Speed Illustration (Image Roser)

Finally, the speed of the line is easy to determine. You simply take the work content and divide it by the length of the line. In our example, we had a work content including losses of 100 minutes for an assembly line that was 25 meter long. Hence, the speed of the line has to be set to

$$Line\ Speed\ (\frac{length}{time}) = \frac{Line\ Length\ (length)}{Work\ Content\ with\ Losses\ (time)}$$

This is the underlying math on distributing work on a continuously moving assembly line. The beauty is that you are not limited to a whole integer number of parts on the line, but can easily have space for only a fraction of a part on the line. But please include also some space to put a part on the line and to remove it again from the line. It is also wise to allow some buffers (i.e., space on the line) to handle fluctuations. And finally, even though the time and space on the line is infinitely divisible, your workers are not, and you still require some line balancing. But more on these in my next post. Now, go out, make sure the line takt of your continuously moving assembly line matches the customer takt, and organize your industry!

PS: This series of blog post was inspired by [Sobha Modular](#).

29 Continuously Moving Assembly Line—How to Do Line Balancing

Christoph Roser, July 18, 2023 Original at https://www.allaboutlean.com/continuously-moving-assembly-line-line-balancing/

Figure 216: Hyundai moving walkable platform assembly line (Image Carol M. Highsmith in public domain)

Continuously moving assembly lines have a lot in common with other types of assembly lines. However, there are also some differences. This third post of this small series on continuously moving assembly lines looks at how to distribute the work along the line. The key point is that you can distribute the work along the line in proportion to its duration, but the worker and the machines have to follow the takt time. Let me explain.

29.1 A Quick Recap

The work that has to be done on the continuously moving assembly line could simply be distributed along the line in proportion to the duration of the work. Together with the line length this will determine the line takt. If the line takt does not match the customer takt, then you can either change the work content or change the line length.

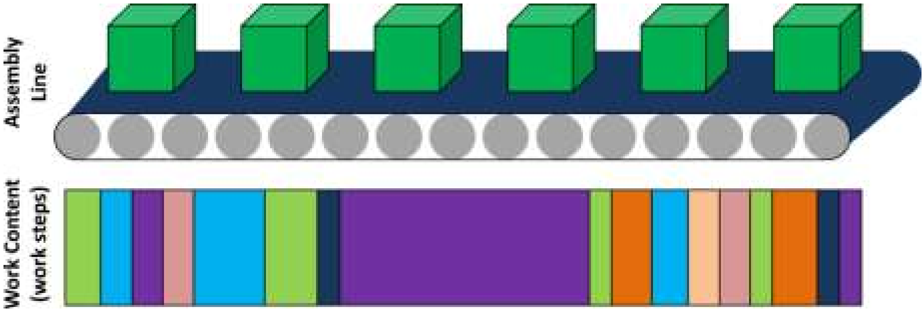


Figure 217: Work on Continuously Moving Assembly Line (Image Roser)

29.2 Workers Follow Takt

Figure 218: Metronome (Image Vladimir Voronin with permission)

The workers, however, need to follow the takt time. Below are three scenarios that similarly apply if a robot or a machine is doing the processing.

- If the work content for a worker is less than a full takt time, then it is perfectly fine to assign only the required space to the assembly line. Afterwards, the part moves into the next station. The worker will also be able to do his work and then move to the beginning of the assigned space. However, when the worker arrives at the beginning, the next part has not yet arrived (since it is exactly one part per takt), and the worker has to wait. If you assign less work than one takt to the worker/station, you don't need as much line length but waste the workers time.
- If the work content for a worker is just about one full takt time, then you have the best case scenario. The space on the line is long enough for one takt, before the part

moves into the next station. The worker also can do his work. When the worker then returns to the beginning of the assigned space, the next part is just arriving and he can work continuously. If the assigned work matches the customer takt, then the time of the worker is not wasted.

- If the work content for a worker is more than a full takt time, then the space on the line has to be extended accordingly to match the time. This way the part is available for the station for the extended time. The worker can complete the first part, but since this takes more than one takt, the next part is already within the work station when the worker completes the first part. The worker is then delayed with starting the next part, and will not be able to complete the task on time. You would need more workers to complete the work. If the assigned work exceeds the customer takt, then the worker cannot keep up and the line will slow down or stop (more on this later).

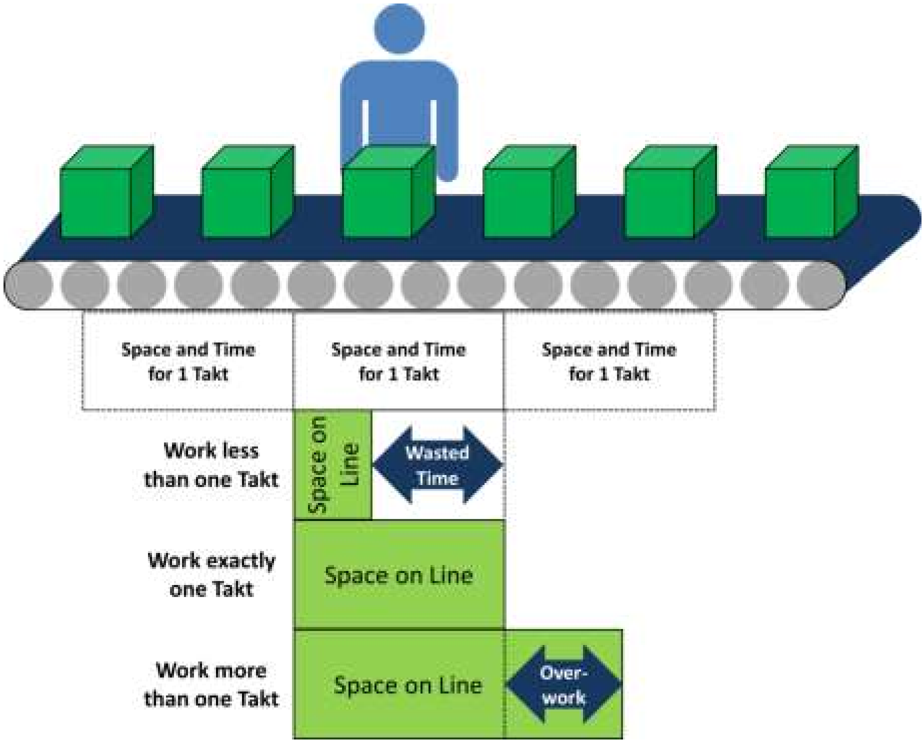


Figure 219: Continuous Line Worker more or less than takt (Image Roser)

29.3 Work Content Exceeding One Takt

Let's go into more detail on work content that exceeds one takt. We already saw that this either requires additional workers or it will slow down and stop the line. You need to provide additional capacity to complete the work. Below is an example from conventional line balancing. You simply increase the number of identical, parallel work stations. The example below is balanced to two takt times (or cycle times if you calculate without losses), and two stations can handle the work. Similarly you can use three or more stations for work content of three or more cycle times. This works best if the work content is a whole integer multiple of a takt time. In other words, two stations for twice as long, three stations for a work content that requires three takts, and so on. It creates waste if it includes a fraction of a takt (i.e., if you have 2.5 takts worth of work content, then you still need three stations, wasting half a takt worth of work with every part).

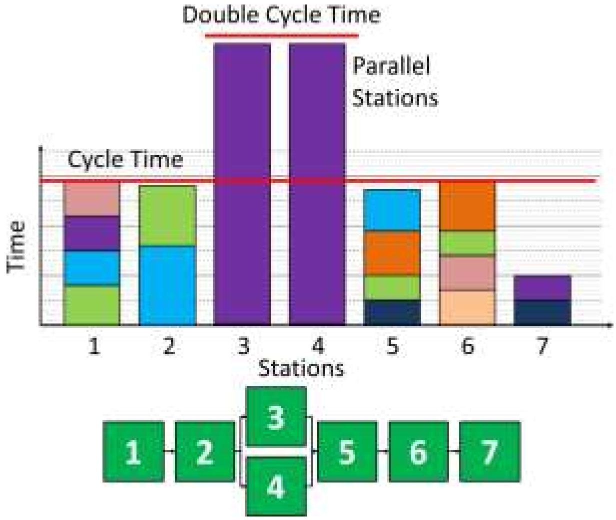


Figure 220: Line Balancing Example Parallel Stations (Image Roser)

Figure 221: No splitting the line (Image Vincent60030 under the CC-BY-SA 4.0)

For a continuously moving assembly line, however, it is not possible to split the line into two for one station and merge them again. But there is an elegant workaround. You simply have two or more stations in sequence. You could have one worker at each station handing over a half-finished part to the next, albeit I imagine that the handover is tricky. It may be better to have two (or more) workers on a longer station. Below is an example with work content for two takts. Two workers handle this station together, being one takt of time apart from each other. The first worker takes the part and starts working. The second worker takes the next part one takt later. By the third takt, the first worker is done and has returned to the start of the station to handle the third part.

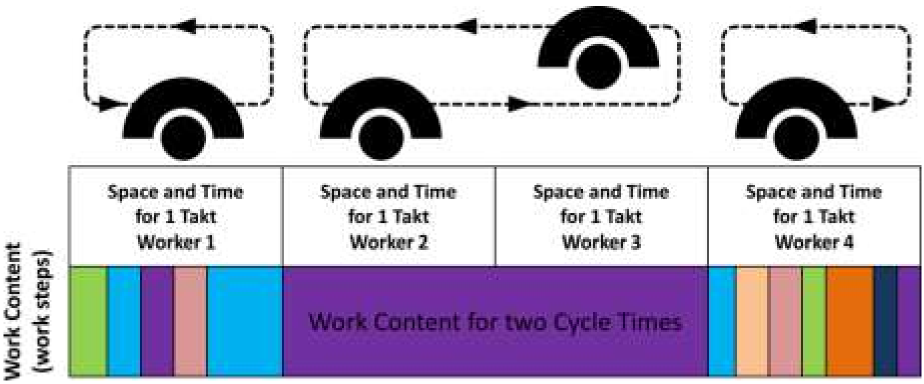


Figure 222: Continuously Moving Assembly Line Double Takt (Image Roser)

Similar applies to work content that is three, four, or even more takt times long; you simply use three, four, or more workers in a loop. The walking distance also makes not much difference. A single worker walks back one station every takt, two workers walk back two stations every two takts, hence, similar walking times per time. It may be a bit trickier for machines or robots. While you still need multiple robots for a multiple of a single takt, moving the robots or machines back to the beginning while another robot or machine moves in the opposite direction is tricky.

Also, be aware that the line has to be long enough to fit all the workers, machines, and materials along the line.

Please be aware that this still works best if the work content is as closely as possible a whole integer multiple of one takt. If it is not, you again introduce waiting times (or line stops), even though the space on the line can match the work content exactly. In sum, whenever you have workers or machines, you still have to do a proper line balancing, even on a continuously moving assembly line, or you will introduce waste in the form of waiting times (work less than takt) or line slowdowns and stops (work more than takt). In my next post I will discuss the (admittedly) uncommon situations where the part needs time, but no worker or machine. Now, go out, balance your line (continuously moving or not), and organize your industry!

PS: This series of blog post was inspired by Sobha Modular.

30 Continuously Moving Assembly Line—Special Situations

Christoph Roser, July 25, 2023 Original at https://www.allaboutlean.com/continuously-moving-assembly-line-special-situations/

Figure 223: Minsk Tractor Works (Image Homoatrox under the CC-BY-SA 3.0 license)

This is the last post on my short series on continuously moving assembly lines, where I will look at some special situations unique to the continuously moving assembly line. These lines have some interesting features for covering fluctuations within the line, for processing time that needs no worker or machine, and on the distance between parts on the line. Maybe some of these apply also to your situation and can help you to make your assembly line even better.

30.1 A Recap

A part on a continuously moving assembly line moves continuously (duh!). Distance along the line also represents time on the line. This distance/time could be split into segments of any size… except that you can't split workers. Hence, since the workers can work efficiently only in multiples of a takt time, you still need to balance the continuously moving assembly line to have the workers and the line work efficiently. But there are some special cases.

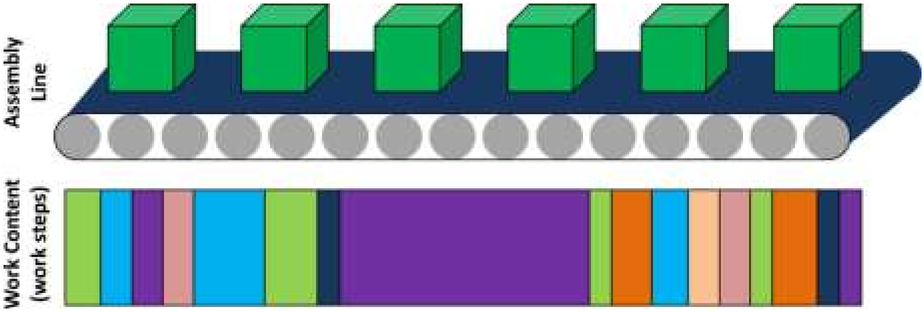


Figure 224: Work on Continuously Moving Assembly Line (Image Roser)

30.2 Worker Independent Time Content

Figure 225: Pouring concrete (Image Edward Miller in public domain)

In some (admittedly uncommon) cases, you have a part or product that needs to spend some time without any worker or any machine. This could be a part that comes from an oven and has to cool down. It could be a glue that needs to harden or a cement that needs to cure. It could be a bread where the yeast has to rise. These situations are not very common, but they do happen sometimes. They all have in common that the part needs time for processing, but it does not need a worker or a machine. Hence, we are no longer bound by the workers to the takt time. Just give the part the right space on the assembly line that gives the needed time to cool/harden/cure/etc., regardless if this time is a multiple of the takt time or a fraction thereof.

There is also an interim case, where the part may still need a tool or machine but not the worker itself. If you need workers, you need one worker for each takt time, including one full worker for partial takt times—which is inefficient. In lean, it is considered impolite (and expensive) to let the worker wait. However, letting machines wait is okay. Therefore, if the process needs a (preferably inexpensive) machine or tool, simply get enough machines or tools to cover all required takt times. It is okay if the machine is then idling for less than one takt. For example, if you wait for something to cool, you may just put a fan next to it. Having one extra fan even though you would need the time of only 0.3 fans is not big issue, and not needing the fan for 0.7 cycles is not a big waste. On the other hand, if you are buying a second multi-million-dollar laser cutting tool because you need 0.1 takt time for this tool, the tool will be idle 90% of the time and your boss will want to have a word with you.

30.3 Buffer against Fluctuations

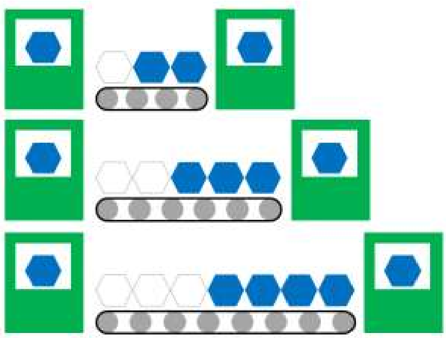


Figure 226: FiFo Lanes (Image Roser)

A second special situations are buffers. Normally buffers are always a whole integer of parts. You may have a FIFO lane buffer for 2, 3, 5, 10 or any whole integer number of parts. However, in a continuously moving assembly line, you can also have a buffer of less than one full takt (i.e., less than one part). If you have a process whose cycle time fluctuates (e.g., due to different work content for different parts coming down the line), then you can simply assign more space to the process. If you want to cover fluctuations of ±50%, you simply give the station 50% more space on the line. If the work takes longer, the worker can use the extra space.

Importantly, however, the worker on average still has to make the takt time, otherwise the line will slow down. Hence, if one part takes a bit longer, the next part needs to be a bit faster or the line gets out of whack and slows down or stops. If the fluctuation in duration is due to different products, this approach with some extra space is incompatible with batching. This touches the topic of mixed-model assembly lines, which I have written a long series of blog posts about, including the animation below for a two door and for door (twice the work) assembly line.

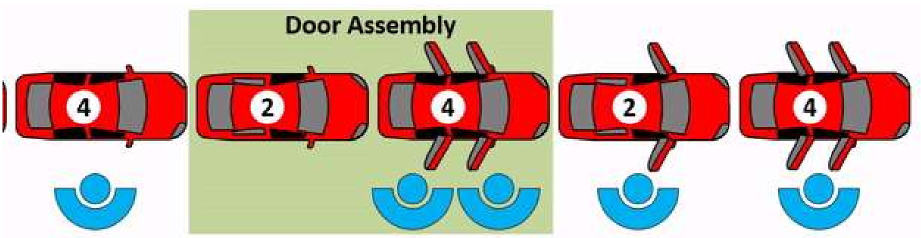


Figure 227: Double Door Assembly Station - Animated (Image Roser)

30.4 On the Distance between Parts

Normally, on a continuously moving assembly line, the parts are always the same distance from each other. Combined with the speed of the line this distance represents one takt time. However, it is sometimes possible to have varying distances between parts. The distance between the start of part A to the start of part B may be different from the distance between the start of parts B and the start of part C. An example is illustrated below.

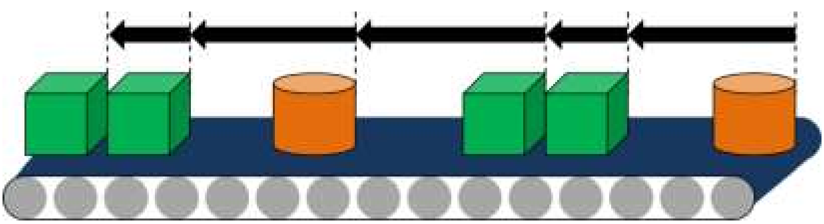


Figure 228: Continuously Moving Assembly Line Distance between Parts (Image Roser)

It depends on the setup of the line if this is possible. If you have fixed size workpiece holders or carts that are coupled, then you may have restrictions in the distance between carts. But if you merely place items on a conveyor belt, you have some flexibility with the distance. Please note that the standard is still parts at equal distances, as anything else becomes much more complex to manage. But it is a possibility to give a part more (or less) time for each takt. Imagine that you have one product that takes longer at one station on the line. If you give this part more space on the line, you give it more time for that process… and all other processes. Hence, if you extend the space to give it more time for one process that needs the time, you give it also more time to all other processes that don't need it… creating waste and inefficiencies. Giving one part more space for all stations has the same efficiency impact as slowing down the line for all parts while this special part is on the critical process.

I can't imagine a situation where a different part needs proportionally more time for all processes on an assembly line. Hence, I would use this option VERY sparingly, maybe for uncommon exotic parts that you produce rarely. Even then, I think I would rather have the normal distance and the normal speed, and simply stop the line if the part exceeds the cycle time at the critical station (keyword for stopping the line is andon). This may be much easier to handle, as the line stop reacts to the actual delay, whereas messing with the speed or distance beforehand is based on the prediction of the actual delay, and hence may be incorrect. In sum, while it may be possible to have different distances on the line, it is usually not advised unless multiple stations need more time for a certain part.

This concludes the series on continuously moving assembly lines. I initially thought it would be one post, then it turned out to be two, then three, and now four posts, with one more still coming up next week on assembly line speeds. Now, go out, use the benefits of the continuously moving assembly line, and organize your industry!

PS: This series of blog post was inspired by Sobha Modular.

31 Continuously Moving Assembly Line—Speed Limitations

Christoph Roser, August 1, 2023 Original at https://www.allaboutlean.com/continuously-moving-assembly-line-speed-limitations/

Figure 229: Skoda Car Assembly Line (Image Nataliya Hora with permission)

Continuously moving assembly lines can move as slow as they need to, to fit the work on the length of the line. However, they cannot be as fast as you like. There are some limitations on the speed of the line due to the limitations of the walking speed of a human worker, and even more so due to the ability of the worker to do work while the line moves. Let's have a look!

31.1 A Quick Recap

A continuously moving assembly line moves the parts continuously. The workers move with the part (either by themselves or on a moving platform). Once they are done, they walk back in the opposite direction to their next location. The animation below illustrates this principle.

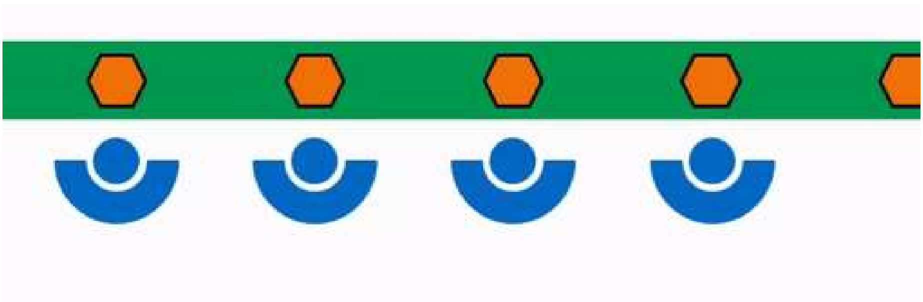


Figure 230: Continuous Moving Line Animated (Image Roser)

31.2 On the Walking Speed of Humans

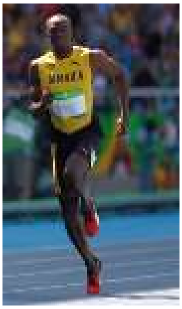


Figure 231: Usain Bolt (Image Fernando Frazo/Agncia Brasil under the CC-BY-SA 3.0 Brazil license)

Obviously, one key limitation in the speed of a moving assembly line is the human worker. So let's first look at the speed of humans. The fastest human ever (so far) was Usain Bolt, who set the world record in the 100-meter sprint at 9.58 seconds. Obviously, this is not doable for your workers. And even if Usain Bolt works for you, it would not be sustainable. Besides, I strongly advise against running in a factory unless someone is in danger. Walking is much better!

The walking speeds of humans vary considerably. People with longer legs and a higher center of gravity tend to walk faster. Younger people walk faster. Rough terrains slow people down. Mashing everything together comes to an average walking speed on flat ground of 1.42 meters per second. In industry, however, the pace may be a bit faster. The Methods-time measurement system of predetermined motion assumes a walking speed of 1 foot every 5.3 TMU, which translates into 1.60 meters per second, not including turning (0.7 to 1.3 seconds depending on the footing) and assuming that the worker does not carry any load. Some companies in Japan even standardized this and have a timed walking distance to train their people on the proper walking speed. I also did this walk, and it is not a leisurely stroll but is quite doable. Obviously, the assembly line cannot move faster than the worker.

Hence, if the worker can move 1.6 meters per second, the line cannot be faster than that. But don't you dare to set your assembly line to 1.6 meters per second, or you will end up with a system like Charlie Chaplin's "Modern Times," and your workers will go crazy. By the way, the assembly line speed in the Modern Times video clip below is just around 1.5 meters per second, or a brisk walking speed. You don't need to watch the video to see that this is insane…but still watch the clip because it is a very good movie.

The Video by Charlie Chaplin is available on YouTube as "Charlie Chaplin - Factory Scene - Modern Times (1936)" at https://youtu.be/6n9ESFJTnHs

31.3 Type of Line

Here we have to distinguish between different types of moving assembly lines.

- For small parts the worker may be stationary and complete the task while the part passes through in front of him.
- For large- and medium-sized parts the worker may be moving along the line on his own two feet.
- For larger parts like cars there is often a moving platform that carries the worker (and his tools) along.

Figure 232: Types of Continuously Moving Assembly Lines (Image Charlie Chaplin in public domain; Siyuwj under the CC-BY-SA 3.0; Carol M. Highsmith in public domain)

A moving assembly line where the worker remains stationary is possible but uncommon. A pulsed line is often better suited for that, since it allows the worker to work on the part without the part moving. If it is a moving line, the speed has to be slow enough to give the worker enough time and a part that moves only very slowly. Don't do Charlie Chaplin "Modern Times," please!

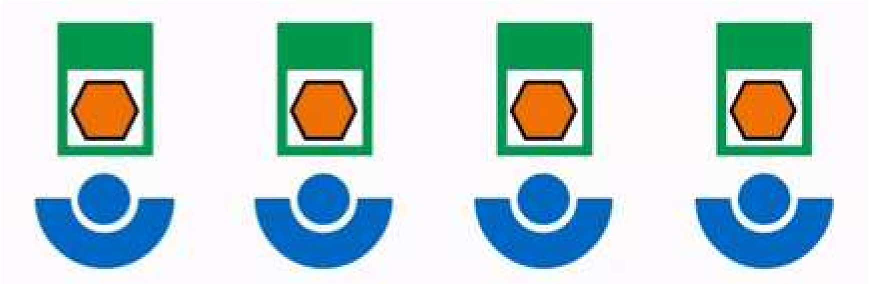


Figure 233: Animation Pulsed Line (Image Roser)

A moving assembly line where the worker walks along with the line (and later back again) is quite common, from automotive to forklifts and others. Usually they are for medium-sized or larger products like cars. Here, too, the line should be slow enough for the worker to comfortably do their work with little walking in between. Tool carts may be designed to move along with the line, and at the end of the station roll back to the beginning of the station.

With moving platforms you could have, in theory, quite a quick speed, but in reality there are problems with that. First, the worker has to get off the moving platform and walk back to the beginning of his station. At the same time the line zips past him. Since the worker is on the way back, the space cannot have any parts or work and must be empty. Hence, a high speed merely makes the line longer by having large gaps between the parts. Secondly, the worker has to get on and off the assembly line to get materials and tools. If the assembly line moves slowly at around 0.1 meter per second, this is easy to do. However, the faster the speed difference is between the moving platform and the (stationary) surroundings, the riskier it is to get on and off.

Figure 234: Moving walkway with Girl Japan (Image MIKI Yoshihito under the CC-BY-SA 2.0)

You surely remember stepping on a moving walkway or an escalator, having to pay attention so as not to stumble or fall. Now imagine doing this multiple times per minute eight hours a day, and it is almost guaranteed that sooner or later you will fall. Moving walkways usually move much slower than an average walking person and often have a speed of 0.5 meter per second or less. Moving platforms in assembly lines are even slower and often have speeds at 0.1 meter per second or less. This makes stepping on and off much safer. In theory the worker could also stay on the platform and walk back, but then he would have to walk against the moving platform too. Such continuously moving platforms are common in the automotive industry.

31.4 Speeds of Continuously Moving Assembly Lines in Automotive

Figure 235: Automotive Assembly Moving Platform (Image Foto-event with permission)

The average length of a car is around 5 meters, although this varies considerably. At the time of writing, the Mitsubishi Mirage is the shortest available normal car with a total length of only 3.845 meters. On the other end we have the Rolls-Royce Phantom VIII EWB with 5.99 meters. Have fun parking that in an European city… but then, you don't park your own Rolls Royce, I guess. If we look at pickup trucks, we also have monsters like the Ford Super Duty at 6.76 meters. Overall, most car assembly lines allow 6 or 7 meters per car on an assembly line.

The fastest automotive assembly line in the world is the Yichang Factory of GAC Motor, where a car is assembled every 46 seconds. However, fast is not necessarily good. The average value for automotive assembly lines is more around 60 to 90 seconds per car. The Audi A8 assembly line in Neckarsulm takes around 9 minutes per vehicle… but this is due to the limited demand of these high-end and ultra-luxury vehicles.

The Yichang Factory, assuming 6 meters between cars with a car every 46 seconds has a speed of 0.13 meter per second. More commonly, however, you have a car every 7 meters with a 60-second takt, giving a speed of 0.11 meter per second. For the Audi A8 line in Neckarsulm, I assume a distance of 8 meters (since they are long luxury cars and the distance may be even more) every 9 minutes, which gives a speed of 0.015 meter per second. For the casual observer that looks like the line is standing still and the motion is not really visible… except a minute later it has moved a bit. Please note that all of these speeds are a mere fraction of the human walking speed of 1.4 or 1.6 meters per second!

31.5 What Are Good Speeds?

Overall, most continuously moving assembly lines are moving quite slow, and a grandma with a wheeled walker would easily outpace the line. Speeds of 0.1 meter per second or even less are common. The line can be as slow as it wants to be to fit the work on the line, but it should not be much faster than 0.1 meter per second; otherwise the workers will find it increasingly difficult and stressful to work. In that aspect, a "fast" line is not necessarily a good line. I would rather have a slower but shorter line than a faster and longer line.

After five posts I think I have written everything I wanted to about continuously moving assembly lines (for now). A lot of this is also my original research, and I would be surprised if you find this anywhere else (if so, let me know in the comments). In any case, I hope this post on assembly line speeds was of interest to you. Now go out, set up your assembly lines, and organize your industry!

PS: This series of blog post was inspired by Sobha Modular.

32 The Soft Power of the Toyota Production System—Yokoten, Nemawashi, and More

Christoph Roser, August 8, 2023 Original at https://www.allaboutlean.com/yokoten-nemawashi-et-al/

Figure 236: Asian business people (Image Tom Wang with permission)

When we are talking about lean manufacturing, we often focus on the tools like kanban, 5S, SMED, and many more. Sometimes, but harder to grasp, is the underlying culture and philosophy of continuous improvement and PDCA. Part of this culture is what you could call the soft power of the Toyota Production System. This is a form of decision making in contrast with the “hard power” more common in Western companies. Let’s have a look:

32.1 Hard Power

Figure 237: Angry boss yelling at People (Image Elnur with permission)

Hard power is decision-making power established through hierarchy. In the end, the boss makes the decision and the employees have to accept it, no matter whether they want it or not. This is also the formal and legal approach, as the boss has the authority to make decisions even if the underlings disagree. The advantage of this approach is its speed. It is faster for one person to make up his mind and form a decision, than for ten people to do so.

32.2 Flaws of Hard Power

Figure 238: Management vs Worker (Image Paolese with permission)

However, such hard power also has its disadvantages. For one thing, the wisdom and experience of a group usually exceeds the wisdom and experience of a single person, no matter how much more money he makes and how much bigger his desk is. Hence, a group agreeing on a decision usually makes better decisions than an individual on his own.

But a second disadvantage of a unilateral decision by the boss is that the employees may not agree. Now, in purely legal terms, the employees have to suck it up and just deal with it, as they are legally obliged to follow the orders of their boss. But only a fool would believe this to be absolutely true. Even though it is not part of the legal system (usually written by the bosses), employees have a multitude of ways to disagree and obstruct any decision by their management. From dragging their feet to strictly following instructions (probably the worst) to complaining behind their boss's back (probably the most common) to many other forms of obstruction due to a lack of commitment and a loss of morale.

32.3 Soft Power in Japan

Figure 239: Asian business meeting (Image Freshpixel with permission)

In Japan and at Toyota, there are often (but not always) some softer approaches to decision making. Instead of forcing a decision on the employees and subordinates, more effort is put into bringing them on board. This is in part due to the Japanese tendency to risk aversion, wanting to make sure there are no surprises or opposition when proposing a new decision. Below I have a couple of Japanese terms related to these softer approaches.

32.3.1 Nemawashi

Figure 240: Asian Business meeting (Image Dragon Images with permission)

Nemawashi (根回し) is Japanese for "laying the groundwork; behind-the-scenes maneuvering; consensus-building process." This is an informal process of talking to people, warming them up to your idea, and listening to them to get their feedback and hear their concerns. The goal is to get their consensus before formally proposing a change. Hopefully the final agreement is then a mere formality, because all (or most?) sides have already agreed beforehand. This also makes it easier to work with disagreement. If another person rejects the idea formally in front of everybody, it is much harder and potentially includes much more loss of face for them to change their opinion. An informal rejection during small talk, on the other hand, can be much easier overcome through consensus finding.

Figure 241: Nemawashi transplant Trees (Image Anish nellickal under the CC-BY-SA 4.0)

On a side note, nemawashi comes from ne (根) for roots of a plant and mawasu (回す) for turning or rotating, and is also a gardening term for carefully digging around the roots of a tree or other plant before transplanting, rather than ripping out the plant. Similarly, in a company you talk your way around before proposing the decision. Different from lobbying, nemawashi is more of a consensus building and transparent communication approach.

32.3.2 Yokoten

Figure 242: Business meeting Bowing (Image Rawpixel.com with permission)

Yokoten is actually an abbreviation common at Toyota for yokotenkai (横展開) for horizontal deployment or application to other fields. The idea is to share leanings and experience across the entire company. You could call it a best-practice sharing across an organization. These best practices can be technical, organizational, or other, not only on the outcomes but also on the process. It is sometimes also written as Yokoni Tenkai (横に展開), but carries the same meaning.

32.3.3 Hansei

Figure 243: Former prime minister of Japan Abe bowing during his resignation. (Image Prime Minister of Japan Official under the CC-BY-SA 4.0)

Hansei (反省) means reflection; reconsideration; introspection; meditation; or contemplation. This is a sequence of self-reflection, taking responsibility, and committing to improvement. This is generally a part of Japanese culture and aims to both understand and admit your own mistakes and flaws. While in the Western world, admitting guilt often opens you up for even more attacks, in Japan it is seen as a step toward improvement. And, yes, it can involve a lot of bowing.

32.3.4 Hourensou

Figure 244: Spinach Leaves (Image Dinkum in public domain)

Hourensou (報連相) is also an abbreviation for houkoku (ほうこく or 報告) for report or inform; renraku (れんらく or 連絡) for contacting or messaging; and soudan (そうだん or 相談) for consultation or discussion. This is a mnemonic in Japan for a style of reporting. The same pronunciation is also the word for Spinach, but written as ほうれん草.

The three words stand for a report by a subordinate or colleague that should include all relevant information. Next, all stakeholders are informed about the current status. The third word refers to discussing with others on the next steps, decisions, and actions. The idea is to do it frequently. The method does not originate from Toyota but from a financial firm around 1982. The opinion on this is divided. Some believe the frequent communication will improve business processes; others believe that this has a too high demand for the work time of both employees and managers.

32.3.5 Tatakidai

Figure 245: Chopping Board (Image Ammy1989 with permission)

Tatakidai (叩き台 or たたき台) is a springboard for discussion; draft proposal; or tentative plan. It also means chopping board. The idea is to seek consensus and informing others when the project is 80% complete to improve chances of acceptance. In English, "to put your head on the chopping block" has a completely different meaning of taking a risk and putting yourself in harm's way. In Japan, it is the total opposite and Tatakidai is used to avoid risks and for slow consensus building. You discuss the proposal with colleagues while it is not yet completed, giving them a chance to update or modify the proposal before it is officially presented for a decision.

32.4 Advantages and Disadvantages of Soft Power

Of course, such a soft-power approach is not perfect either. Decisions usually take longer since you have to include everybody and do a lot of talking. On the plus side, once the decision is made, it is much less likely that people are still against it and will try to torpedo the decision. Besides, there are also plenty of managers in Japan and even in Toyota who are not that good at these soft-power approaches to decision making. The former CEO of Toyota, Akio Toyoda, is one such example where his decision counts and is not to be questioned.

In any case, you have to find a balance between making a decision yourself and a decision where all stakeholders were involved beforehand. The latter is often easier afterward. Now, go out, involve your people in your decision, and organize your industry!

33 Different Ways to Do Kaizen

Christoph Roser, August 15, 2023 Original at https://www.allaboutlean.com/different-ways-to-do-kaizen/

Figure 246: Kaizen (Image Rawpixel.com with permission)

Kaizen (改善), or continuous improvement, is a cornerstone of lean manufacturing. If you stop becoming better, you will fall behind. But not all improvement activities are equal. There are different ways to do kaizen projects suitable for different situations. Let me give you an overview:

33.1 Just Do It

Figure 247: Two People Working (Image monkeybusinessimages with permission)

Kaizen comes in different forms, mostly distinguished by the complexity of the problem they try to solve and subsequently the duration. The easiest way to do kaizen is for small problems. For example, if there is a problem with the arrangement of material at the workplace, then it is often quick and easy to develop or try out a different solution and implement it. For this, you often need only the team leader and the operators. This can, in its easiest form, take mere hours (for example, if the operator suggests a change, the team leader thinks about it and approves it, and they move the boxes around) to weeks (for example, if they need to get some equipment or material).

Such a just-do-it approach can also be started through gemba walks or waste walks. You walk the shop floor on your own or as a small group and look for improvement potentials. The smaller potentials can be kicked off right away, albeit for larger issues you may still need a kaizen blitz or task force.

33.2 Kaizen Blitz

Figure 248: Blue Lightning (Image Digitalintuitive under the CC-BY-SA 4.0)

The kaizen blitz has a very catchy name, which definitely helped with its popularity in modern industry. It sounds like it is fast, which is always popular with management. But in reality, it is not really a "blitz," and the speed can be comparable to a well-managed small project.

In any case, the German word blitz means flash, or lightning, but as a German it reminds me uncomfortably of the Blitzkrieg during the horrors of World War II, and I would like my lean implementation to be less martial… In any case, depending on the set-up, a kaizen blitz can take from two weeks to five months. The actual "blitz" itself is only two days to two weeks, but there may be plenty of preparation beforehand and implementation afterwards. To me, it is just a fancy name for a workshop with some preparation and follow-up.

You start with a few weeks preparing the workshop. This preparation can take two weeks to two months, but the preparation does not involve the entire team, and is also not a full-time activity. Rather, you define the problem, set up a team, and gather the needed data for the workshop.

Figure 249: Team Meeting On Shop Floor (Image monkeybusinessimages with permission)

The actual workshop, however, is a full-time activity for the project team, taking between two days and two weeks depending on the complexity of the problem. During the workshop you present the problem, analyze the root cause, develop (ideally multiple) solutions, pick the best of them, and plan (or sometimes even do) the implementation. Especially for shorter workshops, an A3 may be sufficient for documentation.

After the workshop follows the implementation. This is also not a full-time activity, as there may be quite a few periods waiting for material/machines/programs and other stuff, but it can take months. Please do not forget the Check and Act of the PDCA.

Different from the just-do-it approach, a kaizen blitz needs some more management overhead. People have to be made available for the time needed. Expenses have to be approved. A meeting room has to be reserved for the workshop. Buy-in of and support from other departments may have to be arranged, etc.

The advantage of a kaizen blitz is the focus on a singular topic for the duration of a workshop. This *can* make the progress faster, but there is no guarantee of that. On the other hand, it is quite possible that some steps in solving the problem may cause a delay, which would clash with the single workshop approach. For example, if you want to run a production trial with a new setup of some sorts, or if you need to run some computer simulations, it may take one or more days to get the results form the trial. Hence, this would be impractical to do during the workshop. For such issues, a task force would be better.

33.3 Task Force

Figure 250: Team of people (Image Rido81 with permission)

A task force or a project team is somewhat similar to a kaizen blitz, but it does not have the rigid structure of a single workshop of multiple days. It could be the same, but it could also be a short series of workshops with some days in-between to prepare more data. For me, all kaizen blitzes are task forces, but not all task forces are kaizen blitzes. Personally, I prefer the task force, as the necessity to limit yourself to a single workshop is a constraint that is not worth the possible benefit of a faster workshop. Make the solution fit the problem, not the other way round.

33.4 Long-Term Projects

Figure 251: Team (Image Flamingo Images with permission)

A long-term project is used for bigger challenges. If you set up a new larger assembly line, build a new plant, or develop a new product, you are probably busy for months or years. Similar to a Kaizen blitz or a task force, you need to define the problem, set up a core team, and prepare the data. Different from a kaizen blitz, however, some members of the core team may be fully assigned to the project, and the teams are probably bigger, including temporary members. There may even be a full-time project manager whose major part of his work is the coordination of the different team members and other contributors. There will also be probably multiple shorter and longer workshops. They may also have one permanently assigned meeting room, often called a war room or in Japanese an Obeya. Documentation of the project will be more extensive, and an A3 may no longer suffice.

33.5 Projects with Suppliers

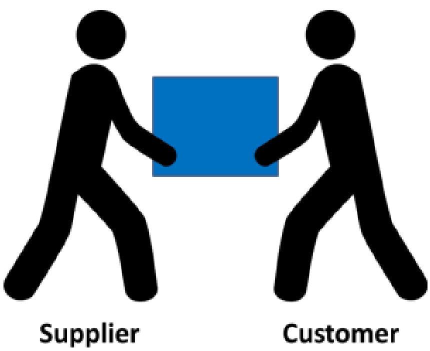


Figure 252: Supplier and Customer (Image Roser)

Projects with suppliers or other companies can be of short, medium, or long duration. Different from all the other projects, however, is the need to go though the hierarchy. Some people, probably quite high up in the hierarchy, need to support this to make multiple companies move in the same direction. Another difference is the willingness to share data. Depending on how much you trust your supplier, you may not want to give him critical data. If you work with your competitors, there may be even more hesitation. But apart from that, you still have a project team that meets regularly to drive the project forward.

Overall, there are many ways to do continuous improvement depending on the size of the problem and other circumstances.

Make sure to always do PDCA to check if the solution actually made it better and not worse. Now, go out, improve your system, and organize your industry!

PS: I was inspired to write this blog post by the excellent book by Michel Baudin and Torbjörn Netland. The entire book is recommended reading: Baudin, Michel, and Torbjørn Netland. 2022. Introduction to Manufacturing: An Industrial Engineering and Management Perspective. 1st edition. New York, NY: Routledge.

34 When to Use Standards…and When Not

Christoph Roser, August 22, 2023 Original at https://www.allaboutlean.com/when-and-when-not-standards/

Figure 253: Illustration for Standard (Image Wrightstudio with permission)

Work standards are a key component to continuous improvement. A standard is a tool that (if used correctly) prevents drifting away from a best-practice approach to do a task. Hence, I sometimes read that everything needs a standard. However, I don't quite fully agree with this. Let me tell you when standards are helpful, and when maybe not.

34.1 Introduction

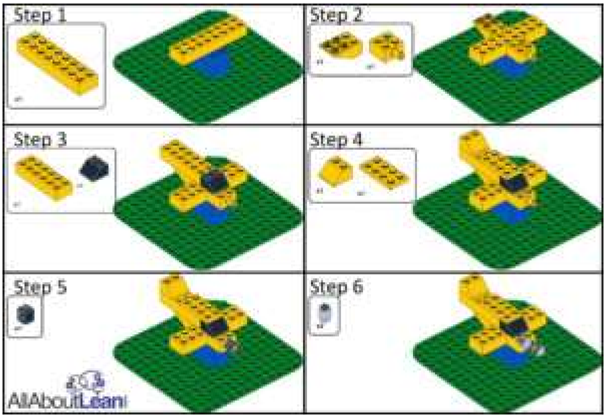


Figure 254: Lego Plane Standard (Image Roser)

I have written an extensive nine-post series on work standards, in addition to the related standard work for organizing the process sequence. The objective of a standard is to provide a clear depiction of a task, deconstructing it into distinct stages. It ought to encompass all relevant elements, with a particular emphasis on those linked to safety and quality. A standard can encompass visual aids, textual explanations, or a combination of both. While it should include all necessary details, it also should strike a balance between too much and too few details.

34.2 When to Use or Improve a Standard

Figure 255: Factory Worker and Lathe (Image World Image with permission)

Work standards are best for repeatable processes. The higher the repeatability, the easier it is to write a standard. It is said that a good takt for a standard is between thirty seconds and two minutes. For a longer takt you need to draw more on the experience of higher-skilled operators. For example, machine tools and airplanes often have a takt of eight hours or more.

Figure 256: Maintenance Work in Industry (Image Somsak Sarabua with permission)

Standards are most frequently written or improved to solve a problem. Where in your area of responsibility are your biggest problems with repeatable tasks? Is it quality? Cost? Time? Or, hopefully not, safety? If you have multiple possible standards that you could or should write, I find an impact effort matrix helpful. Estimate the possible impact of the improved standard versus the effort to achieve it. Select a problem that is relevant and gives a good benefit for the invested effort.

In the (hopefully not too) long run, of course, every repeatable process of some complexity should receive a standard. Here, too, you should start with the most critical processes where a standard could give you the best improvement for the effort.

34.3 When (Probably) NOT to Use a Standard

Standards aim to improve your processes. In a perfect world, all of the actions going on in your shop floor have standards. In a perfect world, these are updated and improved at regular intervals. I read every now and then the advice to standardize everything. But this is not good.

Instead, this is wishful thinking. Realistically, you probably don’t have time to write all of these standards, let alone improve them regularly. Standardizing the cleaning service emptying your trash can have potential, but you may have more pressing issues at hand (albeit the guy emptying my trash can during my sabbatical at Keio University had some serious skills!).

Figure 257: Manager discussing with Employee (Image fizkes with permission)

You should not write a standard for a process that is not repeatable or has high variability between repetitions. Standards describe a set of actions. The more these actions differ at every interval, the fuzzier a standard will be. If you assemble a car engine, you can have detailed standards for every step. If you design a new car engine, you have at best some high-level standards, but all the details of the problem solving and product development cannot reasonably be standardized. One common task that is hard to standardize is leadership and management. Managers solve problems and make decisions, but these vary every time. A standard like the common buzzword "leader standard work" is at best a high-level checklist like "attend the shop floor meeting every day," but this is a far cry from a proper work standard.

Figure 258: Woman painting picture (Image Burst in public domain)

Very related are tasks that use significant human creativity. If you are an artist like a painter or sculptor, you may have some standards on how to prepare the paint or set up the marble. However, the actual creation of the art is an act of creativity. If you want to standardize this process, you better get a copy machine or a printer rather than an artist.

Figure 259: USS Gerald R Ford CVN 78 under construction (Image Ricky Thompson in public domain)

Similarly, standards are not always helpful for tasks with very low repetitions. Creating and maintaining a standard is a lot of work. The benefit comes from using the standard repeatedly. If you use the standard only a few times, you may get little benefit out of the creation of the standard. In the extreme case, if you produce a part only once, you may not even be able to do a proper standard, as you would need repetitions to improve the standard.

However, standards can be part of individual processes within a larger process. If you build yourself a custom house, the installation of the electricity and other building codes are of course a standard. However, you would not write a detailed standard on how to create the entire house besides the blueprint. Furthermore, in some cases the impact of the standard on quality and performance can be so significant that standards sometimes are created even for very few repetitions. The Saturn V moon missions had detailed standards and procedures for the entire production process and many eventualities, and the participants were trained in the use of these standards. However, this was also insanely expensive, with multiple rockets launched for the development process before actually landing on the moon.

Figure 260: Calculating budget (Image S_DM with permission)

Finally, and probably the most common reason for not writing a standard is a lack of resources—or more properly, the decision to invest the resources into more pressing problems. If a consultant advises you to standardize everything, they don’t have to do it themselves and won’t foot the bill (on the contrary, they write a bill for you). As a manager, you will always have limited resources on time, manpower, money, and material. You have to decide where to invest these resources to generate the best benefit for the company. A lot of these resources will go into development and production. Hopefully a significant chunk will also go into improvement. Administration will also hog (more and more of?)

these resources. Standards can help you to solve problems and maintain the (current) best practice. But you don't have the resources to solve all problems. Start with the most urgent ones, and postpone the less pressing issues to a later day. It would be nice to have a good standard for emptying the trash can, but it is probably not the most urgent issue on your agenda.

Having said that, please do not use my words as an excuse to avoid standards. Standards are VERY helpful and useful, and not using standards at all would be gross neglect in most cases. If you lack the resources for creating standards everywhere, it merely means that some standards will be created later than others. I am merely trying to help you to figure out where to best use standardization, and where probably not. But YOU DO NEED STANDARDS! Now, go out, set up standards where they are sorely lacking, and organize your industry!

35 Happy 10th Birthday, AllAboutLean.com

Christoph Roser, September 1, 2023 Original at https://www.allaboutlean.com/happy-10th-birthday/

Figure 261: 10th Birthday Cake (Image nata_zhekova with permission)

It has been ten years since I started this blog. When I first posted on September 1, 2013, I never though that it would go on this long. But it has. Now there are 525 blog posts (or 663 if you include the Chinese and German translations) and a total of 765 000 words with (mostly?) high-quality content on lean manufacturing and related topics. Time to look back and also to celebrate!

35.1 Awards

Figure 262: Shingo Award Trophy (Image Roser; Logo Shingo Institute with permission)

The main award was not for my blog, but for my book All About Pull Production. This work received the prestigious Shingo Publication Award! Excellent! The book is also selling well.

The book also made it on the list of the Top 10 Books on Lean Management, Lean Production, And Toyota History by Katie Andersson. Many thanks, Katie!

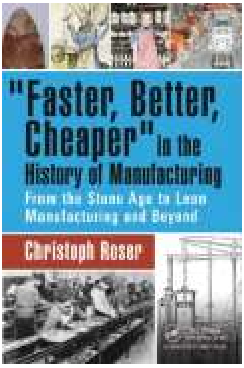


Figure 263: "Faster, Better, Cheaper" in the History of Manufacturing: From the Stone Age to Lean Manufacturing and Beyond (Image Productivity Press with permission)

And, last but not least, one of my other books, Faster, Better, Cheaper in the History of Manufacturing: From the Stone Age to Lean Manufacturing and Beyond, made it onto the Umbrex Best Books on the Manufacturing Industry list. I am actually working on a revised and updated version, hopefully to be published in 2024.

35.2 Publications

There are also even more translations of my book All About Pull Production now. Besides the English, German, Spanish (thanks to Jorge Valle from Lean Transforma), and Brazilian Portuguese (thanks to Wellington Batista do DataLEAN) translations, the book was also translated into Italian (thanks to Roberto Ronzani and Sabrina Ramin from the Istituto Lean Management) and French (thanks to Laurence Drabik and Pierre Jannez from Operae Partners) last year. A Ukrainian translation is in the works (thanks to Serhii Komberianov from the Lean Institute Ukraine), the Chinese edition is almost complete (thanks to 涛杰 华 (Taojie) and Xie Xuan) albeit it may take eighteen more months for the actual publishing process in China), and a Polish translation may be started soon (thanks to Jakub Kocjan from Lean Systems).

Figure 264: All About Pull Production hardcover books in other languages (Image Roser)

35.3 Most Popular Posts

Figure 265: Top 10 (Image Roser)

As I do every year, here are the top ten posts. There continues to be a lot of interest in Amazon and its technology. The second most popular post is an older post on lean in the Japanese toilet, which is definitely a fun read! But the number one spot is on the difference between the Toyota Production System and Lean Manufacturing—a very recent post but with a lot of comments both here and on LinkedIn.

- Toyota Standard Work – Part 2: Standard Work Combination Table
- The Inner Workings of Amazon Fulfillment Centers – Part 3
- What Is Ikigai?
- The Amazon Robotics Family: Kiva, Pegasus, Xanthus, and more…
- The Inner Workings of Amazon Fulfillment Centers – Part 4
- Line Layout Strategies – Part 2: I-, U-, S-, and L-Lines

- Hoshin Kanri – Part 4: The X-Matrix?
- Different Ways to Do Kaizen
- Tales from Japan – Lean in the Japanese Public Toilet
- The Difference between the Toyota Production System and Lean Manufacturing

35.4 Incorporation

Figure 266: All About Lean Logo (Image Roser)

Since the requests I receive for consulting and training are continuously increasing, I got together with my business partner and started the AALean GmbH. I am in the progress of transferring the brand AllAboutLean and the blog to this newly created company. Business is doing well, and even though we are barely two months old we have been active in the USA, Dubai, Spain, and Germany so far. More activities are upcoming, like a slight redesign of the blog (no worries, the content will stay free!). There are also plans to publish more videos to our AllAboutLean.com YouTube Channel. The impressum and privacy policy will soon be updated to reflect this.

35.5 Organizational

Figure 267: X for Twitter (Image Roser)

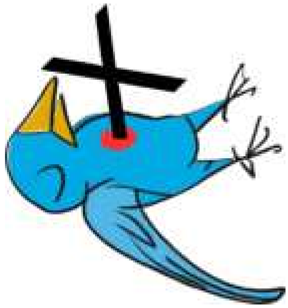


Figure 268: Blue Dead Bird (Image Roser)

There were also some organizational changes. For one, I quit Twitter nine months ago. Not that I was very active, but I published my blog posts also on Twitter. However, I always had the feeling that there are more bots than humans on there. In any case, the increasingly strange behavior of Elon Musk turned me off Twitter. Since then he has continued his eccentric behavior, and Twitter is now "X." I guess you could say that "Twitter is now my eX" and I clicked the Twitter symbol "X" in the upper right corner of my browser. I guess being a billionaire can do weird things to your character.

Figure 269: DALL·E: a robot dressed like shakespeare (Image Dall•E in public domain)

I also started to use AI for some illustrations. In particular I used DALL·E for some eye candy images. As they are created by an AI and not a human, they are also in public domain. I also started to use ChatGPT, but NOT to write my blog posts! The quality of ChatGPT is not too bad, but definitely not good enough for my own standards. But I find it helpful in structuring and giving ideas… which of course I always verify beforehand and divide the good from the bad before including them in my posts. Again, I want to emphasize that I still write all blog posts myself! As of now, I think I can still do a much better job on this than an AI. But I am not sure if you ask me again in twenty years.

I am also in the process of removing the popular Jetpack plugin from my blog. This program has become too intrusive, and may clash with German privacy regulations. But, since it is so deeply ingrained in many WordPress sites, it is not easy to simply rip it out. It is a work in progress, but I do put in the effort to protect your privacy.

Figure 270: AllAboutLean Birthday Cake (Image Roser)

Overall, it has been another fun year with lots of good feedback from you, dear readers. I also got a very nice AllAboutLean Birthday cake from my niece for my own birthday! So, thank you very much for continuing to frequent my site and for reading my works. Now, go out, keep on reading, implement what you read and organize your industry!

36 Preparation for Ramp Up and Down of Production

Christoph Roser, September 12, 2023 Original at https://www.allaboutlean.com/preparation-ramp-up-down-production/

Figure 271: Metalworking Machine Switches (Image Andov with permission)

Some factories work around the clock. But more commonly, factories ramp up at the beginning of the week, workday, or shift and then ramp down at the end. I often have the feeling that this is a somewhat neglected topic despite its influence on safety, quality, and efficiency. Hence I would like to take a closer look at the ramp-up and ramp-down procedures in industry, and how to optimize them. This first post will look at how to prepare a ramp-up before actually flicking the switch of the process.

36.1 Introduction

Ramping a process up and down can have two meanings. One is to start and stop a process. The other one is to install a new process and get it going. For example, when installing a new automotive assembly line, it easily takes six months or more to get it running as intended. In this post I will look merely at the starting and stopping of machines and processes.

Figure 272: Hard to turn off… (Image Viktor Mácha under the CC-BY-SA 3.0)

There are some factories that run around the clock. For example, if there is a very high demand you may want to squeeze all possible capacity out of your equipment by running it around the clock. However, even then you need occasional maintenance. More commonly, a round-the-clock operation is when it is simply not practical to turn off the machine. For example, it would be immensely expensive to turn a blast furnace off and on again, and blast furnaces usually run for decades before wear and tear requires a complete refurbishment. Paper mills, too, often run around the clock. While the switching off would be less expensive than a blast furnace, it still would waste time and paper for the ramp up and down.

Most factories, however, start and shut down processes and equipment as needed. Even in paper mills and blast furnaces there is more activity during the day than during the night, and there are plenty of secondary processes like rolling steel or cutting paper that do not work continuously. There are indeed plenty of reasons to temporarily turn down a process.

Figure 273: Nobody here… (Image zanskar with permission)

Often, processes are turned off at the end of the workday and started again during the next workday. Similarly, few plants are running throughout the weekend. Some processes are also turned off at the end of the shift or for a break. As the workers have breaks, so do machines have maintenance, which is much preferred to a breakdown. Both of which also stop the machine. And, probably most common of all, processes are turned off simply because they produced what they needed to produce and have created all that the customer (or next process) wants. In sum, pretty much all factories frequently ramp processes up and down.

36.2 Ramp-Up: Before Starting the Process

Figure 274: Young Female Worker in Industry (Image pressmaster with permission)

Let's start with the ramp-up. There are the obvious steps of turning on the machine or process. However, there are additional steps that may not be obvious but can really help with safety, quality, and performance. Often, these can take the form of a checklist, sometimes even color coded (green is all good, yellow needs attention soon, and red means you must not start the process). The list below is rather general, since the details naturally depend on your actual process. A milling machine starts differently than a paint line or a foundry. Hence, not all steps apply everywhere, and they would have to be adapted toy our situation.

Figure 275: Remove before Flight (Image Valder137 under the CC-BY-SA 2.0)

The first step should be safety. Do you have everything necessary to operate the machine properly? This could be something simple like having safety goggles, safety shoes, and other personal safety equipment (PSE).

The second step is training. Is the operator properly qualified to do the job. This could often be the easiest point on the checklist. For larger systems you may also check if you have all necessary operators ready. For example, an automotive assembly line needs hundreds of workers to run.

If the operators from the previous shift are still here, a shift handover is helpful, covering any particular glitches, jinks, special requirements on the product, or anything else that could help the next shift to do its work safely. An operator-to-operator handover would be best, but as a second option this may also be sort of a machine diary or other written documentation.

Figure 276: Cleaning Tools in Bucket (Image Nick Youngson / Alpha Stock Images under the CC-BY-SA 3.0 license)

The next step is cleaning. Are the machine and equipment clean? This is one of the steps relevant for quality. Remove any clutter, debris, or obstacles from the work area to prevent tripping hazards. If the last shift did its job, then this should be all okay.

Next is maintenance: Are there any steps necessary for proper maintenance? Often this can involve lubrication, but details depend again on your machine. This is also one of the steps relevant for quality.

Important is also the work order. Is there a proper task for the process to do? Connected with the work order: Do you have the material and tools necessary to do the job?

Next is the set-up process. If you are switching from one product to another product, this may be an entire SMED process with tool changes, etc. But even if you are continuing the same batch from the previous shift/day/week, you should check if the tools are calibrated and aligned. If you have any process control charts, do they show a worrying trend that needs to be reacted to? This is also one of the steps relevant for quality. For larger machines you may have to check certain locations or remove covers, etc. (think like an airplane "Remove before flight" tag).

All of these above steps can be done before you even think of starting the machine and the work, although depending on your system the sequence may vary. So far these points are only a preparation for the actual start of the machine or process. In my next post I will look at how to start the process itself, as well as ramping it down again (i.e., turning it off). I will also look at how to improve these ramp-up and ramp-down procedures if necessary. Now, go out, make sure your operators know how to properly start a machine, and organize your industry!

PS: This post was insipred by a visit to LISI Aerospace in Saint-Ouen-l'Aumône as part of the Van of Nerds in France tour 2022 as well as a question by Joel Gomez.

37 Ramp-Up and Ramp-Down of Production

Christoph Roser, September 5, 2023 Original at https://www.allaboutlean.com/ramp-up-down-production/

Figure 277: Switching a Machine On or Off (Image Kzenon with permission)

In my last post I looked at the preparations for a proper ramp-up or start of a machine or process. This post is the second part where you actually press the button and start the machine. I will also discuss the ramp-down procedures, as well as a SMED-like approach to improve the ramp down and up again process.

37.1 Ramp-Up: Starting the Process

Figure 278: Mechanical Engineer Technician Checking And Inspecting Machine (Image Attapornfoto with permission)

Now you can finally start the machine. For a small machine this may simply switching it on. For larger machines this may be a multi-step operation. This may include warm-up processes, starting auxiliary engines and control systems, before starting the main process. It may also include setting up the part to be processed. There may also be some waste, as the first parts may not be of good quality. For example, in injection molding the first parts are often scrap due to smaller temperature differences. In some cases the first parts may also be produced slower than normal.

Figure 279: Inspection of Fish Egg Battery (Image unknown author in public domain)

Very often this also involves some quality checks. The first few presumed good parts are checked for accuracy and quality. If by any change there was an error in the set-up, you would like to know it as soon as possible before jugging an entire shift worth of production into the bin. These quality checks can be formal (i.e., a 3D measurement machine) or informal (does the machine sound/smell/feel all right?) or both.

Once the process is running properly, you can already put your attention on the next job. What (if any) is the next job, what material and tools do you need?

Now your machine should be up and running safely, efficiently, and with good quality.

37.2 Ramp-Down

Figure 280: Worker pressing Switch (Image XArtProduction with permission)

The ramp-down has a lot of similar steps, but in reverse.

After you have completed the current part, you should turn off the machine. Again this may be an easy switch or a more complicated cool-down process, purging of leftover material (e.g., an injection molding screw), and shutting down multiple systems and computers.

Depending on the duration of the shut-down, you may have to add covers and other parts for a longer idle time (think "Remove before Flight" tags again).

Cleaning: Don't leave a mess behind, not in public and not at work. Clean the machine, and remove dirt, oil, chips, and anything else so the next operator has a clean machine to start with. If the process involves glue or foam, is there a foam nozzle that needs to be removed and the machine cleaned?

Again Maintenance: Are there any steps needed for maintenance? Do some movable parts need to be oiled? Do some parts need to be exchanged? Some processes also benefit from a visual inspection.

Figure 281: Supervisor Checking A Clipboard (Image The Light Writer 33 with permission)

Not popular but necessary is Documentation. Fill out the information (paper or digital) on the product and/or the process. This will help the next operator in starting the machine, and can provide valuable clues when eliminating quality issues or searching for improvement potentials.

37.3 Creating and Improving Ramp-Up and Ramp-Down

There is no explicit tool for improving the ramp-up and ramp-down procedures, but it is basically the same as SMED for changeovers, except without the changeover. Of course it could also include a changeover if needed.

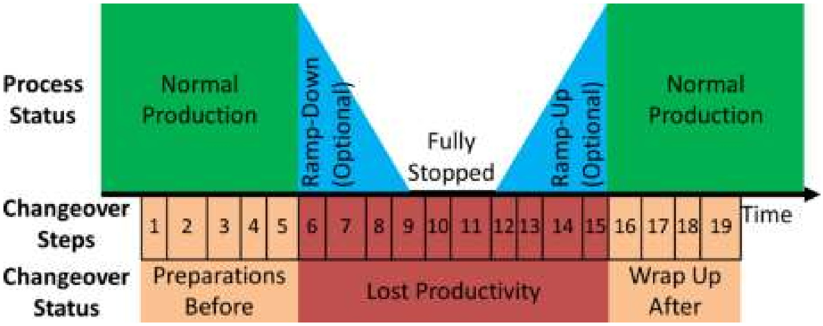


Figure 282: SMED 2.0 Overall Changeover Sequence (Image Roser)

The SMED overall changeover sequence is very similar to a ramp-down and ramp-up process.

- Like a normal SMED process, you first observe the ramp-up and ramp-down procedures to get a list of tasks and their duration. This observation as well as the following steps are best done as a multi-functional group, including at least one operator for the process and if necessary one technical expert if it is a larger machine. This list should include everything that is part of the ramp-up and ramp-down procedures.
- Slightly different from SMED, you should also evaluate if these steps are good, or if they could have a negative impact on safety or quality. If so, please improve the steps until you are certain that it is safe to make good parts. This is not explicit a part of SMED, but SMED would benefit from this too. Often it is done somewhat automatically when doing a SMED workshop. I have listed it here separately since chances are there has not been a detailed analysis of the ramp-up and ramp-down procedures before.
- Some of these steps will be when the machine or process is already slowed or stopped. These would be the internal processes where we lose productivity. Similar to SMED, we look at which internal procedures can be moved to external procedures. This will increase the overall time available for production. If you can move an internal step to external, it is usually worth it even if it takes longer externally.
- Again similar to SMED, see if you can shorten the internal and external procedures.
- Now you verify if these new updated steps are good. If possible try it out, maybe even more than once.
- Finally you create a standard and train the operators.

37.4 When to Standardize the Ramp-Up and Ramp-Down

Figure 283: Testing of a machine (Image shisuka with permission)

Creating and following a standard for a ramp-up and ramp-down procedure is work. As with all standards, you should create a standard if the benefit of a standard exceeds the effort of creating, establishing, and maintaining a standard. Unfortunately, as all so often in lean, the benefit is there but hard to measure. If a failed ramp-up breaks your parts or—worse—your machine, you will regret not having it. Hence, you would need to estimate if it is worth the effort. Also, in lean, people often underestimate the benefit.

Personally, I would go for machines and processes where I either have capacity issues, a history of problems due to the ramp-up and ramp-down, or a major worry that there will be problems due to the ramp-up and ramp-down. This is a choice you have to make.

37.5 Summary

Overall, ramping a process up and down well impacts quality, safety, and efficiency. Key for success is to educate your operators. There should be no rush to produce, but the goal should be to produce good quality safely. Now, go out, get the starting and stopping of your processes in order, and organize your industry!

PS: This post was insipred by a visit to LISI Aerospace in Saint-Ouen-l'Aumône as part of the Van of Nerds in France tour 2022 as well as a question by Joel Gomez

38 Dos and Do Nots for KPIs

Christoph Roser, September 19, 2023 Original at https://www.allaboutlean.com/dos-and-do-nots-for-kpis/

Figure 284: KPI Picture (Image Funtap with permission)

A key part of managing your shop floor is understanding the current state of the shop floor. And KPIs are an important part of understanding the shop floor. But this is also not always easy. In my experience, the three most common pitfalls are to underestimate the effort (and hence the cost) of measuring a KPI, to overestimate the accuracy of a number, and (worst of all) to believe that the numbers tell you everything. Time for a reality check…

38.1 Introduction

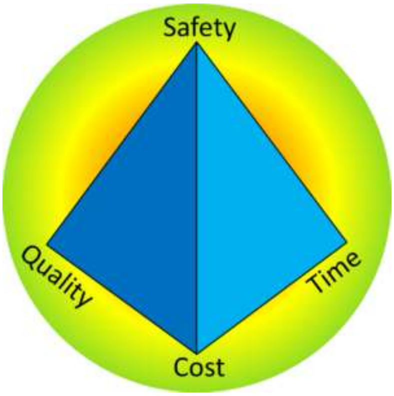


Figure 285: Safety Quality Cost Time (Image Roser)

KPI stands for key performance indicator, a quantitative measurement of some sort of performance. KPIs on the shop floor usually go in four directions:

- Safety: You should measure safety. This is usually a tracking of the frequency of accidents, sometimes also divided into smaller (no sick leave) and larger accidents (sick leave). Sometimes near misses are also measured, but it is harder to get good numbers here.
- Quality: How good are your products? Depending on your product complexity, this may be only a sample check or visual inspection of the finished good, or multiple detailed measurements along the production process.
- Cost: You want to know some sort of cost-related measure. While accounting gives you some more detailed numbers (but with many assumptions behind it), on the shop floor this is usually measured in good pieces produced per time.
- Time: How often are your deliveries on time? How often are you behind, and by how much? A popular measure is OTIF—on time in full, counting the percentage of orders that are delivered in its entirety before the deadline.

Safety is often only a single metric (counting accidents) and its derivatives (days since last accident), but the others are often multiple different measures. Quality is for different products, and often for different aspects at different stages of production. Cost is often not only pieces per time for different products and production stages, but also many other measures that influence cost like inventory, downtime, OEE, or many more. Delivery times are also often tracked for different products.

38.2 What Is Missing?

Figure 286: DallE Management by Numbers (Image Dall•E in public domain)

Do not fall for the mistake of believing that these numbers tell you everything. Management by numbers is a really dangerous way to run a factory. To truly understand a shop floor, spreadsheets and dashboards are not enough; you need to go there yourself and look at it. Visit the Shop Floor or Your People Will Fool You!

For example, one important aspect of production is employee morale… but that is really hard to measure. Some companies do an employee survey, but this merely scratches the surface of employee morale.

Another aspect that is hard to quantify are improvement potentials. Sure, you may see that your quality/cost/delivery time is lacking, but… how do you fix it? Overall, there are plenty of qualitative aspects that you need to understand for managing a shop floor. Even for quantitative aspects you cannot measure everything.

38.3 Is It Really a KEY?

Figure 287: Lots of Keys (Image Friedrich Haag under the CC-BY-SA 4.0)

You cannot measure everything, but it feels like some companies die trying to do that. Management often seems to believe that more numbers is better… but I disagree.

KPI stands for key performance indicator, where the "key" indicates that the number is important, and more so than a normal (not key) performance indicator. Any number wanted by management regularly is automatically a key performance indicator.

Unfortunately, it is often underestimated how much effort it is to get a measurement. Granted, some measurements are easier to get. Counting produced parts is often not too much of a hassle. But others are much more difficult. Measuring an OEE requires a lot of data, and hence a lot of effort. Even if you want put this into your ERP system to measure it automatically, it takes quite a bit of effort by programmers and users to set up the measurement and also maintain it.

Figure 288: Boring Inspection (Image SeventyFour with permission)

In my experience there are plenty of departments (e.g., planning), where a large chunk of the time is used to collect data. In my own department one person spends 30+ minutes every day to measure a leveling accuracy (i.e., how close the actual sequence of production was to the planned sequence). Thirty minutes is a lot of time for a single number… which nobody ever looked at. How do I know nobody ever looked at it? I simply told my guy to stop measuring and reporting this number… and nobody ever noticed. The KPI was once established long ago since someone needed it, but such things have a life on its own, and if you don't pay attention it will continue to be measured long after the need for the measurement is gone.

If possible, weed out your KPI every now and then to focus on the ones you truly need regularly.

38.4 Is It Accurate?

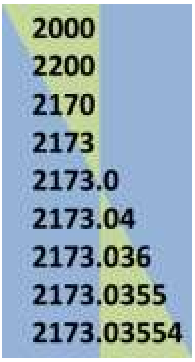


Figure 289: Number Precision (Image Roser)

This brings me to my last point: Are the numbers accurate? Some numbers cannot be measured accurately and need a lot of assumptions (see for example my article on The Problems of Cost Accounting with Lean).

Many others can be measured accurately if you put in the right effort. But due to the overload of the people on the front lines or first line of management, they often simply don't have the time. Hence (somewhat understandably) they cut corners, and the quality of the measurement goes down. And, for a measurement that is only wanted but not used or needed, I can even understand that.

This does not even include the intentional manipulation of numbers so they look good. I wrote a whole three-post series on Lies, Damned Lies, and KPI with examples of fudging, its effects, and possible countermeasures (simple measurements, verify occasionally, and punish liars).

Figure 290: Monthly and daily inventory levels (Image Roser)

I have seen plenty of examples where numbers were outrageously fudged to improve someone's career chances or performance bonus. One example is inventory, where a company was measuring its inventory levels always at the end of the month. However, at one point someone looked not at the end of the month but at the daily levels of inventory, and the difference was staggering. Inventory always dropped magically on the last day of the month, just to pop back up again the day after. Outbound deliveries were accelerated, inbound deliveries were held back, and expensive parts were loaded on a truck and parked on a parking lot for a day, just to look good.

Overall, you need to know the strengths and limitations of your KPIs to understand the shop floor, as well as the effort that goes into measuring these KPIs in the first place. Now, go out, measure the right things on your shop floor, and organize your industry!

39 The Toyota KPI Dashboard—Overview

Christoph Roser, September 26, 2023 Original at https://www.allaboutlean.com/toyota-dashboard-overview/

Figure 291: Toyota Section Manager Dashboard (Image Toyota UK Deeside with permission)

Dashboards, in their many forms, are essential to track the performance of a production system. In this post I will talk more about the Toyota shop floor dashboard. A lot of the information is from Toyota in Japan, but the images are from Toyota UK. Keep in mind that the dashboards are not a rigid standard and there may be differences in how they are implemented in the different plants. For one thing, in Japan they are in Japanese, and in the UK in English, but there are also differences within the KPI itself. Let me tell you more in this short series on the Toyota KPI dashboards…

39.1 Introduction

Figure 292: Toyota Deeside Engine Plant (Image Roser)

Toyota is excellent at tracking information… AND actually using it! One thing that always surprises me at Toyota plants, no matter where in the world, is the amount of paper on the walls that tracks or manages different aspects of the plants. For example, at a recent visit to the Toyota UK Deeside engine plant, the section manager for the final assembly had a whopping 50 meters of whiteboard filled to the brim with paper (plus a large stack of older sheets on a table), which he went through with his team every day. Admittedly, only around 8 meters of these were the KPI dashboard, and for example there were an extra 20 meters of whiteboard due to the final assembly line having trouble making its 44 second target tact reliably, and they were relentless in tracking down and eliminating disturbances. The manager hopes that once the line is back on track, he can stop the extra 20 meters of line breakdowns and go back to his usual 30 meters of whiteboard daily in different meetings. But chances are that the next project will fill the extra 20 meters of whiteboard again.

Figure 293: Chris at Toyota UK Plant (Image Roser)

Also, as mentioned above, there is not THE ONE STANDARD for dashboards across all of Toyota. Plants, and even sections, have the flexibility to adapt the KPI to their needs. The data sheets may look different, A3 sheets may have a different layout, and the KPI may differ slightly from each other. Similarly, you should not merely copy Toyota because it is Toyota, but instead adapt it to your needs. Toyota tracking the production output on an hourly basis works well if you make 100 pieces per hour, but this would not work if you make airplanes with a plane being completed every week. So, use this as inspiration, but not as a template!

39.2 Dashboard Overview

However, while the dashboards may differ across Toyota, they all contain the same main headings. The first one is always safety, because everything at Toyota starts with safety. The next one is always quality, because at Toyota the second most important aspect is quality. After that comes productivity, tracking the output, efficiency, and inventory. Finally, there is cost, because if the other three are good, then the cost will follow. Most dashboards also have a section on the development of the operators. On top of that, most dashboards also include a section on planned production output and assignment of the operators to the different processes. The A3 sheets of the key improvement projects and problem solving are also usually included.

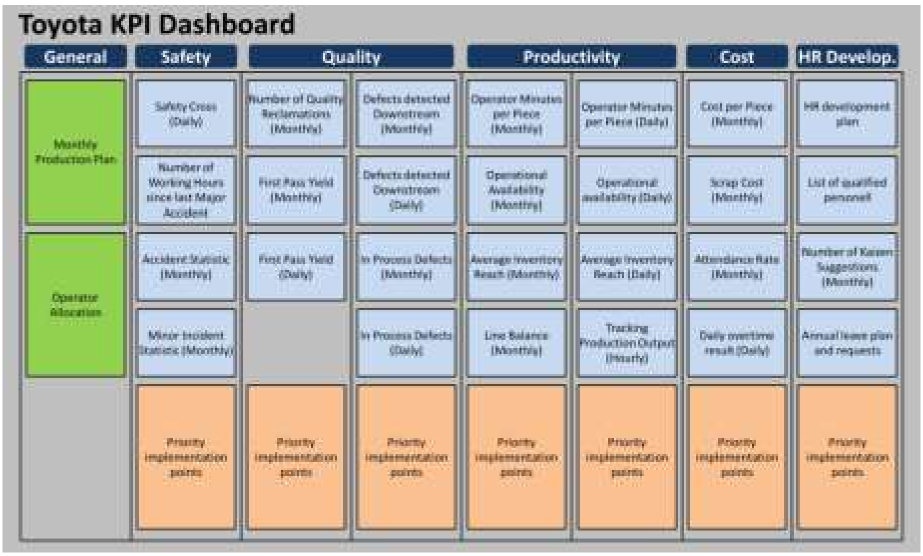


Figure 294: Toyota KPI Dashboard Overview (Image Roser)

Most of the sheets are typical A4 sized paper, usually pre-printed and filled out by hand, although some data was also printed along with the sheet. For A3's they also used (surprise) A3-sized paper. Some areas like the operator allocation is often done using magnets labeled with the names of the operator, placed on a plan or value stream of the section.

39.3 Dashboard Usage

Figure 295: Shop floor meeting (not Toyota) (Image Wavebreak Media Ltd with permission)

These dashboards are discussed at least every workday, and quite likely every shift as part of the shop floor meeting. Similar meetings are also held on a daily basis at higher levels in the hierarchy, and the plant manager regularly attends shop floor meetings too. As part of the Toyota UK visit, I also observed such a meeting headed by the section manager. The amazing part was how quickly they went through the sheets, focusing only on the relevant issues, without wasting time for extended discussions.

As I mentioned before, the section manager discussed 50 meters of whiteboard with his team every day. That sounds like a lot, because it IS a lot! It takes quite some time to discuss all these details. But these pale compared to the time it takes to fill them out! Besides, you don't just want any data on the sheets, you want reliable data for making decisions.

Figure 296: Critical Person (Image OpenClipart-Vectors in public domain)

If you are now worried how to do this in your plant, chances are, you can't. Toyota has quite a lot of manpower on the shop floor to do just that. I wrote before on the Team Structure at Toyota, and there is one team leader for every 4 operators, and one group leader for every 4 team leaders. The task of these blue-collar leadership levels is to a) support the operators on the shop floor, b) do kaizen, and c) record data, usually by hand. Hence, Toyota has much more manpower on the shop floor for such organizational and supporting tasks, which has been sacrificed in the name (but not in the spirit) of efficiency. Hence, when implementing dashboards at your company, ensure the demand on the dashboard matches what your organization can provide!

In my next few posts I will go in more detail on the KPI groups of safety, quality, productivity, and cost, plus some of the other topics. Now go out, keep on reading, and organize your industry!

Figure 297: Me with Akinori Hyodo (Image Roser)

PS: Many thanks to Mikako Lenquist from C2U in Sweden for organizing the Lean Leadership System in Japan 2023, where former Toyota factory manager and Director in charge of TPS promotion Akinori Hyodo shared his wisdom. Most of the data in this post series I learned from this tour.

Additional thanks to the team from the Toyota Lean Management Centre at the Toyota UK Deeside engine plant in Wales, where I participated in their 5-day course. This course gave us a lot of access to the Toyota shop floor, and we spent hours on the shop floor looking at processes. In my view, this the only generally accessible course by Toyota that gives such a level of shop floor involvement (albeit they want to open another center at the UK Burnaston final assembly plant).

Both the C2U Lean Leadership System course as well as the Toyota Lean Management Centre 5-day course are highly recommended!

40 The Toyota KPI Dashboard—Safety

Christoph Roser, October 3, 2023 Original at https://www.allaboutlean.com/toyota-dashboard-safety/

Figure 298: Toyota Safety Gate (Image Toyota UK Deeside with permission)

In my last post I showed you an overview of the Toyota KPI dashboard. This time I will look in more detail at the first (and arguably most important) section on safety. And, while I'm at it, let me also tell you some more about safety at Toyota.

40.1 Introduction

Figure 299: Toyota Safety Dojo Toyota Safety Dojo (Image Toyota UK Deeside with permission)

Toyota likes to say that it puts "safety first." And, indeed, it feels like there is a lot of attention on safety. While of course there are occasional accidents, these are very few. For example, a Toyota Boshoku plant in Aichi that I visited had gone 647 days since the last accident. The target for this was 1320 days (or 3 1/2 years, since the record so far at this plant was 1312 days without accident (from 9.9.2015 to 12.01.2021).

Figure 300: Toyota High Visibility West Safety (Image Roser)

Every Toyota plant in the world that I have been to has a "safety gate" at the entrance of the plant. This symbolizes that an employee entering the plant is responsible for his own safety (and that of others). The earliest Safety and Health Committee and organized Safety Week activities at Toyota Motor date back to 1938, only a few years after its founding in 1933. Their goal is zero accidents, focusing especially on dangers from (1) moving machinery, (2) heavy objects, (3) contact with vehicles, (4) falls, (5) electric shock, and (6) high temperatures.

Figure 301: Toyota UK Engine Hoshin Kanri (Image Toyota UK Deeside with permission)

Safety is also one of the main headings of the Toyota Hoshin Kanri, their structure for setting targets from the top down across all hierarchies. I even found reminders on safety on the back of some of their high-visibility safety wests, stating “If I bet with my life, I gamble with safety.” (Although to me this would read better the other way round: “If I gamble with safety, I bet with my life.”)

40.2 Toyota Safety Dojo

Figure 302: Bamboo safety shoe exercise (Image Toyota UK Deeside with permission)

Figure 303: Toyota Dojo (Image Toyota UK Deeside with permission)

New employees get two weeks of training in a training center (a dojo) on how to work properly in the factory. This is not some complicated technology like welding, but simply for working on an assembly line. A big part of this is safety.

For example, at one station they had an demonstration where a weight is dropped on a bamboo piece in a normal shoe… which shatters the bamboo piece. Next it is dropped on a bamboo piece in a safety shoe, and the bamboo is unharmed. Other different exercises also enforce the concept of safety.

40.3 The Safety KPI Dashboard

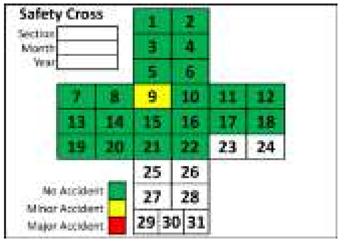


Figure 304: Toyota Safety Cross example (Image Roser)

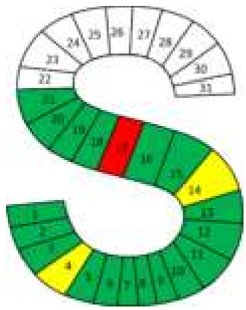


Figure 305: Team Corner Safety S (Image Roser)

But the main topic of this post is the KPI dashboard and its section on safety. Keep in mind that while the main topics are the same across all Toyota locations, the data sheets within can vary quite a bit. Plants are free to adapt the documentation to suit their needs. But one thing I found pretty much everywhere is the safety cross. This is a simple cross with the days of a month (i.e., 1 to 31). Every day the previous day is filled out. Green stands for no accident. Yellow stands for a minor accident. And red stands for a major accident. Throughout the month a very visual representation of the safety statistic emerges. Similar visualizations are used in many plants. If for religious reasons a cross is undesirable, I have also seen a safety "S."

Figure 306: Toyota Number of Working Hours since last Accident (Image Roser)

Below that you often find additional statistics on safety. Very frequently, the “days since the last (major) accident” are listed as a big number. This can also vary, and I also have seen this number measured in working hours since the last (major or minor) accident.

Next often follows an overview of the year so far, showing for example the number of accidents last year, the target, and the number of accidents each month. A cumulative line counts up how many accidents happened since the beginning of the year, and shows clearly if the target can be reached or if the cumulative line approaches or even crosses the target. Often, these values distinguish if it was a major accident with sick leave, a minor accident that caused a line stop, a minor accident that did not cause a line stop, or a near miss. By its nature, near misses are often underreported, but there is at least an attempt to catch these. After all, statistically speaking 20 near misses cause a minor accident, 3 minor accidents cause a serious accident, and 10 serious accidents cause a death. Hence, trying to address near misses can help to prevent minor or major accidents. The example below looks like one of these sheets, but of course the data added is completely fictional by me.

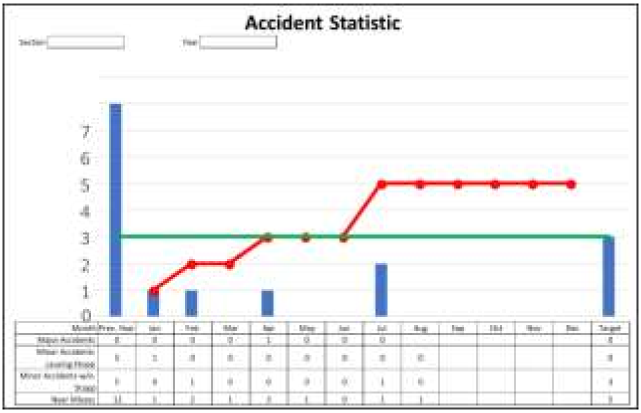


Figure 307: Toyota Accident Statistic Example (Image Roser)

A very similar sheet can be used to track minor incidents, also with last years numbers, targets, monthly incidents, and a cumulative line. Below is an example, again with completely fictional data.

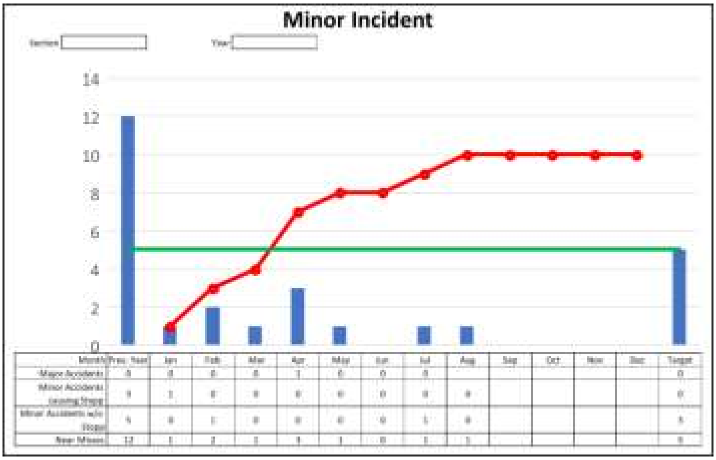


Figure 308: Toyota Minor Incident Statistic Example (Image Roser)

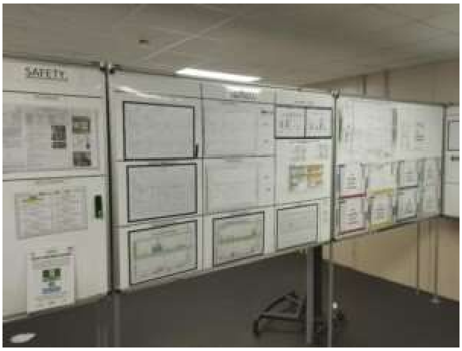


Figure 309: Toyota UK Safety & Quality Dashboard (Image Toyota UK Deeside with permission)

The safety section can be rounded up with details to the last major accident and the actions done to prevent this. This completes the section on safety of the Toyota KPI dashboard. Next week I will talk more about the second-most-important topic at Toyota, quality! Now go out, improve the safety fo your people, and organize your industry!

PS: Many thanks to Mikako Lenquist from C2U in Sweden for organizing the Lean Leadership System in Japan 2023, where former Toyota factory manager and Director in charge of TPS promotion Akinori Hyodo shared his wisdom. Most of the data in this post series I learned from this tour.

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41 The Toyota KPI Dashboard—Quality

Christoph Roser, October 10, 2023 Original at https://www.allaboutlean.com/toyota-dashboard-quality/

Figure 310: Quality KPI Dashboard DallE (Image Dall•E in public domain)

In this third post of my series on the Toyota dashboard we will be looking in more detail at quality. The quality of Japanese car makers in general and Toyota in particular is quite a bit better than the rest of the world's. After safety, quality is the second-most-important issue at Toyota, definitely before productivity and cost. They do put in quite some effort for tracking quality… and then put in even more effort to fix these issues! Let's have a look:

41.1 Introduction

From the Toyota point of view, quality is second only to safety in importance, and definitely behind cost. This is also reflected in the sequence on the KPI dashboard, including the sequence in which it is discussed every day. Toyota puts a lot of effort into quality, and quality circles and other quality-related improvement efforts are firmly part of Toyota.

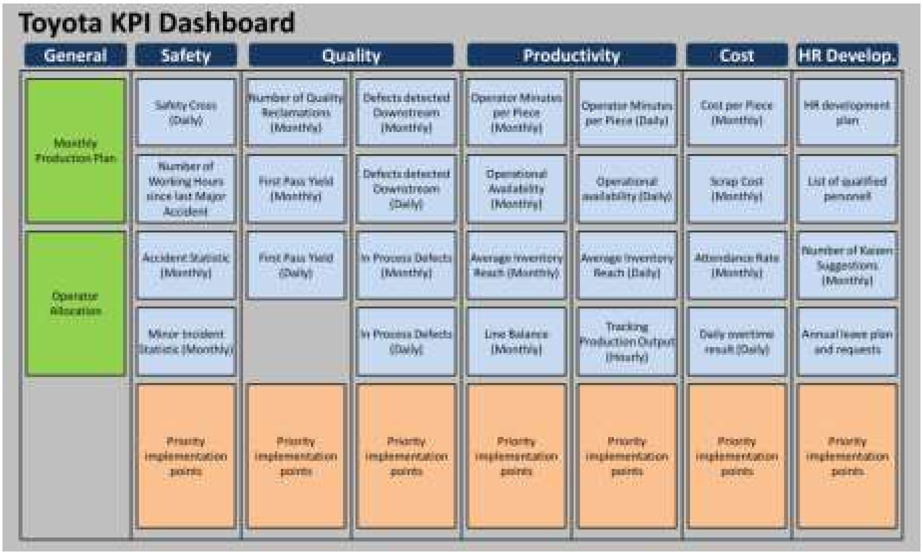

Figure 311: Toyota KPI dashboard overview (Image Roser)

On the dashboard this is represented through statistics of different quality measures, both on a monthly and on a daily basis. Note that this may also differ among different Toyota plants, depending on which KPI are commonly measured or available. As in my previous posts, the example is from Japan but the images are from the UK. The example from Japan measured four different variables: the in-process defects, the first pass yield, the defects detected downstream, and the number of reclamations. This corresponds to the locations on the value chain where the defect is detected (Note: Defects in raw materials are not part of the KPI of the processes, but would be a KPI for a preceding location). Depending on where you are on the value stream, this may look different for you. Naturally, the earlier you detect a defect, the easier and cheaper it is to fix.

Figure 312: Locations of Detecting Defects (Image Roser)

41.2 Reclamations

The worst types of defects are customer reclamations, as these defects have impacted the customer. Keep in mind that not all customers will complain about defects, and some will not inform the company but still may have a bad impression. The number of defects at the customer is usually larger than the number of customers that complain about them.

At Toyota these are measured on a monthly basis. Below is an example with fictional data. It shows the number of reclamations from the previous year, the target (zero reclamations), and the monthly number of reclamations. A cumulative line is also included to show the trends.

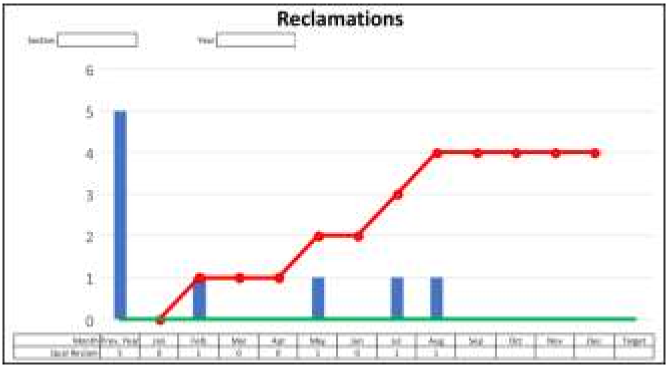

Figure 313: Toyota Monthly Quality Reclamations (Image Roser)

41.3 Defects detected downstream

The number of defects detected downstream—but still within the company—uses a very similar chart. There is the value from last year, the target, and the monthly detected defects. A cumulative line shows the trends.

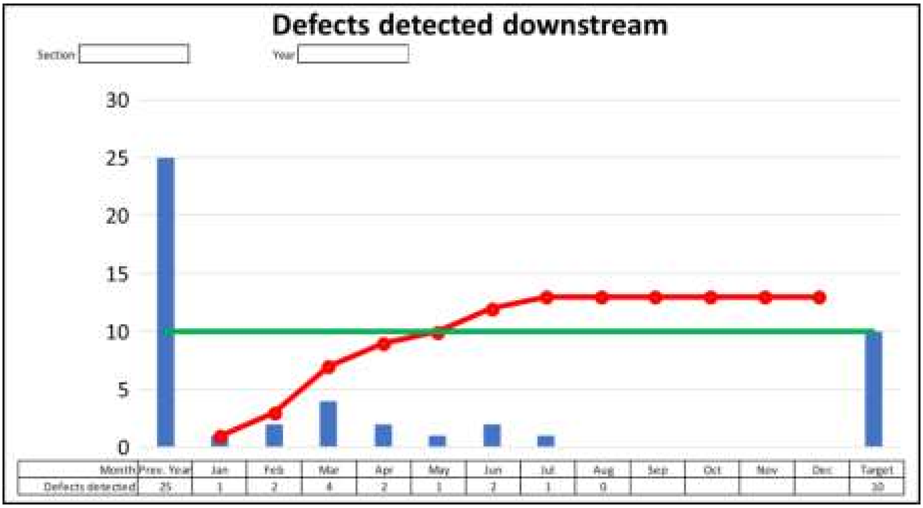

Figure 314: Toyota Defects detected downstream monthly (Image Roser)

Different from the reclamations, however, these were in my example also measured on a daily basis. The chart itself is similar, with an example shown below. However, it may not always include a cumulative line.

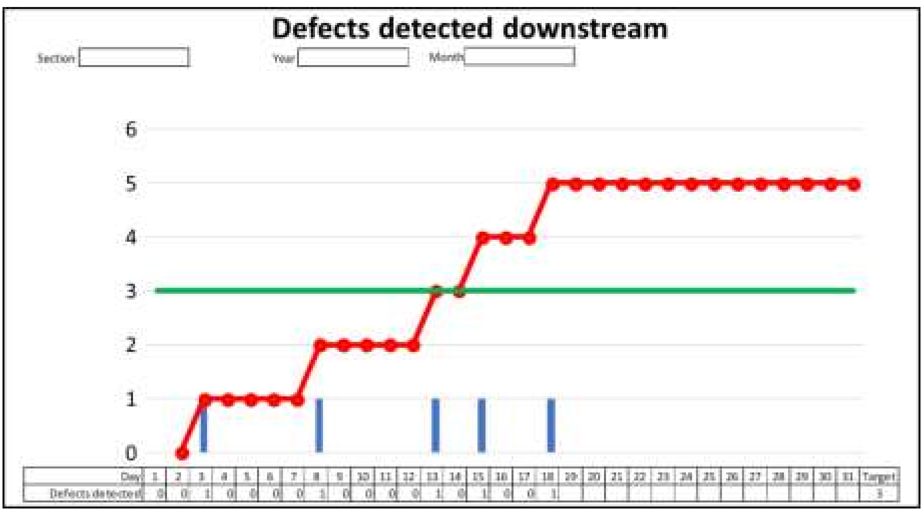

Figure 315: Toyota Defects detected downstream daily (Image Roser)

41.4 First Pass Yield

The first pass yield, also known as throughput yield, measures what percentage of your produced units were of good quality. This sheet includes some more data on how the number is determined—in other words, it includes the total production, the number of defects detected at the quality control, and the corresponding first pass yield (FPY). Below is again an example with fictional data.

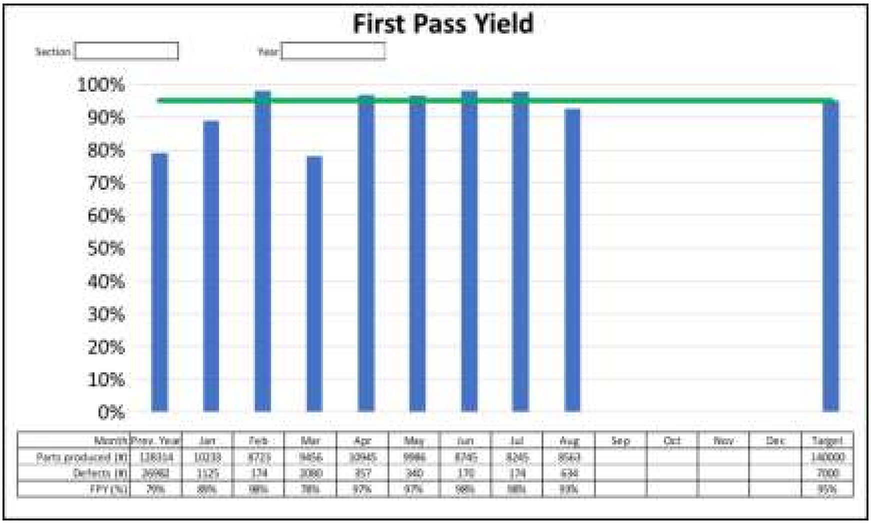

Figure 316: Toyota First Pass Yield monthly (Image Roser)

This value can also be displayed on a daily basis. The sheet is similar to the monthly one, except that the annual one shows the value of the previous year, whereas the monthly one does not show the previous month. But since the monthly data is on the other sheet anyway, this is not needed.

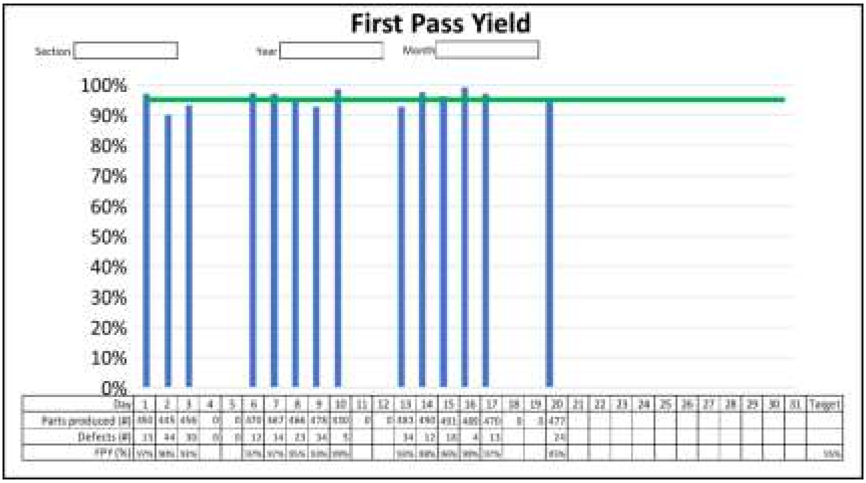

Figure 317: Toyota First Pass Yield daily (Image Roser)

41.5 In-Process Defects

Finally, we have the defects that were detected within the production process (e.g., the assembly line), but before quality control at the end. The sheet itself is very similar to the defects detected downstream. Below is an example with fictional data.

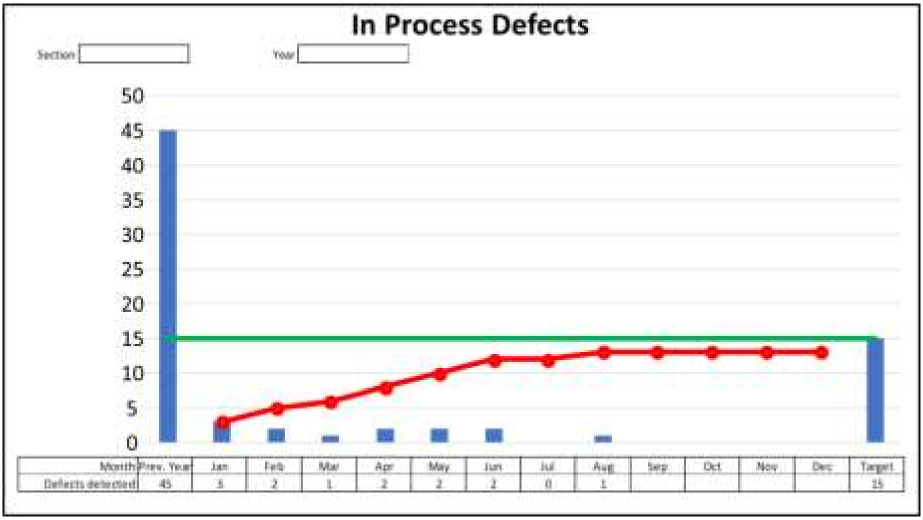

Figure 318: Toyota In Process Defects monthly (Image Roser)

This sheet also exists in a version with daily data; a (fictional) example is shown below.

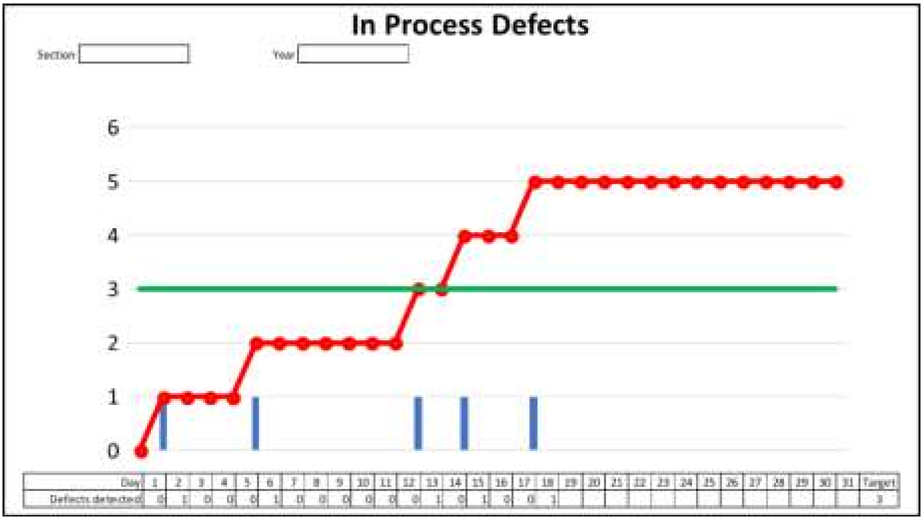

Figure 319: Toyota In Process Defects Daily (Image Roser)

41.6 Summary

Figure 320: Toyota safety quality dashboard in the UK (Image Toyota UK Deeside with permission)

Overall, Toyota measures quality at different stages of the value stream. This can of course differ between different plants. The composition of the data can also differ, with some plants having more data on the sheets than others. The photo here is from the Toyota UK Deeside Engine plant. One or more descriptions or problem-solving sheets for quality issues are also often found on the daily KPI dashboard.

Is this KPI structure the right one for you? Maybe, maybe not. You should definitely track your quality. However, the extent to which you track your quality depends very much on your needs and (which is often forgotten) on the capacity and time that your people have available to do so. It is pointless to track lots of quality data if you never actually use it. Toyota is quite relentless in following up quality (and other) issues in their plant, and they do have the people available to take care of these problems (which may be a topic of a later blog post). Now, go out, track AND improve your quality, and organize your industry!

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42 The Toyota KPI Dashboard—Productivity

Christoph Roser, October 17, 2023 Original at https://www.allaboutlean.com/toyota-dashboard-productivity/

Figure 321: Productivity KPI Dashboard DallE (Image Dall•E in public domain)

This post in my series on the Toyota KPI dashboard looks at productivity. After safety and quality, this is the third-most-important KPI group on the Toyota dashboard. The cost is least important. This section of the dashboard measures different KPIs on the productive output of the system. Let's have a look.

42.1 Introduction

Figure 322: Toyota UK Deeside productivity cost dashboard (Image Toyota UK Deeside with permission)

Productivity can be measured in different ways. At Toyota, this is often using a couple of KPIs, although there may be differences between different plants. One measure is the labor time for the product, which is measured as the number of labor minutes needed per piece (operator minutes per piece). This is measured both monthly and daily. They also measure the operational availability. This is related but not identical to the OEE. The inventory also is relevant here. They also measure the line balance, but this is not what we would consider line balancing, but closer to the OEE. Finally, they also measure the output in pieces. This is one of the few KPI that are tracked on an hourly basis. Let’s dig deeper.

42.2 Operator Minutes per Piece

The first measurement is the labor time needed to produce one part. This is called operator minutes per piece. You simply take the number of operators, multiply it by the working hours of the shift (or actually the working minutes), and divide it by the number of pieces produced. This gives you how many labor minutes you need to make one piece. The sheet with the monthly data also shows the previous year as well as the target value. Please note that all data here is fictional and merely an example.

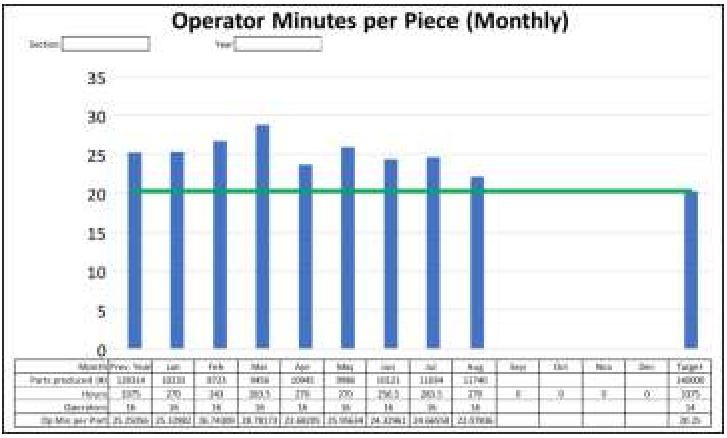

Figure 323: Toyota Op Minutes per Piece Monthly (Image Roser)

A similar sheet measures the daily values. There is no need to show the previous month average, as this is already on the monthly sheet.

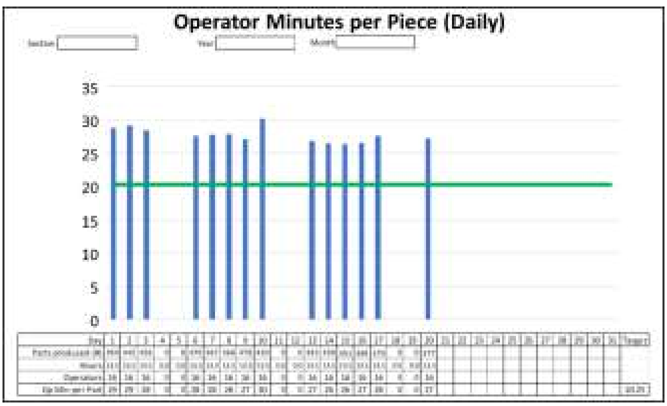

Figure 324: Toyota Op Minutes per Piece Daily (Image Roser)

42.3 Operational Availability

The operational availability basically describes the uptime of the line—what percentage of the time the line is running properly. There are actually different ways to calculate this value at Toyota, depending if the line stops are recorded. If you do not measure the stops of the line, then the operational availability is calculated as follows:

$$Operational\ Availability\ (Percent) = \frac{Theoretical\ Operation\ Time\ (time)}{Actual\ Operation\ Time\ (Time)}$$

The theoretical operation time here is based on the number of pieces multiplied with the takt time to give the theoretical time needed to make the part. Please note while this looks somewhat like an OEE, the OEE multiplies the cycle time (without losses) with the number of pieces, where here we multiply the takt time (including losses) with the number of pieces.

A better way to calculate this, however, is to include the line stops. In this case the equation is as below.

$$Operational\ Availability\ (Percent) =$$

$$= \frac{Actual\ Operation\ Time\ (time) - Line\ Stoppage\ Time\ (Time)}{Actual\ Operation\ Time\ (time)}$$

The second equation is the “tougher” one, as it takes the line stops out of the percentage. However, this requires you to actually measure the line stops. Overall, the operational availability is similar to the availability losses when calculating an OEE. An example for the monthly data sheet is shown below, using fictional data.

Figure 325: Toyota Operational Availability Monthly (Image Roser)

The same sheet is also repeated for the daily KPI values on the operational availability.

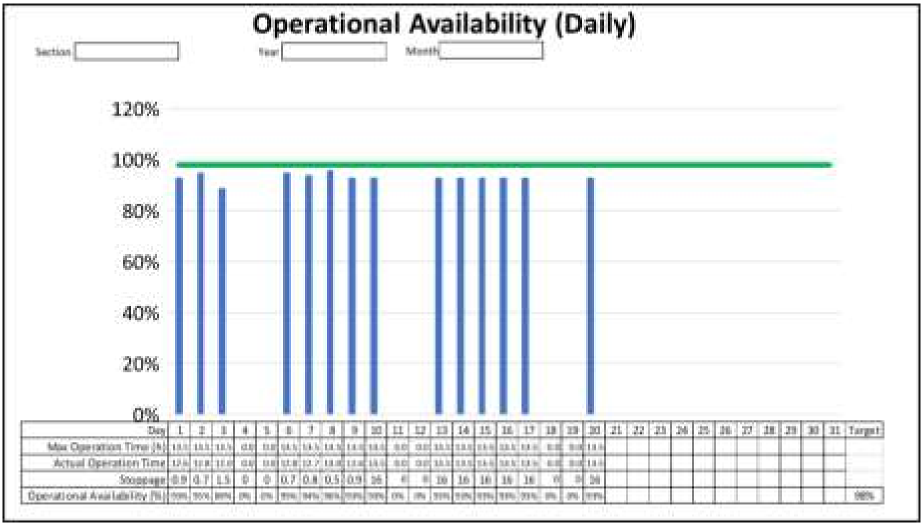

Figure 326: Toyota Operational Availability Daily (Image Roser)

42.4 Average Inventory Reach

The inventory reach shows simply how many hours the inventory lasts. Below is the example for the monthly and daily data.

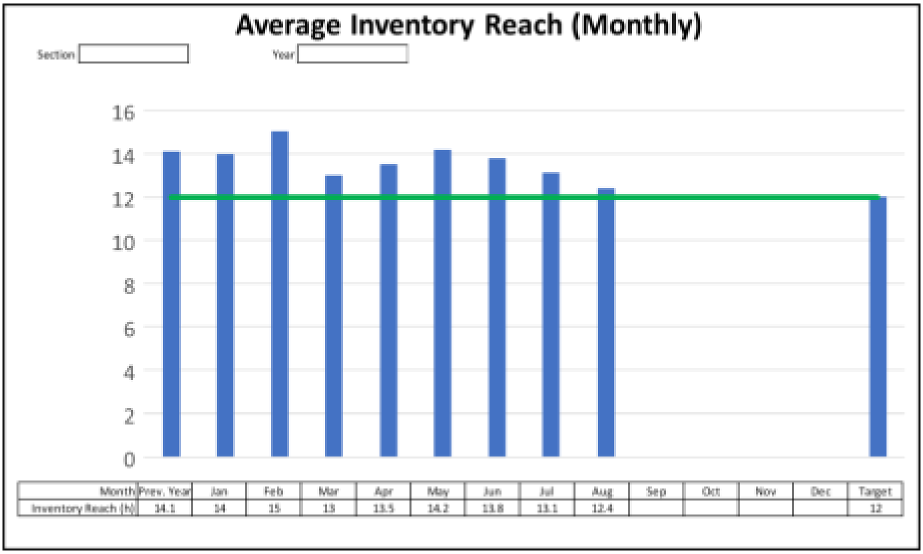

Figure 327: Toyota Av Inventory Reach Monthly (Image Roser)

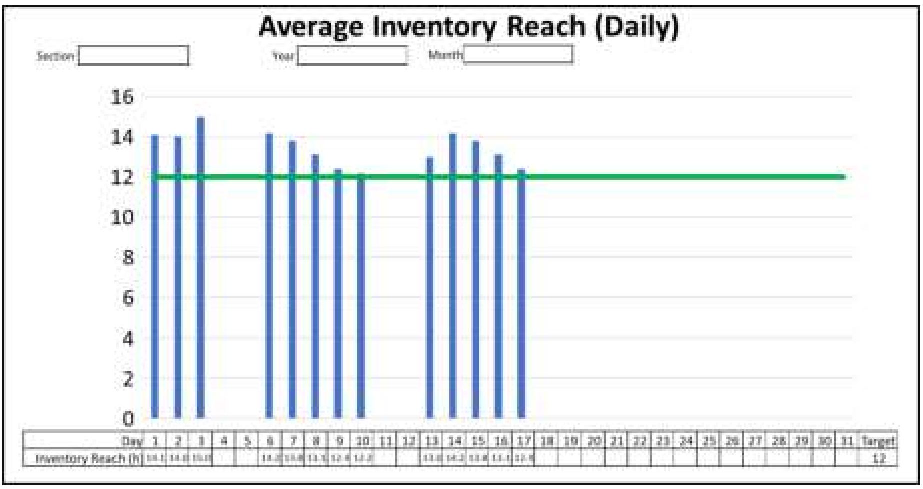

Figure 328: Toyota Av Inventory Reach daily (Image Roser)

42.5 Line Balance

The line balance may be a slightly confusing metric. You know line balancing as a way to distribute the work evenly across all workstations. On the KPI dashboard, this is simply the ratio of how many people you would need, in theory, to produce the output versus how many people you actually have. The theoretically needed manpower would be calculated as follows:

$$Theoretical\ Number\ of\ Operators\ (Operators) =$$

$$= \frac{Daily\ Demand\ (Quantity) \cdot Work\ per\ Piece\ (Operators \cdot Time/Quantity)}{Operation\ Time\ (Time)}$$

You take your daily demand and multiply it by the work needed to make one piece. This work would be the sum of all cycle times. Dividing this by the duration of the workday should give you the minimum number of operators. Let's do an example. You work one shift of eight hours (or 480 min). The sum of all cycle times is 10 minutes' worth of work. If you make 288 pieces in one day, then in theory you would need 10 [operator •min/piece] • 288 [pieces] /480 [min] = 6 operators. Now you simply divide the theoretical number of operators by the actual number of people you have on the line, then you get the line balance. In our example, if you actually had 8 operators on the line, then the line balance would be 6/8, or 75%.

$$Line\ Balance\ (Percent) = \frac{Theoretical\ Number\ of\ Operators\ (Operators)}{Actual\ Number\ of\ Operators\ (Operators)}$$

This is shown in a monthly chart including the previous years average and the target as shown below. A daily chart may be unnecessary.

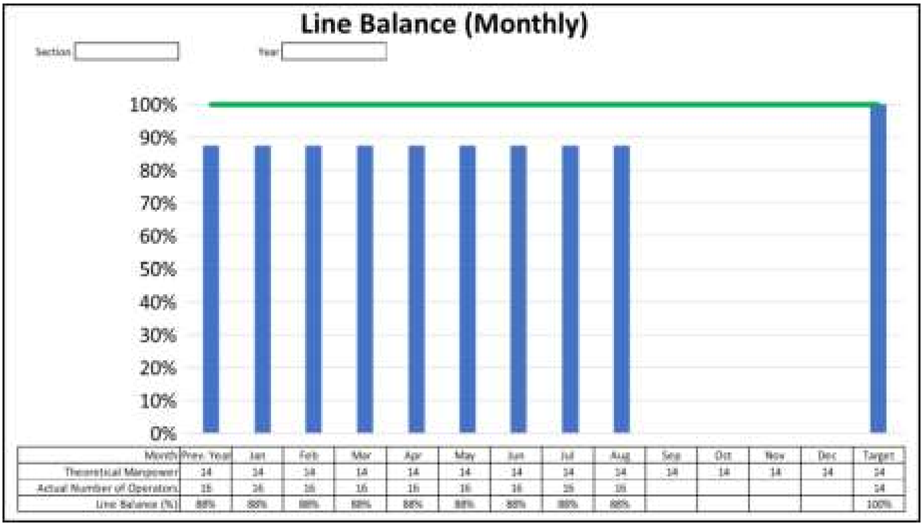

Figure 329: Toyota Line Balance Monthly (Image Roser)

42.6 Production Output

Finally, the last chart is tracking the production output. Unusual compared to all other charts, this is not a monthly or daily chart, but an hourly chart. The team leader or the group leader fills out the data by hand every hour. He adds the target quantity, the actual quantity, the gap, and, if necessary, problems that caused the gap and countermeasures to reduce the likelihood of the problem happening again. Below is such an example sheet.

Production Output (Hourly)

Section | Year | Date | Start Time | End Time

Time	Plan	Actua	Gap	Issues	Countermeasures
6	24	24	0		
7	24	23	-1		
8	24	21	-3		
9	24	23	-1		
10	24	24	0		
11	24	24	0		
12	0	0	0	Break	
13	24	23	-1		
14	24	22	-2		
15	24	23	-1		
16	24	24	0		
17	24	24	0		
18	24	25	1		
19	0	0	0	Break	
20	24	22	-2		
21					
22					
23					
24					

Figure 330: Toyota Production Output Hourly (Image Roser)

Below is also an actual example from the Toyota UK Deeside engine plant fof the hourly quantity. Again, the sheets may look slightly different in different Toyota plants.

Figure 331: Toyota hourly Tracking of Output (Image Toyota UK Deeside with permission)

Overall, there is quite a lot of data on productivity. In my next post I will talk more about the KPIs on the dashboard related to cost. Now, go out, check your productivity, and organize your industry!

PS: Many thanks to Mikako Lenquist from C2U in Sweden for organizing the Lean Leadership System in Japan 2023, where former Toyota factory manager and director in charge of TPS promotion Akinori Hyodo shared his wisdom. Most of the data in this post series I learned from this tour.

Additional thanks to the team from the Toyota Lean Management Centre at the Toyota UK Deeside engine plant in Wales, where I participated in their 5-day course. This course gave us a lot of access to the Toyota shop floor, and we spent hours on the shop floor looking at processes. In my view, this the only generally accessible course by Toyota that gives such a level of shop floor involvement (albeit they want to open another center at the UK Burnaston final assembly plant).

Both the C2U Lean Leadership System course as well as the Toyota Lean Management Centre 5-day course are highly recommended!

43 The Toyota KPI Dashboard—Cost

Christoph Roser, October 24, 2023 Original at https://www.allaboutlean.com/toyota-dashboard-cost/

Figure 332: KPI Dashboard Cost (Image Dall•E in public domain)

In my series on the Toyota KPI dashboard, after safety, quality, and productivity, we finally arrive at cost. While for some companies it is the number one factor, for Toyota it is far behind safety, quality, and productivity. The argument is that if safety, quality, and productivity are in line, it is likely that cost is also good. Both a lack of quality and a lack of productivity will drive up the cost.

43.1 Introduction

The factor cost on a Toyota shop floor is measured as a cost per piece. Additional KPIs are the scrap cost, the attendance rate, and daily overtime. And, looking at this with a critical eye, it seems a bit like a mixed bag. For the Toyota example I have, it feels like they just put things there simply because there was space left. The scrap cost would also fit very well in quality. The attendance rate also would fit well in the HR section (which is not quite a KPI, but still part of the dashboard example I had). Overtime could also fit into productivity or even into the HR section. But these are just my two cents, and maybe I just don't understand some Toyota wisdom behind it. Or, it merely underscores again that cost is the least important KPI group. In any case, it may be not so important where the KPI is, and more important if the KPI is there at all. As always, don't just copy whatever Toyota does, but make your own informed decision!

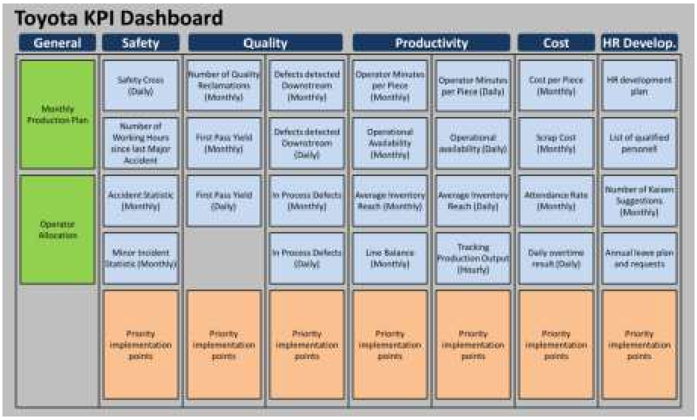

Figure 333: Toyota KPI dashboard overview (Image Roser)

43.2 Cost per Piece

The main measurement for cost on the Toyota dashboard example I have available is the cost per piece. And this opens a whole can of worms on how to calculate the cost. Do you use labor cost only, or also the materials? Do you include the cost of the machines too? Is there an overhead for management and other services? This could be anything from production cost to the total cost of the piece. Depending on the type of cost, this could include many assumptions and estimations, opening the doors to all kinds of number fudging or wrong conclusions (e.g., the wrong way to decide make-or-buy). And, honestly, I don’t know the full details here at Toyota.

However, since this is a KPI for a shop floor dashboard, it would make sense to me to use a metric that shows as much as possible on the shop floor performance, and as little as possible on other factory. On the other hand, the labor cost alone is already represented well by the operator minutes per piece, and having a separate labor cost would only be redundant (and we should avoid redundant KPI). In any case, the cost per piece is a chart on a monthly basis as shown below, including a target (all KPI should have a target).

Figure 334: Toyota Cost per Piece Monthly (Image Roser)

43.3 Scrap Cost

Similarly, there is a sheet for the monthly scrap cost. Below is an example, and—as all examples here—with fictional data. As mentioned above, this could also be seen as part of the quality KPI group.

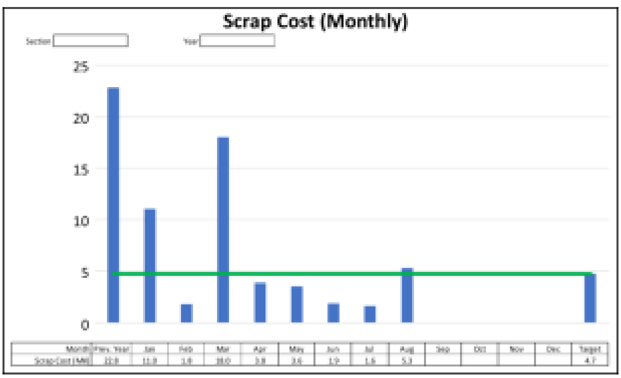

Figure 335: Toyota Scrap Cost Monthly (Image Roser)

43.4 Attendance Rate

The attendance rate shows the percentage of workers who are on-site based on the percentage of workers who should be on-site. The inverse is the absentee rate. Since it is easier to read, I plotted the absentee rate even though the title of the KPI sheet is the attendance rate. In any case, either way works. Also as mentioned above, this could also be seen as an HR related topic.

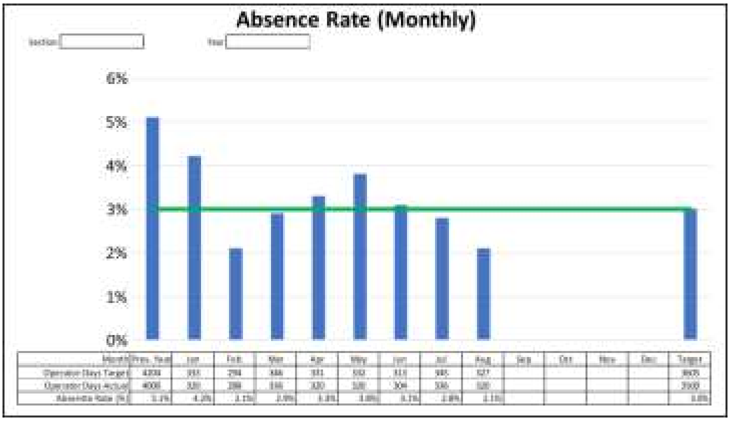

Figure 336: Toyota Absence Rate Monthly (Image Roser)

43.5 Daily Overtime Results

Finally, they show the daily overtime. This is something specific to Toyota and may not be applicable everywhere, depending on your overtime policy. At Toyota, they can schedule overtime every day on short notice. At the UK Deeside engine plant, for example, they can scheduled overtime with as little as two hours' notice. Standard policy at Toyota is to make the daily quantity, and use overtime if a line falls behind. This is of course beneficial for the company (as it improves the quality of the planning data regarding the daily output), but on the other hand it can be harsh on the employees. At Deeside, some people liked it (overtime pay) and some did not (difficulty of planing personal time for the benefit of the company).

Below is an example on how such a chart could look like, also including fictional data. The chart also has a cumulative line.

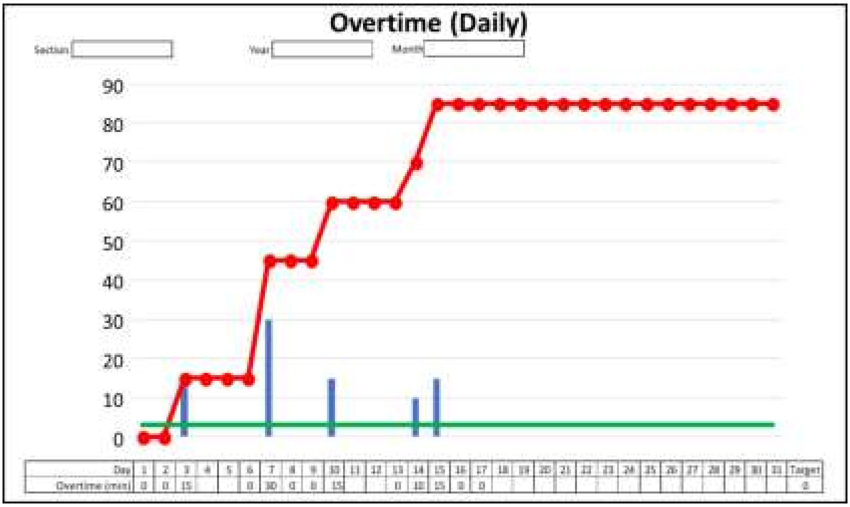

Figure 337: Toyota Overtime Daily (Image Roser)

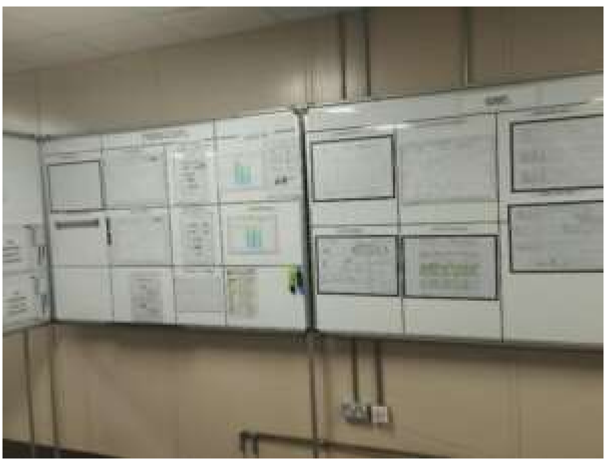

Figure 338: Toyota productivity cost dashboard (Image Toyota UK Deeside with permission)

Here is also a photo of the actual productivity and cost dashboard at the Toyota UK Deeside engine plant. The actual sheets look slightly different, again since there is not fixed standard enforced beyond the Safety—Quality—Productivity—Cost KPI groupings. This post completes the main KPI groups that are part of the Toyota KPI dashboard. However, when used for the daily shop floor meeting, there is also some additional information like a section on HR, a production plan, worker assignment, and problem solving as needed. More on these on my next posts. Now, go out, keep an eye on your costs (even though safety and quality should get more attention), and organize your industry!

PS: Many thanks to Mikako Lenquist from C2U in Sweden for organizing the Lean Leadership System in Japan 2023, where former Toyota factory manager and director in charge of TPS promotion Akinori Hyodo shared his wisdom. Most of the data in this post series I learned from this tour.

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44 The Toyota KPI Dashboard—Human Resources

Christoph Roser, October 31, 2023 Original at https://www.allaboutlean.com/toyota-dashboard-human-resources/

Figure 339: HR KPI Dashboard DallE (Image Dall•E in public domain)

With the KPI groups safety, quality, productivity, and cost, this series on the Toyota KPI dashboard has covered the main topics. However, there is more. Not always but often you can also find a section on human resources (HR) development. Yet, these are usually not KPI, but more organizational topics that may be part of the daily shop floor meeting. Below are some examples of how this section could look, although this may vary quite a bit among different Toyota plants. Let's have a look:

44.1 Introduction

A company makes or breaks with its people. Having the right kind of people, training them, and treating them well is important for the success of a company. You need to show respect for people to have good relations with your workforce and hence have a good workforce. So, not always but often there is a HR section on the dashboard. However, these are usually not KPI, but more organizational topics like the plan for who is on leave and when, as well as the HR development plan to show who should get which trainings when. Even the number of improvement (kaizen) suggestions is not necessarily a KPI, as it may or may not have an actual goal.

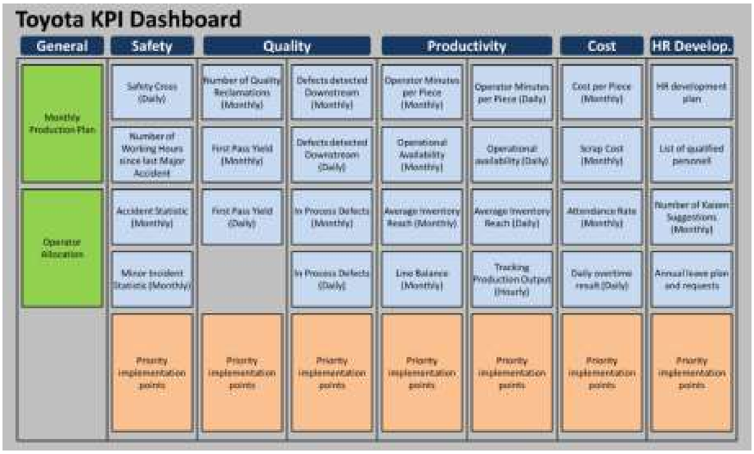

Figure 340: Toyota KPI dashboard overview (Image Roser)

44.2 HR Development Plan

This section can include an HR development plan—for example, which employee is scheduled or assigned for which trainings. Keep in mind that Toyota spends much more time on training and qualification (both on the shop floor as well as off the shop floor) than most other companies.

It may also include generic information on the requirements for promotion. Below is such an example from the Toyota UK plant in Deeside and their “Member Development Map—Manufacturing Team Member up to Section Manager.”

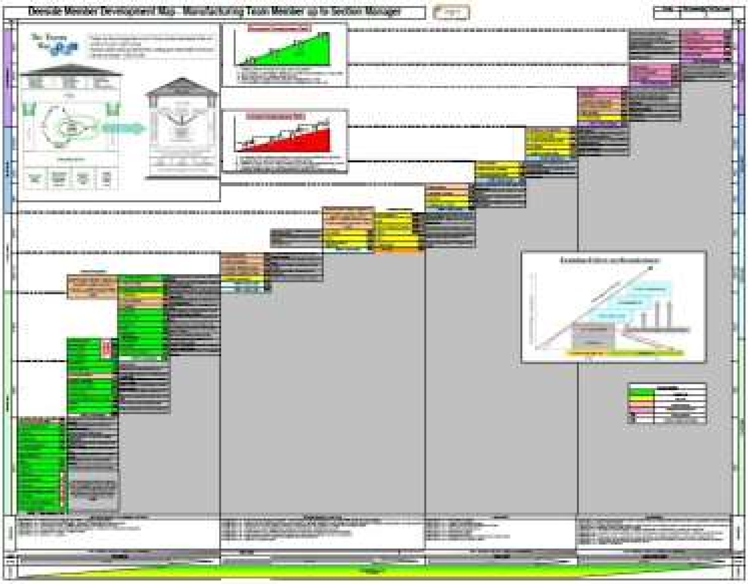

Figure 341: Toyota Deeside Development Plan (Image Toyota UK Deeside with permission)

44.3 List of Qualified Personnel

The list of qualified people can also be included in this section of the dashboard. This could look like a qualification matrix (also skill matrix, competence matrix, or Q-matrix), showing which employee is qualified in which tasks.

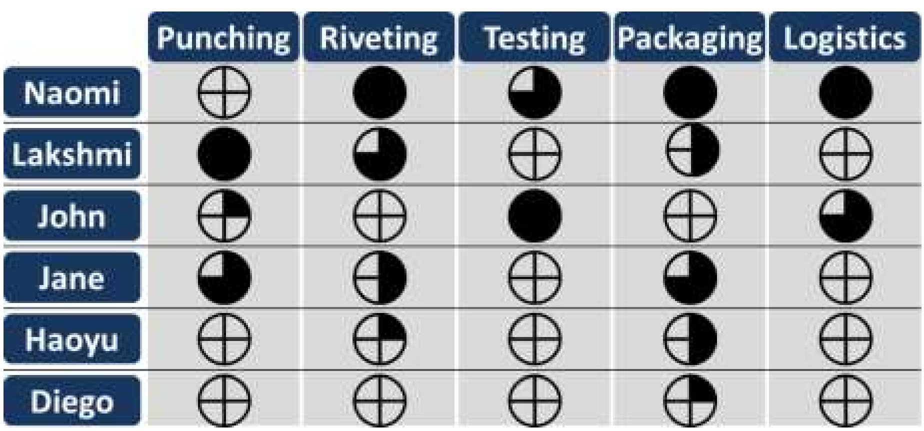

Figure 342: Qualification matrix granular (Image Roser)

44.4 Number of Kaizen Suggestions

At Toyota they also often track the number of improvement ideas that are generated. Below is how such a sheet could look, albeit, honesty, this is my own idea how it could be, and I don't have the actual example from Toyota. I am not even sure if this includes a target or not. I am a bit wary of including targets, as this is a number that can easily be manipulated.

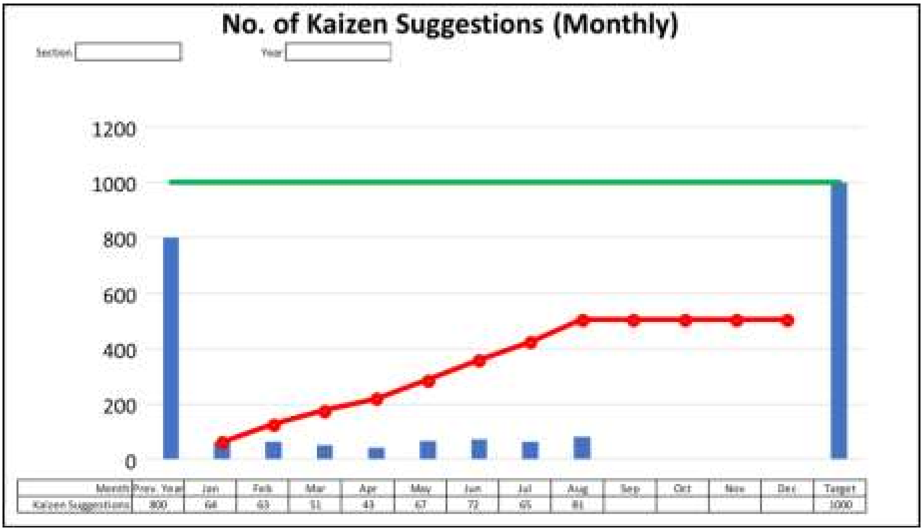

Figure 343: Toyota No of Kaizen Suggestions Monthly (Image Roser)

Figure 344: Toyota UK Kaizen Idea Sheet (Image Toyota UK Deeside with permission)

Here's a photo from the Toyota UK Deeside plant with a box for improvement ideas, including a filled-out idea. Please note that there is a significant difference in the number of ideas generated. While in the USA, there is a measly 0.16 ideas generated by employee and year, in Japan it is a whopping 18.5 ideas per employee and year (source: Corporate Creativity, by Robinson and Stern, 1998, ISBN 978-1576750490). Through my own grapevine I have heard that at Toyota, it is around 50 ideas per employee and year, meaning one per employee and week. Womack mentions 61.6 suggestions at Toyota per employee and year, whereas in Europe there were only 0.4 suggestions per employee and year.

According to Robinson and Stern, the adoption rate in Japan is 90%, significantly higher than the 38% in the USA, and 74% of employees generate ideas in Japan, whereas only 11% do so in the USA. The USA, however, pays better for ideas, with in average USD $458 per idea, where in Japan it is a measly USD $3.88. Money clearly is NOT the motivator for idea generation. Yet, due the significantly larger number of ideas and their adoption, the net savings in Japan is USD $3250 per employee and year, almost ten times as much as in the USA with only USD $334 of savings. The reason for these differences are worth their own blog post, but in my opinion one reason is that Toyota actually has the manpower to implement even smaller ideas, whereas in the Western world all such maintenance and support people have long since been axed to the minimum.

44.5 Annual Leave Plan and Requests

This section of the dashboard can also include annual leave plans and requests for leave. However, these are also often found in the worker assignment section (see next post). Below are two examples from the Toyota UK Deeside plant with different shift assignment boards, one using magnets on a metal board, the other one being digital.

Figure 345: Toyota shift assignment board (Image Toyota UK Deeside with permission)

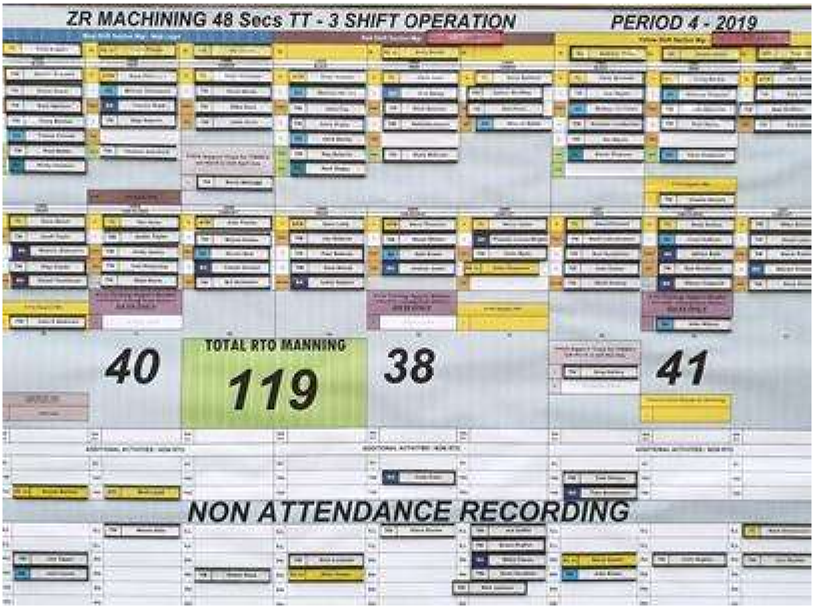

Figure 346: Toyota shift assignment board (Image Toyota UK Deeside with permission)

44.6 Another Version of the HR Dashboard: A3s

Again, there is no fixed standard at Toyota. Below is a dashboard from the Toyota UK Deeside engine plant, labeled H.R.D. (for Human Resources Development), but it is all a list of A3 sheets for problem-solving. The different colors (red, blue, yellow) represent different shifts. The columns are the different section in the engine casting department.

Figure 347: Toyota UK Deeside HR Development A3s (Image Toyota UK Deeside with permission)

In summary, this feels a bit like odds and ends, and may look quite different between different Toyota plants. As always, adapt this for your needs and don't just copy whatever Toyota does. Not even Toyota simply copies what (another plant at) Toyota does. Now, go out, learn from Toyota, but do not copy it, and organize your industry!

PS: Many thanks to Mikako Lenquist from C2U in Sweden for organizing the Lean Leadership System in Japan 2023, where former Toyota factory manager and director in charge of TPS promotion Akinori Hyodo shared his wisdom. Most of the data in this post series I learned from this tour.

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45 The Toyota KPI Dashboard—Production Plan

Christoph Roser, November 7, 2023 Original at https://www.allaboutlean.com/toyota-dashboard-production-plan/

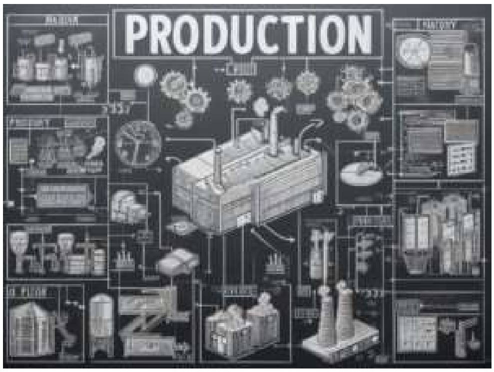

Figure 348: Production Plan illustration DallE (Image Dall•E in public domain)

In my previous posts I went into great detail through all the categories of the Toyota KPI dashboard: safety, quality, productivity, and cost. I also explained the additional section on HR development, albeit this may not really be KPI in the normal sense. However, the dashboard often contains even more: a section with the monthly production plan, a section for the allocation of the operator, and different A3s for improvement. Lets dig deeper:

45.1 Introduction

The Toyota KPI dashboard has a lot of KPI that are useful in managing production, related to safety, quality, productivity, and cost. In some cases, this is all you need. However, for the daily shop floor meeting there are a couple of organizational topics that are also relevant even though they are not really KPI. Besides the human resources section in my last post, there are organizational topics on what to produce (the production plan) and who is doing what (the worker allocation). Below is a schematic overview how this could look, although there are all kinds of different formats in use at different plants of Toyota.

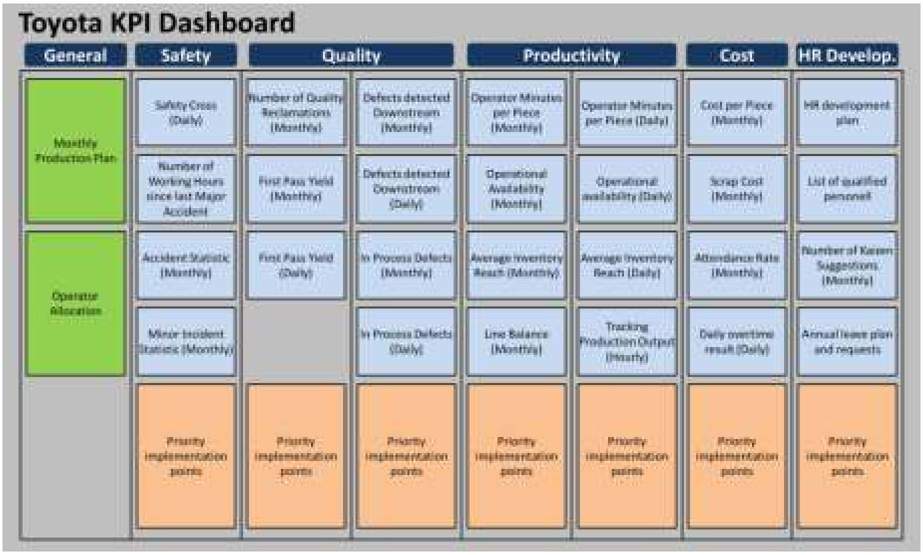

Figure 349: Toyota KPI dashboard overview (Image Roser)

45.2 Production Plan

One important part is the production plan. At Toyota this is often a monthly plan… which is usually impossible at most other plants. Toyota is extremely good at having a stable production plan. They level their production and then make the same quantity every day for one month. From one month to the next, the maximum allowed change is ±10% (barring extreme events like a supplier plant burning down). And (while not perfect) they are very good at sticking with this plan. In quite a few plants all over the world, including suppliers close to Toyota, I have seen production plans that looked like this, where every day has exactly the same quantity (exceptions only for weekends and public holiday, etc.)

- 1st Day of the Month: 743 Parts
- 2ndDay of the Month: 743 Parts
- 3rd Day of the Month: 743 Parts
- …
- 30th Day of the Month: 743 Parts
- 31st Day of the Month: 743 Parts

I have seen many other plants trying to do the same, or even trying to have a two-week plan… and fail miserably. Most plants I have seen cannot even produce reliably for the next three days what they are planning now, let alone for a month! I have seen over and over again that forcing a two- or four-week production plan on a plant that lacks stability and also lacks the needed buffer to decouple fluctuations just ends in misery for all involved. The plant tries to force the long-term plan despite problems with suppliers and changes in the customer demand, making it even worse than if they merely adapted the plan on shorter notice. As such, it is my STRONG recommendation not to try such a two- or four-week plan unless you have stability like Toyota. If you are unsure if your stability is like Toyota, then I can tell you IT IS NOT!

45.3 Operator Allocation

Part of the planning of a shop floor is to determine which people are assigned to which machines. This is done on a daily basis. Below are a couple of examples from the Toyota UK Deeside engine plant. Toyota usually uses magnetic stickers with the names of the employees (and sometimes also a photo). Using such magnetic cards makes it very easy to arrange and it can be done quickly. The magnets are often arranged on a (schematic) layout of the shop floor, where the work positions are indicated, as shown on the first example below. It could also be merely a grouping for different areas, as the second two examples. All examples below show three shifts (the red shift, the blue shift, and the yellow shift), which rotate between morning, afternoon, and night shifts. The last example also shows a (still somewhat uncommon) digital board for such an arrangement, but it is clearly visible that this was inspired by the magnet label type of board.

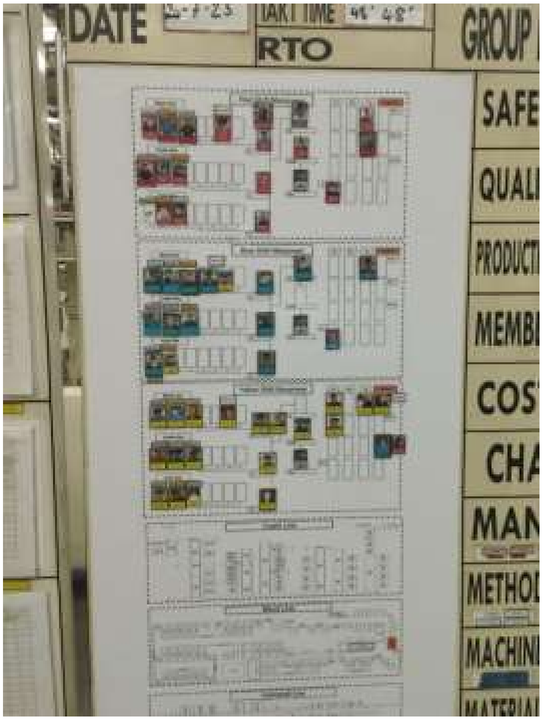

Figure 350: Toyota worker assignment chart (Image Toyota UK Deeside with permission)

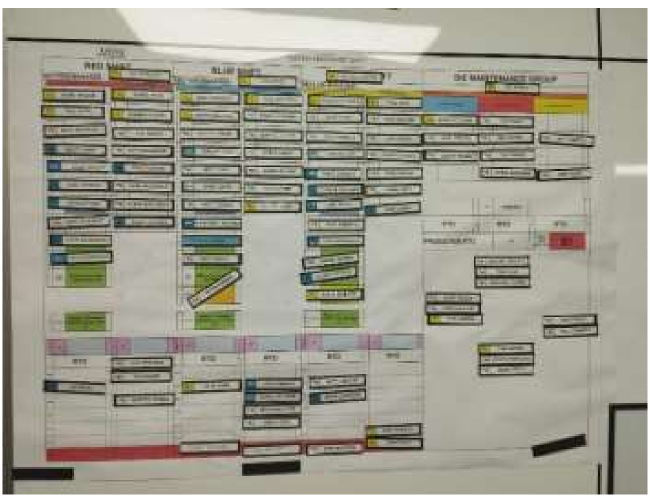

Figure 351: Toyota shift assignment board (Image Toyota UK Deeside with permission)

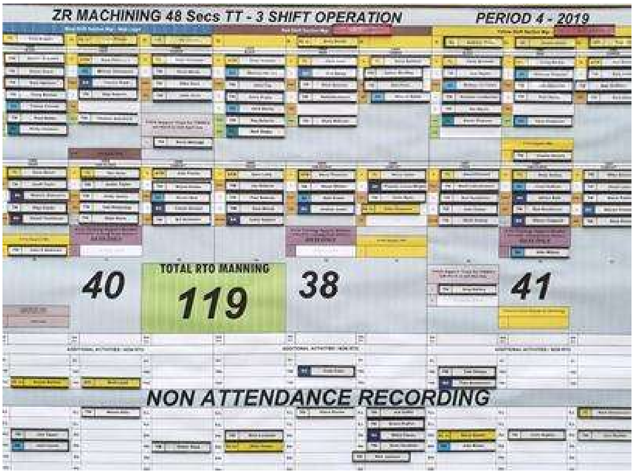

Figure 352: Toyota shift assignment board (Image Toyota UK Deeside with permission)

45.4 A3s

Such shop floor dashboards also often include one or more A3 sheets. Below is a closeup of one A3 from the Toyota UK Deeside engine plant. It follows the overall structure of the PDCA, and also the structure of Toyota problem-solving (more in a later post). It states the reason for the A3, a detailed analysis of the current situation, and a target (including a description why). Next the problem is analyzed in detail (you can see a fishbone diagram included), and different solutions are considered. The implementation of the countermeasures is also tracked. Most importantly, it checks if the implementation actually works by tracking the target KPI. It also includes a section on the lessons learned that could be helpful for other plants. Toyota actually has an internal database that shares such problems and solutions with other plants.

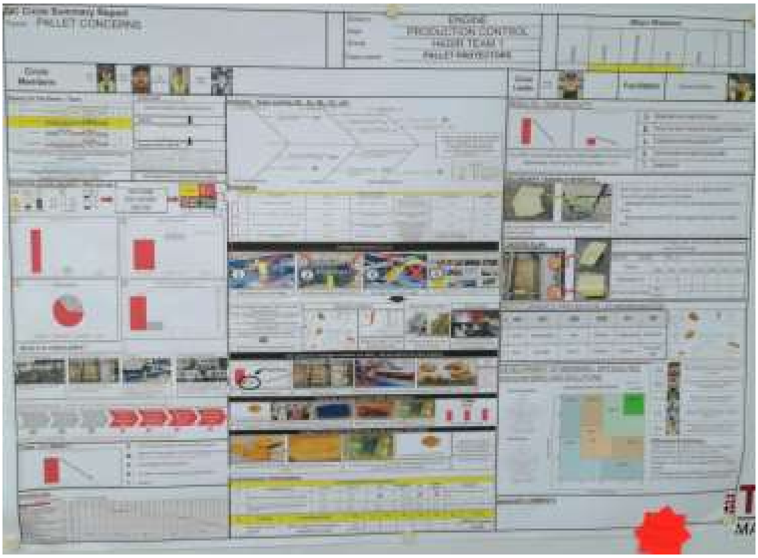

Figure 353: Toyota Deeside Quality Circle A3 (Image Toyota UK Deeside with permission)

Below is an example of multiple such A3s on one dashboard for the Toyota UK Deeside engine plant casting department. There is one A3 for every shift (red, blue, yellow) and section (melting, high-pressure casting, low-pressure casting, and low-pressure finishing). While the example above is a completed A3 sheet, the examples below are in different stages of completion, between just started and tracking results.

Figure 354: Toyota UK Deeside HR development A3s (Image Toyota UK Deeside with permission)

Such problem analyses are also often done with pencil. Below is another example from Deeside, trying to analyze some machine problems.

Figure 355: Toyota Deeside Machine Focus Problem Activity Sheet (Image Toyota UK Deeside with permission)

45.5 Other Dashboard Elements

The dashboard KPI presented in the previous posts are the most important ones. However, sometimes there are more. Toyota is somewhat hesitant to dive headfirst into untested digital waters and often prefers paper, but even at Toyota there is slowly more digitization. Below is an example of such a digital dashboard, showing the details of the breakdown analysis at the Toyota UK Deeside engine plant. More dashboards (e.g., for scrap) are also available. While there is a lot more data available, it is important not to get lost in the details. If you want to look at all available data every day, the day is over before you get around to do anything.

Figure 356: Toyota UK Deeside Breakdown Dashboard (Image Toyota UK Deeside with permission)

This completes my series of blog posts on the Toyota KPI dashboard and related elements for the shop floor meeting that happens daily or for every shift. Now, go out, track and solve your problems, and organize your industry!

PS: Many thanks to Mikako Lenquist from C2U in Sweden for organizing the Lean Leadership System in Japan 2023, where former Toyota factory manager and director in charge of TPS promotion Akinori Hyodo shared his wisdom. Most of the data in this post series I learned from this tour.

Additional thanks to the team from the Toyota Lean Management Centre at the Toyota UK Deeside engine plant in Wales, where I participated in their 5-day course. This course gave us a lot of access to the Toyota shop floor, and we spent hours on the shop floor looking at processes. In my view, this the only generally accessible course by Toyota that gives such a level of shop floor involvement (albeit they want to open another center at the UK Burnaston final assembly plant).

Both the C2U Lean Leadership System course as well as the Toyota Lean Management Centre 5-day course are highly recommended!

46 Lessons Learned from the Toyota KPI Dashboard for Your Own Dashboard

Christoph Roser, November 14, 2023 Original at https://www.allaboutlean.com/own-dashboard/

Figure 357: Generic KPI dashboard Illustration (Image Dall•E in public domain)

In my series of posts on the Toyota KPI dashboard I went into detail about the different sections and KPIs. These dashboards work well fro Toyota. However, this does not mean that they automatically work well for you too. Chances are, you are not making cars. Even if you are, your relevant KPI information may be different from Toyota's. Let's have a look…

46.1 Introduction

In my last series on the Toyota KPI dashboard I went in great detail about the dashboard. At Toyota, it always seems to have the KPI sections safety, quality, productivity, and cost, in that order. Additionally, there is usually a section on people (HR), a general production plan and operator allocation, and quite a few problem-solving activities. Below is the summary example dashboard.

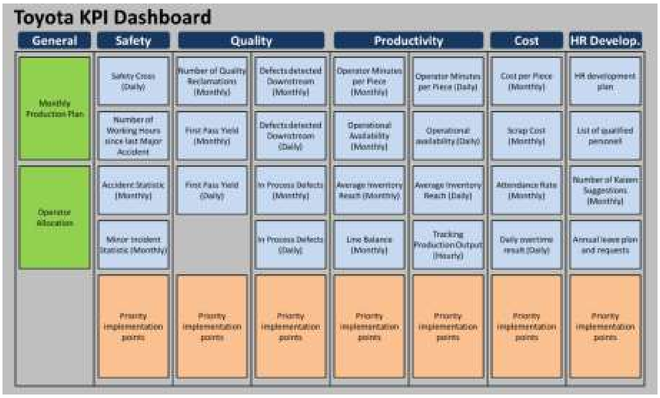

Figure 358: Toyota KPI dashboard overview (Image Roser)

46.2 What You Should Copy

Figure 359: Safety Quality Productivity Cost (Image Dall•E in public domain)

I believe the top-level structure of Toyota is quite good, and I think most companies can copy this. Hence, you should have KPIs on safety, quality, productivity, and cost. And, unless you have a good reason to do otherwise, they should probably be in that sequence of priority. Of course, you can rename them as needed. For example, if your company or your section does not actually make products, you can adapt the name “productivity” as needed. In logistics, for example, this could be “delivery” or “shipments.”

You should also include some sort of improvement activities in the dashboard. This is often the trickiest part, as some activities can be implemented quickly while others languish on the dashboard for an eternity.

46.3 What You Should Adapt

Figure 360: Adapting a KPI dashboard Illustration (Image Dall•E in public domain)

While the headers are pretty much set, you have a lot of flexibility on what kind of KPI to put into the dashboard. It should be something relevant to the section for which the KPI board is set up, and measurable. If possible, also include the targets for the KPIs.For each KPI you should also consider the frequency of measure. This can range from hourly (e.g., Toyota production quantity) to daily, monthly, or even yearly.

The "relevant" part is important, as it should be relevant to the section in the company that discusses this dashboard. The section should be able to actively influence the KPI. Product quality is less important in outbound logistics. Delivery performance is less important to production. A measure on the return on investment (ROI) may make sense for top executives but not for the shop floor team leaders.

Yet, delivery performance is important. A couple of readers asked me why my series on the Toyota KPI dashboard did not include any kind of delivery performance. The example I used did not, since it was a production department dashboard, and for them it is important to make the quantity, which includes the right product type. From there, it is handed to logistics and delivered to other Toyota plants or dealers. Logistics may as well have delivery performance, but the shop floor itself has little influence on delivery performance as long as they make the right products (quantity, quality, type).

The "measurable" part is important, as you should get values that can be measured reliably and accurately. The softer your numbers are, or the more you can fudge your numbers, the less meaning a KPI has. Delivery performance and OEE are two examples of KPI that I find frequently fudged and manipulated (and I even wrote a sarcastic blog post on fudging your OEE). The more precise you can measure a number, the more beneficial it will be on the dashboard to represent a certain section. Unfortunately, sometimes an aspect of business is important but hard to measure. Examples include safety near misses, customer satisfaction, or quality issues in the field. All of them have a tendency to be unreported or difficult or expensive to measure.

I once saw a dashboard in an logistic office that, despite my advice on the contrary, counted the daily "Number of Emails Sent" to measure office productivity, with a bigger number of course being better. Guess what happens if your bosses measure your performance by the number of emails you send out? Exactly, email traffic will increase (because that's what management wanted, apparently). I don't know how it turned out, however. Management claimed beforehand that this will not cause an email inflation. The reason for the measure in the first place was that they wanted to measure office productivity, and this was the only number that they could get. Oh well…

Also feel free to adapt the improvement activities, employee assignment, meeting attendance, and other elements as needed.

46.4 Example KPI Dashboard from Niederrhein-Gold

Figure 361: Niederrhein-Gold Logo (Image Niederrhein-Gold for editorial use)

Here is an example of a KPI dashboard from a company that is quite different from Toyota. It is from Niederrhein-Gold, a German producer of juices and other beverages, and they have evolved it to fit their needs. This dashboard also has the sections productivity (“Leistung“), cost (“Kosten“), and quality (“Qualität“). Safety is part of the employee section (“Mitarbeiter“), where they also track the shift assignments. A general section (“Allgemein“) contains an agenda and an attendance list. Note that this is a picture from a conference where they presented their dashboard, not directly from the shop floor. But it contains everything that is also on the shop floor. I blurred some data for privacy purpose.

Figure 362: KPI Dashboard Niederrhein-Gold Pixellized (Image Roser)

As Niederrhein-Gold does not make cars but juices, the KPI are adapted to their needs. In the performance section they track the daily quantity of products bottled (target, actual, and delta; the latter has a target tolerance interval around zero). They also track how many kilograms of apples they turned into juice every day, as well as the yield rates.

The cost section tracks deliveries and delays. In the quality section they track which days were good using a quality-Q, as well as the number of duplicate laboratory samples taken. The employee section has the familiar safety cross, the shift plan, and the number of people in the different production departments. In the general section besides some meeting guidelines they track the attendance for the shop floor meeting.

A second section has the improvement activities, split into a daily and a weekly plan. The daily plan on the left ("24h – Aktionsliste") includes quick and easy actions that should be done today. As it is supposed to be done on the same day, the date of entry is also the deadline. For every day delay, it gets another red star. Too many red stars, and it moves to the weekly plan ("Wochen-Aktionsliste") for activities that take longer.

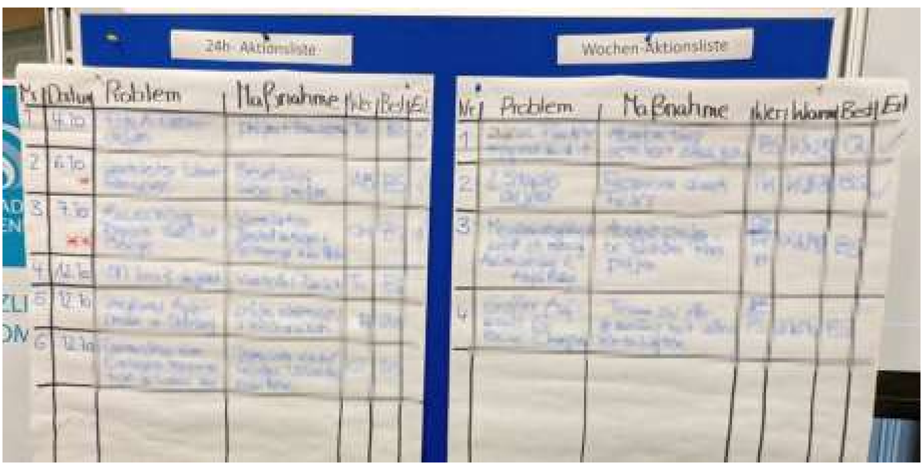

Figure 363: Action List Niederrhein-Gold Pixellized (Image Roser)

46.5 Summary

Overall, you have great freedom in selecting the KPI for your dashboard. It probably won't be a single design, but more of an evolution of KPI parameters. Over time you may add new KPI or take out less relevant ones. Note that we have a tendency to add more but are hesitant to take some out in turn. Over time, dashboards can get crowded, making them less useful. Do not hesitate to also remove KPI from the dashboard again. Now, go out, revise your KPI dashboard, and organize your industry!

PS: Many thanks to Heike Camps from Niederrhein-Gold for sharing their approach at the Akademie Fresenius Praxistage Produktion 2023.

47 What Exactly Is Overburden (Muri)?

Christoph Roser, November 21, 2023 Original at https://www.allaboutlean.com/overburden-muri/

Figure 364: Modern Times Chaplin (Image Taste of Cinema in public domain)

Overburden (muri) is one of the three evils of manufacturing, along with unevenness (mura) and waste (muda). Out of the three, overburden is probably the least understood. Hence, in this post I will look deeper at overburden, including plenty of examples as well as the effects of overburden on your people.

47.1 Introduction

There are three evils that every factory has to fight: waste (muda), unevenness (mura), and overburden (muri). I have Error! Hyperlink reference not valid.. Normally, the focus of many companies is on waste, since it is the easiest of the three to address. However, unevenness is more significant, since it causes most of the waste. Finally, as claimed at Toyota, overburden is the worst of them all.

Figure 365: Waste Unevenness Overburden with text (Image Roser)

Yet, overburden often merely gets a passing glance when the shop floor is studied. In many cases, the meaning of the word is not even understood. Well, let's first have a look at the actual Japanese word muri:

```
Muri (無理): unreasonableness; impossible;
overdoing; beyond one's power; too difficult
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In my view, overburden may be better translated as unreasonableness. While it's not a literal translation, you could also see overburden as stress. The level is important here; a bit of occasional stress may be helpful, but frequently occurring stress usually is not. Keep in mind that different employees also have different tolerances.

Overall, when I walk through a shop floor (or any kind of company), I try to guess if I would feel comfortable working there. Keep in mind that not every job feels comfortable to every person. Furthermore, it is work and not a beach holiday, and a certain amount of tension may be acceptable. The question is if it is reasonable or not. Let's have a look at some examples.

47.2 Examples of Overburden

Figure 366: Overloaded (Image Ermell under the CC-BY-SA 4.0 license)

One example of overburden is a work overload. A short-term work overload may be acceptable. Employees can achieve quite a lot if there is an emergency—if they get some slower periods in between too. But running constantly at 130% is not good. If the emergencies never end, at one point they either stop caring or get burned out. In this case, it is a clear example of overburden that should have been prevented long ago.

Similarly, but less common, is the opposite of a burnout, a bore-out. The employee has so little to do or such a tedious, mind-numbing task that he will have a bore-out. Note that different employees have different tolerances and even preferences on this.

Figure 367: Exhausted elderly employee (Image Dusan Petkovic with permission)

Generally, a physical or mental strain can lead to overburden. For a short period it can be acceptable, but in the longer run it may lead to health issues. In this case, it has been an overburden for a long time. But here, too, different employees have different abilities (for example, some government standards on lifting differentiate between men and physically weaker women).

Another example of overburden is an unsafe workplace. If the health of the employee is at risk, either due to accidents and injuries or due to long-term effects like chemicals, noise, or lack of ergonomics, then it is an overburden.

An employee lacking equipment or not having equipment in proper working order is also an overburden. To do the work you need the right tools in good condition. Anything else, especially in the long run, is overburden.


Figure 368: Angry manager with Employee (Image Kasia Bialasiewicz with permission)

Or more generally, any lack of required resources is overburden. Giving the employee a task requires management to also give them the resources to do the task. This applies on the shop floor as well as in the office or elsewhere. Keep in mind that time is also a resource, and difficult or impossible deadlines are also overburden. This often combines with unrealistic expectations by others. Once in a while it's okay, but frequent unrealistic expectations is overburden.

One aspect of the lack of resources is also a lack of training. An employee should be properly instructed on how to do his work; otherwise you cannot expect him to do his work properly.

Another example of overburden is inconsistency, especially from management. If management tells the employee to do it one way today but a different way tomorrow, it confuses the employee and leads to stress. The employee wants to deliver, but if the expected methods or results change frequently, it is hard to do that.

Figure 369: Dirty Sink (Image unknown author in public domain)

One major point I often look at in a workplace is cleanliness, not only at the place of work or the rest areas, but also especially in sanitation. Unclean, smelly, defective, or otherwise lacking toilets are a prime example of overburden.

All of these points above could be seen simply as a lack of respect. Respect for people, or respect for humanity, is a key part of lean manufacturing, and lack thereof is overburden. Disgruntled employees usually do not hate the company; they hate the managers, usually due to mistreatment or lack of respect. Here, it is not important if the manager feels like he respected the employee; it is only important if the employee feels respected.

47.3 What Are the Effects of Overburden?

There are quite a few effects of consistent overburden or stress. One is health issues. A burned-out employee may need not days but weeks or months of sick leave, causing significant disruption in operations, not to mention cost.

Employees may also vote with their feet and simply quit the company. All the training you put into them is lost, and in the worst case this may benefit the competition. Plus, you now have to make due without the employee until you hire and train a new one. It is quite a hassle.

Figure 370: Unhappy employee resignation (Image Chatchai.wa with permission)

But probably the worst effict is having employees that internally quit, also known as quiet quitting. They no longer care about the company, they are just there for the money, and it doesn't matter to them if the company has problems or not. Every company has a few such people—usually due to mistreatment by (previous?) management—and they are always a drag on operations.

47.4 Overburden on Machines?

Figure 371: Worn out lathe (Image Matt Brown under the CC-BY-SA 2.0)

It is also possible to have overburden on machines. A lack of maintenance, improper processing parameters (e.g., too-high speed or temperatures), improper types of materials (too hard, not uniform), or simply a lack of cleaning can also create undue stress for your processes. Similar to employees, an overburdened machine may also quit (i.e., have a breakdown, which in turn will disrupt your production). So please also do take care of your machines!

This concludes this overview of what exactly overburden is. Now go out, check out the operators' toilet in the farthest corner of the shop floor, consider if you would feel comfortable using it, and organize your industry!

48 Toyota Practical Problem Solving (PPS)—Introduction

Christoph Roser, November 28, 2023 Original at https://www.allaboutlean.com/practical-problem-solving-introduction/

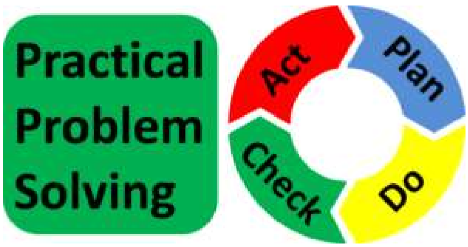

Figure 372: Practical Problem Solving Illustration 1 (Image Roser)

Lean is a lot of problem solving. Toyota excels at such problem solving, and they have developed their practical problem solving (PPS) approach. For many it is surprising how much time Toyota spends on defining and understanding the problem, whereas (many in) the rest of the world immediately jump to a (possibly inferior) solution. Let me go through the process step by step.

48.1 The Framework: PDCA

Figure 373: PDCA Circle (Image Roser)

The overarching framework for the Toyota problem-solving process is, of course, PDCA (Plan, Do, Check, Act). This is, in my view, one of the cornerstones of lean manufacturing and is essential for any kind of improvement activities. Just as a reminder, here are the four steps of the PDCA:

- Plan is to identify and clarify the problem, including collecting data to understand the problem, setting a target, and doing a root-cause analysis.
- Do is the development and implementation of countermeasures.
- Check verifies whether these countermeasures were effective and the target has been reached.
- Act is to re-do and further improve if the targets have not been met (yet). If it was successful, the Act part looks for other locations and applications where this solution could be used (e.g., if it was a smaller trial to be rolled out on a larger scale). Toyota also shares these yokoten on an internal website with other plants.

48.2 Overview

Figure 374: Checklist (Image Clker-Free-Vector-Images in public domain)

Toyota practical problem solving consists of the steps as listed below. Note that sometimes you have a step more if you decide to split a step into two.

- Clarify the Problem
- Break Down the Problem
- Set a Target
- Root-Cause Analysis
- Develop Countermeasures and Implement
- Monitor Process and Results
- Standardize and Share

I will explain all these steps in much more detail, including the risks and difficulties, throughout this small series of posts. But before explaining these steps in detail, let me also show you the structure.

48.3 The Structure: A3

You probably know the structure already, or at least have heard of it: it is the famous A3. This report, named after the standard A3 paper size, is commonly used at Toyota to tackle medium-sized problems. The A3 format was chosen because it was a good compromise between getting lots of data on a single page and also having a page small enough to be carried around on the shop floor. (And, as legend has it, A3 was supposedly the largest format to fit though a fax machine back in the day).

You will find all the steps from above again in this A3 format, an example of which is shown below, plus the obligatory header row with organizational data like title, date, and so on.

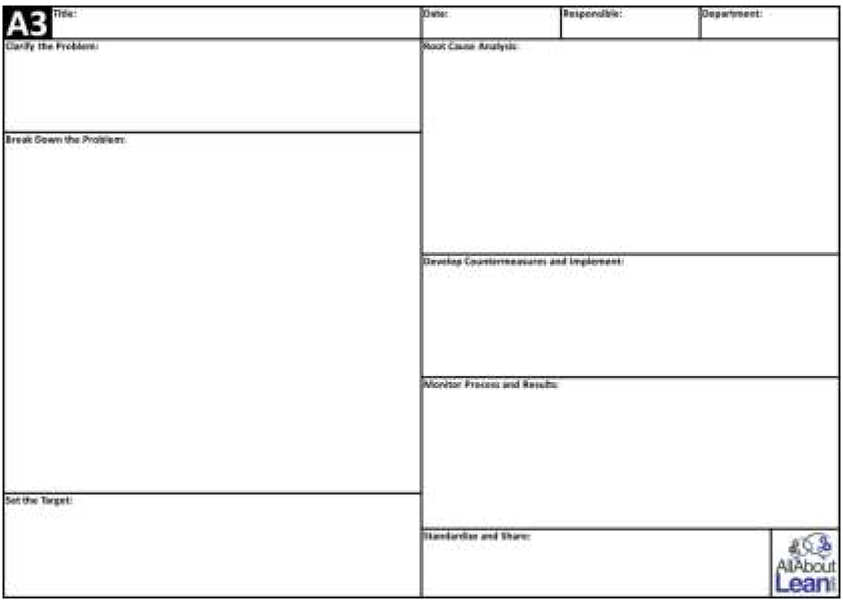

Figure 375: A3 Format Template (Image Roser)

As the steps of the practical problem solving may be grouped differently by different people, so do different A3s have slightly different layouts and contents. Don’t worry too much about it. Actually, you don’t even have to use an A3; you could also use different formats or structures, as the modern digital world gives us many more opportunities here.

The A3 is intended to be filled out in pencil (not pen), which makes changing content easy by using an eraser. Nowadays digital tools are also often used, although Toyota still does this mostly by hand using pencil on paper. Digital A3s are easier to share and look prettier, but they are harder to make and much more effort is needed in creating the A3. If you have ever created an A3 in Microsoft Excel, you know what I am talking about (as Excel is wholly unsuited for such graphical work…Ugh!)

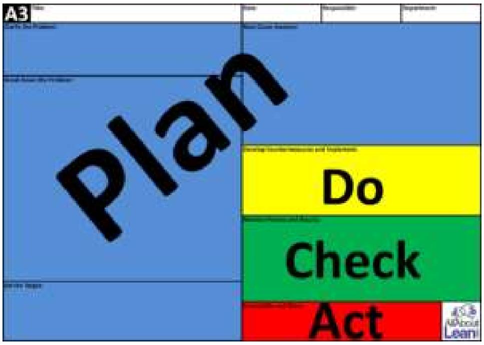

Figure 376: A3 Format PDCA Color Overlay (Image Roser)

As the framework for the practical problem solving is PDCA, you will also find PDCA in the A3 again. But what surprises many people is the weight given to the "Plan" part. Way more than half of the A3 is taken up with understanding the problem, analyzing the problem, setting targets, and understanding the root cause. In the image here I colored these areas in blue.

The "Do" part is actually quite small. If you understand the problem well, the solutions are rather easy. If you don't understand the problem, you still may have a solution, but it will probably be an inferior one, if it works at all. Similarly, the Check and Act are also rather small.

In my experience, this is often done differently (and in my opinion worse) in many other Western companies. The focus is all on doing something, implementing some sort of solution. There is a bit of planning, but the vast majority of the effort goes into the "Do" part. The "Check" and "Act" parts are quite underdeveloped, if they exist at all.

A fancy presentation often substitutes for "Check," resulting in many supposedly successful projects that did not improve much or even made it worse. Below I compared the normal representation of the PDCA circle having four equal quadrants with a PDCA circle based on the effort by Japanese or Toyota standards, and another PDCA circle based on the effort of (way too many) Western companies. I'll let you be the judge on how this is in your company.

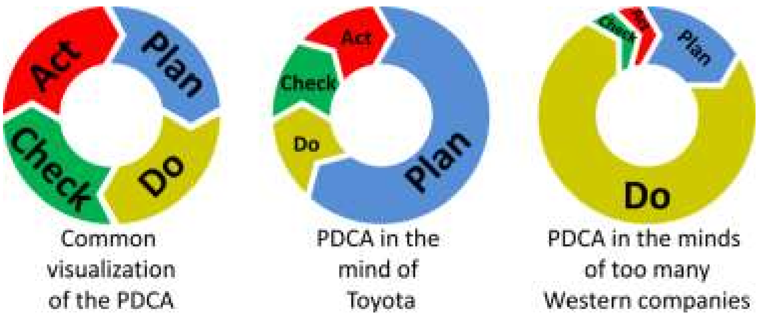

Figure 377: Weighted Version of the PDCA Japan Western (Image Roser)

Over and over again I guide people through the practical problem-solving process, and at every single step they jump to a solution. Let's take a (fictitious) example for the steps of the problem solving, where every step is going right for the solution, ignoring the initial purpose of the step:

- Clarify the Problem: Well, we need kanban!
- Break Down the Problem: Okay, how many kanban do we need?
- Set a Target: That's how many kanban we need!
- Root-Cause Analysis: Um… we did this already. It's the lack of kanban…
- Develop Countermeasures and Implement: Add kanban!
- Monitor Process and Results: Do we have kanban now? Yes, we do. Case closed.
- Standardize and Share: Hey, guys, use kanban!

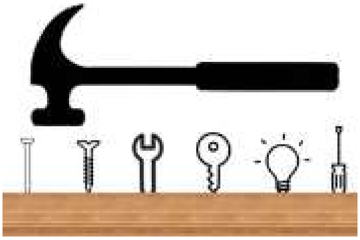

Figure 378: If everything you have is a hammer... (Image Roser)

Just to be clear, the above is sarcasm, but unfortunately not too far from reality. If everything you have is a hammer, everything looks like a nail. Don't make the problem fit the solution, but make the solution fit the problem! Anyway, in my next few posts I will go through the practical problem solving step by step, also showing you why the preparation (i.e., the plan) matters so much. My goals are to turn you away from solving problems before you actually understand them, and then have you verify whether the solution actually worked. Now, go out, see where you have problems, and organize your industry!

PS: Many thanks to the team from the Toyota Lean Management Centre at the Toyota UK Deeside engine plant in Wales, where I participated in their 5-day course. This course gave us a lot of access to the Toyota shop floor, and we spent hours on the shop floor looking at processes. In my view, this the only generally accessible course by Toyota that gives such a level of shop floor involvement.

49 Toyota Practical Problem Solving (PPS)—Clarify

Christoph Roser, December 5, 2023 Original at https://www.allaboutlean.com/practical-problem-solving-clarify/

Figure 379: Practical Problem Solving Magnifying Glass (Image Roser)

In my last post I introduced the Toyota Practical Problem Solving approach (PPS) and gave an overview how it is rooted in PDCA and often used in the form of an A3. Now let's dig deeper and go into the details of the individual steps. The first is to clarify the problem. The second is to break down and stratify the problem—to try to understand the problem better by looking at it from different angles, preferably using data. In my next post I will talk about target setting.

49.1 A Quick Recap

Figure 380: Checklist Illustration (Image Pixabay in public domain)

As listed in my previous post, the Toyota Practical Problem Solving approach consists of the steps listed below.

- Clarify the Problem
- Break Down the Problem
- Set a Target
- Root-Cause Analysis

- Develop Countermeasures and Implement
- Monitor Process and Results
- Standardize and Share

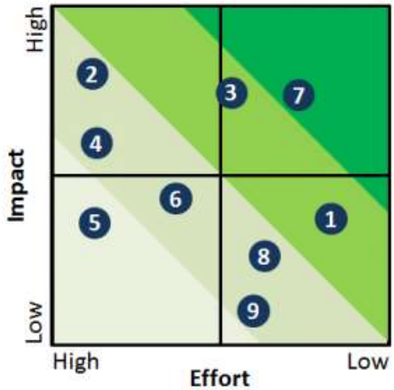

Figure 381: Impact Effort Matrix (Image Roser)

Before you start to clarify the problem, you may also need to consider which of your (presumably) many problems you want to address. You need to prioritize where you want to put your effort and resources. I usually like to do an impact-effort matrix, as shown here. Try to estimate the impact and the effort for all of your possible improvement projects, then select one that has a good trade-off between impact and effort compared to your other potential projects. See my post [How to Manage Your Lean Projects – Prioritize].

49.2 Clarify the Problem

Figure 382: Worker Working On product (Image Dusan Petkovic with permission)

The first step is to clarify the problem. Where exactly do you have a problem in your operations? This is not as easy as it sounds. Take great care not to indicate a solution while describing the problem. For example, if your problem is “not having kanban,” then you’ve already limited yourself to one solution. Besides, “not having kanban” is not a good way to describe a problem.

A problem is often a deviation from a target. You have a target (quality, productivity, cost, etc.), and your actual performance is not meeting these targets. If possible, try to express you target quantitatively (i.e., have a current performance measure that differs from the target for this performance measure). For example, if you have problems with frequent breakdowns of machines, measure the availability of the machine(s). If it is a quality problem, measure customer complaints, first pass yield, or similar quality measures. If you are not happy with your output, measure parts produced per hour or similar. If you can, make a graph, diagram, timeline, or similar visualization; it will be quite helpful.

Try not to narrow it down too much. This will be done in the next step. If you narrow it down too much, you may exclude a root cause that is a major influence on the performance. At the same time, try not to cast a too wide net either. Yes, I know, I am not very helpful here, as it should not be too big nor too small. Unfortunately, while in other cases most people tend to go in one direction (e.g., too much inventory), here I have seen both directions. Some people take a too high-level approach (e.g., analyze company-wide quality issues), while others take a too-narrow view (e.g., quality issue missing weld at process 30). If given a choice, I’d say rather go large then small. The nest step, “Break Down the Problem,” will narrow it down anyway, and it will probably be much more structured than a half-hazarded guess during the problem clarification.

49.3 Break Down the Problem

Figure 383: Workers inspecting parts (Image Tiam 13 with permission)

Now that we have defined the problem, we need to break it down. Here we try to learn more details about the problem. Note that this is not yet developing a solution, but still only understanding more about the problem. Try to understand what is happening and what should be happening. If possible, also look at the problem on the shop floor and collect data.

This includes what Toyota calls "stratification." Try grouping or displaying your data into smaller groups or aspects to analyze them. Try to look at the problem from different angles:

- When is it happening? Is it a certain time of the day? Is it something that did not happen before and now it is happening, and if so, when did it start?
- Where is it happening? Is it at a certain process in the value stream or work instructions? Is it with a specific supplier? Does it happen mostly in selected market regions or market segments?
- What is it happening to? Is it a certain product group or product? Is it a specific module or part? Is it a certain type of customer complaint? Is it a specific type of defect?
- How much is it happening (e.g., how much is produced)?
- Who is it happening to? Is it happening with a certain employee or shift? (Side note: If so, it is probably not a

fault of the employee, but e.g. defective tools, lack of training, etc.)

Above are four bullet points (when, where, what, who) that you should consider. In reality, you may even have multiple aspects to stratify for the same bullet. For example, the question "what" for a quality issue could be looking at the type of complaint, the type of product, or the type of defect, etc.

For more complicated problems you can also try to split it into sub-problems. For example, if you find out during your stratification that there are multiple types of defects that ruin your quality, you may investigate these types of defect separately.

Whenever possible, use graphical charts and displays to visualize the data during stratification. There are many different ways to visualize data, like pie charts, bar charts, Pareto diagrams, timelines and trends, histograms, scatter diagrams, radar charts, surface plots, and many more. below are a few visualizations.

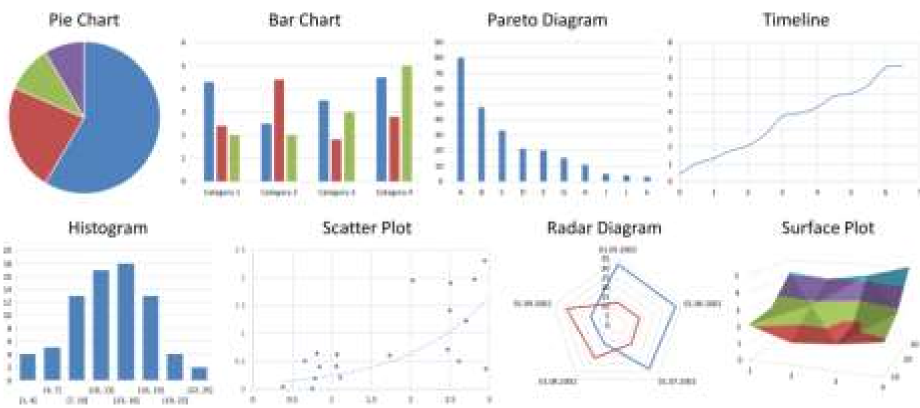

Figure 384: Examples of Visualizing Data using Charts (Image Roser)

The goal of breaking down the problem is to better understand when, where, what, and who is happening. During the clarification of the problem I told you to look at the big picture. The breaking down of the problem narrows this down to the actual problem you are having. Toyota calls this the prioritized problem, and it is often confused with the root cause. This prioritized problem is an essential input for setting the targets… which I will discuss in the next post. Now, go out, define and understand your problem, and organize your industry!

PS: Many thanks to the team from the Toyota Lean Management Centre at the Toyota UK Deeside engine plant in Wales, where I participated in their 5-day course. This course gave us a lot of access to the Toyota shop floor, and we spent hours on the shop floor looking at processes. In my view, this the only generally accessible course by Toyota that gives such a level of shop floor involvement.

50 Toyota Practical Problem Solving (PPS)—Targets and Root Causes

Christoph Roser, December 12, 2023 Original at https://www.allaboutlean.com/practical-problem-solving-targets-and-root-causes/

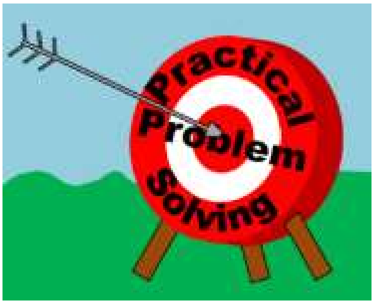

Figure 385: Practical Problem Solving Target Root Cause Analysis (Image Roser)

In the previous posts on this series of the Toyota Practical Problem Solving (PPS) I went into detail on how to understand the problem by clarifying the problem and breaking it down to get the prioritized problem. In this post I will look at target setting and root-cause analysis. Setting the target and doing the root-cause analysis is still the "Plan" part of PDCA. Only in my next post with the development of countermeasures do we get to the next step of "Do."

50.1 A Quick Recap

Figure 386: Checklist Illustration (Image Pixabay in public domain)

As listed in my previous post, the Toyota Practical Problem Solving approach consists of the steps listed below.

- Clarify the Problem
- Break Down the Problem

- Set a Target
- Root-Cause Analysis
- Develop Countermeasures and Implement
- Monitor Process and Results
- Standardize and Share

50.2 Set a Target

Figure 387: Archery Target with Arrows (Image Casito under the CC-BY-SA 3.0 license)

At first glance, setting a target would be easy. We most likely already looked at a deviation of a performance measure from its target during the clarification of the problem. It would be quite easy to take this as a target to get the performance measure back on track. However, don't do that. The deviation of the performance measure from its target during the clarification of the problem was (intentionally) selected on a high level. If we simply take this target as our improvement target, we are including many secondary effects that may influence the measure.

For example, if we want to address a problem related to cost, we should not have a cost target. There are so many other factors that influence cost that it would be hard to evaluate the true impact of the improvement.

Instead, we should use the prioritized problem based on our breakdown of the problem. While the initial problem clarification casts a wide net, the prioritized problem should be quite a bit narrowed down. The target should reflect this prioritized problem. For example, if your overall problem is quality complaints, then during the breakdown you analyzed what type of quality complaints, where, when, and who. Setting the target should be very focused on this what—where—when—who analysis.

Just like any other target, it should be SMART, which stands for Specific, Measurable, Appropriate, Reasonable, and Time-Bound. It should answer the three questions What? By when? and How much? for the prioritized problem. As for the magnitude, Toyota calls this “gentle tension.” It should not be too easy, but still obtainable.

50.3 Root-Cause Analysis

Figure 388: Mind Map (Image jean-louis Zimmermann under the CC-BY 2.0 license)

Once you have your target, you can move to the root-cause analysis (sometimes also called cause and effect analysis). The breakdown of the problem should significantly help you here. The goal is to find the direct cause or causes. This is generally done as a group-effort brainstorming. Keep in mind that, depending on your company’s culture, teamwork can quickly turn into a blame game. Try your best to keep the focus on the problem rather than the person responsible. Try to distinguish between opinions and facts, and avoid generalizations. In case of doubt, go to the shop floor and observe or collect data. This data can then also be stratified like we did during the breakdown of the problem.

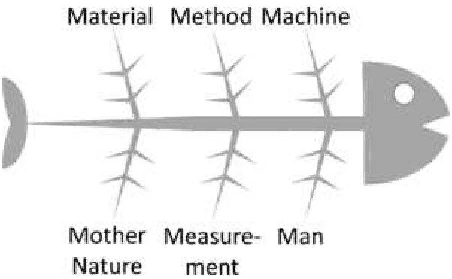

Figure 389: Fishbone Diagram (Image Roser)

As for the analysis of the root cause, there are a number of different tools there. Toyota often uses a fish-bone diagram (which is kind of a structured mind map). In Japan it is also called Ishikawa diagram, named after Kaoru Ishikawa (石川馨). The head of the fish should be the prioritized problem. The fish-bone diagram can work well even if there are multiple causes.

The different bones can be labeled for example Material, Method, Machine, Measurement, Man (or the gender-neutral member) and Mother Nature (or Milieu, to use a word with M for environment). You can also add Management or Money. If you don't like "M," you could also use product/service, price, place, promotion, people/personnel, process, physical evidence; or if you don't like "P" either, use surroundings, suppliers, systems, skills, safety.

Figure 390: 5 Why Graphic (Image Roser)

Another problem-solving tool that is particularly useful for more straightforward problems is 5 Why. The basics of 5 Why are rather simple. You just ask the question "Why?" five times to find the root cause of a problem. It works best with problems that probably have only a single root cause, or at least very few root causes. The more possible causes a problem has, the more difficult it will be to use this method.

Figure 391: 5 Why agressive (Image studiostoks with permission)

After going through 5 Why, there is also a test going back in reverse. This is called the “therefore” test or “So what” test. This is a test to check the validity of the answers. While not foolproof, it may help you to make sure your logical chain is correct. See my blog post All About 5 Why for more.

There are many more problem-solving tools and creativity techniques like the 6-3-5 Technique or Fast Networking (see my blog post Fishbone Diagrams and Mind Maps), Creative Provocation, Reverse Brainstorming, Buzzword Lists and Analogy (see my blog post Creative Provocation, Reverse Brainstorming, and Analogy), to name just a few. If you had a positive experience with one of these tools, keep on using them.

Once you have the root cause you can move on to develop countermeasures, and hence finally get to the “Do” part of PDCA (which is so popular that often the entire Plan is skipped… but do not expect sustainable solutions if you skip on the “Plan”). Also, keep in mind that if you have multiple root causes, you may have to develop countermeasures for them separately. But this will be discussed in more detail in my next post. Now, go out, understand the root cause of your prioritized problem, and organize your industry!

PS: Many thanks to the team from the Toyota Lean Management Centre at the Toyota UK Deeside engine plant in Wales, where I participated in their 5-day course. This course gave us a lot of access to the Toyota shop floor, and we spent hours on the shop floor looking at processes. In my view, this the only generally accessible course by Toyota that gives such a level of shop floor involvement.

51 Toyota Practical Problem Solving (PPS)—Countermeasures and Implement

Christoph Roser, December 19, 2023 Original at https://www.allaboutlean.com/practical-problem-solving-countermeasures-and-implement/

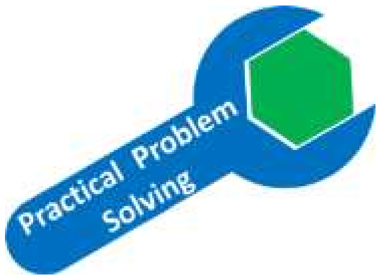

Figure 392: Practical Problem Solving Illustration Wrench (Image Roser)

In this post of my series on the Toyota Practical Problem Solving (PPS), we finally get to the part many were excitedly waiting for—the development of countermeasures and their implementation. Some people like this part of actually doing the improvement (and hence finally the "Do" part of PDCA) so much that they skip the "Plan" part almost entirely. Don't do that! Properly prepare and analyze before implementing a countermeasure. Without the plan, the countermeasure may be flawed.

51.1 A Quick Recap

Figure 393: Checklist Illustration (Image Pixabay in public domain)

As listed in my previous post, the Toyota Practical Problem Solving approach consists of the steps below.

- Clarify the Problem

- Break Down the Problem
- Set a Target
- Root-Cause Analysis
- Develop Countermeasures and Implement
- Monitor Process and Results
- Standardize and Share

51.2 Develop Countermeasures and Implement

Figure 394: Problem Solving Illustration (Image pablo631 with permission)

The task is to develop countermeasures and to implement them. The countermeasures to resolve the problem (or at least to make the problem less common or less damaging) should be based on the root cause. If you have multiple root causes, you may need multiple countermeasures for each of your root causes. Even if you have only one root cause, you may still consider and investigate multiple countermeasures. Look at all possible options that could influence your root cause. Since this is a bit more complex, I have divided it into subsections on developing multiple countermeasures, selecting the most promising countermeasures, and finally implementing them.

51.2.1 Developing Multiple Countermeasures

Developing, or at least considering, multiple countermeasures is actually quite common at Toyota. In the West, the first solution is often followed through, no matter how good the solution actually is. At Toyota, they often consider multiple solutions and compare them.

Figure 395: First generation Toyota Prius (Image IFCAR in public domain)

For example, when Toyota developed the first commercially successful gasoline-electric hybrid, the Prius, they developed around eighty initial concepts for an ultra-low-fuel consumption car. This included everything from fully electric vehicles, to fuel cells, to diesel engines. These eighty concepts were then evaluated and narrowed down to thirty, which were studied further. From these thirty concepts under closer evaluation, the best ten were chosen and studied even more. Out of these ten, a list of the top three promising concepts were selected, and even more research and effort was put in to understanding and developing these three even further. The final winner in the last round was a gasoline-electric hybrid power plant for the Prius.

Hence, let your creativity run wild and think of anything you can that could improve the root cause for your problem. Don't worry too much about the feasibility (yet), since this will be looked at during the next step. Similar to brainstorming, there are no bad ideas, as any idea with not-so-much potential could be an inspiration for an even better idea. More is clearly better here. Do this for all of your root causes.

51.2.2 Selecting Countermeasures

Figure 396: Pick the right ones… (Image Maria Sbytova with permission)

Hopefully you have more than one countermeasure for every one of these root causes you identified. If you have multiple root causes, some countermeasures may impact only one root cause, while other countermeasures impact multiple root causes. Now you need to pick which root causes you actually want to implement.

You may not need to look at eighty different possible solutions to resolve your root cause. But you should definitely take more than one solution under consideration. Look at multiple ideas on how to resolve the root cause, compare them, and pick the most promising ones for implementation. When comparing different solutions, you should consider how effective the solution will address your root cause(s), but you should also consider factors like safety, quality, productivity, cost, timing, and the ease of implementation, as well as its impact on other functions. It is probably best to make a table here with one row for every countermeasure and one column for these performance parameters.

Countermeasure	Effective-ness	Safety	Quality	Produc-tivity	Cost	Timing	Ease of Implemen tation
1							
2							
3							
4							
5							
6							

Figure 397: Practical Problem Solving Comparison of Countermeasures (Image Roser)

Also, do not to get sidetracked to implement something completely different just because it is a nice idea; instead, make sure that your possible actions do improve the root cause! Additionally, try to see it from the view of different stakeholders, answering the question "What is in it for me?" from the point of view of the customer, company, employee, and also yourself. For the Prius, they went with a single final and most promising concept, as they wanted to design only one car model. For your problem-solving, you could implement multiple solutions.

51.2.3 Implement

Figure 398: Button Implement (Image stuartmiles with permission)

You could theoretically implement all selected solutions at once. However, Toyota prefers to implement them one by one to see how much of an impact each solution has on the root cause. There are obvious exceptions when, for example, combining two root causes will significantly reduce the cost (e.g., buying a new machine that has two features/solutions at the same time). But just being faster is not necessarily a good cause for merging the implementation of your solutions. Especially for organizational changes (which are common in lean), you could make a trial period to try it out in order to evaluate its effectiveness and feasibility.

It is really helpful to also build a consensus here, including employees, management, and other impacted departments. This will greatly improve the acceptance of your countermeasures. But if you did the right thing and already involved these stakeholders while clarifying the problem, breaking down the problem, setting a target, doing the root cause analysis, developing countermeasures, and evaluating them, then these stakeholders should already be on board and supportive of your plans. Also consider who has to be informed and who has to approve.

Based on this, you should create a plan for which solution to implement or try out first (probably the most-promising one/highest-value-adding one unless there are other reasons not to), which one second, and so on. For each you should decide what needs to be done by whom and by when.

And then, finally, just do it! Follow through with your plan and implement or at least test these countermeasures. In my next post we will look at the "Check" and "Act" parts of PDCA, where we monitor the process and results as well as standardize and share the learning. Now, go out, do something about your problems (preferably the right thing after a thorough "plan" of PDCA), and organize your industry!

PS: Many thanks to the team from the Toyota Lean Management Centre at the Toyota UK Deeside engine plant in Wales, where I participated in their 5-day course. This course gave us a lot of access to the Toyota shop floor, and we spent hours on the shop floor looking at processes. In my view, this the only generally accessible course by Toyota that gives such a level of shop floor involvement.

52 Toyota Practical Problem Solving (PPS)—Monitor and Share

Christoph Roser, December 26, 2023 Original at https://www.allaboutlean.com/practical-problem-solving-monitor-and-share/

Figure 399: Practical Problem Solving Illustration Box (Image Roser)

This post of my series on Practical Problem Solving (PPS) looks at what to do after you have done the "Do" part of PDCA. Yes, that's right, after implementing the solutions you are not done yet. You need to monitor the outcome to see whether it has actually achieved the target you set much earlier. Here, the next steps can go into two directions. This would be the "Check" of PDCA. If you have not yet achieved the target… well… then you are not yet done and need to keep on working on the problem. If you have achieved the target, congratulations! Now share the wisdom with others. This is the "Act" of PDCA. Let me explain in more detail.

52.1 A Quick Recap

Figure 400: Checklist Illustration (Image Pixabay in public domain)

As listed in my previous post, the Toyota Practical Problem Solving approach consists of the steps below.

- Clarify the Problem
- Break Down the Problem

- Set a Target
- Root-Cause Analysis
- Develop Countermeasures and Implement
- Monitor Process and Results
- Standardize and Share

52.2 Monitor Process and Results

Figure 401: Manager evaluating KPI on a Scale (Image Dall•E in public domain)

The first step is to evaluate the result of your actions. Did your improvements indeed have an effect on the performance? If so, how much? Did you reach your goals? Graphs and diagrams of data, especially with a time-axis showing changes over time, are really helpful here. Keep in mind that these are not the overarching goals but the improvement project specific goals. See my previous post of this series, Toyota Practical Problem Solving (PPS)—Targets and Root Causes, for a refresher.

There are a few points to keep in mind when doing that. First, if you had multiple countermeasures, can you check the outcome individually for each countermeasure? This is a lot easier if you implement countermeasures one by one as suggested in my last post. Otherwise the cause (i.e., the change in the system) and the effect (the improvement) will get muddled and it is hard to understand what caused what.

Second, also check for other effects of your change. Did it also improve some other factors as a side benefit? Did an improvement in the machine availability also somehow improve quality? Such additional effects are actually quite common. Any free additional improvement is nice and welcome. However, it is also possible that something else got worse. For example, did a faster machine speed make quality worse? In this case you have to consider whether the benefit of your improvement is worth the negative side effects.

Also check the views of the different stakeholders. Try to answer the question “What is in it for me?” from the point of view of the customer, company, employee, and also yourself. Is the customer happy about the change? Are the operators happy?

Figure 402: Yes, this does not happen… (Image Dall•E in public domain)

At this point, you have to make a decision. Is the project a success? Did you reach your performance targets and improve the KPIs. Are the negative side effects negligible? If yes, you can continue to standardize and share the results. After that, you can focus on the next biggest issue you have in your area of responsibility. It is rare that managers run out of things to fix. In the pink unicorn situation that you indeed run out of problems to fix, look harder for problems…

If you have not (yet) reached your goals, then the problem is not (yet) solved. You need to go back to understand and break down the problem some more, do more root-cause analysis, and see what you can do differently to achieve your goals.

In my experience, this is often unpleasant and difficult. The final presentation for the project was may be already done, the deadline for the implementation has passed, and focus, resources, and (your) time have already been allocated for the next project. This all needs to be turned back since the problem has not yet been solved. It is, however, a great learning experience. On the other hand, at least some bosses see it as a failure, and hence many employees are worried about how this will impact their career plans. Every company gets the employees it deserves…

52.3 Standardize and Share

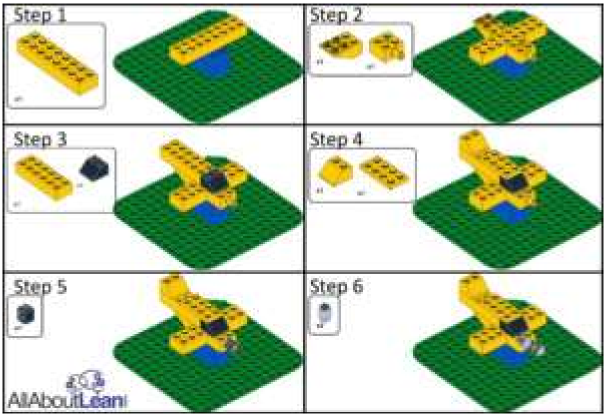

Figure 403: Lego Plane Standard (Image Roser)

Now you are almost done. You need to standardize your achievements to prevent backsliding into an older, inferior way of working. You need to update the work standards, train the operators, and do process confirmation that the operators actually follow the standard. This is standard for anybody working with standards (pun intended).

For the company it is also beneficial if you can share the results. In some cases, the project you just did was merely a test on a small scale to see if it works. Maybe you have ten (nearly) identical production lines, and you fixed the problem for one line. Great. Now fix the other nine. Use the lessons learned from your project to apply it to other, similar problems. This may be another improvement project, where the learning from this current project help to speed up PDCA for the subsequent projects.

Figure 404: illustration of sharing Ideas (Image VLADGRIN with permission)

Some companies provide an infrastructure to share your learning with the rest of the company. For example, Toyota has an internal database where successful improvement projects are uploaded. Other Toyota employees tackling their own problem access and search this database for similar problems from others to get inspirations and ideas for solutions. At Toyota, this is called Yokoten. Prepare and clean up your documentation and share it with your company.

52.4 Summary

You have done it. You have solved a problem using the Toyota Practical Problem Solving approach. This is the right way to do it, and much better than continuous firefighting (albeit some companies and some people just LOOOOOVE firefighting, since it looks so good; see my post on Heroes, Firefighting, and Corporate Culture). Now, go out, make sure your problems are solved properly rather than addressing the symptoms, and organize your industry!

PS: Many thanks to the team from the Toyota Lean Management Centre at the Toyota UK Deeside engine plant in Wales, where I participated in their 5-day course. This course gave us a lot of access to the Toyota shop floor, and we spent hours on the shop floor looking at processes. In my view, this the only generally accessible course by Toyota that gives such a level of shop floor involvement.

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Figure 405: Christoph Roser (Image Roser)

Prof. Dr. Christoph Roser is an expert for lean production and a professor for production management at the University of Applied Sciences in Karlsruhe, Germany. He studied automation engineering at the University of Applied Sciences in Ulm, Germany, and completed his Ph.D. in mechanical engineering at the University of Massachusetts, researching flexible design methodologies. Afterward he worked for five years at the Toyota Central Research and Development Laboratories in Nagoya, Japan, studying the Toyota Production System and developing bottleneck detection and buffer allocation methods. Following Toyota, he joined McKinsey & Company in Munich, Germany, specializing in lean manufacturing and driving numerous projects in all segments of industry. Before becoming a professor, he worked for the Robert Bosch GmbH, Germany, first as a lean expert for research and training, then using his expertise as a production logistics manager in the Bosch Thermotechnik Division. In 2013, he was appointed professor for production management at the University of Applied Sciences in Karlsruhe to continue his research and teaching on lean manufacturing.

Throughout his career Dr. Roser has worked on lean projects in almost two hundred different plants, including automotive, machine construction, solar cells, chip manufacturing, gas turbine industry, paper making, logistics, power tools, heating, packaging, food processing, white goods, security technology, finance, and many more. He is an award-winning author of over fifty academic publications. Besides research, teaching, and consulting on lean manufacturing, he is very interested in different approaches to manufacturing organization, both historical and current. He blogs about his experiences and research on AllAboutLean.com. He also published his first book, "Faster, Better, Cheaper," on the history of manufacturing and his second book "All About Pull Production" on implementing pull production as well as this series of collected blog posts. This book was awarded the Shingo Publication Award in 2022.