Know Your Takt Time

By Jon Miller

Introduction

Takt Time is a one of the key principles in a Lean Enterprise. Takt Time sets the 'beat' of the organization in synch with customer demand. As one of the three elements of Just In Time (along with one-piece flow and downstream pull) Takt Time balances the workload of various resources and identifies bottlenecks. Takt Time is a simple concept, yet counter-intuitive, and often confused with cycle time or machine speed. In order for manufacturing cells and assembly lines to be designed and built Lean, a thorough understanding of Takt Time is required. We will dispel several common misconceptions, as well as introduce a rule of thumb of Takt Time for production line design.

What is Takt Time?

Takt Time comes from a German word *'takt'* meaning rhythm or beat. It is a term often associated with the *takt* the conductor sets so that the orchestra plays in unison. Takt Time is used to match the pace of work to the average pace of customer demand. Takt is not a number that can be measured (Misconception #1), and is not to be mistaken with Cycle Time, which is the time it takes to complete one task. Cycle Time may be less than, more than, or equal to Takt Time.

You can never measure Takt Time with a stop watch. You must calculate it. The formula for Takt Time is:

Takt Time = Net Available Time per Day / Customer Demand per Day

Takt Time is expressed as "seconds per piece", indicating that customers are buying a product once every so many seconds. Takt Time is not expressed as "pieces per second" (Misconception #2). By pacing production to this rate of customer demand, Lean Manufacturing seeks to minimize was and ensure on-time at a low cost.

Speeding up Takt Time

If the goal of Takt Time is to work at the same pace as customer demand, what would happen if the Takt Time (work pace) were artificially sped up? Work would be completed faster than required, resulting in the waste of overproduction and inventory. If other tasks are not available, the workers may also experience the waste of waiting. When, if ever, is it okay to speed up Takt Time?

To demonstrate one situation where speeding up Takt Time, and to illustrate several *Rounding Rules*, we will calculate a sample crew size based on Takt Time. The crew size calculation for an assembly line doing one piece flow paced to Takt Time is:

Crew size = Sum of Manual Cycle Time / Takt Time

Therefore, for a process with a total Manual Cycle Time of 1,293 seconds

Crew size = 1,293 person-seconds / 345 seconds

Crew size = 3.74 people

In this case the crew size will be 4 people since 3 people would not be able to meet customer demand. The 'kaizen way' is to round down from 3.74 to 3 and look for cycle time reduction opportunity. Process improvement tools are used to eliminate waste and improve productivity.

Rounding Rule #1: Round down to determine kaizen target for crew size

However, even after kaizen, it is rare that the crew size calculation equation results in a whole number (e.g. exactly 3 people). The resulting number is most often a fraction. It is impossible to employ 0.74 of a person, so this number is rounded up to 4.

Rounding Rule #2: Round up to determine number of people actually required to run until improvements are made

Another option is to adjust the available time so that the Takt Time is sped up. Because the same demand must be met in less time, Takt Time is faster paced. If the cycle time is fixed, this requires additional labor.

3.74 people = 1293 seconds per piece / (7.5 hours x 60 minutes x 60 seconds / 78 pieces)

4 people = 1293 seconds / (7 hours x 60 minutes x 60 seconds / 78 pieces)

By using 4 people instead of 3.74, speeding up Takt Time and producing the same volume in fewer hours, the work load of the crew is better balanced. When this 4 person crew meets customer demand in fewer than regular hours, they will need to be rotated to another work area or be assigned to process improvement tasks. Because this is not always possible, the kaizen way is to take waste out of the process, reduce the manual cycle time, and bring the crew size down to 3 people.

Slowing Down Takt Time: The 50 Second Rule

We have just demonstrated when it is all right to speed up Takt Time in order to improve productivity. When, if ever, should Takt Time be slowed down?

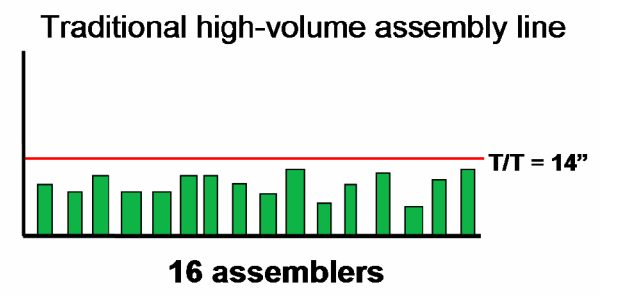
When we visit Toyota's factories we observe that their assembly lines run in the 50 to 60 second range. Many factories run only one shift, or two but almost never 3 shifts. There are 14 factories in the Toyota City area of Japan. Why not combine these assets and run half as many lines at a Takt Time of 30 seconds, doubling the output with half of the assets?

We won't answer this question in its entirety, but part of it has to do with the *50 Second Rule.*

There is a rule of thumb for Takt Time that says that no repetitive manual operation should have a cycle time less than 50 seconds (time from start to start). When Toyota needs 5%-15% more production, they may run overtime, or in many cases they will have multiple lines set up at slower takt times (e.g. two lines at 90 seconds instead of one at 45) to allow them to ramp up and down.

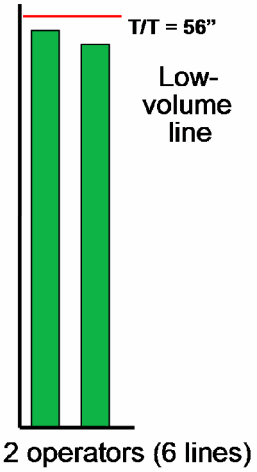
There are 4 reasons why the 50 Second Rule is important:

1) Productivity
Even seconds that are lost to wasteful motions become a bigger percentage of cycle time when the Takt Time is short. When you lose 3 seconds out of a 30 second cycle, this is a 10% loss in productivity. Losing 3 seconds out of a 60 second cycle is 5%. Losing 3 seconds out of a 300 second cycle is only 1%, etc. It is not very hard at all to lose 3 seconds in a repetitive heavy assembly operation, so the longer Takt Times (50 seconds plus) result in better productivity.



Having one line with many workers running at a faster Takt (14 seconds) will save on investment cost (number of lines) but will have a higher operating cost in the long term. We have found that a Lean line designed to Takt Times of 50 seconds or higher easily 30% more productive than fast lines.

By designing more lines with a minimum work content of 50 seconds or greater, a higher productivity is achieved. In addition to productivity, there are three other factors.



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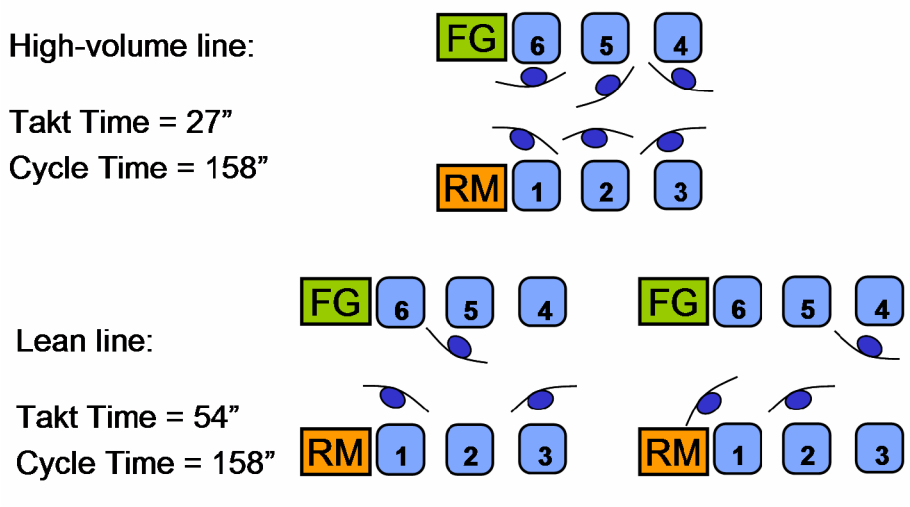
2) Safety & Ergonomics
When the same tasks are performed more often over a shorter period of time there is a greater risk of developing repetitive stress injuries and of fatigue. When a wider range of operations are performed over (for example 60 seconds) muscles have a full minute to recover before starting the same operation #1 again, versus only 14 seconds per repetition.

3) Quality
When performing a wider range of duties (5 operations versus 2) each person becomes their own customer for the each of the operations they do except for the very last one. If a worker is performing 5 operations (instead of two) this causes him or her to pay more attention to quality, since a bad result in operation 3 will impact them in operation 4, rather than being passed on unseen to the next person.



4) Morale
Through our work we have found that when all other things being equal, people have greater job satisfaction in performing a 54 second operation over and over again than in performing a 27 second operation over and over again. People enjoy the cross training and learning new skills, the reduction of repetitive motion fatigue, but the top reasons is that people like to feel that they are building something rather than just running a bolt and putting a plug a hole all day long.

Takt Time & Capital Investment Decisions

The impact of knowing the *50 Second Rule* can be seen in the example of a Fortune 500 company manufacturing and assembling heavy pumps for industrial use. Prior to the Lean redesign project, they were building their product on one long assembly line. Customer demand growth and additional testing requirements required them to design a new assembly line. The company wished to incorporate Lean principles into the design of the new assembly line. One of the first steps was to determine Takt Time.

Takt Time for this product based on peak demand was 40 seconds per unit. When it was pointed out that this Takt Time violated the 50 second rule, and that two lines paced at 80 seconds would be needed instead of one line at 40 seconds, there was some concern

among the engineers in charge of this project. The assembly line had been bid out to several engineering firms for design and fabrication work, and estimates for one line had come back at anywhere between $280,000 and $450,000. Two lines meant doubling the equipment and doubling the initial capital investment.

Even without calculating the Cost of Poor Quality savings, the savings in costs of safety, and morale, the productivity improvements were able to offset the investment cost of the new line. In addition, by having two lines they were able to build each line to suit a particular set of products, and dedicate tooling rather than build one line that could handle anything. This reduced the investment cost per line.

Although the initial investment cost was higher than if they had build only one line, the long-term running cost of the line was lower due to increased productivity, safety costs, and flexibility of having two lines. The initial plan was to build and run only one line one shift at a 40 second Takt Time. In this case it was better to run a single line paced at 80 seconds on two shifts or to build two lines and run one shift at 80 seconds each.

Conclusion

We have seen that following a simple rule that limits the speed of any manual operation to no less than 50 seconds ensures that unnecessary losses can be avoided. Great care should be taken in designing processes so that careful consideration is made of Lean principles such as Takt Time. We recommend that you *Know Your Takt Time* very thoroughly and follow a process such as 3P (Production Preparation Process) to incorporate Lean principles in process design. Lean design will have a positive impact on the safety, productivity, quality, and employee satisfaction of the assembly line.

