# ONE PIECE FLOW - ANOTHER VIEW ON PRODUCTION FLOW IN THE NEXT CONTINUOUS PROCESS IMPROVEMENT


Michal MARTON, Iveta PAULOVÁ

*Author:* ***Michal Marton, MSc. Eng., Iveta Paulová, Assoc. Prof. PhD.***
*Workplace:* ***Slovak University of Technology Bratislava***
***Faculty of Materials Science and Technology in Trnava***
***Institute of Industrial Engineering, Management and Quality***
*Address:* ***Paulínska 16, 917 24 Trnava***
*Telephone:* ***+421 902 570 369***
*E-mail:* ***michal.marton@stuba.sk, iveta.paulova@stuba.sk***



## Abstract

*One-piece flow (also commonly referred to as continuous flow manufacturing) is a technique used to manufacture components in a cellular environment. The cell is an area where everything that is needed to process the part is within easy reach, and no part is allowed to go to the next operation until the previous operation has been completed. The goals of one-piece flow are: to make one part at a time correctly all the time to achieve this without unplanned interruptions to achieve this without lengthy queue times. This paper includes basic theoretical information about one-piece flow technique and following application in practice.*



## Key words

*one-piece flow, process improvement, cell, pull system*


## Introduction

One-piece flow describes the sequence of product or of transactional activities through a process one unit at a time. In contrast, batch processing creates a large number of products or works on a large number of transactions at one time – sending them together as a group through each operational step. In one-piece flow, focus is on the product or on the transactional process, rather than on the waiting, transporting, and storage of either. One-piece flow methods need short changeover times and are conducive to a *pull* system.

## Achieving one-piece flow

While many are familiar with the terminology, there is still a significant amount of confusion regarding what one-piece flow means and, more importantly, how to achieve it. Let us begin by stepping back and attempting to understand the concept of “connected flow.” Achieving connected flow means implementing a means of connecting each process step within a value stream. In a typical MRP batch-and-queue manufacturing environment as illustrated below, parts move from functional area to functional area in batches, and each processing step or set of processing steps is controlled independently by a schedule.

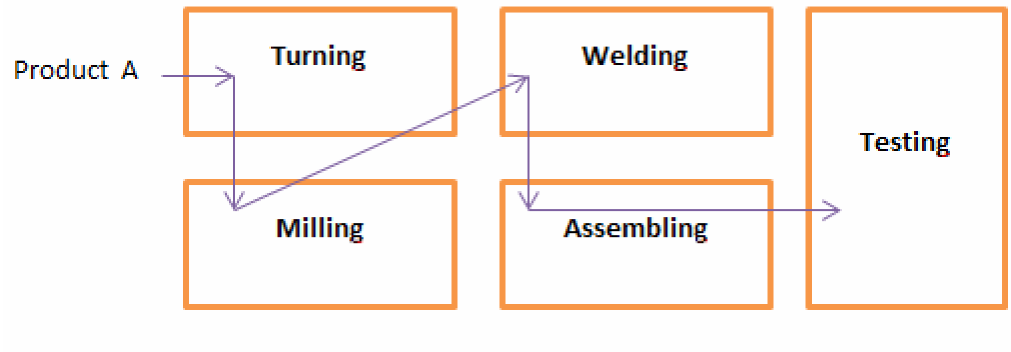


***Fig. 1*** *Batch-and-queue manufacturing environment*

There is little relationship between each manufacturing step and the steps immediately upstream or downstream. This results in:

- Large amounts of scrap when a defect is found because of large batches of WIP,
- Long manufacturing lead time,
- Poor on-time delivery and/or lots of finished goods inventory to compensate,
- Large amounts of WIP.

When we achieve connected flow, there is a relationship between processing steps: That relationship is either a pull system such as a supermarket or FIFO lane or a direct link (one-piece flow). As illustrated below, one-piece flow is the *ideal* method for creating connected flow because product is moved from step to step with essentially no waiting (zero WIP).

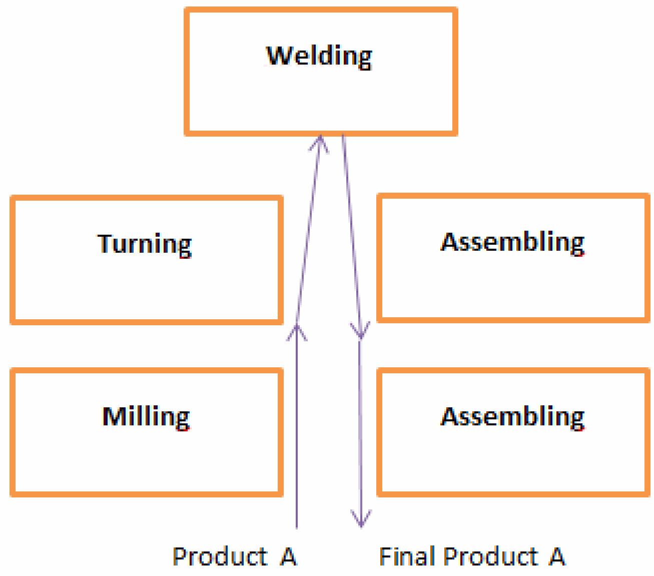


***Fig. 2*** *One-piece flow manufacturing environment*

**Basic condition for achieving one-piece flow**

Why would we not always create one-piece flow for every set of processes within a value stream? To be good candidates for one-piece flow, we must have the following conditions:

- Processes must be able to consistently produce good product. If there are many quality issues, one-piece flow is impossible.

- Process times must be repeatable as well. If there is much variation, one-piece flow is impossible.
- Equipment must have very high (near 100 percent) uptime. Equipment must always be available to run. If equipment within a manufacturing cell is plagued with downtime, one-piece flow will be impossible.
- Processes must be able to be scaled to tact time, or the rate of customer demand. For example, if tact time is 10 minutes, processes should be able to scale to run at one unit every 10 minutes.

Without the above conditions in place, some other form of connecting flow must be used. This means that there will be a buffer of inventory typically in the form of a supermarket or FIFO lane between processes; the goal would be to eventually achieve one-piece flow (no buffer) by improving the processes.

If a set of processes is determined to a candidate for one-piece flow, then the next step is to begin implementation of a one-piece flow cell.

## Implementing one-piece flow

The first step in implementing a one-piece flow cell is to decide which products or product families will go into the cells, and determine the type of cell: Product-focused or mixed model. For product focused cells to work correctly, demand needs to be high enough for an individual product. For mixed model cells to work, changeover times must be kept short; a general rule of thumb is that changeover time must be less than one tact time. The next step is to calculate tact time for the set of products that will go into the cell. Tact time is a measure of customer demand expressed in units of time and is calculated as follows:
***Tact time = Available work-time per shift / Customer demand per shift***

Next, determine the work elements and time required for making one piece. In much detail, list each step and its associated time. Time each step separately several times and use the lowest repeatable time. Then, determine if the equipment to be used within the cell can meet tact time. Considerations here include changeover times, load and unload times, and downtime.

The next step is to create a lean layout. Using the principles of 5-S (eliminating those items that are not needed and locating all items/equipment/materials that are needed at their points of use in the proper sequence), design a layout. Space between processes within a one-piece flow cell must be limited to eliminate motion waste and to prevent unwanted WIP accumulation. U-shaped cells are generally best; however, if this is impossible due to factory floor limitations, other shapes will do. For example, I have implemented S-shaped cells in areas were a large U-shape is physically impossible.

Finally, balance the cell and create standardized work for each operator within the cell. Determine how many operators are needed to meet tact time and then split the work between operators. Use the following equation:
***Number of operators = Total work content / Tact time***

In most cases, an “inconvenient” remainder term will result (e.g., you will end up with Number of Operators = 4.4 or 2.3 or 3.6 instead of 2.0, 3.0, or 4.0). If there is a remainder term, it may be necessary to kaizen the process and reduce the work content. Other possibilities include moving operations to the supplying process to balance the line.

**Why is important using One-Piece Flow in production?**

The following illustration shows the impact of batch size reduction when comparing batch-and-queue and one-piece flow.

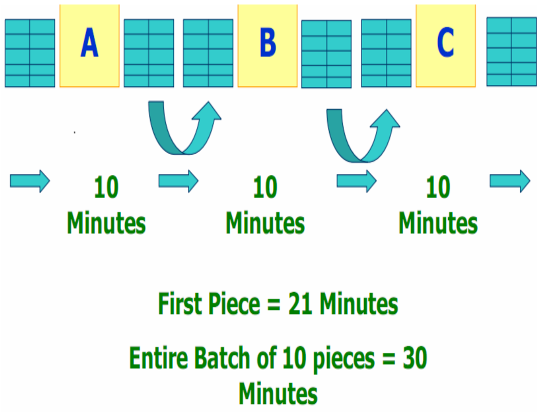


***Fig. 3** Batch and queue flow*

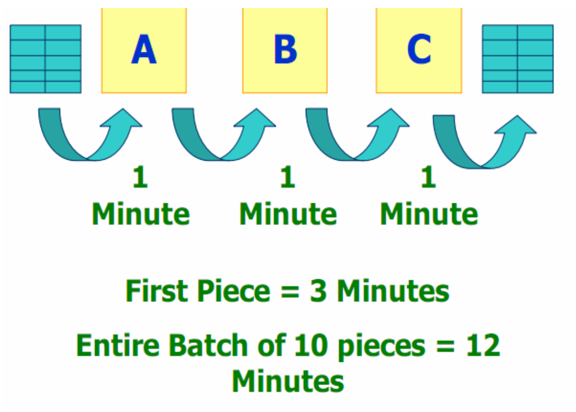


***Fig. 4** One-piece flow*

How we can see differences between these both flow systems is very enormous. One-piece flow system saved 18 minutes for to same batch of 10 pieces. With this system can be produced rather 3 times more as batch and queue system. Next, first piece was in processes only 3 minutes. Does it mean that system or operator can check part immediately in every process (A, B and C). Batch and queue system allowed produce many parts after every process. If will be occurred failure in the system than will be detected too late and many parts will be damaged. On the next table I want to you introduce next differences and advantages of one-piece flow system.

DIFFERENCES AND ADVANTAGES OF ONE-PIECE FLOW Table 1

| Impacts | One Piece Flow | Queue and Batch |
|---|---|---|
| Operations staff | Work as a team in a system.<br>Respond immediately to errors picked up by downstream colleagues.<br>High morale. | Work to own team's service level.<br>Tend not to proactively collaborate with other teams.<br>Do not see impact of their errors. |
| Staff productivity | Superior - each part of the system pulls work to them and avoids backlogs being created.<br>High visibility to staff too busy or idle. | Hostage to build up of backlog when demand or supply factors change.<br>Large amounts of non value added work. |
| Leadership time and effort | Team takes ownership of work and sticks to agreed rules of working.<br>Any issues affecting system performance are immediately obvious. | Constant supervision of 100% of staff.<br>Distracted by dealing with escalations, hidden in the backlog. |
| Customers | Cycle time is very quick and predictable.<br>Errors picked up early and adjustments made. | Cycle time is too long or too variable.<br>Errors are slow to fix. |
| Business Partners, e.g. sales, IT | Respond immediately to rework caused up by sales and feedback provided.<br>No need to escalate as cycle time short. | Major cause of rework.<br>Constantly seeking to escalate deals-in-progress. |

## Research contribution

The authors described in this research theoretical and practical knowledge about one-piece flow system. Results from this research give an impulse for next working out about continues process improvement in manufacturing companies. In the present all companies solving impact of the global crisis and try to reducing costs. On the table above are described basic advantages of one-piece flow and how can be increase efficiency of production system at companies.

## Conclusion

So far this paper has focused on explaining of another sight of production flow. One-piece flow is one of the key concepts within lean manufacturing; in most cases, a piece of a value stream can be transformed into a one-piece flow operation. While one-piece flow is not always achievable for an entire door-to-door value stream, manufacturers must continually improve their processes in an attempt to get closer and closer to true one-piece flow. This will reduce inventory levels, reduce manufacturing lead time, and improve customer service levels.

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