

Increasing Assembly Line Flexibility with Automatic Guided Carts

A Historical Look at the Conventional Conveyor Assembly Line.

In 1919, Jervis B. Webb, a young engineering graduate from Detroit, adapted a forged rivetless chain conveyor used in the mining industry to the rugged needs of the automotive industry, allowing automobiles to efficiently move on an assembly line. Henry Ford quickly recognized the possibilities that existed with this innovative technology and installed 30 miles of Webb conveyor systems in his plants. As a result, this single invention helped revolutionize mass production.

Today, nearly 90 years later, assembly lines are the backbone for manufacturing and production plants all over the world. They're the conventional choice for increasing productivity and reducing costs. The balancing act of assigning tasks to workstations, however, has been a problem for assembly lines for many years. Because each task may require a different amount of time, the time spent at each workstation is rarely equal. This leads to idle time at workstations. One of the objectives of assembly line balancing is to minimize this idle time. A secondary objective is balancing workloads across workstations so that no workstation has excessively high or low workloads.

The assignment of tasks to workstations is done to ensure that the assembly line can meet the demand rate. Thus, each workstation is given a fixed amount of time to complete its task. Depending on the demand rate and task times, it may be necessary to duplicate one or more workstations. When the demand is high enough, it is not uncommon to duplicate the entire assembly line. This shortens the assembly line, but may require more equipment and tooling. Also, because each workstation has a larger amount of time to complete its tasks, more tasks can be assigned to the station, thereby, enriching the work content. Also, if equipment problems occur at a station, other lines can continue to run. A single serial line would have to be shut down whenever there was a failure at any workstation.

While the assembly line balancing problem is typically solved after the assembly process has been designed, it is a good practice to revisit the assembly process to redesign tasks and remove any problem areas. A bottleneck station could be avoided by redesigning some of the tasks and their associated tooling.

Paced and Unpaced Lines

Since the task times allotted to workstations may be unequal, parts are produced at different speeds on the line. Accordingly, stations may either be starved or a queue may build up in front of a station. To regulate the flow of parts, assembly lines are often paced. In a paced line, each workstation is given a fixed amount of time called "C." Material handling systems are designed so that after every C time unit, the system indexes, advancing the part to the next station. If a workstation finishes in less than C time units, it is idle for the remaining period. On the other hand, if the workstation is unable to complete the assigned tasks in C time units, the part will still be indexed forward. The incomplete part will index through the remaining workstations with little or no work being done at the stations. To ensure that this does not happen, it is common to provide some "slack time" at each workstation to reduce the chance of incomplete work. These slack times are more important during the earlier stages. Typically, if a part does not get completed on the assembly line, it is taken offline to a repair and

rework area for completion. It is not unusual for a queue of repaired parts to be kept available to feed the line whenever an empty slot develops on the line.

If there is too much variability in the task times, it is preferable to have un-paced or asynchronous lines. In such lines, each station works at its own pace and advances the part to the next station whenever it completes the assigned tasks.

Mixed Models

The demand for a single product is often not sufficient to justify an independent assembly line. In such cases, it is common to design mixed model assembly lines. Typically, the products being made on the assembly line tend to have very similar tasks and precedent diagrams. One may design a single line for the assembly of a product that has several different options. In designing such lines, different models are appropriately sequenced on the line to ensure a smooth work flow.

Indexing vs. Fixed-Speed Operations

Theoretically, a fixed-speed assembly line will produce a set number of units for a given period of time at a given speed. Therefore, the model complexity required to work and support the line allows for little human error and no interruptions. In other words, everything must be almost perfect to make throughput. Workers must constantly adapt dexterous skills to the work unit as they try to keep pace with the line.

Indexing units over identical work zone distances allows time for the worker to pick parts and/or perform other duties during the index cycle. High speed index travel minimizes lost time and, in most cases, is equal to walk-back time on fixed-speed lines. Indexing allows permissive safety interlocks to assure workers and tools are returned to a safe position before index travel.

Experience has proven real throughput is the same or improved on the indexing line due to stable work position, support, environment, reduced worker stress and fatigue, as well as system control over the events at each individual workstation.

The Dilemma Facing Conventional Conveyor Assembly Lines

While the assembly line provides undeniable benefits, three challenges can't be ignored. First, scalability is an issue because assembly lines are typically designed for the maximum potential production rate up front. Second, installation generally takes many weeks or months to complete. Third, modifications are typically very expensive and also take many weeks or months to complete – not including potential building modifications.

Automatic Guided Carts: The Flexible Assembly Line Solution

The SmartCart® Automatic Guided Cart (AGC™) is a flexible and cost-effective material handling solution

from Jervis B. Webb Company, a subsidiary of Daifuku Co., Ltd., which is ideal for moving products on an assembly line.

What makes SmartCart AGCs so flexible and cost-efficient? SmartCart AGCs are guided by magnetic tape, allowing for quick installation or modification of the guidepath in as little as a few hours. In addition, SmartCart has numerous load handling options to meet specific needs. Over time, the load handling carrier can be replaced to accommodate different products, protecting the initial investment.

The Modern Approach To Increasing Productivity And Reducing Costs

A prime area for cost savings in manufacturing plants is through in-process inventory reduction. Simply by adding or removing SmartCart AGCs from the line, assembly production rates can be increased or decreased on demand. This is a substantial benefit over conventional conveyor methods, which require the assembly line to be designed and installed up front for the maximum potential production rate. And, because of their flexibility, SmartCart AGCs are an excellent choice for companies adhering to continuous improvement initiatives.

SmartCart AGC provides the assembly line designer with a variety of problem-solving tools, such as:

- conforming layout to existing physical geometry, which is not limited to straight line operation
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- providing workstation configuration and spacing to flow around columns and other fixed installations
- allowing parallel workstations in number or physical relationship to serial workstations
- dedicating mixed-model workstations to single or multiple product assembly tasks
- accomplishing continuous improvement adjustments during breaks, off shifts and weekends
- indexing synchronous or non-synchronous systems based on take time and/or permissive input signals
- optimizing throughput for pre-set speeds between main line operating speeds
- reducing operator fatigue and stress with fixed workstation locations that allows operators to perform intermittent duties during AGC index
- providing individual workstation safety and ergonomics
- increasing reliability because AGCs are not subject to main line prime-mover failure.

optimum balance among all workstations. SmartCart AGC technology provides this flexibility while allowing organizational input to become operational reality with the least amount of downtime and disruption – making SmartCart the newest innovation to help revolutionize the assembly line.

Recap: SmartCart AGC Strengths vs. Conventional Conveyor Assembly Lines

- **Scalable Material Handling:** SmartCart allows you to increase throughput by simply adding AGCs.
- **Easy Installation:** SmartCarts can be installed in as little as a few hours; conveyor system installations can take weeks or months to complete.
- **Easy Modification:** Changes to the SmartCart guidepath can be made in as little as a few hours, while conveyor system modifications can be very costly and take weeks or months to complete.
- **No building modifications** are required with SmartCarts.

SmartCart AGCs: The Ideal Assembly Line

The ideal assembly line is meant to be very flexible in nature – contracting or expanding by deleting or adding individual workstations to suit the ever-changing work and product requirements, while also maintaining