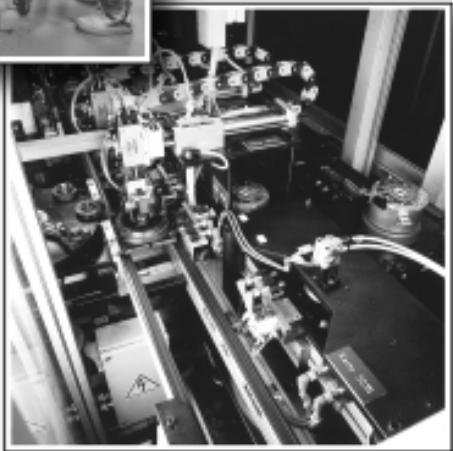


How to Optimize Your Assembly Operations

Designing an assembly system to fit the manufacturing process



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The flexibility of your assembly operation can make the difference in your manufacturing profit

It's tough to make a buck in manufacturing today. Rapid change is driving the way products are made and even the products themselves. Products are increasingly complex and require more assembly steps. But the biggest pressure comes from time, because while product variations expand, product life cycles contract (see Figure 1). The challenge is to get better products to market faster, while maintaining profit margins and lowering manufacturing costs. To do this, most manufacturers are staying flexible.

Today's manufacturing operations present both opportunity and challenge for improvement.

To stay ahead of the pack, manufacturers must seize every opportunity to increase productivity and throughput, reduce costs, increase product quality and reliability, while managing change on an almost daily basis. Typically, the labor involved in producing individual components—operations such as metal cutting, forming, and machining or plastics molding and finishing—represents between 8% and 30% of total manufacturing costs. The labor involved in inspection and testing typically represents between 4% and 15%. But the labor involved with assembly can run between 50% and 75% of total manufacturing costs (see Figure 2). This is clearly where the largest manufacturing cost savings can be achieved.

While assembly operations may offer the greatest potential for increasing efficiency, they can also pose several challenges. These include:

- Reducing work-in-process (WIP) inventory (the number of piece parts and materials waiting idly for value-added assembly operations to be carried out).
- Controlling product quality: test and inspection generally take place after all assembly operations have been completed. Rejected assemblies needing rework increase WIP and cancel previous value-added gains.
- Managing rapid growth: for example, when customer demand is outstripping current capacity and/or the product mix is proliferating.

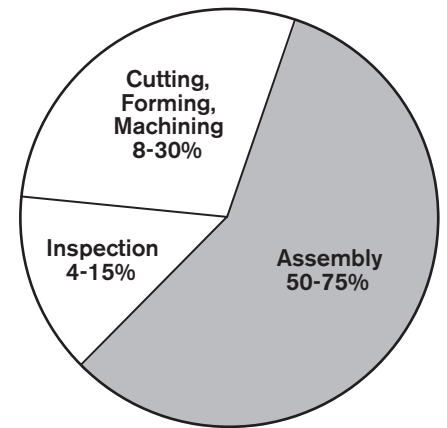
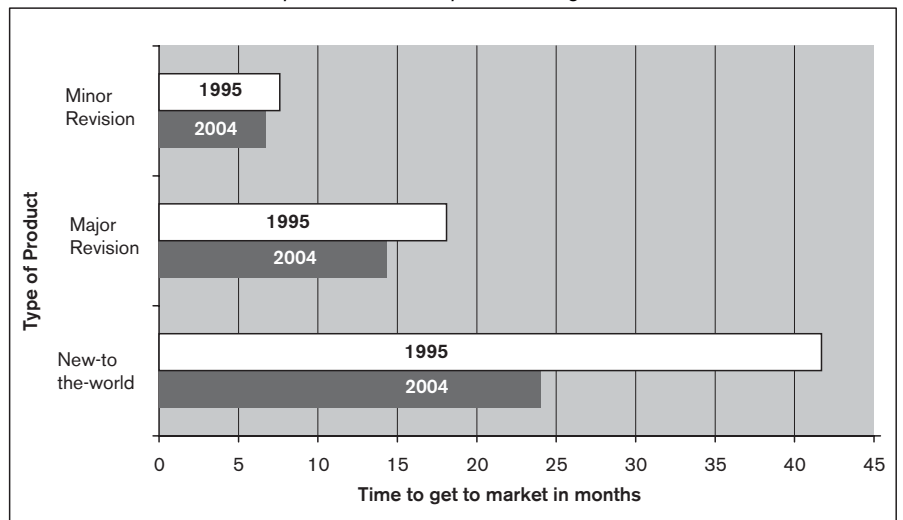


Figure 2: Production Labor
Biggest manufacturing efficiency gains can come from assembly tasks

Figure 1
Product Development Time Keeps Shrinking for U.S. Marketers*



*Source: Product Development and Management Association

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While agile and lean may be the ultimate goal for assembly operations, achieving that goal is seldom simple.

There are numerous variables involved in designing the best assembly methods to move products through a manufacturing operation. The more complex the product, the more extensive the product mix—the more difficult the task. Shorter product life cycles also complicate the situation. As product mix or volume increases, traditional material handling methods (i.e., the use of plywood pallets and/or roller conveyor for staging and transferring WIP) may prove inadequate or counter-productive. Adding more of the same is clearly not a long-term solution.

Additional common assembly challenges include:

- Numerous parts, components, and/or subassemblies
- Assembly operations requiring precise, repeatable positioning
- Special environmental provisions such as clean rooms, ESD (electrostatic discharge) protection, temperature control, etc.
- Operations to accommodate model variations with differing lot sizes
- Products requiring up to 100% inspection

Companies successfully managing the demands of continued, profitable growth have recognized the need for a mechanized solution, i.e., conveyor systems designed specifically for assembly flexibility. Often, the best product assembly strategy requires the right mix

of automated and manual operations and the ability to adjust that mix as necessary. Flexible assembly conveyors, seamlessly integrated into the assembly processes they support, provide the best solution for today's complex assembly conditions.



Old-fashioned assembly methods, like this, are both labor intensive and inefficient.

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Assembly conveyor systems are generally classified into two basic types, each with distinct characteristics:

- *Synchronous conveyor systems* utilize indexed movement of parts from station to station, along a fixed path and at a fixed cycle rate. Examples include rotary dial machines and cam-operated, in-line machines. Short cycle rates, standardized production, and a high level of automation are features of the synchronous system. But synchronous systems also have their shortcomings. System throughput, for example, must be geared to the slowest operation on the assembly line. And there is no provision for cycle independence; all parts of the production line move in "lock step."
- *Non-synchronous conveyor systems* provide independent movement of parts from station to station on an as needed basis, as they become ready for the next operation. Work can be routed independently along a flexible path providing the option of batch manufacturing or custom processing all on the same line. Non-synchronous systems can accommodate the full range of product sizes and weights. Moreover, there are virtually no limitations on the number or complexity of assembly steps with non-synchronous systems. Manual tasks can be readily integrated with automated operations because the system allows for varying station cycle rate. In addition, you can easily add buffers as needed to balance assembly line work flow.

Conveyor systems play an increasingly important role in today's production operations. As production levels increase, for example, a company might consider converting from batch to sequential assembly operations or incorporating automated workstations into existing sequential manual lines. The challenge will often include the upgrade of an existing facility (retrofit) rather than creation of an entirely new one.

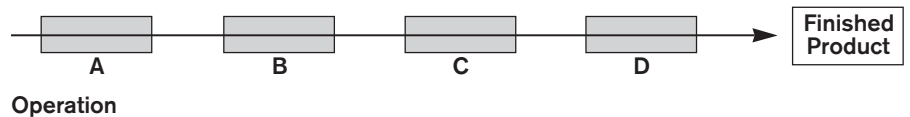


Figure 3A: Synchronous

The fixed path, synchronous system does not provide for cycle independence. Throughput depends on the slowest operation on the assembly line.

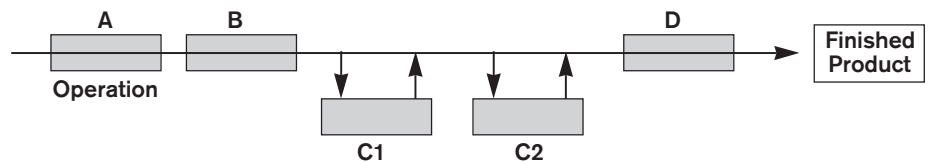


Figure 3B: Non-synchronous

Non-synchronous assembly allows buffering in slower task work areas, while maintaining continuous flow on the main production line.

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For increasing numbers of manufacturers, the use of non-synchronous, pallet-based modular conveyors is an ideal solution to their assembly system requirements. Non-synchronous assembly conveyors typically incorporate a continuously moving belt or chain with pallets and pallet components, which move with the conveyor unless held by a stop. Modular conveyor components and accessories ease assembly and future reconfiguration or expansion as conditions warrant.

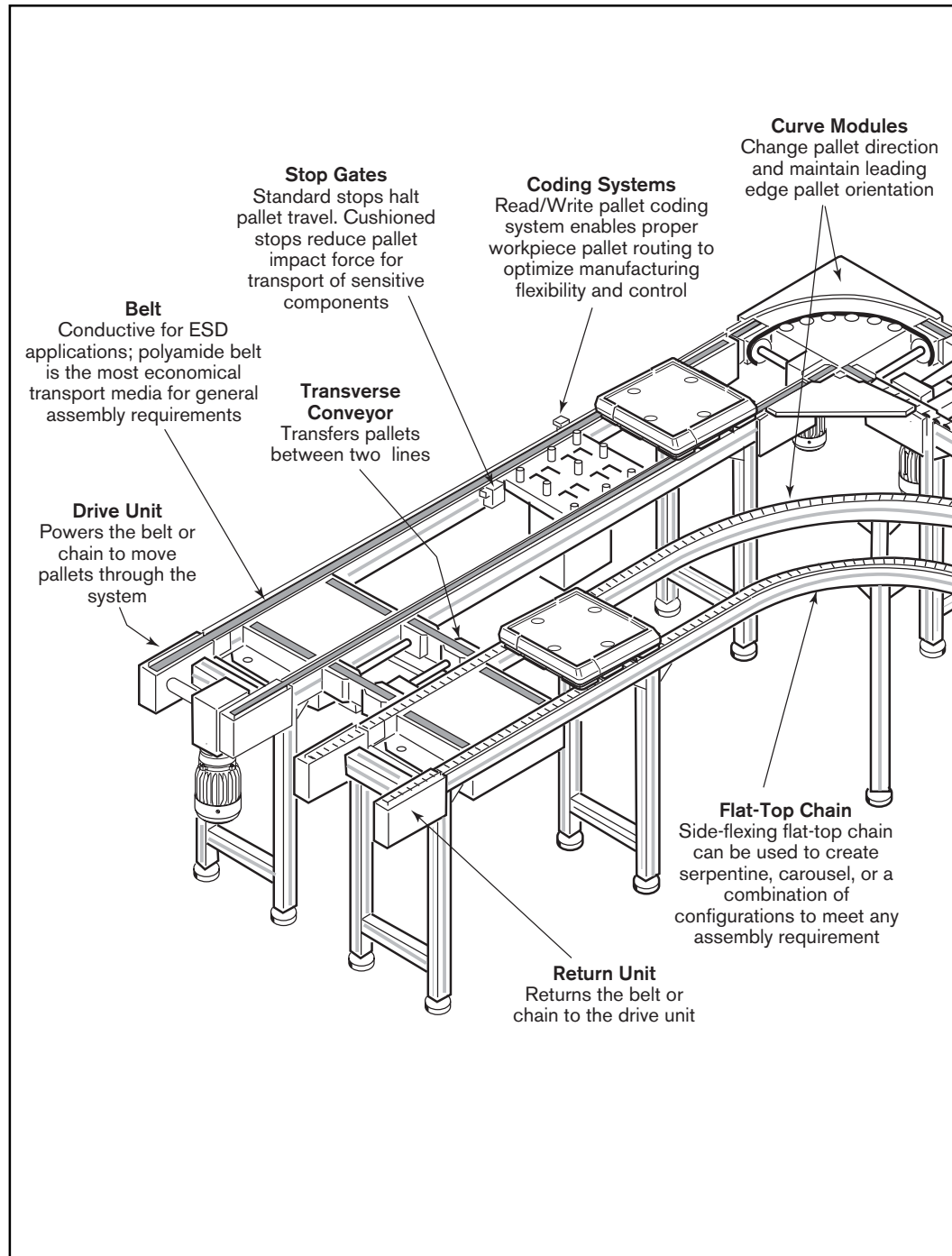
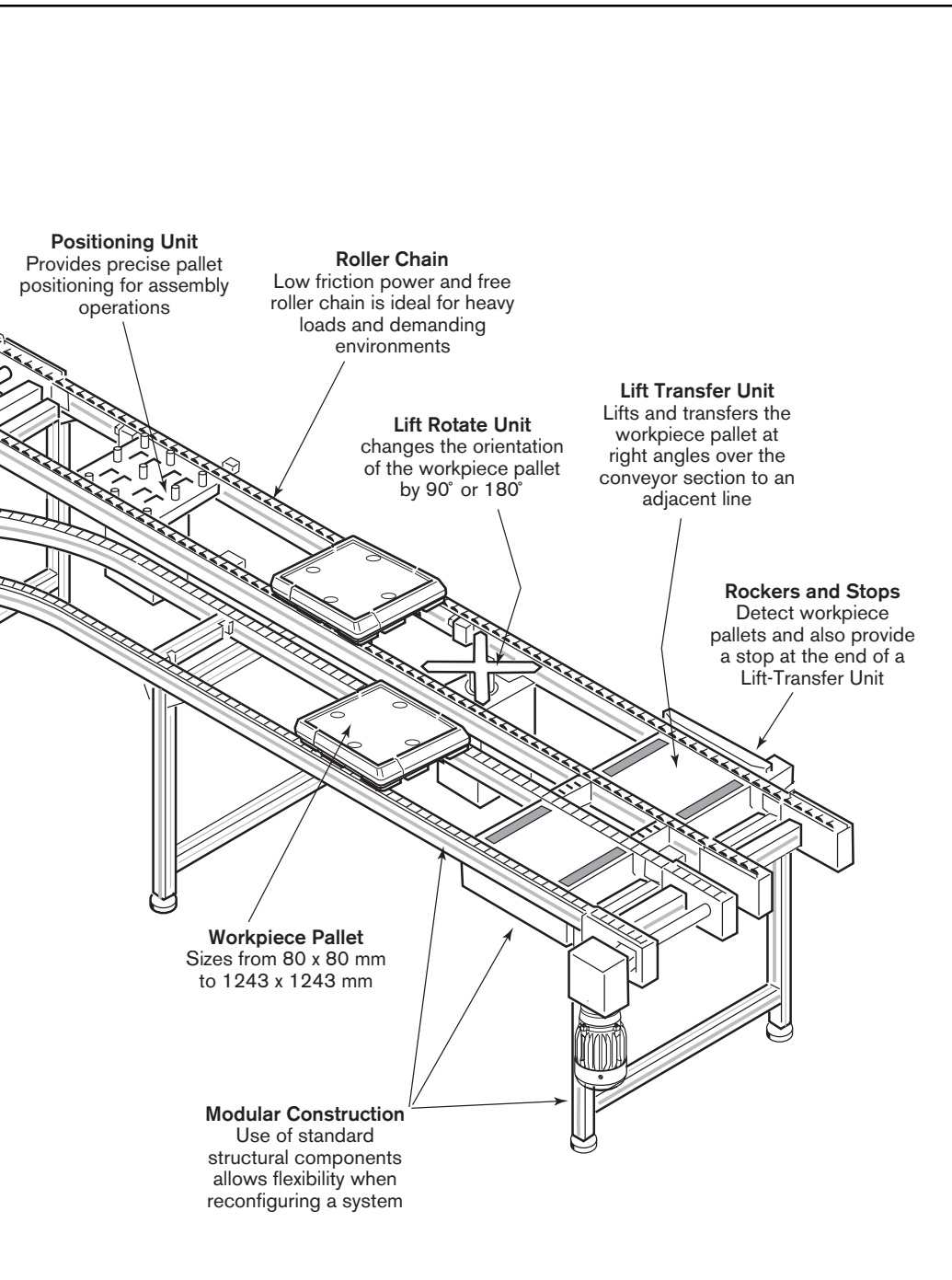


Figure 4: A typical non-synchronous, pallet-based conveyor system is made up of modular components

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When to consider pallet-based modular conveyors

While some product assembly operations may not call for a non-synchronous, pallet-based modular conveyor system, it could be the ideal solution when:

- Multiple product models result in frequent and time-consuming production changeovers.
- Changes to product design and corresponding assembly operations are frequent.
- Product delivery lead-times are shrinking.
- Introducing automated assembly operations is essential to improve productivity.
- Material flow paths must be reconfigured.
- Precision assembly tasks are required.
- Line balancing is a crucial element of production efficiency.
- Space is at a premium.

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The benefits of modularity mesh with today's assembly environment.

Based on a "building block" concept, modular, non-synchronous conveyor systems provide an unmatched level of flexibility because the conveyor components can be quickly configured to provide required functional characteristics. They can be reconfigured when production requirements change, and their availability as off-the-shelf modules can dramatically speed project implementation. System payback (ROI) is another advantage for using non-synchronous systems. Compared to heavily automated systems, payback on a flexible assembly conveyor occurs sooner because:

- Start-up costs are lower
- There is a shorter debug time
- Reuse reduces later capital investments

The flexibility of modular, non-synchronous, pallet-based conveyor systems provides a long list of benefits that mesh with today's assembly environment. These include:

1. **Phased implementation** - Stand-alone assembly tasks, for example, can be moved on-line to increase productivity; later, manual stations can be replaced with automated stations, as required. See Figure 5.
2. **Integration of automated processes** - Many factors drive the need to introduce, or increase the level of automated processes to the assembly function. These include incorporation of new manufacturing technology, changes in product design, an increase in product mix, the need to

lower unit costs, or any combination of these. Using conveyor modules, the task of integrating automated processes such as screw driving, ultrasonic welding, or testing into what may have been completely manual assembly operations can readily be accomplished.

3. **Line balance flexibility** - Balancing work load is a primary goal for assembly operations. Without the flexibility to respond effectively to changing production requirements, the ability to maintain optimal line balance may be seriously compromised. However, the line routing flexibility of modular systems allows parallel spurs to be added for balancing of cycle rates between slow and fast workstation tasks or the routing of reject parts off-line and reworked parts back on-line.

4. **Integration of test functions** - As assembly operations become both more complex and efficient, test and/or inspection functions are being incorporated as an integral part of the process. Retrofitting these functions into an existing system may pose insurmountable obstacles unless the system is modular and affords the flexibility of reconfiguration.

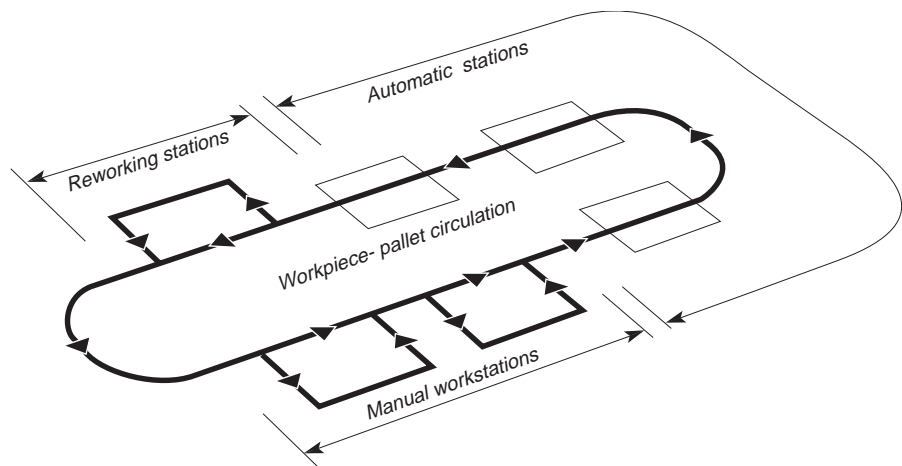


Figure 5: Line balance

Balancing using automated/manual operations on the same assembly line.

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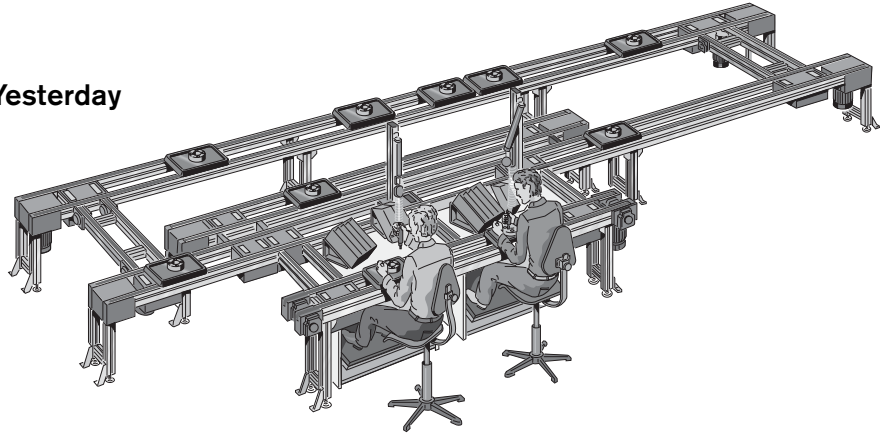
5. Implementation of process control(s) - The ability to fit pallets with read/write devices permits each workpiece pallet to be uniquely identified. This in turn, allows the control system to track the status and control the movement of units through automated workstations and provides a way of collecting data for statistical process control (SPC). Such a process control system allows for two or more models of a product to be assembled on the same line and provides for product rework as necessary.

6. Material flow options - Material flow through an assembly facility can be affected by changes in any facet of the assembly operations. These can include the replacement of manual workstations with automated workstations, a product design change that requires a modification to assembly procedures, or the introduction of new models. An existing modular conveyor line can easily allow material flow patterns to be modified or reconfigured. See Figure 6.

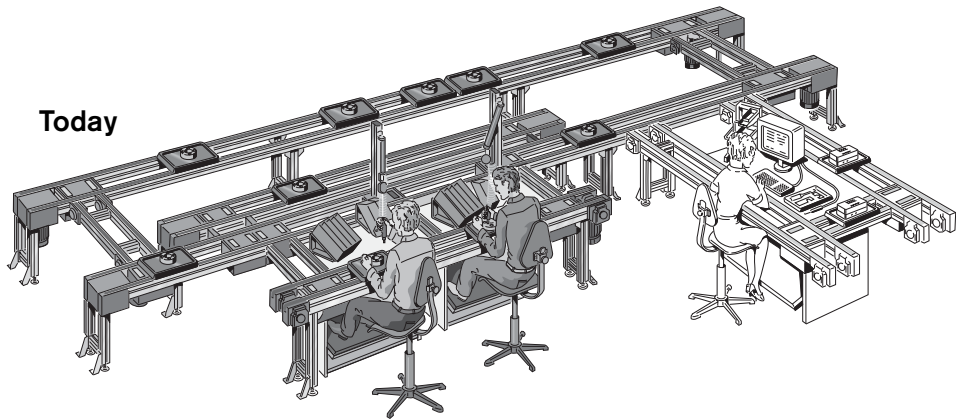
Figure 6:

Install a system that expands with your needs

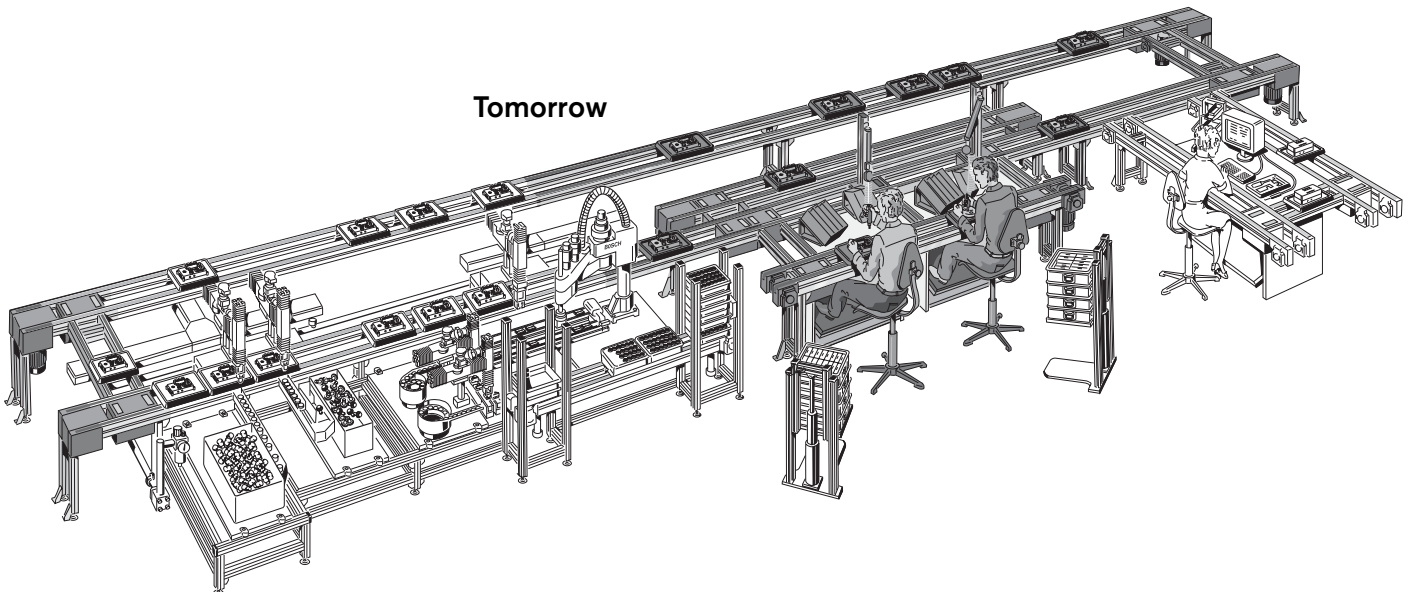
Yesterday



Today



Tomorrow



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7. Reduced WIP - Reducing the level of WIP can have a major impact on lowering assembly costs. Non-synchronous, pallet-based conveyor systems, by their very nature, focus on keeping work moving, not piled in stacks on the production floor. Thus, a transition from batch to progressive, sequential assembly can pave the way to reduced in-process inventories necessary for Just-In-Time (JIT) manufacturing operations.

8. Improved ergonomics - There is growing evidence that sound ergonomics goes hand-in-hand with improved productivity. The pallet positioning and orientation modules available with these modular conveyor systems are designed to reduce wasted motion and fatigue of a worker by presenting the workpiece properly positioned for the required assembly task. Moreover, compared with alternative systems such as a roller conveyor, these modular assembly conveyors are basically quiet in operation. Low ambient noise level is another important element in the overall ergonomic scenario.

9. Reduced footprint - The variety of conveyor types and modules are geared for system designs that conserve space and accommodate a wide range of production requirements. Modular construction permits complete freedom in system configurations, including rectangular, carousel, serpentine, over/under, parallel, and in-line (see Figure 7). The ability to run multiple product modules on a single line provides another significant opportunity to conserve space.

10. Reusability - Like the ability to reconfigure lines, reusability is an important consideration in an assembly system investment. Not only do assembly operations change, but entire manufacturing facilities might be moved from one site to another. The fact that assembly conveyor modules can be “packed up and moved” is a significant factor in reducing their life-cycle costs.

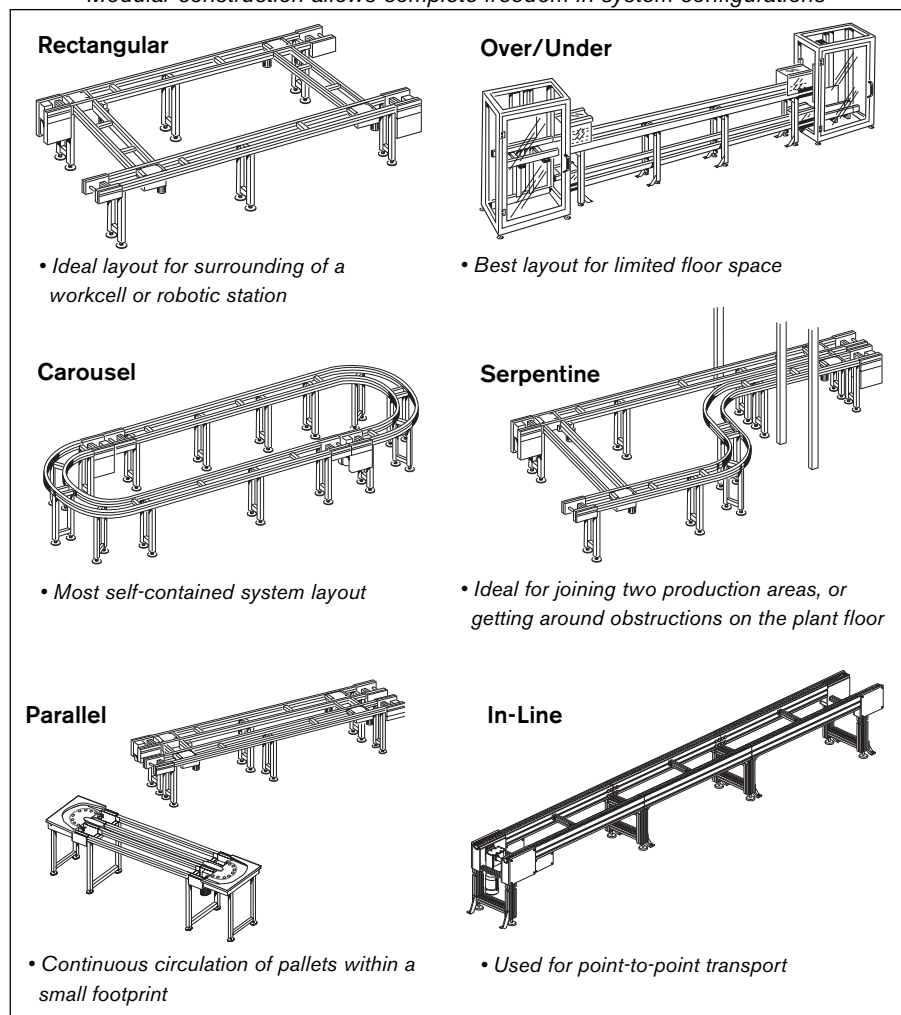
For more information about optimizing assembly operations, write or call:

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Figure 7:

Modular construction allows complete freedom in system configurations



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Bosch Rexroth - The World Brand Leader in Flexible Assembly Conveyor Systems

Bosch Rexroth provides the modules that make up these flexible assembly conveyor systems. They are pre-engineered and have established an extensive track record in the field with well-documented performance capabilities by thousands of companies worldwide. This proven performance leads to a high probability of successful system performance. Bosch Rexroth includes extensive product documentation to simplify both start-up and maintenance operations. And when it comes to repair, the modular, standardized design of all Rexroth components means they can be shipped quickly for replacement, resulting in minimum downtime.

System design and support is yet another benefit that Bosch Rexroth provides. Our skilled applications engineers will work with you or your current machine-building resource to evaluate your specific needs and provide the technical support necessary to ensure successful implementation. Or if you prefer, we'll put you in touch with an experienced systems integrator who can help you find a turnkey solution using Bosch Rexroth components.

Why wait? Put the Bosch Rexroth advantages of improved productivity, better product quality and cost reduction to work in your manufacturing operation now.

Call 1-800-322-6724 and we'll get you started.

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