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The Problem Child in Automation

Exposing the Myth that Assembly Process Automation Cannot be as Agile and as Efficient as an Injection Molding Machine **(Part 1)**

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The case for pre-engineered automation systems

Over approximately the last 30 years, the evolution of automated systems implemented to enable advanced manufacturing has led to the proliferation of the pre-engineered, automated work cells. In turn, this has enabled significant growth in the global deployment of automated systems throughout all facets of global manufacturing where virtually any redundant task is automated. In general, the buyer's incentive to adopt a pre-engineered system beyond capacity and quality is one of, or a combination of, the following:

- The lowest total cost of ownership
- Machine utilization per square meter of factory space
- Shorter build and delivery lead times
- Decreased technical risk by acquiring equipment with a proven performance track record
- Capability of re-deploying the automation to produce multiple or different product types

Automating redundant tasks utilizing pre-engineered automated systems has been very successful across a myriad of manufacturing processes. Examples include machining, injection molding, labeling, packaging, case packing and palletizing. But what is it about these examples that makes them candidates for pre-engineered automation? And why aren't there assembly-related examples?

4 Characteristics of Pre-Engineered Automation Systems

There are many processes that lend themselves to pre-engineered automation solutions. The trick is in understanding the characteristics of these processes that make them viable candidates. So, let's take a closer look at 4 of these characteristics.

Firstly, pre-engineered solutions are generally focused on common processes – cutting, molding, filling, weighing, labeling, bonding. These processes are associated with many products in many different industries. As a result, there is strong supplier motivation to develop solutions that can be deployed broadly with the highest profit. Unique or individualized processes require engineering design effort and are therefore not suitable to pre-engineered solutions.

Secondly, pre-engineered solutions tend to be associated with a single value-added process. For example, CNC machines are dedicated to cutting metal. A labeler is dedicated to the application of label to product. A single focus makes it easier to design a standard solution that can be used over and over again. A process that is clearly defined and understood can have a standardized solution including hardware and software.

Thirdly, pre-engineered solutions generally have a single input brought to a single-entry point. Consider the injection molding example in which plastic resin is supplied to the injection unit on the molding equipment. Or the cartoner example, in which a product is supplied to the carton loading area of the cartoner. Any pre-entry processes are not considered within the boundaries of the pre-engineered system – it is assumed that the requisite input will be present at the right location and in the right format. These pre-entry processes may be pre-engineered solutions in and of themselves, but they are independent.

And lastly, the pre-engineered solution is designed to be redeployabe, i.e. to accommodate entirely different products by virtue of a couple of engineering techniques.

- Interchangeable hardware – The majority of the pre-engineered solution never change, but through the adoption of interchangeable hardware, or enabling certain functionality, customization can be made to achieve different form factors. Revisiting the CNC machine example, cutting tools and fixtures can be changed to create different parts. Cartoners are generally designed to handle a range of size and shape of cartons; and while the base machine remains the same, there is a catalogue of standard options to address glue flap vs tuck flap, or single load vs dual load, etc.
- Recipe-driven software – I like to think of control software as having two parts: the behind the scenes or “under the hood” part, and the user interface part. In the case of pre-engineered solutions, the ‘under the hood’ part remains the same for all products produced on the system. The user interface part allows you to adjust what happens within the system specific to your product. For example, the dispense time, pressure, temperature, etc. can all be changed to deliver a different amount of glue, but still utilize the same gluing system. Similarly, the load pattern for a pallet can be changed on a palletizer in order to accommodate cases of different sizes and weights.

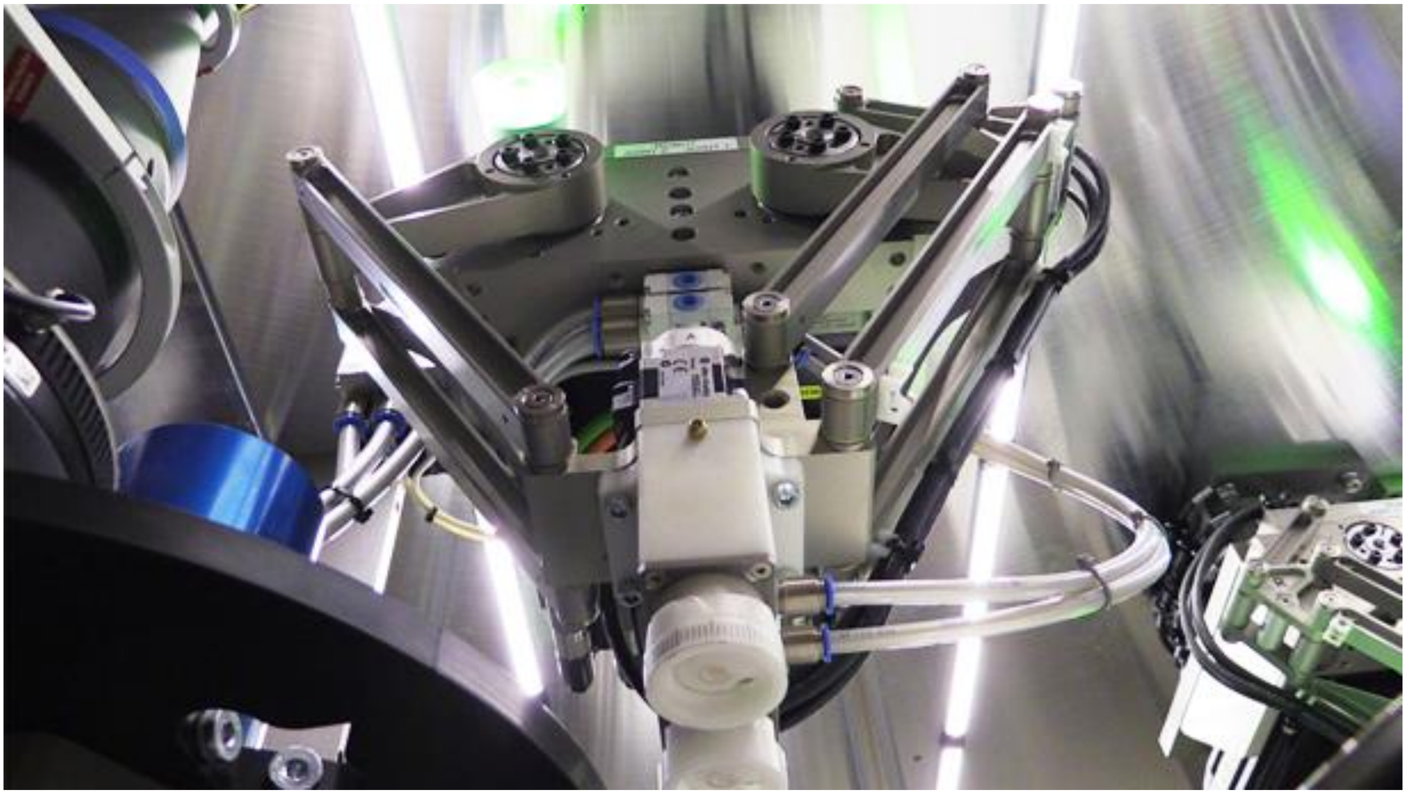
The Problem Child: Assembly Automation

There remains one elusive manufacturing area that the pre-engineered automation solution has not been able to penetrate – assembly automation. Considering the previous discussion, it is easy to understand why. We are not talking about a single value-add process or a single input and single-entry point. Yes, the assembly processes associated with the product may be commonly understood, but the way in which they are applied is usually specific to the product and complicated by the nature and number of parts that are being assembled.

Assembly applications also have some unique characteristics that at first glance do not appear to make them candidates for pre-engineered solutions. These include production rate, controls logic, and process order of operations.

The vast majority of automated assembly systems become bespoke or custom-built and are viable only at higher production rates. The financial justification is based on the tradeoff between the cost of labor and capital investment. The pre-engineered automated system may be successful for lower run rates, but success is less sure as the throughput requirements increase. The richer these pre-engineered systems are in terms of flexibility, the slower they tend to be in terms of output rate. This is because their versatility typically derives from their incorporation of standard, general-purpose robots interacting with part-carrying pallets ideally suited for less demanding output.

These devices not only have speed limitations of their own but are invariably controlled in a way that amplifies inefficiency and restricts throughput.



A robot packaged in a pre-engineered cell is powerful and flexible. But the physical features that make it flexible also tend to limit its speed. Consider first its work envelope, typically designed to be as broad as possible for maximum freedom with respect to workstation design and functionality. Unfortunately, the greater the distance the robot must cover, the more time it needs to complete its cycle. Likewise, for a robot to do a wide range of repetitive, force-bearing manufacturing operations, it must have the requisite strength and durability. But strength and durability require mass and mass comes at the expense of speed. (For the inverse situation, consider a delta style “spider” robot whose low-mass linkages allow it to move at very high speeds, but without the ability to do more than relatively “light” work.)

Closely linked to production rate is control logic. The control methodology used in conventional pre-engineered systems further restricts their throughput. Operations are invariably carried out in sequential, indexed motion, a technique that accumulates non-value-added time. Consider a pick-and-place operation, where each motion - from the pallet’s arrival in the station to the robot’s movements to and from the pallet to the pallet’s release for travel downstream - is carried out in sequence, with checks along the way to make sure a given motion doesn’t start unless and until the previous motion has been completed. The actual time involved in placing the part at its destination (that is the value-added operation) amounts to a tiny portion of the overall cycle time. The balance of the time is all non-valued-added prep work, hence the limited operational speeds.

And lastly, assembly processes change from product to product in three major ways; the types of processes, the number of processes, and the order in which the processes are executed. Pre-engineered solutions are generally not intended to execute more than one process – they are focused on a single value-add process. They do offer flexibility with respect to adding or subtracting single processes and varying order of operations as you can reconfigure each for specific solutions. You can implement change tooling like end of arm tools on robots to accommodate a different part geometry, but production rate remains the limitation. Attempting to complete more than one value-add processes with a pre-engineered solution drastically increases the processing time; flexibility and speed are inversely proportional.

Until now there has been limited success in employing pre-engineered automation solutions in an assembly environment. The challenges posed by high production rates and product-specific processes and order of operations have left the assembly buyer relying on custom automation companies and systems integrators. These systems, although reliable and repeatable, are costly and lack the flexibility and adaptability of the pre-engineered system. As products are modified or new products are launched, more custom systems are required, and the buyer is caught in a repeating cycle.

But the question is do we accept the status quo? Surely there is a method to tame the unruly child in automation and leverage the benefits of pre-engineered automation systems in the assembly world. Stay tune for our next blog on how ATS has tamed the problem child.

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