Article

Principles of Design for Automated Manufacturing

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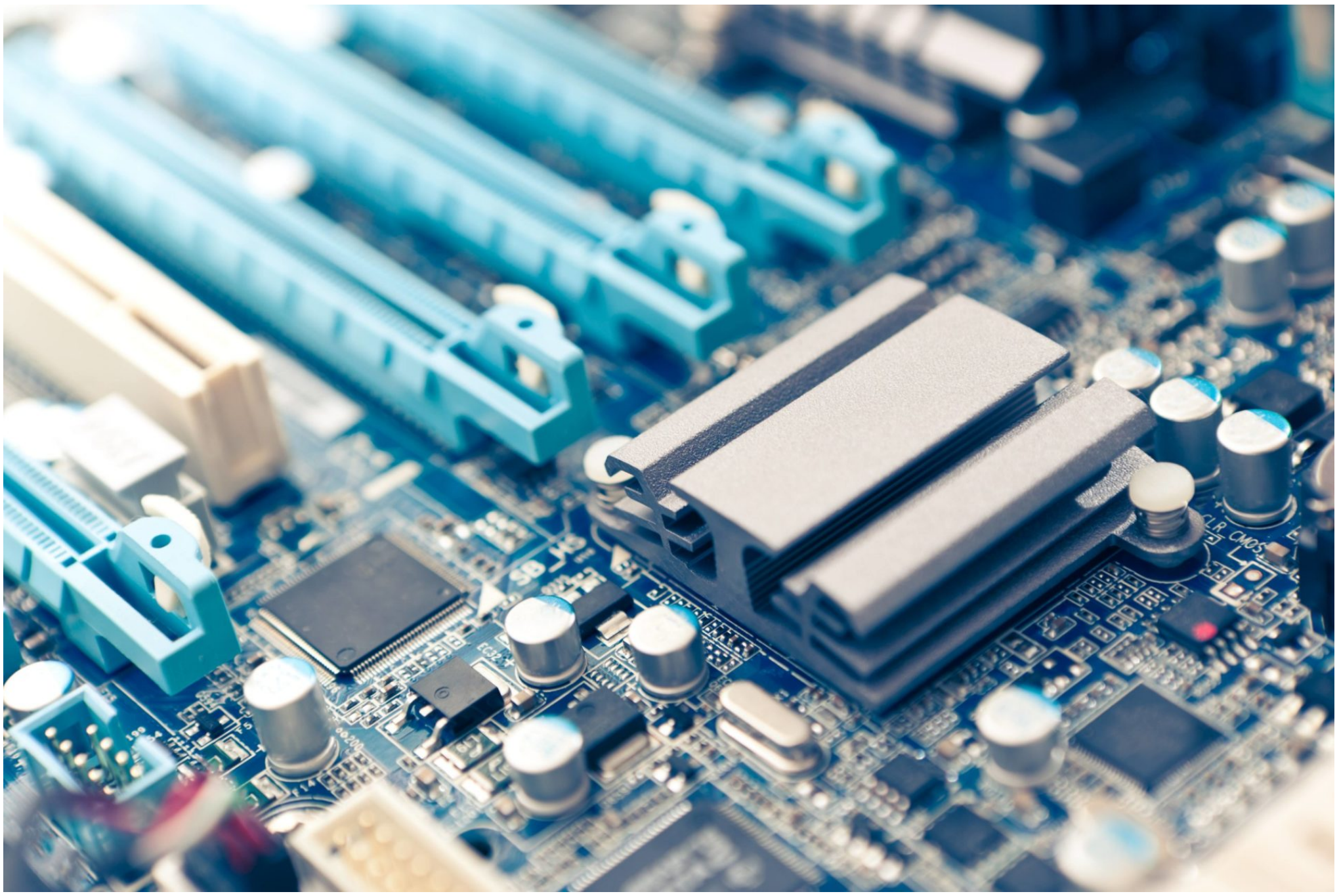
HARDWARE MANUFACTURING AUTOMATION ROBOTIC SYSTEMS INTEGRATION TEST AUTOMATION



To enable success in achieving your design for automated manufacturing (DFAM) objectives and goals, we recommend creating thoughtful business and product requirements to inform your automation design processes. If you create a product that is suited for automation, you set yourself up for success down the line during the design of the automation equipment, product assembly, and test processes once the automation is deployed in the field.

Here are a few considerations of principles worth considering.

Business and product planning

The choice to develop a product assembled by automation is not a decision to be made by engineers or product development professionals alone. Understanding the full requirements including business, marketing, and lifecycle requirements are essential components in planning for a product that has the potential for automation-based assembly.

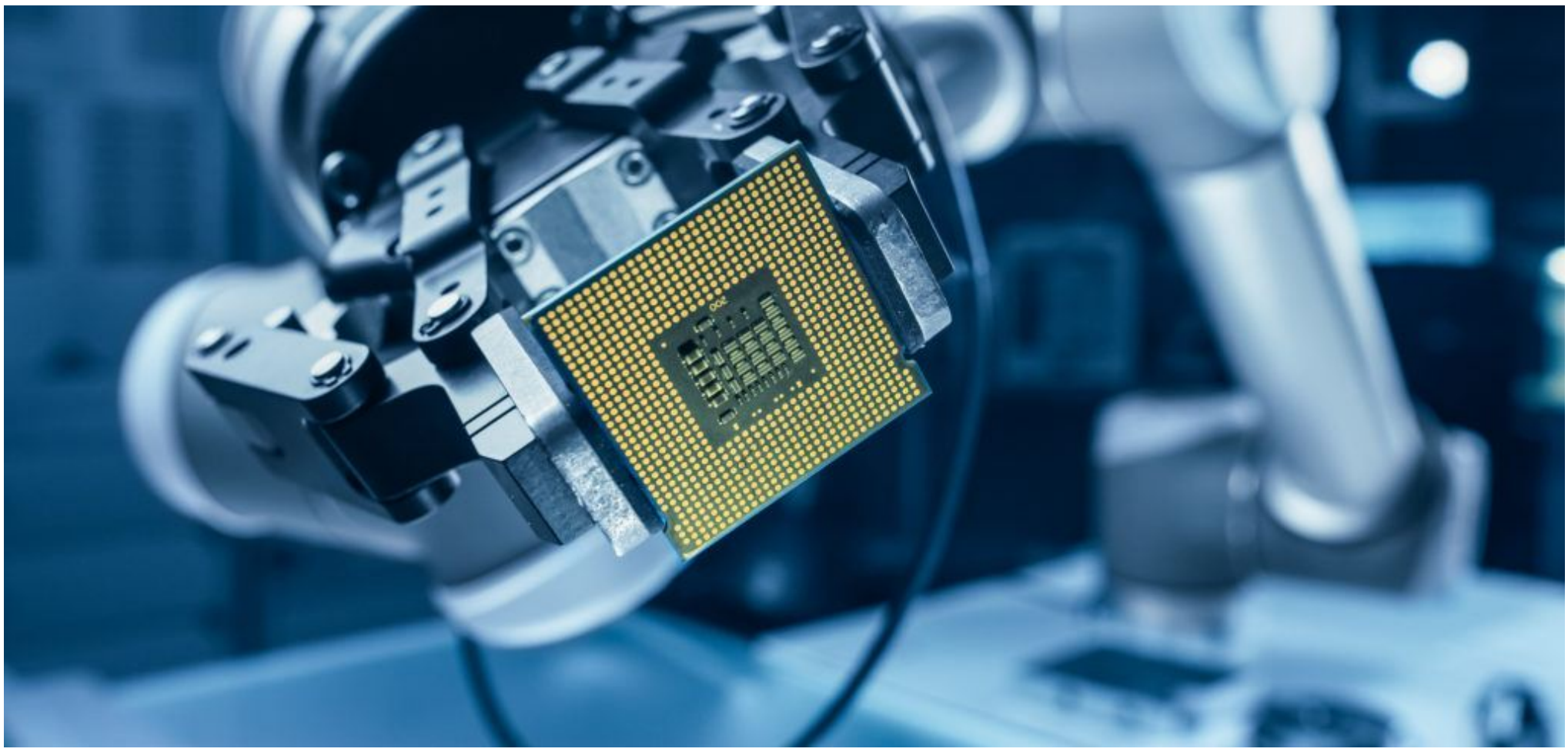
Understanding the fundamentals of your market plays a significant role in determining whether or not you should automate. Automating a new product as a startup in a new market sector without a track record and historical sales data may not be the best situation for automation. Automating a product that may require quick iterations to meet market expectations wouldn't be the best situation either. Understanding the intended life and volume of the product will be key factors in determining the ROI of any automation capital investment to be made.

Establishing KPIs and Operational Metrics

For any robotic or automated manufacturing process, you should establish a key set of performance indicators and operational metrics to enable measurement and performance of the system.

Common yield calculations, such as first-time yield, will not provide a full picture of the state and health of a given system. Overall equipment effectiveness (OEE), and the constituent OEE components, are more telling.

You may also want to consider and establish any other key metrics which are supportive of your business objectives early in the planning process. Having these metrics planned and discussed early will allow you to set expectations for the system with your team or any integration partners. These metrics are often critical in the automation development in determining when the equipment is ready to be deployed or accepted for delivery, functioning as expected, or when something just isn't working properly in normal operation.



Grippers and end of arm tooling (EOAT)

Grippers are one particular method of moving materials that are worth expanding on. A gripper can be an end of arm tool (EOAT) or end effector, which is essentially any type of device attached to a robotic arm meant to interact with a part or anything else in the environment. Like conveyance methods, there is a universe of solutions and providers that can work for nearly any situation. In manual assembly, humans are fairly good at handling and manipulating an object without causing damage or harm. Grippers which more closely mimick anthropomorphic movements are quickly developing and getting better.

A robot and simple griping solution is rather unintelligent and unsophisticated as they often lack any type of sophisticated sensing and feedback network (like a human), but can be equipped with sensors to detect object presence. Special considerations may need to be made to the part at the time of design and material selection (or specialized material handling systems need to be developed) to enable the part to be gripped, picked up, or fed in a reliable manner.

Nests, positioning, and crowding

Parts need to be designed for their intended purpose, but they also need to have secondary considerations for the automation equipment processing the part.

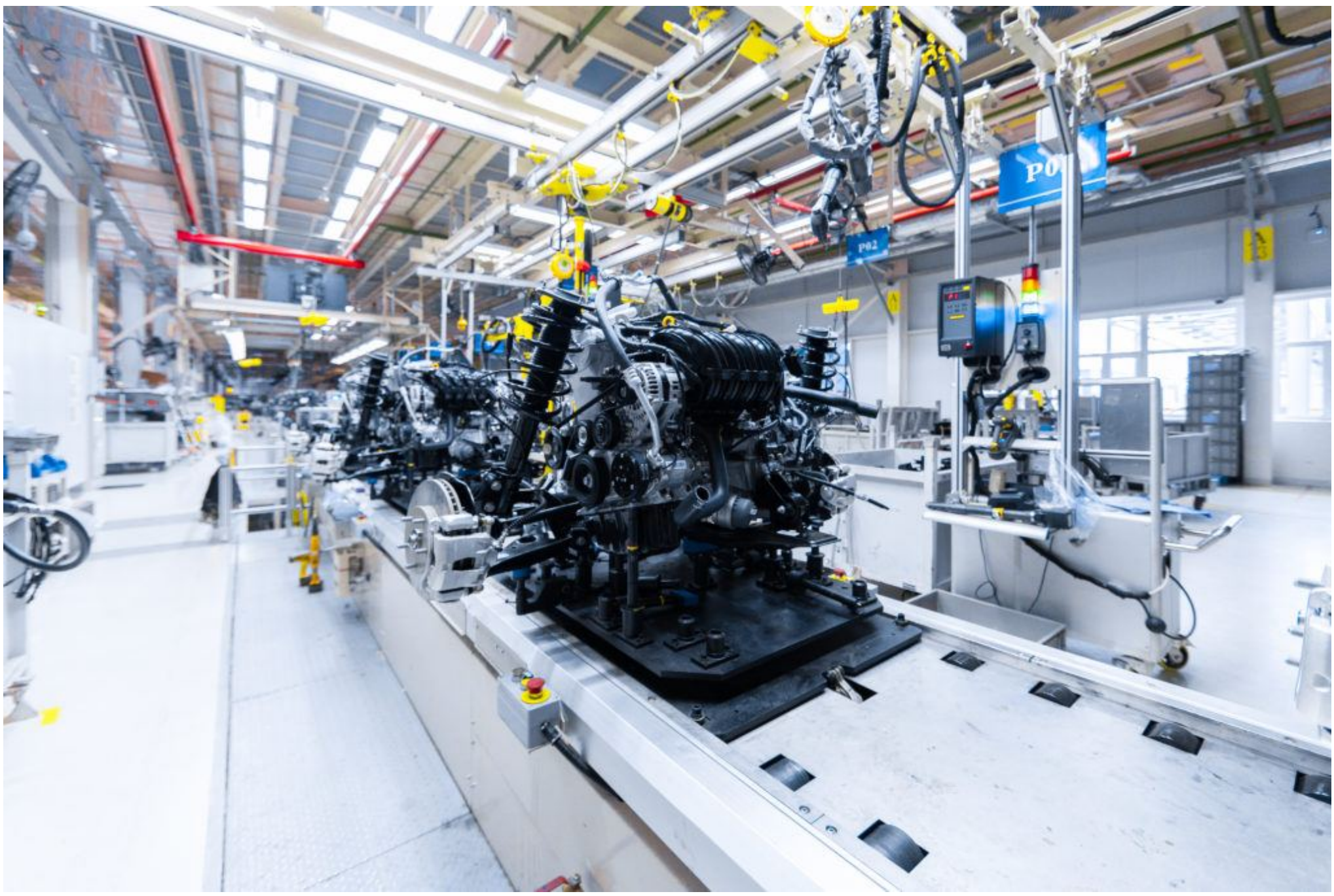
As mentioned, conveyance, gripping, and material handling are all important considerations for a part to get to where it needs to be operated on. The fixture where a part is placed or positioned is typically called a nest, which is a designed pocket or tool with the purpose of holding the part in a very specific position. The success of an automated assembly process typically is dependent on the controlled interaction or interface of two parts. With the relative physical positioning in space of parts and moving actuators, tools, grippers, end effectors or other parts being so critical, it’s necessary to reduce any tolerances or margin of error as much as possible.

the system. It's the first place to look when troubleshooting. Robots and automated systems are based on consistency and can run reliably when operating within the designed tolerances. Sources of variation, or parts falling out of the expected tolerances, are often signals that a process has shifted or variations have increased beyond the expected tolerances.

Understand the value add and product cost at each step in the process

At each step in the process, you should know the value of the materials being consumed or added, as well as the value of the increment of work being performed.

This will allow you to calculate the value of parts consumed or assemblies as they progress. The value of the assemblies increases until you have a finished, functional product. Understanding the value of all materials in and out of the process will help you assess how and where to focus efforts when troubleshooting and developing processes for value recovery of any discrepant or failed materials that may have fallen out of the process along the way.



System flexibility

High-speed automation tends to have very specific equipment, designed to perform a very precise operation, in a very efficient manner. Similarly, they require and expect highly precise position control of the material as it moves. Robotic operations may be more adaptable to changes and variations in part velocity and positioning, but may not be able to move

Have a backup plan for the most challenging and unknown processes

When automation seems like the right decision, there will still be many unknowns and risks to address in the process. In some situations, no matter how well thought out, designed, engineered and executed, there might be stations or processes that just do not work as planned or up to the desired operational efficiency requirements. When and where it makes sense, have a backup plan. This may entail including extra space in a station for duplicate or additional operations, locations for offloading parts to a manual station, or just starting with a manual process until any technical challenges.

The automation supply chain

Are you building a single test or assembly station that you will load by hand? If so you are pretty much done. You will grab your product, place it carefully into the station and perform the assembly or test operation. But you will need to consider the staging of any materials that are needed or consumed in the process and how they are installed or placed

In more complicated systems, staging materials, the supply to the line, and the flow of all materials and pieces of work through the process is a massive challenge to address efficiently. All materials need to be readied, staged, and brought to the assembly lines in logical and efficient quantities dependent on the assembly rate and velocity of the process. Some products like cars and airplanes are manufactured in time frames measured in hours or days. You only need to have a few pieces of the necessary materials on hand to complete a given operation. Other products, ballpoint pens, for example, might be manufactured at rates measured in the 1000's or 10,000's per day, and will need a corresponding supply of materials to keep production moving.

Once you have an efficient supply of materials being ordered, received, and staged, you'll now have to determine how materials will be loaded or brought to the assembly line for consumption by the automation. While computer vision systems might be great at recognizing variations in the positioning of parts and might be able to adapt to these variations, the higher the rate of assembly and volume of parts consumed, the greater the need for a highly organized and predictable method for material presentation.

In high rate robotic and automated systems that are dependent on materials being manipulated for assembly, the challenge of material staging and presentation is as important as the process being performed on the materials. Preparations to standardize the presentation and positioning of materials can be expensive and have significant impacts throughout the supply chain.

Plan for dashboards, data reporting, cloud access and remote reporting, long term data storage, and retention

What will you do with all of the data and metrics you are now collecting and beginning to store? You'll need to have a plan for the management of the data, how much will you be gathering, what type of system is collecting the data and making it useful from an operational standpoint. Getting data into the cloud is a great way to store, retain and allow access to other

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Marco brings over 20 years of experience in managing engineering teams. Throughout his career, he has led teams shipping iconic innovations at companies such as Valve and Microsoft.

Marco has driven automation, product development, supply chain, and manufacturing for products including the Xbox 360, Nike GPS...

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