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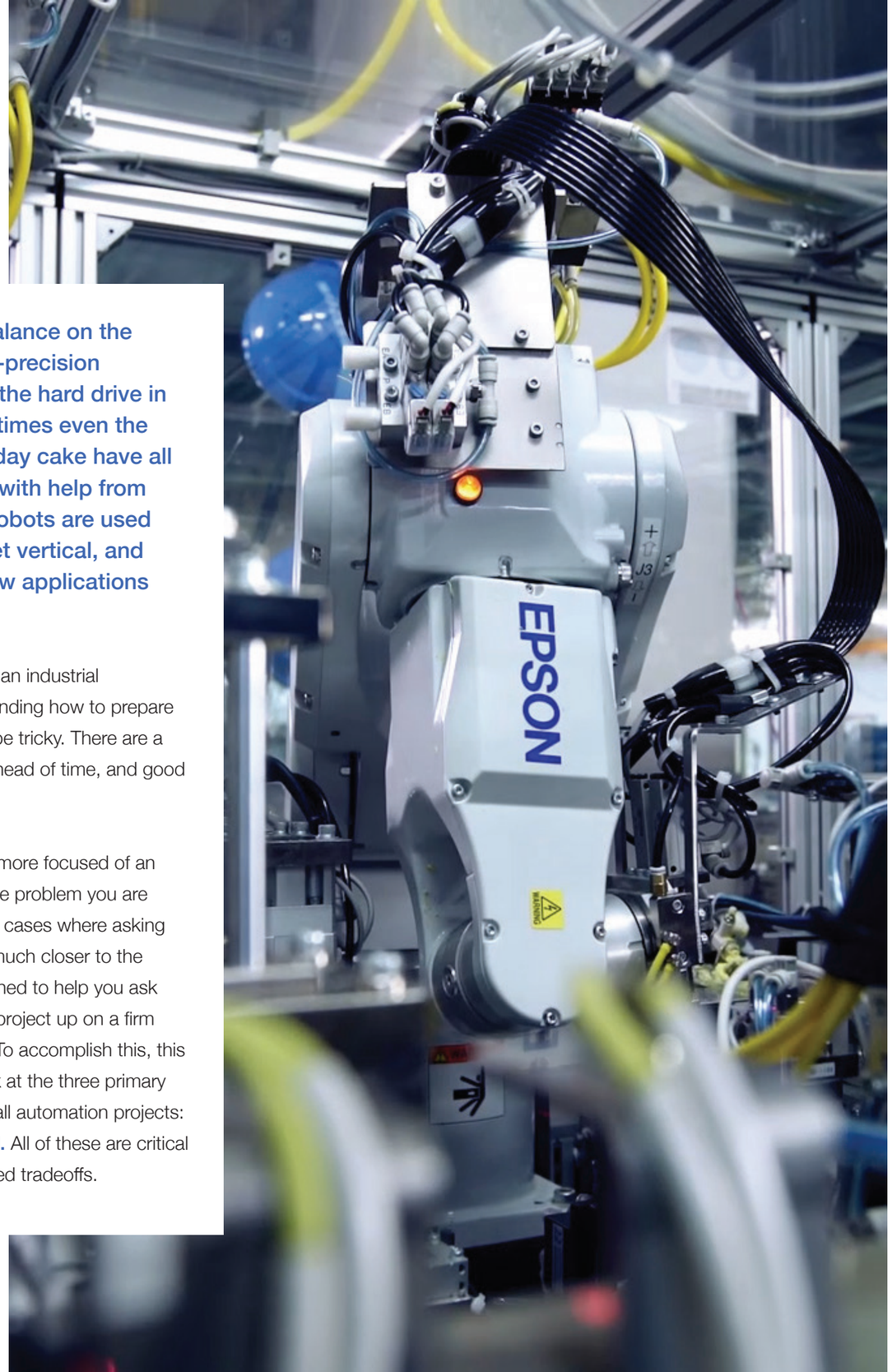
AUTOMATION 201

A Deep Dive into Clarifying Your Requirements for Project Success



The contact lenses you balance on the tip of your finger, the high-precision electronics in your home, the hard drive in your computer, and sometimes even the decorations on your birthday cake have all likely been manufactured with help from robots and automation. Robots are used across nearly every market vertical, and you can be sure to see new applications constantly cropping up.

Robots make a big difference as an industrial manufacturing tool, but understanding how to prepare your factory for automation can be tricky. There are a lot of things you need to know ahead of time, and good preparation is key.

The better that you prepare, the more focused of an understanding you will have of the problem you are looking to solve. It's one of those cases where asking the right questions can get you much closer to the answer. This whitepaper is designed to help you ask the right questions and set your project up on a firm footing for automation success. To accomplish this, this whitepaper will take a closer look at the three primary requirements that impact nearly all automation projects: **Speed, Precision, and Payload.** All of these are critical to consider, as are their associated tradeoffs.

A brief review: Automation 101 recap

Automation is a big topic, and for those new to the field, addressing the "how to get started" question can be quite daunting. To help facilitate this discussion, Epson developed Automation 101, a simple 5-step framework for how to start integrating automation into your business:

1. **Define Your Goal.** Why do you want to automate? Are you looking to reduce cost? Increase product volume? Improve product quality? Something else? Before you do anything it's important that you and your organization clearly define your reasons for automating, and make sure your team is fully aligned.

2. **Document Your Current Process.** Identify and document your current process with as many details as you can. This helps you identify the simpler items for automation which can provide you with a quick proof point for success as well as a potentially stronger return on the investment. Even if you end up not going the automation route, documenting processes is an important best practice, and it is helpful in getting new hires up to speed and making sure that you don't have a single point of failure.

3. **Define Your Requirements.** Really dig into the details. Do you need cycle time, precision, speed? We'll spend more time unpacking this item in the sections below.

4. **Identify Necessary Components.** Having gone through the previous steps, you should now have a better idea of each of the necessary components, such as conveyors, cameras, feeders, required for automation. Many people go right to this stage as a first step. Don't make that mistake – always make sure to understand your goals, current process and requirements before you buy equipment.

5. **Allocate Tasks and Responsibilities.** Who is going to do the work? Do you want to keep things in house or work with an integrator? Be cognizant of your capabilities and know when outside help and guidance are required.

Once you have spent time outlining your project goals and have documented the current process you'd like to automate, you're in a good position to define your requirements.

The “three-point tradeoff”: Speed, Precision, and Payload

A project will have many different requirements, however the three most important are typically speed, precision, and payload. You’ll have to truly understand your specific needs in these three areas because when implementing automation there will always be trade-offs. For example, many customers would love to have a robot moving at the highest speed, achieving the highest level of precision, and carrying the heaviest payload. Unfortunately this is not physically possible. It’s therefore critical to understand your goals and expectations because as you define your requirements you will very likely need to make some compromises. And those compromises must be aligned with your business objectives.

Let’s now take a closer look at each of these key requirements, so that you can understand exactly how to think about them, and the level of detail required to lead you to project success.

SPEED

Speed is often one of the most important justifications when making a business case for robotics. A common scenario is a customer who wants automation and yet only cites “speed” as their rationale. They have no set specification for the number of parts per cycle required, what part of the process they want sped up, or any idea of what they’re willing to give up to achieve an improvement in “speed.”

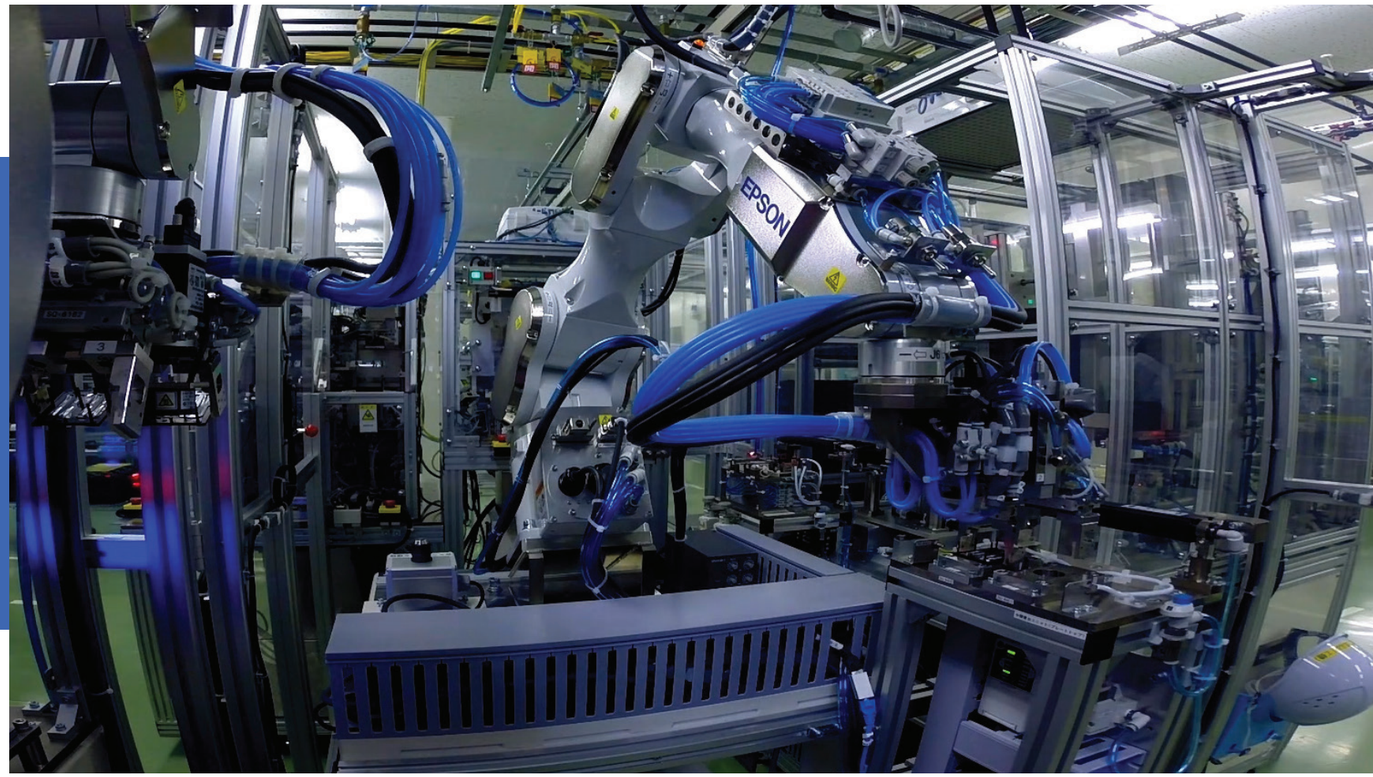
Questions to consider when optimizing for speed:

1. What are you trying to accomplish?
2. What part of the process are you trying to improve?
3. What’s your current bottleneck?
4. Do you want gains by percentage or magnitude?
5. Are your speed requirements realistic? (Lean on your system integrators or robot manufacturers for their expertise)

Before going any further, it’s important to point out that the term “speed” is a broad category that requires a clear definition for your specific project. For example, one factory might need the cycle time of a specific robot improved, while another factory might need the throughput increased for an entire manufacturing line. Taken a step further, both of these factories can communicate their speed requirement in terms of magnitude (i.e. a ¼ second improvement) or percentage (i.e. a 50% improvement). None of these definitions are wrong – they are all “speed” enhancements, yet each will require a very different solution set. It’s therefore critical to define exactly what is required for your specific application. If you get stuck or need assistance defining what you are looking for, always look to your robot vendor or system integrator for assistance.

A deeper look at speed requirements

As you evaluate your requirements, make sure to look at your manufacturing workcell as a system



of processes that work together. With that in mind, which part of your process do you want to make faster? Perhaps you want to adjust for a delay in a sequential process. Maybe you need to rotate or present a part quicker. Perhaps you need to reduce the time required to update a Human Machine Interface (HMI). And what are you willing to give up to achieve those objectives? Maybe you can give a little bit on precision or the payload you carry to achieve your speed requirement.

“What part of the process do you want to speed up? And what are you willing to give up to achieve that?”

When thinking about speed, particularly that of the robot, it can be tempting to go straight to the specifications — like you would when buying a personal printer or a cell phone. But in robotics, it is critical to understand how the specifications are created and that unlike a cell phone the performance of a robot is very dependent on the application it will be used for. A cycle time specification will use a metric known as a “champion cycle,” which is an industry standard motion cycle. The reality is that the champion cycle is an arbitrary move with an ideal payload and most likely does not reflect the actual motion of your application. Most applications require a fuller range of motion of the robot and the application payload, inertia, and repeatability requirements will greatly affect the cycle time. You therefore often can’t rely on this to evaluate cycle time performance for your project. Better tools have been created to

Automation tip

Little adjustments can add up to great throughput or speed gains. For example, if you're using air for your system, think about switching to quick-exhaust. Quick-exhaust can allow air pressure in your system to evacuate swiftly so that you can move on to what's next.

allow you to simulate your application, with the actual positions that the robot will have to travel to, the level of repeatability that is necessary, and even dwell times to understand the true cycle time of your application. If you don't have those simulation tools in-house, lean on your robot manufacturer or system integrator for assistance with a feasibility study to make sure you are getting the right robot for your specific application.

ZOOMING OUT

Review Your Entire System

If you followed the aforementioned Automation 101 framework, you have studied your manufacturing process and discovered the best opportunities for optimization through automation. You know where your system is spending most of its time and have considered each aspect of the system as they work together. Here are a few suggested areas to consider as you look to optimize your system for improved speed:

Take a look at your physical layout. Is your workcell layout fixed? How far out the robot arm moves will impact your speed. See whether you can "localize" your layout for a shorter reach.

Reduce component time delays. Look for and mitigate communication or process delays between your vision system, PLC, or other peripheral.

Optimize robot motion and profiles. For example, look for ways to reduce robot path lengths or change acceleration or deceleration timing.

Optimize your HMI. Are you serving up only actionable data in your HMI? Don't send over data to your HMI that won't be impactful and that will only slow down your system.

PRECISION

Precision requirements are often tied to smaller and smaller components that become unmanageable to assemble or handle by existing systems or manual processes. This is a growing trend across all industries, particularly in electronics.

You know you want precision, but do you know where you want it? Many times, customers have a desire to improve precision, but they haven't yet defined exactly where in the system they want the precision. Remember, you need to consider your entire system with all its parts working in harmony. You need to know exactly which area you're looking for improvement and how much improvement you're looking for.

Your precision needs can vary. For example, do you need it in the end of arm tooling (EOAT)? In the robot arm? Would it make the most impact in a peripheral tool, like a conveyor? Precision improvements in your manufacturing process can make a big impact in improving product quality and throughput, but you need to first make sure that you're investing in the right place.

Precision is not accuracy

When defining precision, recall that it's not the same concept as accuracy. A good way to illustrate the difference between precision and accuracy is the common bull's eye image. If you throw a dart at a bull's eye and it lands off

Precision in action

In hydraulic valve assembly, precision is critical. Every time a component is placed during the manufacturing process, the parts need to arrive at a very precise location.

center, but in the same off-center place time and time again, that's precision. If the dart is in the dead center, it's accurate, but if you throw it again and it lands outside, it's not precise. In robotics, precision is what most engineers are looking for, and they often refer to this concept as *repeatability*.

ZOOMING OUT

Review Your Entire System

Now that you know how to define your precision, take a look at your entire system. Each piece of that system has its own effects on precision and tolerance. Some factors you can consider are:

End of Arm Tool (EOAT)

- Know the type of EOAT required to work with your parts. Higher precision environments often use custom tools. Use an experienced tools designer to design and build the EOAT appropriately.
- Are you using mechanical or vacuum grippers? Although the negative pressure from a vacuum can tell you the product has been picked up, it will have less precision than a mechanical gripper. One option is to go with a custom-molded vacuum gripper which offers greater precision, yet at the tradeoff of cost.

Peripheral equipment that is brought into the automation work cell

- Peripherals are a key part of the system. Look at the feedback you're getting from them. This also includes things such as manufactured parts, conveyors and pallets.
- Do you need a vision system or a smart sensor? Equipment like this can produce incremental precision gains.

Questions to consider when optimizing for precision:

1. Are you using the right robot type?
2. Are you keeping things (parts, components, moves, etc.) localized?
3. Are you considering the entire workcell, and not just the robot?

- A manufacturer will often use parts from two or more different manufacturers for redundancy and back-up. Because these parts come from different manufacturers, make sure to evaluate each of these parts as their precision and tolerances might be different.
- Also consider any pull or rigidity that power, air or communications cables may place on your robot arm

Determining the level of precision

Now that you've considered every part of your system, you can determine the level of precision that's required to move and place all these parts and which robot to go with.

If you're unsure of your precision requirements, you may ultimately choose the wrong robot or end up with one that is insufficient (or even maybe in excess) of your needs. For example, if you don't require complex movements of parts such as roll and pitch, you might not need a 6-axis robot. Don't be hesitant to rely on qualified robot vendors or system integrators because they can help define tolerances and precision tolerances for your application. And remember, precision will have trade-offs with speed and payload!

KG PAYLOAD

When looking at payload, it's a common mistake to only consider the part that the robot picks up. However, that's only part of the equation. You need to look at the entire payload, which is the end of arm tooling in addition to the mass of the part being picked up. Customers must also take into account everything that's mounted physically to the robot, such as mounting plates, grippers, air valves, and cameras, to name a few. All of these components add weight and must be accommodated.

Of course, your robot is likely not standing still, so you'll also need to consider the inertial effects that the workpiece and EOAT have on the robot. In a perfect world all of the payload would be concentrated on the center of the robot face, which provides the lowest inertia. However, in practice the workpiece and EOAT may need to be placed farther away from the center faceplate, increasing the inertial load on the robot. If these items are too far away from the robot face plate this can increase inertial effects which may dramatically degrade robot cycle times. In this case sometimes it may be beneficial to move up to a robot with a higher inertia value to keep the cycle time reasonable. This is best discovered through an application simulation with your system integrator.

Questions to consider when optimizing for payload:

1. What does your part weigh?
2. What EOAT is required, and what does it weigh?
3. Are any valves, cameras, or cables attached to the EOAT?
4. Is there flexibility in the placement of the parts above?
5. How far are you moving your part?
6. Is the center of gravity different for the EOAT and the part? Remember to take inertia and center-of-gravity impacts into account.

ZOOMING OUT

Review Your Entire System

When preparing to optimize for payload, take a step back and make sure that you're considering all the factors involved, especially those that will change throughout the cycle.

Take a look at your layout. Short, localized layouts will help improve performance. A fully stretched-out arm can increase cycle times.

Account for dynamic changes. Beyond the gripper, consider all peripherals on the arms and their positioning. Consider how the payload changes over time as the arm moves.

Account for changing centers of gravity. As the center of gravity of the load moves away from the center of rotation, the greater inertial impact it will have on the robot joints. You want to get that center of gravity of the EOAT back to the center of rotation. This helps reduce those inertial forces on the robot, which can improve robot speed and performance.

Preparing for robot animation

As you review your requirements of speed, precision, and payload, take account of your entire system and clearly define your goals. Remember that all this upfront work will help you buy the most appropriate tools for the job. It may seem like a lot of preparation, yet investing time correctly in the beginning can make way for a faster payoff when it comes time to implement your solution.

And remember, you don't have to go through this alone. Throughout your research and defining stages, rely on your robot vendor and system integrator for any support that you may need.

Customers often ask what separates those who succeed in automation from those who don't. Simply put, the most prepared teams are the most successful teams. It's those who've taken the time to understand what they're solving for and where in their system they're solving for it. They've done their due diligence and have aligned their goals across the team. They're familiar with their current process backwards and forwards and know exactly what they're looking for. And perhaps most importantly, they're able to zoom in and out of their system. They can not only pinpoint exactly where they want to see improvements but also see their system from a bird's eye view, understanding how all of their parts work together to achieve their goals.

Are you considering automation?

The Epson Robots Applications team is here to provide insight and help you find the answers to your automation questions. Let us help you find the right solution for your project or application by calling 562-290-5997. Or visit **epson.com/robots** today.

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