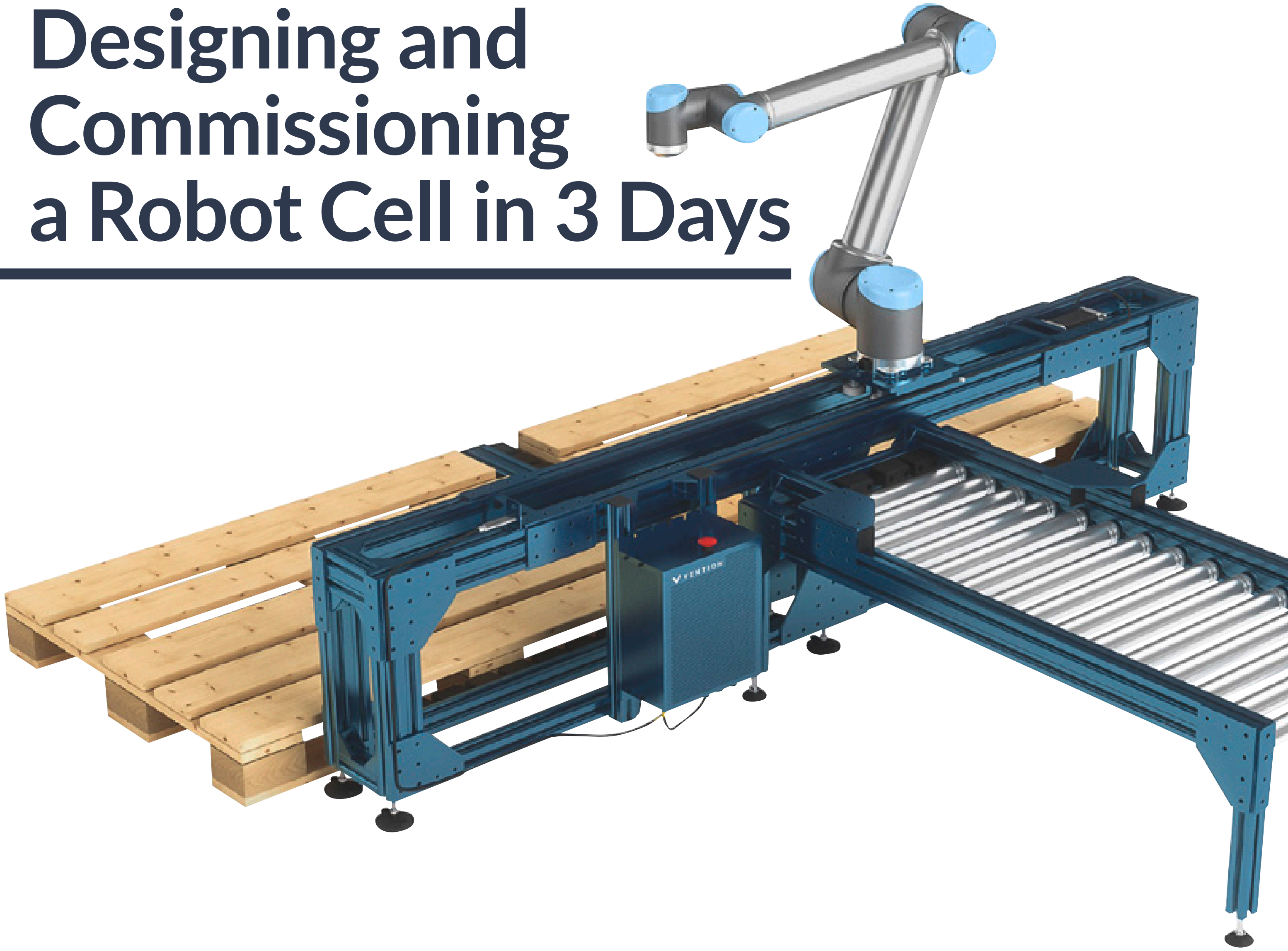
Designing and Commissioning a Robot Cell in 3 Days



WHITE PAPER

How cobots and cloud-based machine design platforms are shrinking the duration of automation projects from months to days

DESIGNING AND COMMISSIONING A ROBOT CELL IN 3 DAYS

The robot industry has changed. Collaborative robots have marked a new era in the pace of the adoption of robotics, bringing simplicity and democratization in an industry that until today, relied on experts.

The number of robotic-savvy individuals is rapidly growing. Several of them are taking on the design and commissioning of robot cells on their own, and rightfully so. Fueled by the availability of cobots and a cloud-based machine design platform, the design of robot cells is also being democratized, transforming what used to be complex engineering projects into a streamlined e-Commerce experience.

This white paper presents a high-level approach and set of tools to design and commission your next robot cell in as fast as three days and explore under which conditions such a project should be taken on single-handedly or via the assistance of an integrator.

A high-level approach to high-speed robot cell design and commissioning

Designing and commissioning robot cells in three days represents a cycle-time breakthrough versus the average duration of 60+ days for those projects. For some, this 20x improvement in duration appears doubtful. For others, this has been a reality for a few months already.

The process below highlights the steps to follow for the design and commissioning of robot cells in as fast as three days. Each key step of the design phase is then further explained in the following sub-sections.

Figure 1.
High-level process flow for the design and commissioning of robot cell in 3 days

1-3 days **Design and order robot cell**	1 day **Delivery to end-user**	1-3 days **Assembly and commissioning of the cell**
■ Map the process flow to automate *(3 hrs)* ■ Develop the cell architecture *(1 hr)* ■ Design the required equipment for the cell *(2-6 hrs)* ■ Place the order	Next day delivery across United States	■ Assemble the various equipment ■ Commission each equipment ■ Program the robot ■ Monitor and implement quick-win improvement opportunities

DAY 1: DESIGN AND ORDER THE ROBOT CELL

Mapping the process flow to automate

The design of the robot cell should start by mapping the full sequences of tasks to be automated. A target lead-time for each task should be established. Each task can then be grouped into "stations," where a robot or an operator will be assigned. Ensure that part movement from one station to the next is included in the task mapping.

For each station identified, list the equipment you will need, whether it's a holding jig to position the part being manufactured, part presentation equipment or a feeder to ensure continuous supply to the cell. Each station where a robot is assigned will need a pedestal. Pedestals can be anchored to the floor or move on wheels. The robot cell designer can consult this guide to create an effective cobot pedestal.

The template below can be used to complete the process flow map.

Figure 2.
Task map template example

Station ID	Task mapping	Target lead-time	Required equipment	Operators or robot?	Robot pedestal type
1	Take part from feeder	7.5sec	Feeder for capacity of 50 parts	Robot	Fixed pedestal
1	Position part on laser engraving machine	6.8sec	Laser engraving machine, holding jig for laser engraving machine	Robot	
1	Laser engraving operation	34.2sec	Laser engraving machine	Robot	
1	Remove part from laser engraving machine and drop on conveyor	6.3sec	Automated conveyor	Robot	
2	Remove part from conveyor and place into the jig	11.5sec	Holding jig	Robot	Fixed pedestal
2	Capture assembly pin from feeder	7.2sec	Feeder for capacity of 50 pins	Robot	
2	Assemble positioning pin on the part	9.3sec	None	Robot	
2	...	...	...	...	...

Develop the cell architecture

Once the tasks and required equipment have been mapped, the high-level architecture of the cell can be developed. All stations should be positioned relative to each other to maximize the overall cell throughout, ensure the safety of the operators and provide easy access for maintenance. Upon completing this step, you should have a clear understating of the overall cell dimensions as well as how material gets in and out of the cell.

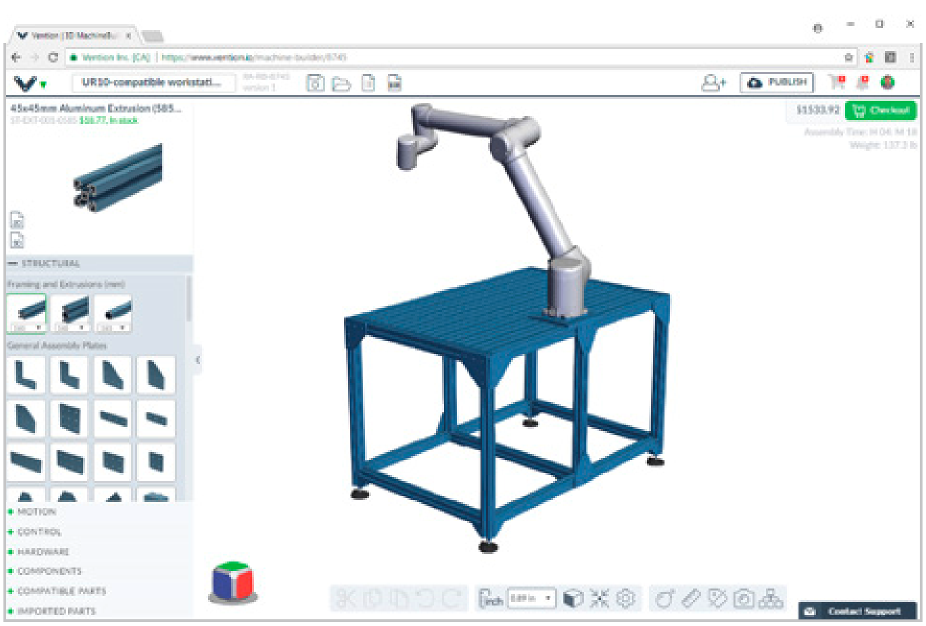
The ideal tools to help realize this step can range from a basic 2D sketcher (i.e., Draft Sight, Visio) to a blank sheet a paper.

Design the required equipment

Upon completing the high-level architecture of the robot cell, the design of the various pieces of equipment can be conducted. Recent advancements in cloud-based machine design platforms now empower automation specialists to design in 3D and order their equipment in just a few hours.

To enable such speed, machine design platforms such as Vention provide their users with free web-based 3D design software, loaded with industrial parts that ship next day. Those parts, when assembled together, enable the design of equipment ranging from a simple robot pedestal to a more complex seventh axis.

Figure 3.
User interface of Vention digital manufacturing platform



Users of these platforms can design all the custom equipment required for the robot cell online, see the cost and assembly time in real time, and process the order for next-day delivery, directly from the online 3D environment.

The schematic below showcases the wide variety of robot cell equipment that can be designed and ordered for next-day delivery throughout the Vention platform. All of this equipment is available as "open-source" on Vention's public library and can be further customized to fit the specificities of the robot cell.

Interestingly, the digital workflow of a machine design platform like Vention not only speeds up the robot cell project, but also shrink costs. A study conducted by Vention shows that costs can be compressed by up to 40%. Most of the cost savings come from engineering and procurement steps, as tasks like creating 2D drawings or preparing quotation packages are either not required or are fully automated in such a platform.

Figure 4.
Example of robot cell equipment publicly available on Vention

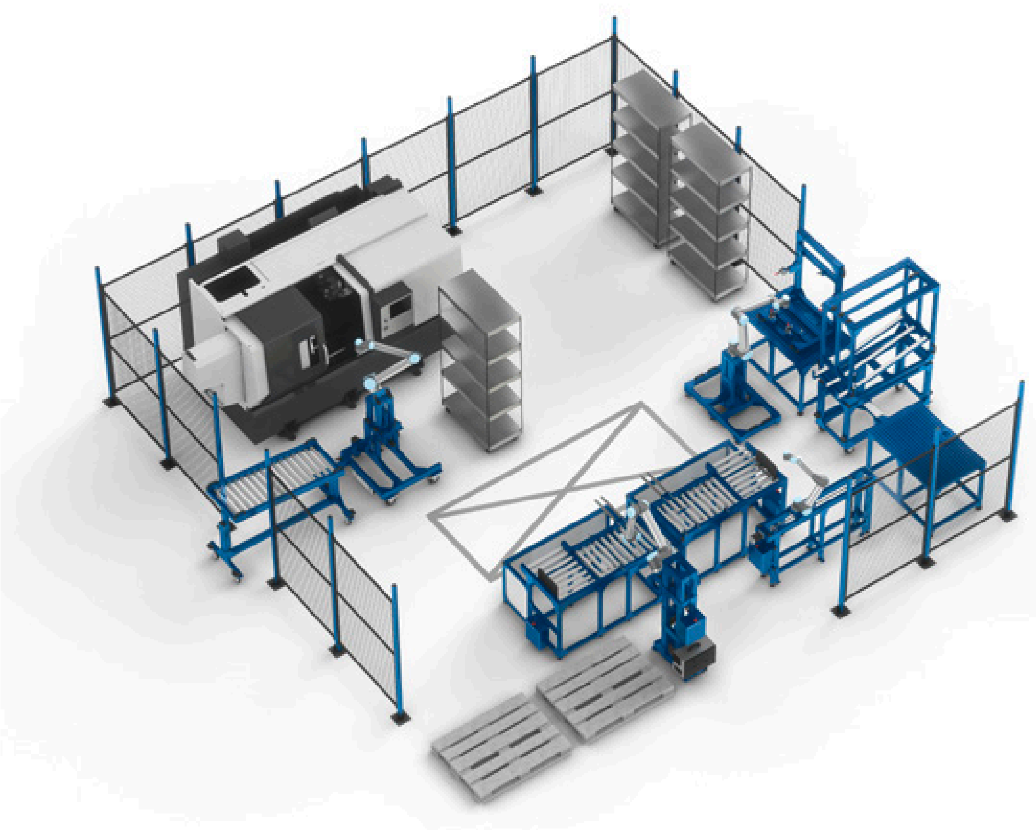
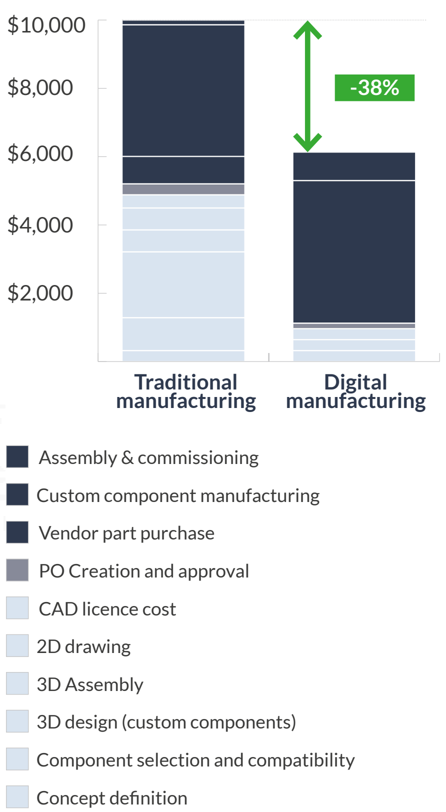


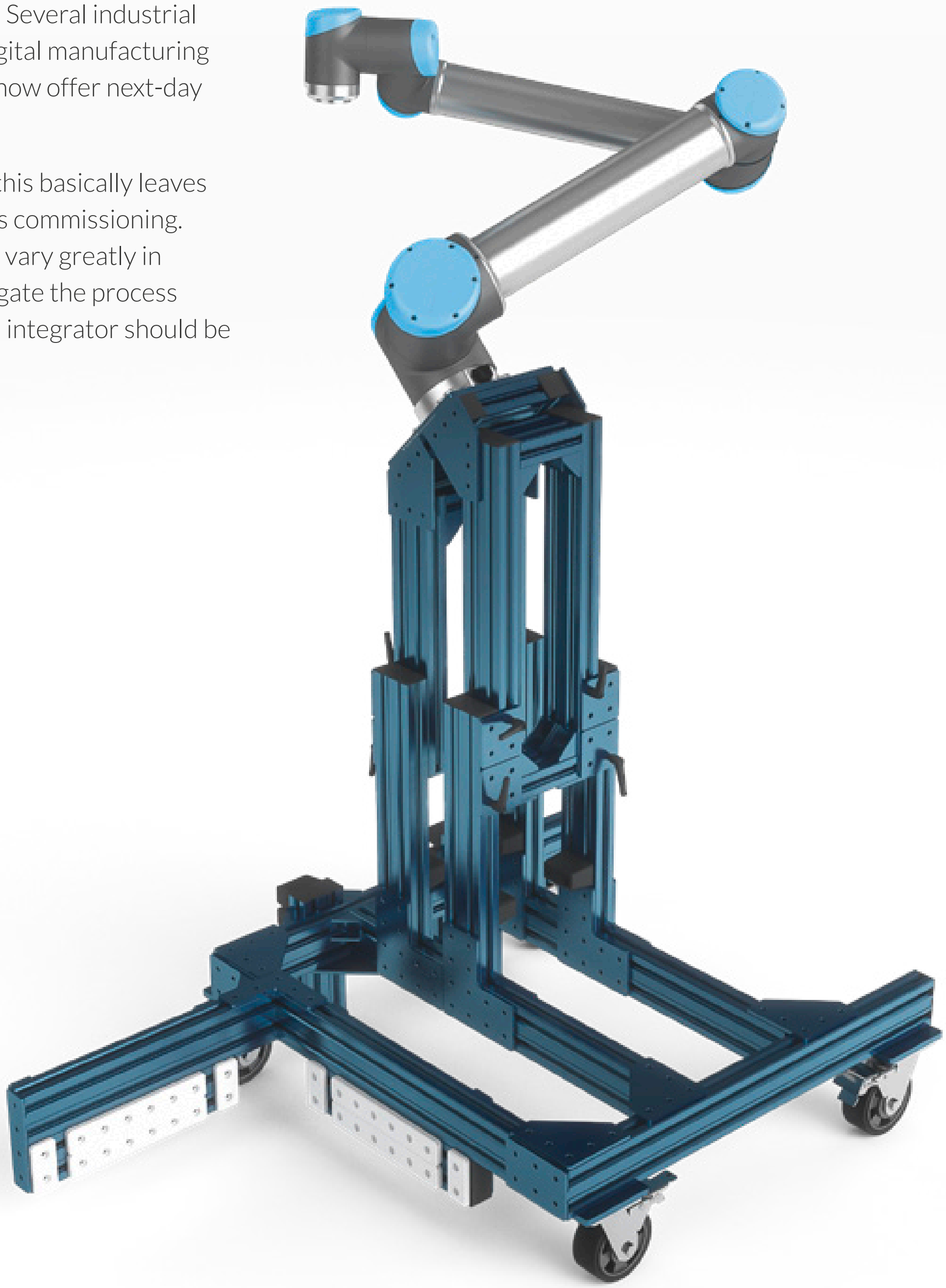
Figure 5.
Cost saving resulting from digital manufacturing platform for machine design



DAY 2: SHIPPING OF YOUR EQUIPMENT

With a target of only three days from “design” to “commissioning,” the logistics for ordering this type of equipment should not take more than a day. Now, the growth of e-Commerce retailers such as Amazon and Walmart has forced logistics providers such as UPS and FedEx to perfect their game. Thus, any good ordered today from any location in the US can reach any other location in the country in less than 24 hours. Interestingly enough, such speeds are also available for industrial applications. Several industrial distributors (i.e., McMaster, Digikey) and digital manufacturing platforms (i.e., Xometry, Protolab, Vention) now offer next-day shipping as their primary logistics offering.

Taking this one day of logistics for granted, this basically leaves two full days for the design of the cell and its commissioning. Tasks to be accomplished during those days vary greatly in complexity, and therefore, decisions to navigate the process single-handedly or with the assistance of an integrator should be well-thought out and deliberate.



DAY 3: ASSEMBLY AND COMMISSIONING OF THE ROBOT CELL

Usually, equipment designed on a machine design platform arrives in a kit that is ready for assembly with no subsequent manufacturing required. Each piece of equipment also comes with its assembly time estimate and set of assembly instructions.

Below are the assembly time estimates for various types of equipment typically found in a robot cell.

Once assembled, each piece of equipment can be positioned in its respective station of the cell, and proper commissioning can start.

Fig 6.
Average assembly time for various robot cell equipment

Robot cell equipment	Average assembly time
Holding jig	6h36
Workstation	4h25
Gravity conveyor	5h12
Machine tending pedestal	11h55
Heavy-duty robot pedestal	6h04
Part dispenser	15h24
Robot range extender / 7^{th} axis	5h55
Automated & smart belt conveyor	14h07
Palletizer	9h08
Safety perimeter	4h15

Navigating the process single-handedly or with an integrator

Building expertise in-house versus relying on specialized firms for automation projects has been a hot discussion topic for years. That said, with the simplicity brought by collaborative robots such as Universal Robots, some of the answers appear more straightforward than they used to be.

Manufacturing floors are about to absorb a massive influx of robots in the coming years. Being able to rapidly deploy those robots, optimize the robot cell operations and eventually “repurpose the robots” will become a significant competitive advantage. For some manufacturers, mastering those skills might lead them to bid on a contract for which they would not have been competitive previously. For others, this will make them realize that opportunity for automation in their factory is greater than initially thought. Tight collaboration between functions of the company such as sales, finance and manufacturing will be required to capture the full benefits of robots. For those reasons, building expertise in robotics in-house will be just as strategic as having strong CNC machining expertise or lean manufacturing experts.

This does not mean that automation projects can or should be executed without the assistance of integrators. A good approach is often to pair in-house robot experts/emerging experts with an integrator, with the stated end goal of becoming self-sufficient later on.

Below is a list of consideration to help you decide the level of in-house expertise that should be developed and the level of external assistance required:

Figure 7.
List of consideration for selecting an integrator vs building in-house expertise

Considerations	Rationale
How many collaborative robots will be deployed in your factory in the coming year?	**Consider building in-house expertise** if the robot will become a key component of your manufacturing strategy
How complex is the task to be automated?	**Consider working with an integrator** if the task to automate is technically difficult (i.e., glue deposition, welding, etc.)
How often will similar tasks be automated?	**Consider building in-house expertise** if similar tasks will be automated in the future
Do you have or will you have a single Robot Operating System across your factory?	**Consider working with an integrator** if standardization of your Robot Operating System is unlikely
Are there "natural owners" within the organization for future robot deployment projects?	**Consider working with an integrator** if there is no natural owner in the organization

Transforming engineering projects into democratized e-Commerce experiences

Collaborative robots and cloud-based machine design platforms have started to democratize an industry that, until today, primarily relied on experts. Those technologies are highly compatible with a "self-serve" model, with the end-user navigating the entire design and commissioning of the robot cell in just a few days by themselves. As those technologies continue to mature, we can expect their scope to increase from robot cells made of a few pieces of equipment to bigger and more complex factory projects integrating several assembly lines.

ABOUT THE AUTHOR

Etienne Lacroix is the founder and CEO of Vention, the first digital manufacturing platform for machine design. Before founding Vention, Etienne was an associate partner at McKinsey & Company, serving Fortune 500 industrial clients on topics of operations and product development. Etienne holds a Bachelor's degree in mechanical engineering from Ecole de Technologie Supérieure and an MBA from Harvard Business School.