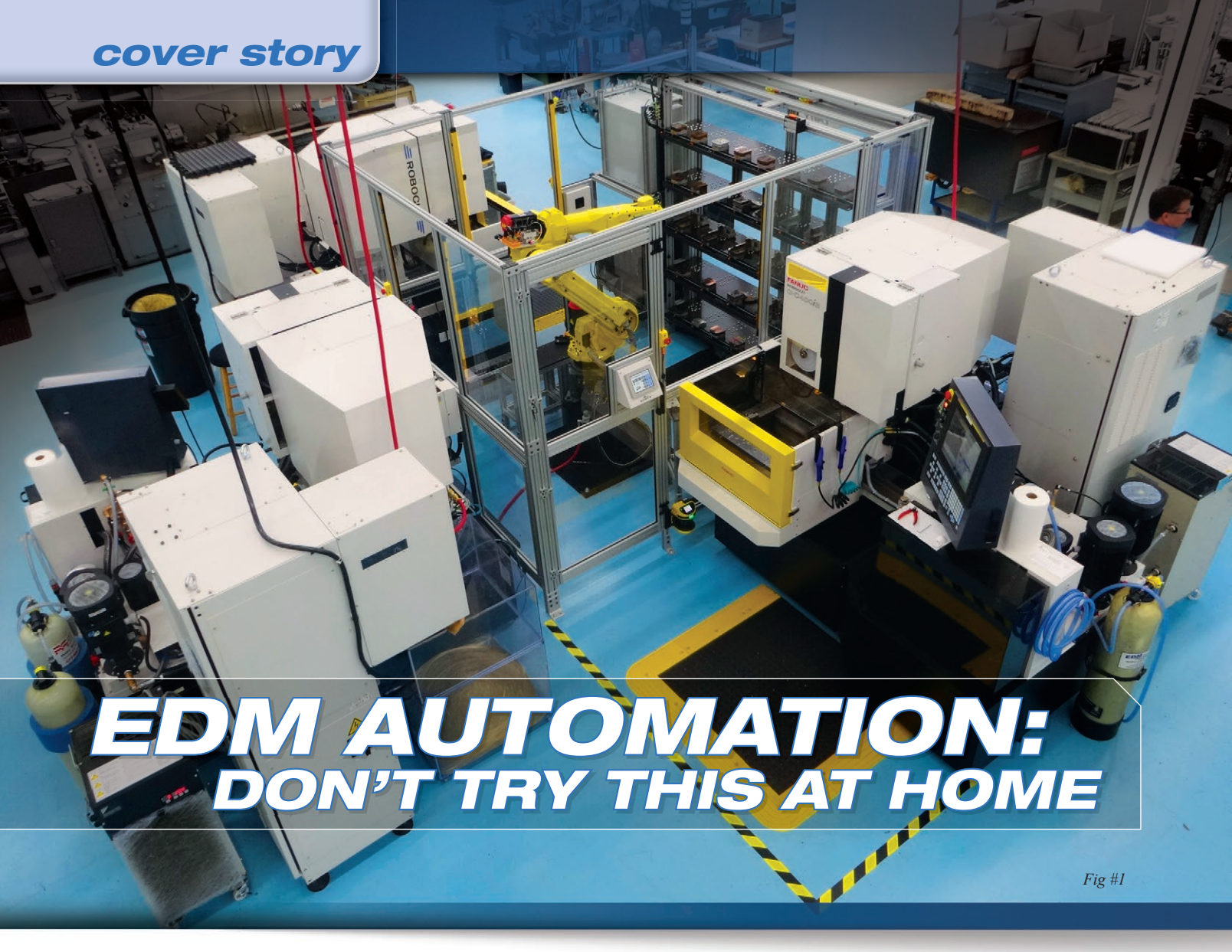


EDM AUTOMATION: DON'T TRY THIS AT HOME

Fig #1

Unity Precision Manufacturing is a highly successful, industry leading producer of medical implants and instruments located in Dayton, Minnesota. Unity Precision Manufacturing has extensive experience manufacturing medical implants, including bone screws, for use all over the human body: spine, wrists, shoulders, hips, fingers, toes, knees and dental. Unity Precision Manufacturing also produces medical instruments servicing the Vascular, Orthopedic, Endoscopic, Arthroscopic and Dental disciplines.

The name Unity was chosen for a reason. They focus on unifying elements for the better – better relationships, better turnaround, and better products to ensure the success of their customers.

Unity Tool was founded by Ron Van Essen in 1969. Its humble beginnings originated in a basement with just one machine. Ron's dedication and expertise grew Unity Tool to a company delivering products to local and global customers. Unity is a true American success story of a family business, built from long hours, hard work, and a commitment to quality. Mike Van Essen, who was nine years old when his father started the business and is currently Unity's General Manager, has been with Unity for his entire career. Mike's son Ryan, who began working at Unity during high school and college, serves as Unity's Production Manager. Over the past nearly 50 years, Unity has grown into a precision-driven, customer-focused, global contract manufacturing company, assisting customers to reach the pinnacle of manufacturing excellence. Their shop houses over a hundred pieces of equipment, including CNC turning/Swiss, CNC milling, Wire EDM, CAD-CAM systems, Inspection equipment, and Finishing equipment. Unity employs 42 people working two shifts five days per week. They rely on automation to run their EDM's, mills and Swiss machines overnight and during weekends.

When Unity decided to automate its Wire EDM operations, T. Bryce & Associates, the local distributor for FANUC Wire EDM's, brought in Methods Machine Tools and together they created a full turnkey, autonomous, three-machine cell solution for five-sided Wire EDM'ing.

It is important to note that a turnkey EDM automation solution is far more complicated than merely purchasing an array of disparate components and calling it an automated cell. A successful automation solution requires an integrator with years of both EDM and automation experience. Methods Machine Tools has more than a decade of experience of designing and

constructing both milling and EDM automation cells. Methods is in a unique position in the industry, since it's long standing, first-party relationship with Fanuc provides it with OEM level access to EDM machine tools, robotic equipment and technology.

I got a first-hand look at Unity's remarkable Wire EDM cell during a recent visit to their facility, and, in the following paragraphs, I'll share with you what I learned.

Fig #1 is an aerial view of the cell, which consists of three Fanuc ROBOCUT C400iB Wire EDM's, a Fanuc Model M20iA/35 6 axis articulated robot, a pallet rack, a gripper rack, a transfer station, a robot controller, job scheduling controller and software, and safety systems. We will examine each of these cell components in detail.

One of the things that makes this cell unique is the ability of the cell to perform five-sided machining of a pallet mounted part or parts without the need for an expensive indexer. This is accomplished by mounting one pallet receiver in the normal X-Y plane of the machine table and another pallet receiver perpendicular to the machine table on the other side of the tank (See Fig #2). This configuration allows the robot to consecutively load the part in two orientations, facilitating unattended five-sided machining.

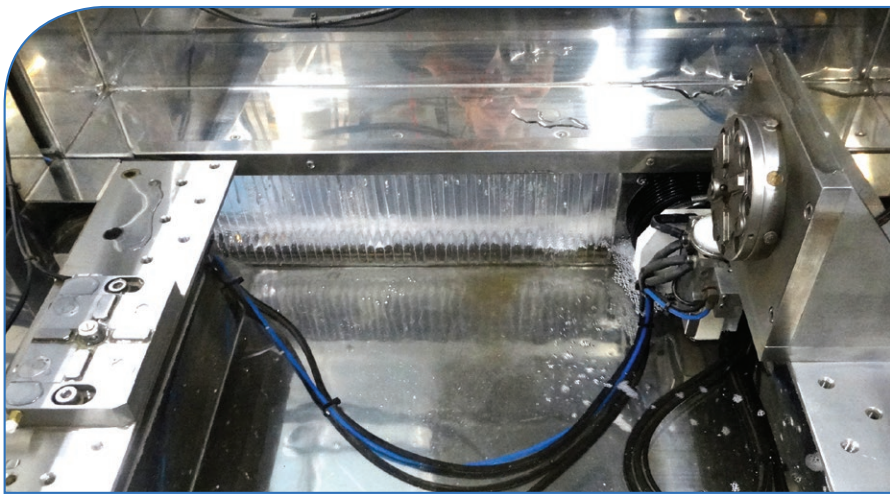


Fig #2

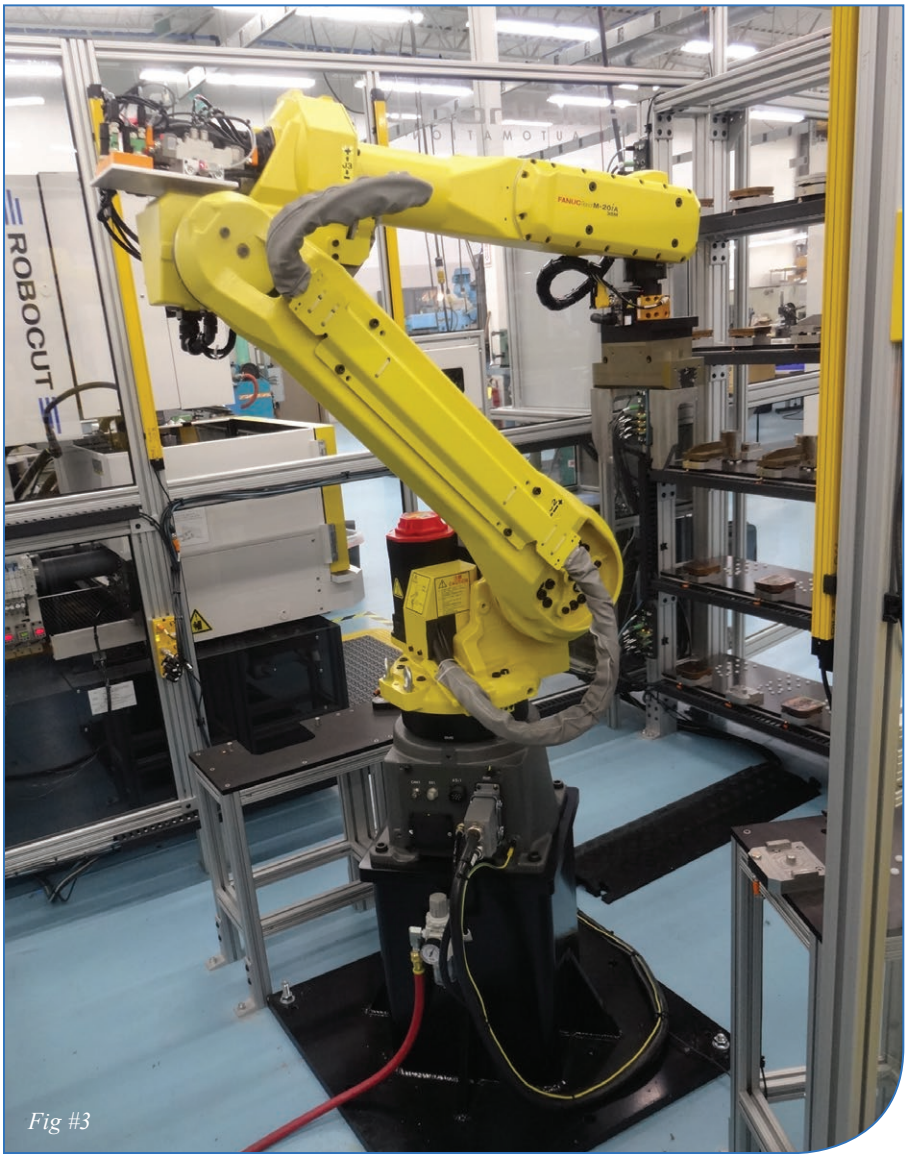


Fig #3

It is important to note that a key factor leading to the efficiency and versatility of the cell is the arrangement of its components.

In the case of the Unity cell, the Wire EDM's are arranged in such a way that enables the robotic loading and unloading of the machines from the side, allowing unimpeded access to the front of the machine for purposes of process observation, machine maintenance or manual machine operation.

The Machines

The key factors in selecting a Wire EDM for an automation cell are:

- A compact machine footprint
- An automation ready control
- An OEM with substantial cell automation experience
- An absolutely reliable auto-threader

The Robot (See Fig #3)

The key factor in selecting a robot is reliability. Fanuc robots have MTBF (Mean Time Between Failure) of eight years!

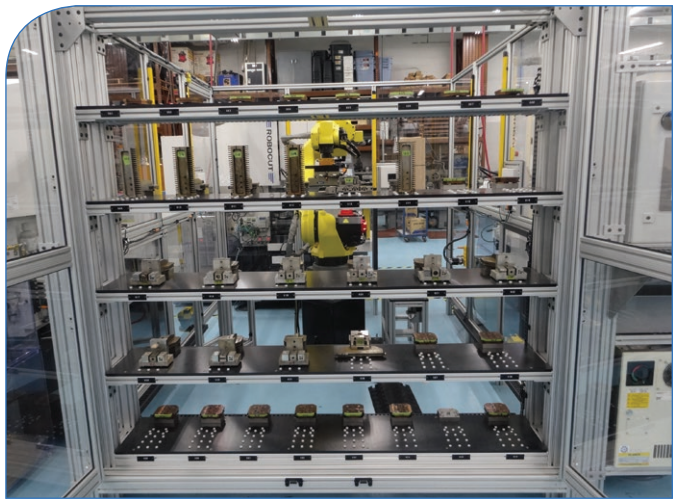


Fig #4

The Pallet Rack
(See Fig #4)

The pallet rack is utilized to store workpieces before and after machining. The Unity cell pallet rack has 36 positions, 12 positions for each of the three machines. Each position consists of a System 3R receiver and a series of support buttons to support overhanging pallets. (See Fig #5) For Unity's application, upper rows of the pallet rack have substantial vertical clearance to allow for pallets that contain fixtures that hold stacks of workpieces. (See Fig #6) Each pallet receiver has two air line connections, one for clamping and the other for monitoring that the pallet is properly seated on the receiver. Each pallet has an embedded RFID chip which uniquely identifies it. At the top of the pallet rack is a sensor which is read by the job scheduling software each time the robot picks a pallet from the rack to assure that is the one identified in the program. This eliminates the possibilities of pallet loading errors.

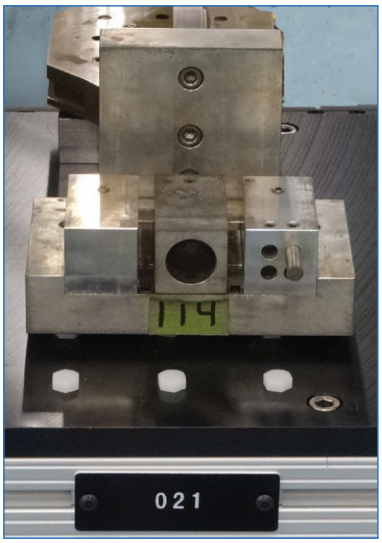


Fig #5

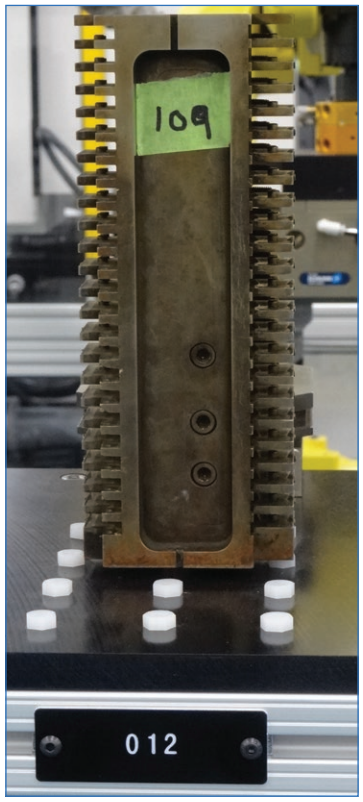


Fig #6

The End of Arm Tooling Rack (See Fig #7)

This rack is located within the operating range of the robot and serves as the storage location for the two gripper "hands" used by the robot. Two grippers are necessary in this application to accommodate the loading of pallet receivers in the machine that are perpendicular to each other.

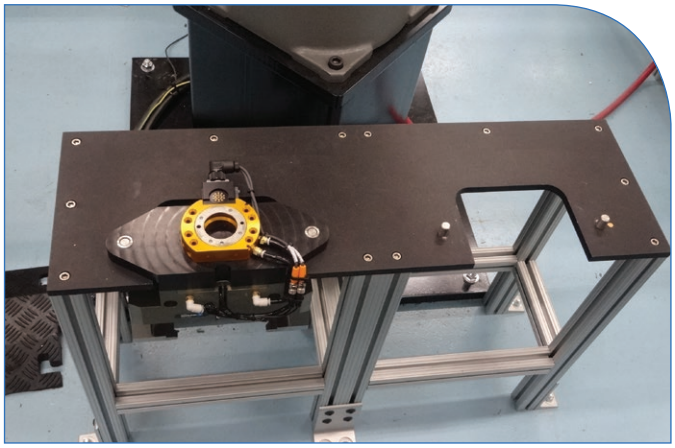


Fig #7

The Transfer Station (See Fig #8)

The transfer station is located within the operating range of the robot and serves as a temporary docking location for pallets that have been removed from the pallet rack while the robot changes grippers.

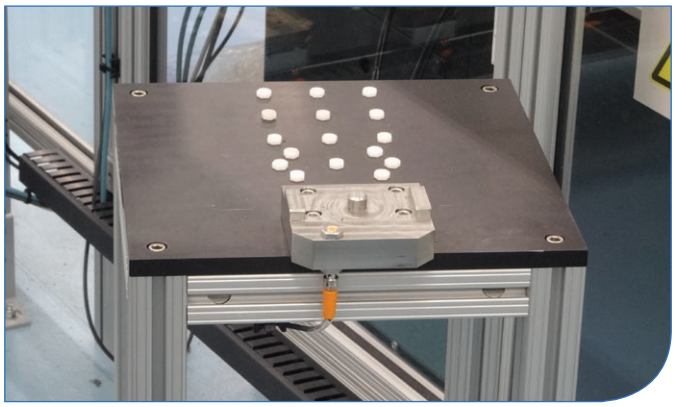


Fig #8

The Robot Controller (See Fig #9)

The robot controller is essentially a Fanuc CNC dedicated to managing the robot and its motions including:

- Picking pallets from the pallet rack
- Positioning pallets above the RFID reader at the top of the pallet rack
- Loading and unloading pallets to the machines

Fig #9

- Placing pallets in the transfer station and removing them
- Changing grippers

The MMAC Controller and Job Scheduling Software (See Fig #10)

Fig #10

The MMAC (Methods Machine Automation Control) Job Scheduling Software is the heart of the cell automation. It is to the cell as a conductor is to an orchestra. The MMAC and its software are proprietary products of Methods Machine. The MMAC:

- Manages all the pallets in the rack
- Maintains the link between the pallets and their associated Wire EDM programs
- Manages the scheduling of the palletized jobs and the three machines
- Coordinates the activities of the robot and the machines
- Manages the cell safety systems

Cell Safety Systems

Whenever one contemplates creating an automated cell involving a robot, addressing safety concerns is paramount. While operator safety is the primary concern, workpiece safety must also be considered.

Operator safety is addressed by a variety of systems in the Unity cell:

- The pallet rack door can only be opened if the robot is not removing or replacing pallets in the rack.
- Access doors to the cell can only be opened if robot movement has been disabled. (See Fig #11)
- A light curtain guards the window between the machine and the robot motion area.
- A remarkable video scanner monitors and guards the yellow lined rectangular floor area around the front of the machine. (See Fig #12)

All of these devices, working in conjunction with the MMAC, effectively prevent harmful interactions between humans and the robot.

The primary workpiece safety hazard is the remote possibility for a pallet not to be firmly seated in its receiver. To guard against this possibility, there is a second pneumatic line connected to each receiver on the machines and verifies that the pallet has been successfully clamped and seated.

Fig #11

Fig #12

How it Works

Okay, we've looked at all the cell components, so now let's put it to work.

First, jobs are loaded onto pallet mounted fixtures. As noted earlier, each pallet contains an RFID identification chip. Next, the cell operator chooses an open pallet position in the rack for the particular machine that is to run this particular job. (Note: one of the three cell machines utilizes a Fanuc Model CCR indexer instead of a right angle pallet receiver to accommodate jobs that require an index other than 90 degrees.) (See Fig #13)

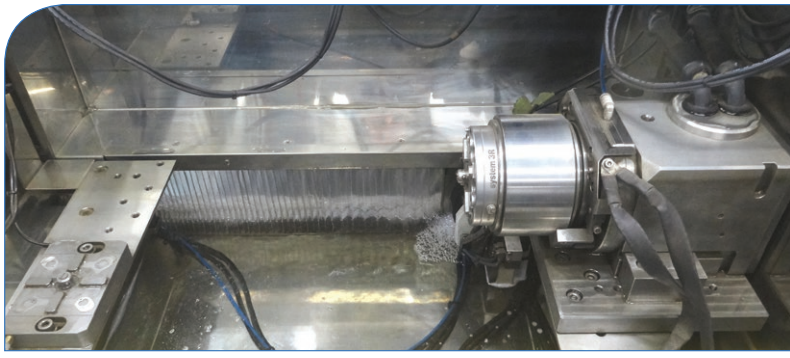


Fig #13

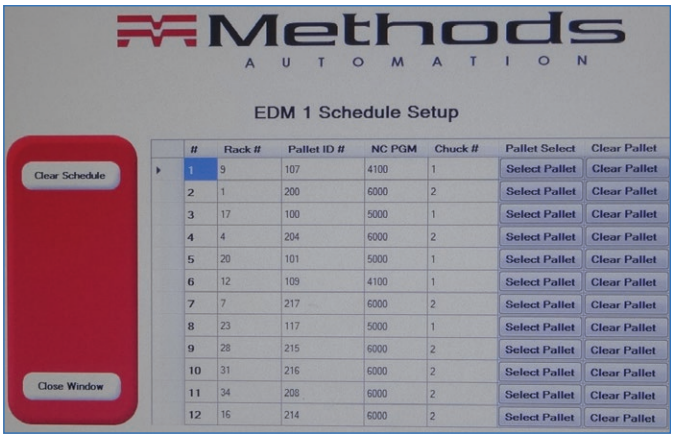


Fig #14

Then, utilizing the setup screen (See Fig #14) for that particular machine, the cell operator chooses where in the schedule this job will be run, scans the RFID chip, assigns it to the open pallet position, selects which of the pallet receiver that will be utilized and then assigns the program to be used for this particular job. He then places the pallet in the rack.

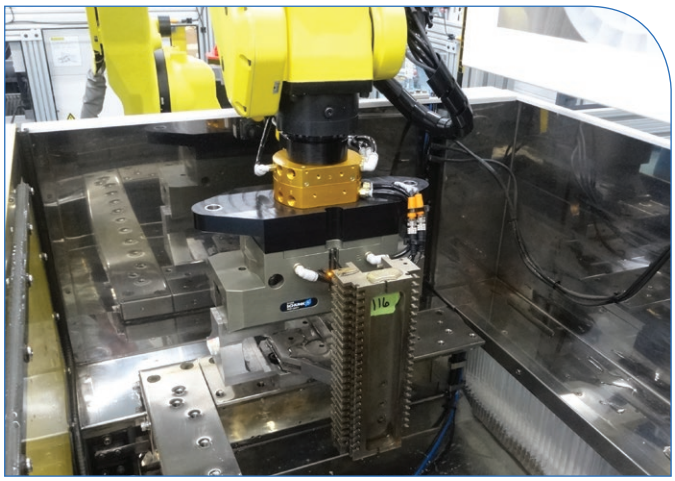


Fig #15

When the schedule for the selected machine calls for this job:

- The robot pulls the pallet from the rack.
- The robot positions the pallet over the RFID scanner on top of the rack and the chip is scanned to verify that the correct pallet has been selected for this job.
- Depending upon the receiver designated for this job, the robot will either:
  - Load the job onto the machine receiver (See Fig #15)
- Or:
  - Load the job onto the transfer station (See Fig #16)
  - Change grippers
  - Pick up the job from the transfer station
  - Load the job onto the machine receiver
- The job is then EDM'd.

After EDM'ing is completed, the reverse procedure is executed, or the part is loaded onto the other machine receiver to accomplish the ninety degree index and a second burn commences.

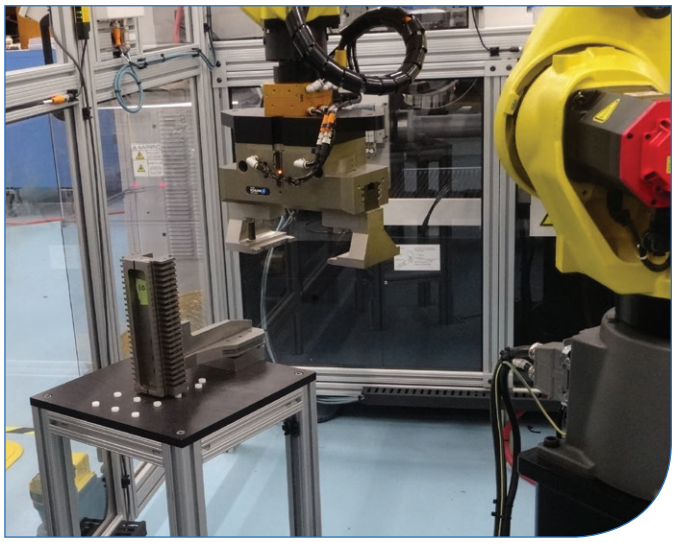


Fig #16

The status of any job in the cell is displayed on the cell controller status screen as shown in Fig #17.

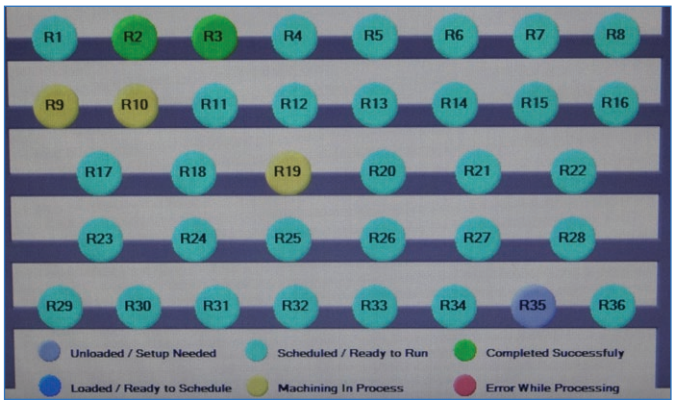


Fig #17

It Takes a Village

While offering tremendous productivity advantages, EDM automation is not a project to be undertaken on a whim. Successfully navigating these waters requires the close cooperation of a team consisting of the customer, the dealer and the OEM.

The first, and most critical, stage is planning. In this stage, the team determines the critical customer requirements for the cell such as:

- Workpiece envelope
- Workpiece and fixture weight
- Types of cuts
- Indexing
- Slug control

The planning stage is not a "one-and-done" exercise. Often, based upon the feedback from the dealer and the OEM, the customer realizes that the cell can handle additional tasks that weren't originally envisioned and modifications to the cell design must be made to accommodate them. Once the planning stage is completed, a price for the cell is negotiated and the construction begins.

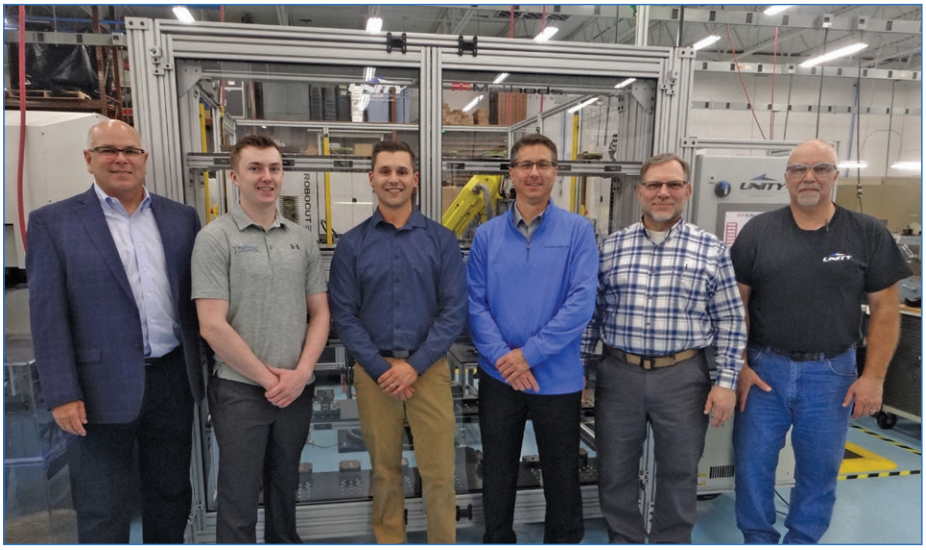
The OEM then designs the cell, customizes the proprietary cell controller software, assembles the components and conducts a cell runoff at the OEM's facility.

The cell is then disassembled and shipped to the customer.

The cell is then reassembled at the customer's plant, and another runoff is conducted along with customer training.

It should be noted that throughout this process, the dealer acts as a critical "on location" interface between the customer and the OEM.

The typical time frame for a cell project like this is six months from the initial contact to the cell production.



(L-R) Steve Bond-Methods Machine; Kulin Dahlquist-T Bryce; Clay Olson-T Bryce; Matt Kelly-T Bryce; Mike Van Essen-Unity Precision; Gary Anderson-Unity Precision

Methods Machine Tools

For over 60 years, Methods Machine Tools, Inc. has been North America's foremost supplier of leading-edge precision machine tool and additive solutions – providing superior products, engineering and automation, parts and service, training, and integration.

Founded in 1958, with three employees and a few refurbished machines, Methods Machine Tools, Inc. has grown into one of the largest, most innovative precision machine tool importers in North America. With over 300 employees, eight sales and technology centers, and over 35,000 machines installed throughout the United States, Canada and Mexico, Methods supplies leading-edge precision machine tools and solutions. The founder, Mr. Clement McIver, Sr., established principles from the company's beginning that continue to set Methods apart from conventional importers or distributors. "Anyone can sell a machine," said the company's late founder, "but not everyone provides the extra effort that makes a difference in the company's bottom line."

With high quality machine tools, automation equipment and application expertise, Methods provides fully integrated solutions for North American manufacturing customers.

T. Bryce & Associates

Founded in 1980, T. Bryce & Associates, Inc., is a highly regarded Minnesota company serving all sectors of the EDM market. Located in Brooklyn Park, Minnesota, T. Bryce & Associates offers a full range of services for all the Fanuc EDM machines. Their team of technical professionals are local and combine world-class expertise with local knowledge to efficiently facilitate machine selection; equipment installations; additions and modifications; machine operation; training and programming, laser calibration and general maintenance.

I'd like to thank Mike Van Essen, General Manager of Unity Precision Manufacturing, for his gracious assistance in facilitating my visit to his fine company.

www.methodsmachine.com
www.unitytool.com
www.tbryce.com

EDM