Feature Article *(A Competitive Success Piece from Modern Machine Shop)*

Classy Shop, Classy Cells

The automated EDM cells in this shop are distinguished by their thoughtful design and careful attention to detail--as is the rest of the shop.

By Mark Albert

Almost everyone who visits TNT EDM, a job shop in Plymouth, Michigan, remarks about its unusual décor. With natural wood trim around the doorways, polished granite flooring in hallways, concealed lighting and wainscoted walls, this 40-person shop has the ambience of an office suite for a brokerage firm or design studio. Yet the 60,000-square feet of manufacturing space at TNT is home to more than four dozen EDM (electrical discharge machining) units, both wire and CNC sinker, and an almost equal number of CNC milling machines and machining centers. The "professional" atmosphere created by the décor simply reflects the shop's serious devotion to high quality, high precision machining.

Like all of TNT's automated cells, this wire EDM cell features a robot and carrousel between two machines. The robot loads either machine from the closest side, as shown directly above.

TNT's newest automated machining cells typify this distinctive combination of advanced technology and artful style. All seven of these cells consist of two machine tools served by a single robot and carrousel. Three of the cells are for CNC sinker EDM; two are for wire EDM; and two are for milling graphite electrodes. At first glance, the arrangement of these cells seems very typical of many roboticized cells installed in shops around the country since the 1990s, especially in progressive mold shops.

A closer look at these cells reveals some important refinements. These refinements enhance each cell's capacity for extended periods of untended running, economical yet efficient operation and ease of servicing and maintenance. In most cases, one person per shift is assigned to each group of cells, making labor a minimal part of the cost of production on these cells. This is obviously a competitive advantage in today's global marketplace.

Competition with other shops, however, is not the point. It is "competition" with the shop's own growing use of hard milling as an alternative and complement to EDM that is the issue. Although TNT was founded strictly as an EDM shop largely devoted to plastic injection molds, the shop began moving into other applications in the late 1990s. Hard milling capability has been the main driving force behind this new strategic direction.

"EDM is still extremely important to us," explains company founder and president Tom Mullen. "Although hard milling represents our new growth area, work that involves hard milling very often involves EDM." The more hard milling the shop does, the more important highly efficient, highly economical EDM becomes, he explains. Thanks in part to the engineering of the automated EDM cells, these cells complement and support the shop's operations in hard milling.

A Competitive Success Story

Although this shop is diversifying into new areas of machining expertise, it continues to refine and renew its original specialty of electrical discharge machining. This strategy gives the shop both breadth and depth of experience, allowing it to handle its customers' most challenging manufacturing jobs.

Against The Wall

All of TNT's automated cells are set up so that the machine tools stand close to the wall, with their fronts facing the interior of the manufacturing bay in which they are located. In each cell, one robot and its integrated carrousel are positioned between a pair of machines. The robot loads and unloads either machine from the closest side. Thus, the operator has complete access to the unobstructed worktables or worktanks of the machines.

The motion of the robot is guarded by interlocking light curtains rather than by gates or enclosures. This arrangement makes the cells safe yet uncluttered. It is easy to scan the cell at a glance. With light curtains, there are fewer surfaces and moving parts to collect dirt or require maintenance. The carrousel and robot can be reached easily for loading workpieces and/or electrodes.

Stationing the cells along the perimeter of the manufacturing bay allows all utilities to reach the machines from the rear through or along the walls. Air and electrical lines come out of the wall, avoiding cords, conduits or hoses that descend from the ceiling. Network cabling is also routed along the walls. Setting up or relocating the cells is fairly simple and flexible because hookups are always nearby.

Piping and ductwork run along the wall behind the cells as well. The shop has centralized systems for handling dielectric fluid, so there are no chillers and filtering units to take up floor space near the EDMs.

Although the shop's layout is entirely functional and carefully engineered, high construction standards give it an attractive yet professional appearance.

The 4-inch PVC pipes for the dielectric fluid connect machines to the central systems. Wherever practical, valves and shutoffs are located where they can be reached between the cells. Electronic sensors on the floor are strategically arranged to detect fluid that might indicate a serious leak. The sensors are designed to shut flow to the entire bay and send an alarm signal if a puddle reaches them, a safeguard that makes untended operation more secure.

The shop is divided into several manufacturing areas dedicated to a particular process or type of machine. Each area is essentially a large room with machine tools along the walls surrounding islands of workbenches and countertops in the center. Sinker EDM, wire EDM and electrode production are grouped together, with corresponding centralized systems located in adjacent spaces. The centralized system for chilling, filtering and deionizing the water used in wire EDM, for example, is housed in a room next to the bay dedicated to wire EDM. The same goes for the room that houses filters and chillers for the oil used as a dielectric in sinker EDM: It is located near the sinker EDM bay.

Effective use of floor space is a key benefit. The cells are clustered together on the same or adjacent walls so that one person can tend all of the cells in this area single-handedly. Because the cells stand against the walls, the workbenches in the center of the room are only steps away.

Workbenches and countertops provide plenty of space to organize workpieces, tooling and electrodes without crowding. Setup stands for workpiece fixturing are located on the benches near the appropriate machines, as are any gaging or inspection units. There is plenty of room to spread out drawings and other documents. Convenient storage space under the counters and conscientious housekeeping discipline prevent clutter. Ample aisle ways make it easy to maneuver carts for transporting workpieces and tooling items.

A look behind one of the automated cells reveals the tidy, accessible arrangement of utilities serving each machine tool. The large pipes running against the wall are connected to a centralized dielectric fluid system.

Right Hand, Left Hand

One of the keys to the layout of the EDM cells is the left- and right-hand configuration of the machine tools. Each of the two wire EDM cells consists of a pair of FA10 models from Mitsubishi EDM (Wood Dale, Illinois). Each of the three CNC sinker EDM cells consists of a pair of EA12E sinkers from the same builder. In each cell, a WorkMaster robot from System 3R (Totowa, New Jersey) loads and unloads workpieces. The robot also serves as an automated electrode changer in the sinker EDM cells.

The FA10 and EA12 units are normally configured with the operator's control pendant on the right side only. To meet the requirements at TNT, the builder agreed to provide units with a control on the left side to fit the side-by-side layout of the cells. These modifications were designed at Mitsubishi EDM's U.S. headquarters in suburban Chicago and executed in the builder's plant in Japan. According to Bill Isaac, product sales manager, the modular construction of these machines made the modifications feasible. Operation of the machines and control units is otherwise unaltered. (The left-hand configuration is now available to other users by special order.)

The left- and right-hand configuration of the sinker EDM units allows the machines to face the front while the robot is stationed in the middle.

At TNT, System 3R's integrated tooling system is used on the CNC sinker and wire cells, as it is on all of the shop's EDM equipment. Milling machines used for electrode production all use this integrated tooling system, ensuring that the exact location and orientation is maintained throughout the entire machining and EDM process. The robots are equipped with grippers compatible with the System 3R tooling.

The shop's two automated graphite milling cells also feature right- and left-hand configurations. The Okada GM544 high speed CNC graphite milling machines also required modification to the control pendants and automatic toolchangers to provide clearance for the robot arm. Each machine is equipped with an air-operated lift panel on the right or left side of the machine enclosure for robot access.

The two graphite milling cells are identical, except for the fact that one cell is equipped with Nikken CNC 100 rotary tables to give these machines four-axis capability.

Tom Mullen, president of TNT EDM, holds an aluminum clutch housing on which internal and external splines are produced by EDM. The electrode in his other hand is one used to produce the internal splines. This long-running job is ideal for untended production on the automated CNC sinker cells.

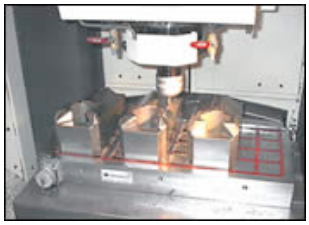
Hard Milling Comes On Strong

Although the shop has been investing in its hard milling capability, Mr. Mullen does not see a retreat from his company's focus on the EDM process. Hard milling has certainly reduced the amount of EDM the shop does as a percentage of each job, but the EDM operations remain essential.

One area in which the shop has specialized is the manufacture of warm forge tooling and production tooling for forging powdered metal (PM) parts. Punches and dies for forging PM parts are more precise than tooling for conventional cast parts. The geometry of this tooling is more complex, and tolerances are tighter. As a result, forging of PM blanks yields a stronger part that is closer to net shape.

This kind of tooling lends itself to hard milling because the geometry is relatively shallow. Five-axis machining is often required so that the complex geometry can be reached without excessive tool length in areas formerly produced with EDM. The shop performs rough milling on OKK three-axis machining centers. Finish milling is accomplished on either Yasda three-axis machining centers or on Hermle five-axis machining centers.

The punch and die sets for forging a PM part blank provide a good example of the interaction between hard milling and EDM. In this particular case, the lower dies feature a large through-hole. Wire EDM must be used to produce these openings.



On forging dies for a PM part, hard milling has replaced much of the machining once done by EDM. However, wire EDM is routinely used for a large opening in the lower die.

The size and depth of these openings preclude the use of hard milling for this operation. These openings are wirecut on a Mitsubishi FA20 wire EDM, which features submerged cutting. The parts are fixtured in multiples. Submerged cutting provides an advantage because the thickness of the part varies around the diameter of the opening, creating uneven flushing conditions that would be difficult to contend with on non-submerged wire machines. By cutting inside a tank filled with deionized water, the process produces a better surface finish and more accurate geometry at faster cutting speeds.

Mr. Mullen believes that the successful application of hard milling and EDM ultimately rests on a clear understanding of the capabilities and limitations of each process. "We do as much as we can with hard milling and use EDM where it is indispensable," he says. His years of experience with EDM have proven to be an invaluable guide in sizing up opportunities for maximizing the effectiveness of EDM while taking advantage of the productivity offered by hard milling. "Both EDM and hard milling are here to stay," Mr. Mullen says.

Advances in cutting tool technology, spindle design and high speed CNC controls will continue to make hard milling more effective. At the same time, advances in EDM automation will continue to make this process more efficient.