

## **Automation for the Small Shop**

(MIDDLEBURG HEIGHTS, OH) – Defining automation opportunities for a manufacturing organization can be a daunting task. Each option and the resulting investment must be weighed against potential savings, with the initial assumptions usually being reduced headcount. Such assumptions also include that the organization's volume must support investing in automation. Most often, this is interpreted as only high-volume, low-variable operations making thousands of the same parts around the clock can make automation pay off.

Small shops, however, can reap significant benefits in flexibility and production throughput with the same automation system. Combined with advances in metalworking technology, such as high-speed, five-axis machining, material-handling automation systems provide small shop owners with low-volume, high-variability parts significant payoffs in increased productivity, improved part quality, and reduced process times.

K-M-S Industries (Middleburg Heights, OH) is a relevant example. K-M-S is a self-described contract machining house specializing in precision parts for various industries, including performance racing, energy, transportation, and aerospace. Established on April 1, 1980, the shop currently employs 28 and works two shifts, seven days a week.

Low-volume but lucrative, the manufacture of high-performance components for demanding top-fuel and funny car drag racers (as well as boats) represents about half

the business at K-M-S. Other NHRA and IHRA parts made by the company include clutch floater plates and super-high-performance blowers for hot rod engines.

Another major workload category is contract machining of custom wheels, mostly for the automotive aftermarket. The typical mix of workpiece materials is 80 to 90% aluminum, with the rest being alloyed steels. Limited-volume parts coming off one at a time are the norm.

For K-M-S, the opportunity to automate came hand-in-hand with advancing its production technology. In 2001, the company purchased a Variaxis 630 high-speed multiple-face vertical machining center from Mazak (Florence, KY) with an integral tilting rotary table. The Variaxis was purchased for simultaneous 5-axis machining of parts such as the supercharger end caps and housings, as well as contoured spokes and features on custom wheels. To take full advantage of the throughput possibilities of the machine, K-M-S opted for a Mazak Palletech Manufacturing Cell with 16 pallets that can be pre-loaded and queued while the machine is making chips. K-M-S has the distinction of being the first US shop to couple the popular Palletech system with the advanced Variaxis machine.

### **Queuing the Work for Unattended Operation**

With 16 pallets of pre-fixtured parts on tombstones feeding the Variaxis 630 5-axis, 30 Hp, 12,000 rpm high-speed spindle machine, K-M-S can run unattended for eight hours, without interruption. Pallets can be re-sequenced after fixturing to enhance customer-driven scheduling. Company founder Dick Malone says, "With a single setup and the ability to run unattended, we have much more flexibility to move to a build-to-order system and run what we need when we need it."

Machinists are freed up to prep upcoming projects or run other machines. Most importantly, part fixturing time does not subtract from machining time, making throughput

much higher than before. “It was always at least two setups on two separate horizontals,” Malone says.

The modular design of the Palletech system works with the Mazak production equipment to provide automatic operation. Once the production schedule is input into the controller, pallets are automatically transferred from the pallet stocker to the machining center, and the machining starts automatically. When machining is finished, the completed pallet is automatically changed with the next one according to the production schedule.

### **Done in One**

The first factor that the advanced equipment improves is the part-machining process itself. Each part is handled less because it can be completed in the Variaxis machine without re-fixturing. Programming is simplified for contoured parts, such as the wheel features, due to the 5-axis capability. The Variaxis can efficiently blend radii on a wheel to reduce stresses. On prismatic parts, Variaxis can machine the top and four sides of the workpiece as well as inclined faces and angled holes. Dick Malone explains: “Going the way we did eliminated all this extra setup time. Total cycle time reduction is substantial.”

Mechanical attributes of the machine also contribute to the fast cycles. Tool change time (tool-to-tool) is 0.9 second, with high-speed traverse rates up to 1969 IPM. Ballscrew core cooling is provided to maintain a stable temperature and high accuracy.

Overall part quality is increased since the part is kept in one fixture, and not moved between machines. There is no need to transfer part programs, relocate parts in a second machine, and re-enter part datums. The Variaxis 630 comes equipped with the Mazatrol Fusion 640M 5X CNC control with conversational programming. The Fusion

640 can be easily networked with other operations using standard protocols, allowing program downloads from an off-line PC.

The processing power of the Mazak control matches the dexterity of the machine. The rotary trunnion table with a 24.8" x 19.7" pallet constitutes a 360° rotating C axis , that in combination with a tilting range of 150° (the A axis), gives the user a tremendous amount of flexibility in terms of angles for approaching the work with a tool. The A and C axes can be indexed in 0.001° increments.

### **Surface Finish Quality Benefit**

Enhanced surface finish to the point of eliminating grinding is another significant advantage. For certain custom wheels K-M-S provides from forgings, the former production process included spin-grinding with form cutters the company had to make. Now with the 5-axis Variaxis, "we can use standard tools normal to the surface," Malone says. "Surface finish is so improved that secondary buff and polish operations are eliminated."

Dick Malone summarizes the significance of his new approach, in terms of future plans: "I'll never buy another three-axis machine again." He intends to run traditional three-axis parts as well as prismatic five-axis parts on his Variaxis and Palletech setup, and knows that he grow with it, due to the profitability of three specific benefits: "The workholding is simplified, since I only need to grab the part one time. Secondly, I get better geometries and closer tolerances. The third big benefit is that, with Palletech, I can set up parts while the machine keeps running. You really get the best of both worlds: improved machining accuracy and a pallet changer for untended automation. In my opinion, it's the future for most low-volume machining operations."

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Caption:

At K-M-S Industries, custom wheels are fixtured flat and queued on 16 pallets within the Mazak Pallettech system that feeds the Variaxis 630 Vertical Machining Center, where spoke features are finish-machined via the machine's 5-axis capability.



Caption:

Supercharger housings and end caps are pre-fixtured on "tombstones" within the modular, expandable 16-pallet Pallettech system. The pallet-loader robot shown here transfers and loads the pallets into the Variaxis.



Caption: Mazak's Variaxis 630 with a Palletech Manufacturing Cell.