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In some businesses, work is approached as a problem. Doctors and nurses work to locate the source of a problem and take steps to correct the error and ease the distress. In other businesses, work is approached like a responsibility, as in the way farmers manage their fields and orchards, or ranchers tend their stock. Their task is to wait for nature to take its course, preparing for a future development and working or sacrificing to bring about the expected results.

We approach our work like explorers, seeking out things that are new or unknown, aiming to bring these novelties to the attention of the wider world.

But the business of manufacturing is different than all of these. Manufacturers are creators. They take a concept or a “design” and create that idea in physical form. They create the means for that creation too, by defining the program that will result in the physical result.

So, it is wrong to emphasize future or potential developments in manufacturing, because manufacturing is an activity that takes place only in the present.

But do not be misled. Manufacturers are creators because they have a lively and accessible vision of the future. They see what is possible. They know what is pending and can evaluate what is potential.

When manufacturers approach new technology it is with active understanding that it will be applied to work — their own work, or some work that they are prepared to start. They are not looking for the unknown or fixing what is not right. They are applying what is ready to achieve what is necessary.

Manufacturers are thriving now — as we can document by the ongoing rise in new machine tool orders and the continuing growth in demand for cutting tools, all pointing to the sustained rise in industrial demand and manufacturing activity. Also proving the strength of manufacturing now is the extraordinary success of IMTS 2018, recently concluded with nearly 130,000 attendees, a record for the biannual event. There they saw displayed the forward trajectory of manufacturing technology — its machines, its controls, its peripheral systems, its programs and its networkable solutions. It was all there, available, ready for work.

The manufacturing that is happening now is at the peak of its long progress, and it will continue to be that as long as manufacturers are at work.
Operators of machine tools pause, however briefly, every time the phrase “manufacturing technology” is used to describe their work, their industry, their corner of the world. Manufacturing technology is the label now applied to the industrial sector that cuts, turns, grinds, finishes and does so much more to produce critical component parts. It’s a label that’s still a little ill-fitting, but they’re growing into it.

This is not to say that machine-tool operators, or machine-shop managers, or owners, spend a lot of time considering the linguistic implications of the work they do or the tasks they perform: they work. They approach their technology as tools – which, in very practical way they are. But, in selecting and buying new tools, the technology of manufacturing works its way into their understanding. “Manufacturing technology” may be growing on them as a label, but they are giving the term all the validity it deserves by the ways they apply these emerging processes and functions.

None of this is a secret. It was all out in the open for 120,000 or so people to see and share at IMTS 2018, in September. Now more than 90 years in business, the International Manufacturing Technology Show — still “the machine tool show” to lifers — proves that as a gathering of designers, engineers, physicists, experts in material science, information technology, electronics, hydraulics, and machinists too – as well as the financiers, marketers, buyers and sellers that make manufacturing big business. It proves that machining parts is high technology. Manufacturing technology.
Douglas K. Woods may be the one person among the many thousands who has a clear vision of all that is happening in the business. He is one of those lifelong manufacturing professionals with extensive personal associations with machine shops and machine-tool and cutting-tool developers. He’s held executive positions and directorships for commercial enterprises, in business development programs like the Reshoring Initiative and the National Center for Defense Manufacturing and Machining, and for technology initiatives like MTConnect (the manufacturing interoperability standard) and MTInsight (a manufacturing business intelligence platform.)

As the president of AMT – the Association for Manufacturing Technology since 2009, Doug Woods has led the IMTS sponsoring organization through five iterations. He’s seen the many phases of technology that are shaping manufacturing.

“IMTS clearly is the largest manufacturing-technology event in the Western Hemisphere,” he offered, “and it’s an opportunity for the builders of manufacturing-technology equipment to show their achievements and innovations to a broad base of industrial users.”

“It’s a place that you can come to look for a solution to a specific manufacturing need, or if you’re just seeking to find out the latest that’s happening in your technology space, how you might in the future improve the productivity or efficiency of your operation.”

Woods described the thousands of ideas that are emerging as commercial offerings in tooling or fixturing, or in controls or automation, or measurement. What IMTS presents in its ‘Emerging Technology’ pavilion are projects and ventures that will affect manufacturing operations “five or 10 years down the road,” he noted — if not even sooner.

If IMTS stands as a platform for manufacturing innovations, it’s also the stage for the trends currently shaping manufacturing, the most notable of which is “expansion.” In that development, North American
industries are drawing on manufacturing’s skills and resources to achieve their growth objectives.

From his position, Woods gained perspective on those plans. “What we’re seeing, and hearing, is a lot more planning for new product debuts and new technology introductions,” he reported in the weeks leading up to the event, “especially by the international OEMs.

“I think the big reason for this is not only the strong economy in the U.S., but that the United States is being seen by these equipment technology developers as the frontline of what’s happening in the manufacturing ‘space,’” according to the AMT president.

“Whether their particular emphasis is digital manufacturing, or Smart manufacturing, or transformative technology or exponential technology, people are recognizing that this is the hot spot in the world for that, and so they want to ‘premiere’ products or advance products here, for automation, for augmented or virtual reality, or machine learning and artificial intelligence,” Woods suggested.

Describing the types of manufacturing technologies presented on the IMTS stage, Woods first identified “a real emphasis on ‘hybrid manufacturing,’ with substantially more exhibitors highlighting those technologies.” Indeed, a long list of top-tier machine tool builders — DMG Mori, GFMS, and Mazak — are ‘breaking through’ ideas combining machining with additive manufacturing.

“Integrated subtractive and additive technologies have expanded quite a bit,” Woods observed, emphasizing that additive-manufacturing system suppliers “no longer want to be portrayed here as emerging technology.”

Another area of progressive technologies involves robotics and automation. “The exhibitors are realizing that the attendees want to see full turnkey solutions presented, not only the (machine tool) OEMs but also the automation and robotics developers.” This is a consequence of the shortage of skilled personnel as well as of the rising volume of data collection and evaluation that goes on in manufacturing, data that is critical to OEE. “The attendees would like to see an integrated solution where all these devices are working together and sharing information seamlessly.”
DIGITAL THREADS

Another emergent dimension of manufacturing technology is what Woods referred to as “the digital thread” that runs from product design and process simulation, to metrological product certification and the sharing and optimization of production data.

“We’re going to be doing more to highlight the ‘digital thread,’” he explained, “with multiple types of seamless data sharing and optimization of automation, and capturing digital information more seamlessly, some of which goes toward the concept of creating a digital twin.”

For example, Woods offered the developers of coordinate measurement machines (CMM) and metrology in it broader applications. “It’s now possible to capture huge amounts of data from the real part, and real-part information also can feed into the packages used to build the digital twin of the entire process – the machining, the measuring process, the testing process, so building the true digital picture is now a part of lots of different pieces of technology,” he explained.

IT’S GETTING CLOSER

“I think you’ll see a lot of exhibitors in the traditional CAD/CAM engineering ‘space’ offering full integration of Cloud-based tools, where they’ll aggregate lots of other information and create some unique, value-added solution. While some of these developers are doing this with MTConnect, leveraging its ability to grab structured data from equipment and develop OEE information, to allow the operators to do things they could not do before; others are offering super-high-end data networks that create true digital twin products that are available for prototyping without ever making a part.”

In short, the manufacturing technology industry of today presented at IMTS 2018 was really a window to a very near future, one that’s coming to life because of the way that machine tools link the skills and imaginations of people to the power and reliability of technology.

Doug Woods noted this potential has become deeper and broader over the past decade, fueled by the rise of data networks (sensors, software, advanced analytics) and guided by innovations of skilled manufacturers and technology “visionaries,” the so-called “maker community.”

“When you look at what people have been buying it becomes clear that they want to have available the latest technology. So, I think when you look at machine shops, tool-and-die businesses, all types of manufacturing companies – there is still a lot of capacity to be updated or replaced.” And a lot of opportunities to be pursued.
THE ALL-OF-THE ABOVE CHOICE

Hybrid Manufacturing means that forward-thinking machinists do not have to choose between “subtractive” production and additive manufacturing.

It seems curious now that “additive manufacturing” should be regarded as anything novel or extraordinary. It was merely four years ago that the organizers of IMTS instituted a special pavilion to display the support technologies and design and production potential for additive manufacturing systems. Now, additive manufacturing is an extension of the capabilities for many CNC machine developers, and additive manufacturing figures prominently in the design and automation programs that inform the wide field of manufacturing technologies.

For the manufacturers and machine shops adopting these systems, it means

The machine tool builders figured out the contiguity of these technologies long ago: their incorporation of additive manufacturing into the spectrum of their manufacturing concepts and capabilities — as “hybrid manufacturing” — demonstrates not merely the breadth of their understanding but the potential for growth as design and production become increasing fluid and interactive.

At IMTS 2018, hybrid systems represented its own branch of manufacturing technology — equivalent to turning or grinding in its relevance to the work of manufacturers. Hybrid manufacturing is the connecting point machine shops need to all the quickly expanding dimensions of design and materials.

But let’s step back: At IMTS 2016, CNC machine giant Mazak Corp. made its commitment official with the first demonstration of its “hybrid multi-tasking” machining concept, centered on its VC-500 AM five-axis system, able to machine large-dimension parts as well as to apply additive technology with a laser-powered cladding head tool. The latter function imparted high-quality finishing details in multiple materials, accomplishing both material and geometric details as the part’s application may indicate.

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VC-500 AM I This VC-500 AM was introduced in 2016: the new VC-500A/5X AM HWD will incorporate “Hot Wire”, a co-development of Mazak Corp. and Lincoln Electric Corp.
Just two years have passed, and now Mazak offers the VC-500A/5X AM HWD multi-tasking machine, which it reports offers “part processing capabilities beyond those of conventional multi-tasking to reduce lead times and part costs, increase machining accuracy and part quality and achieve even higher levels of productivity, flexibility and profitability.”

The VC-500A/5X AM HWD incorporates a new additive manufacturing technology called “Hot Wire” that Mazak developed with Lincoln Electric Corp., the arc-welding/plasma and oxy-fuel cutting technology and product specialists.

According to Mazak, with Hot Wire laser deposition, the VC-500A/5X AM HWD offers a high-speed additive solution and programmable welding automation, in addition to the full five-axis machining capabilities of the Mazak VMC that is the core of the unit.

As in arc welding, a torch melts metal wire to apply a new structural element to a base material and/or part; the wire and workpiece may be similar or dissimilar, but the fusion is completed. Machine shops or other manufacturers can achieve “exceptionally precise sealing coatings along with near-net shape part features, or use the machine to repair costly complex components such as impellers and turbine blades, along with tool-and-die parts,” according to Mazak.

The VC-500A/5X AM HWD’s laser cladding head has the same five-axis capability as its milling spindle, so the machine can be fully programmed to add new part features or weldments on all surfaces of a workpiece. “It is well suited for high-volume additive manufacturing and helps minimize equipment and material costs,” Mazak emphasized.

The Hot Wire head incorporates an automatic wire-feeder system that delivers welding wire to an argon gas nozzle. The head achieves a deposition rate of three to four pounds per hour, with a 98% material utilization rate.

The VC-500A/5X AM HWD has a trunnion-style rotary/tilt table for processing small, complex parts with five-axis flexibility. It also features the MAZATROL SmoothX CNC and MTConnect capability to simplify programming and increase cycle times. It’s also networkable, for full digital manufacturing.

As for its milling functions, the VC-500A/5X AM HWD is supplied with a CAT-40, 12,000-rpm spindle as standard, for exceptional metal removal with all common materials (steel, aluminum, cast iron. Speeds of 15,000 rpm and 20,000 rpm are available to address a part production requirements.

A 30-tool storage magazine, a compact chip conveyor, and mist collector with smoke filter will allow continuous part machining.

At IMTS 2018, hybrid systems represented its own branch of manufacturing technology — equivalent to turning or grinding in its relevance to the work of manufacturers. Hybrid manufacturing is the connecting point machine shops need to all the quickly expanding dimensions of design and materials.

Of course, Mazak was not alone in “introducing” hybrid manufacturing capabilities. DMG MORI has been incorporating additive manufacturing technologies to its portfolio for five years, basing its efforts on “directed energy deposition using powder nozzle technology,” or laser-based melting of powder metals. At IMTS 2018, the developer highlighted its progress by showing the Lasertec 30 SLM.

The powder bed technique allows very small, very complex parts to be manufactured by selective laser melting. The Lasertec 30 SLM lets operators use various different materials with an “intelligent powder module concept” for changing material in
less than two hours. The closed powder circuit also promotes workplace safety and process autonomy. The machine’s ergonomic design simplifies workpiece handling and maintenance work thanks to the arrangement of doors and flaps, while the DMG More Stealth Design Control Panel keeps all important buttons and operating elements in direct view.

Possibly the fullest realization of hybrid manufacturing is evident by the alliance of machine tool builder GF Machining Systems and additive manufacturing specialist 3D Systems. Together, they announced their collaborative effort: the DMP Factory 500 system, an SLM process capable of round-the-clock production, with a build envelope for 500 x 500 x 500 mm metal parts 24/7. The manufacturing system consists of five modules, and achieves full traceability for metal powder batches to maximize quality and lower material costs.

The function-specific modules are designed to maximize efficiency by optimizing utilization. Each module is fully integrated with a Removable Print Module (RPM) that is vacuum sealable for a controlled print environment and engineered to move between printer and powder modules for a continuous production workflow.

Printer modules are designed for 24/7 printing of parts. powder-management modules (PMMs) are designed to “depowder” parts efficiently on the build platform and automatically recycle unused powder, to prepare the RPM for the next build.

Repeatable quality for the parts produced is addressed by the RPM, which provides consistent powder control from batch to batch. A vacuum chamber keeps oxidization under control during part formation. Powder waste is managed thanks to the vacuum chamber that ensures material quality remains consistently high, sufficient to be recycled for later use.

The modular design of the DMP Factory 500 Solution promotes continuous functionality of all metal 3D printing and powder management modules, maximizing uptime and throughput. The ability to match the number and type of modules required for a particular workflow helps to optimize the manufacturer’s investment – and the minimal manpower requirements help to reduce cost of ownership and operating expense.

The collaboration of GFMS and 3D Systems underscores the meaning of hybrid in “hybrid manufacturing”: it’s not simply a consolidation of production processes, but a confluence of capabilities for machine shops and manufacturers that allows them to present an all-of-the-above choice to product designers and component buyers.
SPEED, PRECISION, AND FLEXIBILITY
DRIVE HOT FORMING DESIGN

New machine addresses automotive suppliers’ need for lighter cam lobes, with high pressing force and maximum productivity.

In any discussion of manufacturing innovation, there is some tension over the inspiration of new technology: Does the new idea descend from demands made by consumer markets, or is it the result of some important design or scientific breakthrough? Once the innovation catches on, however, this debate may not matter. The market issues its decision on the new technology — and it’s the developers goal to get to that moment as quickly as possible.

The forming technology developers at Hatebur Umformmaschinen AG will surely accomplish that much. The HOTmatic hot forming machine series is long established among forgers producing precision parts in high volumes: wheel flanges, gear wheels, rolling bearing rings and nuts. For obvious reasons, the automotive manufacturing sector is an important destination for HOTmatic products. Over several decades since the Swiss company introduced the first HOTmatic system, it has developed a dozen or so variants to suit the scale of operation that customers require.

The latest innovation is the HOTmatic AMP 20 N, which Hatebur engineers developed specifically for hot forming cam lobes.

In a combustion engine, the cam lobes are fixtures located on a camshaft that open and close the intake and exhaust valves in time with the motion of the piston. Cam lobes control the valve lift, and there is a direct correlation between the shape of the cam lobes and the per-
formance of an engine at different speeds. With the HOTmatic AMP 20 N, Hatebur indicated it aims to improve the efficiency and productivity of suppliers of automotive components.

“Almost all of the forged cam lobes supplied worldwide are produced on Hatebur machines,” according to CEO Thomas Christoffel. “With the development of the HOTmaticAMP 20 N, we are responding to new trends… We want to make our customers even more productive and strengthen our market leadership.”

Most of the forged cam lobes are produced on two earlier versions of the machine, the HOTmatic AMP 30 S and 20 S, and the results are reliable and efficient. But, the lightweighting design prerogatives of automakers inspired the new machine design. “The trend goes toward thinner cam lobes in order to support the lightweight construction of engines,” Christoffel explained. Thus, Hatebur’s R&D division initiated a fundamental approach to their project, focusing on cam lobes that are just 8-mm thick, in contrast to the 12-mm standard that has been the basis for previous designs.

“The thinner cam lobes impose the highest demands on the forming machine,” according to the Hatebur executive, “in particular in terms of the shearing quality, the pressing force and the part transfer.”

The resulting machine design “is ideal for manufacturing) thinner cam lobes with high surface quality, outstanding wear-resistance and precise geometries,” Christoffel said. And, while the production of lighter automotive cam lobes was the intended function and the focus of the design initiative, Hatebur emphasized that it is not offering a single-purpose machine. “The AMP 20 N is flexible and can be used in a wide variety of applications,” Christoffel said.

Operating with a total press load of 1,500 kN — the designers specified a reinforced machine body to ensure the necessary stability — the AMP 20 N nevertheless maintains consistent precision in forming parts and production speed.

“In three forming stations and with a maximum of 200 strokes per minute, the AMP 20 N produces cam lobes with an outer diameter of up to 48 mm out of raw parts with 24 to 217 grams,” according to Hatebur marketing and sales chief Reinhard Bührer.

Steel bars up to 6 meters long and heated to almost 1200°C are brought into position by four feeder rollers, powered by servo drives. “When thin parts are being processed, the transport between the forming stations needs utmost accuracy to achieve an ideal surface quality,” Bührer emphasized.

One critical element of the process design is the shearing unit. “This is where parts with a cut-off length of 20-45 mm are made,” Bührer noted. “Just as on other Hatebur machines, the surface quality of the shear plane is outstanding. The forming of the parts can start from the first station.”

Almost all standard cam sizes for passenger cars can be produced on the AMP 20 N. “Most of the tools are compatible with the HOTmaticAMP 20 S,” according to Bührer. “Low maintenance and operating costs as well as the high productivity lead to an exceptional cost-benefit ratio.”
DIGITAL TWINNING FOR MACHINE MAINTENANCE

New machine addresses automotive suppliers’ need for lighter cam lobes, with high pressing force and maximum productivity.

Machinery is the object of intensive design and redesign – and as machines’ function grows more specialized, the role of design remains preeminent in the machines’ performance. For example, diecasting is an increasingly relevant process in the production of critical components in automotive manufacturing, capable of precision and high-volume, especially for lightweight materials. The process delivers accurately dimensioned, sharply defined, smooth or textured-surface metal parts.

Diecasting involves forcing molten metal into reusable metal dies under high pressure. The design of the completed part is the goal, but the design of the machine is what makes the process so effective.

That makes diecasting machinery a suitable application for some of the latest applications of advanced manufacturing technology, augmented reality (AR) and virtual reality (VR), and the use of “digital twinning”.

The Digital Twin concept is a convergence...
of design and function, virtual and physical reality.Beginning in the design phase and continuing through deployment, machine designer and machine operator are able to maintain a complete digital parallel of their products. The digital version generates data in real time, so businesses can analyze and predict the problems in advance, receive warnings of coming events, prevent downtime, and develop new products using simulations.

Digital Twins incorporate other technology trends too, like Big Data, Artificial Intelligence (AI), Machine Learning (ML) and Internet of Things, all within the Industry 4.0 paradigm.

Digital Twins, virtual counterparts to physical assets, are duplicates of actual machines defined and created by the use of data collected from sensors on the actual machine. Digital assets can be created prior to the actual creation or operation of the physical asset. Design information plus AI algorithms are integrated into a physics-based virtual model of the machine’s activity, and by analyzing the models that result from this the designers and operators are able to gain insights into the performance of the physical asset. The digital twin thus works as a simultaneous, live model of the physical machine.

Software developer Aveva is supplying AR and VR technology to a diecasting machine builder as a way to implement “digital twin” functionality for system maintenance of its capital equipment. Italpresse Gauss will “embed” Aveva’s software in its diecasting machinery, using a new tool called AMe.

It will allow diecasting machine operators to use mobile devices, Industrial Internet of Things protocols, and VR/AR technology to achieve “interoperability” … or “maintenance as a service.” For example, an operator would be able to use a camera-enabled tablet to isolate a view of a machine part, and extract augmented data and maintenance documentation related to that part to diagnose and repair faulty components or processes.

Then, a VR headset can be used by a remote engineer to guide the service or repair procedure on-site.

“In an increasingly competitive global marketplace, it is critical to separate ourselves from the competition by providing new value for our customers,” stated Italpresse Gauss president Carlo Scalmana.

Describing the new functionality as part of a “digital transformation strategy,” Scalmana noted the AMe technology allows maintenance technicians to address service requests faster, reduce downtime, and increase machine productivity.

Italpresse Gauss had previously adopted Aveva’s Wonderware Monitoring and Control capabilities. In 2015, the press builder developed the HMe a system for monitoring and control of diecasting process. Access to the operations data gained via HMe has been foundational to developing AMe.

“The Industrial IoT has unlocked new business opportunities to offer innovative services,” said Maurizio Galardo, director of AR/VR business at Aveva. “This “digital twin” service is a competitive differentiator …”
FIXED ON FIVE-AXIS

X-Y-Z + A + B remains the formula for flexible manufacturing, and the route to machine shops’ success

Human nature overlooks the everyday wonders while it anticipates the possibilities of the future. In complex operations like machine shops, where fresh challenges arrive with almost every new order, it can be easy to overlook high technology while considering higher technology. So, while the manufacturing world buzzes about additive manufacturing and hybrid manufacturing, five-axis machining continues to execute projects in ways that seemed like miracles of engineering just a decade or so back.

It’s not simple, but to understand five-axis machining in simple terms just think of all the directions in which a cutting-tool spindle can move around a workpiece. The X and Y axes refer to movements in the horizontal planes (left-right, front-back), and the Z axis refers to movements in the vertical plane. Together these will accomplish three-axis machining, which itself is quite impressive. But now consider the space between these axes and the ability to reorient a workpiece via a rotating table: the rotational axis around X is thus considered the A axis, and the rotational axis around Y is considered the B axis.

The emergence of computer numerical control (CNC) programming made five-axis machining conceivable, and eventually possible. Now, it is actual: five-axis machining creates infinite possibilities for machining parts of different dimensions, processing five sides with just one set-up.
Once five-axis machining was established as possible, different possible approaches were developed. In simultaneous five-axis machining, or the machine tool’s X, Y, Z, A, and B axes all engage the workpiece at the same time. In 3+2 machining, the machine works through a three-axis milling program with the cutting tool set in a tilted position, before the workpiece is rotated into position for the tool to complete the A and B axes sequences.

In recent years, five-axis machining has come to be understood as the baseline for machine shops, nearly all of which are able to program simultaneous or 3+2 projects, using the various advancements in machine design and the functionality of CNC programming.

But even if five-axis machining is common now, it remains the focus of innovation for many machine tool builders, as IMTS 2018 introductions made clear. Hermle Machine Co. presented three five-axis machining for the first time in North America, including its newest model, the C 650. It is the largest machine of the Hermle Performance-Line, following the earlier C 250 and C 400. C 650 uses a modification of Hermle’s gantry-type design, with a machine bed that is manufactured in Hermle’s own mineral casting foundry in Germany. The swiveling rotary table can accommodate workpieces up to 1,500 kg, allowing for high-precision machining.

The C 650 has an integrated tool magazine for 42 tools, with two additional magazines with 50 or 88 extra magazine pockets available as options.

Five-axis machining increasing productivity and eventually the throughput of machine shops — effectively initiating a need for more automated peripheral systems like gantries or tool magazines. “We pride ourselves on providing solutions to our customers machining demands. In today’s market if you aren’t taking steps toward smart manufacturing you really aren’t providing the best possible machining solutions,” according to Hermle president and CTO Gunther Schnitzer. In fact, while it demonstrated several five-axis systems at IMTS, Hermle put its emphasis on the systems’ availability for shops to execute smart manufacturing, with flexible automation and Industry 4.0 connectivity. “We have tran-
sitioned from being a machine manufacturer to a process provider because we believe that achieving the highest level of automated efficiency absolutely includes integration of the entire work environment and periphery,” Schnitzer added.

Another five-axis machine debuting at IMTS 2018 was the Fives Cincinnati HMC 800, for precision machining on very hard materials, like workpieces destined for aerospace and oil-and-gas programs. The HMC 800 combines high spindle torque and power with exceptional dynamic machine stiffness, plus dual ball screws that provide remarkable feed (45 m/min.) and acceleration/deceleration (0.5G) rates.

The machine’s bridge and saddle provide optimal finish and tool life in hard metal applications. “The Cincinnati HMC 800 is the perfect solution for the aero or industrial customer who machines hard metal applications, from steel to titanium. The unified structural design allows for fast installation on existing shop foundations,” stated Brent Keller, engineering director at Fives Cincinnati. “We are targeting those applications where accuracy, rigidity, and reliability are priorities” — in a way offering that the flexibility of five-axis machining is a functionality assumed by machine shop decision-makers.

The Cincinnati HMC 800 is capable of five-axis/five-sided complex part manufacturing. The five-axis design combines twin ball-screw-driven axes in XYZ; an infinite contouring B-axis table; and compact, u-frame A-axis tilt spindle for full five-axis contour machining of complex part geometries. All combined, the HMC 800 delivers five-sided machining capability with balanced speed, accuracy and range for complex part manufacturing, and reduced part set-up time to reduce production cost-per-part.

Another well-known name in five-axis machine innovation is Haas Automation. As anticipated, the California-based developer presented a range of simultaneous and 3+2 machining options to the IMTS 2018 crowd, including its UMC-1000SS, designed for performance and speed in both five-sided and simultaneous five-axis machining.

The Haas UMC-1000SS features a 40-taper inline, direct-drive spindle capable of speeds up to 12,000 rpm. Its X/Y/Z-axis travels measure 40×25×25 in. (1016×635×635 mm), and the spindles uphold a 1,200-ipm (30.5-m/min) feed rate. An integral, dual-axis trunnion table and a 30+1 tool side-mount toolchanger add to the machine’s functionality.

The trunnion offers a 170-degree/second feed rate for five-sided machining or simultaneous five-axis contouring. The trunnion provides 110 and -35 degrees of tilt and 360 degrees of rotation for tool clearance and large-part capacity.

The 25-in. (635-mm) platter on the Haas UMC-1000SS has T-slots and a precision pilot bore for fixturing versatility. To simplify job set up, the company’s control offers Dynamic Work Offsets, Tool Center Point Control and the Wireless Intuitive Probing system.

The machine’s spindle is powered by a 30-hp (22.4-kW) vector drive system that yields 90 foot-pounds (122 Nm) of cutting torque. The inline system couples the spindle directly to the motor to reduce heat, increase power transmission and improve surface finish. A 15,000-rpm spindle is also available in either 40-taper or dual-contact HSK A63 taper.

For high-volume production, high-mix/low-volume machining, and unattended operation, the machine is available with an eight-station pallet pool. A 50+1 tool side-mount toolchanger, a belt-type chip conveyor, a high-pressure through-spindle coolant system, and an expanded program memory are options, too, Five-axis machining has matured past the time when its developers promoted the novelty of cutting any size or shape — but that flexibility remains the foundation of its value. As the technology promoters turn to emphasize automation or network-connectivity, five-axis machines will remain ready to approach, turn, rotate, and complete the high-throughput production programs sent their way.
EXPANSION UNDERWAY

The fastest growing area of manufacturing technology is the wide-open space between CNC machines and the Cloud, where information is waiting.

The fastest growing area of manufacturing technology is the wide-open space between CNC machines and the Cloud, where production data, performance data, work-in-progress data, and ultimately new-order data are waiting to be located, referenced, collected, and posted. All of the systems and technologies that make manufacturing more reliable, more productive — faster — are at work in that space.

More than this, that space represents machine shops’ best opportunity for growing their business, by increasing product quality and process flexibility using the availability of Cloud-coordinated production and performance data; and by incorporating all the available resources of automation to improve productivity. In a sense, the wide-open space is becoming the development zone in which and machine builder, CNC

The fully configurable, Fastems LLC FMS One machine tool pallet automation system.
developer, or peripheral designer is able to originate products or functions that address a shop’s needs — and thus not only offer customized functionality to the customer but enhance its own capabilities and experience.

At IMTS 2018, Finland-based Fastems LLC showed an array of automation solutions for handling high-mix, low volume production, including a recently updated FMS ONE configurable machine tool pallet automation system. A compact, robotized machine-loading cell called Halter Load Assistant was demonstrated, too.

Fastems’ automation equipment includes extendable and flexible manufacturing systems, robot applications, and control software; stacker cranes; conveyors; loading/unloading stations; pallet magazines and assembly organizers; and raw material stations to name a few. These automation systems have open interfaces and they can be incorporated with virtually any modern CNC machine tool and auxiliary equipment brands. Typical applications range from joining two machine tools together with Flexible Palletized Container (FPC) to highly sophisticated, factory-wide flexible manufacturing systems.

The lingo developing by technology developers to describe their work in the wide-open space is revealing. Heidenhain GmbH, which develops motion control applications for manufacturing, emphasizes “connectivity.” Its Connected Machining package of functions helps manufacturers control their activities on the shop floor and in that wide-open space, so for example digital order-management is not only possible but effective. “You have direct access from the control to all that data that you can use at the machine: technical drawings, CAD data, NC programs, tool data, work instructions, parts lists, warehouse information, and e-mails. So you can transform the workshop from an outpost into a full-value component part of an efficient process chain,” according to Heidenhain.

The advantages it lists range from reduced workload for programmers and operators, to easier data access and smoother, faster workflow. Remote data access is an increasingly popular function that Heidenhain emphasizes, so users can communicate with each other as well as with their systems, not relying on the availability of others for reports or results.

The Heidenhain DNC interface promotes “vertical integration of the workshop in networked manufacturing,” and lets machine programmers and operators connect their production activity with order management systems, or automatically send feedback to processes during production. “This enhances transparency in manufacturing … and supports on-time order management,” according to the developer.

Machine tool builder Index Corporation has taken a holistic view of the opportunity presented by the wide-open space. Index introduced iXworld, an online portal that expands service offerings and establishes a single interface for “a broad spectrum of information and functionality”. iXworld includes iX4.0, iXplore, iXshop and iXservices — four distinct areas of services that offer fast, secure connectivity, production data, remote diagnostics, spare parts ordering from the machine and more, all to minimize downtime and boost machine utilization rates.

iX4.0 enables remote and automated monitoring and reporting of machines that have been equipped with a genubox, a dedicated piece of hardware that provides highly secure remote access via an encrypted online connection. All Index machines sold since 2016 have included a genubox and all machines sold since 2007 can be upgraded with one. Through iX4.0, users can conduct usage analysis, set automatic notifications for specific conditions that occur, monitor machine data such as vibrations and temperature and incorporate predictive maintenance to maximize machine uptime.

iXplore provides easy and intuitive access to relevant information from Index. iXservices encompasses a range of functions related to identifying spare parts, tracking fault reports, calculating cycle times and receiving real-time support from Index engineers. iXshop replaces Index’s online shop for ordering spare parts and requesting services, as well as tracking the status and history of orders.

Of course, any discussion of shop automation must consider the role of robots. The new offerings are numerous, from long-established suppliers as well as the new wave of collaborative robotics developers. In response to rising demand for fast, flexible, and compact industrial robots, Kawasaki Robotics
developed two 6-axis vertically articulated robots with a maximum payload capacity of 7 kg and different reach. The RS007N and RS007L models are the latest additions to the company general-purpose R series line of small-to-medium payload (3-80 kg) robots, which offers excellent functional and environmental performance for assembly, material handling, machine tending and other applications.

Both the Kawasaki RS007N and RS007L robots incorporate a newly redesigned arm structure and main-unit weight reductions. These enhancements result in the fastest operating speeds in these robots’ class (12,100 mm/s) along with increased working ranges. By redesigning the arm structure and adjusting the acceleration rates in accordance with load weights and robot positioning, these models also offer consistently optimized performance by significantly reducing cycle times.

The RS007N robot features a 730-mm reach and the RS007L a 930-mm reach for greater flexibility in production facility layouts. By using a cantilever design for the upper arm section, Kawasaki has achieved a longer maximum reach and an expanded range of motion: below, behind and in the immediate vicinity of the robot. Additionally, these floor- or ceiling-mounting models are designed to house vision cables, sensor harnesses, air lines and other components inside the arm structure. This prevents interference with and from peripheral equipment, thus allowing for operation in tight installation spaces.

If the need for coordinated handling requires more than robots, Liebherr Automation Systems offers the new PHS Allround pallet handling system, designed for a broad range of shops to engage in flexible production in combination with 4- and 5-axis machining centers. The new modular concept, available in three capacities, can handle loads up to three tons, is extremely flexible, and can be individually configured and expanded. This corresponds to pallet sizes of 500x500 mm to 1000x1000 mm. Users can introduce flexible production systems with manageable investment and expand them when necessary.

The customer is able to combine preconfigured modules as needed to match production handling needs: the storage locations can be arranged in a circular pattern, with one or more machines, or in a line.

Machine tool builder ANCA offers a new, custom-designed and -built low-cost industrial robot loader — the AR300. It’s a three-axis system with a capacity of 380 tools that accommodates tool sizes up to Ø20mm (Ø3/4") x 150mm (6") long.

The AR300 loader is contained within the compact machine footprint of ANCA’s new FX5 Linear. In addition to saving floorspace and labor, it operates with no need to change gripper fingers between batches, which further maximizes the potential productivity increase.

According to Liebherr, this space-efficient system fits in almost every production floor. The user can easily expand a production system with the Allround, spreading investment over different expansion stages. It is no problem to start with one or two machines and increase this number to five, for example, as production changes.

For all Liebherr pallet handling systems, a new cell control with simple, graphically-guided interface concentrates functions on the main computer in a user-friendly manner, and if required also allows full
production control (e.g., resource planning, cutting tools management, and NC data management, plus interfaces to the ERP systems.)

For some machine shops the need for coordination is great, even if the work volume is not overly large. The opportunity lies in the management software. Adion Systems, developers of ProShop comprehensive shop-management program offers a new generation of software ideal for Industry 4.0 practitioners, in particular small- and medium-sized manufacturers that are not necessarily suited to ERP systems. One of the most significant differentiators about ProShop is its integrated, comprehensive set of modules for managing the shop’s typical ERP operations, and also includes MES and QMS functions such as ISO-9000, AS9100, API and ISO 13485.

In addition to the more typical ERP segments having to do with “front office” activities (e.g., estimating, quoting and purchasing), ProShop also includes MES (Manufacturing Execution System) and QMS (Quality Management System) control, monitoring and collection capabilities. For instance, among the MES functionality is tracking machine utilization, cutting tool management, media-rich work instructions, part inspection data, and more, including integration with coordinate measuring machine data, which is unique to ProShop.

ProShop offers an integrated, comprehensive set of modules for managing a shop’s QMS — such as ISO-9000, AS9100, API and ISO 13485. This includes standards, equipment, users, training, audit reports, non-conformance reports, corrective actions and the like – all of the tasks required to comply with the various quality systems in place at the worksite. The program may be hosted in the cloud or on site, depending on the customer’s preference.

Closer to the production activity, Shop Floor Automations proposes the DataXchange machine monitoring system, which offers real-time machine utilization alerts with various flexible options.

SFA is well known for floppy drive emulator solutions, with plug-and-play Haas models available and a universal model that fits a large variety of machine makes/models. The newest addition is the Okuma Floppy Connect: This device replaces the floppy drive core in an Okuma machine and takes minutes to install. The Okuma floppy emulator allows up to 100 disks per USB flash drive, allowing users to hold hundreds of files on a single USB stick.

Legacy machine owners can extend the life of their machines by adding USB ports, or adding Ethernet capabilities to them. With the LAN-USB Connect from SFA, they can accomplish both goals at once. Operators can drag and drop files to the CNC data server and utilize an Ethernet connection via the FTP protocol. Drip-feeding is accomplished with various protocols including X-modem. If your internal net-
work goes down, you can still operate with the USB port for sending, receiving or drip-feeding.

If “connectivity” is a buzzword in the new manufacturing space, then the space itself is deserving a label. The choice may be “seamless factory.” WireFreeCNC recently introduced Excellerant API, network device for connect every CNC machine tool controller, no matter the brand, so manufacturers can monitor and manage each machine’s data in real time, and send that data to the company’s MES and/or ERP systems.

“We expect this product to get a lot of attention,” said Christopher Levesque CEO at WireFreeCNC, “because Excellerant API is the fundamental link that’s been missing to simplify data driven manufacturing at the shop floor level.

“It’s been a source of frustration at even the most sophisticated manufacturing companies applying the latest concepts in Industry 4.0 – that there hasn’t been a universal decoder to connect and capture CNC machine data as it happens,” he added.

Excellerant API builds on MTConnect, Fanuc Focas, OPC-UA, Haas MNET Q-Codes, and other machine control connecting protocols, as well as legacy CNC machines. This allows companies to link across systems while substantially expanding and customizing the information they receive. Although some control systems offer the ability to link to their same brand, manufacturing companies typically have a variety of different control systems and a combination of older and newer machines, thus requiring a more universal solution. Excellerant API allows manufacturing firms to keep all of their current systems including upstream programs such as ERP and MES.

It works through a graphical user interface, “clear and logical functionality,” and an array of convenient output types. Machine operators can communicate problems, request assistance, and report progress at the touch of a button. Supervisors and managers can assess cycle time, downtime, and process status by job, machine type, operator, and a host of other useful dimensions. Executives now can run reports in real time, with continuous and immediate feeds from machine controllers through to the ERP level.

Now that the wide-open space has been discovered by machine shops and manufacturers of all types, each one is ready to explore. And manufacturing technology developers of all varieties are providing them the means for conquest.
THE SWIFT, SUDDEN EVOLUTION OF END-ARM TOOLING

New advances in end-effectors show that industrial robots have developed a finer touch, and reveal an array of possibilities.

BY JOHN HITCH, NEW EQUIPMENT DIGEST

For some reason, I can’t think about the 60 or so years of industrial robotic evolution without drawing parallels to our own rise from pre-Australopithecus primates to the ambitious, innovators we are today. We didn’t get to the point of building megacities and sending satellites out of our solar system by being the biggest and strongest creatures. We did those things with our brains and hands.

Those two attributes are responsible for current explosion of industrial robots’ capabilities. Instead of highly developed cerebral cortices and opposable thumbs, though, multi-axis robots rely on software, algorithms and the next generation of end-arm tooling.

Those advances, specifically in end-effector offerings, were apparent in the devices and systems exhibited at IMTS 2018 in September. Showcasing ingenuitive motion and heightened sensitivity, this new species of automation promises to work smarter, not harder, while manipulating the tiniest of components.

ORIGIN OF THE SPECIES

The 1980s began with General Motors chairman Roger B. Smith predicting robots would replace humans, as wages rose. A dollar an hour hike would lead to a thousand more robots on the factory floor. Reality proved his math was off, and by the end of the decade, robot sales were in decline.

“There was stagnation, and robots weren’t selling in the way everybody thought they would,” recalled Robert Little, CEO of ATI Industrial Automation.

It’s not that the idea of robots was flawed, as they could handle heavy materials and weld components, but something was missing: versatility. Humans can learn to do pretty much whatever is asked of them, while robots then were fixed, hardwired, inflexible, and due to limited choices for end effectors, severely lacking in dexterity, a feature at which people excel. Often powered by hydraulics, the robots of that generation had a gorilla-like grip. It is why Little, along with fellow engineers Keith Morris and Dwayne Perry founded ATI in 1989.

“We had a mission to develop end effectors that could survive the harsh treatment robots give them,” said Little, who started as ATI’s COO.

“We built ourselves on engineering bullet-proof end effectors, and it worked. The quality went up, and our sales started to rise. It made robots easier to use and increased robot sales in general.”
New robot installations in U.S. operations increased steadily in the early 1990s, nearly doubling from 1993 to 1995, when the market first crossed the 10,000 unit threshold. How much of that can be attributed to end effectors is debatable, but what’s not is that the robot attachments improved in quality and capability. Grippers, now powered by pneumatics, picked up parts with greater precision.

Adding force-torque sensors led to better feedback, further refining accuracy and repeatability. Interestingly, six-axis force/torque sensors were used as early as 1973 at NASA’s Jet Propulsion Laboratory, as noted in a JPL research paper at the time:

“The drive motor torque required to achieve the link angle/time function is then computed based on a model of the manipulator hardware. The motor voltage/torque characteristic is also modeled, and the computed torque is converted to applied motor voltage. This voltage is computed at a very high rate, applied to D/A converter, and finally to the motor input.”

ATI, now a global leader in six-axis F/T sensors, has advanced the initial concept, culminating in its new Axia80. The high-powered, compact attachment couples to the robot arm and can fit a number of end effectors to increase dexterity. Whereas traditional robots are seen as mechanical and rigid, attaching an Axia80 achieves acute responsiveness that is ideal for high-precision operations.

This makes it the perfect accessory for collaborative robots. The Axia80 works with leading cobot manufacturer Universal Robots’ UR-3, 5, and 10.

Cobots, such as the new E-series UR models, include F/T sensors already, but the Axia80 sensor is up to five times more accurate, with as much as 20 times the resolution.

“It’s always good to ensure you have the best force sensor available,” Little observed. “The Axia80 something as simple as a finger underneath a part.”

In this regard, the creation has surpassed the creator. Although a human hand may cause a tiny amount of deflection, the Axia80 can sense these minimal variations and signal the robot to react.

Keeping all workers safe is a top priority of any automated cobot system, followed closely by improved performance. F/T sensors are able to improve safety and process flexibility simultaneously. Better sensing makes way for a wider variety of applications, which is an excellent development for those who invest in robotics. As technology keeps advancing, there will be more and more opportunities for robots and humans to work together safely and efficiently.

Unlike the GM chairman’s forecast almost four decades ago, the jobs these robots take are not the ones people will miss. A worker would be much better suited to managing several machines and talking to current or prospective customers than grinding and polishing a metal part.

“Robots always succeed in doing work people don’t want to do,” Little said.

PARALLEL (GRIPPER) EVOLUTION

Three decades of experience support ATI’s initiatives. Still, innovation can come from anywhere, at any time, even from a company that has existed for about five months. That’s how old the Danish firm OnRobot is: the end-effector and sensor manufacturer fused three startups—from Denmark, Hungary and the United States—to bring machine shops and other automation users three new solutions for tending and assembly. IMTS visitors saw OnRobot’s devices attached to cobots and conventional industrial robots built by Universal Robots, Kawasaki, FANUC, and KUKA.

“They go hand-in-hand with the collaborative mindset of easy programming, flexible equipment and being able to use robots in different tasks,” said Kristian Hulgard, OnRobot’s general manager for the Americas.

Expect the Gecko Gripper to generate a lot of manufacturing buzz, too. Not to be confused with the biomimetic grippers Festo has become known for, this attachment doesn’t immediately resemble a Gecko’s foot, though it works the same, using a
quantum dynamics phenomenon called the van der waals force. It’s complicated, but the short explanation is that s a polarity, and weak attraction, forms between two objects. Like the early force-torque sensors, this functionality was developed by NASA’s JPL too, this time as an alternative to Velcro.

“The Gecko gripper works completely differently than anything we’ve seen on the automation market,” Hulgard asserted. Though it was launched officially in North America at IMTS, select customers have been using it on steel, glass, plastic bags and even printed circuit boards (PCBs).

The RG2-FT smart gripper, an evolution of the previous RG-2 and RG-6 servo grippers, employs a six-axis force torque sensor in each “fingertip.”

“We can now [be used in] new tasks and start being intelligent,” Hulgard said. “We give the robots so much feedback and intelligent sensing that it’s opening up new doors.”

One of these is in circuit board assembly.

“Imagine, if you need to put a pin in a very tight hole, and use your wrist, not your fingers,” Hulgard said. Built-in proximity sensors also zero-in on the part before touching it, to ensure a proper grip automatically. This also allows the wrist to tighten its grasp on electronics manufacturing, which cheaper labor in Asia has wrested away.

“By giving robots the sensing abilities and being able to automate more, that gives us the competitive advantage,” Hulgard said. “This keep jobs and keep manufacturing where we want it.”

The final new offering, the Polyskin Tactile Gripper, uses sensors on the fingers to offer a less refined, but effective solution for assembly and bin picking. Some features include individual alignment of each finger and bump detection. It’s ideal for sensitive or irregular workpieces.

The economical alternative “might not have all features, but you get the major functionality, such as force control and variable grip distance,” Hulgard said.

OnRobot also demonstrated the RG-2 and RG-6 servo grippers, which along with the Dual RG2 Dual gripper, have been available for about three years. The Dual Gripper specifically has cut robotic cycle times by 40% and helped a Danish high-mix, low-volume machine shop save time and money.

In that instance, the shop’s operators noticed how inefficient it was for a robot to remove a finished part from the machine and set it down before picking up the next part to work on.

“When we put two grippers on, we could grip and place the object in the machine in the same cycle,” Hulgard said. “That cuts out a movement in and out of the machine.”

Hulgard stressed that as these humanlike end-effectors are performing as the cobots’ “hands,” they are augmenting the workers efforts, and allowing for more work cycles to be done.

As cobots’ “brains” evolve to a more general intelligence (as anticipated during in the next decade) all this could change; ad human workers will have to change, too. Survival of the fittest and all that. But that’s the subject of a different argument for another time.

What isn’t debatable now is this: any manufacturer using, or planning to use, the current generation of cobots must be just as adept at knowing what end-effectors are available for their specific task.

“The choice of end effector will start to mean more and more,” Hulgard said. “Now, we’re in that time when we have to educate the market — and show them these new possibilities.”

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