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FEATURES

COLLABORATIVE AGREEMENT

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cover story

EFFICIENCY PAYS OFF

Toolpaths with smooth radial motions and controlled force on the spindle and cutting tool are easily generated by Diamond Machine Works when using VoluMill.

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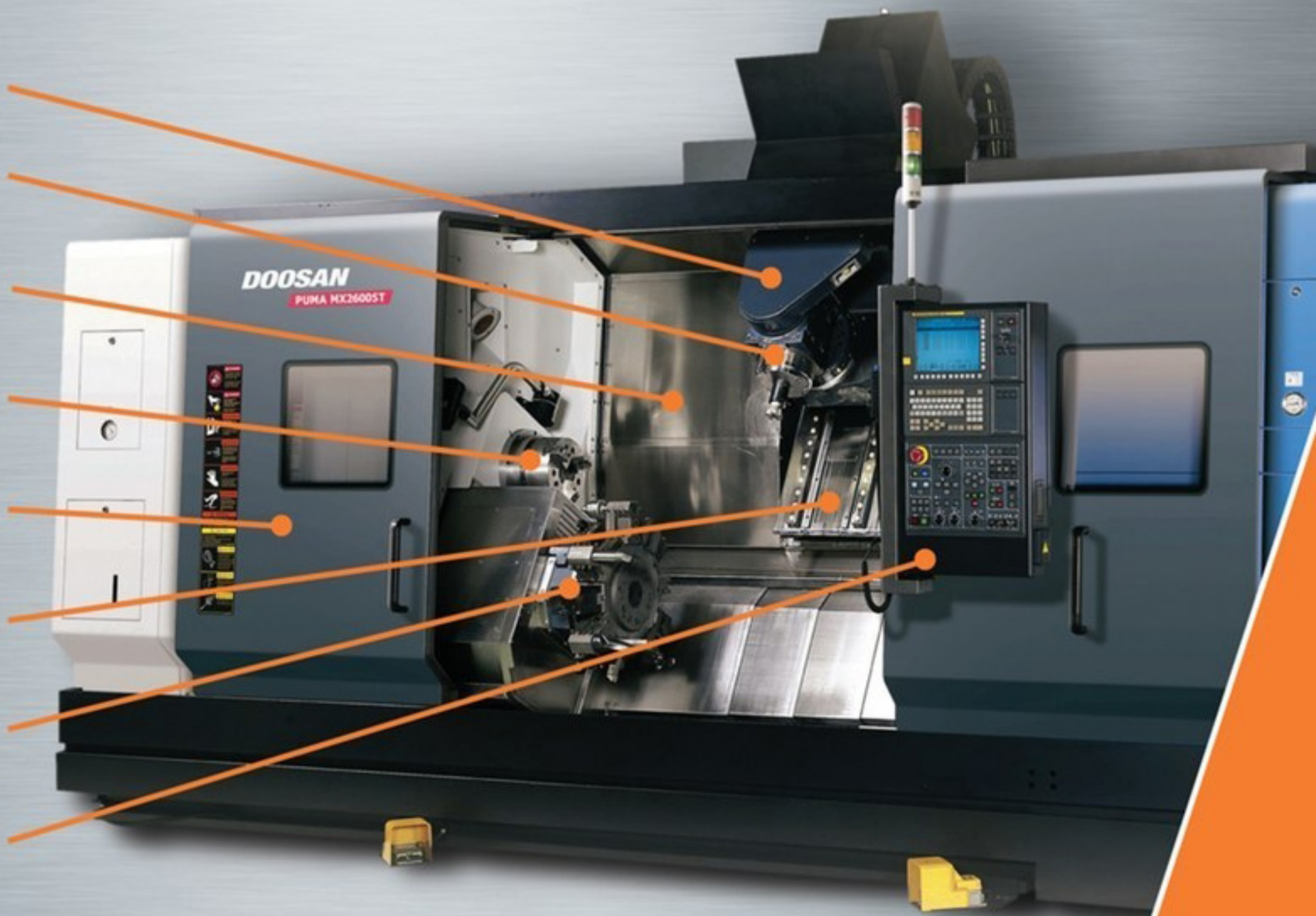
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ABOUT THE COVER

Diamond Machine Works has improved its speeds and feeds, cycle times, and programming time by rough machining complex aluminum, stainless steel, and titanium aerospace and defense parts using toolpaths generated with VoluMill. The software also has given the aerospace-oriented job shop greater flexibility with how it utilizes its machines. Turn to page 32 for the full story.

SHRINK-FIT TECHNOLOGY



The concept is simple. Shrinker toolholders are manufactured with an inside diameter smaller than the shank diameter of the cutting tool. A heat induction unit quickly heats the holder end of the Shrinker, expanding this inside diameter. At this point, the tool shank slips easily into the holder. As the holder cools, the resulting thermal contraction exerts a tremendous, uniform pressure around the entire surface of the tool shank. No moving parts, no accessories, just total concentric gripping strength. Available in ANSI and DIN styles.

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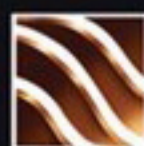
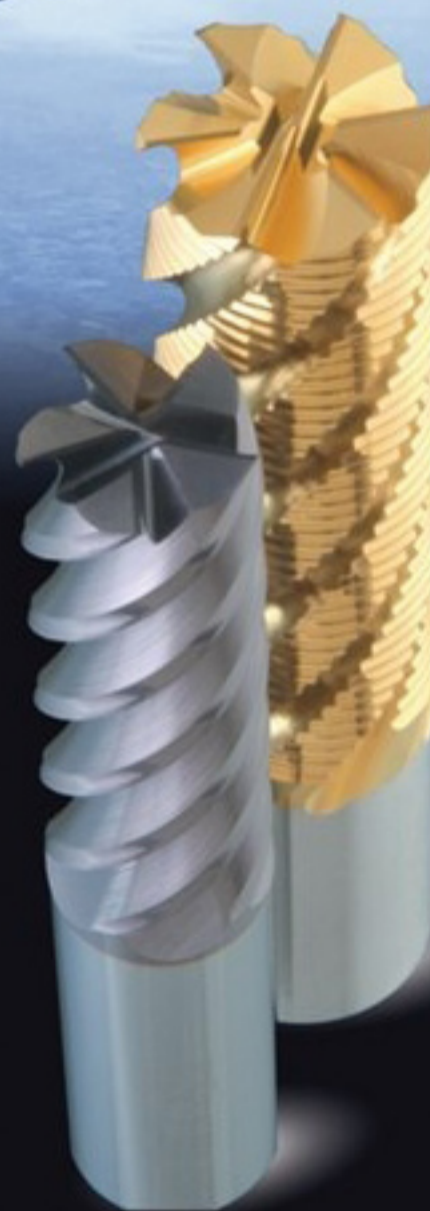
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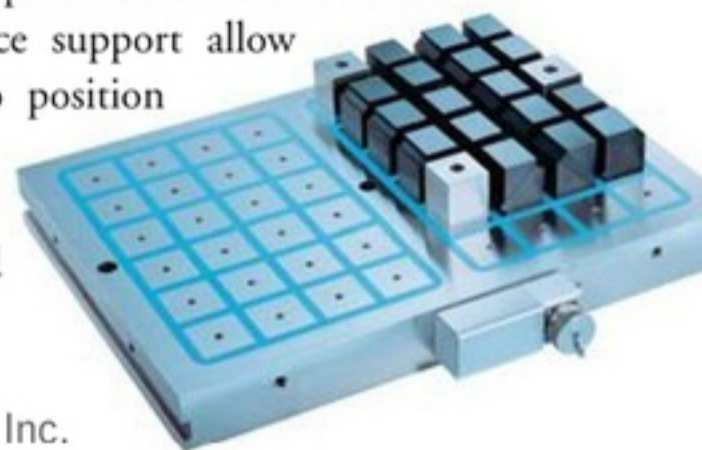
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We may be on the road to recovery but it is full of potholes

As bad as 2009 was, it really ended on a high note and brings promise for the new decade. Bloomberg reports that U.S. companies expanded in December at the fastest pace in almost four years, signaling the economic recovery is gaining speed heading into 2010.

Additionally, the Manufacturers Alliance/MAPI expects a 5% growth in manufacturing production in 2010 and 6% growth in 2011. "There are, however, cautionary flags that may dampen this recovery," says Daniel J. Meckstroth, MAPI chief economist. "For example, job losses will continue through mid-2010; there is relatively little, if any, wage growth; credit is still difficult to obtain without stellar credit scores; housing prices may fall further; and consumers are repaying debt and building a cash cushion."

While these cautionary flags are real and can cause major headaches for manufacturers, there are even bigger threats on the horizon. Troubling signs are surfacing that indicate manufacturing is not keeping up with technology investments and favorable government policies in order to remain competitive with emerging industrial powerhouses like China and India, and the high-tech leaders in countries such as Germany and Japan.

Worst of all, the government is not helping manufacturers to compete on a worldwide basis. Rather, they are thwarting technology investments with additional taxes. Hopefully, individuals like Ron Bloom and Aneesh Paul Chopra will come to the rescue of the manufacturing sector and get our elected officials to legislate investment tax credits rather than imposing new taxes.

Now, if you're wondering who these individuals are, don't panic. In all likelihood, I would guess less than 2% of all manufacturers know them. Bloom is the new manufacturing czar and Chopra was appointed to the position of chief technology officer of the United States.

Waiting for Bloom and Chopra to surface as strong manufacturing advocates may take some time. Since neither of these individuals have a manufacturing background, I have serious doubts as to what they can accomplish in the short term.

However, if you're concerned about your business and wondering how to get U.S. manufacturing back in the world series of global competition, take the time to read "U.S. Manufacturing at a Crossroads: Choices Now Will Shape the Future." Co-authored by Thomas J. Duesterberg, president and CEO, Manufacturers Alliance/MAPI and Emily Stover DeRocco, president, The Manufacturing Institute, this commentary on the facts about modern manufacturing can be found at mapi.net.

Expounding on the viewpoints of General Electric Chairman and CEO, Jeffrey Immelt and Rockwell Automation Chairman and CEO, Keith Nosbusch, both Duesterberg and DeRocco make a strong argument for paying attention to basic research and development, an environment promoting innovation, and to a skilled workforce. In addition, they stress the importance of making sure the incentives to invest are adequate and that public investment adds to the strength of the private economy. They also see the need for our elected officials to address cost burdens, such as those related to tax, healthcare, regulation and tort policies, all of which undermine our global competitiveness.

After you read the MAPI commentary, highlight the points most important to you and send it off to your senator, asking him/her to deliver it personally to both the new manufacturing czar and the chief technical officer. Perhaps some eyes will be opened concerning the problems U.S. manufacturers are facing. **A**



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NAME THAT PLANE

Aerospace Manufacturing and Design welcomes all aircraft enthusiasts to join in the fun and NAME THAT PLANE! Each issue, a new aircraft will be featured in the Aviation Appreciation section. Given a photo and a clue box, readers are encouraged to guess which plane is being described and send in their answers to the AMD staff.

Prizes include:

1st place

A high-quality model of the featured airplane complete with stand and winner's certificate.

Runners-up

(2nd through 5th place)

An AMD consolation prize, which may be hats, pens, T-shirts, or other exciting products.

Please send your answers via e-mail to: **Matt Grasson**, mgrasson@gie.net, with "Aviation Appreciation" in the subject line. **Only e-mail entries will qualify.**

The entry deadline for the January/February contest is March 29, 2010, with winners announced in the April/May issue of AMD.

Have fun and good luck!

In order to give everyone ample time to submit their replies, we are going to implement a two-issue cycle for announcing the winner of the *Aviation Appreciation Contest*.

*Contestants may not win the first place prize more than once throughout the duration of the contest, and may only win consolation prizes once per calendar year. Due to the unpredictable nature of postal delivery, prizes will be determined by random drawing from all correct answers received, after a three week waiting period from the issue's mailing date. The first drawing will name the 1st place winner, followed by four consecutive drawings for consolation prizes. Please send comments or feedback regarding the contest to Matt Grasson, mgrasson@gie.net

RAPID-FIRE FACTS:

- Its maiden flight was on November 23, 1942
- The brainchild of Charles H. Zimmerman
- The aircraft could plow through the air at speeds as low as 40mph
- It was designed for the U. S. Navy

SPECIFICATIONS

- WINGSPAN: 32ft 6"
- LENGTH: 28ft 7"
- HEIGHT: 14ft 9"
- EMPTY WEIGHT: 13,107 lb
- TOP SPEED: 425mph
- RANGE: 1,064 miles
- ENGINES/HORSEPOWER: Had two 1,600hp Pratt and Whitney R-2000 radial engines



ATTENTION PAST WINNERS!
Where do you display your airplane? Send us a picture of you and the model airplane you won for having the correct answer to the *Name that Plane* contest and you may be featured in a future issue. E-mail your high resolution photo to: Matthew Grasson at mgrasson@gie.net.

PREVIOUS ISSUE'S ANSWER:
XP-59A Airacraft

PREVIOUS ISSUE'S WINNER:
Michael Rogers, Project Manager,
Carolina Unmanned Vehicles, Inc.

HOW LONG HAVE YOU BEEN IN THE CURRENT INDUSTRY?
More than 40 years, I started in 1969

HOW DID YOU BECOME INTERESTED IN AIRCRAFT? I joined the Civil Air Patrol in 1963.

WHAT IS YOUR FAVORITE AIRCRAFT?
My favorite aircraft is the P-51 Mustang. I believe that it has the best overall looks and performance to go along with its historical significance.

Runners Up:

Jason Kepler, Director of Engineering,
Aero Twin Inc., Anchorage AK

Daniel Dopp, Internal Applications Engineer,
Guyson Corp., Saratoga Springs, NY

John Mueller, Applications Engineer,
Sumitomo Electric Carbide Inc., Mount Prospect, IL

George Giller, Senior Engineer
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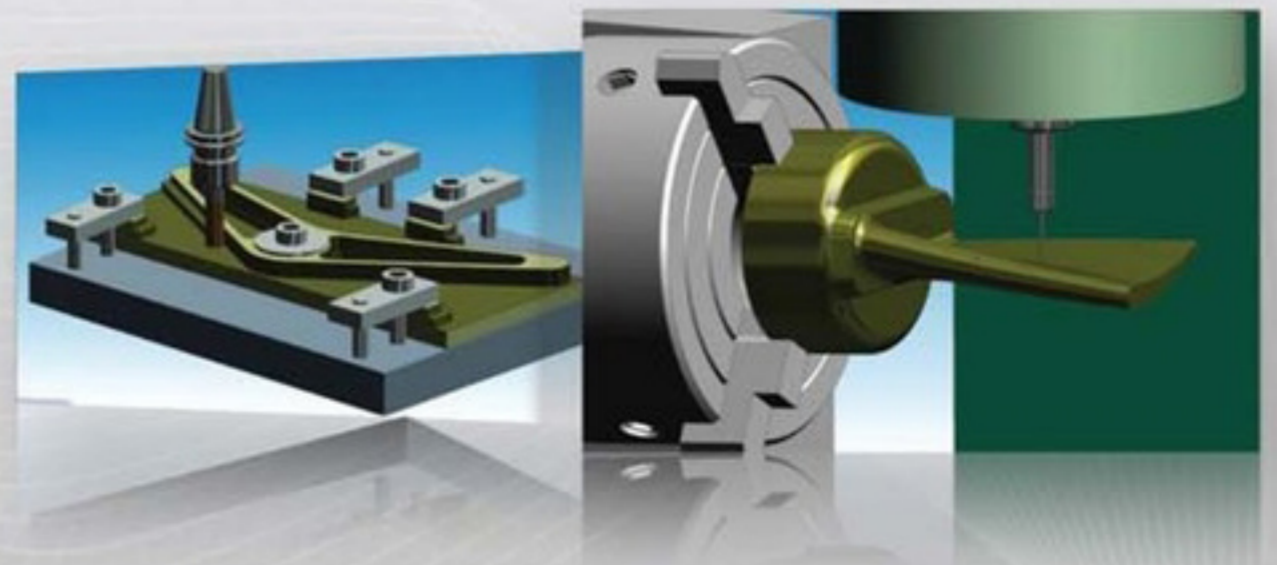
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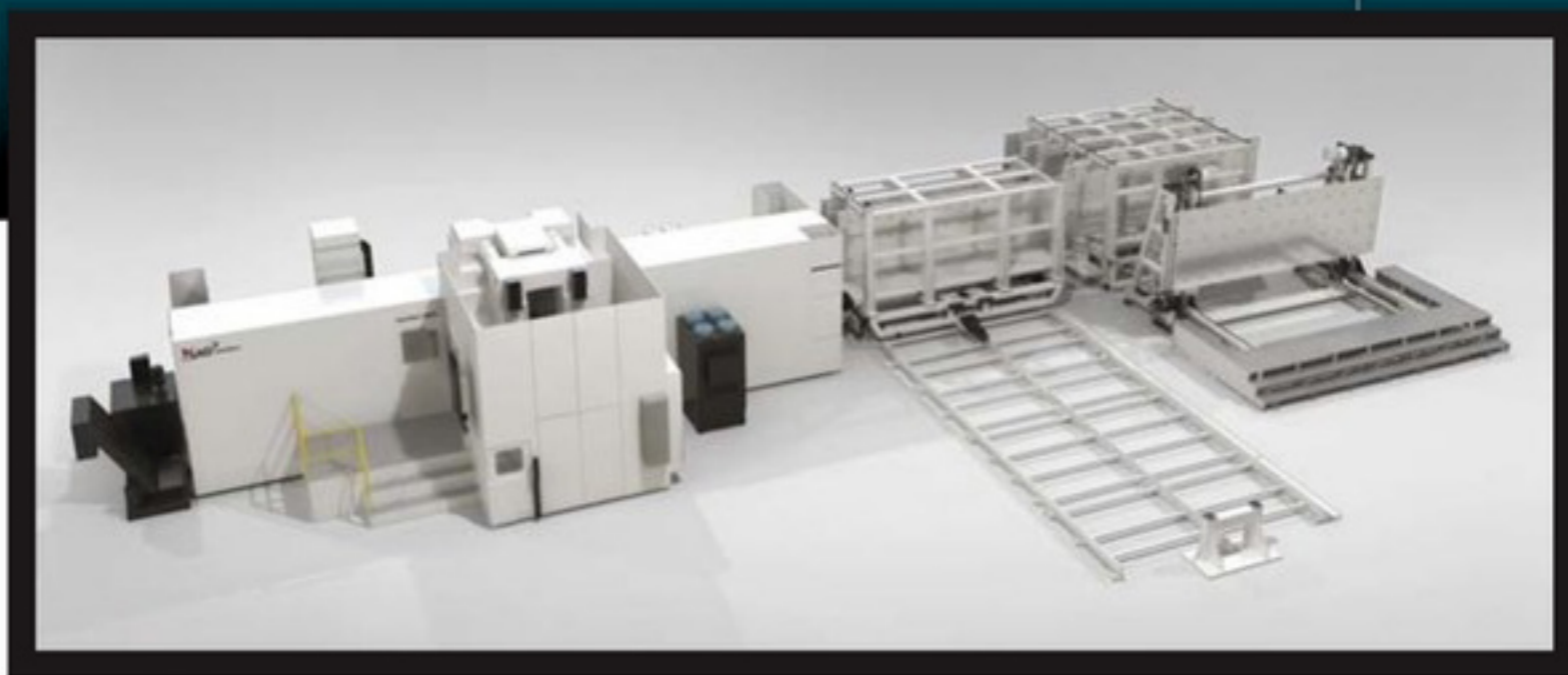
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CONTOURING EFFICIENCIES WITH 5-AXIS

MAG's HyperMach H-Series now includes the H12000, allowing horizontal part loading on the 12m x 2m (39.4ft x 6.5ft) pallet for large-part machining. The models for aluminum machining offer an expanded choice of 30,000rpm with 60kW (80hp) or 100kW (134hp) HKS 63A motorized spindles, or 20,000rpm with an 85kW (115hp) HSK100A motorized spindle. The high-speed spindles deliver high metal removal rates of 8,066.5cc/min (500 in³/min) on

The MAG Modular H-Series machine is shown above as a single machine starter cell with an RGV pallet delivery system, four-pallet storage, and a roll-down load station.

aluminum plate or forgings. GTi titanium models in the H-Series offer a choice of two geared, high-torque HSK100A spindles delivering 850Nm or 1,050Nm torque at 6,000rpm or 4,800rpm.

All HyperMach H-Series machines feature a full portal, open center design. Cutting operations are totally enclosed with chip fall-through to a high-volume conveyor, avoiding chip recutting and the need for a chip blow-off attendant. Full-portal closed-loop construction maximizes stiffness and ensures consistent cutting performance at any position of the pallet and spindle, while eliminating thermal drift and

periodic realignment between column and pallet table. The 12m model uses a traveling column, stationary pallet receiver.

Water-cooled servomotors are utilized on all five axes of the H-Series machines to eliminate thermal influence of the motors and maximize performance for high feedrates. The X-axis pallet receiver and the Y and Z axes are capable of speeds up to 50mpm (2,000ipm). **A**

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REFERENCEGUIDE

Reliable, Affordable Measuring Systems

By Mark Arenal, Managing Director, Starrett Metrology Division

With the metrology industry's seemingly boundless quest for ultra-high accuracy and sophisticated designs, the question is begged, how much accuracy is absolutely necessary and especially at what cost? Fortunately, recent advancements in video measuring equipment design provide highly accurate, productive, cost-effective solutions that are well within the vast majority of even the most stringent metrology requirements.

The common drivers of today's requirements include miniaturization, high volume, increased accuracy and 3D measurement – some of the buzzwords heard more frequently in the metrology business – and they dictate the capabilities designed into today's video and multi-sensor measurement systems.



Metrology system manufacturers are designing cost effective video measurement solutions for high accuracy and productivity.

New Directions

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REFERENCEGUIDE

While the cost factor may seem to be at odds among the other drivers, there are design enhancements that are being incorporated into larger travel systems that come virtually free of charge. In addition, component manufacturers are receiving the same pressure to increase performance while decreasing cost.

DESIGN ENHANCEMENTS

Nothing demonstrates component optimization at reduced cost better than the changes in the linear encoder industry. Virtually all precision measurement systems utilize linear encoders to monitor the position of their stages. In a manual machine, this simply means that the op-

erator positions the stage to the desired coordinates as displayed on the digital read-out (DRO). A computer numerically controlled (CNC) system would direct a stepper, servo or linear motor drive system to position the transport using various voltages, current and frequency variables, but would adjust and confirm the final position by referencing the linear encoder(s).

While this type of scale is still common, some system designers have switched to adhesive backed tape scales. These are as accurate as the glass scales, and in many cases more so, and can be directly affixed to the structure of the machine, which on larger systems is often granite. Moreover, they are far more immune to damage and misalignment and can be much less expensive than their glass counterparts.

The availability of finite element analysis (FEA) can also deliver more possible improvements. FEA on desktop computers permits the selection of structural elements that decrease cost and weight while sacrificing nothing in the performance category.

The most obvious advantage on a measuring machine relates to the design of the granite base-plate and bearing ways. The bulk of the cost on these items is confined to their precision flatness and squareness. FEA allows the completed structure to be synthetically driven and the resultant distortion to be displayed and analyzed in a range of modes. Small modifications to the support structure can often result in a dramatic decrease in the thickness, weight and cost of the structure.

Computer aided design (CAD) offers another advantage with the advent of parametric modeling. This capability retains the relationship of specific entities so that design changes can be accomplished quickly and with less likelihood for error.

When properly utilized, today's CAD systems yield many other benefits as well. For example, a rendering of the design model can be created in full 3D and the system can be tested for performance and collision avoidance, as well as analyzed from an ergonomics standpoint. Additionally, these animations can be used for training aids for assembly or for maintenance tasks in the field. Schematics, wiring diagrams, exploded views and bills of material (BOM) can all be generated on the CAD system. This system further offers a foolproof way to store all of the information for a specific machine in archival form on DVD for future refer-



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ence. All of the above can be achieved for a minimal investment – the utilization of these tools control their payback.

Video, laser, and touch probes can all be integrated into one multi-sensor system with the tools identified above. The interaction of these devices can be plotted, studied and stored. Magnifications can be increased, accuracies can be improved and resolution can be enhanced using these techniques. Multi-sensor systems are ideal for complex, multi-featured parts that may require non-contact, contact and 3D probing measuring routines.

With increasing magnification, vibration isolation will become more important as systems exceed 1,000X – but there is no reason to doubt that we will not see accuracy and repeatability figures in the near future that rival machines of the highest caliber, and at a fraction of the cost. Modern measurement machines map the inherent errors in the operating envelope and store the correction data in a lookup file. These corrections are applied at machine start-up and require no operator intervention. In addition, periodic re-calibrations can be accomplished quickly and efficiently.

DESIGN EXAMPLES

Some systems utilize ballscrew drive systems. They can be noisy, expensive, maintenance prone and difficult to install properly. They are also slow compared to competing technologies. The most advanced systems today have either servomotor or linear motor drive systems. When coupled with an air-bearing stage and non-contact linear scales, these systems are virtually friction-free, leading to better repeatability. A further benefit is the absence of lubrication, making their use more compatible for cleanroom environments.

Another no-cost method to increase repeatability on larger systems is to center-drive the moving axes of a system. This eliminates the inherent hysteresis of off-axis drives and contributes significantly to system performance. This is most easily achieved with the use of a split-axis transport system. A compound transport nests one axis within the other. This makes interaction between the axes unavoidable and generally locates the drive system outside the measuring envelope (off-axis). A gantry system fixes the part to the granite base and drives the probe(s) from the side, often mandating the use of dual encoders.

Finally, there is the feature of illumination – an area where enormous benefits can be obtained while decreasing costs. LED lighting offers the advantages of no-heat, incredibly long lamp life, even distribution of light, flexibility for all types of illumination and, of course, low cost.

Thanks to these new components and

design techniques, the seemingly unrealistic goal of attaining higher performance while lowering costs is being achieved by today's metrology systems manufacturers. **A**

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EXPERT OPINION

MANAGING Your Process

By Sanjeev Gupta, CEO, Realization Technologies

It can often take many weeks to a few years to totally dismantle, repair and remanufacture a helicopter or design and build a satellite. The business benefit of cutting down the time it takes to do such projects can be substantial. Not only would it accelerate the availability of the satellite or turbine to their operators, but it also frees up engineering and manufacturing capacity earlier to start the next project or to take on more projects in the same time.

It is being done all over the world for such project-based entities. Project Execution

Management, leveraging Dr. Eli Goldratt's Critical Chain method, has been adopted by engineering organizations and project manufacturers around the world to shorten delivery times by 20% to 30% and increase productivity by 15% to 25%. While not a panacea, it can dramatically increase profits, improve asset utilization, and accelerate cash flow for all participants in the respective value chains.

That is the experience of Boeing Space & Intelligence Systems in making satellites for government and commercial customers.

Boeing met their goals by managing execution so that activities and resources stay synchronized within and across projects, allowing resources to be concentrated on the right tasks at the right time. They reduced cycle times on the one hand and increased efficiencies on the other.

INCREASED PRODUCTIVITY 64%

Employing 4,000 people, Boeing's Satellite Development Center faces the same problems as many other ETO organizations. Since every program and every mission is different, the final product produced is different. Recurring business is very low. In many respects, the organization is building prototypes as typically only two to three spacecraft are needed for each program. Since they are expensive to launch, Boeing must make them light. Since they have limited power and space, Boeing must make them efficient. Contrary to most products, these final assemblies cannot be serviced.

On the government side of the business, bidding and performance are incredibly

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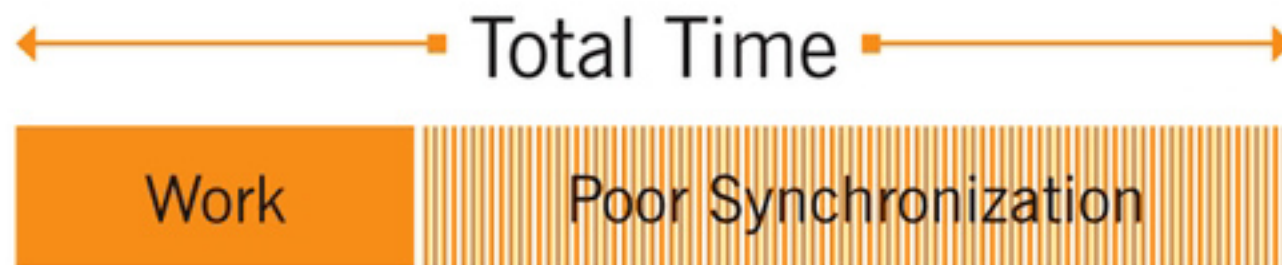
EXPERT OPINION

competitive. As ominous on the commercial side, if Boeing does not deliver on time, they lose the entire contract. Therefore, Boeing has minimal wiggle room.

That is what Darrel Uchima, deputy manager of Boeing's El Segundo, CA, Satellite factory loses sleep over. About five years ago, Uchima's group was having difficulties in

meeting their schedules. The constraint was the reflectors for the satellite antennas. Achieving synchronization in execution was the major difficulty in accelerating the delivery of these units.

meeting their schedules. The constraint was the reflectors for the satellite antennas. Achieving synchronization in execution was the major difficulty in accelerating the delivery of these units.



Many different types of subassemblies are required from many different groups, often in different locations, who must work collectively. Parts might be cut in one facility and sent to another for fabrication, then sent to another location; most of the time the various facilities were not synchronized with each other. Each was operating to the pulse of their own pressures and local milestones.

At a detailed level, parts must be ordered to create the new order's subassembly, yet there are always part shortages and some parts have long lead times. Adjustments (work-arounds) must be made when vendors do not deliver as planned. Customer approvals needed at various completion points might add to the delays, forcing fabrication or design to wait.

Since there is also a contention for resources, people are pulled in multiple directions. As a result, everyone is working hard but on different priorities. An extreme effect of being pulled in multiple directions is multitasking – which hurts quality and causes rework.

Finally, customer specifications might change during execution and technical problems are often found. These uncertainties cause further loss of synchronization, completely disrupting original schedules.

The net effect is that the time taken to do the work is only a fraction of the total time taken to build reflectors – the rest of the time is lost to poor synchronization.

To accelerate the delivery of reflectors, Boeing did three things:

1. They sequenced and released reflector projects into execution based on satellite due-dates and priorities. This immediately caused resources to get synchronized and cut down multitasking.
2. They did away with operations-level schedules and moved safeties hidden in individual tasks into explicit buffers where they would do the most good – protect the longest path. The longest path is that series of tasks – from start to finish – taking into account task as well as resource dependencies. This ensured that the overall project kept moving despite local delays. Moreover, collective buffers are more efficient than safeties built into all individual tasks.

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EXPERT OPINION

3. They synchronized execution based on how much buffer was remaining. Tasks with the lowest buffer ahead of them got the highest priority. Since everyone is looking at the same buffers, priorities are automatically synchronized. Therefore, if buffers in a project are running too low, project managers and executives now

have the early warning signals to take corrective actions.

According to Uchima, "We pipelined and sequenced the reflectors. Within the year, we doubled throughput and were able to deliver both of our programs in the same time that it used to take to deliver one program. We had a 28% improvement in delivery of our anten-

DESPITE EVERYONE'S BEST EFFORTS, ONLY A SMALL PERCENTAGE OF ENGINEER-TO-ORDER (ETO) AND MAINTENANCE, REPAIR AND OVERHAUL (MRO) PROJECTS FINISH ON TIME, WITHIN BUDGETS, OR IN TOTAL SCOPE. IF IT IS ALREADY DIFFICULT TO DELIVER PROJECTS, HOW CAN ORGANIZATION'S RISE TO THE CHALLENGE OF DOING MORE PROJECTS FASTER, OFTENTIMES WITH FEWER RESOURCES? PROJECT EXECUTION MANAGEMENT, USING THE CRITICAL CHAIN METHOD, MIGHT PROVIDE THE MISSING LINK.

nas as a result. We broke the constraint to where something else became the program constraint. We decided that we should take this process from beyond the antennas out to the whole organization."

The antennas group now had more time so they took on the additional duties of managing the payload projects, without adding any more people. On the government side of the business, the antenna and payload projects were not only holding costs but also returning money quarter after quarter back to the customer, the government.

"We showed a 64% improvement on the next satellite and a 26% improvement on the one after that," Uchima reports.

On June 7, 2009, Boeing Integrated Defense Systems, of which Space & Intelligence Systems is a part at the El Segundo Satellite Development Center, received an achievement award. The award was for its demonstrated longevity in the successful use of Theory of Constraints (TOC) tools and significant contribution to the TOC community from the Theory of Constraints International Certification Organization (TO-CICO) at its North American Conference in Tacoma, WA. **A**

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COLLABORATIVE AGREEMENT Offers Unlimited Possibilities

By Tom Grasson, Editorial Director

It has been said that synergy is the magic force that allows for enhanced cost efficiencies when two companies come together in terms of a merger, or in the case of Mori Seiki and Gildemeister, a collaborative agreement.

When this collaborative agreement was announced between these two well-known machine tool builders, located halfway around the world from each other, questions started to surface relative to what these two companies envisioned that would benefit endusers within the global machining sector. U.S. manufacturers were

especially interested in learning what this agreement would mean to them and how it would affect their relationship with each of the companies.

When it was brought to the attention of Dr. Masahiko Mori, chief executive officer of Mori Seiki and Dr. Rüdiger Kapitza, chairman of the executive board of Gildemeister, that U.S. manufacturers were perplexed by the collaborative agreement of these two major machine tool manufacturers, they agreed to meet with our staff at the EMO Show in Milan, Italy. The meeting was to help clarify any misunderstandings

and/or confusion regarding the agreement.

At the onset of the meeting, Dr. Kapitza was quick to point out that sometimes one plus one equals more than two. He then went on to explain that worldwide, customers using both Mori and DMG machines in their facilities accounted for only 1% to 2% of total sales for both companies. "In fact, in Turkey, Gildemeister and Mori Seiki have slightly more than 300 clients. Yet, only 12 of them have both a Mori and DMG in their facility," Dr. Kapitza notes. "It is either one or the other."

Reinforcing this statement, Dr. Mori pointed out that the same scenario holds true for South Korea. In fact, many potential customers in countries such as Taiwan, Thailand, Indonesia, and Turkey have commented to Dr. Mori that Mori Seiki is always competing with DMG and the two companies should be working together for the common good.


With similar comments being heard at Gildemeister, the foundation was set in place for Dr. Mori and Dr. Kapitza to join forces and work out a collaborative agreement. Each company agreed to a cross-



As Dr. Masahiko Mori, (center) looks on, Dr. Rüdiger Kapitza, (left) explains to Tom Grasson (right) that the goal of DMG and Mori Seiki is to build a strategic partnership and closely collaborate on areas which include, but are not limited to, production, research and development, and purchasing.



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shareholding investment of 5%. Under the agreement, Dr. Mori and Dr. Kapitza would be appointed to high-level positions within each other's firms. Moreover, Mori Seiki would become the largest, single shareholder in Gildemeister. In addition, it was agreed upon that a steering committee would be setup to manage the partnership.

Under the terms of the agreement, the two machine tool builders will function under one brand (DMG/Mori Seiki) in four markets: Taiwan, Thailand, Indonesia, and Turkey. As for the United States, both Dr. Mori and Dr. Kapitza agree that a strategy is not yet in place. Currently, the plan is to take it one step at a time and look at strengthening the synergies between the two companies, market by market, where Mori Seiki and Gildemeister have complimentary activities. By consolidating sales activities in selected regions, such as in the countries mentioned above, the new partners see an opportunity to invest jointly in emerging markets. Eventually, the focus will turn to the United States and a strategy will be developed to benefit the U.S. customer. However, for now the focus of the collaboration agreement will be on global business opportunities outside the United States.

When you take into consideration that both German and Japanese machine tool sales have declined by more than 60% in 2009, the forward thinking of Dr. Mori and Dr. Kapitza could be the right prescription for both companies as they cope with the effects of a global recession. As Dr. Kapitza points out, at the moment it



Both Dr. Mori and Dr. Kapitza have a proven history of running profitable companies and understand that remaining in the forefront requires innovation.

makes no sense for DMG to merge with another German company. Nor does it make sense for Mori Seiki to merge with another Japanese company. What does make sense is to blend German engineering with Japanese technology and gain from the benefits of both worlds. Today, DMG buys components from Mori Seiki, such as spindles and ballscrews, and without hesitation, Dr. Kapitza admits that they work perfectly, without a flaw. However, the vision of this collaboration agreement is intended to go much further than working together on the interchangeability of machine components.

Neither Dr. Mori nor Dr. Kapitza is a stranger to the machine tool industry. Over the years, both men have been very successful. They have a proven history of running profitable companies and understand that remaining in the forefront requires innovation. In addition, both of the industry leaders are very confident in their plans for the future.

So, as we look ahead, the collaboration between Mori Seiki and DMG will encompass much more than sales and service. They will also build a strategic partnership and closely collaborate on areas that include, but are not limited to, production, research and development, and purchasing. This, according to Dr. Kapitza, will bring about the highest level of efficiency ever achieved by either company. Reinforcing this comment, Dr. Mori points out that the fusion of technologies and strong sales and service networks brings together greater productivity benefits for the customers as well.

On a final note, Dr. Mori sees the United States as a very important market. Especially in the aerospace, energy, and medical sectors, he believes that in the long term this collaborative agreement will benefit U.S. manufacturers with the best combination of designs and technologies that Germany and Japan have to offer.

Both Dr. Mori and Dr. Kapitza realize that when the strategy for the United States is finalized, it must deliver added-value for the customer as well as both machine tool companies in order to be truly successful.

Knowing that Mori Seiki has been much stronger in the U.S. market than DMG, Dr. Kapitza has agreed to have Mori Seiki provide the leadership and focus on developing the joint U.S. strategy.

No doubt, Dr. Mori and Dr. Kapitza are about to set a new standard in the machine tool industry, and in the months ahead, we can be assured that we will be hearing a great deal more about DMG/MoriSeiki. **A**

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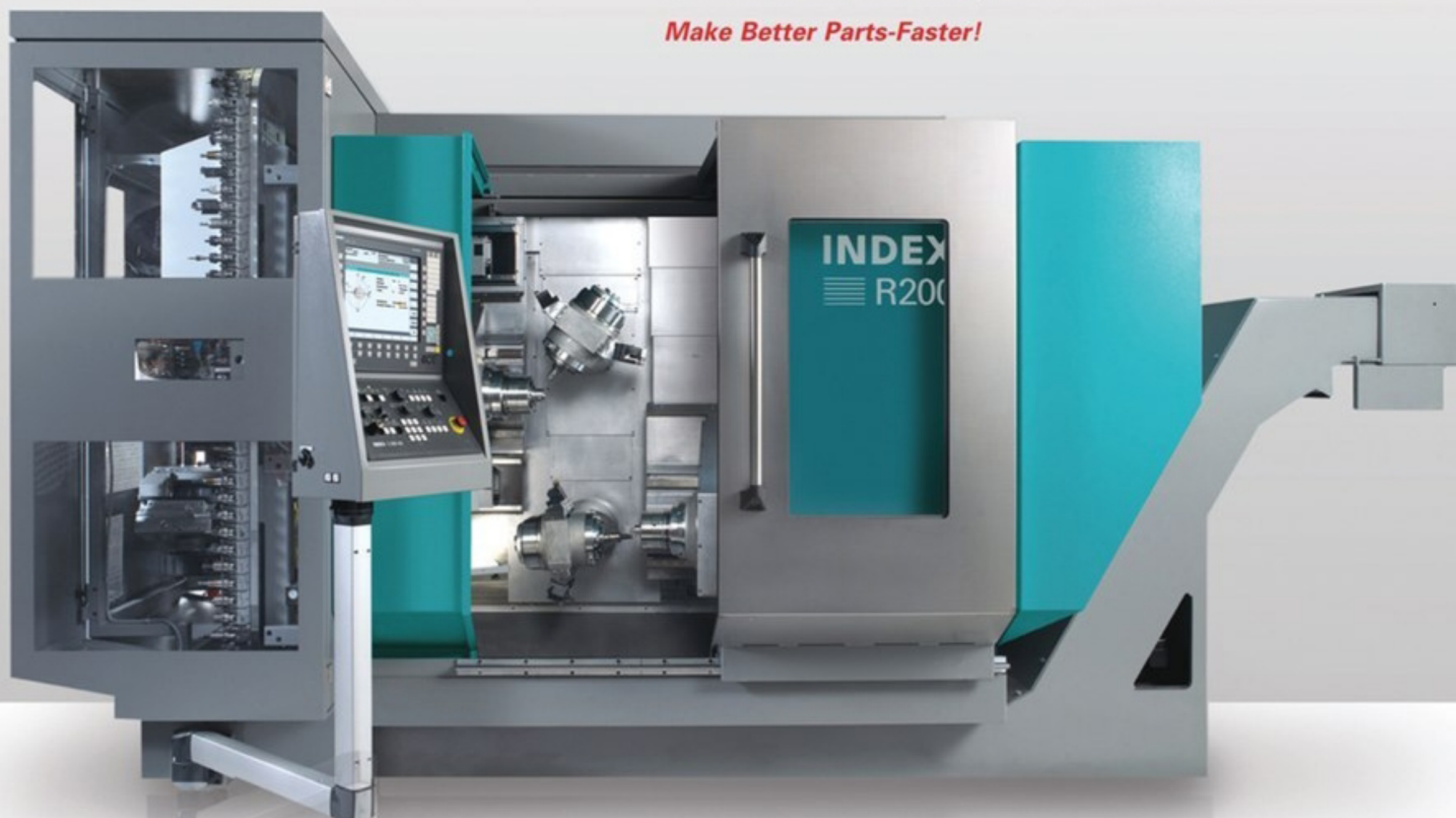
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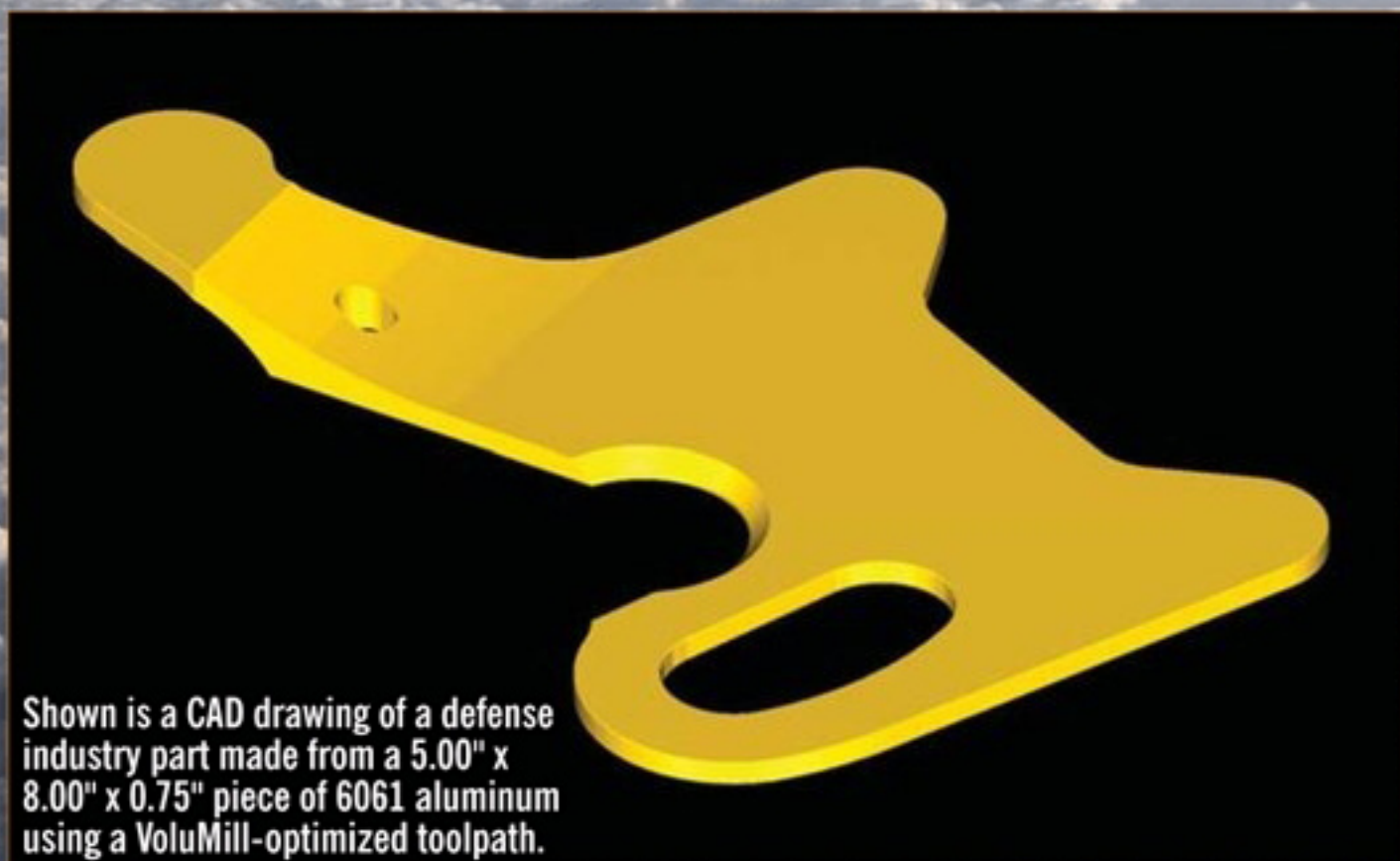


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Shown is a CAD drawing of a defense industry part made from a 5.00" x 8.00" x 0.75" piece of 6061 aluminum using a VoluMill-optimized toolpath.

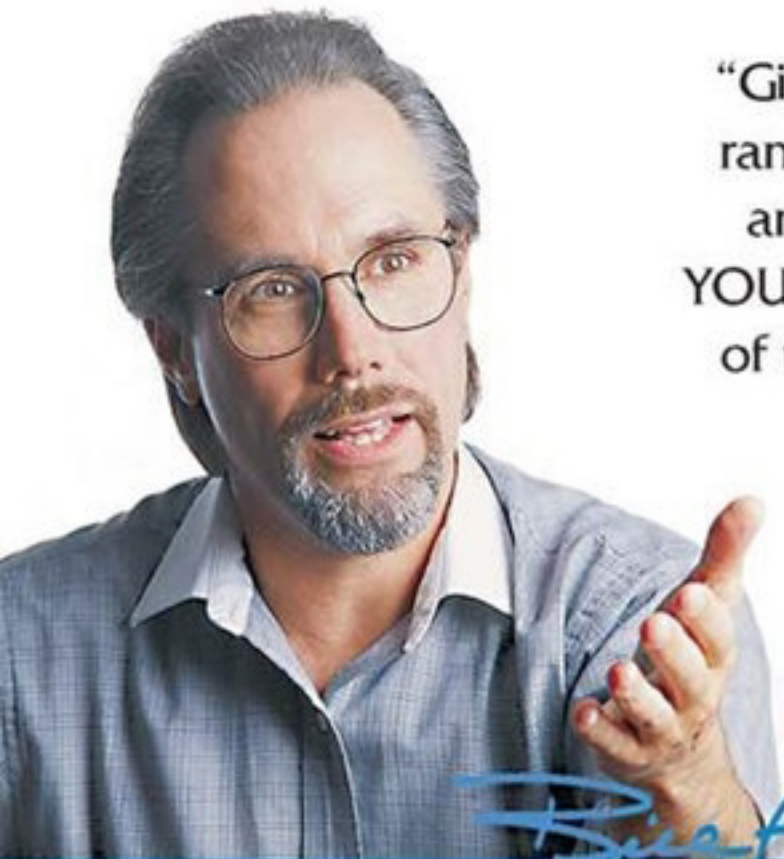


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Prior to VoluMill, DMW was using two separate tools to machine this aluminum part with a cycle time of 3 minutes 53 seconds. Using VoluMill, DMW is now able to use one tool and reduce the cycle time to 1 minute 58 seconds.

According to David Pruett, the company's CNC programmer for 15 years, close to 90% of DMW's work is for nearby aerospace and defense giant Boeing.

"We do a little bit of everything," Pruett says. "As a job shop, we take a lot of work that other people will not bother taking. We excel with aerospace parts that no one else wants to make, due either to their complexity, low volume, or both."

DMW prides itself on its ability to handle complex jobs made from steel, and other harder materials, in addition to aluminum.

"Some of the parts we cut are overly complicated," Pruett says. "At first glance, it may not seem like a very complex component, but when you really look at the drawing, it is a part that you are going to have to work smart to make money. They are often filled with intricate, difficult-to-machine, and tight-tolerance features."

The complexity of the parts produced at DMW led Pruett to research the latest high-speed toolpath software available. He settled on VoluMill, and accepted the company's offer to try it free for two weeks.

"During that time, I programmed four or five parts," Pruett recalls. "At first, I used VoluMill paths on our oldest 50-taper machine, which is nearing the end of its useful life. We experimented with some high-speed, machining-style roughing using solid carbide endmills, versus hogging with larger indexable insert tools. The toolpath itself was noticeably easier on the machine. We are able to run much higher surface footage and much higher feedrates.

IN THE BEGINNING

Before VoluMill, DMW was roughing a 5" x 4" x 1.25" 15-5 stainless steel blank into a classified airplane part with a 1.25" diameter, three-flute indexable insert cutter on the 50-taper machine at 400sfm and 22ipm with a 0.4" deep cut. With VoluMill, speed was increased to 800sfm and feed improved to 153ipm, all with a 1/2" diameter endmill.

"Our 40-taper machines could not even come close to handling a cutter that large," Pruett says. "It is very hard on

the machinery. Once we were able to see how fast and easily the material was being removed using VoluMill, toolpaths and high-speed machining on the 50-taper, we decided to give it a go on the 40-taper. We were pleasantly surprised to find out that the parts machined just as well on the 40-taper as they did on the 50-taper.

"The ability to run this job on the smaller, lower-powered machine, with smaller, less-expensive cutting tools, is a significant advantage for us," Pruett says. "We benefit from the cost savings on inserts and machine wear and tear, and, most important, from the dependability of the process."

According to Pruett, when roughing these parts with indexable tools, sometimes the operator had to stop and change inserts, and an operator had to watch the machine 100% of the time.

Other timesavings came when applying VoluMill toolpaths to an important part for the defense industry, machined from 5" x 8" x 0.75" 6061 aluminum.

Prior to VoluMill, DMW was using two separate tools, a 1" indexable insert endmill and a 1/2" ballnose endmill to machine the part. Cycle time was 3 minutes 53 seconds, using 0.25" step-downs for each pass. With VoluMill, DMW uses one 1/2" three-flute carbide endmill, at 7,640rpm and 275ipm, triple the previous rate. The new cycle time is 1 minute 58 seconds. DMW machines about 120 of these parts per year and saves approximately two hours of machining time per part using VoluMill.

Even on smaller parts made of harder materials like titanium, DMW has seen

improvements in productivity using VoluMill toolpaths.

Pruett cited another difficult component made from 3" x 3.5" x 1.75" heat-treated 6AL4V titanium. "In the past we were roughing it out and sending it out to be heat treated," Pruett states. "I wanted to eliminate the mid-process heat treating, so I tried the high-speed toolpath on the hardened material. It was a 4-minute roughing time and we got it down to a 1.5 minutes. After the changes, the cycle time is now 25 minutes per part. Where applied, VoluMill toolpaths reduced the roughing cycle time by 62.5%.

"In the short time that I have had VoluMill, I have saved anywhere from just a few minutes to around an hour programming some parts with VoluMill," Pruett says.

THE BENEFITS

Arguably, the greatest benefit VoluMill's efficiency has provided for DMW is the flexibility to move work from its 50-taper mill to 40-taper mills.

"One of our 50-taper machines is about to die," Pruett says. "Since we have certain jobs that require 50-taper machines, we will have to replace the 50-taper. We have some space limitations in our shop so a 50-taper horizontal is out of the question. If we can prove to ourselves that we can machine parts efficiently on the 40-taper machines, that will allow us to replace the 50-taper machine with a 40-taper horizontal. This will not only be beneficial on our current jobs, but will open up a whole new world to us by allowing us to be more competitive on other types of work."

"For us, the point of buying VoluMill was to see if we could machine parts faster and more efficiently on a smaller machine."

In the meantime, Pruett continues to find more opportunities for the toolpath engine. "When we first got VoluMill, there were only about four or five jobs that I thought we would want that style of toolpath for," Pruett states. "Once I started working with it, I discovered that I could use it for a lot more than I originally thought." **A**

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2010

At A Glance

Aerospace Industry Analysis

By Brad Curran, Senior Industry Analyst & Nathan K. Smith, Industry Analyst, Frost & Sullivan's Aerospace & Defense Team



Photo by Mark Evans

COMMERCIAL SECTOR

As the industry looks ahead to 2010, the commercial aircraft industry must remain focused and continue to seek improvements. There is the need for a positive turnaround since 2008 and 2009 were bleak.

Stabilization is a key theme in the industry. Airports, airlines, and aircraft manufacturers are looking for market stabilization. Manufacturers are in search of new aircraft orders with fewer cancellations and deferrals. Airlines are in search of lower unit costs and increased load factors, while airports anticipate higher passenger traffic, increased flight frequency, and new routes.

By the end of the third quarter of 2009, Airbus delivered 358 aircraft, with more than 200 aircraft deferrals and cancellations, and booked a total of 149 orders for the year. Through Q3 2009, Boeing delivered 359 aircraft with 215 deferrals and had 181 orders placed for the year. Going forward, it is expected that aircraft manufacturers will exert more pressure on aircraft operators to enforce delivery contracts.

Currently there is a sufficient amount of aircraft in the global active fleet to absorb any aircraft cancellations and deferrals. It is likely there will continue to be excess capacity in 2010, adding additional pressure for increased load factors and aircraft utilization.

The continuation of retirement and parking of older aircraft should offset any new aircraft deliveries.

The airline industry must continue reducing cost and replacing older, less-efficient aircraft with next generation aircraft that provide greater efficiency and reduced operating cost. Fuel cost in the fourth quarter of 2009 is greater than that in the fourth quarter of 2008 with fuel costs continuing to increase. Therefore, it is more attractive for the airline industry to replace older aircraft, which in turn enables manufacturers to see fewer deferrals and cancellations and more aircraft deliveries.

Currently, there are more than 2,100 global aircraft in storage with values for used aircraft declining. Financing used aircraft is more difficult as the value for some used aircraft has severely eroded during the past 20 months. Additionally, many financial institutions are seeking to preserve cash reserves by focusing on new aircraft. In most instances, parting out older, high-time aircraft is of greater value to operators and lease companies than the cost of restoring these aircraft to full service. Therefore, parting out the aircraft is the better solution than incurring the huge cost of overhaul, as it also provides a greater return on investment.

The current 2010 forecast is a continuation

of lower global travel demand, followed by rising fuel prices and greater pressures for wage and benefit improvements from labor unions. Air travel is expected to be greater in 2010 than 2009, but less than those of 2008. Passenger traffic is not expected to return to 2007 levels until 2013. The industry is expected to see a passenger CAGR of around 5% in 2010.

Airports are expected to continue seeing a trend in additional flights and new routes especially for regional and low-cost carriers. Total global available seat miles (ASM) for 2009 are forecasted for 3,793,787,206,180 with the global aircraft fleet growing from 22,226 to 24,775 by 2014.

Aircraft delivery in 2010 is expected to exceed aircraft delivery numbers in 2009 due to fewer aircraft deferrals and cancellations, as well as an improving airline economy. Aircraft are on sale, and at the lowest deal levels in the decade. This deal level is an advantage for the airline industry, and especially for those who can afford new aircraft purchases.

DEFENSE SECTOR

Defense aerospace in 2010 will be led by platforms and technologies for counter-insurgency and counter-terror operations. These complex missions will continue to require robust funding for a wide variety of

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2010

THE YEAR AHEAD

spacecraft, aircraft, weapons, and services. Military aircraft sales are expected to increase by about 2% in 2010 to \$64 billion. Led by the U.S. armed forces, there will be fewer, but more capable, multi-mission airframes. Increased buying in Asian and Middle Eastern countries in 2010 will not offset continued ITAR difficulties and military spending cuts in Europe, with total exports down from 2009 levels. Despite an emphasis on fixed price contracts to encourage the use of mature commercial technologies, defense aerospace industry employment and profits should remain stable.

The fastest growing segment in 2010 will continue to be UAVs of all types. Though dominated by fewer major manufacturers such as General Atomics and Northrop Grumman, the essential communications and sensors packages afford a wider mix of market participants. More extensive domestic utilization of UAVs for homeland security, law enforcement, and research flights is restrained by safety issues that will not be resolved by the industry and FAA in 2010. Manned ISR aircraft avionics and sensors are being upgraded to meet demands for ground and littoral counter-insurgency missions. In addition, the U.S. Navy is building a replacement aircraft for the P-3 that will focus on open ocean surveillance and strike.

Satellite-related products are expected to total around \$35 billion in 2010, led by shifts away from large, immature and expensive systems toward operationally-responsive, smaller and cheaper communications, and sensor spacecraft that can be assembled and launched quickly, using mature commercial technology as a foundation. Military forces around the world will continue to be dependent on commercially owned transponders for about 70% of their bandwidth needs in 2010.

Shortages of medevac, ground attack, and transport aircraft were keenly felt in 2009, especially by allied forces in Afghanistan. Boeing is already benefiting from increased orders for the heavy Chinook helicopter from the U.S.,

the U.K., and Turkey. The Osprey tilt-rotor built by Bell-Boeing made its first operational deployment with the U.S. Marines in 2009 and production will continue in 2010 along with Air Force and Special Operations Command deployments. The controversy over the next U.S. Air Force tanker will continue in 2010, as Northrop Grumman and teammate EADS compete with Boeing for the estimated \$35 billion deal. Boeing's C-17 Transport aircraft will continue production in 2010 after additional congressional mandates. The C-17 is also expected to attract additional foreign military buyers.

The F-22 and F-35 fighters manufactured by Lockheed Martin continues with partners



Looking ahead, the F-22 will continue with partners and customers in at least eight countries. Photo by Leo Cachat

and customers in at least eight countries. The U.S. intends to give both fighters additional ISR capabilities in order to show more relevance to the current counter-insurgency operations. The first operational F-35 squadron

is due in 2012. Another operational success that will expand in 2010 is Hawker Beechcraft's teaming with Raytheon, Harris, and Lockheed Martin to meet Air Force requirements for small intelligence support and light attack armed reconnaissance aircraft based on current commercial models.

Other market segments that will continue to have very heavy contract activity and margins in 2010 include missile manufacturing led by Raytheon, training aircraft, spare parts, logistic and maintenance services, as well as alternative fuel and fuel cell development. The 2010 focus on counter-insurgency and counter-terror missions combined with an extremely high operations tempo will stress airframes, engines, avionics, and sensors. In 2010, and the years that follow, there will be increased maintenance contracts, avionics upgrades, and air frame replacements. **A**

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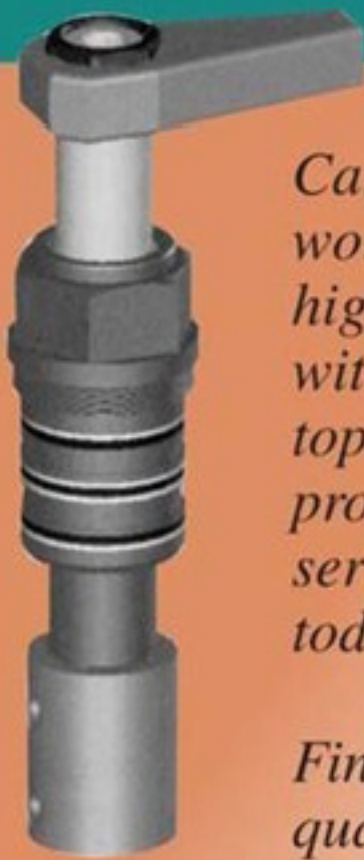
STOCK CONTROL SOFTWARE

Planit Software's e2i manufacturing management system has just released significant enhancements in its 2010 R1 release. Included in 2010 R1 is Stock control, which has been rede-

signed to make management more intuitive. Users can now manage the total quantity of a stock item in relation to real time supply and demand, rather than individual allocations. Stock Control has been enhanced to enable users to record the consumption of raw materials at the point of use. The latest release of e2i supports both Windows Vista and Microsoft Windows 7.

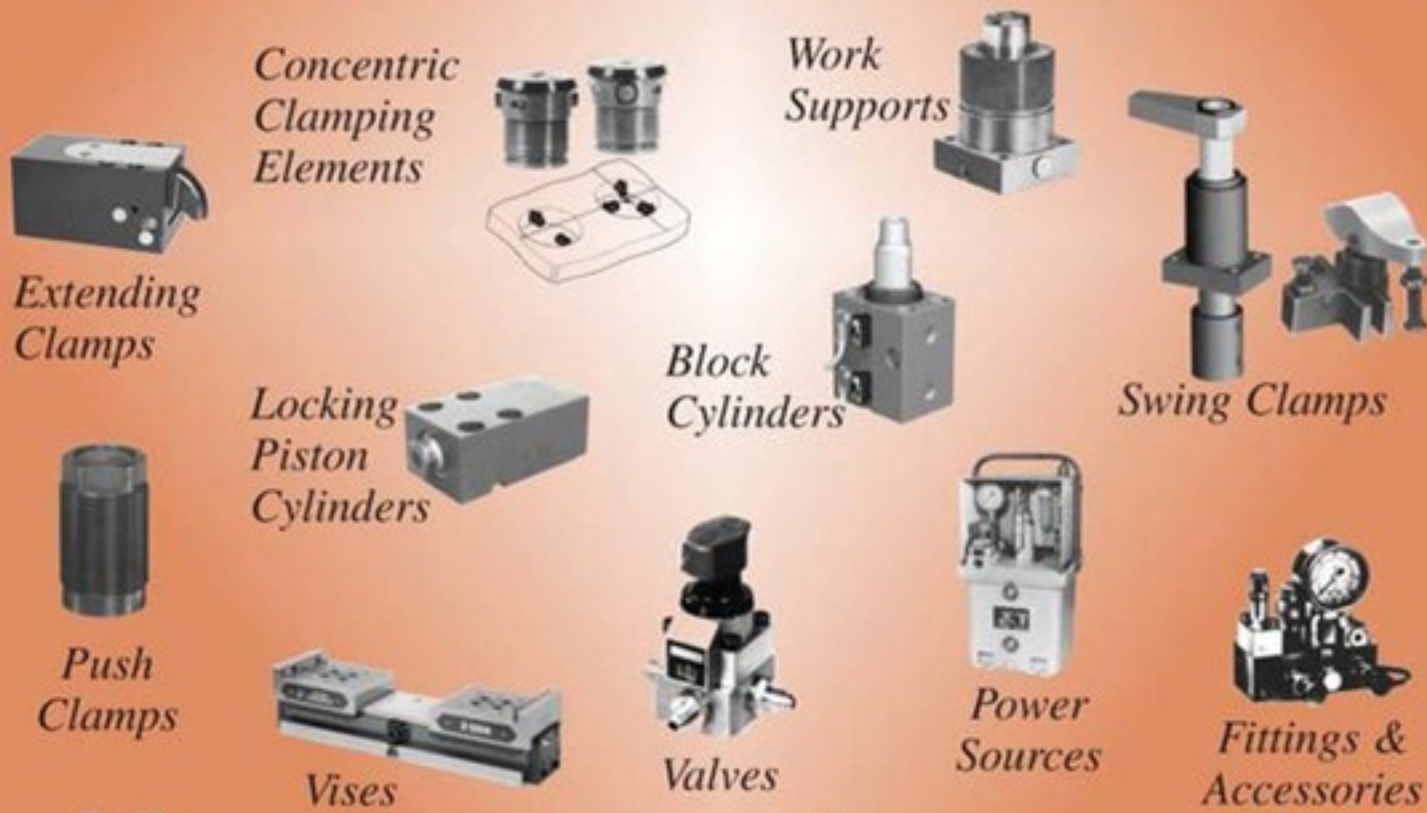
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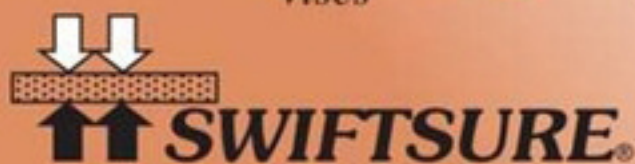
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For convenient tool management, the STN550M utilizes a 12-position drum turret for rapid tool indexing. The machine is also equipped with a 10hp, 4,000rpm high speed milling spindle for roughing, grooving, endmilling, and facemilling operations, allowing many processes to be completed in a single machine cycle. The STN550M's total travels are 18.25" in the X-axis and 129.88" in the Z-axis, with a 40.7" swing capacity and a capacity steady rest of $\phi 16.14$ ". **A**

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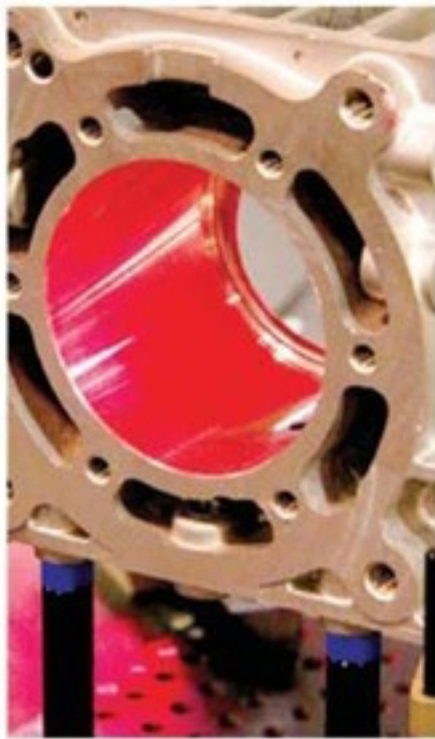
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Shown to the left is a model undergoing wind tunnel testing at the University of Washington Aeronautical Laboratory.

number of external fasteners on the vehicles critical surfaces. Holes for fasteners on the lower pressure surface of wings and the tail often require constant attention during testing. Covering or filling each hole, to provide the model with a smooth outer mold line is a must so alternatively, any hole not placed in those critical surfaces will reduce the number of issues related to configuration repeatability.

Material costs are typically a small fraction of the total model cost, but the material's machining properties are often a more important factor in the overall cost. Machine time and labor are by far the largest portions of a model's cost, so every effort is made to incorporate industry manufacturing best practices to lower model construction times and costs.

Each year Aeronautical Testing Services Inc. (ATS), while supporting the University of Washington's airplane design course, tests and develops innovations in model design, construction and construction materials. Models built for these projects are at no cost, or a reduced cost, and result in wind tunnel models designed and built in a period of three to four weeks, with lessons learned during these models incorporated in other follow-up projects.

One recent design improvement incorporated into follow-up projects are small electro-mechanical motors for remotely-actuated control surfaces. The actuators are inexpensive, strong and robust, and lend themselves quite easily for implementation in wind tunnel models. Additional changes in design practices allow measurement of the resultant aerodynamic loads on the control surfaces in parallel with having those same surfaces powered. The capability to measure hinge moments offers a better understanding of the aerodynamic forces that the model experiences as well as providing some valuable information for the design of the vehicle's control system.

It is the inclusion of novel features, such as these, that are allowing customers to get more from their testing experience. **A**

Aeronautical Testing Service Inc.
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CLOSING THE DESIGN CYCLE

By: **Paul Christensen**,
Design and Test Engineer, Aeronautical Testing Service

Getting the most return on investment is a business principle that is normally on the minds of business leaders. Given the current economic climate, this principle is more important now than perhaps it has ever been, particularly in the aerospace industry. The magnitude of the cost to develop, and eventually certify, a new airplane can be quite daunting. Experimental class airplanes, not being obligated to meet all of the Federal Aviation Administration's (FAA) certification requirements, start in the millions of dollars and costs can end up in the tens of billion-dollar range for a transport category airplane. One underlying principle, common in all successful programs, is the early identification of design deficiencies with mitigation resulting in a superior product and a better bottom line.

Carried out in a wind tunnel, early identification of design deficiencies is often the first validation and verification for a new airplane. The data gathered in the wind tunnel enables designers to determine how many required changes there are, along with the opportunity to make the appropriate changes. It is important to understand that there typically are problems, but the key is to address them in a timely manner. That is what wind tunnel testing is for, delivering the vital feedback to the designers which, in turn,

gives them the opportunity to improve the performance and handling of their aircraft.

Consistently working on ways to improve wind tunnel models is always a part of the product development process. Regularly evaluating the design and construction process enables identification of the areas where improvements would be beneficial. The wind tunnel model determines how productive a wind tunnel test can be. How fast the model can change from one configuration to another is very important and includes not only how long it takes to change the control surface deflections, but also how fast the wings, flaps, and tail surfaces can be added or removed to get the desired configuration of interest. Accounting for all of this when designing the model determines how quickly changes can be made – all being vital for process improvements.

While as much model design standardization as possible is desired, within the limitations imposed by a given vehicle configuration, having an institutionalized manufacturing process that is too rigid can stifle innovation. However, in an effort to keep the model as simple as possible, a guiding principle of model design is having low part count with ease of manufacturing. As an example, an additional refinement in model design is the minimization of the

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