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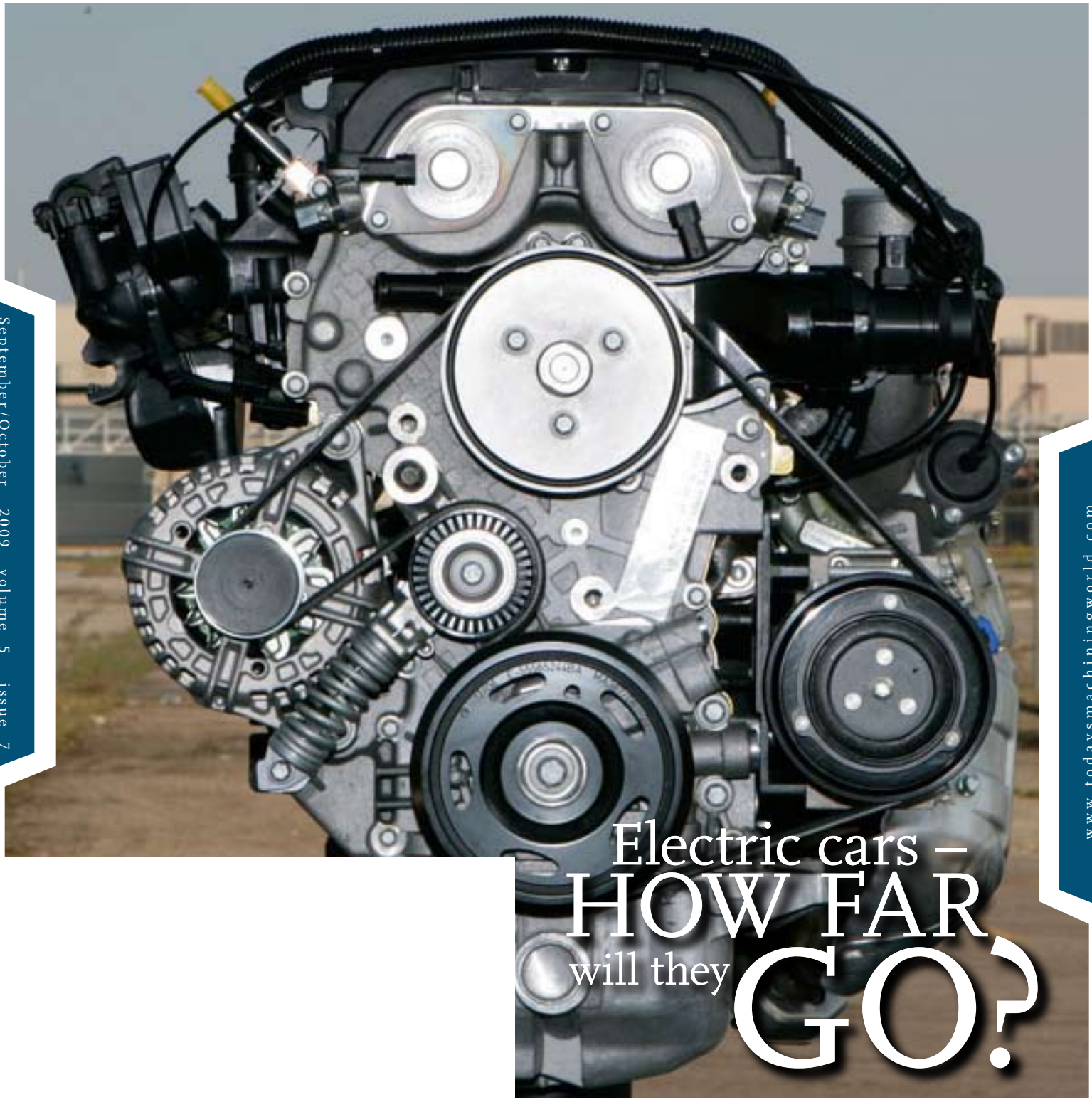

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September/October 2009 volume 5 issue 7

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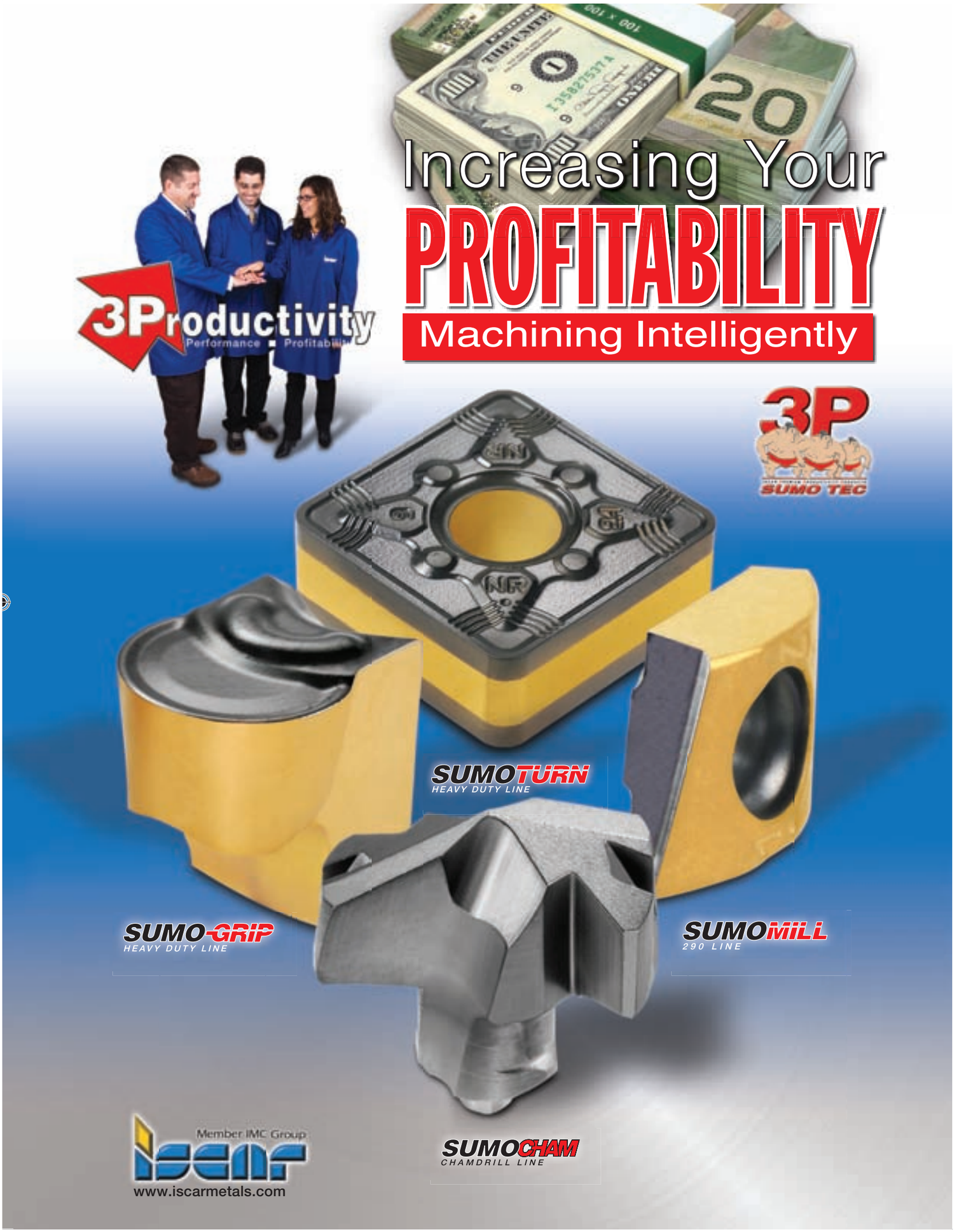

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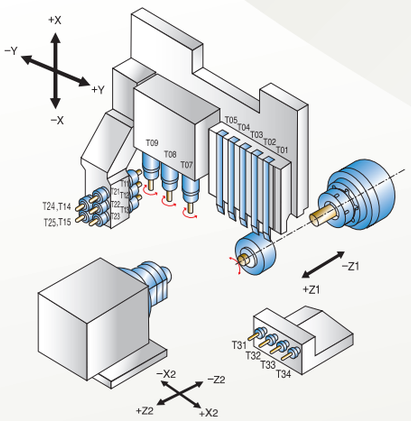

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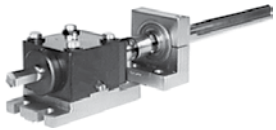

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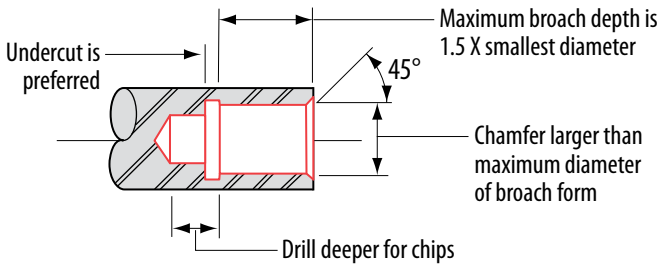

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This Work is Really Fun

Jessica DuLong recently sent me a copy of her first book, entitled *My River Chronicles*. It tells the story of her quest to become the chief engineer of an aged fireboat plying the waterways around New York City.

It is a personal story of her 30-something life as she comes to understand how much she loves the time spent getting dirty around old machinery on ancient boats.

Jessica has written many pieces for *Today's Machining World* over the last four years, starting with a piece about the firm her brother worked for in Massachusetts which was fading fast as the demand for its papermaking equipment diminished. In her book she writes lovingly about her father's passion for things mechanical. He had a car repair shop in Boston specializing in German vehicles, so she grew up smelling the perfume of the engine flower.

She left working class Boston for the pinnacle of academia, Stanford University, and then gravitated to the dot-com money pot just before the bust. Jessica then pieced together a career as a freelance writer in the early part of the decade, but her inquiring mind and penchant for machinery ultimately led her to the fireboat on the Hudson.

One of Jessica's major interests is in women doing traditional "men's" work, and she did an article on the topic for *TMW* in 2007.

I admit that I feel a vicarious pride in her book, because I believe my tutoring and prodding of her contributed to its breadth.

One of the beautiful things about being involved with this magazine is that I get to surround myself with talented, ambitious young people, like Jessica and Noah Graff and Emily Aniakou, who energize me every day.

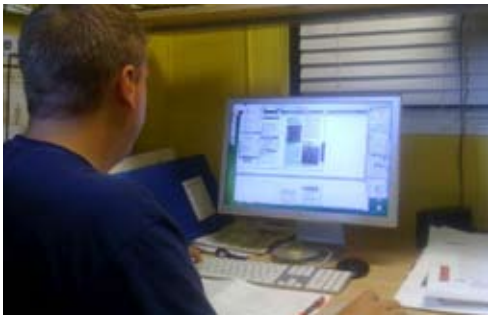
We are fortunate to have recently added Ryan King as National Sales Manager and Todd Toborg as Creative Director, both young and accomplished in their fields.

This work is really fun.

Lloyd Graff
Editor/Owner

contributors

Lloyd Graff started *Today's Machining World* in 2000 to serve the precision parts community. His love of good journalism started with reading the work of great sportswriters like Jim Murray and Jimmy Breslin. He honed his interest in writing as a sports editor and columnist for the University of Michigan *Daily*. His love for the machining business started with being regaled by his father, Leonard Graff, and uncle, Aaron Pinkert, with stories about deals and characters out of their business careers. Lloyd's view of magazine writing is that its core should be important ideas illuminated by real human stories.



Todd Toborg, *TMW's* new Creative Director, has degrees in graphic design and communications from Wichita State University and has been working in the design business for over 15 years. He began his career designing graphics for bicycles, skateboards and snowboards before seven years in the advertising world. In 2005 he left the world of large and impersonal advertising to open his own full-service agency in downtown Chicago. Todd's favorite food is chicken fried steak and he's a sucker for truck stop drive-ins, where he loves the open-faced turkey sandwiches.

Ryan King, *TMW's* new National Sales Manager, grew up in Bloomingdale, Ill. He played baseball at Lake Park High School and graduated from the University of Iowa in 1999, making it out in four years flat. He started his sales career 10 years ago working at the *Chicago Sun-Times* and then the *Chicago Tribune*. Ryan loves running, golf (handicap is 25) and spending time with his wife. He is from an advertising family. His parents both sold advertising for the *Chicago Tribune* in the 60's and his wife, Melissa King, currently sells advertising for the *Tribune*. Ryan dislikes mayonnaise, air travel and any song by SEAL. He could eat pizza every day of his life.

Emily Aniakou (formerly Halgrimson), *TMW's* Managing Editor, has an eclectic background which includes a degree from the Eastman School of Music in French horn performance, a year at a Bangladeshi orphanage, training at a Zen Center, and most recently—a stint in the Peace Corps in Benin, West Africa. She and her new husband just bought a home in northwest Indiana and want to thank the government for the $8,000 housewarming gift and the excellent interest rates. Go Hoosiers.

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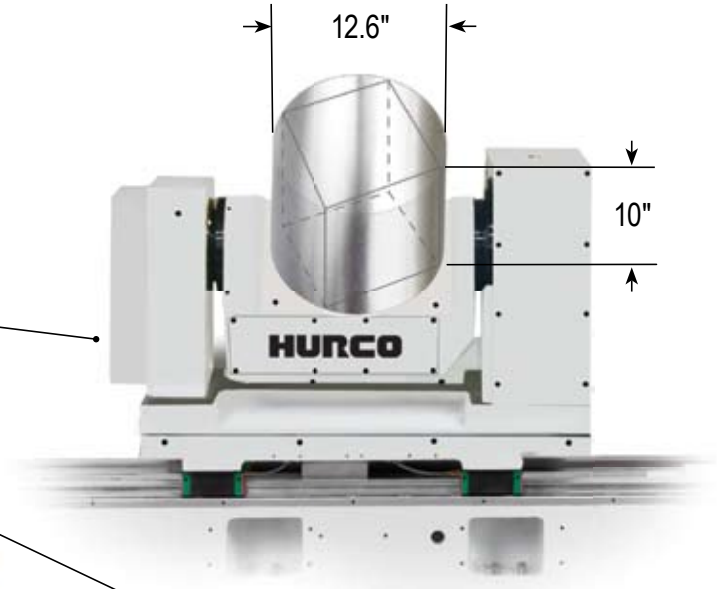

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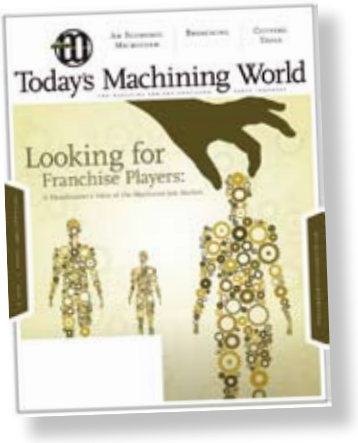
Unlike the Others

I look forward to reading each new edition of *Today's Machining World*, to which my boss has a subscription and lets those of us in the shop read. Your articles are always well-written, informative and relevant to today's current business environment. I enjoy reading about new technologies, unique solutions to problems many of us encounter in our daily work, as well as the non-machining-related articles and book reviews. An article about the medical industry in the May/June 2009 issue, "Who's Eating Off Mary's Plate," particularly caught my eye, with its personal story of an accident and subsequent surgery leading to a revelation about the current status of our health care system.

I also appreciate the care you take in the design and editing of your magazine. Unlike many of the other publications we receive in the shop, yours has a beautiful design, one in which the easily perused layout and typography are accompanied by large, clear and relevant photos. This is in direct opposition to those who try to crowd as much information as possible into each page, with the end result being a crowded, unfriendly mess. I also very rarely encounter the sorts of spelling and grammatical errors that rather irk me in other publications.

Mathias Tabor
Cleveland, Ohio



Mistake Found!

There is an error on page 13 of the July/August 2009 issue. Don Wood was not the founder of *Screw Machine Engineering*. It was started by Howard Spaulding. I am not certain that this is the founder's last name, but it's as I remember it. Don Wood took over the magazine and along the way changed its name to *Automatic Machining*. Also, in looking for your email address, I believe page 5 should be updated. You publish more than six times per year. More trivia, September 1, 2009, I will be starting my 61st year in this business, still enjoying what I do. Although my first love has changed from machining to cold heading.

Dick Kerr
Kerr Lakeside Inc.
Euclid, Ohio

Editor's Note: *The information in this letter was verified by Wayne Wood, Don Wood's son.* Screw Machine Engineering *was started in 1939 and changed its name to* Automatic Machining *in 1950. Don Wood began working at the magazine in 1957. Regarding TMW's publishing schedule, we will go to 9 times per year in 2010.*

It Amazes Me

I love reading *Today's Machining World* and thought I would write and share a few things. I'm 49 years old and I only have a little experience in CNC milling machines, but I help my brother-in-law and sister in their shop. We just finished some 39,000 hinges for the military and are still working on some parts for NASA. Parts are so demanding and needed in our world. My brother-in-law has two Haas machines and is running almost 24/7. I love helping out just to see what the machines can do, it amazes me.

Donald Miles
Toscombia, Alabama

Something on your mind? We'd love to hear it.

Send your comments to: *TMW Magazine* 4235 W. 166th Street, Oak Forest, IL 60452

Or email us at: emily@todaysmachiningworld.com or lloyd@todaysmachiningworld.com

By Lloyd Graff

The Scorpion and the Frog

The struggle between Mercury Marine and the International Association of Machinists and Aerospace Workers Local 1947 sounds like the story of the scorpion and the frog.

The union knows that the more it fights the givebacks the company asks for in its contract, the greater the likelihood the headquarters' plant in Fond du Lac, Wisconsin, is going to be downsized and eventually closed. But the union continues to fight, because that's what unions do, like the scorpion that bites the frog that is transporting him across the river, dooming them both to die. It's what scorpions do.

Mercury faces wicked competition these days from Yamaha and Honda in the marine space, and moving from unionized, $20 per hour Fond du Lac to non-union Stillwater, Oklahoma, makes economic sense for the Brunswick owned company.

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swarf

I am saddened to see Marshall Manufacturing in Cape Canaveral, Florida, and Lewisburg, Tennessee, are going to be auctioned off by Myron Bowling in mid-October.

I've known Marshall's Ducanis family for my entire business career. We sold them 1 5/8" RB8 Acmes to make worm gears for casement windows, which was one of their core businesses for decades.

Another big screw machine company dies. Hopefully a few of the people who worked for Marshall will start up their own shops.

On the opposite side of the spectrum, the new owners of Anderson Precision in Jamestown, New York, Steve Godfrey and Dave Archer, who bought out the long-time owner John Castle, are looking to expand.

They bought the company late last year and rode a wave of good business until the crash of 2009. They did the necessary triage to survive the worst of the crisis and now are hiring to meet new demand. Old customers are ordering and giving them a bigger slice of their business, and they plan to dedicate their Davenport Automatics to particular jobs rather than jogging on the setup treadmill. They want to expand their eight-spindle Euroturn line and add CNC machines. The partners worked for Anderson for eight years before buying the firm. Both are from upstate New York and dig 120 inches of snow. Godfrey had been in computer software before he started at Anderson, and Archer sold industrial hardware.

Enoch Manufacturing is a successful job shop in Clackamas, Oregon. The Dawes family had run the company with fiscal soundness through good times and bad. When a change of management was decided upon, the company brought in Tom Aitchison, who was an outsider in the machining world. I talked to Aitchison at length and he says Enoch has escaped the economic crevasse without damage. He says that Enoch pruned workers who were not at the top of their game or who just did not fit what the company viewed as its future. He has brought in improved IT skills and a new sales manager. The company planned to buy a new M-32 Citizen before the downturn, deferred the purchase, and then went through with the buy. They also bought new Mori-Seiki equipment and have dry powder for more machine tool buys this year.

Aitchison says they have stayed consciously diversified and expects sales to be about even with last year, which he considers to be a solid win for Enoch.

There is a huge overhang of repossessed Haas equipment on the market today. Haas Automation is not alone in having to sell against its own repos, but because the company was selling 1,200 machines a month at the peak there are a lot of machines that ended up back with the lenders.

From my observation there is still an underlying demand for the repos which is keeping the prices above the bargain basement.

The issue confronting many machining operations today is whether to bring back employees who were laid off or hire new people. Companies went into survival mode nine months ago but today most have seen a rebound and some are quite busy. I have talked to several owners lately who are hiring to catch up, but are also hiring defensively because they are fearful that they will not be able to get the skilled workers when their peers are busy. Some managers also feel that there is an opportunity to upgrade and get younger on the floor today, but the window of hiring opportunity may be short.

The Toyota Corolla was the hottest seller in the "Cash for Clunkers" program. To me this says consumers are less interested in advanced technology and going green than they are in good old reliable transportation. The Honda Civic was second on the seller list, and the Toyota Camry and Ford Focus finished third and fourth respectively. The Toyota Prius was fifth.

Les Paul, the famed guitarist, died recently at 94. He played his instrument in a jazz club until just before his death, even though he had the use of only two fingers in his left hand because of arthritis. Paul's right arm had been badly crushed in a car accident in 1948. One doctor suggested amputation, but Paul insisted that they fix it at a right angle so he could play his guitar.

He developed the first solid-body, electric guitar for Gibson. The company did not see a future for the instrument until 1952, after rival company, Fender, introduced its hugely popular Fender Telecaster electric guitar to the music market.

Paul's story is an intriguing one for me. It resonates with another tidbit I heard recently.

Crusty old Arlen Specter, 78-years-old, who had five terms in the Senate as a Republican from Pennsylvania, flipped to the Democrats in May of this year. One reason he did so was to keep more clout on appropriations for the National Institute of

Health, which funds a huge part of the medical research in the United States. Almost single-handedly, Specter forced $10 billion into the Obama stimulus package for the NIH.

The person who told me about Specter is closely involved with medical research and said that this infusion of money is already making a big difference.

Specter is currently undergoing chemotherapy for his second bout of Hodgkin's lymphoma, an often lethal type of cancer.

Les Paul and Arlen Specter chose totally different life paths, but both have demonstrated that you can make a difference by doing what you love and never giving up, despite any supposed disability.

Doreen Koop is a gutsy

young woman with a kitchen dream.

She is an industrial engineer, recently laid off from United Launch Alliance of Decatur, Alabama, where they make parts for Delta and Atlas rockets.

Doreen decided to go into the manufacturing business in her hometown, Pulaski, Tennessee, so she could do work for her old company. She needs ISO certification before United will buy from her. She decided to build a product she knew, a high-end spatula aimed at cast-iron cooking devotees.

Her father had made such a utensil for the family decades ago, and she decided to improve upon it and find a market.

She contacted me looking for a machine to make "Chicago screws" out of stainless steel. After grilling her about the screw and the application, I became intrigued by her story. Before I talked to Doreen, I had never heard the words "Chicago" and "screw" used together in this way.

Doreen has seven distributors lined up for her spatula, which will sell for $32. She calls it a "Williams Sonoma" type of product. She has local Amish folk cutting her oak handles and another Amish "blacksmith" doing the metalworking. Currently she's buying her screws from Fastenal for a dollar a piece, but the engineer in her knows they should be much cheaper.

Doreen wants to make rocket parts, but the spatula now appears to be a viable project. She is now working on her next piece, a high-end fork.

If you think you can help Doreen Koop with her quest for American-made stainless steel fasteners email her at emily@todaysmachiningworld.com.

swarf

Richard De Leon is looking for more than a few good men. He took an ad costing several hundred dollars under the "Careers" category in the Saturday *Wall Street Journal*, searching for lemon and orange pickers to work from September 17, 2009 to Jan. 31, 2010, near Yuma, Arizona.

I called Mr. De Leon at his firm, Servicios Agricolas Mex Inc. to see how many refugees from Wall Street had applied for the $7.95 per hour seasonal job. He was affable and informative.

I asked him why he advertised in the *Journal* and he said it has a big circulation and a long reach, so he figured something good would come from it. He needs 150 workers for the upcoming season. With the difficulty in getting traditional migrant workers across the border he is looking all over.

He admits that the work is tough. A worker must haul a 40-pound tree ladder from the site drop area. The picker carries a bag for the fruit and clippers. I asked him if he gets many college students to pick. He says he gets several every season but they rarely last more than a few days. The temperature in Yuma averages 110 degrees in the fall.

I told Richard that my view of the job was colored by the apple pickers in the movie *Cider House Rules*. He hadn't heard of it. A few years ago I traveled to Wenatchee, Washington, during the apple harvest. I love apples and have picked apple sauce quantities from nearby Michigan orchards. I know it was "apple picking for sissies," but I think there is real value for young people to leave the comfortable settings they know and go to Africa, Peru or Yuma to feel what rigorous manual work is like, and sleep in barracks and carry a picking bag of lemons along with a 40-pound ladder.

My brother Jim has been compiling a family tree of the Graff clan in America. He reminded me recently of the family folklore about how the Graff and Pinkert tribes hooked up in Chicago back in the early part of the 20th century.

The Graffs and the Pinkerts both came from the town of Brinsk in Russia. The Jews were pouring out of the anti-Semitic, czarist, pogrom plagued land. Most of the Graffs went to Palestine, but one man, Morris Graff, found his way to the south side of Chicago at the time of the 1893 World's Fair. He made some money, bought a big house and had a lot of children. When fresh immigrants from the old neighborhood of Brinsk came to Chicago they gravitated to Morris Graff's house and rented a bed.

One of those young guys was Simon Pinkert (formerly Pincovich). He was a baker by trade who worked the night shift. When he came home after a long night of making bread he wreaked of yeast. He took the bed of Morris Graff's daughter, Ida, who slept during the evening. According to the lore, Ida was attracted to the scent left by the yeasty Simon. They met on the Sabbath, confirmed the aromatic attraction and soon united the Graff and Pinkert tribes in marriage.

Simon and Ida had 12 children. Louis Graff, Ida's brother, married Ethel Levinson (another, sadder story) and had five kids including my father, Leonard. Aaron Pinkert was one of 12 Pinkerts and ultimately teamed up with my Dad in the machinery and screw machine business.

Never underestimate the attraction of warm bread.

By Jerry Levine

Voices from the Moon

One July night 40 years ago, after probably one of the most tense aircraft landings ever, Neil Armstrong calmly announced to the world, "The Eagle has landed." And so, with only 17 seconds of fuel to spare, space travel became a reality.

To read Andrew Chaikin's *Voices from the Moon* is for me to be bathed in nostalgia, pride and emotion. Like Armstrong and many of the early astronauts, I am a Purdue University engineer of the 1950s—totally left-brained and pretty darn unemotional. However, reading the Apollo astronauts' matter-of-fact descriptions of the entire 10 moon missions—from early preparation until the final splashdown—left me drained.

Chaikin takes quotes from over 150 hours of interviews with the astronauts and pairs them with breathtakingly beautiful photographs taken by the explorers to create an extraordinary first person chronicle of one of the greatest achievements in human history.

Reflecting back, there's an ironic contrast between the first flight, Apollo 8, silently and peacefully orbiting the moon on Christmas Eve, 1968, and the anything-but-silent-and-peaceful turmoil of that year back on earth—arguably one of the least peaceful years of the 20th century.

The Cold War space race drove the moon project. Ironically, on the same day Neil Armstrong and Buzz Aldrin walked and slept peacefully in the "Sea of Tranquility," a Soviet aircraft crashed and burned in the "Ocean of Storms" on the moon.

Such great potential morality plays this era could inspire, but the astronauts were engineers and pilots, not philosophers and poets. They did not wax poetically. They were boring. They just did their jobs—like the thousands of other extraordinary people on their support team—and they did them all so flawlessly.

The astronauts were chosen for their scientific ability and trained until all emotion was washed out. The key was training—practice, practice, practice. So much practice that the real event became almost mundane.

Yet the astronauts were still caught off guard by situations unanticipated on the training simulator. For example, there was Bill Anders' first view of Earth as he circled out from behind the moon—earthrise! "The most beautiful thing that I had ever seen," he proclaimed. Totally unanticipated because "we were going to the moon and not looking back." *Voices from the Moon* has a great selection of beautiful first photographs of Earth taken from space.

Several astronauts commented on how as they entered the moon's shadow the command module began to round the dark side of the moon where there was total blackness in front of them—a gigantic black hole. No one was quite sure if they would be sucked right into the void. But then suddenly, whoosh—they went sliding into the sunlight, a mere 60 miles above the surface. Frank Borman describes the moon as resembling what Earth must have looked like before there was life. Anders added, "This space shot is man's first step away from his home planet. We're talking about a second Genesis."

Walking on the moon was awe-inspiring. Dave Scott said, "Oh, the beauty—the spectacular beauty. I didn't expect it. You are not heavy in one-sixth gravity, but you have the sensation of slow motion. You step and wait to be drawn back to the surface."

Most of the astronauts had great anticipation, even jitters ahead of lunar liftoff. At one-sixth gravity, liftoff was more powerful than what they experienced in practice and shocked some of the astronauts. Mattingley said, "You're really moving out. You can see the moon get small. I'm leaving that sucker. And you really don't want to. Because, I mean ... I can't go back tomorrow."

In spite of themselves, these left-brainers often do wax poetically. They were 240,000 miles away from home reading Genesis and experiencing it in a new way.

But it was still the science and engineering that got them there and brought them home safely. The program sent engineers to the moon and brought back home-spun poets and philosophers, which may be a miracle of sorts. They traveled a half million miles round trip and splashed down only minutes off schedule. That took some plain old science and engineering miracles too.

Comments? You can email Jerry Levine at jerroldlevine@yahoo.com.

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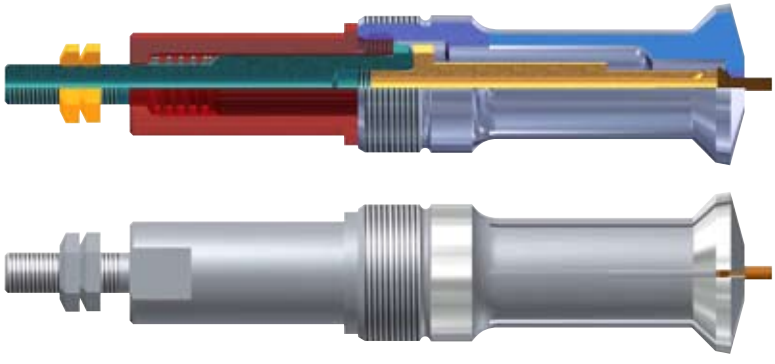
Hanwha Machinery America introduces the XDI20, another high precision Swiss-type turning center to its lineup. This high speed turning center has powerful liquid-chilled built in motors on the main- and sub-spindle. It has an innovative tooling system and tooling capability of 3 path 11 axes in same class. This XDI20 allows simultaneous drilling, end milling and multiple tooling capability.

For more information, please visit Hanwha Machinery America at www.hanwhamachinery.com.



Hardinge

Hardinge manufactures collets for all brands of machines and adapters used in the fastener industry. They engineer precision collets to grip blind bolt fasteners, solid and blind rivets, bolts, screws, nuts, inserts and studs. A majority of these fasteners are used in the global aerospace market. Hardinge workholding design and applications engineers work with other machine tool builders for complete turnkey packages. Along with aerospace, Hardinge supports the automotive, commercial transportation, defense and industrial markets with these products.

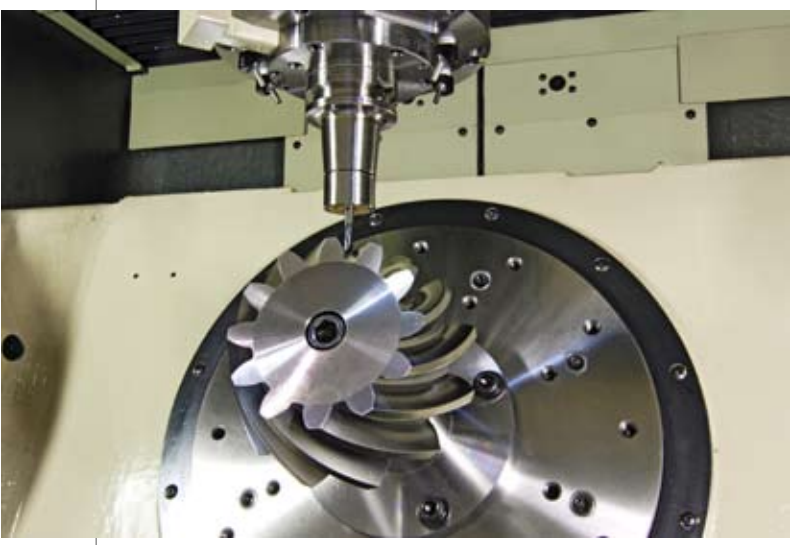
For more information, please visit Hardinge at www.hardingeus.com.

fresh stuff

▶ ISCAR

ISCAR is expanding the HELITURN Lay Down family and application range with new inserts and tools, produced with the new SUMO TEC grades. The new WNMX, CNMX and DNMX inserts have high positive radial, helical cutting edges and positive rake angles, which is a combination that substantially reduces cutting forces. Their corner angle is 88 percent, which provides increased strength. HELITURN LD inserts were designed for heavy machining applications.

For more information, please visit Iscar Cutting Tools at www.iscarmetals.com.



◀ Mitsui Seiki

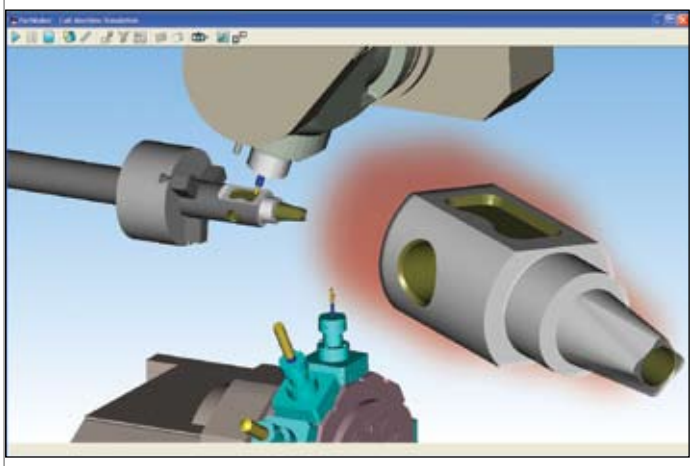
Mitsui Seiki's Vertex machine is suitable for ring gears up to 16", and a special gear making model incorporates a rotary trunnion table for the finish turning operations. "This machine can turn the gear faces, the final profile of the internal bore, and generate the gear teeth," says Mark Speier, Sales Engineer at Mitsui Seiki.

For more information, please visit Mitsui Seiki at www.mitsuiseiki.com.

▶ NSK

The HPS250 and HPS500 Series Spindles are available with either 25,000 rpm or 50,000 rpm and are perfect for applications where small hole drill and light milling are required. They are available with either BT 30 or CAT 40 arbors and are fully tool changeable from the machine magazine to the main spindle. They are also very accurate with less than 1 um T.I.R. in spindle taper.

For more information, please visit NSK America at www.nskamerica.com.



▲ PartMaker Inc.

PartMaker Inc., a division of Delcam Plc., will unveil its latest version of PartMaker Software for programming CNC Mills, Lathes, WireEDMs, Turn-Mill Centers and Swiss-type lathes at EMO 2009, October 5 – 10, 2009 in Milan, Italy. Major highlights of this newest release, PartMaker Version 2010, include the ability to perform 5-axis simultaneous milling on multi-axis lathes, more powerful milling functionality and the ability to better visualize thread whirling. A host of additional productivity, user-driven enhancements will also be featured in PartMaker Version 2010.

PartMaker will be exhibited in the booth of its parent company Delcam Plc. at EMO 2009.

PartMaker Version 2010 is slated for release in the fourth quarter of 2009.

For more information, please visit PartMaker Inc. at www.partmaker.com.

▲ Slater Tools Inc.

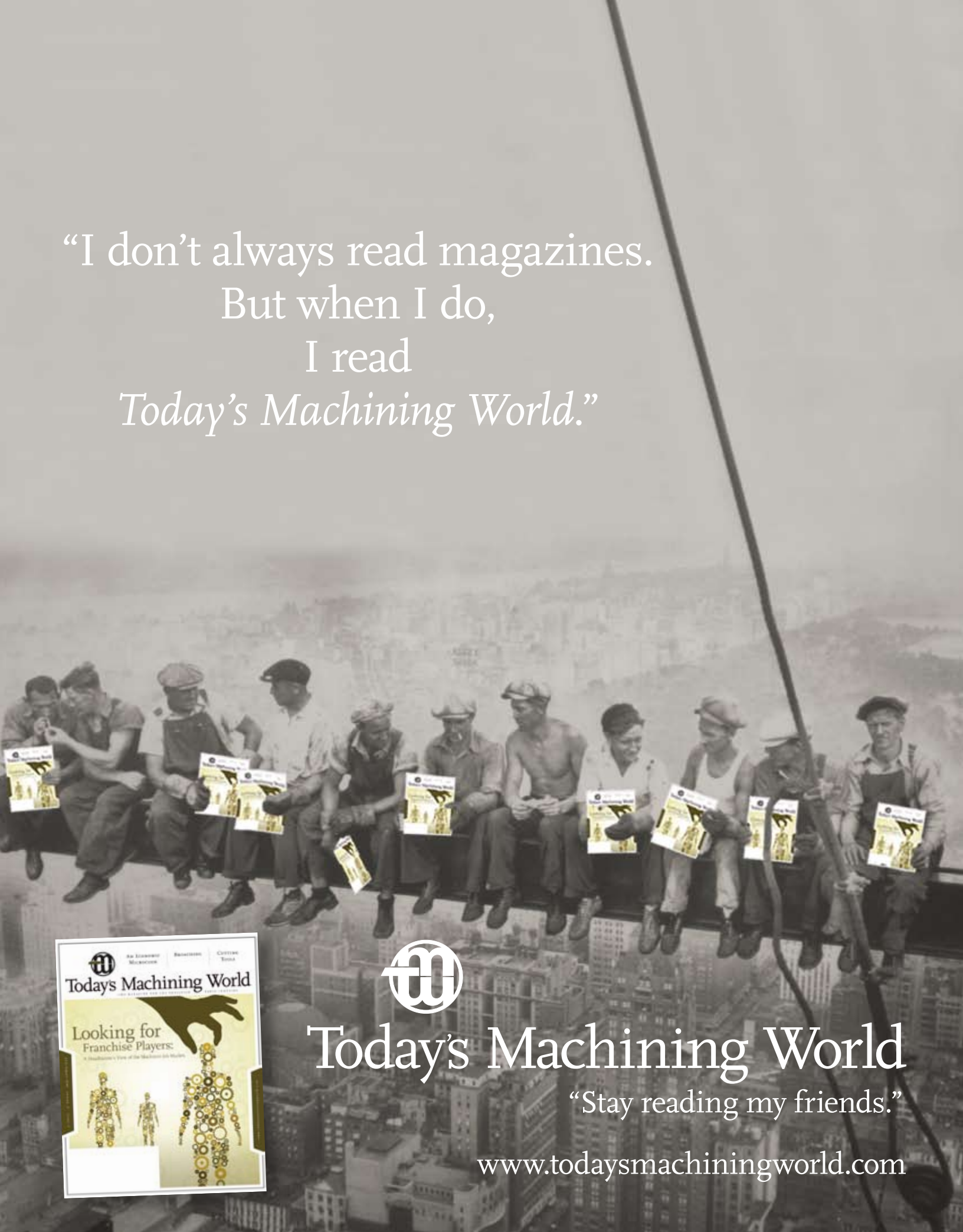
Slater Tools Inc. announces its largest expansion of Swiss-type rotary broaching tool holders to date. These machine tools allow machinists to put hex and square shaped holes into metal parts such as aerospace and orthopedic bone screws. Slater Tools Inc. has expanded its line of rotary broaching tool holders for CNC, screw and Swiss lathe machines and milling machines to 38 different Swiss broach holders. Rotary Broaching tools are used to put hex and square shaped holes into metal parts such as aerospace and orthopedic bone screws.

For more information, please visit Slater Tools at www.slatertools.com.

◄ TMT Swiss/Nexturn

TMT Swiss/Nexturn introduces the new SA20B Swiss Style Turning Center. The SA20B features full 7-axis capability including "C" axis on both the main- and sub-spindles. The SA20B is equipped with the Fanuc OiTTC Dual Path Control System. The OiTTC system features a large capacity PMC and high speed processor for cycle time reduction.

For more information, please visit TMT Swiss at www.TMTSwiss.com.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5/8" 6-spindle, thdg., pickoff, 1971-88 (8)
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1-3/8" 6-spindle, 1967-1979 (3)
1-3/4" 6-spindle, 1965, 1984 (10)
1-3/4" 8-spindle, 1970
2-1/4" 6-spindle, 1962, 1973-79 (3)
3-1/4" 6-spindle, 1973,
6-5/8" 6-spindle, 1979
5-5/8" 6-spindle, 1978,

ACME
7/16" RA6, 1975 (6)
1-1/4" RB8, 1981
1-5/8" RBN8, 1979, thdg., pickoff
1-5/8" RB8 thdg., pickup '68-72 (5)
2" RB6, 1979
3-1/2" RB6, heavy recess, '66
2-5/8" RB8, 1979

CNC INDEX
G200, 1997, Index
G300, 1997, Index
ABC 60mm Index '96

SCHUTTE
SF51, 1985
AF32, DNT, 1998 (2)
SF26, 1979
SF51 PC

CNC SWISS
Star ECAS 20,2008
Star ECAS 30,2008

CNC MACHINING CENTER
Haas VF255, 2006

CNC LATHES
Daewoo 1500 LY, 2006
Doosan VT 900, 2008

HYDROMATS
Pro 20, 1999
HW 25-12, 1994
HB45-12, 1996
HB45-16, 1989 - '97
HS16, 2001
CNC 36/100 HSK tool spindles w/2-axis CNC flange and valves w/ 6-axis CNC, new in 2006.
VE 20/80 QC unit
26/80 QC unit
40/80 unit
36/100 unit
30/60 unit

Gildemeister
GM 20AC 1999

EUBAMA
S-20, S-12
S-8.1 1999

ESCOMATICS
D9 (2), 1995
D6SR (2)
D-2, D-4, D6SR

MISCELLANEOUS
MSO Machine, 5 heads
Acme Recess 3-1/2 RB6
2 5/8" RB6 spindle bearings
New repair parts- 3/4 RA8, 1-5/8 RB8
Reed B-13 thread roll attachment (3)
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C&M Wickman pickoff 1" and 1 3/4"
Hydromat recess unit and flange
Siemens varispeed motor off Wickman
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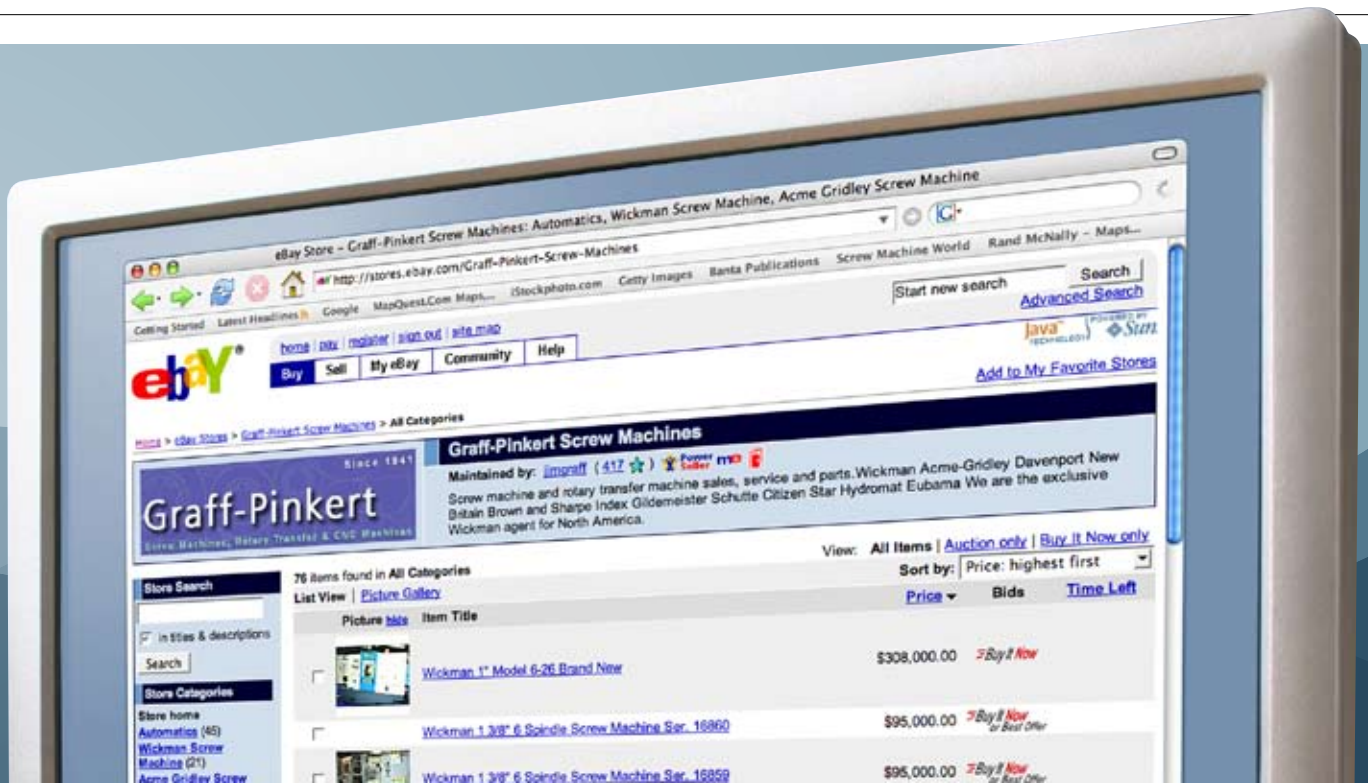


The yet-to-be-released GM Segway PUMA (Personal Urban Mobility and Accessibility) is an all electric two-seater that will be marketed for city dwellers.
Photo courtesy of Segway

Electric cars – HOW FAR will they GO?

BY PAUL EISENSTEIN

IT WASN'T QUITE CHRISTMAS IN JULY, BUT WHEN PRESIDENT BARACK OBAMA AND HIS VICE PRESIDENT JOE BIDEN FANNED OUT ACROSS THE AMERICAN MIDWEST, EARLIER THIS YEAR, IT MIGHT HAVE WELL BEEN. THE TWO LEADERS HANDED OUT THE FIRST CHUNK OF WHAT WILL EVENTUALLY BE $2.4 BILLION IN FEDERAL AID DESIGNED TO KICK-START THE COUNTRY'S ADVANCED BATTERY INDUSTRY.

The Growth of Battery Power

At the moment, there's but a single plant in all of the United States capable of producing lithium-ion batteries from their raw materials. But if the Obama administration has its way, the nation will soon be on a par with the Asian nations, notably Japan, China and South Korea, that currently lead the race to develop the reliable, affordable and high-powered Li-Ion chemistry that could soon transform everything from telecommunications to the auto industry.

The auto industry, in particular, is becoming increasingly desperate for these advanced batteries, for they're the critical link in the push for what's become known as "electrification." Whether to curb the dependence on foreign oil or to reduce the production of emissions linked to smog and global warming, there's a growing consensus that automakers must move away from the time-tested internal combustion engine.

How soon that can happen is a matter of debate, but by now, virtually every major manufacturer has announced plans for some sort of battery-based drive train, from so-called "mild" hybrids, all the way up to pure battery-electric vehicles, or BEVs.

A New Kind of Car

Just days before the White House giveaway, in early August, Nissan Motor Co. CEO Carlos Ghosn grabbed the spotlight in Yokohama, Japan. But the dedication of the carmaker's new corporate headquarters was just the backdrop for the unveiling of the much-discussed but as yet-unseen Nissan Leaf. Due to market in roughly a year, the Li-Ion-powered 5-door is part of a grand plan by the Brazilian-born Nissan Chairman Carlos Ghosn to take the lead in the electric car market. Initially, Leaf will be marketed to fleet buyers who can control and monitor the car's use and performance, but by 2012, Nissan believes it will be able to market Leaf to consumers.

Of course, there is a drawback—a maximum 100-mile range. To downplay that restriction, Nissan plans to equip the BEV with an advanced infotainment system that will not only help you navigate to your destination, but constantly monitor Leaf's state of charge and show the driver the way to the nearest charging station.

"This car represents a real breakthrough," said Ghosn, who also serves as CEO of Nissan's French alliance partner, Renault. "We have been working tirelessly to make this day a reality—the unveiling of a real-world car that has zero, not simply reduced, emissions."

New Technology, New Restrictions

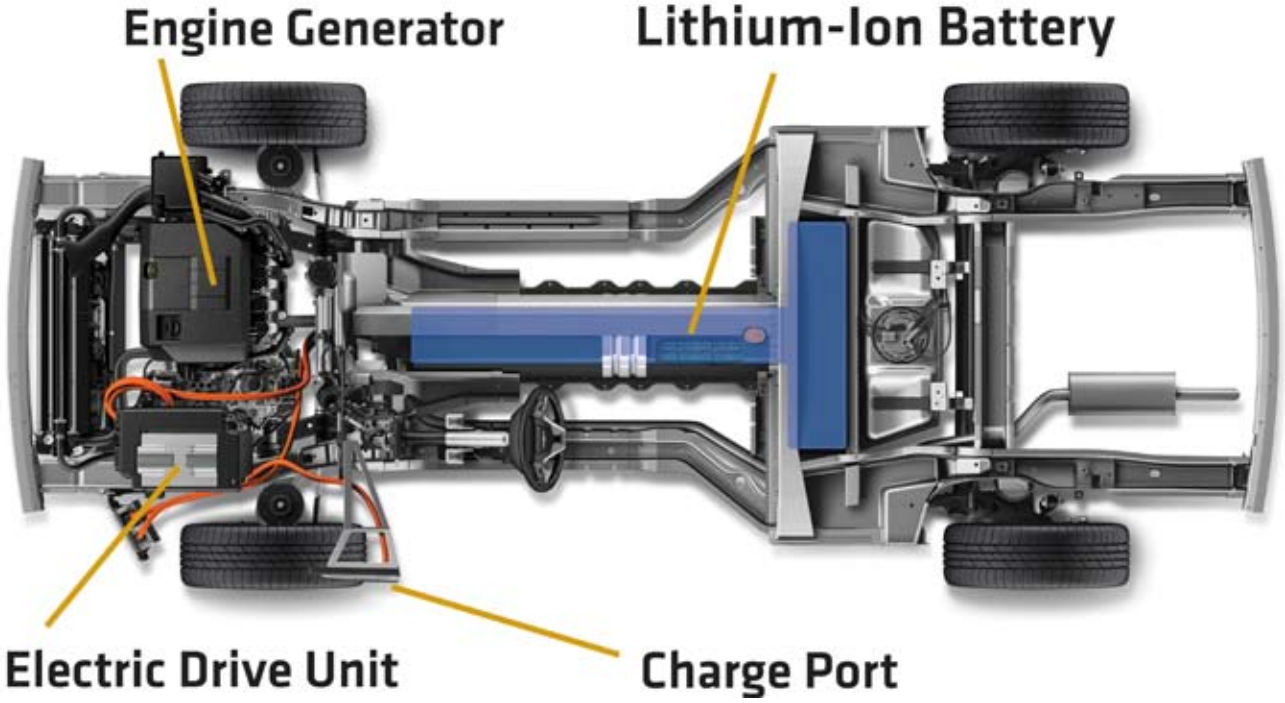
Nissan isn't the only automaker hoping to find a market for pure battery vehicles. Ford Motor Co. will launch a BEV version of its new Transit Connect van in a little more than a year, and follow it with a Focus battery car, in 2011. Toyota also promises a BEV by then, though the maker seems to be reacting more to competitive pressure than out of a sense that there's a real market waiting for the technology. There are serious limitations to Li-Ion technology, cautions Jim Lentz, the Japanese automaker's top-ranked American executive, underscoring his belief that there is no "silver bullet, single solution to the need for alternative power." Toyota may pass on Lithium for now.

General Motors officials echo that point, noting that they're working on everything from hydrogen-powered fuel cell vehicles to mild hybrids, like the Saturn Vue. But the automaker has been making plenty of hay over the 230 mile-per-gallon rating its new Chevrolet Volt is expected to receive under a proposed fuel economy measurement system designed specifically for electrified vehicles.

Leading the Way—The Volt

GM is also promoting the fact that Volt won't be limited to local jaunts, like pure battery vehicles. Chevy's so-

Below: Chevy Volt series hybrid chassis.
Photo courtesy of GM



called "extended-range electric vehicle" or EREV, will carry just enough batteries to run 40 miles on electric power, though GM Vice Chairman Bob Lutz, asserts that will be more than neccessary "for 70 percent of American commuters." On a longer drive, Volt's small internal combustion engine will fire up. A serial hybrid, the engine serves only as a generator, providing power to the motor driving Volt's wheel, or to recharge the battery.

Though its official introduction doesn't come until the fourth quarter of 2010, GM just began low-volume production of Volt, which will be put through extensive testing over the next 14 months.

The automaker, newly emerged from bankruptcy, can't afford any big unforeseen setbacks in the program. The 230-mpg rating given to Volt is generating plenty of controversy—as is the fact that Leaf will be rated at 367 mpg. How, ask the skeptics, can that happen when the Nissan BEV only has a 100-mile range?

Better, But Cheaper, Too?

Even the assertion that battery cars will be cheap to run is a matter of debate. It's true they'll likely be more affordable than a gasoline-powered vehicle if you're only looking at energy costs. Using off-peak electricity, GM estimates it will cost just $0.40 to fully charge Volt. With Leaf, a dollar would cover its 100-mile range. Even plugging in at peak hours would do no more than double to triple those numbers, which of course would still be significantly less expensive than running on gasoline.

Of course, that's only part of the equation. GM's EREV is expected to command a price tag of somewhere between $35,000 and $40,000 when it launches in late 2010, nearly twice as much as a comparably-priced sedan. "That's high," admits Henderson, but he stresses that "new technology is always more expensive." The goal is to boost volumes, enhance the economies of scale, and then get to Volt "gen-two," in industry lingo, as quickly as possible.

Toyota saw a nearly 50 percent drop in the cost of its second-generation Hybrid Synergy drive, used in models such as the popular Prius. But that didn't happen with the recently-released, third generation hybrid, acknowledges Lentz. "We got there with the motor, the controllers and most of the rest of the hardware," he notes, "but not with the battery."

To make a business case for battery technology, manufacturers are looking at a variety of non-traditional approaches. "We may opt for selling consumers the car but leasing them the battery at a price roughly equal to what they'd expect to spend each month on gasoline," suggests Tom Lane, Nissan's director of global product planning. Nissan is just one of several makers considering alternatives to the eventual disposal of automotive Li-Ion batteries. Though they might no longer be good for use under the hood, they'd likely have enough life left, says Lane, to work as back-up storage at power plants, particularly with green energy generators, like wind, solar and wave, that can suffer tremendous shifts in power output moment to moment.

How Far Will it Go?

Cost is just one of the issues with batteries, however. Range is arguably even more of a challenge. Tesla founder and Chairman Elon Musk insists the technology is making significant gains, and he hopes the 200 mile range of his company's little 2-seat Roadster, it hopes, will double by the middle of the coming decade.

Some of the most promising claims are being made

Above: The interior of the new Tesla Roadster.
Photo courtesy of Tesla

by the Chinese automaker, BYD. Short for Bring Your Dreams, the company actually started out as a Li-Ion battery maker and continues to serve as one of the largest suppliers to the cellphone industry. Technologists note there are more than a dozen distinct families under the broad Lithium-Ion umbrella, and BYD claims its Lithium Ferrous Phosphate chemistry will deliver 250 miles on a charge of as little as three hours. Better yet—at least if the technology delivers as promised—BYD's battery comes in at $500 per kilowatt hour, roughly half what other automakers are targeting for other lithium-ion formulations.

"No bloody way," asserts Tesla's Musk. But BYD's technology is enticing enough that mega-investor Warren Buffet has invested $230 million in the Chinese firm—garnering 10 percent of its stock.

Where Will the Batteries Come From?

According to Nissan battery chief, Toshiyuki Motohashi, his company and its partner, NEC, have found a way to produce flat, or laminate batteries, rather than conventional, cylindrical cells—such as those used in the Tesla Roadster.

That saves space and weight, meaning in practical terms, more energy stored and longer range.

Nissan, meanwhile, has set up a variety of joint ventures around the world, including a consortium in Israel in which a network of battery swap stations will be established. Though the Israeli EV can be recharged like a conventional battery car, it will also be able to have its batteries switched out almost as quickly as a gasoline-powered vehicle could refuel.

The push to electrify the automobile has created some strange bedfellows. Virtually every major automaker has established a relationship with one of the leading battery manufacturers. GM, for example, will use some of the federal battery grant money to set up a factory in suburban Detroit where it will assemble battery packs for the Volt. But the basic manufacturing will still be done in South Korea, by its partner, SG Chem.

And that underscores the concerns of the Obama Administration, which fears that Asia—notably Japan, China and Korea—could effectively gain control of the most fundamental components of the battery industry without a concerted U.S. effort to set up a competitive manufacturing base in the States. Right now, there is only one domestic, high-volume producer of Li-Ion batteries, a factory in Indianapolis that's a subsidiary of Ener1, Inc.

That battery maker it turns out, is now the largest stakeholder in the Norwegian-based BEV manufacturer, Th!nk, which emerged from bankruptcy protection at the end of August, and should restart production of its 2-seat Th!nk City battery car by year's end.

Th!nk and Tesla are just two of the automotive wannabes who are betting billions that electrification will open up an industry that has long frozen out new entrants.

Above: The GM Segway PUMA.
Photo courtesy of Segway

Not Just for Cars

One of those companies that sees expanded opportunities is Segway, the producer of the quirky, two-wheeled Personal Transporter. In April, the company unveiled a prototype 2-seater, dubbed PUMA, for Personal Urban Mobility and Accessibility, that it developed in a joint venture with GM. PUMA has only two wheels, but rather than a conventional, tandem design, PUMA's passengers ride side-by-side, as they do in a conventional automobile, thanks to the same stabilization system used in Segway's one-person PT. A more advanced version of the skeletal prototype, shown at the New York Auto Show, could be revealed by early next year.

Segway has already drummed up support, including some financial assistance, from a number of cities around the world, including London, which sees an opportunity for the downsized alternative to a conventional automobile.

There's been similar interest by traffic-snarled cities, like London, in smaller BEVs being developed by BMW's Mini division and by the Mercedes-Benz sibling, Smart.

One of the curious paradoxes of our day, notes Professor Bill Mitchell of MIT's Smart Cities program, is that the more urbanized the world gets, the more its citizens want their own personal transportation.

So vehicles like Volt, PUMA or the Smart ED (for Electric Drive) have tremendous potential. But Dr. Mitchell cautions that just because a vehicle is green won't be enough to win over an audience. "You can't get people to accept a vehicle solely on the basis of saving the planet," he stresses. "It also has to be fun and fashionable." And functional. And reasonably affordable.

Will it Work?

That underscores the risk the industry is facing with its increasing emphasis on Li-Ion technology. It works in cellphones and laptop computers, but whether it will deliver reliably in the challenging environments faced by the typical automobile is yet to be proven. But with government regulators in most major markets enacting tougher emissions and fuel economy standards, automotive planners simply can't wait to find out for sure. In turn, governments can't afford to let the industry fail, which is why the Obama Administration's cash infusion is both critical and unavoidable.

The U.S., of course, isn't the only country making a push into battery power. Governments from Beijing to Berlin are coming up with subsidies for manufacturers and the new generation of suppliers that will be needed to move the world of the electric automobile forward. Some traditional parts manufacturers are hoping to get into the game. Those who don't could face an increasing struggle to survive should the internal combustion engine become as dated as the buggy whip. But how soon that will happen is uncertain.

There are plenty of skeptics who say it never will. They insist battery technology is simply too inefficient and expensive. And in some segments of the market, they may be right. GM's new product development director, Tom Stephens, notes that it takes 100 litres of batteries to store the energy of a litre of gasoline. That may be fine for small vehicles, like Volt or Leaf or the Tesla Roadster, but it likely

won't work, without massive breakthroughs, when you're talking pickups and SUVs. For his part, Nissan CEO, Ghosn, believes that even if the industry is successful, only about five to 10 percent of the vehicles produced by the end of the next decade will be battery powered—either pure BEVs or plug-in type vehicles that run primarily on electric power.

> "Even if the industry is successful, only five to 10 percent of cars in the next decade will be battery powered."

Of course, financial incentives can move markets. The recently-concluded Cash-for-Clunkers program convinced more than 600,000 Americans to trade their old and inefficient vehicles in for higher-mileage small cars and hybrids. The government of Ontario is looking at financial incentives that could help make as many as 10 percent of the vehicles sold in that province battery-powered. And the German government hopes to put as many as 1 million battery vehicles on the road by 2020.

The cost of this transformation is, for the moment, incalculable. It will require not just a shift in design, engineering and manufacturing at the assembly line level, but a transformation among automotive suppliers. Governments will clearly have to become involved, supporting manufacturers, encouraging new research and even laying out plans to modernize the electrical grid systems that will be needed to provide power to potentially millions of battery vehicles. But if the fears outlined by proponents, ranging from climate change to declining supplies of petroleum, are true, the price tag will be a bargain in the long run.

The iPod doctor doing surgery.

one on one

Interviewed by Noah Graff

Demetrios Leontaris,

also known as the NYC iPod Doctor, and his team of two other technicians drive around Manhattan daily going door-to-door to fix laptops, iPods, PDAs and cell phones. He fixes 10-15 devices on an average day for waitresses, high school kids and Wall Street workers, in addition to repairing devices sent to him by mail.

What inspired you to start your business?

DL: I started it because people weren't getting a lot of support from the manufacturer after the warranty ran out on their products, so they didn't have a place to get them fixed. I [personally] had tried going through the manufacturer for a broken iPod screen, which they told me wasn't under warranty. It would have [cost] $250 to replace the iPod. The retail price at the time was $300, so I ended up buying another broken one and putting it together that way. I've been dabbling with my computer and electronics for years—it's not new to me.

What's the most common problem you encounter, and where do you get your replacement parts?

DL: Broken screens from being in the pocket or dropping them on the pavement. It'll take a hit like that four, five, six times and then one time it just breaks. I get parts either from scrap or from suppliers in China. I get my LCD screens from a place in the states for laptops, not far from where I live. One of the big eBay sellers are laptop LCD screens.

What do you typically charge for your services?

DL: On average, for an iPod it's between $59 and $100 and change. Laptop LCDs start at $115, but on one I had to go to $595. It was a rare Sony 10" screen that I had a hard time finding, but the computer was worth around $2000. Then my labor was $100.

What was one of the craziest things you've dealt with?

DL: I had a couple who got into a fight—with their iPhone in the middle. She threw it at him, he kicked it back to her and she stomped on it. In the end I ended up fixing it by replacing the LCD screen. I have had them run over by cars. People forget that it's in their pocket and then they wash their clothes. My son actually has a water damaged one he's been using for eight months now.

Isn't it time-consuming to travel all over New York?

DL: Yes, but have you checked out retail space in Manhattan? I think the last place I [saw] might have been 700 square feet for $21,000 per month. It doesn't make sense to have a store in Manhattan.

What are the most frustrating things you deal with in your job?

DL: No schematics or maps for the electronics. It can be time consuming writing my own map of the circuit boards. Luckily we don't do much repair on circuit boards—we generally swap them out. But occasionally it's worth it to at least see if there's a possibility of repairing by switching the circuits.

It sounds to me like you don't like saying "no" to people.

DL: I'm very bad at saying "no." It's not the best thing for business, unfortunately. But it makes people happy to get their stuff fixed. If I'm not doing that, I don't see a point in doing this at all.

Today's Machining World's "Shop Doc" column taps into our vast contact base of machining experts to help you find solutions to your problems. We invite our readers to contribute suggestions and comments on the Shop Doc's advice. If you consider yourself a Shop Doc or know a potential Shop Doc, please let us know. You can also check out the *TMW* online forum at www.shopdocforum.com.

Dear Shop Doc,

I'm trying to run a part that is made from extruded aluminum stock. The dimensions of the material are not symmetrical top to bottom or left to right. I've heard that Swiss-type machines are well suited for running this shape of material. How do I set up my machine to utilize this material?

A Little Off

Dear A Little Off,

You are correct that CNC sliding headstock (Swiss-type) machines are well suited for making parts out of extruded material. One of the benefits of a sliding headstock is that you can machine very small extruded material that will be supported by the guide bushing as the material is being machined.

Before we get started, make sure your machine has these capabilities: Revolving guide bushing, spindle phase synchronization and diametric capacity (measure across the points of the extruded material). Also, the keys in the main spindle, guide bushing and sub-spindle must be aligned (phase synchronized). All new machines will already have the keys phase synchronized with each other. If you have an older machine, then you should verify this before setup.

Now for the collets and guide bushings. Most major workholding companies will know how to make profiled collets and guide bushings. Simply send a drawing of the part to your preferred collet company and indicate where you want the center line to be. Also, indicate the radial position you want the key ways to be. This will allow you to position the profile exactly where you want for part pick-off and live tooling. The workholding company will then EDM the desired profile into the main spindle collet, guide bushing and sub-spindle collet.

After you receive your collets and guide bushings, install them making sure all of the keys are aligned. The tension should be set similar to how you set standard round collets and guide bushings.

For programming, your "C 0.0" will position the keys up. This will allow you to program the features of the extrusion and maintain positional accuracy for live tooling processes. During the pick-off process, you'll need to add a phase synchronization code to your program. Do this during your normal programming after the rpm synchronization code. Depending on the age of the machine, you may want to add some G4s after the rpm and phase synchronization codes.

Now that you have your workholding completed, the rest of the setup is the same as for machining round material. The one thing I would add, just to be on the safe side, is to command your rpm and phase synchronization codes in MDI mode and test to make sure the sub-spindle is aligned by bringing the sub-collet over the material. Clamp and unclamp the collet, then inspect the part to make sure there is no damage of the material. If there is damage to the pickoff area, you'll need to adjust the machine parameters (not the program) for the sub-spindle to align the phase of the sub-spindle.

David Cogswell
Ellison Technologies

David Cogswell is a Tsugami product manager at Ellison Technologies in Santa Fe Springs, CA.

Have a technical issue you'd like addressed? Please email noah@todaysmachiningworld.com.
We'll help solve your problem, then publish both the problem and solution in the next issue of the magazine.

shop doc

Dear Shop Doc,

My 1-1/4RA6 Acme-Gridley is having trouble machining consistent diameters. We are seeing outside diameter variation from spindle to spindle that has gradually gotten worse. We can no longer produce parts within specification. We put an indicator on the spindle carrier and checked the endplay. That seems good, but when we checked the carrier rack with moderate pressure we found more than .004" radial play in the carrier. The locking pin spring is fine and the pin is fully engaged. What do we do now?

Inconsistent Play

Dear Inconsistent Play,

It sounds like your locking pin and blocks are worn and need to be reconditioned. You have to pull out the spindle carrier to do this.

There are other things you want to consider while the carrier is out of the machine, but we will address only the carrier lock-up issue here.

Once the carrier is out of the machine, remove the locking pin sleeve from the headstock. You can either grind the I.D. of the old sleeve and reuse it, or replace it with a new sleeve. Replace the old locking pin with a new one. The O.D. of the new pin has to be ground to fit the I.D. of the sleeve. This should be a slip fit of about .0007"-.0009".

Next you have to grind the drop step in the new pin using the old pin as a guide to establish the depth of the step. This step engages the positive side of the locking block and locates the spindle carrier on index. This keeps the carrier aligned properly as designed by the OEM.

Now remove the old locking blocks from the spindle carrier, making note of the orientation. You have to install six new blocks in the carrier and these must be ground to fit. The blocks have a positive side (squared inside face) and a lockup side (tapered inside face). Grind the outside of the block on the lockup (tapered) side until you have a press fit (.0005" max.) with the carrier cavity. You may have to remove them again pending the results of a test you will perform later, and a tight press fit will make them harder to remove. Install all six blocks onto the carrier.

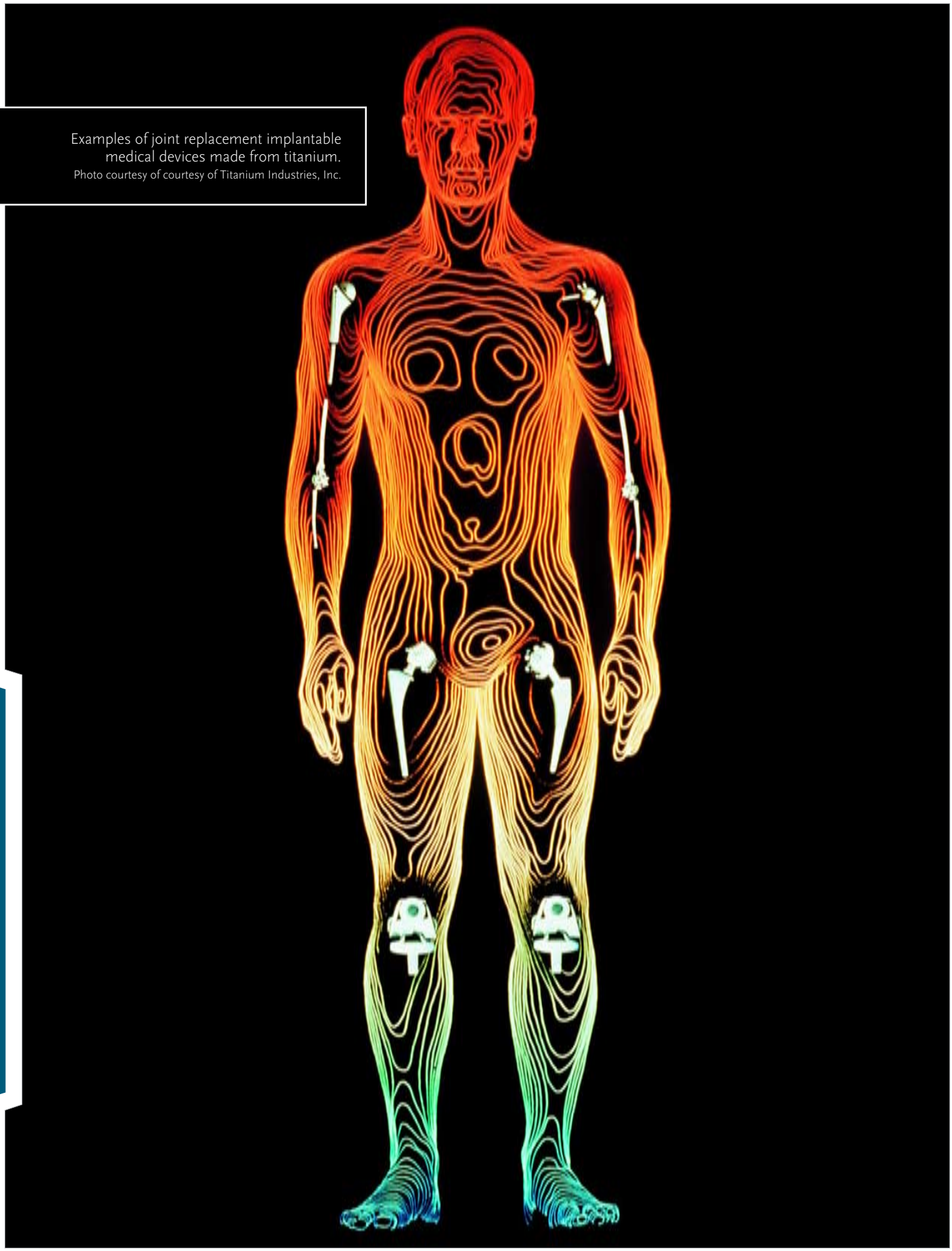
Once you have the carrier back in the machine you will need to perform a block test to check your index spacing. To do this install two knee turn tools on the main tool slide in the first and fourth position to cut on the radial centerline of the spindles. Then machine about a 1/2" long diameter on soft bar stock such as 12L14 at slow speeds and feeds as close to the spindle as possible. Index the carrier until cuts have been made on all six spindles and check the diameters for variation. OEM standard specification calls for .003" diameter maximum variation across all six spindles.

If you have more than .003" variation, remove and grind specific blocks on the positive side (inside square face) to correct them and reinstall them in the carrier. Once that is accomplished the block test should be repeated to verify the results.

Keep in mind that in order to perform a valid block test your main tool slide and stem cannot have more than .001" lift and your tool slide guide block cannot have any taper, as that will affect the results of the test.

Dave Johnson
Champion Screw Machine Engineering Inc.

Dave Johnson is the rebuilding manager at Champion Screw Machine Engineering Inc., an Acme reseller and rebuilder, and supplier of replacement parts, tooling and attachments for wide range of multi-spindle screw machines.



Examples of joint replacement implantable medical devices made from titanium.
Photo courtesy of courtesy of Titanium Industries, Inc.

By Barbara Donohue

Machining Titanium

Known for its strength, light weight, corrosion resistance and biocompatibility, titanium and its alloys serve in increasing numbers of aerospace, medical and industrial applications.

An amateur geologist discovered the element titanium in the 1700s. Titanium metal came into industrial use in the 1950s as a structural material in military aircraft. Titanium offers extreme resistance to corrosion, and its structural alloys offer a high strength-to-weight ratio.

Buy-to-fly

Long used for certain aerospace applications, titanium is being used more and more in the latest generation of aircraft, such as the Boeing 787 Dreamliner. The composite materials used in these aircraft match the thermal expansion characteristics of titanium better than those of aluminum. As a result, titanium has replaced aluminum as the material of choice for many structural components, according to Bill Pallante, vice president-commercial, RTI International Metals, Inc., Pittsburgh, Pa.

The "buy-to-fly ratio" compares the amount of raw material stock used to make a part to the amount of material in the completed components as assembled into an aircraft. For the Boeing 787 Dreamliner, the buy-to-fly ratio for titanium is approximately 6:1, said Marty Procko, key account director, RTI International Metals, Inc. About 250,000 pounds of titanium end up as about 42,500 pounds of parts. That's a lot of machining. Higher performance aircraft tend to have an even higher buy-to-fly ratio. For the F22 Stealth fighter, it's 30:1, he said. Procko gave an example: one aircraft component starts out as a 5000-pound chunk of titanium, and after it's machined, it weighs 365 pounds.

Greater demand for titanium components in these new aircraft means there is also an increased need for titanium-machining capacity. Though the parts may look similar, the machining process is somewhat different in titanium and aluminum, and the machines that cut the aluminum parts won't necessarily be able to cut titanium.

No Corrosion

Titanium's corrosion resistance comes from its ability to form a tough oxide layer on exposed surfaces. "You can put titanium in the ocean today and come back in 100 years and it looks the same," said Jeff Wise, vice president of sales and marketing, Titanium Industries, Inc., Rockaway, N.J. Much of titanium's industrial use is due to its immunity to corrosion. In power plants, for example, where brackish or salt water is used for cooling, heat exchanger components are made from titanium.

Making Chips

Among those who have experience with titanium, the metal has a reputation of being tricky to machine. After working in titanium for more than 25 years, machinist Larry Kerbs at Aerometals, El Dorado Hills, Cal., knows better. "Titanium is highly predictable," he said. You just have to know how to work with it. You have to keep down the speed/surface feet per minute (SFM). In a certain cut, if you were cutting alloy steel at 500 to 700 SFM, you'll need to run 150 to 160 SFM in titanium, he said. And the feed rates and chip load per tooth will probably be about the same as alloy steel.

In addition, you'll need to be sure to have a rigid setup

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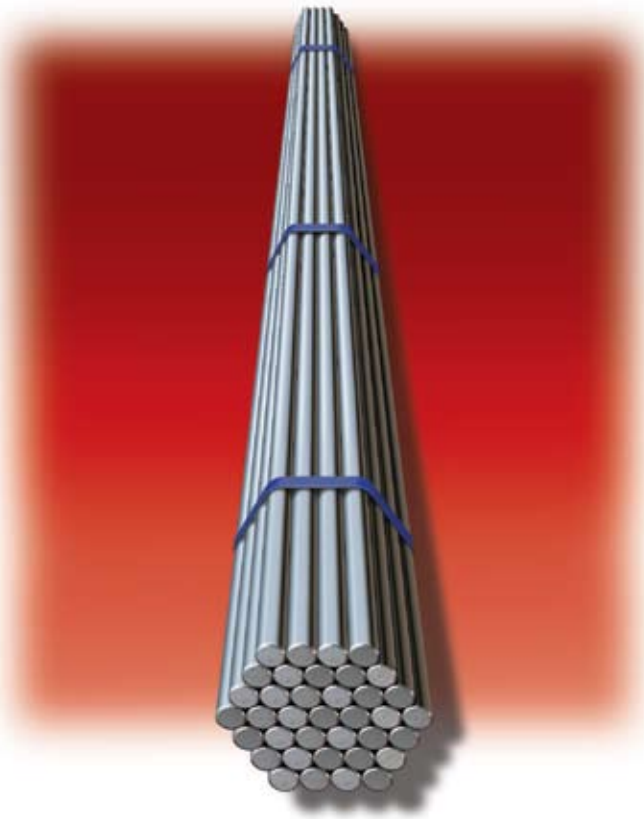

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how it works

Below Left: Titanium forging that will be machined into a helicopter component.

Below Middle: Completed titanium helicopter component.

Below: Right Titanium gives high strength and low weight to components used in aircraft, such as this helicopter.

Photos courtesy of Aerometals

with titanium, more rigid than with a steel workpiece, as titanium has a lower modulus of elasticity and will tend to flex more.

For tooling, you'll need sharp tools with steep shear angles, said Kerbs. "Essentially, you can use the same tooling on titanium you would on aluminum. You want the same shearing action," said Kerbs. "When you cut titanium, use a sharp tool. It helps keep the tool cool. If you lose the edge, it will gall and the titanium will weld itself right to the tool," he said.

Tools have changed a lot over the years, with different coatings and geometries, but when it comes to titanium, the new technologies don't seem to make much difference, Kerbs said. "If you have the right feed and speed on titanium, it's not that difficult to cut. If you push your speed up, you're going to lose a lot of tools or inserts."

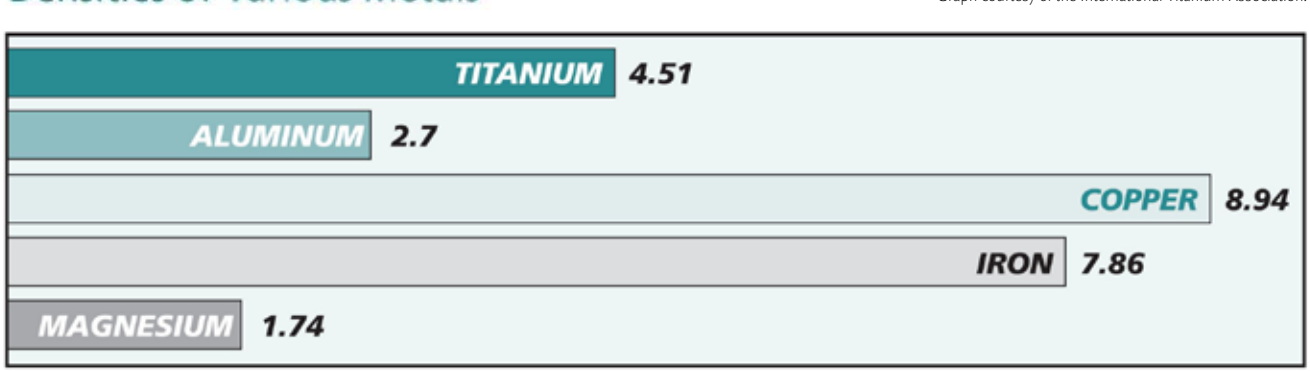
At first, you'll fine-tune the feeds and speeds for a part by trial and error, said Kerbs, always proceeding with caution. Titanium is quite an expensive metal, and you may be starting with a forging that costs $1000, he said.

To successfully machine titanium, Kerbs recommended the following:

- *Examine the tool after each cut.*
- *Use a load monitor on the machine.*
- *Listen to the machine and be alert for the change in sound that says a tool has begun to dull.*

Below Relative density of several metals.

Graph courtesy of the International Titanium Association.



Above: Formed and machined titanium extrusion for commercial aircraft application.
Photo courtesy of RTI Metals International, Inc.

Keeping the tool cool is also critical. Make sure you have a generous flow of cutting fluid in the cut. "Titanium doesn't have good heat dissipation factors, and, of course, heat destroys tools," Kerbs said. Also, he cautioned, be careful to keep the tool moving through the metal. "One thing you don't want to do is let the tool dwell in the titanium. That will fry it. You have to back the tool off right away."

Be sure the cutting fluid you use is compatible with titanium, said Pallante. You risk corrosion with fluids that contain halogens–chlorine, fluorine, bromine. In a fresh cut, apparently, the titanium may not be able to form its protective oxide layer before contacting the fluid.

Though conventional wisdom says that you should machine titanium with the highest feed rates possible, recent research has revealed that this can cause problems. If you machine titanium too aggressively, said Pallante, you can induce porosity in the surface due to tearing across grain boundaries. The damage shows up in nondestructive testing such as dye penetration inspection (DPI). Until this link to aggressive machining was discovered, often the titanium supplier was blamed for the porosity.

"Titanium is very machinable," said Pallante. "There are obstacles but there certainly is enough information out there [about how to machine it]. It's not the mystery it has historically been made out to be."

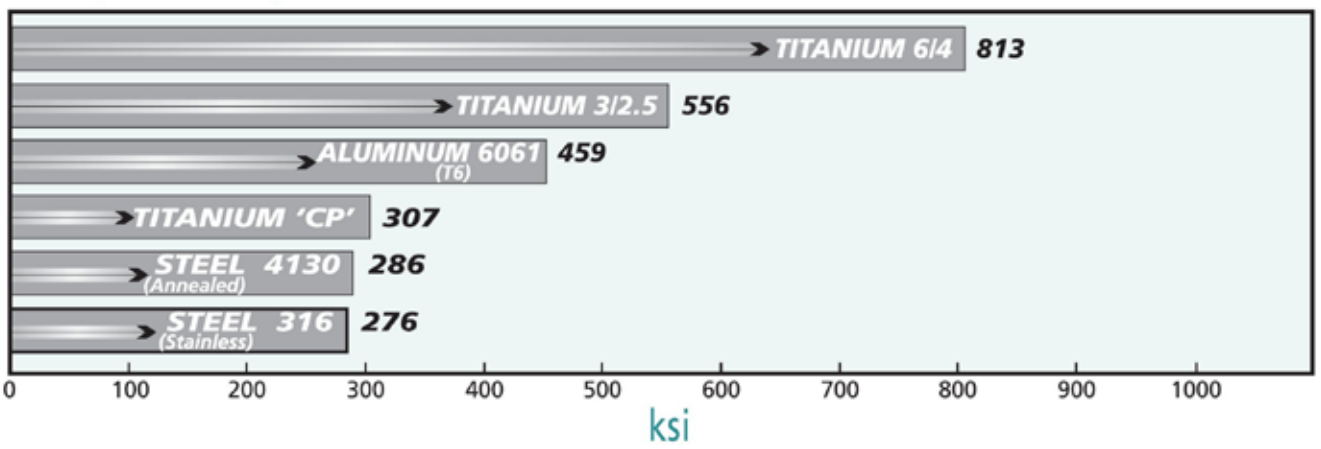
Chips for Sale

All that machining means there will be lot of chips. Since titanium is a relatively expensive material (a recent price for one typical alloy stock was a few dollars per pound), you can receive good money for your recycled scrap. Besides the chips, save the trimmings from sheet, the flash from forgings and the end crops from billets. To get top dollar for your scrap, segregate it by alloy, each in its own labeled bin, Pallante recommended.

Fire Safety

While titanium stock won't burn under ordinary conditions, titanium dust and fine titanium chips can. Fires rarely occur, but if you're cutting titanium, you'll want to store the chips safely, practice prevention and be prepared.

Below: Strength-to-weight ratio of titanium and other metals.
Graph courtesy of the International Titanium Association.



Making Titanium

Above: Titanium stock at the Rockaway, N.J. warehouse of Titanium Industries, Inc.
Photo courtesy of courtesy of Titanium Industries, Inc.

Titanium is the ninth most abundant element in the earth's crust, and the fourth most prevalent of the structural metals.

The most common sources for titanium are the minerals rutile (titanium dioxide, TiO_2) and ilmenite (iron titanium oxide, $FeTiO_3$). They look like black sand, and are found in commercial quantities in coastal areas of South Africa, Norway, Australia, Canada, Finland and the U.S.

Only about 5-10 percent of the titanium produced is used as metal. The rest is used in the form of titanium dioxide, an intensely white pigment commonly used in many products, including paint, paper and cosmetics.

The refining process starts with the black sand ore, and yields metallic titanium in a porous "sponge" form, so called because it resembles natural sponge. The sponge is compressed, and then melted by vacuum arc remelt, or by electron beam or plasma melting.

"I've seen titanium burn in production," said Gregory Creswell, regional safety manager, Titanium Metals Corporation (TIMET), Exton, Pa., and safety committee chairman for International Titanium Association. The size of the chip will have a big impact on whether it will burn. "If it's a very light chip, a thin chip, it may want to burn. Something similar to a Brillo pad would have more inclination to burn. A thick chip is less likely to burn," he said.

Burning titanium will react with water to produce explosive hydrogen, so never put water on a titanium fire. You'll need to put out the fire by smothering it with sand, salt or an appropriate fire suppressant. Table salt (sodium chloride) will do the job, said Creswell. "We buy table salt in 50-pound bags." A titanium fire burns so hot it melts the salt, he said, and the salt forms a crust over the hot material.

For suppression of titanium fires inside the machine, Firetrace International, Scottsdale, Ariz., offers an installed system that automatically blankets a fire with quantities of a Class D fire suppressant. "It's like fine sand and has a smothering effect," said Paul Gugliemi, Firetrace's northeast regional manager. He has more often seen oil fires in machines cutting titanium. However, he said, if you run titanium lights-out, a titanium fire could happen if the coolant flow fails.

Above: Titanium resists salt water corrosion and is used in marine environments in applications such as offshore oil drilling facilities.
Photo courtesy of courtesy of Titanium Industries, Inc.

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Wise said he thought the fire hazard is overstated. However, he suggested making your local public safety agencies aware that you work with titanium. "At our facilities, we invite the local fire department in so they know what they'd be handling," said Wise. Whether you're working with steel, titanium or whatever, it's a good idea to let your local fire department know what goes on in your shop, he said.

> "Whether you're working with steel, titanium or whatever, it's a good idea to let your local fire department know what goes on in your shop."

Applications

Titanium applications take advantage of one or more of its qualities of strength, low density, corrosion resistance and biocompatibility.

Heat exchangers for power plants, piping and fittings for chemical processing, oil exploration and drilling equipment, and marine devices such as sonar housings make use of titanium's inherent corrosion resistance.

Titanium 6Al-4V alloy, which contains 6 percent aluminum and 4 percent vanadium, represents about half of the titanium used in the U.S., Wise said. It serves for structural components in such applications as aircraft engines, airframes and landing gear, ships, space vehicles, and oil exploration and processing equipment.

In the medical realm, titanium goes into many devices, including implantable hip joints, surgical instruments, and wheel chairs. It is especially valuable for implantable medical components, as bone adheres well to titanium's oxide surface without the need for any additional coating.

Even sports and leisure equipment uses titanium. You can find it in bicycle frames, golf clubs, tennis rackets, pool cues, skis, and pitons, crampons, ice axes and other climbing equipment. Titanium is used in eyeglasses, watches and other personal accessories.

Enough Spindles for Titanium Demand?

Industry projections show significant increases in the demand for titanium, said Pallante. The trend is toward using more titanium in aerospace, commercial and industrial applications. To meet the expected demand, titanium suppliers have been ramping up their mining and refining capacity in recent years. Since a lot of that titanium

will go into machined parts, Pallante wondered if there will be enough spindles out there to handle the volume of titanium machining, when the economy turns around.

These won't necessarily be the same machines that cut the aluminum parts, he pointed out. Aluminum needs to be cut at high speed. Cutting titanium requires high torque at the required lower machining speeds. This could provide opportunities for shops that own machines that have this capability.

Contributors to this article:

Aerometals: www.aerometals.aero

Firetrace International: www.firetrace.com

International Titanium Association: www.titanium.org

RTI International Metals, Inc.: www.rtiintl.com

Titanium Industries, Inc.: www.titanium.com

Titanium Metals Corporation (TIMET): www.timet.com

For more information:

Background information about the element Titanium (Ti):
http://pubs.acs.org/cen/80th/titanium.html

Titanium Guide:
www.rtiintl.com, Click on "Titanium"
Click on "Download the full Titanium Alloy Guide."

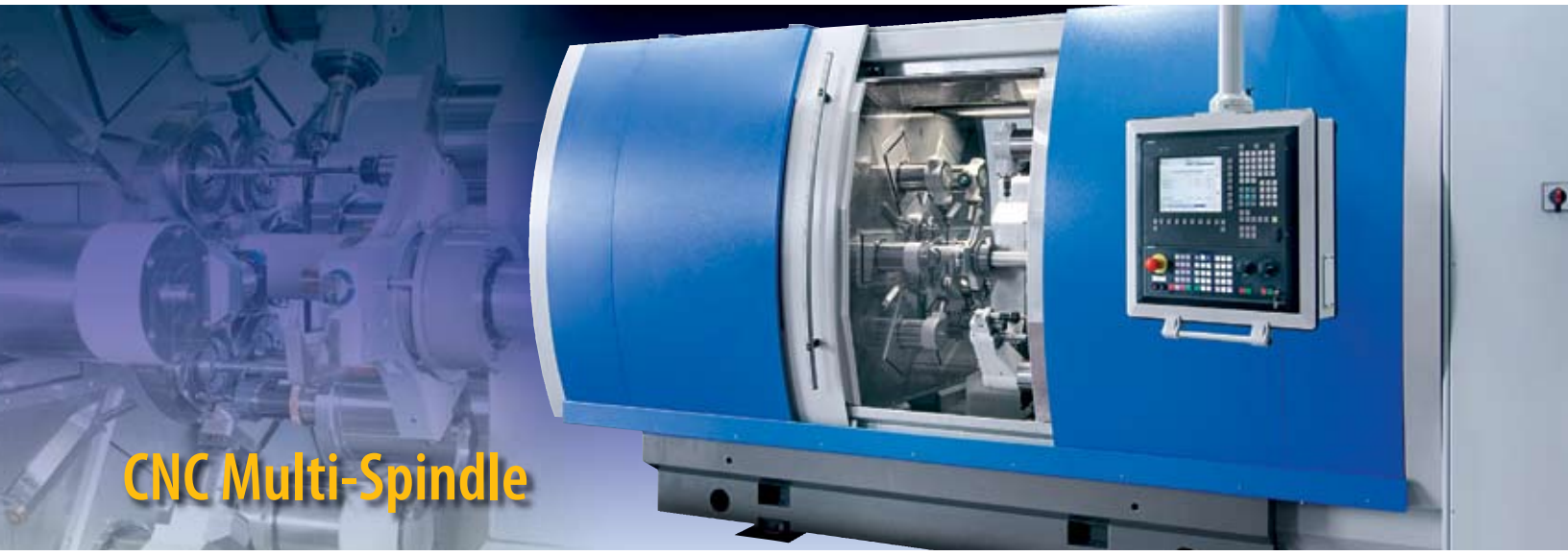
Machining Titanium booklet:
Request from RTI International Metals, Inc.,
www.rtiintl.com

Booklet about Titanium from International Titanium Association:
http://www.titanium.org/files/ItemFileA3319.pdf

Titanium dioxide article from the Chemical Heritage Society:
http://www.chemheritage.org/explore/milestone_titanium.html

Shape Memory Alloys, *Today's Machining World*, March 2009:
www.todaysmachiningworld.com/files/backissues/March_TMW.pdf

The Schütte Family of CNC Precision



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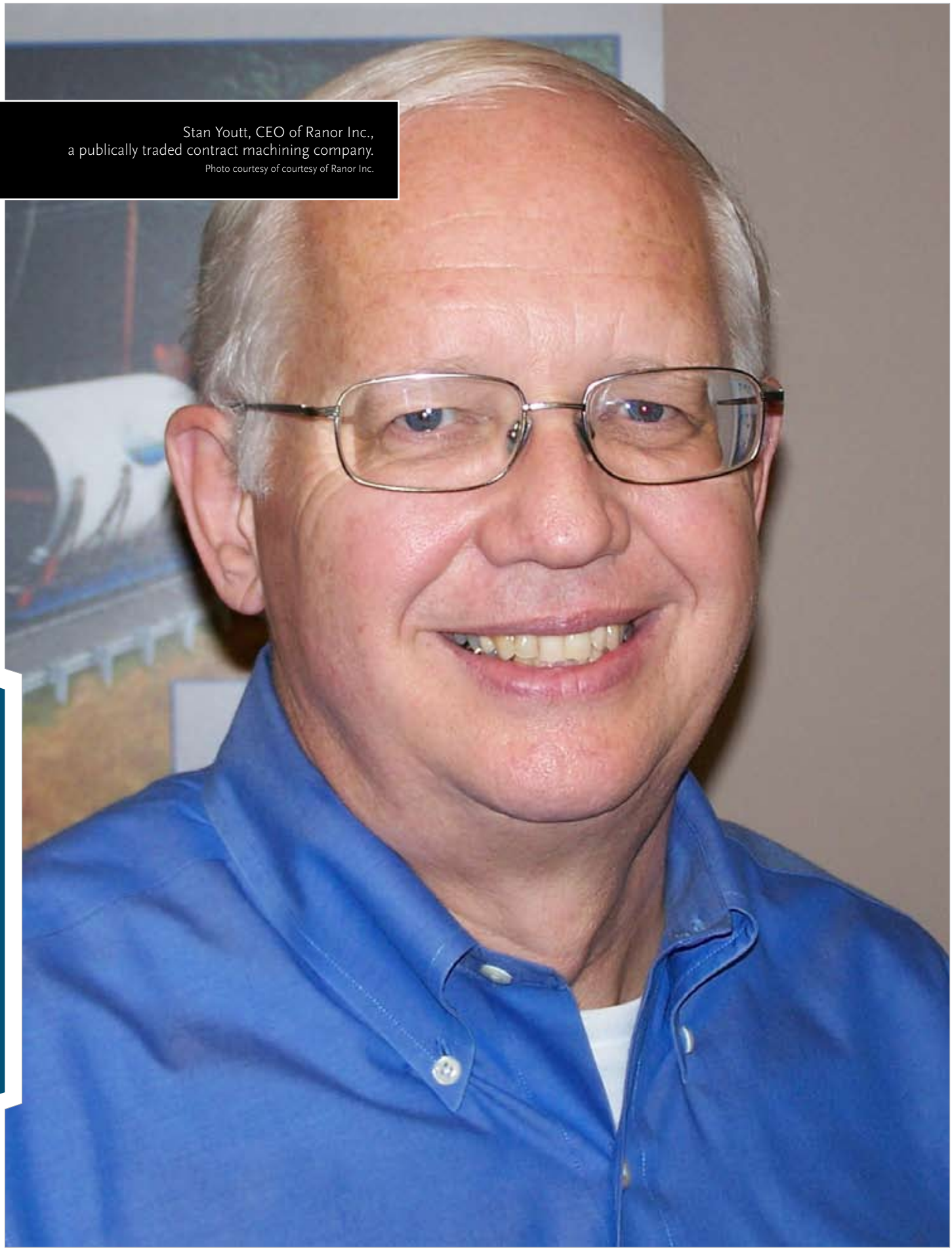

Stan Youtt, CEO of Ranor Inc.,
a publically traded contract machining company.
Photo courtesy of courtesy of Ranor Inc.

stan youtt

Lloyd Graff interviews

Stan Youtt

of Ranor, Inc

Stan Youtt is CEO of Ranor, Inc., the primary subsidiary of TechPrecision Corporation, a publicly traded contract machining firm. They work in high-tech industries such as solar, nuclear and medical. They recently saw solar, their biggest client, go from 51 percent of their business to almost nothing. I wanted to understand how they operate their business in this environment.

Lloyd Graff: Stan, I want to talk to you about the nuts and bolts of running a contract machining business for high-tech products.

Stan Youtt: One thing about us that's different from other contract manufacturing companies is that we're both a fabricating shop and a machine shop all in one. This gives us the ability to start with raw plate and produce fabricated and machined products which we can also assemble and test. All of this is done under the presence of our quality assurance system, which has nuclear, military and commercial capabilities. So we are capable of providing complete manufacturing solutions for a wide variety of industries.

LG: In the recent stock analyst conference call, Mr. Fitzgerald, CFO of TechPrecision Corp., talked about wanting to try to move away from what he called auction or bid work to value-added work and to selling your intellectual property. I want to know how you're attempting to do that within the framework of a contract machining company.

SY: Our customers generally design the products we build. In cases like our proton beam medical product, we work with a customer's preliminary drawings and his design team to make the product more producible. At the end of the program, generally speaking, the design still belongs to our customer. However, the process by which we manufacture the product, which is documented in manufacturing routers, is our intellectual property.

LG: Do your clients want to get into manufacturing, or are they happy to send it to you or competitors of yours?

SY: I find that customers are moving away from manufacturing. Some of the major military customers, for example, believe that they save money by subcontracting

a larger content of their product. Companies that are developing a new product from their own intellectual property often have no intention of manufacturing. This trend is clearly good for us.

LG: Can you give me some background on the medical proton beam product?
SY: We were involved with making advanced propulsion motors for the military that utilize compact, superconducting magnets. We found a commercial customer who was interested in using this type of technology to accomplish proton beam therapy. Our experience with related state of the art materials and manufacturing techniques was needed.

LG: How did the commercial customer find out about you?
SY: They are a Massachusetts-based company and some common people between the two projects brought us together. Ranor Inc. has been here for 53 years and there are a lot of interrelationships. A lot of our business comes from referrals.

LG: Stan, you run a job shop serving a variety of industries yet you reached a point last year when solar provided half your volume. What do you do when solar goes from 50 percent of your business to virtually nothing?
SY: We were never a solar company. We're a manufacturing company that happened to be largely involved in servicing the solar business. The work cells that we used in the solar product industry had been used to build dry storage canisters for spent nuclear fuel. Right now, the object is to get that work cell active in other programs. We've had some success, but are still in the process of trying to get that team of people engaged in other projects.

LG: What if solar comes back strong? Would Ranor anticipate nearing 50 percent again with any particular customer or industry?
SY: It certainly could happen. We were aware of what we were doing when our business grew in solar. We're more comfortable with a more diverse customer base at all times. I'm not saying we never would, but if we did, we would do it carefully knowing the risks.

> "Ranor, Inc. has been here for 53 years. A lot of our business comes from referrals."

Below: Ranor, Inc. in Westminster, Mass.
Photo courtesy of courtesy of Ranor Inc.

Above: Ranor Machine Shop in Westminster, Mass.
Photo courtesy of courtesy of Ranor Inc.

LG: Your volume goes from $11 million to $3 million. What do you do with all the people?

SY: We certainly have had a layoff. Most of the remaining people have been transferred to other products and we've developed some other product lines to help fill the gaps.

LG: I'm interested in your growth into the nuclear refurbishing market. Can you talk a bit about that?

SY: We've been in the nuclear business for over 25 years during which time there has been very little new construction in the U.S. We build reactor components for new power plants for one customer, but most of these components over the last few decades have been for power plants in other countries. Right now, we're in the process of shipping a fairly significant project for the Three Mile Island Power Plant, so there is ongoing after-market work for U.S. nuclear plants as well. Our company has always taken the long path where nuclear power is concerned. I think the [U.S.] is about to see a renaissance of nuclear power, and companies like ours with nuclear capability are likely to get a significant amount of that business.

LG: How many engineers do you have on staff? How do you divide up your staff between your office staff and your floor staff?

SY: We have six sales engineers who are involved with marketing, estimating and developing bid proposals for our customers. They also serve as the point of contact between us and our customers throughout the manufacturing process of each project. We also have eight manufacturing engineers who work with our customers to make designs more producible, and to develop a manufacturing process in collaboration with our quality department and our manufacturing team. The manufacturing process is documented in manufacturing routers. Our engineers develop a router for each component that we build. There may be many routers for a complete project. We maintain appropriate documentation and material traceability for each project including welding procedures, welder qualifications, dimensional data, etc. Our routers are always structured the same. Our quality system is always the same. If the customer needs a simple commercial product, there's a lot less detail to be recorded. If the customer is military or nuclear, there's a lot more detail.

Above: (From left to right) From Still River Systems: Mark Jones, Gordon Row, Mark Robinson, Earl Cleveland, Marc Buntaine
From Ranor: Stan Youtt, Joe Ciras, Joe Duval, Tom Jankauskas, Don Fluet, Tom Ziobrowski, and Joe Quinn.
Ranor entered into an exclusive 3-year manufacturing and supply agreement to produce key components for a revolutionary proton beam radiotherapy device to treat cancer that is being developed by Still River Systems.

** The Still River Systems Monarch 250 has not been cleared by the US Food and Drug Administration for commercial distribution/ clinical use.

Photo courtesy of courtesy of Ranor Inc.

LG: I'm curious about this router. Can you flesh that out a little more for me?

SY: It's a manufacturing process that defines step-by-step how that particular product is going to be fabricated and/or machined. Basically each step is defined and each step then is documented.

LG: The router is a process.

SY: It's a process. It's a book.

LG: How do you figure your costs?

SY: We have different cost rates for the various processes required to manufacture a product. There are rates for fabrication, machining, engineering and quality assurance. Everyone charges his time to the project that he works on, so if you multiply the labor hours by the appropriate rates, you can calculate the actual labor cost to produce a product. More complex projects like military or nuclear projects incur for example more quality assurance costs, and more engineering costs. Simpler commercial projects incur lower costs. When we create an estimate for a job we use the same process, only we estimate the labor

hours we that will be required for each process. The hard part is to assess the amount of time it's going to take to manufacture something that's never been built before.

LG: Are your stockholders tolerant of that?
SY: I'm thinking about that.

> "The hard part is to assess the amount of time it's going to take to manufacture something that's never been built before"

LG: I look at contract machining as a very difficult place to make money and a contract machining company that goes public is an interesting idea to me. There haven't been a lot of notable successes.
SY: Our business plan involves having manufacturing product lines and using our contract manufacturing capability to help a customer develop a prototype that leads to production. That doesn't mean we don't also do just the contract job, because we will. But using the skill of a contract manufacturing company to develop a customer's prototype product and then producing the product in quantity, that's what we're very good at. We have two military product lines and had our solar product line, which isn't necessarily gone for good. We are developing a product line with medical, the Still River Program.

LG: Do you ever go home at night and say, "Gee, I wish I had two Haases and a couple Mories and I'd go in business for myself and have one employee?"
SY: I think the former owners of this company felt that way. I know they are proud of what they did but they're glad enough not to be doing it anymore.

LG: But how about you? You're 62, you've got a wealth of knowledge. You know all kinds of stuff about fabricating and machining. You have access to a million customers.
SY: I'm committed to doing what I'm doing.

LG: Thank you, Stan.

The following companies have provided information on multi-spindle machines.

product focus

The CNC multi-spindle builders have found a market for the manufacturers of high-value, sophisticated, turned parts, but the downturn in the automotive and hydraulics industries have hampered the demand. The new builders are struggling with overcapacity at their European plants because automotive suppliers have virtually stopped buying. They are looking to high volume medical and military buyers to step into the depressed market.

▼ Davenport Machine

Davenport Machine, the manufacturer of the precision oriented Davenport HP machine, is the only American owned and operated multi-spindle screw machine builder in the United States. The Davenport HP machine is ideal for long or short runs of small parts and boasts a powerful PLC controller allowing for reduced set-up times and quicker adjustments. The Davenport HP allows operators to concentrate producing more complete parts rather than spending time fine-tuning. Davenport Machine manufactures Davenport Screw machines, tooling and genuine Davenport replacement parts. With our legendary Davenport Model B and the precision oriented Davenport HP.

For more information, please visit Davenport Machine at www.davenportmachine.com.

▲ INDEX

The new INDEX MS40C is an affordable, fully CNC multispindle for nearly unlimited operations on small workpieces from bar up to 40 mm diameter or for chucking up to 120mm. With six fully independent liquid-cooled, hollow-shaft CNC spindle drives each capable of up to 7000 rpm, the MS40C includes a main spindle drive with increased stiffness, and hydrostatic guide bushings on each carrier slide which eliminate wear and the transmission of vibration to the tool. The main spindle provides quick acceleration and high torque, helping to reduce cycle times. With liquid cooling, spindle and drum cooling is accomplished away from the work area through a local or central cooling system; heat can be released into the plant to utilize heat energy or outdoors to lessen the summer cooling burden.

For more information, please visit INDEX at www.index-usa.com.

◀ Champion Screw Machine Engineering, Inc.

The New-Matic was developed to be a direct replacement for the old Acme pneumatic stock stop. Where the old stop is difficult to set, prone to malfunction and impossible to keep operational, the New-Matic is easy to set, has a robust simple design and provides continuous hours of carefree operation. The New-Matic offers all the advantages of short part detection without the hassles.The strong, patented hinge design has a long service life. Internal components are easily replaced and low in cost. The unit works with your existing air control package.

For more information, please visit Champion Screw at HYPERLINK "http://www.championscrew.com" www.championscrew.com.

product focus

▲ Tornos

The new MultiSigma 8x24 offers a complete and unique solution to produce complex parts in one setup. Eight powerful and independent spindles allow flexibility while an integrated robot allows for the automatic unloading of parts into a pallet. The new MultiSigma 8x24 is supplied with the latest generation of motorspindles and a very powerful, well proven motorspindle technology found previously in the MultiAlpha line. The new MultiSigma machines are equipped with latest generation spindles which feature synchronous motors. Each spindle functions independently of the others for cutting rpm, spindle stops and indexing. The spindles with independent speed settings enable the full range of cutting tools to be employed.

For more information, please visit Tornos at www.tornos.us

▶ ZPS

The only 8-spindle machine in the industry, the new ZPS TMZ 867 can accommodate bar stock up to 72 mm diameter and can operate as an open-front chucker. Provided with a double Siemens 840 D CNC, the European-built machine offers up to 72 CNC axes and can perform nearly any metal cutting operation on precision parts from drilling and tapping to milling and hobbing. TheTMZ 867's standard features include eight independent AC-driven CNC horizontal spindles, 8+1 independent compound slides (X and Z), eight independent tool carriers with 8 12000-rpm driven tools, five backworking tools (three driven), and a wide range of standard presettable VDI tooling.

For more information, please visit www.zpsamerica.com.

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Truth City

You are on your way to Truth Town, where the inhabitants always tell the truth. At one point you reach a fork in the road, with one branch leading to Truth Town and the other leading to Liar Town, where the citizens are all liars. The road sign at the junction is confusing, but there is a man standing there from whom you can ask directions. The only problem is you don't know if he is from Truth Town or Liar Town.

If you have time to ask him only one question, what question will ensure that you will be headed to Truth Town?

Sudoku Solution

Puzzle found in the July/August 2009 issue

5	4	9	8	2	3	1	6	7
2	7	6	1	9	4	3	5	8
1	3	8	5	6	7	9	2	4
8	6	2	9	7	1	4	3	5
3	5	1	6	4	8	2	7	9
7	9	4	2	3	5	8	1	6
4	1	3	7	5	9	6	8	2
6	8	5	4	1	2	7	9	3
9	2	7	3	8	6	5	4	1

Who are the number whizzes?

Robert Vogt of Fortress Forms Inc., in New Berlin, Wis.; **Dave Rosbottom** of Bucci Industries USA in Charlotte N.C.; **Cathy McDaniel** of A-1 Machine Works Inc. in Bristow, Okla.; **Ken Hill of Lasercut Machine Inc.** in Dallas, Texas; **Fred Indoe** of Crowley Tool Co. in Hendersonville, Tenn.; **Patricia Rueb** of Northruck Industries, Inc. in Medford, N.Y.; **Matthew Ecker** of Hunter Engineering in St. Louis, Mo.; **Terry Acosta** of Weatherford International, in Woodward, Okla.; **Al Grella** of National Distribution Inc. in Farmingdale, N.Y.; **Ron May** of Hunter Engineering Company in Bridgeton, Mo.; **Rick Stein** of K. Key Products Inc. in Milwaukee, Wis.; **Neal Kauffman** of Kauffman Doors in Lincoln, Mo.; **David P. Smith** of ElectroSwitch in Raleigh, N.C.; **Jerry Levine** of Today's Machining World in Oak Forest, Ill.; **Dan Cibulskis** of Aurora Air Products, Inc. in Aurora, Ill.; **Ram Chandran** of Muller Martini Mfg. Corp. in Newport News, VA; **George Stringe** of Highland Service in Frederick, Colo.; **Uli J. Kuster** of Blaser Swisslube in Rohnert Park, Cal.; **David R. Weitz Sr.** of Davlan Engineering Inc. in Saint Louis, Mo.; **Larry Willenborg** of Iowa Screw Machine Products Inc. in Carroll, Iowa.; **Tamara Hawn** of Sunnen Products Co. in St. Louis Mo.; **Douglas Edwards** of BorgWarner Emissions/Thermal Systems in Fletcher, N.C.

postings

Noteable and newsworthy information and events for upcoming months.

SOUTHTEC

Exposition & Conference

Oct. 15-16

Charlotte, NC

www.sme.org

Canadian Manufacturing Technology Show

Toronto, ON, CANANDA

Oct. 19th to the 22nd

www.sme.org

Aerospace Measurement, Inspection & Analysis Conference

Baltimore MD

Sept. 29th to Oct. 1st

www.sme.org

Wisconsin Machine Tool Show

Oct. 6th thru 8th

West Allis, Wisconsin

www.expoproductionsinc.com

ICALEO

Int'l Congress on Applications of Lasers & Electro-Optics

Orlando, FL

November 2nd to 5th

www.laserinstitute.org/conferences/icaleo/conference

EMO Milano

Oct 5th to the 10th

Milan, Italy

www.emo-milan.com

MLB World Series

Oct. 28th

Black Tuesday

Stock market crash of 1929 begins. 12.9 million shares traded.

Oct. 24, 1929

Birthday Jimi Hendrix

Nov. 27, 1942

Microsoft Windows

version 1.0, released November 20, 1985

calendar

Today's Machining World

ad index

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10 AMSCO Stocks a large variety of parts and tools for B&S, Davenport, Acme, New Britain and Lipe Bar Feeds. Call 800-832-6726.

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45 COMEX Swiss CNC & cam experts. Large stock of automatics, attachments and replacement parts. "Turnkey" including training. AMEA-CEA certified appraisals.

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afterthought

Learning from the "Sock Summit"

You had to be a quick draw on the computer to reserve a spot at the first "Sock Summit" held August, 6-9 in Portland, Oregon. Thirty thousand people tried to register for 1,500 openings in the first hour and crashed the server, according to Tina Newton, one of the primary organizers of the event.

The "Sock Summit" was a gathering of sock making knitters from all over the planet who wanted to share a sense of community and learn from other folks who love to rub two sticks together to make cool stockings from fiber.

So why do we care?

I think the "Sock Summit" tells us a lot about what is going on now in business and social interaction.

> "Social beings still hunger for touch and conversation."

This huge get-together was a grassroots phenomenon. Vendors attended and paid for the privilege to sell and advertise their wares, but the event was not orchestrated or paid for by marketers. People journeyed to Portland because they wanted to share their love of sock knitting with their sisters (and brothers) of the stitch. We live in a cubicled, fragmented world today in which the pub and the bowling league have been replaced by TV and Twitter. But social beings still hunger for touch and conversation. Group knitting seems to fill that hole for many people.

I understand that on many college campuses knitting classes are usually over-enrolled, not just by women but by guys who have heard they are the best places to meet girls.

I think that the deterioration of the trade show in the machining world is largely because the organizers take the opposite approach of the sock summiteers. The metalworking exhibition is developed for the marketers, not the attendees. At the recent PMTS show in Columbus, Ohio, there were about as many sellers as visitors. The organizers seemingly viewed their primary task to be selling space, which is not an indictment of them, but a comment about why most shows today are on the wane.

I would predict that a really big show, like IMTS in September of 2010, could be a really big flop if attendees feel no compelling reason to gather except to see many of 2008's machines with new paint.

I know the events are not exactly analogous, but a show like IMTS today lacks a cohesive sense of community. There is little excitement or fun at an Eastec or Westec either, because these events have become almost solely about the marketers who rent the space. Unfortunately, there is no event if the visitors do not come, and today they are voting "no" with their feet.

The "Sock Summit," according to Tina Newton, was arranged to serve the knitters. If the marketers sold wool and needles so much the better for all, but the event was about community, learning and having fun.

People heard about the "Sock Summit" through blogs like "Yarn Harlot" and "Blue Mountain Fiber Arts" and on a huge Facebook network called "Ravelry." We're talking about free media with enormous reach, written by members of the community.

You may think you do not share anything with the millions of knitters who congregate in churches, coffee shops and bookstores for stitch therapy on a regular basis, but the thirst for community and the embrace of social media that the "Sock Summit" embodied point to the way business and relationships are rapidly moving. Community, learning and fun, power the show.

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