

01:07

# Laser *Community*

THE LASER MAGAZINE FROM TRUMPF

## Liftoff!

Disk lasers for aerospace

## Study Break

Marking laser helps doctors  
bone up on the latest in medicine

# Tough as Steel

Light is the sharpest tool available  
to cut ultra high-strength steel → Page 10

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# 01:2007

**IMPRINT**



One of the largest obstacles to the use of lasers in production is the lack of a knowledge base. Many companies are missing the technical personnel to recognize and exploit the potential of laser technology. The situation is a paradox. On the one hand, the laser is an established tool, and institutions around the world are conducting research more and more in the area of laser beam sources and their applications. On the other hand, this technology is missing from most curricula and is not part of the standard education for engineers and other technical personnel. “Establishing a global alliance for research and education between science and industry on different continents in order to provide students with practical experience in global cooperation and production technology” is a stated goal of the Global Alliance for Research and Education in Laser Aided Manufacturing (GARELAM). The participants goal is to encourage international governmental bodies to support this project, together with plans to introduce a global manufacturing platform for engineering education and to offer a curriculum with a portfolio of courses and global internship opportunities. It is important to our industry that these initiatives be successful.

## Every Initiative Is Welcome!

The technology platform Photonics21 in the European Union is pursuing a boost in photonics, including laser technology. Both industry and science use this platform to coordinate their research activities for optical technologies throughout Europe and to make policy recommendations for the use of European research funds. Only by joining forces is it possible to be heard.

Nonetheless, the Industrial Laser Group’s joining with the Society of Manufacturing Engineers in the USA and the founding of the section Promozione L@ser in the Associazione Italiana di Tecnologia Meccanica in Italy show that the interconnection of lasers and production is continuing internationally at a personnel level. It is both important and appropriate that industrial laser technology develop into a “conventional” technology. Every initiative supporting that goal is welcome.

A handwritten signature in blue ink that reads "Peter Leibinger". The signature is stylized with a large, sweeping 'L' and a trailing flourish.

**PETER LEIBINGER**

Managing Partner of the TRUMPF Group,  
President of the Laser Technology / Electronics Division  
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Image: Stahl-Werk

HIGH-STRENGTH STEEL 10



TARGET: TURKEY

06-09 WHO-WHAT-WHERE



15 STATEMENT



ROLE MODEL

## COMMUNITY

## TOPIC

## STATEMENT

### Lasers and People at a Glance PAGE 06

**WHY TURKEY, MR. ISIK?** PAGE 07 // What GARELAM wants // Comau is betting on remote welding // Why Tosei Electrobeam is so important to Japan // Austria's first 6 kW disk laser // **DAGMAR WÖHRL VISITS LASER PIONEER MEYER WERFT** PAGE 08 // BMW trades in screws for lasers //

08 NETWORK NODE

09 CALENDAR

29 PEOPLE + IDEAS

30 MARKET VIEWS

### TOPIC

## Taming Toughness

Ultra high-strength steel: How the automotive industry masters a material that has absolutely earned its reputation. PAGE 10

### Hard-Core

From the coil to a supporting component. PAGE 12

### What Matters

Mechanical tools or lasers?  
Where the laser scores. PAGE 14

“In most countries it is obvious that training engineers is a matter of highest priority.”

Dr. Arden L. Bement, Jr., sees the future of the world in the hands of engineers. PAGE 15





JOINING TECHNOLOGIES **16**



SYNBONE **18**



**21** ARBURG



**24** COOL TOOL



PROF. URSULA KELLER **26**

## REPORT

## SCIENCE

## PEOPLE

### Growing Its Business

In aerospace new parts are expensive. This makes resurfacing attractive to Joining Technologies.

**PAGE 16**

### Lesson with Broken Bones

What bone was that? A laser puts the answer on SYNBONES' practice bones. **PAGE 18**

### Solid Basis

The pedestal of an ARBURG machine is an unwieldy piece of sheet metal. For its manufacturing the machine builder looked for an XXL solution. **PAGE 21**

### Hot Press, Cold Heart

How do the cooling pipes get into the deep-drawing mold? Prof. Ralf Kolleck solves an old problem with a new technology: automated laser metal deposition. **PAGE 24**

### “Ursi, explain that to us”

We asked Prof. Ursula Keller how to become successful. What she achieved was completely unexpected, but she took full advantage of her opportunities.

**PAGE 26**

### 5 questions for ...

... Dr. Antonio Vendramini **PAGE 29**

**NEW: Our title as e-postcard**

**TO RECOMMEND THIS MAGAZINE:**

[www.trumpf-laser.de/laser-community](http://www.trumpf-laser.de/laser-community)

## S P O T

### --- COOPERATIVE

**European Laser Institute (ELI)** and **Laser Institute of America (LIA)** are furthering their mutual cooperation. According to the "Journal of Laser Application," the organizations will work together on conferences such as **ALAW (Automotive Laser Application Workshop)** among other efforts. [www.eli-online.org](http://www.eli-online.org)

### --- JAPAN EDITION

**Industrial Laser Solutions (ILS)** will have a Japanese edition. In addition to U.S. executive editor, **David Belforte**, **Sachiya Inagaki** from the **Yano Research Institute** will write for ILS Japan as an expert for the Japanese laser market. [www.ils.pennnet.com](http://www.ils.pennnet.com)

### --- IPO

The machine manufacturer **Manz Automation** from Reutlingen, Germany, has issued almost one million shares. The total volume of issues is 18.6 million Euros.

[www.manz-automation.com](http://www.manz-automation.com)

### --- EFFICIENT

A 5-axis laser system from **TRUMPF** ensures additional cost efficiency and quality in complex formed workpieces for the British aeronautics technology company **Middleton Sheet Metal Co. Ltd. (MSM)**. [www.msmgroup.org](http://www.msmgroup.org)

### --- DRIVE

Italy's **Association for Industrial Production Technology (A.I.Te.M)**, has founded a laser section. **Promozione L@ser**, spearheaded by Prof. Edoardo Capello, Politecnico de Milano, will provide a link between research and application. [www.aitem.org](http://www.aitem.org)

### --- SUPER PROTECTIVE

**Hauzer Techno Coating** is offering a system with the laser arc module from the **Dresdner Fraunhofer IWS**. This new technology gives the module industrial uses as one of the first super-hard amorphous carbon layers. [www.iws.fraunhofer.de](http://www.iws.fraunhofer.de)

### --- REJECTED

**Coherent Inc.** has failed in its takeover bid of **Excel Technology Inc.** While USA antitrust authorities approved the takeover, the German Federal Cartel Office rejected it. [www.coherent.com](http://www.coherent.com), [www.excetechlinc.com](http://www.excetechlinc.com)



"We need a global manufacturing platform for first-hand learning"

Professor Jyoti Mazumder,  
GARELAM chairman

## Global Alliance

GARELAM to link theory with practical experience in laser technology

■ The ICALEO 2006 in Scottsdale, Arizona, saw the introduction of the "Global Alliance for Research and Education in Laser Aided Manufacturing" (GARELAM). At the convention its chairman **Professor Jyoti Mazumder** from the **University of Michigan** presented the first results of the successful international cooperation launched in July 2006. GARELAM intends to create a closer global network between manufacturers and reputable universities worldwide. To achieve these goals the founding members want to establish a well coordinated curriculum and an international internship program for undergraduate and graduate students. GARELAM also plans to initiate cross-organizational structures for a continuous training of scholars and industrial professionals. [www.icaleo.org](http://www.icaleo.org)

## Remote Catches On

■ Laser remote welding with robots ever more fascinates robot manufacturers. Just recently, **Comau** began offering a new 3D laser welding system. Its SMART Laser consists of a robot arm and a laser source, such as the **TRUMPF** disk laser. The fully integrated control unit for the seven axes of the arm and the scanner optics is programmable via a handheld panel. The SMART Laser's simple architecture allows it to be easily integrated into complete body shop systems as well as laser network configurations with multiplexing. The laser optics, which has a range of 750 to 1,100 millimeter, can move the beam from one weld seam to another in 0.1 seconds.

[www.comau.com](http://www.comau.com)



The beam of Comau's SMART Laser jumps from one weld seam to another while the arm repositions, cutting down on cycle times.





Turkey as a new market for laser applications? Entrepreneur Bektas Isik is a firm believer.



## “Turkey has discovered the laser”

Bektas Isik is successful in Germany with repair welding. Now he has his eyes on Turkey—we want to know why.

**You are developing a laser business in Turkey for deposit welding with pulsed solid-state lasers. Are you homesick or do you smell a lucrative market?**

So far, Turkey has been a niche market for deposit laser welding applications. There's a lot of potential there, but to be honest, homesickness, of course, plays a large part, too.

**Is the Turkish market ready for these laser applications?**

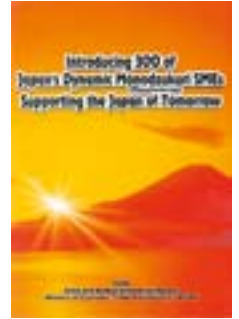
Turkey has discovered the laser. Demand is continually on the rise and there are more and more suppliers. We strongly believe that our business model will be successful there as well. And not least because we distinguish ourselves from the Turkish competition with our laser technology.

**What market opportunities do you see in Turkey?**

Over the years, in Germany we have had positive experiences with repair welding in tool and mold making. In the future, we will also focus on other industries. The Turkish economy is growing. New industries are constantly emerging. The market offers us a good opportunity to have a large piece of the pie.

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Some 300 enterprises that support Japan's competitiveness.



## A List with a Future

■ The financial future of Japan depends on Tosei Electrobeam. That is what the Japanese Minister of Finance, Commerce and Industry, Toshihiro Nikai says. Tosei Electrobeam, Japan's largest laser job shop, is one of 300 small and medium-sized companies to be chosen by the ministry to appear on its list of “Japan's Dynamic Monodzukuri (Manufacturing) Small and Medium Enterprises.” Japan's international competitiveness is riding—for the most part—on firms of those sizes, according to the ministry. Companies were selected based on criteria such as their technological potential or the impact that their technology has on everyday life.

[www.tosei.co.jp](http://www.tosei.co.jp)



Austrian Styria's Minister of Research Kristina Edlinger-Ploder receives a lasered coat of arms from Institute Directors Elmar Brandstätter and Prof. Reinhold Ebner.

## 6 kW for Joanneum

■ Joanneum Research is the first company in Austria to install a 6 kW disk laser at its Leoben Laser Center. The powerful system is being used to develop industrial welding, alloy and deposition welding processes. But the focus is on refining scanner welding, which uses mirrors to guide a light beam across a workpiece, thereby reducing positioning time. [www.joanneum.at/lzl](http://www.joanneum.at/lzl)

## NETWORK NODE

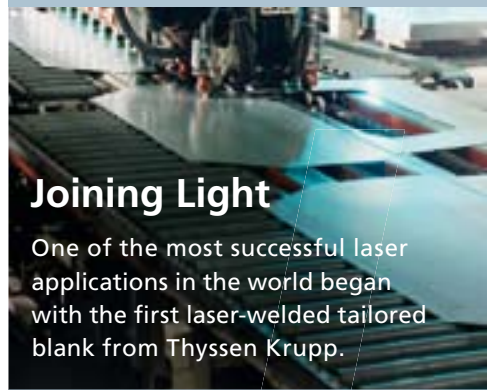
### JOINING AND WELDING RESEARCH INSTITUTE, OSAKA UNIVERSITY



■ One of today's leading research centers for joining technologies was founded at the University of Osaka in 1969 as the Welding Research Laboratory. This was done in response to a recommendation put forth by the Science Council of Japan, which is responsible for the nation's technical development. The Council proposed that welding technology, central to industrial manufacturing, be systematically advanced. The institute's approach to stabilizing Japan's position as a leader in scientific and technical development also embraced laser technology. Recently deceased Schawlow Prize winner Professor Akira Matsunawa, who retired in 2003, was a laser welding specialist who enjoyed worldwide renown. In particular the Smart Processing Research Center, founded in 2003, researches "extreme" future applications such as welding ultra-thin plate or working materials with ultra-short laser pulses. Here parallel research efforts focusing on materials, processes and energy sources in the various departments are to stimulate one another. [www.jwri.osaka-u.ac.jp](http://www.jwri.osaka-u.ac.jp)

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## Quantum Leap



### Joining Light

One of the most successful laser applications in the world began with the first laser-welded tailored blank from Thyssen Krupp.

1983

## An End to Screws

TRUMPF CO<sub>2</sub>-laser welds axle differentials at BMW



*BMW headquarters in Munich: The company continues to look for and find new ways to use laser welding.*

■ BMW has put into operation a new TRUMPF powertrain system. Axle differentials, a cast and steel combination, are being welded by laser for several models, including cars in the 3 Series which are equipped with the more powerful engines. For automotive engineering, eliminating the conventional screw connections not only saves money, it also reduces the transmissions weight and results in smaller assembly dimensions. And the laserwelded joints transfer greater amounts of torque. All this makes the cars more dynamic and stable in extreme driving situations.

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## Laser Model

Dagmar Wöhrl visits Meyer Werft

■ A short visit to the Ems: On February 5, the German Federal Coordinator of the Maritime Economy, Dagmar Wöhrl, visited the Meyer Werft. One of the most advanced shipyards in the world, this pioneering company in northern Germany primarily builds cruise ships for shipping lines around the world. For the last 13 years, the shipbuilders in Papenburg have taken a leading role in the use of laser technology. The shipyard owns a record: Of the 850 kilometers of weld seams in the Norwegian Pearl completed in November 2006, about 450 kilometers were welded using four laser systems with 12 kW CO<sub>2</sub> lasers. Currently, the world's first 8 kW disk laser, developed by TRUMPF in Scharnberg, is being tested at the Meyer Werft. Thanks to its modular design, it offers an availability of more than 99.5 percent. Even in changing ambient conditions, the integrated, absolute performance control ensures reproducible process results. [www.meyerwerft.de](http://www.meyerwerft.de)



*Maritime Coordinator Dagmar Wöhrl is shown around the Meyer Werft by Managing Director Bernard Meyer.*





"The MD&M links laser and medical technologies."

## High-Tech Medicine

■ The MD&M show is held three times a year across the USA. It targets medical device manufacturers and vendors to showcase their services and capabilities. At the MD&M West we asked Sales Engineer **Ray Regan** from **Innovative Laser Technologies Inc.** why it is a place to be:

### Laser industry and MD&M—where is the link?

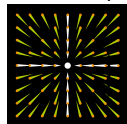
Laser manufacturers, integrators and contract service providers see the shows as an access to manufacturers of devices for surgical implants, non-invasive devices, surgical tools and disposables. They expect to get insights into current and upcoming requirements of medical device manufacturing.

### And who can MD&M visitors meet?

The shows provide a one-on-one contact with key engineers and designers, allowing vendors to respond with immediate problem-solving solutions.

## A PLACE TO GO

# LASER 2007



■ Experts gathering and the latest in laser technologies—that is what the **LASER. World of Photonics** has to offer to visitors. Taking place June 18–21, 2007, at **Munich International Trade Fairs**, the technology trade show marks its 18th anniversary this year. Since its beginning in 1973, the trade show has become one of the leading events in optical technologies. Nearly half of the exhibitors and visitors at **LASER 2005** came from abroad, an indication of the show's uniqueness and noted reputation.



**INTERMOLD:** Japan Die & Mold Manufacturing Technology Exhibition  
[www.itp.jp/im](http://www.itp.jp/im)



**LASER. World of Photonics:** Trade Show for Optical Technologies  
[www.world-of-photonics.net](http://www.world-of-photonics.net)



**SEMICON West:** Semiconductor Equipment and Materials  
[www.semi.org/semiconwest](http://www.semi.org/semiconwest)

### LASER. WORLD OF PHOTONICS CHINA

March 21–23, 2007, Shanghai, China  
Trade Show for Optical Technologies China  
[www.world-of-photonics.net](http://www.world-of-photonics.net)

### ALAW

April 17–19, 2007, Plymouth, MI, USA  
Automotive Laser Applications Workshop  
[www.alawlaser.org](http://www.alawlaser.org)

### INTERMOLD

April 25–28, 2007, Tokyo, Japan

### MACH-TECH

May 8–11, 2007, Budapest, Hungary  
International Trade Exhibition of Machine Manufacturing and Welding Technology  
[www.mach-tech.hu](http://www.mach-tech.hu)

### WELDING KOREA

May 8–11, 2007, Seoul, Korea  
Global Strategy for Your Welding Equipment & Material, [www.weldingshow.co.kr](http://www.weldingshow.co.kr)

### EUROWELDING, CAST-EX, CHEMPLAST, EMA

May 22–25, 2007, Nitra, Slovak Republic  
International Engineering Fair  
[www.agrokomplex.sk/akcie/msv2007/en](http://www.agrokomplex.sk/akcie/msv2007/en)

### MD&M EAST

June 12–14, 2007, New York, NY, USA  
Medical Device Design and Manufacturing  
[www.devicelink.com/expo/east07](http://www.devicelink.com/expo/east07)

### MINAT

June 12–14, 2007, Stuttgart, Germany  
International Trade Fair for Precision Mechanics and Ultra-Precision, Micro and Nano Technologies, [www.messe-stuttgart.de/minat](http://www.messe-stuttgart.de/minat)

### BLECHEXPO & SCHWEISSTEC

June 13–16, 2007, Stuttgart, Germany  
Sheet Metal meets Business  
[www.blechexpo-messe.de](http://www.blechexpo-messe.de)

### LASER. WORLD OF PHOTONICS

June 18–21, 2007, Munich, Germany

### SEMICON WEST

July 16–20, 2007, San Francisco, CA, USA

A large industrial steel mill with glowing hot metal being processed. The scene is filled with bright orange and yellow light from the molten metal. In the foreground, a long, glowing hot metal slab is being processed on a conveyor system. In the background, another glowing hot metal slab is visible, and the industrial structure of the mill is partially obscured by the intense heat and light. The overall atmosphere is one of intense industrial activity and high temperatures.

# Taming

*The dance of the atoms:  
When steel cools slowly in the  
steel mill, it forms cubic crystal  
lattices. When it is quenched,  
however, atoms jump from the  
cube surfaces to the inside and  
strengthen the lattice, making  
it a high-strength steel.*



Everyone is talking about the triumph of high- and ultra high-strength steel in automotive engineering. The heroes behind the scenes have made it possible: a new form-hardening process and the laser.

# Toughness

■ Scorching heat as is in the steel mill. The incandescent strip of steel in the drawing press is reminiscent of hot shining lava and, at 900 °Celsius, it is almost as hot as a volcano flow. The material that's now glowing so brightly in the press will later be built into cars as high-strength and ultra high-strength steels. It is a very special alloy and one that carmakers are using ever more frequently. Two reasons are its stability and the associated enhancement of passenger safety. Other reasons are its light weight and the favorable effect on fuel consumption. Novel manufacturing processes make this possible. A new in-mold hardening process toughens steel in mass production while precise laser cutting whips it into shape. The advantages of the high-strength steels are obvious. Their tensile strengths are many times those of conventional steel alloys. That makes it possible to reduce sheet metal thickness without affecting the components' structural strength. An additional benefit: Combining several reinforcing parts in a single component and thus reducing the number of components in an assembly slashes not only the weight, but the manufacturing costs, too. In the meantime, many motor vehicle manufacturers and their suppliers have put their faith in higher-strength steels in the body structure. Examples of current uses include the high-performance body of the Porsche Cayenne and VW Touareg SUV, the high volume mass-produced body for the Volkswagen Passat, and the trendy Eos hardtop convertible, another product of VW Wolfsburg's engineers.

**Breakthrough with press hardening** The glowing benefits of high-strength and ultra high-strength steels didn't simply fall into carmakers' laps. The question of how to shape such alloys had to be analyzed before they could be used. A new in-mold hardening process brought about the





*Glimpse into the hot stamping press (top): It forms the steel, heated to 900 °Celsius, and then quickly draws out the heat. Because the process is costly, high-strength steel has so far been used to a rather limited extent and in critical design areas (below and right).*

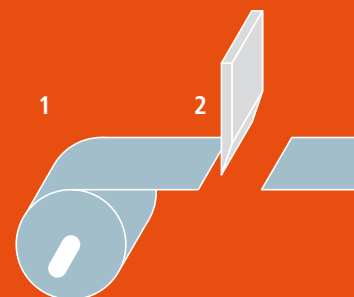
solution: hot forming with hardening in the stamping press. The parts made of high-strength and ultra high-strength steels are heated to a temperature beyond 900 °Celsius prior to shaping. They are then immediately placed in a deep drawing press. The water-cooled dies in the press stay closed until the component has cooled down, in a regulated process, to about 170 °Celsius. Since this takes place extremely quickly, a martensitic structure is created, significantly increasing the tensile strength of the steel.

It was only a few years ago that this process revolutionized auto manufacturing. Volkswagen was an important pioneer here. “We were one of the groundbreakers in the use of high-strength steels and the first carmaker to itself fabricate hot stamped parts to this extent,” explained Ulrich Schlennstedt, planning engineer at the Volkswagen pressing plant in Kassel, Germany. In 2004 a highly committed project team in Kassel started installing six hot stamping lines comprising presses, roller hearth furnaces and industrial robots. The roll-out for the new Passat in the autumn of 2004 was also the launch date for mass production of almost a dozen hot stamped components in each vehicle. Included among them were the high-strength structural components for the passenger compartment such as the B-pillar, the center tunnel and the “hockey bat,” as the tops of the interior side panels are called in-house. Daily production volume corresponds to the number of parts needed for about 2,000 Passat units (Sedan and Variant station wagon). These components are then dispatched to assembly plants at Emden in Westphalia and at the town of Mosel in Saxony. The experts at Kassel are proud of their hot stamping lines, even though their output accounts for only a small share of overall production. The pressing plant in Kassel processes a total of about 1,300 tons of sheet steel daily for various VW models. Scheduling was tight. And yet, the team was not only able to assemble the entire system on time. The first components left the press hardening units eleven months after the start of the project. Mass production, running three shifts a day, five days a week, ran smoothly from the very outset.

**Wear-free cutting with laser light** Hot stamping was only the first step toward a solution, however. A further hurdle to be cleared was high tool wear during trimming after shaping. That’s because the cutting tools are not always up to the hardened sheet metal. Mechani-

## HARD-CORE

Steel becomes high or ultra high-strength only during processing. “Soft” steel is delivered in coils (1) and cut into plates (2). A furnace heats the pieces to 900 °Celsius (3). For the temperature of the steel in the press precise timing is important (4). The forming press quickly cools the component down to 170 °Celsius (5), and the crystal lattice forms. The workpiece is then at maximum strength, and it has become a real challenge to work with it. At that point, lasers (6) are the ideal tool for the task.



VW is one of the pioneers using high-strength steel. From early on, the Wolfsburg engineers had to rack their brains over the process.

*In the support structure of the chassis, high-strength steel reinforces the passenger compartment; here the VW Passat.*



cal cutting was out of the question particularly for narrow contours and small-radius curves. The experts at the VW plant in Kassel had a solution here, too. Laser cutting was the answer. No matter how hard the material might be, laser cutting is always entirely free of wear. Volkswagen has already invested in 17 LASERCELL 1005 units for 3D machining in Kassel. TRUMPF set up the last of these systems to date in April of 2005. "If the steel exhibit strengths of up to 1,500 Megapascal, there are hardly any economically interesting alternatives to laser cutting at present," Ulrich Schlennstedt emphasizes. "This is true particularly because the investments in costly punching and cutting tools as well as for the otherwise required presses are also eliminated." That is why the 3D laser cutting systems are now being included in mass production of body panels. In the past it was primarily their flexibility that was of interest. It came fully to bear in prototyping and for vehicles made in very low numbers. When dealing with high-strength steels it is, in fact, wear-free cutting that is in the foreground. Schlennstedt nonetheless sees the laser system's flexibil-

ity as a highly desirable side effect. "Components cut with the laser can be modified quickly and without undue effort. This is true whenever we reposition a cutting line or incorporate an additional hole." Located in Detroit, Martinrea Fabco Hot Stampings, a subsidiary of leading North American automotive supplier Martinrea International, Inc., has also had excellent experience with laser cutting of high strength steels. Flavia De-Veny, Martinrea Vice-President of Engineering stated that, "Martinrea's Detroit operation is currently cutting sheet metal components with great consistency and to extremely close dimensions using multiple five-axis systems and delivering them to automotive OEMs in North America."

The carmakers' demands are well known. Regarding component precision, tolerances between minus zero and plus three millimeters are expected. If the parts are to be joined after laser cutting or if critical tolerances with regard to the overall dimensions of the vehicle body have to be met, then the tolerances can be narrowed to as little as plus/minus 0.4 millimeters. Such exacting accuracy is superbly suited for subsequent

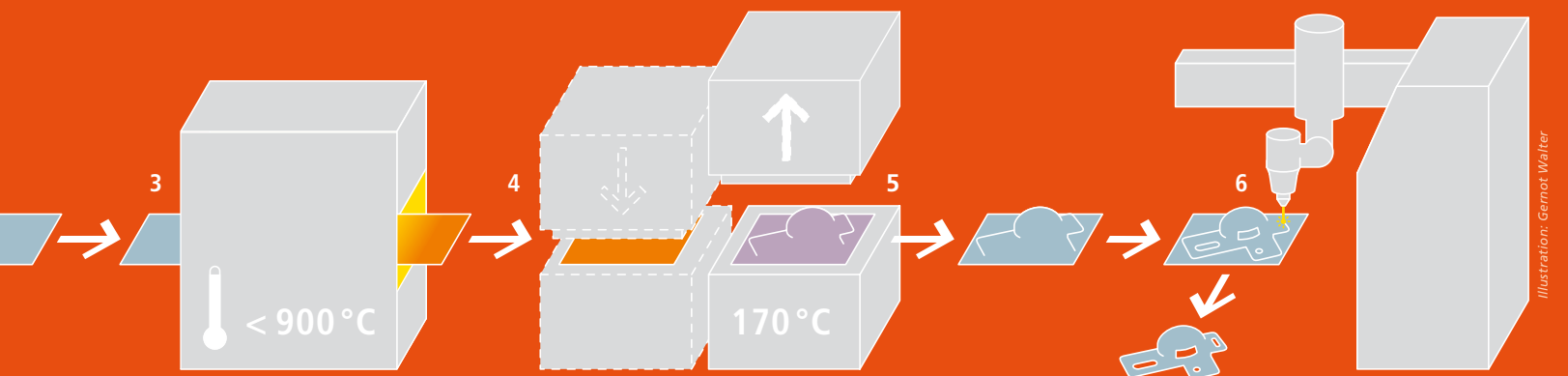


Illustration: Gernot Walter

joining with lasers. This also offers advantages for high-strength steels from the metallurgical viewpoint. What's important here is matching cutting speed and laser power with the nature and thickness of the material in each application, otherwise roughness, burring or burn-in can happen. Alternately, the material might not be cut at all. Technology data for the machines and the expertise of TRUMPF's application specialists can help to prevent from dissatisfying results.

## Competition among technologies

In spite of its many advantages, laser technology is under competitive pressure. The market is calling for shorter processing cycles so that fewer systems need to be purchased. The keys to success are optimizing processes and further tweaking the systems. One good example here is the cycle time of the Passat's B-pillar. TRUMPF and VW specialists have improved the time required for cutting significantly. The new process technology incorporated in high-speed, 3D laser cutting with plasma and the greater dynamics of the new TRUMPF TruLaser Cell Series 7000 form the basis for even faster processing.

The success of the efforts at Kassel has set a precedent for the use of laser systems in pressing plants. The satisfaction registered at Volkswagen infected Audi, its sister company, too. The company invested in the new TRUMPF systems for high-strength components at Ingolstadt for the next generation of the Audi A4. But the manufacturers of mechanical machine tools have not been idle. As a consequence, plants that process high-strength steels can look forward to ongoing and exciting competition between the technologies. While on the one hand manufacturers are working on extending the service lives of mechanical tools, the laser systems are raising the tempo and racking up points with flexibility. ■

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*When hardened steel meets high-strength steel, tool wear is extremely high.  
Not so with laser cutting.*

# What Matters

When high-strength steel is concerned, industry is increasingly turning to lasers. Four topics that are crucial.

## Wear and Tear

When they look at the tensile strength of steel, potential users focus mostly on high downtimes. In contrast to mechanical cutting, more can be accomplished with light. The laser being an optical, non-contact tool has big advantages, especially since the melting point of "usual" and high-strength steel is almost identical.

## Cycle Time

In addition, short cycle times are especially desirable. One disadvantage that laser cutting has compared to mechanical punching is its low speed. But that can be increased. Prime examples are the 3D laser processing machines of the TruLaser Cell Series 7000. They offer sensor-supported piercing on-the-fly and plasma high-speed cutting. Overall, the laser system provides increased machine power and added dynamics due to the decreased moving masses.

## Availability

Another significant factor is a high availability. The laser cutting systems, which have proven themselves in practical applications a thousand times over, are very reliable. This is simply because they operate contact-free and so are not exposed to high forces. Even the loser unit provides maximum availability. TRUMPF's additional incentive for users is a magnetic coupling between the optics and the B/C axis. In the event of a collision, the coupling minimizes damage to the machine and thus limits downtime.

## Material Flow

A coherent material flow concept is also required. This includes a rotation exchanger so that the two-part work table of the laser system can be unloaded from one position and supplied with the next component at the same time. The handling of the rotation exchanger could also be automated with a robot.



Director of the National  
Science Foundation  
Dr. Arden L. Bement, Jr.



# Future needs Engineers

Engineers built societies throughout history. Dr. Arden L. Bement, Jr. advocates finely trained engineers to become the cornerstones upon which we will collectively build the future.

■ Human capital is the key component to future competitiveness in the global arena. There are still many disparities in the global economic, technological and educational landscapes. However, all nations, no matter the stage of their development, recognize that their human capital is the single most important resource to compete in the knowledge economy. They understand that they must make engineering and science education their highest priority. There will have to be greater emphasis on programs aimed at tapping the potential of minorities and women. It is irresponsible to neglect this precious human capital. As the face of our nations change, so must the face of our disciplines and institutions. Just as we in engineering and science have been adept at embracing change in our fields, we must be equally willing to welcome the demographic and cultural changes that are upon us. This is a matter of national survival for us all.

Today, the ever-decreasing lead times from research to product will create a pressure cooker effect. Engineers are lynchpins for the success of this process. A critical component to the achievement of the engineer is effective education and training. Our methods, curricula and pedagogies need to change as quickly as our globalizing context is changing. The present and future are high energy, high speed and high stakes. To be globally competitive depends critically on speed to market.

In essence, a new generation of engineers will have to think nimbly, collaboratively, and comprehensively across the boundaries of disciplines, the borders of geography and the battlements of industries. Tomorrow's engineers will have access to increased computing power and connectivity. Young engineers will have to operate collaboratively across integrated enterprises that include energy, transportation, manufacturing, finance and policy-making sectors. Engineers will have to be able to simultaneously think and act both globally and locally. It may seem somewhat

counterintuitive that collaborating among competitors is a winning strategy. However, collaborations will strengthen the bonds of understanding across disciplines sectors, and cultures.

It is vital for today's young engineers to be well schooled in the humanities as well as the sciences. Knowledge in social sciences is increasingly important as the world converges in all of its diversity. Such skills will deepen the engineering field, not dilute it. Young engineers need these skills to become thoughtful and effective leaders in the new global economy.

Engineers have powered civilizations since the beginning of human history. They will continue to give structure and shape to the brightest ideas. They will be the architects, builders, and master craftsmen of the 21st century. We must be sure that engineering education is equipping the newest engineers for mapping these new eras. It is not just the responsibility of governments or universities or private companies. It is a global task that will require a global effort from all engineers both young and old. ■

#### Information:

National Science Foundation, USA, [www.nsf.gov](http://www.nsf.gov)

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# Growing Its Business

Joining Technologies: Expanding with laser technology. Disk laser provides a wider range of work than electronic beam — and improves the quality as well as reduces the costs.

■ “We have very aggressive growth plans for the next 12 – 24 months.” When Joining Technologies CEO Michael Francouer made that statement more than a year ago, his company — an ISO and AS9100 certified job shop specializing in the precision welding of miniature and micro-welded parts — had its sights set on entering the aerospace overhaul and repair market. With the June 2006 installation of a two-kilowatt continuous wave disk laser from TRUMPF, those plans — and a lot more — have been accomplished. “We bought the HLD 2002 disk laser because we wanted the latest in laser technology,”

says Joining Technologies President Dave Hudson, who joined the company two years ago after 20-plus years in the manufacturing world. “It has essentially been designed for us.”

Two Joining Technologies workstations are currently tied into the disk laser at the company’s East Granby, Connecticut production facility, including one dedicated to the aerospace overhaul and repair market. “We are using the new disk laser in tandem with a specialized workstation for the wire-applied resurfacing of aerospace components,” Hudson adds. “It has enabled us to fully enter the overhaul and repair



*Left: Housings for pressure switches ready for precision welding.*

*Right: "The disk laser increases our capacity to do laser welding for industries that use delicate parts," Joining Technologies President Dave Hudson says.*

## **"We are using the new disk laser for the wire-applied resurfacing of aerospace components."**

market, just as we planned." The disk laser also allows Joining Technologies' process development specialists to experiment with resurfacing various aerospace components made from high-end aerospace alloys, such as titanium, Waspoly and Inconel. "New engine parts are extremely expensive," says Hudson, who notes that Joining Technologies recently added 4,500 square feet of space dedicated, primarily, to R&D for such aerospace OEMs as Boeing and Pratt & Whitney. "The airlines are always looking to cut costs, so this is a very important market for us."

### **More welding operations for new markets**

According to Hudson, the disk laser, which also is tied into a four-axis workstation, allows Joining Technologies to do deep penetration welds that would otherwise be accomplished at an electron beam welding station—a more time-consuming and costly operation. "The disk laser is four times more powerful than our most powerful pulsed Nd:YAG laser," he says. "As a result, we can deliver deeper penetrations

with smaller heat-affected zones. Furthermore, the disk laser increases our capacity to do laser welding for the medical device and sensor industries, as well as other industries that use small, delicate parts that require precise joining." Hudson pauses. "For a privately held job shop to have this kind of sophisticated, high-power laser capability is something that very much sets us apart."

In summarizing the benefits of the disk laser, Hudson emphasizes that the laser's intense, high-quality beam has allowed Joining Technologies to cover "a wider range of work" in a highly competitive manner. "The use of the laser disk widens the overlap between electron beam and pulsed laser beam welding. It enables us to be more energy efficient, improve the quality of the work we do and reduce the cost of operation—all of the things that tie into our core values and business model."

At Joining Technologies, that business model includes a dedication to emerging technology and strategic partnerships. "We consider TRUMPF

to be an important strategic partner," Hudson says. "It's part of our commitment to finding creative solutions that go above and beyond the usual boundaries of joining." So what creative solutions are on the horizon? "We are looking to expand into the resurfacing market via powder applications," says Hudson. "In fact, we hope to bring powder technology in-house within a year." Joining Technologies also has plans to install a fully integrated robotic workstation using the disk laser.

Laser technology will continuously gain in importance. "We see the laser taking on more work in what has traditionally been the electron beam world," says Hudson. "We have made a conscious decision to grow our business in laser technology." ■

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# Lesson with Broken *Bones*

Surgeons are learning their craft on artificial bones from the Swiss company SYNBBONE.

Before that, the ARGO Davos workshop had marked the foamed blanks with a laser.



Artificial bones in the finishing phase: The boring jig for marrow-nailing (left); Marking in a VectorMark compact workstation (right).

■ Matthias Fischer from the ARGO Stiftung Bündnerische Werkstätten und Wohnheime für Behinderte [Federal Foundation for Workshops and Residences for the Handicapped] holds a thighbone in his hand. It has a clean break right above the joint. “Surgeons are not the only ones who use bone saws — we do too,” he says. Only the number on the side, which has been lasered in, reveals that this is not a real bone. “Of course, we can’t use the saw for every fracture in plastic bones,” says Fischer. “We also have other special tools, so we can ‘break’ bones in every conceivable way.”

**Breaking bones for training purposes** It may sound brutal but there’s a very humane reason. SYNBBONE AG in Malans, Switzerland, produces and markets polyurethane human and animal bones and is the world’s second-largest manufacturer of artificial bones. In 2006 alone, SYNBBONE produced 135,000 polyurethane bones on which surgeons and veterinarians can practice their skills. The lifelike fractures simulate typical injuries. Thomas Parkel, managing director of SYNBBONE says, “We manufacture proper training models — that means only bones that people or animals could break in real life.” The employees at the ARGO workshop in Davos fabricate the fractures in the artificial bones. And they have been plastering, deburring, assembling and marking the foamed blanks from Malans since 1988, when SYNBBONE was founded.

**Each bone has a number** “The traceability of our bones is very important to us,” says Thomas Parkel. “That way when talking with customers we always know which bones are being referenced and when they were produced. So, all of our products are marked — from the little toe to the skull.” Up until spring 2006, SYNBBONE marked the bones itself using a conventional inkjet method. A major downside, though, was that the ink often immediately smudged on the silicone wax, which is used in production as a separator for the die and bone. To solve the problem, SYNBBONE turned to ARGO in



*The whole thighbone right before being broken: This is what the marked polyurethane bones look like before they are "broken" with a bone saw or other special tools at ARGO.*



ARGO employees carefully fabricate artificial breaks in the polyurethane bones with tools such as a saw or even a hammer and chisel (left). Beginners practice properly placing bore holes or implants in such fractures (center). Skulls and thighbones alike are stored in the model and sample archive (right).

“The traceability of our bones is very important to us. So, all of our products are marked — from the little toe to the skull.”

Davos: The workshop had been using laser technology for four years to mark metals and various kinds of plastic. “So why not plastic bones as well?” the director of the ARGO workshop in Davos, Alfred Meier, asked himself.

**Polyurethane, a special case** But then it wasn’t quite so simple. The heat of the laser light generates a color change in the material. The power density of the laser beam determines the intensity of the color change. And this density must be precisely set for each plastic. Until now, there has never been a parameter setting specifically for polyurethane. The specialists at TRUMPF application lab in Grüşch, Switzerland, successfully determined the setting using a test

matrix. That was in April 2006. Since then, in addition to the VectorMark compact 3, a new VectorMark compact 5 has been marking the artificial bones on a VWS 800 workstation. As a color change with moderate foaming, the mark is completely indelible. The laser source’s excellent beam quality and its integrated defocusing enable the typeface to be uniformly clear, and the laser beam balances out even height differences in the polyurethane of up to twelve millimeters.

**Please touch** Thomas Parkel is satisfied: “Even with our top models — the hollow bones like the femur and the upper arm — that pass through many hands, the markings do not smudge. For

years the typeface stays as perfect as it was on the very first day. And this is regardless of how many surgeons, veterinarians or biomechanical labs have practiced on these bones.” ■

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LESSONS WITH ARTIFICIAL OBJECTS

In addition to “healthy” bones, SYNBONE also manufactures artificial damaged bones that simulate osteoporosis, for example. Surgeons can use them to practice which orthopedic treatment options there are for the various fractures and bone conditions. Veterinarians also use the polyurethane bones to practice treating animal bone breaks.



When producing machine pedestals for ALLROUNDERS, ARBURG trusts on technology from TRUMPF.



# Solid Basis

You have to be crazy to insist on building world-renowned machines in the Black Forest only — or you have a good reason or two. One would be a new production cell of extremes.

■ Though they are used in 70 countries around the world, the machines' production is located exclusively in Lossburg. The community of 7,000 inhabitants is located in the Black Forest, six kilometers south of Freudenstadt, Germany. For the machine manufacturer ARBURG, this location means both tradition and high-tech. "Germany is the only production location for ARBURG, now and in the future," says Manager Production, Siegfried Finkbeiner, in describing the attitude of the machine engineering firm in Baden-Wuerttemberg. Not that they haven't looked around in recent years — in China or India. But the management always came to the same conclusion: "We would rather invest in a truly modern factory in Lossburg, which we can continue to improve, then have to make com-

promises abroad." The question is: What constitutes a successful company? The answer for ARBURG formulates its business principles — "technological leadership and a willingness to innovate" along with a flexible, customer-oriented organization and motivated employees.

**Solid foundation** The constant search for innovation also applies to the production of the ALLROUNDER plastics injection molding machines, for which the ARBURG brand name has stood for the past 50 years. During this time, the company has grown into a global leader in manufacturing. The injection molding machines from ARBURG are long giants that have one mechanical thing in common: They sit on U-shaped machine pedestals, three to five



*On the new unit: Michael Lemke examines the position of the two blanks. With ongoing production, the camera takes on this task.*



*Wolfgang John, Department Manager Chipless Production, and Siegfried Finkbeiner, Division Manager Production, intend to use the new technology to keep the Lossburg-based company internationally competitive.*

### “A camera measures the size and path of the gap between the two pieces of sheet metal, allowing the laser beam to follow the seam precisely.”

meters long, which in the past were produced in one piece from sheets of metal that were four to eight millimeters thick. For processing such enormous pieces, ARBURG used a TRUMPF punching machine consisting of two connected Trumatic Top 300s with a shared loader and a shared control unit.

“This is how the production cell has been working since 1983,” says Siegfried Finkbeiner. “But around the turn of the millennium, it turned out that a new solution was necessary to modernize this part of production.” The sheet metal in the sizes required by ARBURG came in special dimensions that cost more. “In addition, these machines are about 20 years old and are really slow given today’s demands,” says Finkbeiner. In spring 2003 the decision was made to replace the long-serving Top 300 duo with a new system. To eliminate any reliance on the special dimensions of the material, the machine base plates had to consist of two or three sheets welded by a laser. The sheets were also to

be joined on their longitudinal sides with the blanks that were nonetheless still of a considerable size. TRUMPF was again able to secure the order.

**The new solution** The new production cell has now been in place at ARBURG since late summer 2005. The two systems used are a maximum capacity standard machine tool with all accessories in conjunction with the combined punching/laser machine TRUMATIC 6000 LASERPRESS and a special laser unit for welding and cutting. “We can use it to process metal sheets a maximum of 1.6 by 4.8 meters that are up to eight millimeters thick,” says Finkbeiner. The largest blanks weigh almost 500 kilograms. The unit has a loading portal that removes the sheets from the available storage cassette and sends them to the machine tool via a movable cart. The TRUMPF SheetMaster then grips the sheets individually and carries them to the combo-machine for punching and lasering. It

deposits the sheets on a second cart of the loading portal. While the SheetMaster is already bringing a new blank to the TRUMATIC 6000 LASERPRESS, the second cart takes the processed sheet to the welding unit. There the processed sheet comes to rest on a mobile clamping table on which it is automatically aligned and magnetically clamped. Next the laser cuts off a narrow lengthwise strip to create a defined welding edge. The procedure is repeated with the second sheet and with the third as well, if necessary, because the machines’ pedestals consist of up to three parts.

“The sheets are combined along their longitudinal sides after the edge is prepared,” explains Finkbeiner. A camera, positioned on the processing head, first measures the size and path of the gap between the pieces of sheet metal, ensuring that the sheets are properly aligned and clamped. The laser beam can then follow the gap that’s a maximum of 0.1 millimeter in width. In an initial cycle, the sheets are first tacked with



XXL joining technology: The unit welds sheet metal that is eight millimeters thick with an edge length of up to 1.6 by 4.8 meters and weighing up to a half ton.

a weld seam depth of only one millimeter. This prevents from distortion of the blanks during the ensuing depth welding. “The actual welding is the final step in the production cell,” explains Finkbeiner.

**Special thrill** The conversion from old to new got exciting. “We didn’t have the room to set up the new machines before the old ones were taken out of service,” says Finkbeiner. In late summer 2005, everything had to go hand-in-hand: Disassembling the old unit, refurbishing, setting-up the new unit and starting up. “In total we had six weeks and in the end five were enough. Not least because TRUMPF had previously run-in all welding and cutting processes,” the Division Manager Production says in summing up. The new unit now runs in three shifts, seven days a week — fully automated. At night and on weekends there is someone present only when disruptions occur. “With it we were able to shorten the throughput times for the machine

pedestal by 35 to 40 percent over the old unit,” says Finkbeiner. It’s a time savings that can’t be underestimated because the new production cell is involved in every injection molding machine that leaves the ARBURG plant. The new unit also reflects ARBURG’s philosophy of complete processing: Instead of intermediate storage of workpieces, the machine manufacturer — as much as possible — tries to achieve a continuous flow for the workpiece. “As a result we have fewer work operations and less downtime,” explains Finkbeiner. “And in turn that shortens our throughput times and increases accuracy.” All of which bolsters the commitment to excellence for a machine that bears the name ARBURG.

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## FROM FLASHBULB TO THE INJECTION MOLDING MACHINE

The international family-run business ARBURG is a world-class specialist in injection molding machines. Such illustrious names like Bang & Olufsen, Lego, Nokia and Playmobil are customers of the machine maker, which recorded 307 million Euros in consolidated sales for 2005.

It all began in 1923, when Arthur Hehl founded a company in Lossburg. In 1943 the company’s name was changed to ARBURG — a combination of Arthur and Lossburg. At the time ARBURG built flashbulb devices; the plastics injection molding did not come into the picture until the 1950s. In 1956 the company started serial production of injection molding machines, soon concentrating exclusively on this business field.

ARBURG employs almost 2,000 people worldwide, about 1,650 at its headquarters in Lossburg. The average age of the staff at approximately 38 is proof of the company’s rapid growth, while the average number of years employees stay at the company — 13.3 years — is a symbol of the employees’ loyalty.







*A glimpse under the tough skin of a Cool Tool shows how the cooling pipes fit the tool geometry.*

# Hot Press Cold Heart

by Prof. Ralf Kolleck

An old idea from tool construction. A new technology from laser processing. A team from the University of Graz puts one and one together. Bottom line: a revolution in costs.

■ Blacksmiths used to have time. They would hammer glowing metal into knives, scythes or horseshoes for hours. Carmakers don't have as much patience today. Their hardened car body sheet metal made of boron-alloyed steel go into the deep-drawing press at around 900 °Celsius only to be taken out a few seconds later, formed and cooled to 170 °Celsius.

**Cooling channels for the tool — but how?** The tool cools the workpiece: During the forming process, cooling water flows through channels in the press tool, transferring the heat away. The more precisely the channels fit the tool geometry, the faster the process goes. And this is precisely the core problem of the entire production process that should be solved with the work on Cool Tool at the Technical University of Graz, Austria. Drills can only be used to manufacture straight tubes, not complicated curved ones. And tool builders had abandoned the self-evident method of casting tubes into the tool. Cast iron simply cannot withstand the loads. Measured against the lifespan of stainless steel tools, casted tools almost deteriorate from one drawing cycle to the next. So, for a long time there was nothing anyone could do except assemble

## The cooling system increases output and saves the carmaker manufacturing costs of at least 10 percent of the component costs.



complete stamps or dies from many individually drilled segments. This is expensive and permits only very simple cooling systems anyhow.

The research team at TU Graz returned to the idea of casting tubes into the tool. Although the team had to put up with the weaknesses inherent in cast iron, the team members were placing their hopes on a technology that earlier engineers did not have — while the casting technology perfectly solves this problem of cooling pipes.

### The path to the Cool Tool

Standardized steel tubes were welded to a tube system to serve as cooling water pipes. In the future, tool builders will be able to adapt the pipes to the tool design. The research team developed a special simulation program for this purpose. This program calculates the heat flow through the tool and proposes a layout for the cooling channels with which the heat can later be transferred away as quickly as possible.

The prototype of the new Cool Tool was created in collaboration with two project partners in Germany: Siempelkamp Gießerei in Krefeld and the laser specialist TRUMPF in Ditzingen. The B-pillar of a car was to be pressed using the tool. Cuts made through the cast tool show that the idea bears fruit: The steel tubes do not melt during casting but rather combine well with the modular graphite casting used. Contact between steel tubes and the casting material does not deteriorate until the tube diameters are greater than 20 millimeters.

The advantages are obvious: Standard tubes, bent tubes and modular graphite casting are very affordable materials that can be easily reworked, enabling any number of cooling geometries. Despite the surface processing required, this results in 40 percent lower costs on the whole than with a tool made of drilled segments. On top of that are the advantages in the process itself: Because Cool Tool is ideal at transferring heat away, the workpieces cool off more rapidly. Usually, a complete cycle of press hardening lasts for about 15 to 25 seconds, from closing the tool, followed by the actual forming, and then the cooling off to about 170 °Celsius. The last stage, cooling, takes up the most time — 12 to 20 seconds. Cool Tool

shortens this time span by at least two to three seconds. This may seem only a marginal gain, but it does considerably increase output in the production line and saves the carmaker manufacturing costs of at least ten percent of the component costs.

**The casted tool must become harder** Initial tests showed that the deterioration of the soft cast tool is purely a surface problem. Only the contact area on the sheet metal is worn down. The tool body retains its shape. For this reason, the goal from the very start was to find a way to protect the surface of the cooled tools. And along the way a still very new laser application proved to be fascinating: laser deposition welding with powder nozzle. On the surface of the workpiece a high-powered CO<sub>2</sub> laser with a 10.6 micrometer wave length generates a molten pool on which a ring-shaped nozzle sprays metallic powder. The powder — such as a cobalt/nickel base alloy — melts and combines to form a new, hard surface with high wear-resistance and low friction coefficients. This is true even for modular graphite casting with a high carbon content, which is the case with Cool Tool. TRUMPF played a decisive role in developing this technology, providing the project with know-how and the laser deposition welding system.

The 3,200 Watt laser beam travels across the tool at a meter per minute, leaving behind an approximately 1.5 millimeter wide by 0.5 millimeter deep groove on each pass. With the prototype for a B-pillar, this took about 45 minutes for four layers that were two millimeter thick in total. Higher laser powers increase the speed accordingly.

The technology reveals its added charm when the layer is worn: In just 45 minutes, a laser can deposit a new anti-abrasion layer, restoring the tool to use. And if the alloy is no longer up to the task, it is possible to weld on another, better-suited one. In other words, the tool is not only cost effective, it can be used longer. ■

**The author:** Prof. Ralf Kolleck has been Director of the newly founded institute Werkzeugtechnik und spanlose Produktion at the Technischen Universität Graz since July 2004. Primary areas of research are tool / processing technologies for (ultra) high-strength steels.

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# “Ursi, explain that to us”

How does one become professor of quantum physics at the best university in Switzerland at the age of 33? For Ursula Keller it was grit, talent—and a bit of luck.

*Professor Keller, your chances of having a scientific career were not very good at first.*

*So what brought you to physics?*

I come from a working-class family and it was clear that I would take on an apprenticeship after secondary school. As part of the vocational guidance process, I had to take an IQ test. And when the guidance counselor was evaluating the test, she suddenly became very quiet. I guess I was good. She then asked me if I wouldn't rather continue on in my schooling and suggested that to my father. It's thanks to her advice that I graduated from college at all. Even if my teacher was against it.

*The teacher was against it?*

Well, you should know that my talent is very one-sided. In language studies I was very bad at school, but then I was very good at math. When

the teacher had no more answers, my classmates always said, “Ursi, explain that to us.” The teacher couldn't deal with the situation and didn't really support me.

*Did that influence your attitude toward the educational system?*

I am a very strong advocate for well-equipped public schools and a completely open pathway to the top. That opens the door for late bloomers and kids with a one-sided talent. But I have a real problem with the private schools springing up here. Only rich people can afford them and it is not a law of nature that they will automatically produce the most intelligent offspring.

*Speaking of children, you were back working full-time at ETH only a few weeks after the*

*birth of each of your two sons. What kind of lifestyle does that represent?*

At the time I was often asked why I had children at all. Would anyone ever ask this question to a father with a career? It can't be that you slave away and struggle for years only to suddenly be sent home. Don't misunderstand me: We have children because we want children. But it's a matter of quality and not only quantity when it comes to spending time with family. And also when they were babies, both of them had the best care you could find.

*But one has to be able to afford that care...*

That is less of a financial problem than a structural one. The costs of preschool here in Switzerland depend on the income—therefore anyone can afford it. But there are not enough spots available and not enough all-day schools.





*Ursula Keller has a résumé that you dream about: Ph.D. student at Stanford, scientist at Bell Labs, professor at ETH Zurich, co-owner of a laser company—and mother of two children.*

And if children cannot be cared for during the afternoon, then that is simply a problem for working women.

*How do you manage your various roles as mother, professor and entrepreneur?*

In reality, my husband is the entrepreneur of the family. I only sit on the supervisory board. My children not only have a mother but a father as well. And, of course, in my heart of hearts I am a professor, but I also have a team of 25 or 30 people behind me.

*As a female physicist do you have to fight problems of acceptance among male physicists?* People joining my team don't have any problem with a female boss. And those who do, stay away. But there is something else that I had to get a handle on at first: Because I am no longer



“I’m not afraid of making decisions. If it’s a matter of making the leap, I make the leap.”

## PROFESSOR DR. URSULA KELLER

The Swiss physicist developed a technology for the simple generation of extremely short laser pulses, making ultrafast lasers available for industry. Her development, the Semiconductor Saturable Absorber Mirror (SESAM), opens up broad technological applications in measurement technology, medicine and materials processing.

Prof. Keller received the 2004 Berthold Leibinger Innovationspreis and the 2005 Philip Morris Forschungspreis 2005 for SESAM, among other things. In 1994, she and her husband, Dr. Kurt Weingarten, founded the company Time-Bandwidth Products to market her patented and trademarked SESAMs.

ETH Zurich: [www.ulp.ethz.ch](http://www.ulp.ethz.ch)

Time Bandwidth Products AG: [www.tbwp.com](http://www.tbwp.com)

*Laser physicists refer to ultrashort pulses when the duration lies in the domain of femtoseconds (in figures: 0.00000000000001 seconds) or more recently attoseconds (another 1,000 times shorter than a femtosecond).*

knee-deep in every experiment, people often know the details better than I do. And now and again there are Ph.D. students and especially postdocs who make that known. I have discussed that among colleagues. I guess it’s not a problem typical to any gender. We all have to put up with it.

*Getting back to the start of your career, were you a geek at school?*

I think so. My hair was too short, my glasses too thick and I was very good in math — better than all the guys in the class. That wasn’t exactly optimal for dating.

*How did you deal with that?*

I began studies in physics at ETH in Zurich and had the opportunity to start something like a new life. I enjoyed the new freedom, went to every party, and up until the preliminary diploma, I wasn’t very industrious.

*Nevertheless after graduation, you were accepted at Stanford as a Ph.D. candidate...*

Yes, I absolutely wanted to go abroad, preferably to a good university in the United States. So I really went all out for the diploma exams. Of the five American universities that I applied to, all five accepted me. I decided on Stanford.

*You met your husband there and had a “bi-coastal marriage.” What can we make of that?* It happened like this: my husband Kurt is an electrical engineer and had a good job on the

West Coast. But my dream job was waiting for me a couple thousand miles away at Bell Labs on the East Coast. It was a tough decision but I knew that if I didn’t follow my dream for the sake of my husband that at some point I would resent him for it. So I went.

*Was that due to strong resolve, seizing the opportunity or egoism?*

You can call it egoism if you like. But my husband and I think that we share a very healthy and honest egoism, even now that we have been living together again for a long time. Our partnership is not based on self-denial and substitution. We’re together because it’s good for the individual. And besides, it was very romantic at the time to meet somewhere once a month between the East and West Coast for an extended weekend.

*But then in fact you did give up your dream job at Bell. How did that happen?*

One day the phone rang. It was ETH and they offered me a professorship. At first I laughed and asked them if they knew how old I was. I was 33 at the time and actually didn’t want the job. But the offer kept getting better so I took the plunge.

*And your husband, what did he say?*

He said OK, if you have a good job and can earn enough for the both of us, then I’ll go to Switzerland and risk starting up my own laser company. At the time it was one of the first spin-offs of ETH and is now very successful — due to SESAM.

*Have you ever regretted the change from the American economy to Swiss science?*

At Bell I conducted every experiment myself. Because of capacity issues, many ideas fell by the wayside. Here at ETH, there is a large team and I have the opportunity to put several things into motion at the same time. I very much like being a researcher in academia; there are still so many limits to be figured out. ■

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“Given the situation, the laser was never invented?”

# 5 QUESTIONS FOR DR. ANTONIO VENDRAMINI

*“I would have tried and given my contribution to its ‘invention’ in Italy”*

*Which laser application seemed impossible ten years ago?*

Let us think of many applications in the microelectronics field, especially those based on the very short pulses from solid-state lasers. Many applications on plastics as well, were also thought of as impossible.

*What is your wish, that lasers should also be able to do?*

I wish that lasers could become an affordable tool for the possibly largest amount of factories, thus spreading even more the countless benefits of this “wonderful light.”

*What change in laser technology is for you the most important one?*

Currently I do not consider any change to be necessary, apart from its affordability. I would consider positive a change in the

general attitude in order to present more carefully and seriously what is offered to the industry, which is often not able to grasp the real benefits coming from a new technology.

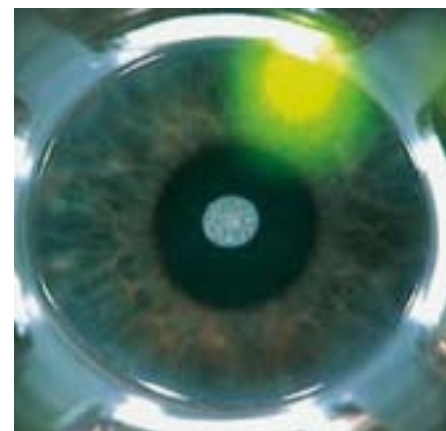
*Do you have any laser technology role models or “idols?”*

It is hardly possible to have idols in a field developing that fast. Certainly I would appreciate if the same “fiver” of the pioneers of laser applications, who put so much power in making that “wonderful light” of the 20th century accepted by the industrial world, would arise again.

*Dr. Antonio Vendramini has been fascinated by the laser since his physics studies at the University of Milan, Italy, with the development of the first inorganic liquid laser with neodymium. In 1979 he became head of the laser application laboratory at CISE in order to promote the diffusion of the laser in Italy. In 1988 he founded the consultancy company Lasertec. Additionally he promotes the advantages of laser processing as a journalist and by supporting the Italian Fair EXPO LASER.*

**More questions for Dr. Antonio Vendramini:**  
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*The femtosecond laser scalpel flashes so quickly and briefly that the eye feels nothing—except at the focal point.*



## Bladeless Eye Operations

*The femtosecond laser scalpel operates inside the cornea—without damaging the surface.*

“I am having my eyes lasered,” a person with defective vision might say. This actually means that an eye specialist removes layers of the cornea using a laser beam until the surface geometry fits the calculated correction. This procedure is called LASIK. What is not mentioned here is that before the laser there often was the blade. In the usual procedure, physicians first cut into the top layer of the cornea and remove a flap. Only then they do reshape the inner layer with a laser device. But the mechanical cut poses a substantial risk. For this reason, ophthalmologist Dr. Ronald Kurtz and laser physicist Dr. Tibor Juhasz tried to find a way to operate directly inside the cornea using laser light. For them, a femtosecond laser also acts as a scalpel. It generates ultra-short light pulses

lasting less than a millionth of a millionth of a second. These pulses are so short that the molecules around the focal point do not react. The tissue remains unharmed. It disintegrates only at the focal point. As a result of a close research and development cooperation for years, a reliable method and the necessary device have been developed. It is successfully marketed worldwide by IntraLase Corp. in Irvine, California. More than one million blade-free procedures have since been made with IntraLase equipment. ■

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# Down Under

Professor Milan Brandt on the situation in the Australian laser market

Industrial laser systems are today one of the established production methods in Australia. Their number and the number of their applications have steadily increased over the past 20 years. Two factors were decisive for this growth: On the one hand, the Australian government at the end of the '70s recognized the laser to be one of 20 important technologies that would help modernize the domestic production industry. The government then supported research efforts accordingly. On the other hand, industrial laser systems spread around the world in these past 20 years, and Australia, as a technological hub, did not miss out.

The Australian market for laser processing systems is estimated to be around 10 million Euros, which is equivalent to 2 to 3 percent of the global market. Pulsed solid-state lasers do not play a major role because Australia does not have its own microelectronics industry — so there's no user basis for the technology. The few Nd:YAG lasers in the country are used for drilling, fine blanking and welding.

In Australia as well, the standard industrial laser application is two and three dimensional laser cutting of steel shapes and plastics. The lasers used — often carbon dioxide lasers — fall within a power range of between 3.5 and 6 kilowatt. Third-party manufacturers with five to ten employees and annual sales revenue of around 600,000 to 1.2 million Euros are among the typical users. But the owners of these companies often have a background in business. A typical third-party manufacturer has between one and three carbon dioxide lasers and operates on a two- or three-shift cycle.

There are currently two companies in Australia that manufacture laser systems. They buy the lasers abroad. One is HG Farley Laser Lab,

which belongs to the Chinese company HG Tech; the other is Bristow Laser Systems, an independent Australian company.

As established as laser cutting is in Australia, laser drilling and welding are equally scarce. Laser welding in particular has so far seen limited uptake. One reason for this is that Australia doesn't have a large automotive industry. These trendsetters, as the case may be, in other countries were and are quick to take to advanced technologies.

In addition to that, the Australian automotive industry is an offshoot of the international parent, and the international car manufacturers are conservative when updating their facilities in Australia as the market is small and the costs of laser welding systems are high.

Things look better for laser marking and laser surfacing, and cladding in particular is a growing application; the number of installed units is about 200. The interest in cladding coating has grown in Australia, especially in the past five years. The driving force behind this development is the need for components with better wear and corrosion resistance as well as the repair of high value components in industries such as mining and power generation, major industries in Australia. Machines used in mining are exposed to greater wear and corrosion. Laser beam cladding offers new ways to reduce maintenance times and extend maintenance cycles. ■

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Milan Brandt is director and professor of the Industrial Research Institute Swinburne in Melbourne, Australia. He has influenced applied laser research in the land down under like no other person in Australia.



# Where's the laser?

***IN THE END, UNDER THE SKIN:*** Implants like this alignment plate for broken hand bones are mostly made of titanium. The material doesn't corrode and is both non-toxic and lightweight. Though at the same time, it is extremely strong as well as sensitive to temperatures.

That's precisely why the implant manufacturers prefer lasers: The thermal impact zone measures only a few micrometers with pulsed lasers. The beam cuts at various angles, so screws can be aligned exactly with the bones. In addition, the laser features nonporous cutting and inscribes numbers or characters without any pitting, deposits or pigments on the metal surface. As a result, there's no room for microorganisms, foreign particles or sharp edges that could prevent the tissue from healing quickly.



# 0.00058 mm

*This small number is the focus diameter of the blue laser beam that reads a Blu-ray disc. The minuscule laserspot can read data that are only 0.32 micrometers apart, allowing for higher volumes of data, currently up to 50 gigabytes per disc.*

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