ATHANASSIOS KALIUDIS

This is how the laser became a success story for TRUMPF

When light becomes a passion: Only those willing to leave their comfort zone, those who demonstrate determination, daring and pioneering spirit while developing a true passion for the work – only those can advance to a position of global market leadership.

For the “Nibbler King” it was almost an affront – a tool that uses heat to cut curves. A tool that cuts thin sheet metal precisely and virtually without wear. This was a foray into the realm mastered by TRUMPF, the “Nibbler King.” If anyone, anywhere in the world wanted to process sheet metal at industrial scale, then there was no way to not at least consider TRUMPF. Punching and nibbling machines were the pride and joy of the family company in Ditzingen. But at the end of the 1960s, these reports from the USA reached Professor Berthold Leibinger, the father of TRUMPF’s success. Cutting sheet metal? That can be done without punch strokes – by using a laser.

The most unsettling thing about laser cutting was that it seemed to solve one of the gravest problems associated with nibbling. Reworking the cut edge was hardly necessary. One of TRUMPF’s representatives in America even predicted that the laser would replace nibbling entirely. Berthold Leibinger pondered the situation and then devoted intense interest to laser technology and the options it offered. More than 40 years later, the laser has revolutionized the entire world of manufacturing and has also lifted TRUMPF to new heights – even though this triumphal march was by no means certain at its start.

The solution – but for which problem?

It was in the 1960s that a trade journal awarded to TRUMPF the thoroughly fitting title of “Nibbler King.” But in another corner of the world, the first light produced by laser had already shot through the ether. As early as 1960 U.S. physicist Theodore Harold Maiman developed the first functioning laser in his laboratory. His work was based on the proof of light amplification, published by Albert Einstein in 1917. The device invented at that time was a solid-state laser, pumped optically with xenon flashlamps and using a ruby as the active medium. Even though elation among researchers and experts was high at the outset, the laser soon encountered initial difficulties that were by no means insubstantial. The materials used in the laser were not pure enough, the entire laser system was susceptible to breakdowns, and laser output was often too low.

The "hottest topic in solid-state physics since the transistor," is how Time magazine raved about the laser, even though it was still in its infancy. Every attempt to apply the laser to existing tasks seemed doomed to failure; using conventional methods was always more profitable. Maiman himself ultimately described the laser as "a solution in search of a problem." In 1964, amidst all this uncertainty, electrical engineer and physicist C. Kumar N. Patel developed the carbon dioxide laser (CO2 laser) in the USA. This proved to be a decisive step toward using the laser in industrial manufacturing. Ultimately, this was also one of the incentives for Berthold Leibinger, just a few years later, to give thought to using the laser as a new tool.

Of clocks and picture tubes

At the beginning of the 1970s, developers at the Carl Haas company in Schramberg, Germany, worked on a special solution for the clock industry. The assignment was to use the laser to weld clock springs. Why was the laser suddenly so important? Because the laser does not touch the pieces being worked. That makes for greater component quality and higher accuracy in the movements. To accomplish this, Carl Haas assembled a team of experts headed up by Paul Seiler. The name Seiler was destined, over the course of the coming decades, to become inseparable with the laser.

"The laser and its possibilities were and are my passion," Seiler recently explained in an interview with Laser Community. "Over the course of the years there were many moments that reflected the thrill and the excitement of the initial encounter. Of course we had to cope with difficulties and setbacks. But that never smothered the passion. Quite the opposite! Challenges fired that passion. That's because it's exactly the challenges that bind us to an idea – even over 50 years."

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In 1973 Seiler and his team mastered the first major challenge. The first machine to automatically weld clock springs went to work at Carl Haas. It used a specially developed solid-state laser, the so-called LKS 15 laser component system. The production of flat coil springs for electric clockworks and watches marked the successful launch of volume production. The increasing demand for color television sets prompted AEG-Telefunken to seek an automated technique for welding the cathode components for picture tubes, setting the stage for large piece counts.

Carl Haas had the right solution with its laser. The breakthrough was finally made with a large order from Philips. The Dutch company converted all its picture tube production to laser spot welding. Paul Seiler recalls: "Thanks to this renowned customer, our laser component system came to be known around the world. The Haas laser suddenly became a brand name."

A keen nose for innovations

One thing became perfectly clear to Berthold Leibinger at the close of the 1970s: TRUMPF could use the laser to set new yardsticks for industrial manufacture. The company recognized the opportunity and did not shut its eyes to the "light of hope" as Reader's Digest once wrote. At that time TRUMPF did not have a laser in its own product range. Consequently the company worked with a laser manufacturer in California, building bought-in lasers into its own machine tools. The first combined punch and laser machine, with a CO2 laser producing 500 watts, was unveiled by TRUMPF in 1979 – a world first. The machine was designed for flexible sheet metal manufacture and to cut user-programmable curves.

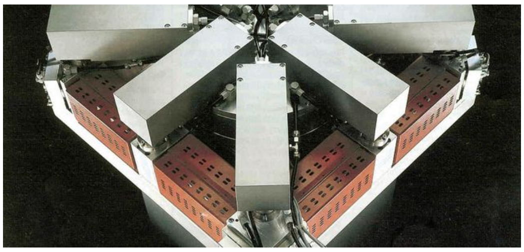
That first success quickly sparked a hunger for more. TRUMPF wanted a laser that could reliably cut thicker sheet metal. The partner in the USA was not broad-based enough to achieve this, however. What's more, every bit of information about the latest findings would also be accessible to the competition – at least in theory. Berthold Leibinger demonstrated foresight and integrated the development and production of the CO2 laser into his own company.

The goal was to build a laser of sufficient power, suitable for industrial use. In 1982, the research institute of the German Test and Research Institute for Aviation and Space Flight, in Stuttgart-Vaihingen, joined in the fledgling laser development work at TRUMPF. Barely one and a half years later, the team had developed a 900-watt laser featuring transverse flow and high-frequency excitation. It could, however, maintain a laser beam only for about 90 seconds.

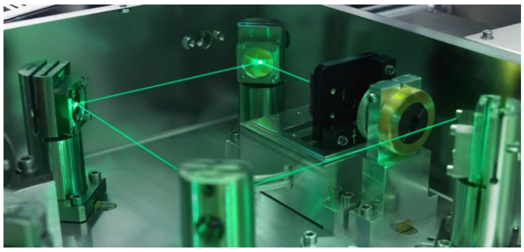
Another one and a half years down the road, and utilizing the newly developed axial flow laser concept, TRUMPF was ready – in 1985 – to make a presentation at the EMO – the world machine tools exhibition in Hannover. There it unveiled the first of its own CO2 lasers, with 1 and 1.5 kilowatts of laser power. It caught competitors completely unawares. From a technical point of view, TRUMPF had become the world market leader in laser cutting – from a standing start – and was no longer dependent on an outside laser supplier.

Beginning of solid-state laser development at Carl Haas in Schramberg in 1971. Used for own production: welding of clock springs.

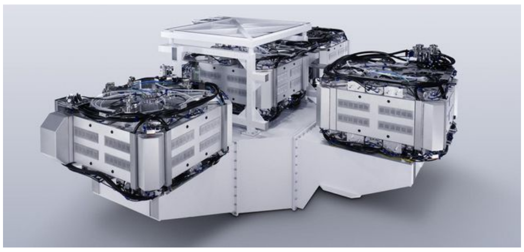
TRUMPF bilds its first own CO2-Laser in 1985, the TLF 1000. It has a laser power of 1 Kilowatt and is the first compact laser resonator with RF-excitation.



TRUMPF presents the folded high performance CO2-Laser in 1989 – the basis for the today’s best-selling multi-kilowatt laser.



In 2008 TRUMPF introduces the picosecond lasers.



The TRUMPF laser amplifier, a pulse-type CO2 laser system, delivers the laser pulse for the EUV project.

Then it was time to tweak

That same year Paul Seiler and his team in Schramberg continued to work toward the triumph of the solid-state laser. They developed the first laser light cable for industrial use. In contrast to CO2 lasers, the light emitted by solid-state lasers – due to their shorter wavelength – can be coupled into flexible glass fiber waveguides. The advantage here is that the laser light can be passed to the workpiece conveniently and without detours, making the solid-state laser far easier to integrate into production lines.

“Without the laser light cable, the solid-state laser would never have achieved is current relevance,” surmises Paul Seiler. Thanks to this laser light cable, laser systems can be used more economically and profitably – ultimately the reason for their significant expansion in the early years.

Following the successful market launch of its own laser, skeptical voices at TRUMPF fell still. Berthold Leibinger recalls: "One of our department managers felt that lasers could do exactly the same work as nibbling, but at far higher costs." The laser team at TRUMPF was nonetheless successful in developing and optimizing the technique. And soon they were tracking the scents of new potentials. Within the company itself, calls for beam sources with higher power, intended to work in a number of applications, became ever louder. But lasers with higher beam quality were absolutely necessary for this purpose. Development engineers had to go into the huddle.

High beam quality requires the longest possible resonator. And what could make more sense than to fold that resonator into a square, making it more compact? That was easier said than done. The turbo radial blowers needed to move and cool the laser gas consumed almost two additional years of development time. In 1989 TRUMPF finally presented the folded, high-performance CO2 laser with 1.5 kilowatts of power, thus forming the basis for the multi-kilowatt laser – the unit most frequently sold, right down to the present day. The industry soon demanded higher power, but that was certainly not a surprise. By 1993 TRUMPF was able to boost its laser output to 12 kilowatts. Today, CO2 lasers producing 20 kilowatts are standard in the company's line.

A steep rise

In the meantime the Carl Haas company in Schramberg had spun off its laser division, forming an independent firm organized as Haas Laser. Paul Seiler was appointed CEO. Shortly thereafter the marking lasers made by the Gretag company were merged into the company. 1991 was a memorable year: At a trade fair in Munich, Haas Laser unveiled its study for an industrial 2-kilowatt solid-state laser with laser light cable.

That made the industry sit up and take notice. Everyone considering the laser then realized: The solid-state laser, with its flexible laser waveguide using a light cable, would move into higher performance ranges and thus become an ever more attractive tool for industrial production at large volumes.

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>
> Paul Seiler, former TRUMPF CEO in Schramberg

The people at TRUMPF were working on elevating the company to become the largest vendor of lasers intended for manufacturing. The path had already been set in the field of CO2 lasers, but the company did not yet have any solid-state lasers in its product line. Especially in the fields of precision mechanics and medical technology, solid-state lasers were well established and much in demand.

Leibinger wanted and had to close this gap. And thus the next step appeared to be only logical. In 1992 TRUMPF became a partner in Haas Laser and four years later folded the pioneer in solid-state lasers into the TRUMPF parent company. Paul Seiler, who headed up Haas Laser, continued to hold an executive post until his retirement in 2003. "TRUMPF was the partner we wanted to merge with; our product lines complemented each other perfectly," Paul Seiler explained at that time. Today we would certainly say that it was a classic win-win situation.

In the years that followed, TRUMPF worked its way up to become the world's largest maker of lasers for manufacturing technology. In 1995 the first flat-bed cutting machines incorporating solid-state lasers were marketed. They united the core competencies of the two organizations. Three years later, diode-pumped marking lasers joined the product line, which was growing apace. At that time the technology of diode excitation was new and a bonanza for TRUMPF. In 1999 the first diode-pumped disk laser, with 1 kilowatt of laser power, was introduced as a laboratory unit. Shortly thereafter this laser went into series production. Today the disk laser is the platform for all of TRUMPF's high-performance, solid-state lasers.

In 2002 the first large orders were received from the automotive industry – for the new lamp-pumped, 4-kilowatt, solid-state laser. The first short-pulse laser in 2005 opened the path to micromachining. The most delicate texturing, ablation, drilling and cutting were made possible with the newest generation of lasers. The multi-kilowatt industrial laser with its great brilliance was marketed in 2009. It uses high-performance diodes as a direct beam source. No other manufacturer ever had or now has a broader product line, embracing a wide variety of laser models, than this family-owned company in Ditzingen. And that is exactly the secret of its success.

In his autobiography, Berthold Leibinger cites the laser and its applications as "the most important product of the TRUMPF Group." In 2005 he laid his company's fortunes in the hands of the next generation and withdrew from operative business. With his daughter Nicola Leibinger-Kammüller as President of the Managing Board and his son Peter Leibinger as Co-President, TRUMPF continues to be a family-run company. Peter Leibinger, too, sees laser technology as the "key to the future." This is ultimately highlighted by current developments. At the end of 2013, German Federal President Joachim Gauck awarded the German Future Prize to a team of experts drawn from TRUMPF, Bosch and the University of Jena – something like a knightly accolade. They had developed the ultra short laser pulse to create a new tool for mass production.

The laser is gentle as it works almost any material. It is precise and highly productive. In the blink of an eye it emits as many as 24,000 pulses with enormous peak power. Peter Leibinger emphasizes: "Microprocessing with ultra short pulse lasers is a manufacturing technique of the future – and German companies are the world's leaders in this field."

A further example is the newest generation of direct diode lasers. They are extremely thrifty when using energy , achieving efficiency levels as high as 40 percent. This makes it highly suited for "green production," something being pursued ever more vigorously. In generative manufacturing, too, TRUMPF is setting benchmarks and moving to the fore. With this technology, any needed parts can be created directly from the 3D design program. The product is shaped, layer by layer, from metallic powder joined with the laser's power. The technology has the potential to partially replace procedures like milling and casting. Great hopes also rest in the so-called EUV project. The goal here is to generate extreme ultraviolet light, with a wavelength of 13.5 nanometers. Only in this way can the very delicate structures for tomorrow's CPUs be made up. To put it plainly: The future of the entire electronics industry depends on whether this project can be readied for production use. TRUMPF delivers the key component for these highly complex manufacturing techniques: a CO_2 laser pulse with 30 kilowatts of power.

At the close of the 1960s TRUMPF racked its brains about this new tool, which was in competition with its punching machines. Without hesitation and without clinging to time-tested products, the company even then showed itself to be inquisitive, open – and farsighted. With courage, the right ideas, and the necessary bit of luck, TRUMPF advanced – during stormy years – to become the world leader, both in the market and in innovations. Regardless of which laser applications, as yet unimagined, might become possible tomorrow: TRUMPF will play a decisive role in shaping the future of the laser and its use.

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