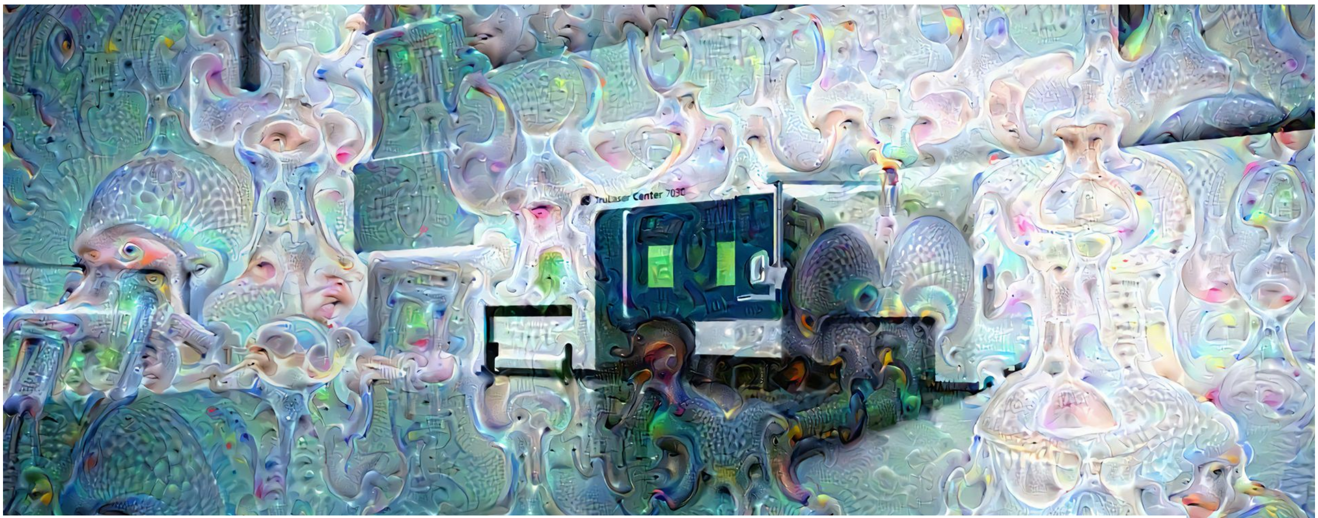

ATHANASSIOS KALIUDIS

Brain power unleashed: AI in laser material processing

Artificial intelligence is transforming industry. So where are we right now? And what changes lie ahead? Join us on a journey into the future of laser material processing.

Chess players accepted defeat long ago. When an IBM supercomputer beat world chess champion Garry Kasparov at his own game in 1996, there was no longer any doubt that artificial intelligence, or AI, was far superior to humans – at least when it came to chess. But the story didn’t end there. Fueled by remarkable quantities of data and driven by incredible computing power, the AI developed moves that were so novel, elegant and surprising – moves that no human player would ever have come up with – that they elevated chess to an entirely new level. Nowadays, anyone who is serious about playing chess knows how much they can learn from AI, so they deliberately pit their skills against it to pick up tricks and ideas. Ultimately, this has made human players better than ever before.

The next step in industry 4.0 is AI

Chess players have learned to accept and enjoy this process – but for mechanical engineers, production planners and design engineers, the journey is only just beginning. The whirlwind of Industry 4.0 is now reaching its peak as artificial intelligence sweeps into the world of manufacturing. AI long ago swallowed up critical tasks in other sectors that do not produce physical goods. In banks and the financial sector, for instance, algorithms already assess peoples’ creditworthiness, buy and sell shares and detect credit card fraud. In the realm of medicine, they help doctors diagnose conditions such as skin cancer, and in the online retail world they support pricing and other marketing tools. But now the time has come for algorithms to make themselves useful on the shop floor, too.

AI makes machines better and better over time.

It all starts with the areas where algorithms can play to their strengths, namely in organizational, non-material processes. Tat's where programs with AI components are already flexing their muscles, with self-learning algorithms checking production planning strategies and helping to ensure optimum capacity utilization. But that's not all: they are also helping to manage the invoicing process, correctly assigning each invoice and sending it on schedule. Handwritten orders can now be automatically incorporated in SAP using text and speech recognition. And every time these machine brains succeed – as well as every time they fail – they become a little bit smarter and increase their chances of doing things better next time.

AI neurons have only recently taken a step closer to the actual machines on the shop floor. Once again, the first and easiest point of entry is the 'soft' digital side of the machinery. Predictive maintenance is a good example. Fed with huge quantities of historical data and connected to sensors, an AI can detect when a machine needs maintenance and forward the data to production planners. This prevents unexpected downtime and enables companies to plan their maintenance work more efficiently, integrating it more smoothly in the production process.

TRUMPF uses AI for flatbed laser machines

Occasionally, something might still go wrong – but, even then, an AI is on hand to help. At TRUMPF, for instance, self-learning software supports the quality assurance team on a production line for highly sophisticated flatbed laser machines. In the past, any problems encountered during test runs would require the team to inspect or even replace numerous parts of the machine – a laborious process that wasn't even guaranteed to succeed. Nowadays, sensors capture huge quantities of data in a short test run and send it to the cloud where it is compared with all previously known information and analyzed accordingly. It takes no more than a few seconds for the software to run through countless operating states. If it detects any irregularities, it can give its human colleagues a precise description of where the error most probably lies and how it should be corrected. Once again, the software gets better each time it's used.

High degree of freedom required

Now, however, the time has come for AI to cross over to the other side. It is meeting metal head on, bridging the gap from a realm where data is the only currency to the real, solid core of industry where physical things are made. Unlike the software applications that are used for tasks such as production planning, however, AI struggles to carry out test runs on real parts in industrial applications. In this environment, one false move can result in car doors or electronic components ending up on the scrap heap. What's more, AI isn't even an option unless machines have been specifically designed to incorporate it – and arguably there's little point in adding a brain to an interlocking gripper that simply moves back and forth. For algorithms to actually learn something and make use of what they learn, the machines must have a high degree of freedom.

The fully automatic TruLaser Center 7030 laser system from TRUMPF is one of the first examples of how this can be applied to te 'hard' side of industry. In this case, the required degrees of freedom stem from the 180 movable pins that are supported by an AI. The machine cuts parts from a metal sheet and then removes them automatically. Currently, this repetitive job is often done by hand because the parts may tilt slightly as they come out of the sheet. A human can easily jiggle the part into the correct position – but this task can quickly overwhelm an automated solution. Not any more, however. In the TruLaser Center 7030 system, pins lift the part from the scrap skeleton from below while suction plates hold it in place from above. What makes things trickier is that these cut parts come in an almost endless assortment of shapes, sizes and thicknesses. But if a part gets stuck on the first try, the suction plates and pins simply repeat the process in a slightly different way until they succeed. The machine sends all the data on these failed attempts to the cloud where it is evaluated centrally. In the future, all TruLaser Center 7030 systems will receive regular updates, allowing each and every user to benefit from what the algorithms have learned worldwide. This huge pool of machines, all connected to the same central hub, offers real benefits to users by making their individual machines better and better over time.

AI assesses quality of weld seams

The same applies to monitoring weld seams and cut edges. TRUMPF is currently training a self-learning software program that uses optical sensors to assess the quality of weld seams and edges and notifies users whenever these deviate from the stipulated tolerance range. Researchers are putting the AI's performance to the test in the complex task of welding hairpin windings for electric motors. Once again, the software becomes increasingly confident in its judgment the more times it performs the task. Soon it will be capable of assessing laser processing results not only much faster than a human expert, but also much more accurately.

By working together to evaluate data, companies can benefit from the results of AI.

The changes sweeping industry in general are particularly relevant to laser applications, which already inhabit a realm beyond the hard border that AI is currently seeking to cross. Unlike milling cutters, drills and all other mechanical tools, the laser is fully in its element in the digital world. Ever since their first use in industry, lasers have been numerically controlled and primed to create real objects out of data. And that's not the only advantage lasers have over their mechanical counterparts: with laser systems, the only thing standing between the data and the product is a physically unconstrained beam of light. From Industry 4.0 to AI's introduction in industrial domains, it is hard to imagine a tool that is more flexible, adaptable and direct than the laser. Whenever an AI generates a new processing strategy□–□whether through a series of nuanced adjustments or, as in AI chess, through a sudden blinding flash of paradigm-shifting inspiration□–□the laser can tap straight into that pure information and immediately put it into practice. It's impossible to imagine any greater degree of freedom.

Lasers also score highly on their ability to capture vast quantities of data using a whole host of sensors□–□data that is steadily becoming more and more valuable. Algorithms trained on the basis of human experience can constantly detect new patterns in this jumble of information, invisible to the human eye, and then use these patterns to draw conclusions. Researchers worldwide are developing these kinds of AI systems right this second. And the results will gradually improve not just laser material processing, but also lasers themselves. Much like today's chess players, laser users a decade into the future will be the best laser users of all time□–□and they will have learned to love their AI.

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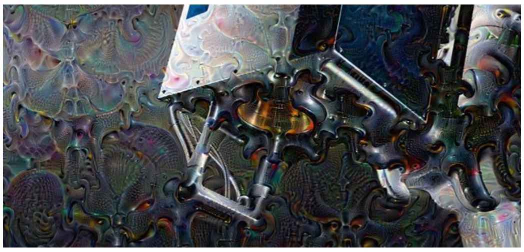
The dream in the workpiece?



The brain in the processing head?

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