



Daedalus

Robotics and software advances in CNC manufacturing

How Daedalus uses robots and software-defined manufacturing to improve low volume CNC production runs

CNC machining is a versatile manufacturing process with applications in various industries. The ability to handle complex materials while accomplishing tight tolerances makes it an essential tool in the production of high-precision parts across a diverse array of industries. Manufacturing companies have two options for the production of CNC manufactured parts: they can either set up an inhouse CNC production line or outsource the manufacturing process to CNC shops.

For high volume production runs, setting up an inhouse production line provides low unit costs and fast lead times while allowing for end-to-end quality control. Automation technology can further reduce unit costs for batch sizes in the millions.

For lower volume production runs, e.g., for high-mix product portfolios and during prototyping, the significant investment in CNC machines and machinists required for setting up an inhouse CNC shop typically outweighs these benefits. For that reason, small volume orders are commonly outsourced to external CNC shops. This way, the company does not incur capital expenditures and remains flexible in case of changes in part design or volume. This increase in flexibility comes at the cost of higher unit costs, slower lead times and a loss of quality control.

By setting up a fully autonomous CNC shop, Daedalus aims at bringing the benefits of automated inhouse production to outsourced, small volume runs. Its autonomous high-mix CNC production system can quote, manufacture and deliver any new part without human intervention. To understand the importance of robots and software-defined manufacturing in achieving this, let's first look at how traditional CNC shops operate.

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STATUS QUO

With their tasks ranging from planning the production process and picking up raw material to clamping and unclamping the part, machinists play an essential role in any CNC shop's operation. Upon receipt of their next order's CAD model, a machinist first plans the sequence of operations in which the part will be machined.

Typically, a part has to go through several machining setups, with different fixturing equipment and tools required in each setup that incrementally form the final shape of the part. They use semi-automatic Computer-Aided Manufacturing (CAM) software to program the movement of the cutting tool. Then, they proceed to manually prepare the machine and clamping equipment needed to hold the part throughout each setup. These

“machine setups” are highly non-standard assemblies that need to be customized for each particular part, and are critical to achieving tight tolerances and repeatability. Once the fixturing equipment is set up, raw material for the first part can be loaded into the machine, and the machinist will manually move the part through the separate stages of production followed by the remaining parts in the production run. Once the batch is complete, the machinist disassembles the clamping equipment and prepares for the next order.

Because of the labor intensive nature of CNC machining, labor cost typically accounts for about 60% of final part cost, thus providing a significant lever for cost reduction.



DAEDALUS' TECHNOLOGY

Now, how does Daedalus' approach differ from traditional CNC shops? Daedalus is developing an autonomous CNC production system that enables the production of high-precision and high-mix parts at low costs. Their fully autonomous CNC shop uses general-purpose robots to handle all manual tasks as well as software to control the robots and holistically optimize the shop floor operation. This software-defined manufacturing enables the production of any new part without human intervention.

A general-purpose robot takes over all manual tasks previously executed by the machinist. It is able to navigate between raw material inventory, CNC machine and finished goods storage and can grip, move, clamp and load parts, independent of their shape and material.

The robot as well as the overall production process are orchestrated by a proprietary software system. The system analyzes the industry-standard CAD file produced by the design engineers of the customer containing the desired geometry of the final part. Based on this information, the software plans the production process without

further manual involvement, including procurement, capacity planning, as well as technical process parameters such as cutting speeds and tool wear offsets that are traditionally hand-tuned by the machinist.

Its general-purpose architecture allows the production system to manufacture all types of parts as opposed to conventional automation technology which is highly specialized for specific products and difficult to reconfigure.

BENEFITS

The autonomous production system developed by Daedalus can produce all types of CNC parts without the need for a machinist. Its ability to operate 24/7 enables lower unit costs and shorter lead times while the use of robots and software prevents human errors and allows for end-to-end quality control. Customers benefit from the following advantages.

Lower units costs—The 24/7 utilization of CNC machines and the autonomous operation without machinists make for drastically lower unit costs.

Shorter lead times—The 24/7 operation combined with the software's ability to plan and start production instantaneously allow for shorter lead times, comparable to those of inhouse manufacturing.

End-to-end quality control—The use of robots and software prevents human errors, enables tracing every step throughout the production process and allows previous batches to be manufactured again without fluctuations in quality, hence allowing for an end-to-end quality control that matches the capabilities of inhouse manufacturing.

Flexibility—As Daedalus customers outsource their parts to the autonomous CNC shop operated by Daedalus, they don't need to invest in CNC machines and machinists, remain flexible and can react quickly to changes in part design and volume without incurring switching costs.

In short, Daedalus' technology enables customers to combine the flexibility and CAPEX omission of outsourcing with the quality control of inhouse manufacturing at even lower unit costs. Small volume production runs now possess the same benefits companies previously only enjoyed for high volume production runs. This brings the economic efficiency and benefits of high volume automated manufacturing lines to small volume, high-mix production runs that were previously expensive and challenging to manage.

If you are interested in the technology developed by Daedalus, feel free to reach out!

The Daedalus engineering team comprises Silicon Valley software engineers and robotics experts, as well as CNC manufacturing veterans from major German manufacturing companies. The team is currently working on widening the range of parts the production system can manufacture autonomously. To best meet the requirements of the manufacturing industry, Daedalus is always interested in any form of input by partners.