Desktop Metal

CASE STUDY

Training Teachers for Hybrid Manufacturing

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HGS and SolidCAM Additive offer further education on combining AM and CNC using the Studio System

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Modern 3D printing is no longer new territory for the vocational school Hohentwiel-Gerbeschule Singen (HGS) in Germany. In 2024, the school installed Desktop Metal's Studio System to its extensive-line up of learning equipment with the support of the metal 3D printing experts at SolidCAM Additive, one of Desktop Metal's trusted partners in Germany. This classroom-friendly system enables safe, high-precision printing of metal parts, making it a valuable tool for school projects.

Customer
Hohentwiel-Gewerbeschule Singen (HGS)

Location
Singen, Germany

Industry
Education

Application example
Cutter head

Machine
Studio System™ 2

Material
17-4 PH Stainless Steel

Website
www.hgs-singen.de

Partner
Solidcam Additive

Location
Schramberg, Germany

Industry
3D Printing Service Provider

Website
www.solidcam.com/solutions/solidcam-additive

Lifelong learning for educators

Manufacturing is undergoing rapid transformation, with the emergence of new processes and technologies such as additive manufacturing (3D printing), hybrid manufacturing, CNC automation, and Industry 4.0. To ensure that manufacturing educators are equipped with the knowledge and skills necessary to effectively teach students about the latest advancements in manufacturing processes, it is imperative that they stay abreast of these developments through further education or advanced trainings.

Two highly motivated teachers at the Hohentwiel-Gewerbeschule Singen (HGS), a vocational technical school and college in Germany, recognized the value of providing educators in the field with further education in modern manufacturing techniques. These teachers, Pascal Noppenberger and Florian Buschle, developed an advanced training program on hybrid manufacturing, a combination of additive manufacturing and CNC machining. They believe this approach is superior to traditional manufacturing processes for complex applications in several ways, including enabling more complex designs and reducing production time and costs.

To balance the theory and practice of training, the school partnered with SolidCAM Additive, a renowned 3D printing service provider that supports machine shops to streamline their operations through additive manufacturing.

"Our school's Learning Factory 4.0 is investing in a lot of modern equipment, such as 3D printers. We have everything from production planning to quality management. Once we purchase a system, we have to develop a teaching concept for it that is applicable to the industry. And what better way to do that

than with an industry partner like SolidCAM Additive that we've known for many years," said Noppenberger, the school's senior teacher.

This advanced training entitled "Hybrid Manufacturing: From Metal Printing to 5-Axis Milling" is offered once a year exclusively in a classroom format with a total of eight teaching units, each 90 minutes. This program is designed specifically for teachers at industrial technical schools in the German state of Baden-Württemberg, who teach metal part manufacturing and metal production technology. However, technical college students may also participate in the training program and receive credits from it.

The goal of the program is to provide educators with a comprehensive understanding of the hybrid manufacturing benefits and processes, from designing metal parts from an additive manufacturing perspective and 3D printing them, to sintering and post-processing the parts on a 5-axis milling machine. In addition to the theory, the participants can directly apply what they've learned during the course by manufacturing a real metal part using the technologies available at the school.

Learning focus: Bound Metal Deposition

Because additive manufacturing encompasses many processes and technologies, this training focuses on only additive processes that can be safely taught in a classroom setting, including Bound Metal Deposition (BMD) and Fused Deposition Modeling (FDM). The school purchased a Desktop Metal Studio System BMD 3D printer for training purposes in 2024.

"The Studio System is very safe to use in the classroom. We don't need a mask to use it. We don't get brutal toxic fumes, and we don't need an exhaust system. The machine is small. We can just put it in our office. It is also very easy to use," explained Noppenberger.

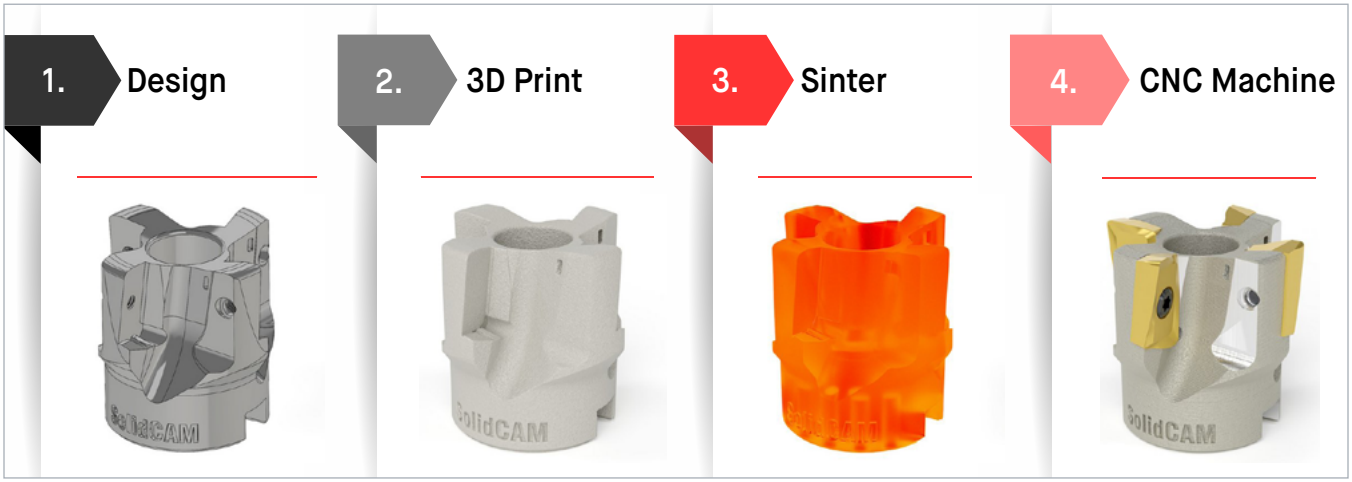
Jörg Vollmann-Schipper, Business Director of SolidCAM Additive, who conducts the training on the basics of metal 3D printing and the use the Studio System, added a point about the suitability of using the system for learning. "It is important for us to use a system that really works in the marketplace, especially in education, training or workshops, where many people discuss not only the good things about manufacturing systems, but also all the problems they have. The Studio System works well and is simply predestined for education."

About Studio System: Using the Bound Metal Deposition™ (BMD) technology, the Studio System extrudes bound metal rods into complex shapes layer-by-layer, similar to the FDM process. Rods of pre-bound metal powder are loaded into the machine, eliminating any loose powder handling from the process. This eliminates many of the safety requirements often associated with metal 3D printing while enabling new features, such as the use of fully closed-cell infill for lightweight strength. As a result, the Studio System 2 is suitable for any classroom, office, or studio space. The Studio System is an easy-entry system that makes it possible for machine shops, MIM houses, service bureaus, and educational institutions to quickly get started printing metal for tooling, jigs, fixtures, prototypes, and batch production.

Learn more about the user-friendly process of the Studio System 2: Studio System™ | Desktop Metal

Hybrid manufacturing learning

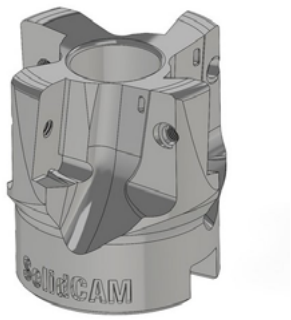
The training covers both theory and practice of the four hybrid manufacturing steps:



Using these steps, participants learn to produce the components required for a face milling cutter, a rotating component equipped with tools or blades designed to remove material from a surface or workpiece. Cutterheads are commonly used in a variety of industries, including woodworking, machining and metalworking.

"After watching SolidCAM Additive's video on the hybrid manufacturing processes of a cutter head, which covers everything from part design to quality management, I was inspired to include it in our teaching module," said Noppenberger. Figure 2 shows the cutter head without milled insert seats and fasteners. He explained that this application needs a large a number of variants, which also means small quantities for the individual components down to batch size of one. Due to the small quantities of the parts, it is too complex and expensive to source them using conventional manufacturing processes. Consequently, the most effective approach is to utilize 3D printing to produce these customized parts. This method is a digital process that does not require any tooling and allows for the creation of more complex geometries.

SolidCAM Additive pointed out other benefits of hybrid manufacturing of the cutter head: "The cutter head is a special component on SolidCAM's product portfolio. Using a hybrid production method that combines 3D printing and CNC machining can significantly reduce production costs and time, improve precision, and enable easy customization of low-volume cutter head manufacturing and other highly functional tool components," said Vollmann-Schipper of SolidCAM Additive, who has assisted German manufacturing companies in addressing their production challenges by integrating AM and CNC.



1. Designing

Training participants are required to design the cutter head using 3D computer-aided design (CAD) software from SolidWorks to define the geometry, cutting angle, and positions of the cutting plates. They also learn how to optimize design for additive manufacturing (DfAM) and why this is important.

"We show that 3D printing design allows for customized components without tooling and complex geometries not possible with conventional manufacturing. We're able to include lattice structures within the cutter head, which reduces part weight without compromising strength. We can also put cooling passages directly on the outer wall, which is great," shared Noppenberger.

In addition, there are other benefits of designing for additive manufacturing: "By optimizing the topology of the cutter head for 3D printing, we can reduce the part to the smallest possible geometry, so less material is needed for production without sacrificing performance. This results in lower production costs, a lighter part, and less material waste," added Noppenberger. 17-4 PH stainless steel is selected as the material to ensure durability and wear resistance of the part.

The training also provides an insight into rapid prototyping, which is another benefit of 3D printing with the Studio System. The additive system makes it possible to quickly and inexpensively produce initial prototypes of the cutter head, which can be tested for functionality before going into final production.

2. 3D-Printing

After the design phase, the training continues with an introduction to additive manufacturing (AM), how it differs from subtractive manufacturing, and an overview of current AM processes for producing metal parts. Participants will then be asked to determine the strengths and weaknesses of these processes and which process is best suited to produce the cutter head.

They also get insights into the benefits of combining AM with CNC machining and how SolidCAM Additive typically produces its specialty parts, including:

- Functional prototype in plastic (using ETEC's digital light processing 3D printing technology)
- Prototype or small series in metal (with the Studio System, a BMD system from Desktop Metal)
- Serial production in metal (with Shop System™, a binder jet platform from Desktop Metal)

The Studio System offers a streamlined metal 3D printing through its easy, two-step of print and sinter process. It also features next-generation Separable Supports technology and a software-controlled workflow through Live Studio™ that manages the creation of parts from CAD or STL files to sintered components. The software integrates with the Studio System printer and furnace to reduce operator workload, ensure process efficiency and automatically optimize the production of high-quality metal parts.

The software's intuitive interface makes it accessible to both trainers and training participants. There is no need to be an expert in metallurgy or machining to create complex metal parts as the software automates all aspects of part creation, from printing to sintering. It automatically scales the part, orients it for print and sintering success, generates separable supports, and applies expert metallurgy to optimize fabrication. They can simply upload their designs and follow the workflow for step-by-step guidance.

In addition to learning about small-batch 3D printing with the Studio System 2, the training also provides information about metal binder jetting with the Shop System from Desktop Metal, which is suitable for large-volume production.

Upon completion of the training, participants are required to apply their newly acquired knowledge by 3D printing the basic structure of the cutter heads using the Studio System and the provided print parameters.

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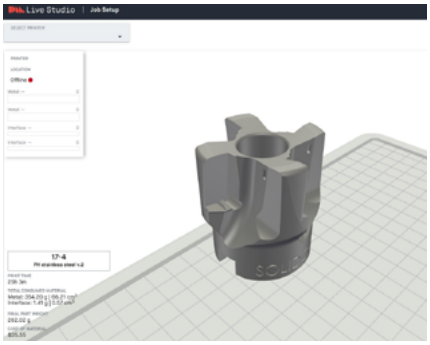

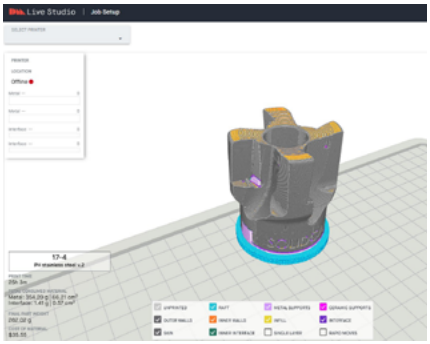

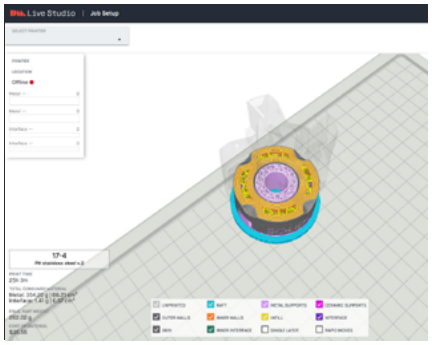

3. Sintering

Following the printing of the basic cutter head structure, detailed information about the sintering process with the Desktop Metal furnace is reviewed. The furnace first heats the parts to remove any binder, then raises the temperature to near-melting point to provide industrial-strength sintering. Built-in temperature profiles, tuned for each build and material, ensure uniform heating and cooling without the residual stresses introduced by laser-based systems.

The course emphasizes evaluating printed components prior to milling and understanding the various factors that can influence the outcome. To ensure an efficient learning experience, SolidCAM Additive provides pre-sintered cutter heads so that training participants can directly measure the reproduction accuracy and shrinkage behavior of the parts according to the default values of the provided sample parts. "Precision is particularly important for technical applications where tight tolerances are required. The accuracy of the parts printed on the Studio System is perfect," stated Noppenberger.

4. CNC-Machining

Following the information session on sintering the cutter heads, participants learn to create CNC toolpaths with SolidCAM software and to finish the component on a 5-axis milling machine to achieve the necessary precision and surface quality.

- **Plate seat:** The cutter head is precisely positioned on a fixture so that the 5-axis milling machine has optimum access to all relevant surfaces.
- **Fine machining and tolerances:** The 5-axis milling machine allows for precise shaping of components and sharpening of cutting edges. In particular, the cutting insert holders and the surfaces that require precise dimensions are optimized by milling.

Benefits of hybrid manufacturing demonstrated in quality control

The training program underscores the significance of quality control in every aspect of the hybrid production process. Participants are therefore required to evaluate the entire production process, cutting data, tool selection, measurement results, and calculate production time and costs. They also learn to optimize production processes for quality and cost reduction, find solutions to problems that arise, create quality control charts, and document and present the results of their work.

"By the end of the training program, the participants had proven that the hybrid manufacturing process is ideal for producing innovative and high-functional tool components like the cutter heads," Noppenberger noted. The training summarizes the following benefits of combining additive manufacturing and CNC machining:

- **Complexity and precision:** 3D printing makes it possible to create complex shapes, that are then machined to the desired tolerances and surface finishes on the 5-axis milling machine.
- **Optimized geometry:** By using lattice structures or internal cooling channels, cutter heads can be made lighter and more efficient.
- **Time and cost savings:** 3D printing reduces material usage and manufacturing costs, while the milling machine provides the required precision.

> "We're exploring the possibility of offering more in-depth training, such as a structured course that goes beyond the basics, or a course specifically designed for designing parts for 3D printing."
>
> Pascal Noppenberger, Senior Teacher, Hohentwiel-Gewerbeschule Singen

Further training cooperations

Following the initial success of the teacher training program, HGS and SolidCAM Additive have decided to offer the same training program on an annual basis. However, they have identified opportunities for further refinement. “We’re exploring the possibility of offering more in-depth training, such as a structured course that goes beyond the basics, or a course specifically designed for designing parts for 3D printing,” said Noppenberger, who is also pursuing collaborations with other educational institutions that might offer a similar course.

SolidCAM Additive also plans to collaborate with other educational institutions in other German states and with companies to offer a similar training program or workshops.

This collaborative approach to further education ensures that educators can equip their students with the latest knowledge and skills in manufacturing techniques, preparing them to meet industry requirements.

About Hohentwiel-Gewerbeschule Singen (HGS)

HGS is a German educational institution with a strong focus on technical and industrial subjects. With a history spanning 132 years, the institution boasts a faculty of 120 educators who guide approximately 1,700 students in modern classrooms, laboratories, and workshops. HGS offers a diverse curriculum, ranging from high school to vocational college. Its Learning Factory 4.0 is equipped with state-of-the-art machinery and networked machining centers that meet industry standards.

Learn more: www.hgs-singen.de

About SolidCAM Additive

SolidCAM Additive is the additive manufacturing business line of SolidCAM, a global leader in innovative CAM software for CNC machining. With its extensive machining knowledge, SolidCAM Additive guides and educates manufacturers on how to best leverage the advantages of combined 3D metal printing and CNC machining.

Learn more: www.solidcam.com/solutions/solidcam-additive

About Desktop Metal Inc.

Desktop Metal is driving Additive Manufacturing 2.0, a new era of on-demand, digital mass production of industrial, medical, and consumer products. Our innovative 3D printers, materials, and software deliver the speed, cost, and part quality required for this transformation. We're the original inventors and world leaders of the 3D printing methods we believe will empower this shift, binder jetting and digital light processing. Today, our systems print metal, polymer, sand and other ceramics, as well as foam and recycled wood. Manufacturers use our technology worldwide to save time and money, reduce waste, increase flexibility, and produce designs that solve the world's toughest problems and enable once-impossible innovations.

Learn more about Desktop Metal and our #TeamDM brands at www.desktopmetal.com