SIEMENS

Background Information

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Additive Manufacturing

Siemens enables industrialization of additive manufacturing

- **Siemens industrializes additive manufacturing with polymers with EOS and DyeMansion as partners**
- **Siemens and EOS support Hexr in the mass customization of additively manufactured bicycle helmets**
- **Digital Enterprise portfolio offers integrated software and automation solutions for the industrialization of additive manufacturing**
- **Additive Manufacturing Network – an online order-to-delivery collaboration platform for the industrial additive manufacturing community, helps streamline the AM production process**

Siemens' Digital Enterprise portfolio consists of software and automation solutions that optimize process steps along the entire value chain of additive manufacturing. This holistic approach is unique in the field of the industrialization of additive manufacturing. "The automated chain of coordinated production steps from all suppliers, from design and printing to post-processing, as well as end-to-end IT integration, is crucial for high productivity and maximum flexibility. This applies to series parts as well as to a highly flexible lot-size-1 production for individualized products or spare parts," explains Dr. Karsten Heuser, Vice President Additive Manufacturing at Siemens Digital Industries.

Additive Manufacturing industrialized – from the sole to the helmet

For example, Siemens is demonstrating the integration of manufacturing steps together with partner companies EOS and DyeMansion as part of the first virtual additive manufacturing reference factory for selective laser sintering with polymers. Using the example of a midsole for footwear applications in which parameters such as design, fit and color are individually and economically considered, Siemens, EOS and DyeMansion will demonstrate what the next step towards the industrialization of

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selective laser sintering with polymers can look like along the entire production chain. This way the individually adapted shoe sole comes within reach.

Made to measure bicycle helmets are also becoming a reality thanks to digitalization and additive manufacturing - and all this in an affordable framework for everyone. The head is simply scanned with a smartphone app and the process for the custom-made helmet is initiated. Siemens, together with EOS, has supported this vision of the bicycle helmet manufacturer Hexr. With the help of end-to-end solutions, Siemens has created the digital twin of an industrialized additive manufacturing factory, helping to optimize the design and streamline the production processes for customized bicycle helmets even before production begins. By combining simulation, design optimization and a high degree of automation in production, the costs per part could be predicted and significantly reduced, allowing Hexr to scale the scan-to-print application to mass production.

End-to-end solutions with the Digital Enterprise portfolio

Whether Powder Bed Fusion, Directed Energy Deposition, Material Extrusion or Jetting all processes have in common that workpieces are built up layer by layer based on digital 3D design data. This makes it possible to produce highly complex structures that can be both light and stable at the same time and can also be economically manufactured individually in batch size 1. Progressive digitalization offers the possibility of optimizing additive manufacturing processes. With its Digital Enterprise portfolio, Siemens offers integrated solutions for additive manufacturing. The holistic approach, which covers the entire value chain, leads to sustainable competitiveness. More than 60 OEMs worldwide are already industrializing with automation from Siemens. Siemens itself today operates more than 200 industrial AM machines at over 45 locations and thus also occupies a leading position as a producer. An expert pool for AM design through to factory planning offers customers value-add services.

End-to-end workflow

With NX software, a leading integrated solution for computer-aided design, manufacturing, and engineering (CAD/CAM/CAE), Siemens offers functions specifically for additive manufacturing. In an integrated workflow, NX covers the entire process from development and design, through preparation of the construction job, to generation of the machine code for the 3D printing system. The entire digital process chain is represented in a single, integrated, associative software environment and can

be operated via a uniform user interface. This eliminates error-prone data conversion with possible loss of information content. This increases process reliability and efficiency and enables users to mass-produce high-quality products even with complex printing processes.

PLC and CNC automation solutions for production

Intelligent automation of production systems plays a decisive role in the industrialization of additive manufacturing. Totally Integrated Automation (TIA), the industrial automation from Siemens, stands for the efficient interaction of all automation components. With Simatic, the core element of TIA, users rely on a maximum of consistency. The basic automation with Simatic, the Sinamics drive system and the Simotics motors for moving the mechanical units of the machine for Powder Bed Fusion and Jetting brings benefits to users. Thanks to their scalability, these solutions can be adapted to actual requirements in an extremely flexible and economical manner. Integrated engineering and efficient programming in the TIA Portal reduce the time-to-market and diagnostic functions are projected instead of complex programming. Sinumerik's multi-axis technology opens a high degree of freedom for Material Extrusion or Directed Energy Deposition. In conjunction with Sinamics S120 and Simotics motors, the CNC allows precise and dynamic multi-axis motion control.

Siemens Advanta with planning services for the digital AM factory

Siemens Advanta, the IoT integration branch of Siemens, supports the industrialization of AM technology with a modular approach - starting with strategy development, optimization of product design, design of the manufacturing process, piloting, and profitability analysis, through to the planning and realization of a turnkey AM factory. Based on the digital twin, a flexible and scalable manufacturing concept will be developed and validated, which will already meet the requirements of a classical serial production with regards to productivity and costs before the start of production and will allow an early certification

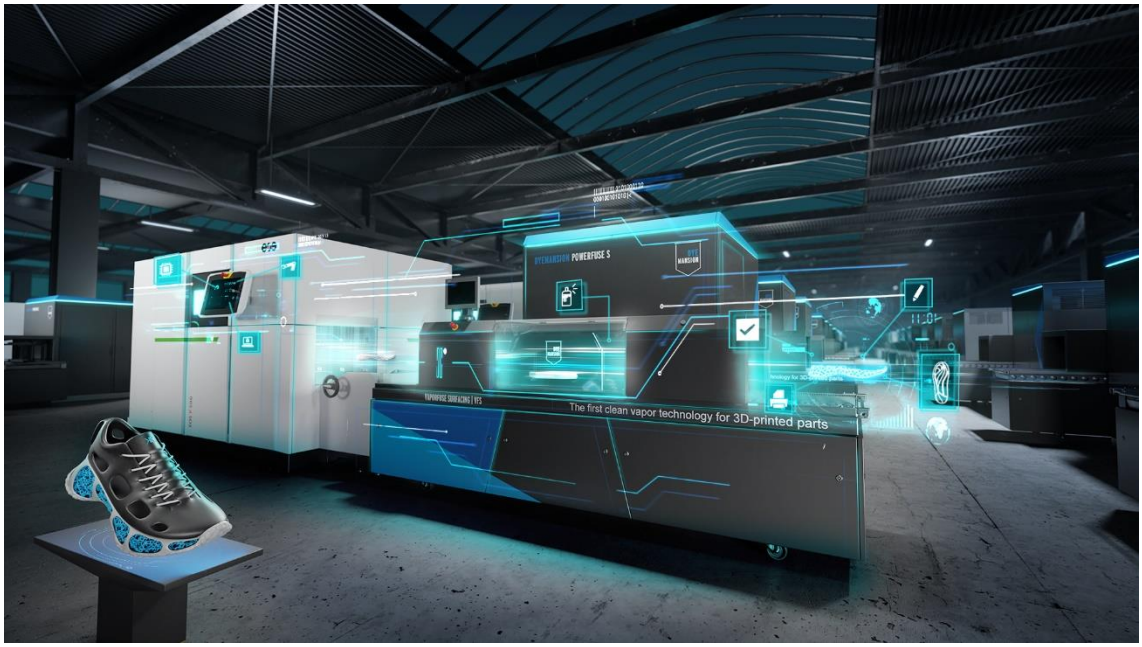
The Additive Manufacturing Network - a digital platform for the AM ecosystem

The Additive Manufacturing Network from Siemens creates an online platform based on partnership, offering on-demand design, engineering know-how and production capacities for industrial 3D printing worldwide. The network immediately connects qualified members with each other to foster collaboration and process orchestration between engineers, procurement, and suppliers of 3D printed parts. Parts buyers and

manufacturing service providers benefit from the network because it gives them the opportunity to collaborate, bid, purchase, and track orders. As a result, it simplifies the development of innovative additive manufacturing products and physical inventory can be replaced by digital inventory. The network also contributes to the Siemens vision of reducing the risks that can arise when entering additive manufacturing.

Additive Manufacturing Experience Center (AMEC)

Siemens has an interactive Additive Manufacturing Experience Center (AMEC) in Erlangen, Germany, where the integrated, seamless additive manufacturing process chain and AM-related products from Siemens are demonstrated. The AMEC provides an overview and insight into the various industrial AM technologies as well as information on the demanding industrial requirements for AM design, simulation, and production. So far, 4,500 visitors have taken part in interactive workshops at the AMEC. Since the opening of the digital AMEC in mid-May, over 4000 interested people have already visited the AMEC virtually. The AMEC demonstrates Siemens' experience as a producer and solution provider.



Using a footwear application, Siemens, EOS and DyeMansion demonstrate what the next step towards the industrialization of selective laser sintering with polymers can look like along the entire production chain.

Siemens supports Hexr in the serial customization of additively manufactured bicycle helmets

Further information on Siemens Additive Manufacturing can be found at www.siemens.com/additive-manufacturing

Press releases regarding Additive Manufacturing at Siemens Digital Industries:

- **Siemens supports the machine tool industry in utilizing the full potential of data for flexible and sustainable action** https://sie.ag/3hHcWtB
- **Volkswagen plans to use new 3D printing process in vehicle production in the years ahead** https://bit.ly/3DffFSY
- **Siemens industrializes additive manufacturing with polymers with EOS and DyeMansion as partners** https://sie.ag/35Xz0t7

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Siemens Digital Industries (DI) is an innovation leader in automation and digitalization. Closely collaborating with partners and customers, DI drives the digital transformation in the process and discrete industries. With its Digital Enterprise portfolio, DI provides companies of all sizes with an end-to-end set of products, solutions and services to integrate and digitalize the entire value chain. Optimized for the specific needs of each industry, DI's unique portfolio supports customers to achieve greater productivity and flexibility. DI is constantly adding innovations to its portfolio to integrate cutting-edge future technologies. Siemens Digital Industries has its global headquarters in Nuremberg, Germany, and has around 72,000 employees internationally.

Siemens AG (Berlin and Munich) is a technology company focused on industry, infrastructure, transport, and healthcare. From more resource-efficient factories, resilient supply chains, and smarter buildings and grids, to cleaner and more comfortable transportation as well as advanced healthcare, the company creates technology with purpose adding real value for customers. By combining the real and the digital worlds, Siemens empowers its customers to transform their industries and markets, to transform the everyday for billions of people. Siemens also owns a majority stake in the publicly listed company Siemens Healthineers, a globally leading medical technology provider shaping the future of healthcare. In addition, Siemens holds a minority stake in Siemens Energy, a global leader in the transmission and generation of electrical power.
In fiscal 2020, which ended on September 30, 2020, the Siemens Group generated revenue of €55.3 billion and net income of €4.2 billion. As of September 30, 2020, the company had around 293,000 employees worldwide. Further information is available on the Internet at www.siemens.com.