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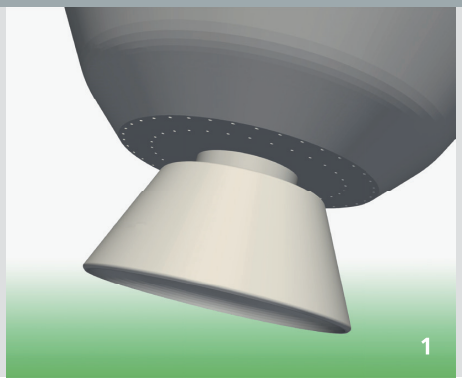
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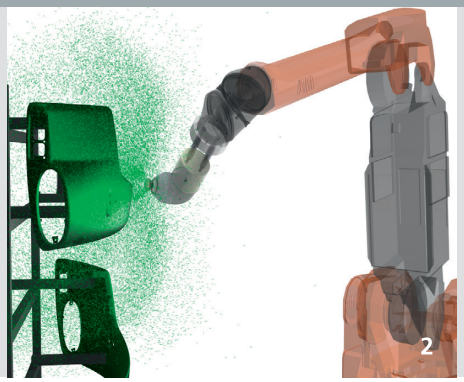
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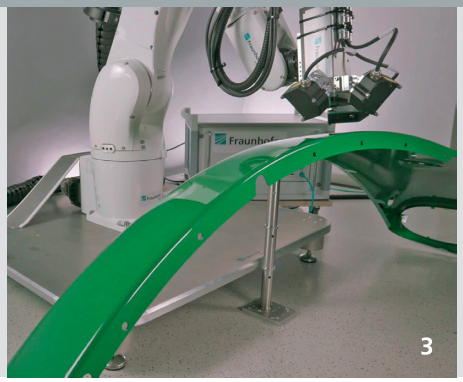
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1 *Brush and laydown simulation*

2 *Path-planning and painting*

3 *Thickness measurement*

Fraunhofer Institute for Manufacturing, Engineering and Automation IPA
Nobelstraße. 12, 70569 Stuttgart
Dr. Oliver Tiedje
Oliver.Tiedje@ipa.fraunhofer.de
www.ipa.fraunhofer.de

Fraunhofer Institute for Industrial Mathematics ITWM
Fraunhofer Platz 1, 67663 Kaiserslautern
Dr. Joachim Jonuscheit
Joachim.Jonuscheit@itwm.fraunhofer.de
www.itwm.fraunhofer.de

Fraunhofer-Chalmers Centre FCC
Chalmers Science Park,
SE-412 88 Gothenburg
Dr. Fredrik Edelvik
Fredrik.Edelvik@fcc.chalmers.se
www.fcc.chalmers.se

THE SELF-PROGRAMMING PAINTING CELL

Product preparation in todays paint shops is a slow and costly trial-and-error procedure, as a large number of prototypes are painted, measured, and scrapped. The goal of "Self-Paint" is to revolutionize this process by creating a painting cell, where the robot program and painting process parameters are automatically generated and controlled to provide a high-quality paint finish. For the first, time this is realized by connecting 3D scanning, paint simulations, paint production technology, and online terahertz thickness measurements. Such a painting cell overcomes the lack of versatility in current paint shops, e. g., in the automotive industry, and allows for innovative and modular production processes. This innovative concept is able to handle a wide variety of parts, supports product individualization, and facilitates the shift to automated processes in areas where the manual painting is still dominated.

3D Scanning

The automatic painting of individual products up to lot-size-1 requires the knowledge of the exact position of the product to be painted in the painting cell. The 3D scanning concept, developed by Fraunhofer ITWM, is based on mapping the well-known CAD model of the object to the aquired 3D point cloud. The scanning system consists of a 3D camera system with filtering and mapping algorithms, running on a standard PC. The algorithms are not limited to special cameras.

- Finding CAD model in real-world painting cell
- Short capturing and processing time
- Multi-camera systems available for large-scale objects

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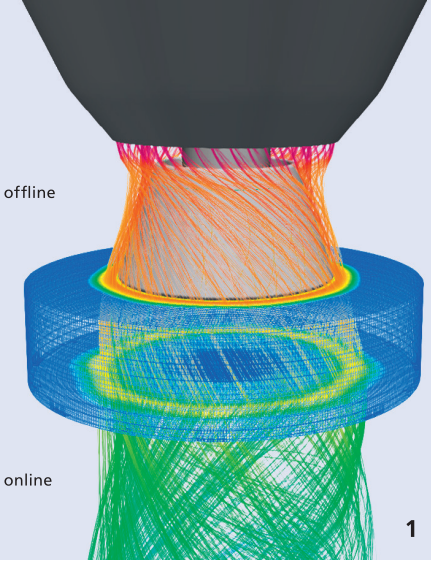

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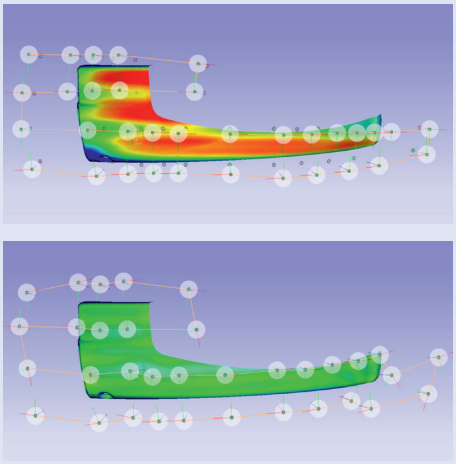

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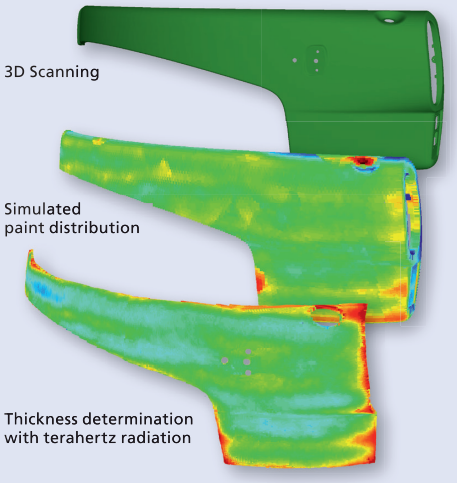

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1 *Brush and near-bell simulation is a very challenging step to understand the laydown process during painting. The developed algorithms provide a powerful tool for optimizing the painting process.*

2 *Laydown simulations in combination with path-planning algorithms open new possibilities achieving a homogeneous spray pattern and reducing time consumption and amount of paint at the same time. The optimized path can then automatically painted with a robot.*

3 *Fast thickness determination of coating systems with harmless terahertz radiation offers the possibility of 100% inspection of the painted product. With the thickness determination device fast and reproducible results are available for single and multilayer coatings.*

Bell-Cup and Laydown Simulation

The investigation of the nearfield spray characteristics of bell cups is essential for the understanding of the spray pattern on a sample. The Fraunhofer IPA carried out the experimental characterization of the paint properties, such as density, particle size, solids content, etc., and the simulations of particle distribution based on these results. This tool is not limited to a certain bell cup. The offline part is directly coupled to the online laydown simulation, developed by Fraunhofer-Chalmers FCC. The laydown simulation takes into account the Magnus effect, air flow and electrostatic effects for spray-pattern calculation on flat as well as curved samples.

- Experimental paint characterization
- Rotation speed as well as paint- and air-flow characterization
- Split near- and far-field calculation

Path-Planning and Painting

Based on the bell-cup and laydown simulation results, an optimized path for the painting robot can be calculated. Besides the amount of paint, robot speed and path, the Magnus effect is also taken into account. As optimization parameters, the thickness distribution but also the amount of paint or cycle time can be considered. The calculation time is significantly reduced by using a paralyzed approach. With this software tool, developed by Fraunhofer-Chalmers FCC, the robot motion and control, including crash protection, is also included. With controlling each joint of a robot, different robot types are controllable with this software solution.

- Optimization of thickness distribution, amount of paint, and cycle time
- GPU-based software tool
- Different robot types controllable
- Robot motion simulation including crash protection
- Individual solutions available

Layer Thickness Measurement with Terahertz

Quality management in the production is important to improve the product. Especially for high-end and small-lot-size products, 100 % inspection is inevitable. With the terahertz-based thickness measurement system, developed by Fraunhofer ITWM, we are able to determine each layer in a multilayer system with fast measurement time. With the evaluation algorithm, real-time thickness results are provided.

- Contactless and fast measurements
- Multilayer systems up to 5 layers with an accuracy of 1 µm, wet and cured coatings
- Robot-ready measurement device

Further information: www.itwm.fraunhofer.de/selfpaint