

1 | 2 Robot-based assembly system

**Fraunhofer Institute for
Manufacturing Technology
and Advanced Materials IFAM
– Adhesive Bonding Technology
and Surfaces –**

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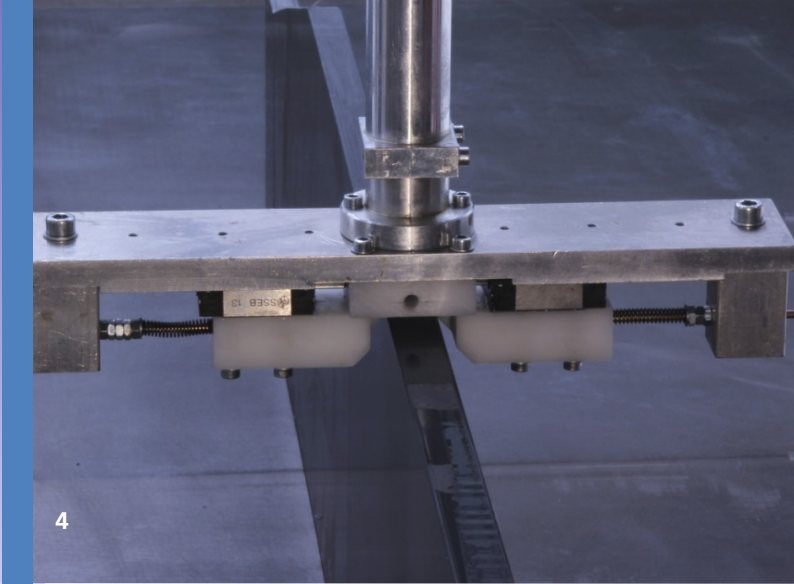
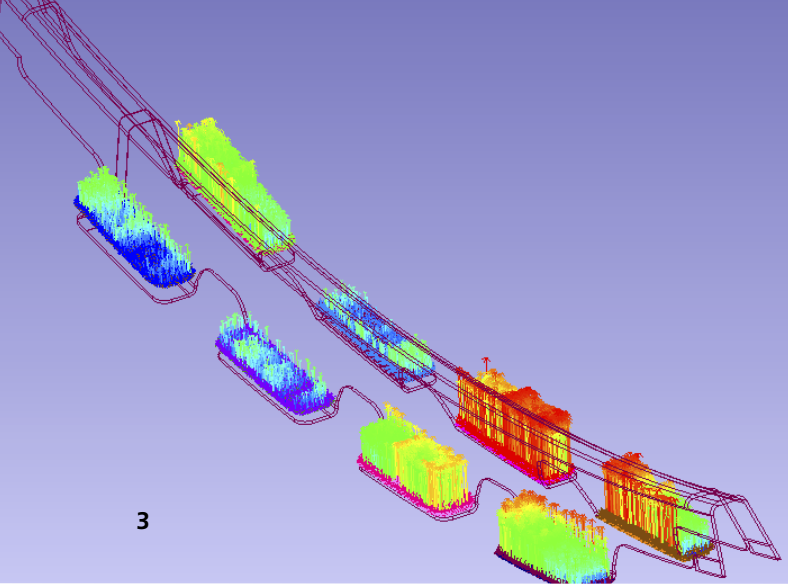
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ADHESIVE BONDING – ADAPTIVE ASSEMBLY – SEALING

Adhesive Bonding

The Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM has more than forty years of experience in the area of the adhesive bonding and provides partially and fully automated processes which achieve a high degree of security and long-term resistance in the adhesive bond. The Automation and Production Technology department in Stade has a robot-based assembly line available for the development of customer-specific assembly solutions, which is flexible and can be configured to suit large structures made from lightweight materials. The central element connecting the four assembly stations is a 40-meter linear axis with various industrial and lightweight robots with a payload range from 10 kg up to 270 kg. A range of varied tool end-effectors is available, which are equipped with automated exchange systems and can be deployed at

all assembly stations. Many of the end-effectors, for example units for gripping components or applying adhesives, have themselves been developed by the Fraunhofer IFAM in cooperation with our partners and have been specifically designed to meet the requirements of large-structure assembly. A flexible, configurable holding fixture consisting of collaborating hexapods also adapts large components with low geometric accuracy to the optimal shape and position for the respective process. The vacuum grippers themselves feature integrated force and torque sensors to ensure that the components are not damaged during shape adaptation, a precaution which is indispensable for automated tolerance management.



Adaptive Assembly

The Fraunhofer IFAM offers modular solutions for the automated assembly of tolerance affected components. One of these process modules is adaptive assembly based on in-line measurement of the components deviation from the target geometry. This method provides precise, three-dimensional gap geometry as digital data. For particularly thin-walled joining parts, an array of collaborating actuators allows for the automatic, force-controlled adjustment of gaps using defined best-fit criteria. Furthermore, the data being measured generates the control commands for the robots and adhesive end-effectors, specifying how much and where adhesive has to be applied in order to ensure a complete gap filling with a predefined squeeze-out at the overlapping edges. Small bonding surfaces allow force controlled joining to be carried out using the robot arm. For long, extended bonding surfaces requiring high levels of pressure that the robot arms cannot provide, grippers with vacuum technology apply uniform pressure to the adhesive, thereby achieving the specified layer thickness.

Sealing

In the production of large-scale structures in the field of aviation, the sealing of joints and component edges plays a major role. In manufacturing today, sealing is carried out manually whereby there is great potential for improvement. Often the first step is the automated processing of approved sealants developed specifically for manual application. The goal is to process the highly viscous, two-component sealants with the correspondingly designed dosing and mixing technology and to apply it within the specified tolerances, which are often in the range of tenths of a millimeter. The experts here at the Fraunhofer IFAM develop and test the specific performance profiles for the required nozzles with rapid prototyping methods quickly and accurately. Sealing tasks that require aerodynamic precision or involve irregular gap or edge profiles are a particular strength of our team. Our portfolio of automated procedures also includes solvent-based or abrasive surface cleaning, surface activation for adhesive and coating processes, and speed up the curing process. There are also modular systems for in-line process monitoring of surface quality all the way to bonding available.

Performance Spectrum

- ➔ Analysis of the potential for optimization of assembly processes
- ➔ Development of customer-specific, unitized process modules
- ➔ Development of end-effectors
- ➔ Automated tolerance management
- ➔ Partial or full automation of the entire process chain from the feeding of the components to surface pretreatment and quality control
- ➔ 1:1-scale industrialization validation for small and large structures, also taking into account human-robot collaboration
- ➔ Cleaning, abrasive or activating surface treatment procedures
- ➔ Acceleration of curing operations
- ➔ In-line quality assurance with automated data evaluation by camera or sensor-based image processing systems
- ➔ Integration of 3D geometry measurement technology for process control
- ➔ Implementation of data-supported process management

In cooperation with the Institute for Production Management and Technology of Hamburg University of Technology:
 PD Dr.-Ing. habil. Jörg Wollnack
 (Research field: opto-mechatronics)

3 *Gap management for adhesive application*

4 *CFRP cut-edge sealing*