



<sup>1</sup> Flexibility in production becomes more and more important, due to raising variant diversity and shortened product life cycles.

## AUTOMATED ADJUSTMENT: HIGHLY FLEXIBLE MANUFACTURING

The E<sup>3</sup> concept puts the view of interactions among the levels of technologies and equipment, logistics and factory processes, and the integration of the human being into production in a new analytical-methodological context. This change in perspective opens up new opportunities for specific solutions to address key manufacturing engineering requirements by using and implementing synergy effects.

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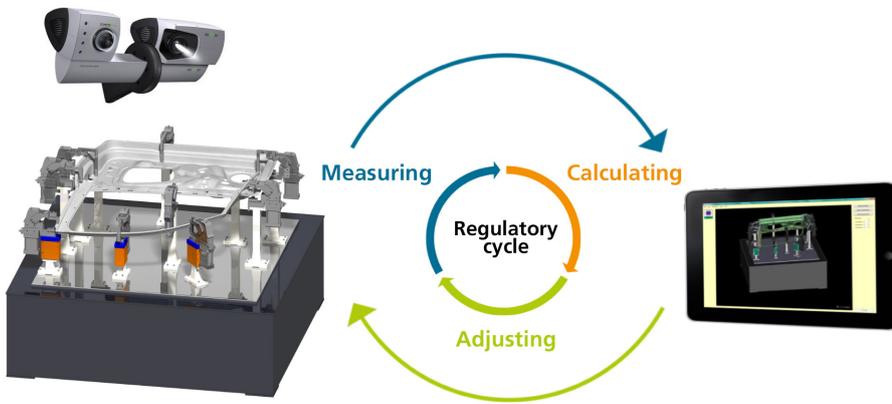
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### The Challenge

The trend towards a consumer preference for individualized products in the automotive industry results in an increasing range of variants, on the one hand, and shorter product life cycles, on the other hand. To fulfill market requirements, it is necessary to set up highly complex production equipment for new or modified car models as quickly as possible. In car body manufacturing alone, the high level of automation and the associated long production equipment setup times make achieving flexibilization

more complicated. Errors in manufacturing cause expensive production stops and interruptions – corrections frequently must be executed manually and in areas that are difficult for the operators to access. At the level of the factory process, new shorter quality control loops have to be connected with the machinery, and their conceptual design has to be thought through in a way that addresses ergonomic considerations, in order to avoid reject parts and machine downtimes. It is possible to support individuals as creative thinkers and problem solvers, as well as to significantly accelerate



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the necessary corrections to be made by the machinery operators by engineering intelligent software assistance systems and embedding them directly into innovative machines and systems.

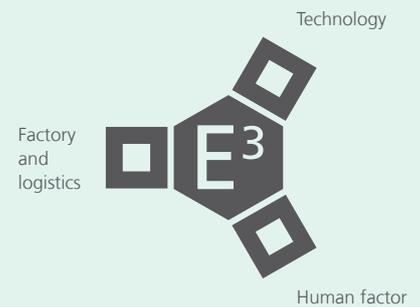
### The approach

Components are clamped in type-specific devices and fixtures to assemble individual elements, such as a door or side panel of a passenger car. For these operations, accuracy in the range of tenths of a millimeter counts. Since the component has not yet been firmly welded, it is not stable – if it is adjusted at one point, it may be deflected elsewhere. If this is to be avoided, the clamping elements of the fixture must be adjusted precisely. This process is complex, and the success of the positioning measures significantly depends to a great extent on the expertise of the personnel. In the case of variations in the shape of subassemblies that are used repeatedly for the same car model, it can take several hours to switch to a new car model, and then up to several months to readjust the equipment in an optimal manner. This quality-relevant process, the manual readjustment and the resulting interruptions in production take time and drastically decrease the equipment's productivity.

A software-assistance system prototype to conduct this process in an automated way was engineered at Fraunhofer IWU in co-operation with an industry partner. The adjustment process, which has been hitherto based on experience, is executed by an intelligent IT system that offers targeted assistance to the machinery operators. First, a measurement system monitors the adjusting activities of the operator, from which a software system derives correction proposals. The assistance system is linked with another innovation: Electromechanical adjustment axes replace the manual control elements. When a button is pressed, the corrections proposed are directly transmitted to the clamping device. The aim is to shorten the time required for these previously manual processes - in the machine ramp-up, the setup time should be cut from months to days, and, in the case of errors during production, the necessary readjustment time should be reduced from hours to seconds. The solutions should not only be limited to components that are used identically for the same model of car, but also significantly reduce the time needed for setups from one car model to another.

### E<sup>3</sup>-Effekt

An overall adjustment process system was engineered that considers the interaction of the three levels of technology, factory and logistics, as well as the human being. The overall adjustment process system puts the human being, supported by an innovative assistance system, at the centre of a new, shortened quality control loop.



### The E<sup>3</sup> concept

#### Adjustment of clamping devices

#### Energy and resource efficient production

Individualized products | Innovative technologies | Integration of information and communication technologies | Efficient production systems

#### Emissions neutral factory

Zero error production | Process monitoring | Quality cycles | Energy and material cycles

#### Embedding of the human factor into the production

Knowledge and information | Human factor as creative problem solver | Production assistance | Motivation

### Photo Acknowledgment

Picture 1: iStock

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