

# Sub-project: “Powermoulds”

## The Use of Embedded Diagnostics Systems in the Injection Moulding Tool

### Project period

08/2013 – 08/2016

### Problem

Sensor signals in the injection moulding tool are only rarely used by the machine operator for fault analysis and optimisation of the manufacturing process. However, the optimum process window is not only important for special products in medical applications, but also for any type of conventional products. The goal of this research project is the development of an intelligent embedded diagnostics system (EDS) for automatic recording and monitoring of the process parameters.

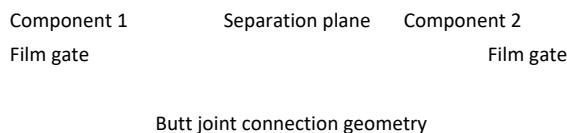


Fig. 1: Design drawing of the two-component tension rod for investigating the adhesion of the plane of division

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### Solution approach

A permanently installed EDS, including integrated signal processing, is used to help derive specific decision-making aids for the machine operator in the event of a fault using machine learning methods. The statistical test plans for the two test moulds serve for teaching the assessment algorithms. In addition, a 3D scanner and other devices are used for investigating quality characteristics of the manufactured plastic products and for teaching the computer-assisted evaluation algorithms.

Representation of the voltage curve on the piezoresistive sensor  
AD values in mV

Fig. 2: Representation of a laboratory pattern of the recording hardware

Fig. 3: Evaluation criteria of the manufacturing process

Pressure curve on the piezoelectric sensor

## Results

A statistical test plan is implemented to facilitate recording of a majority of possible fault events. The thus implemented manufacturing conditions, in connection with other quality criteria, permit an objective assessment of the component quality. In this regard, specific amplifier techniques are used to facilitate more efficient use of the sensor data. Thanks to the use of machine learning methods, such as e.g. decision trees, fuzzy guidelines, support vector machines or Artificial Neural Networks, it is possible to derive and represent decision-making aids for the machine operator.

## Keywords / Technologies

- Hard and software development
- Microcontroller programming
- Assessment and analysis using SCILAB
- Machine learning methods
- 3D measurement / quality control
- Sensor selection and positioning
- Statistical test planning
- Data fusion

## Project partners

Applied Plastics Technology,  
Faculty of Mechanical Engineering, Prof. Seul

Embedded Diagnostics Systems,  
Faculty of Electrical Engineering, Prof. Wenzel

## Information on funding

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Maschinenbau (ThZM)

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## Project sponsor

Thüringer Aufbaubank (TAB)  
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## Publications

- [1] Manuel Schneider und Andreas Wenzel. Entwurf eines Eingebetteten Diagnosesystems zur Überwachung von Prozessparametern bei Spritzgießen. Tagungsband zum Tag der Forschung, FHS-prints, ISSN: 0949-1767. Apr. 2014. doi: 10.13140/RG.2.1.4739.5441.
- [2] Thomas Seul, Andreas Wenzel, Manuel Schneider, Peter Röstel, Rainer Jahn und Ruben Schlutter. „Auf die inneren Werte kommt es an.“ In: Kunststoffe (Nov. 2015).
- [3] Thomas Seul, Andreas Wenzel, Manuel Schneider, Peter Röstel, Rainer Jahn und Ruben Schlutter. „It's the inner Values that Count.“ In: Kunststoffe International (Nov. 2015).
- [4] Manuel Schneider, Rainer Jahn und Andreas Wenzel. „Erprobung eines echtzeitfähigen Auswertungsalgorithmus zu Bewertung der Fertigungsqualität beim Spritzgießen mit Hilfe eines eingebetteten Diagnosesystems“. In: 17. Nachwuchswissenschaftlerkonferenz. Apr. 2016. DOI: 10.13140/RG.2.1.3829.2887/1.
- [5] Manuel Schneider, Alexander Jahn, Norbert Greifzu und Norbert Fränzel. „Entwicklung eines unipolaren differentiellen Ladungsverstärkers für die Anwendung in eingebetteten Diagnosesystemen zur Druckmessung in Spritzgussmaschinen“. In: 18. GMA/ITG-Fachtagung Sensoren und Messsysteme. Mai 2016, S. 782 –789. doi: 10.5162/sensoren2016/P9.2.
- [6] Manuel Schneider, Christian Walther und Andreas Wenzel. „Proceedings 26. Workshop Computational Intelligence“. In: KIT Scientific Publishing, Nov. 2016. Kap. Classification of Production Quality in Injection Moulding with an Embedded Diagnostic System Using a Fuzzy Inference System, S. 193–203.