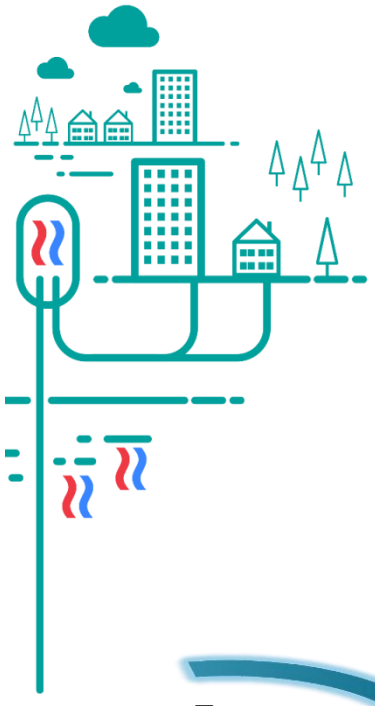
GeoUS

- Kickoff-Meeting, April 23th 2020 in Ostrava



Component manufacturing

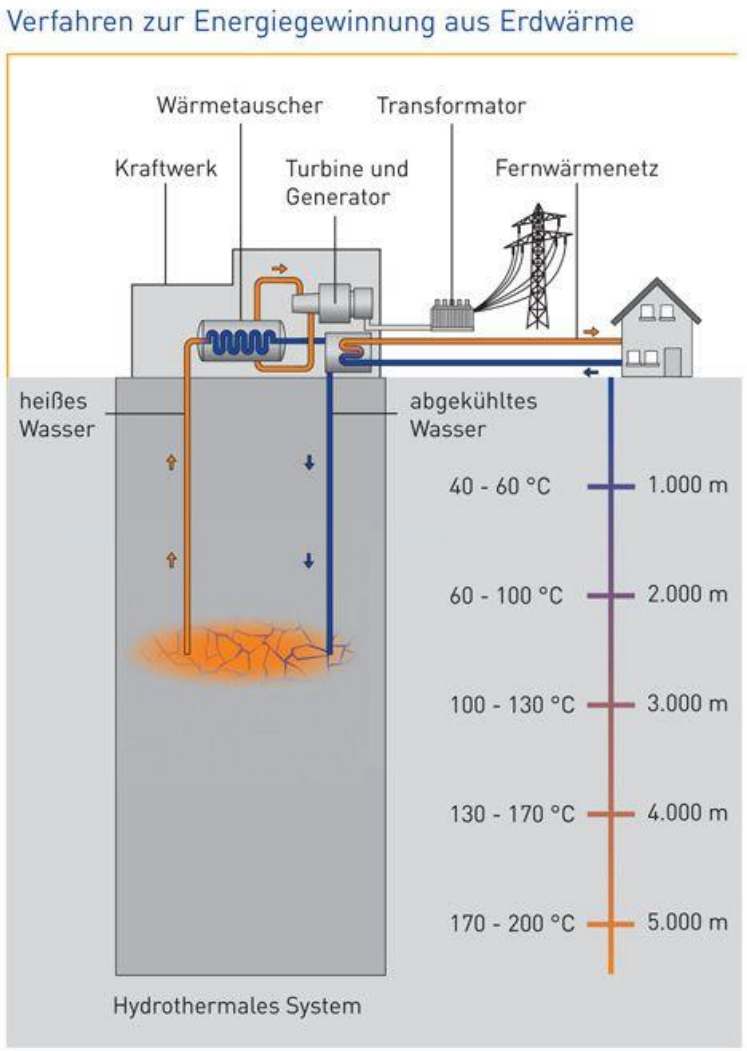
Quality Control of components

Condition State

Energy data

Life time
Efficiency
Flexibility

Manufacturing of components



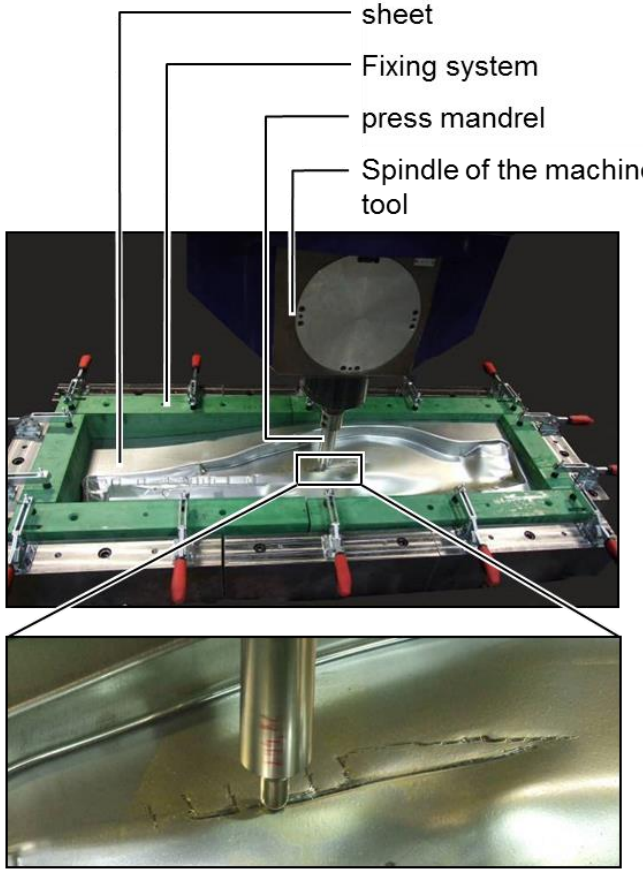
- conventional forming technologies (like deep drawing)
- individualized geometries (incremental sheet metal forming)
- High speed 3D printing (plastics)
- Manufacturing of turbine-fanplates
- Inside high pressure forming of tubes and profiles by a temperature up to 800°C (for titanium)
- Sensors, control & monitoring systems

Manufacturing of components: **Incremental sheet metal forming**

Procedure classification Procedure of the Fraunhofer IWU

- Machine tools or robots for mandrel movement
- Use of different Press mandrel variants
- mainly rotating mandrels
- Use of variable stenter frames
- Use of partial or full patrixes

Universal machining centre Dynapod of the IWU



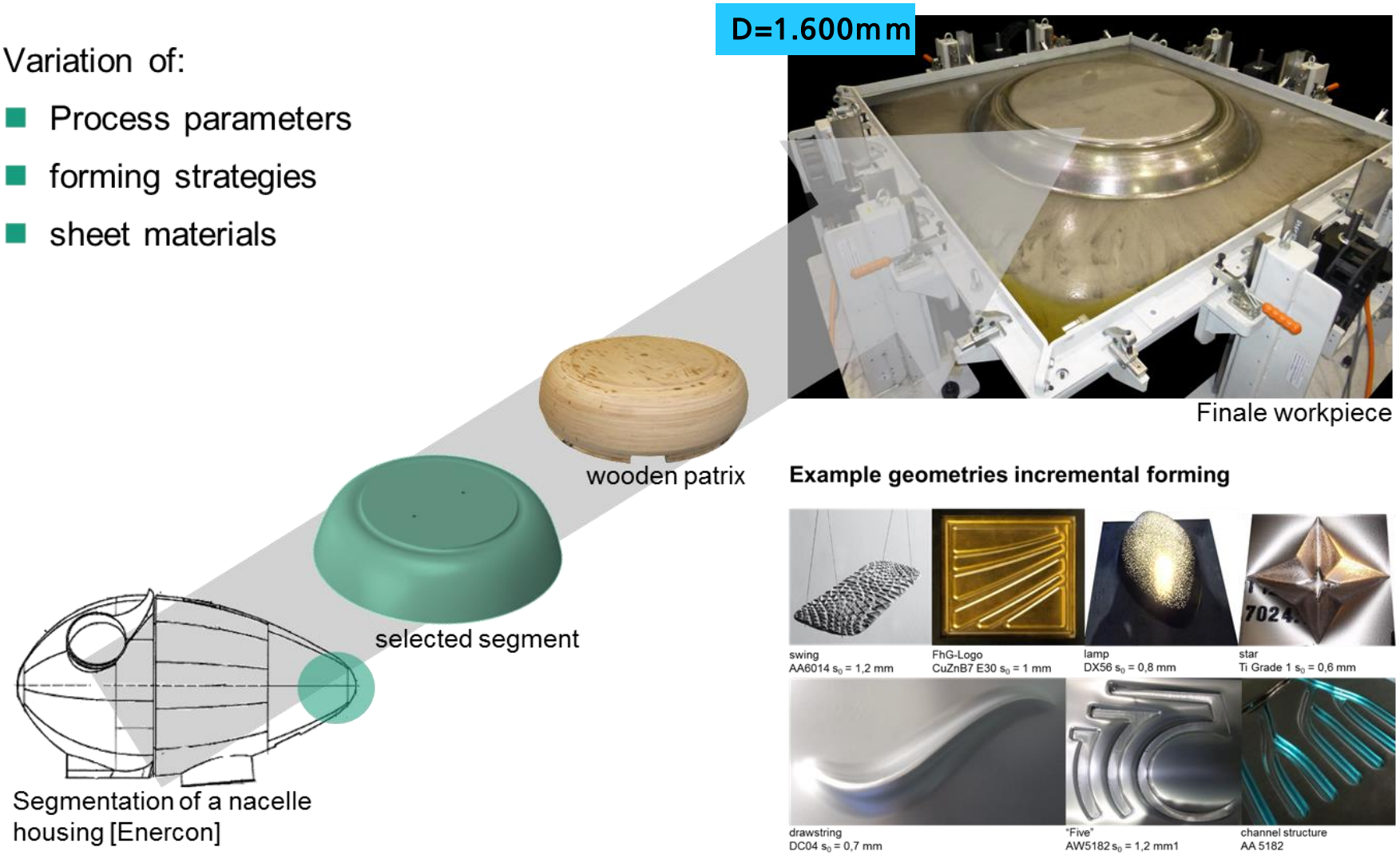
Incremental sheet metal forming at the IWU

Fraunhofer IWU

Manufacturing of components: **incremental forming**

Variation of:

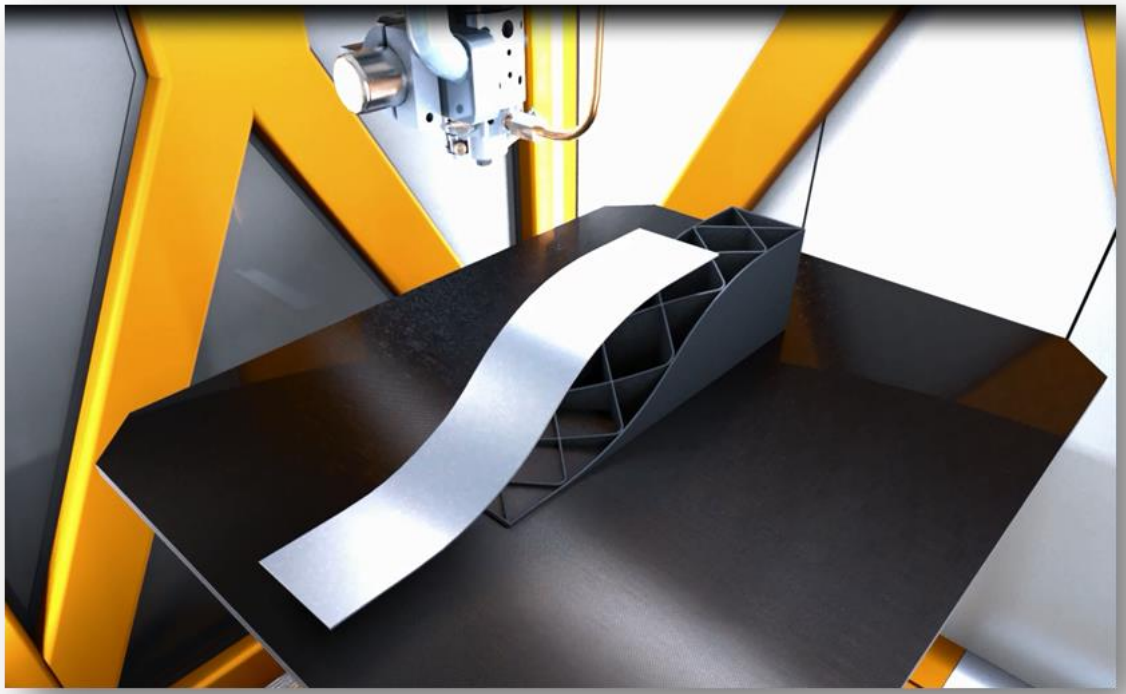
- Process parameters
- forming strategies
- sheet materials



Example geometries incremental forming

Fraunhofer IWU

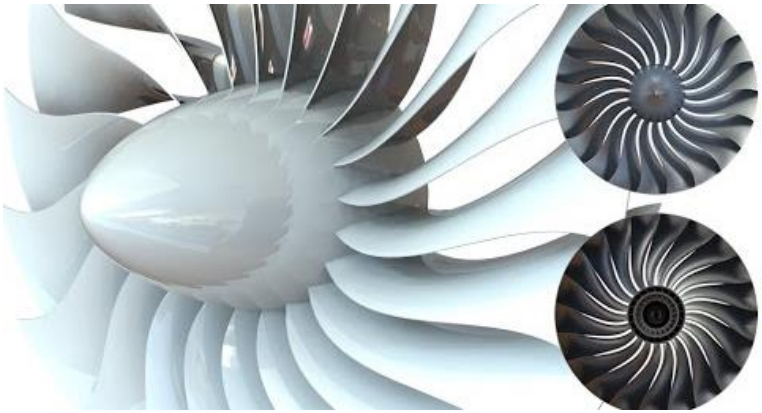
Manufacturing of components: **special components (3D Printing)**

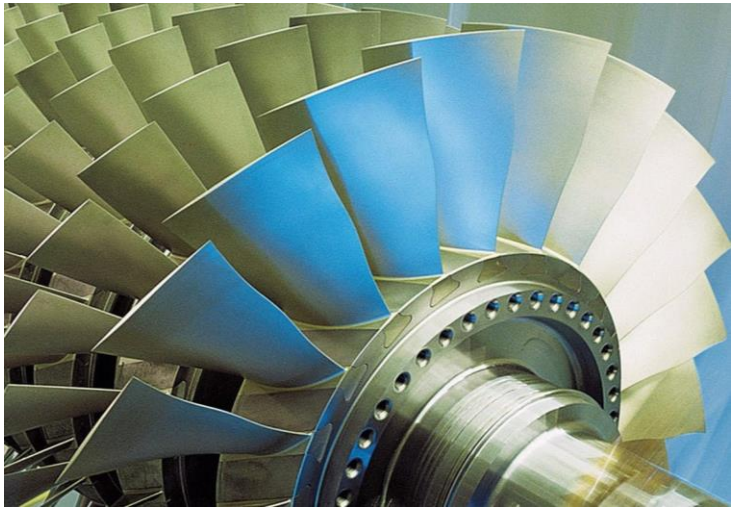


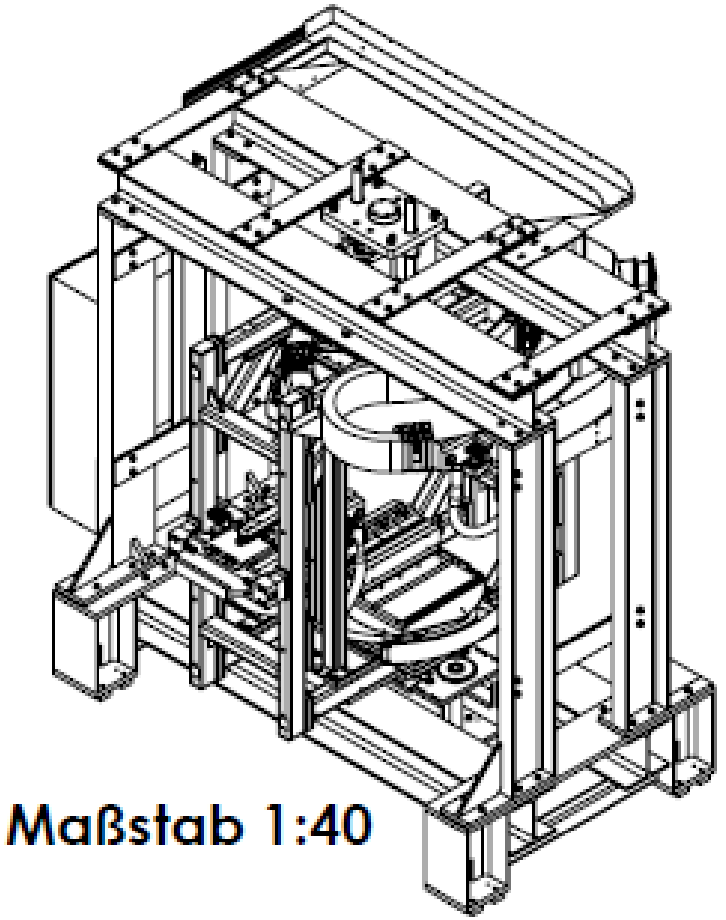
SEAM_264_Prozessvisualisierung_V3.mp4

Fraunhofer IWU

Manufacturing of components: **fanplates for turbines**







Fraunhofer IWU

Manufacturing of components: **conventional sheet metal forming**

Deep Drawing & Stretch Forming of Blanks

Our Expertise

- **Methods planning** and simulation based **process layout** for different blank materials:
  - Steel
  - Aluminum
  - Magnesium
  - Titanium
  - Hybrid Metal-Polymer Compounds
  - Organic Blanks
  - Tailored Blanks
- **Tool layout** and **Design**
- **Experimental Investigations** and **Tryout**
- **Manufacturing** of **Prototypes** and **Pre Series**
- **Controlled (intelligent) Forming processes**
- **Analysis** of **Process Chains** and **Technology Optimization**

Street light housing Aluminum (6000er)

Inner door Magnesium Tailored Blank (AZ 31)

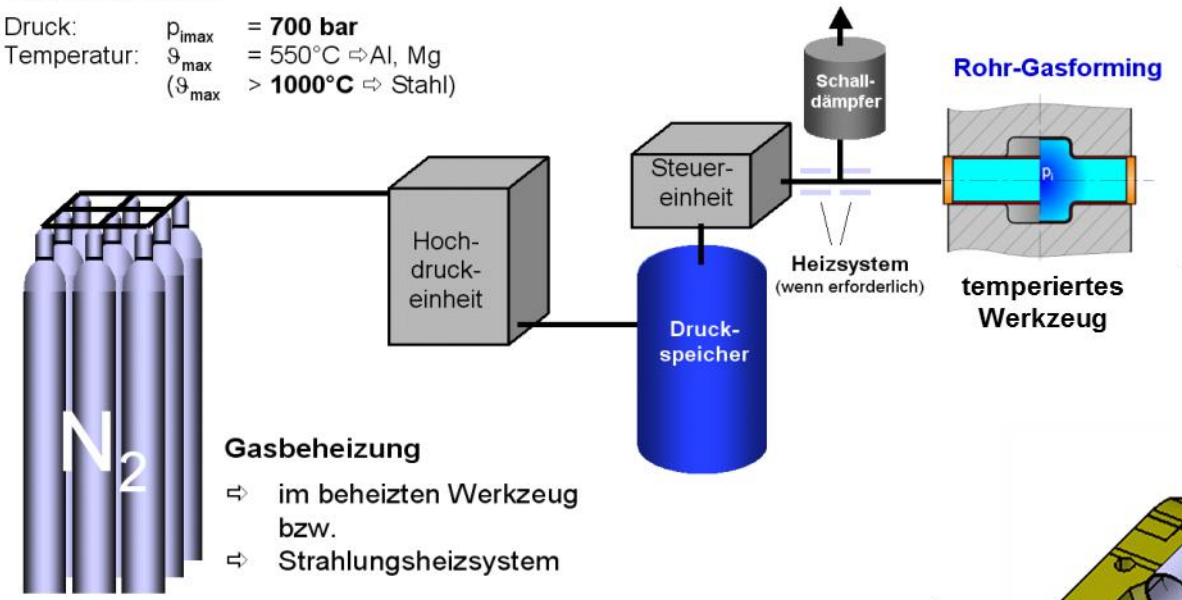
16 000 kN hydraulic Tryoutpress

Fraunhofer IWU

Manufacturing of components: **inside high pressure forming**

Technische Daten

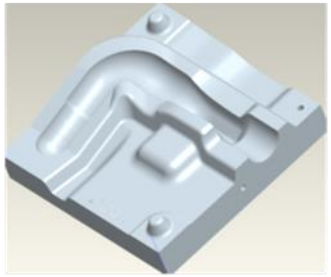
Druck: p_{imax} = **700 bar**
Temperatur: ϑ_{max} = 550°C ⇨Al, Mg
(ϑ_{max} > **1000°C** ⇨ Stahl)



Temperierte Innenhochdruck-Umformung mit gasförmigen Wirkmedien (Beschichtung der Aktivteileinsätze und der konstruktiv optimierten Dichtstempel)

Gasbeheizung

- ⇨ im beheizten Werkzeug bzw.
- ⇨ Strahlungsheizsystem

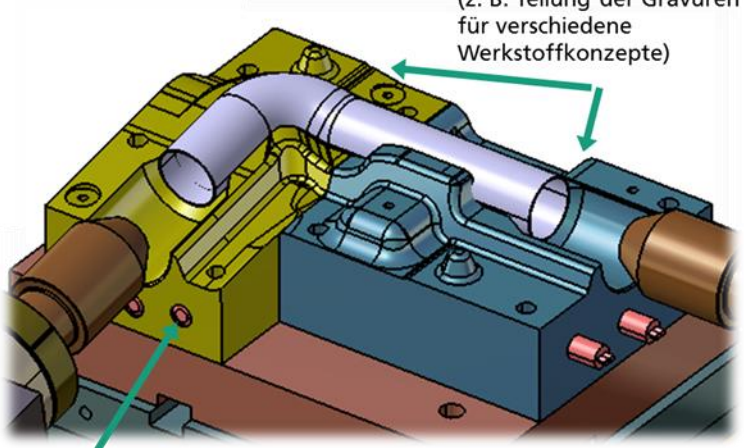


IHU-Prozess: einstufig, warm, ohne Glühprozesse

Fertigteil

Werkzeugkonzeption

(z. B. Teilung der Gravuren für verschiedene Werkstoffkonzepte)



Erarbeitung einer Heizkonzeption in Abhängigkeit des definierten Temperaturbereiches

What could be done?

instrumentation of geo-thermal system and qualification of a condition monitoring system

Current system state (condition monitoring)

Long-term load history

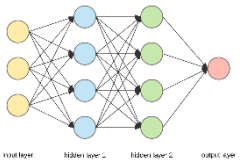
Planned energy production in the future

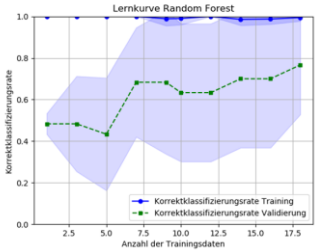
prediction

future trend of wear, rest life time of components

Deterministic / physical models of failure mechanisms
digital twin

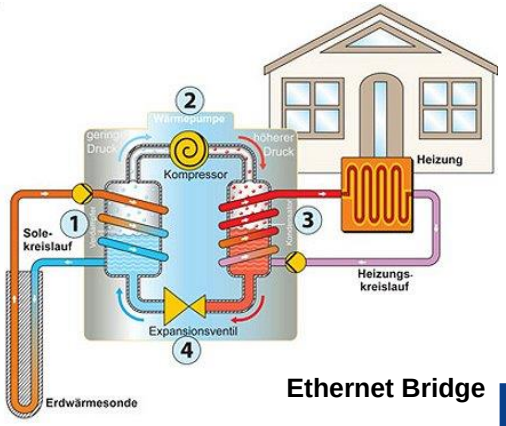
Pattern detection, data mining, machine learning
„learning from history“
-> big data basis needed





Fraunhofer IWU

System concept - Monitoring system



Controller of geo-thermal system

Ethernet Bridge

PT 100 | 4..20 mA | ±10 V | DI 8 | ICP

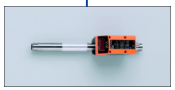
Data aquisition & pre-processing (Beckhoff-IPC + I/O)

Pressure

Viscosity

Particle counter

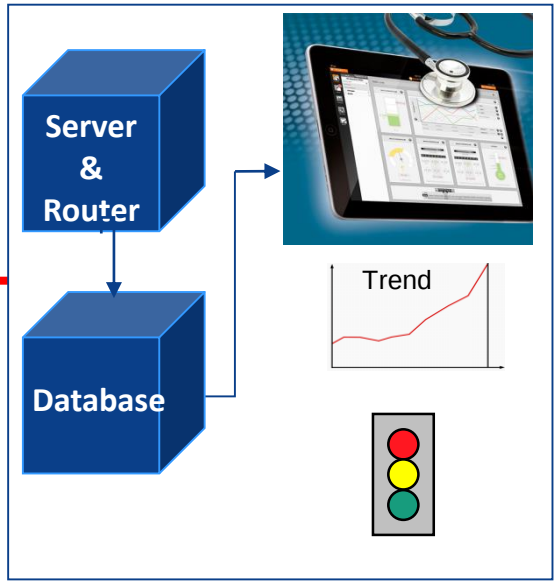
Temperature (fluid, bearings, ..)



Energy consumption

Internet

Monitoring, long-term big-data analysis, decision making, cloud services



Fraunhofer IWU

Relevant background knowledge of Fraunhofer IWU

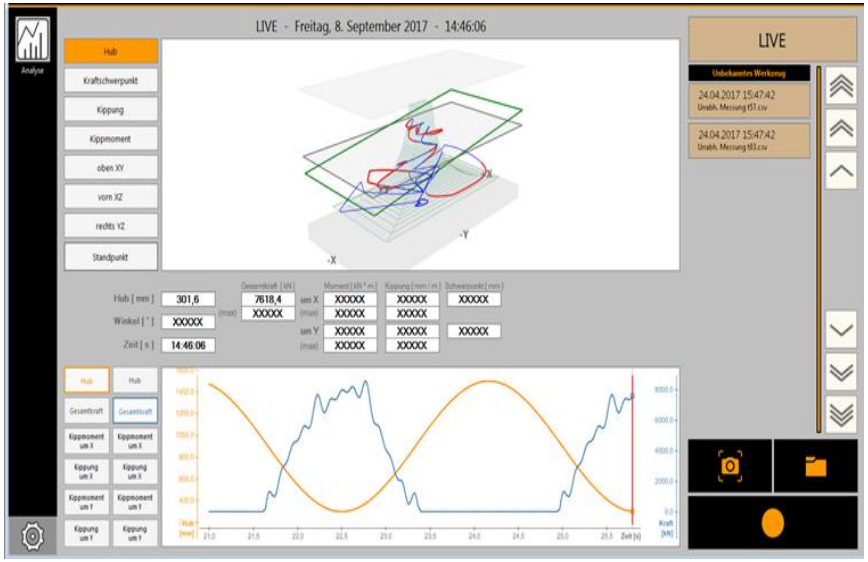
SmartStamp – Fingerprint of forming processes

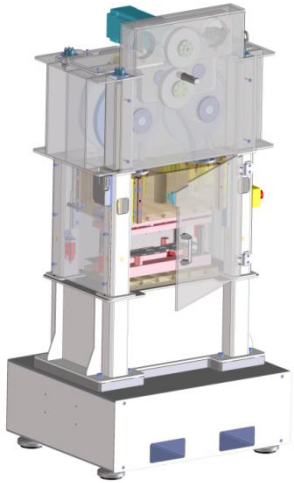
Measured values:

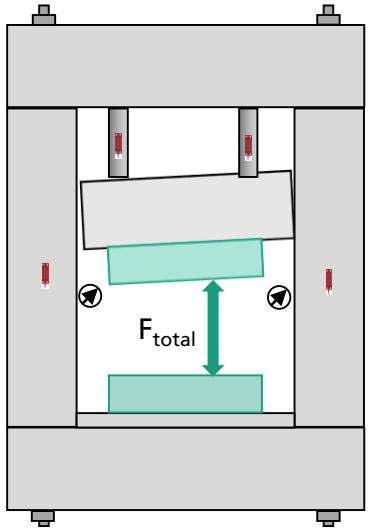
- 4 press forces at ram or in frame pillars
- position over press table (4x sensors)

Derived information:

- Total press force [kN],
- Tilting moments [kNm] around x- & y- Axis
- Ram tilt [mm/m] around x- & y- Axis







Benefits for press owner:

- Avoidance of press overloads, comparison with permissible values
- Identification of forming tools that overload the press
- Matching of forces, tilting moments and ram tilting to ram stroke / crank angle

Fraunhofer IWU

Relevant background knowledge of Fraunhofer IWU

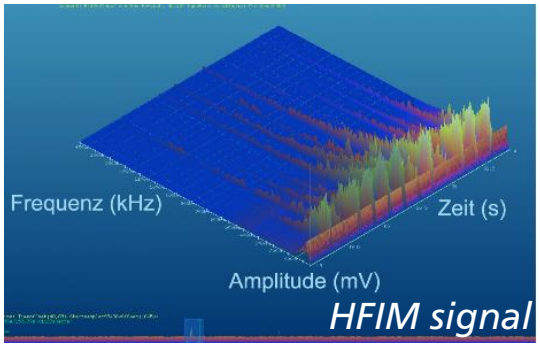
In-process check systems for cutting processes

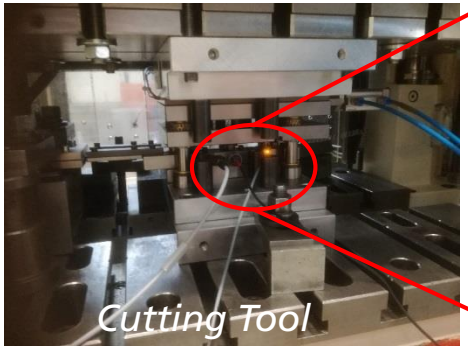
Implementing of monitoring system (HFIM) in Fraunhofer tool

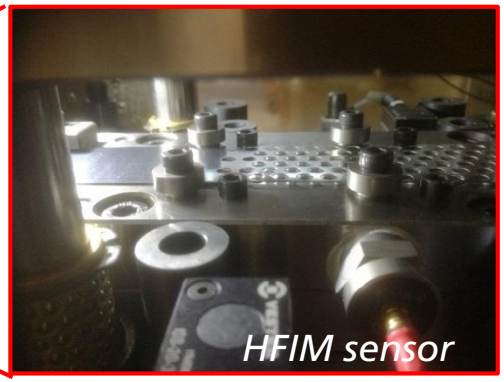
- Integration in cutting tool on high speed press Bruderer BSTA 25USL
- Experiments were realized from coil with 250 strokes per minute
- Material: spring steel 1.4310 (Rm = 1750 – 1850 MPa)

Measurement system

- Quass optimizer 4D (sample rate 50 MHz)
- Analysis of time, frequency and amplitude

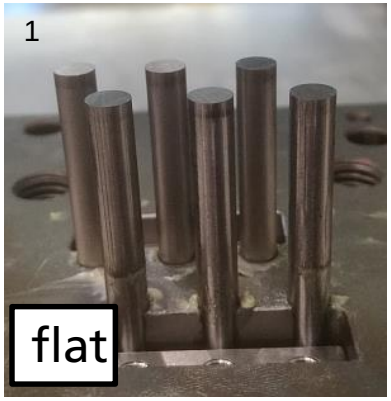


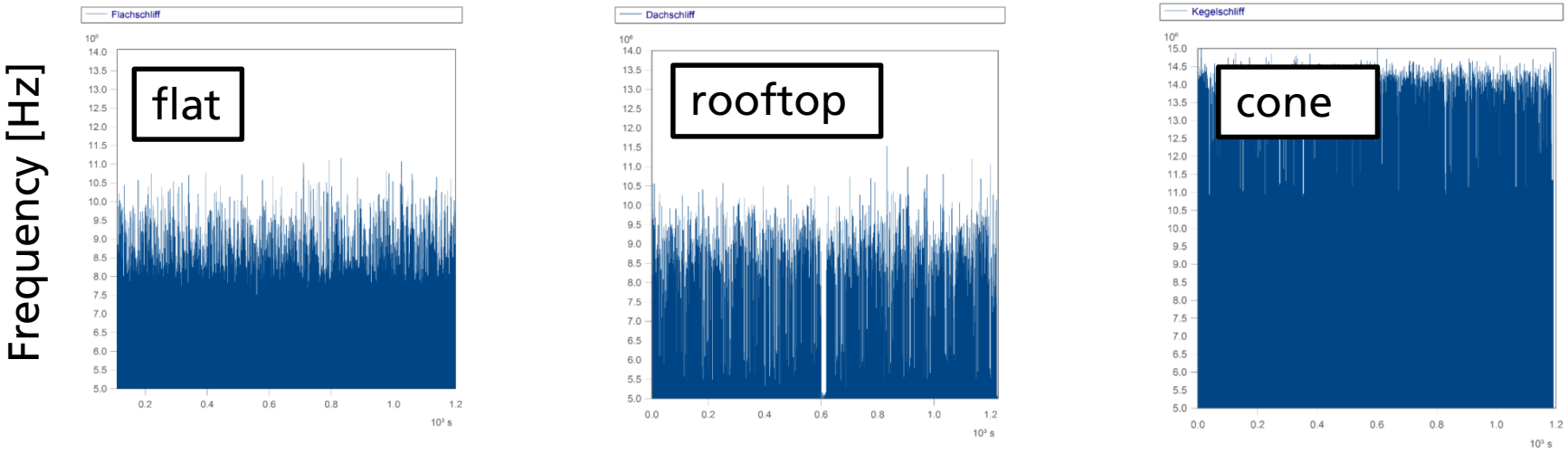




Relevant background knowledge of Fraunhofer IWU

In-process check systems for cutting processes



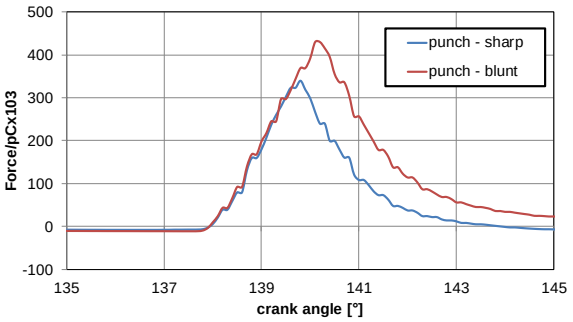


Fraunhofer IWU

Relevant background knowledge of Fraunhofer IWU

In-process check systems for cutting processes

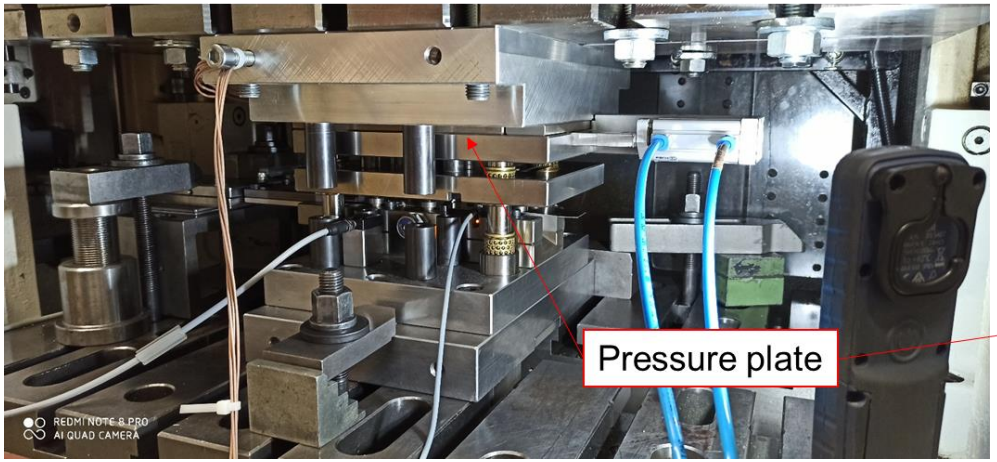
- Integration of 4 piezo electrical sensor in the pressure plate of the cutting tool
- Cutting force can be measured more direct
- Comparison of the force – crank angel curves from ‘sharp’ punches (500 strokes) to ‘blunt’ ones (50000 strokes)

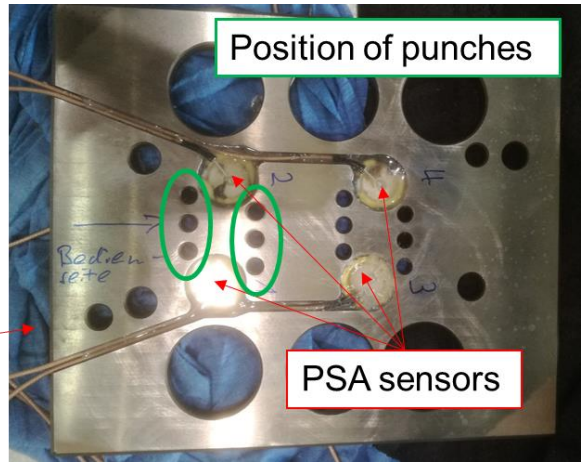


Results

- Significant change in signal between sharp and blunt
- Both the maximum force and the work can be evaluated

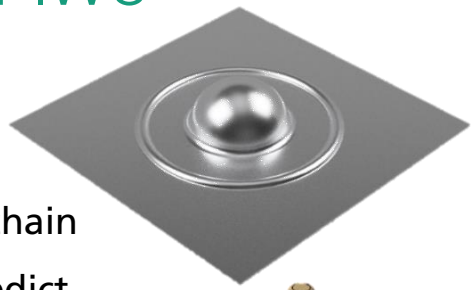
→ **Method is valid to measure tool wear**

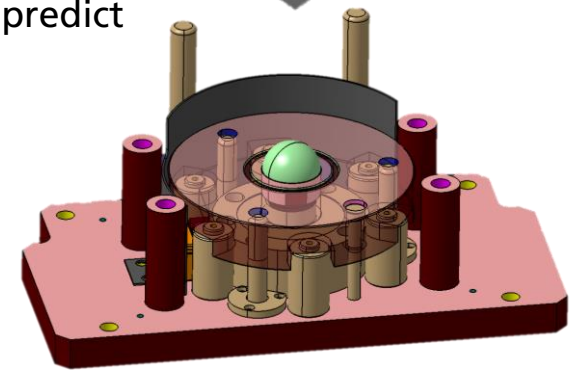




Relevant background knowledge of Fraunhofer IWU

Inline material characterization





Prediction of product quality using miniaturized material tests

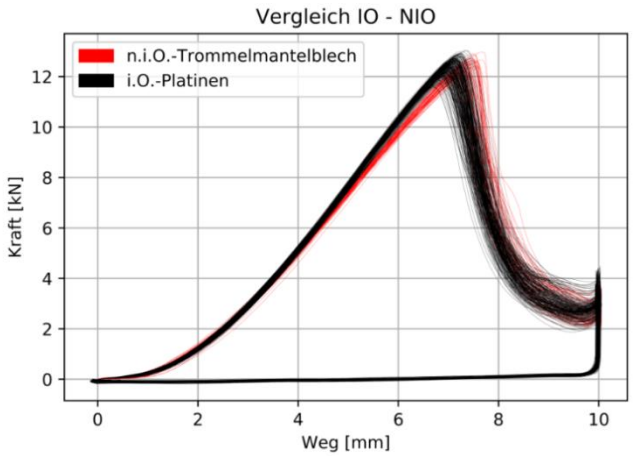
- Integration of the material test at the right stage in the process chain
- Using AI methods for live analyzing the inline test results and predict the part/material quality

Sensor concept

- Using of load cells for process force measurement
- Using laser triangulation for displacement measurements
- → Integration of sensor in forming tools

Results

- Prediction of part quality based on the measured force displacement curves
- Quality prediction for each part
- Using the forecast to make a decision
  - ✓ Taking out the blank
  - ✓ Adjusting the process to get a OK-part

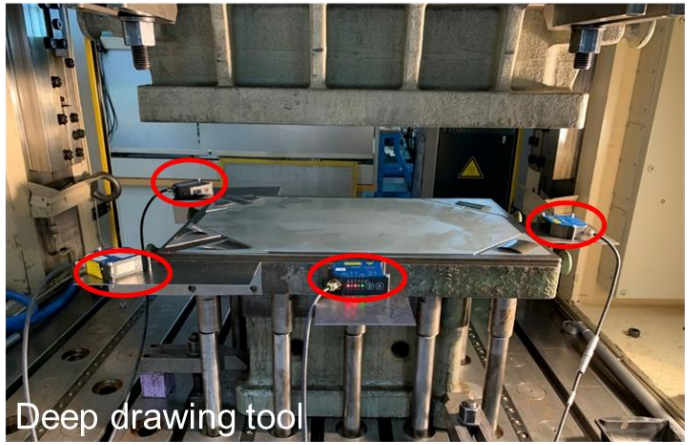


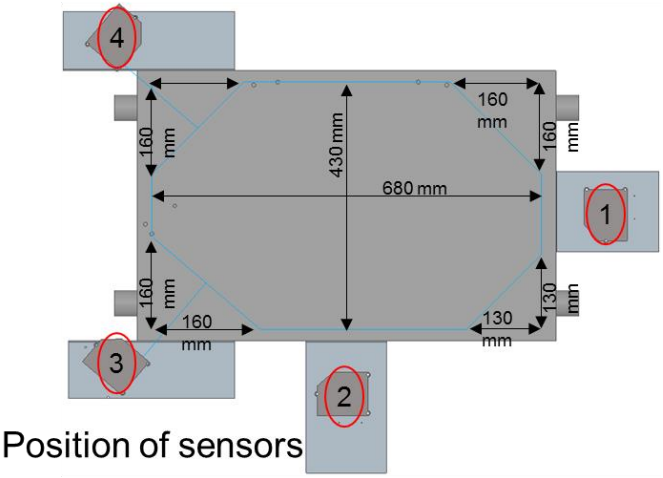
Fraunhofer IWU

Relevant background knowledge of Fraunhofer IWU

Experimental setup

- Laser sensors were installed at the forming tool
- Experiments were realized with 270 kN blank holder force and 40 mm drawing depth



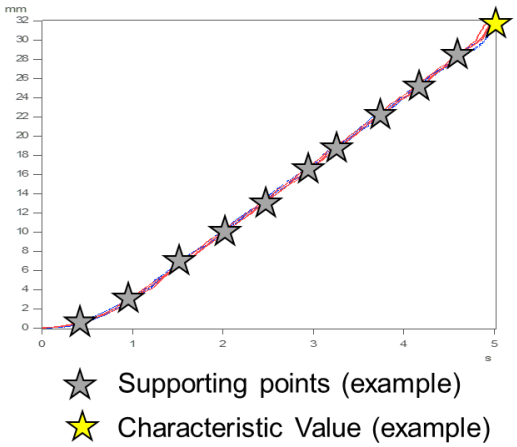


Data analysis

- Using machine learning algorithms for the prediction of part quality
- Used data: 100 experimental datasets (24 not OK, 76 OK)

Procedure:

- Feature extraction from draw-in curves from each sensor to generate feature vector
  - Discretization of curves at 50 supporting points
  - Characteristic values (e.g. maximum displacement)
- Supervised training of ML-models with feature vector and part quality
  - Splitting data set in training (80%) and validation data (20%)
  - Investigation of different algorithms (K-nearest neighbors, random forest)



Fraunhofer IWU

Thank you for your attention!

Fraunhofer IWU