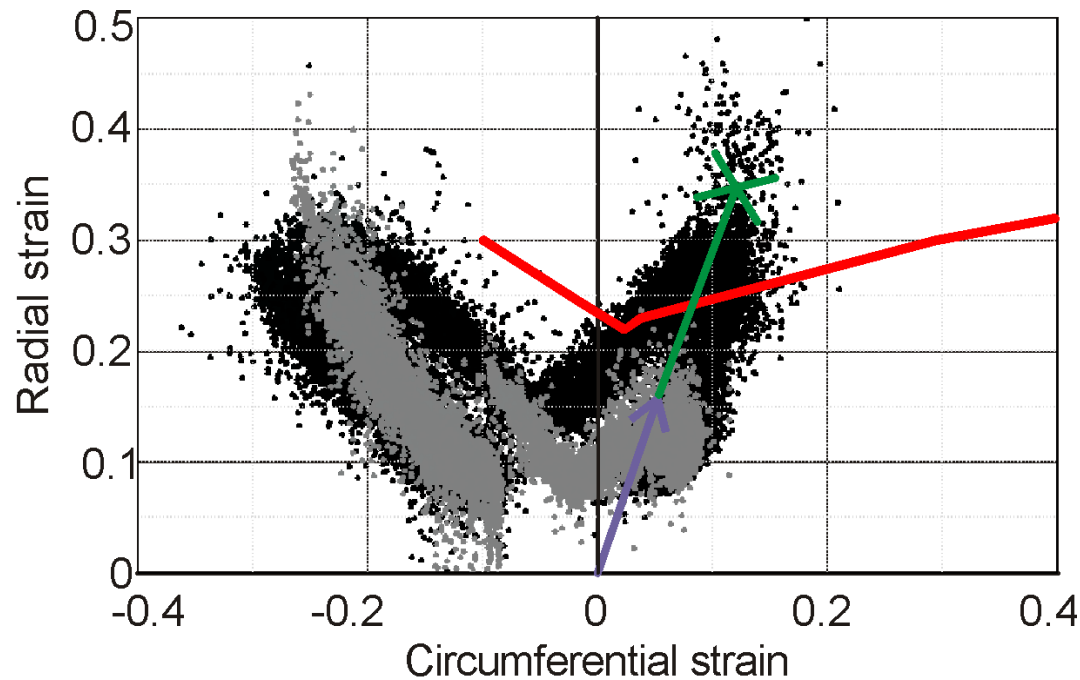


# Development of a methodology regarding combined quasi-static and dynamic forming processes

A. Erman Tekkaya



# Organization



- 2 funding periods (2009 – 2011 and 2012 – 2014)
- 4 research projects (+ 1 transfer project)
- 4 research institutions
- 20 researchers
- 58 publications



**Method** planning  
for combined quasi-static –  
dynamic forming processes



# Commemoration of Prof. F.-W. Bach



Prof. Dr.-Ing. habil. Dr.-Ing. E.h. Dr. h.c.  
Friedrich-Wilhelm Bach  
† 18.08.2014

2001-2012

Head of the Institute of Materials Science of  
Leibniz Universität Hannover

Since 2006

Member of acatech

Since 2012

“Niedersachsenprofessor“

Significant initiator of the PAK 343

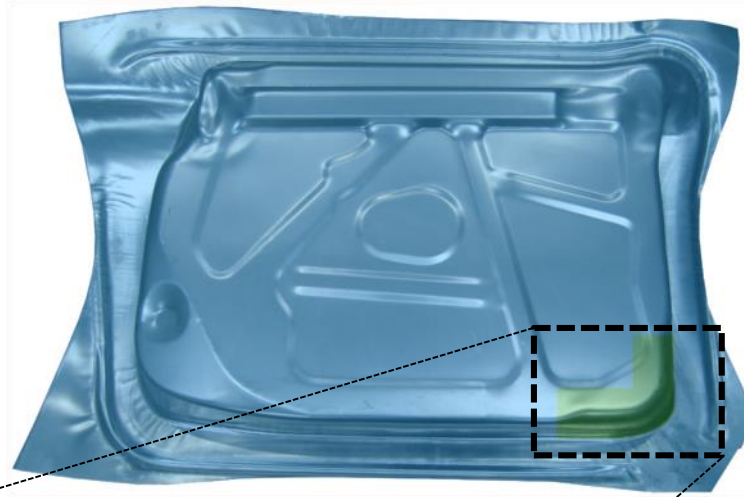


## Expansion of forming limits of conventional forming processes

Large-area,  
noncritical zones



quasi-static forming



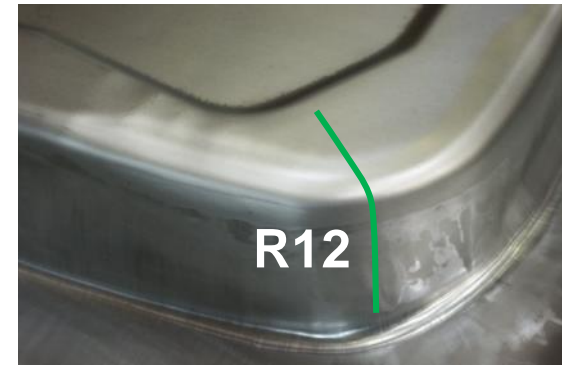
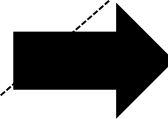
Local, critical zones



dynamic forming



Feasible geometry  
by deep drawing



Target geometry

Inside door panel  
(Source: PSA Peugeot Citroën)

# Timeline

2009

2011/2012

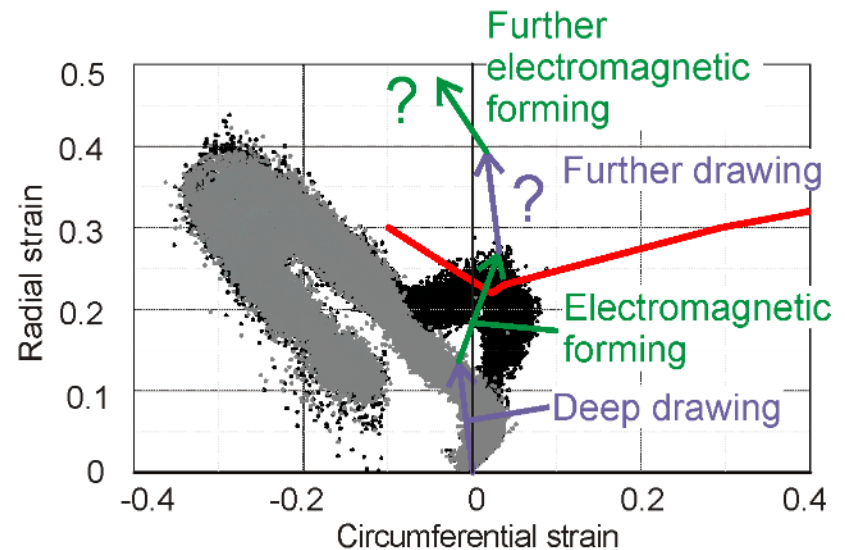
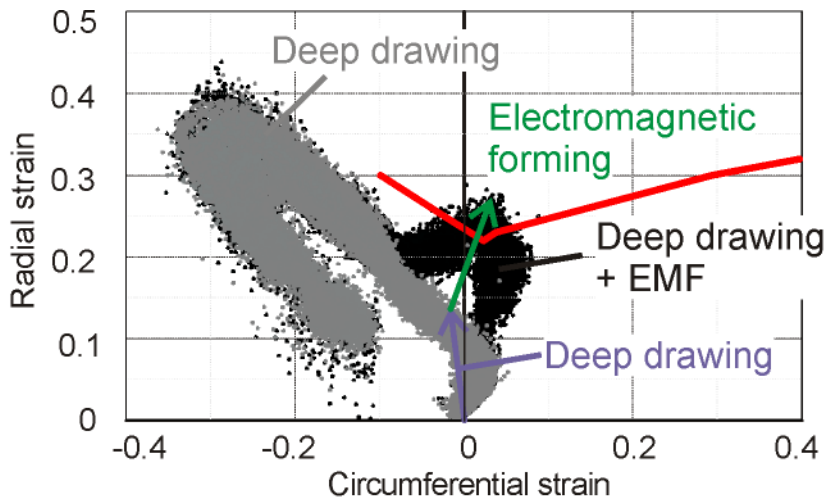
2014

1. Funding period

2. Funding period

Feasibility of process chain with single change of strain rates and paths

Multiple changes of strain rates and paths



# 1. Funding period: Objective

**Objective:** Design of process chains for changes in strain rates and paths

## Sheet metal:

Deep drawing



Electromagnetic sheet metal forming

## Tubes:

Electromagnetic tube compression



Tube hydroforming

## Fundamental questions:

- Influence of changing strain rates and paths on the process window?
- Process design by mathematic optimization?
- Damage or FLC concept?
- Efficient FEA technologies?

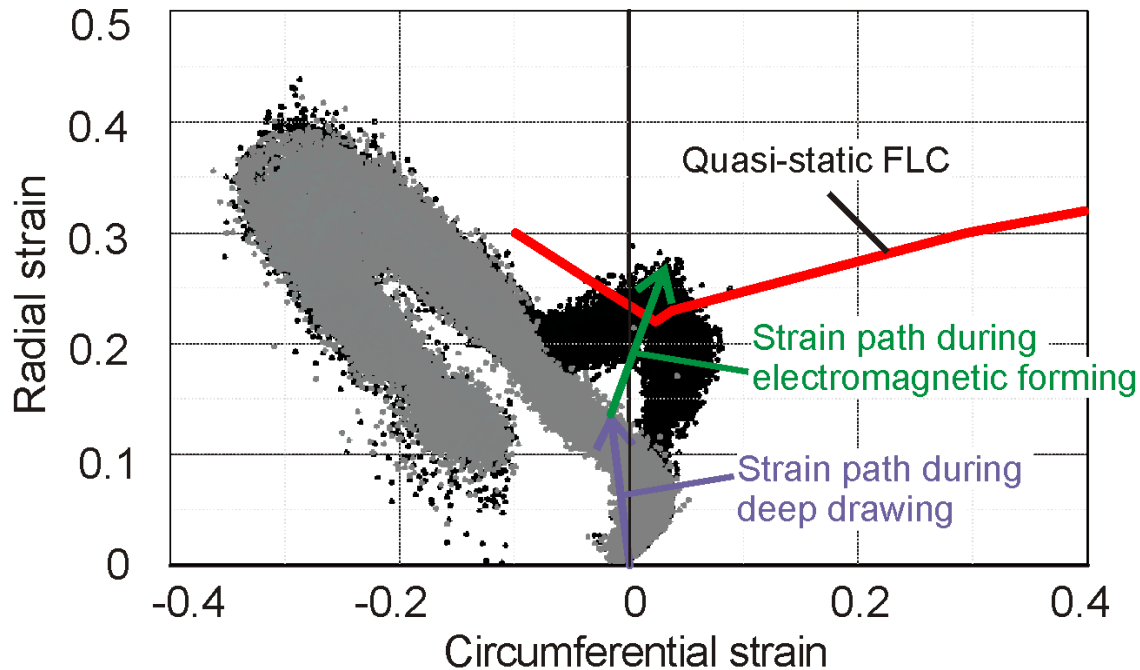
# 1. Funding period: Approach

## Example: Sheet metal

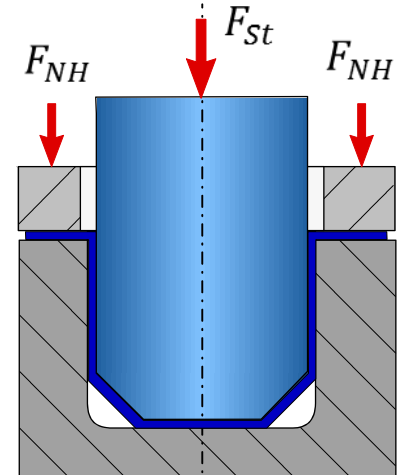
Deep drawing



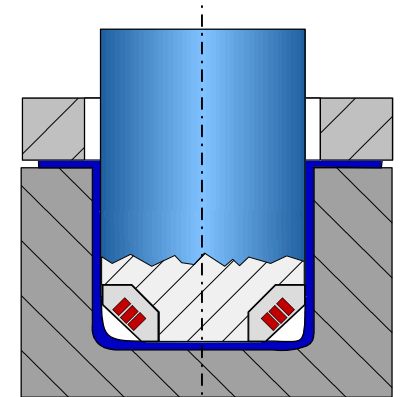
Electromagnetic sheet metal forming



### 1. Deep drawing



### 2. Electromagnetic calibration



## 2. Funding period: Objective

**Objective:** Enhancement of the drawing ratio in deep drawing

**Concept:** Multiple changes in strain rates and paths

**Sheet metal:**



**Fundamental questions:**

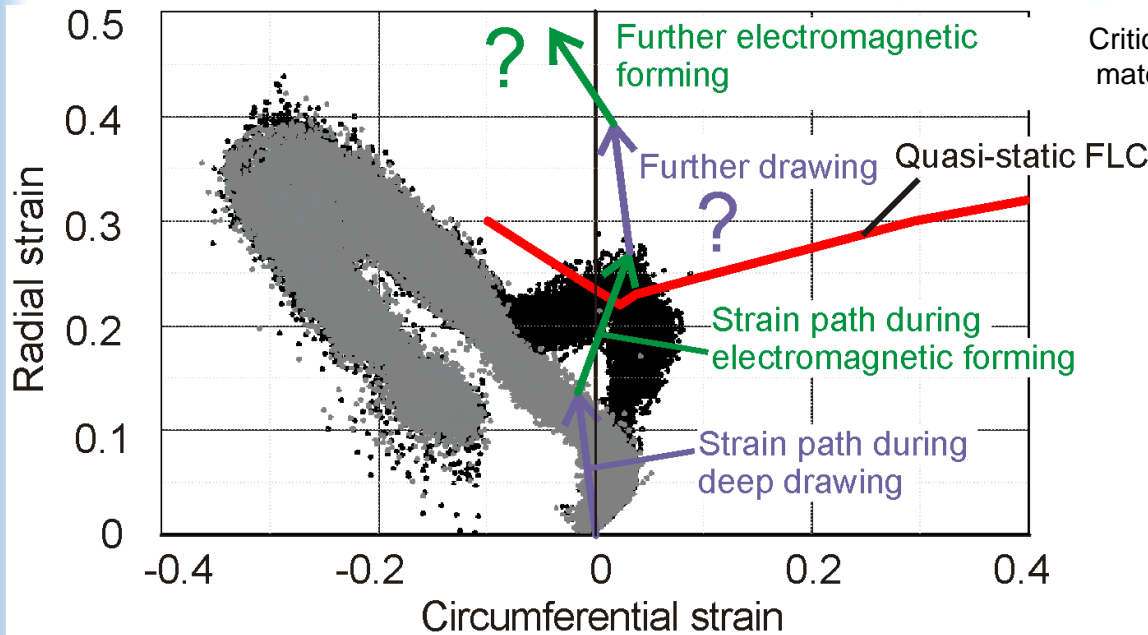
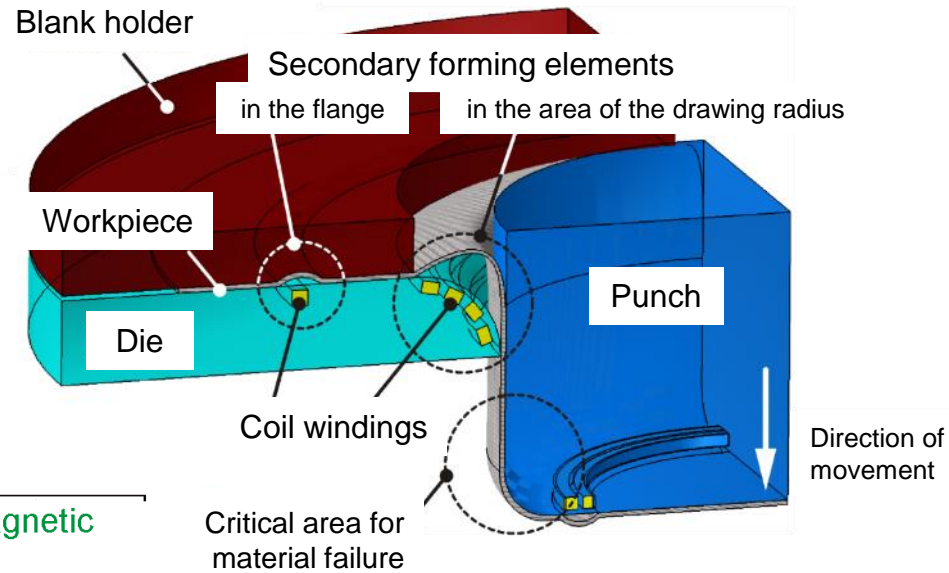
- Process control for complex process chain?
- Efficiency, robustness of optimization?
- Implementation of damage model into optimization?
- Material behavior under complex, non-linear loadings?



# 2. Funding period: Approach

## Example:

Sequential steps of deep drawing and electromagnetic forming

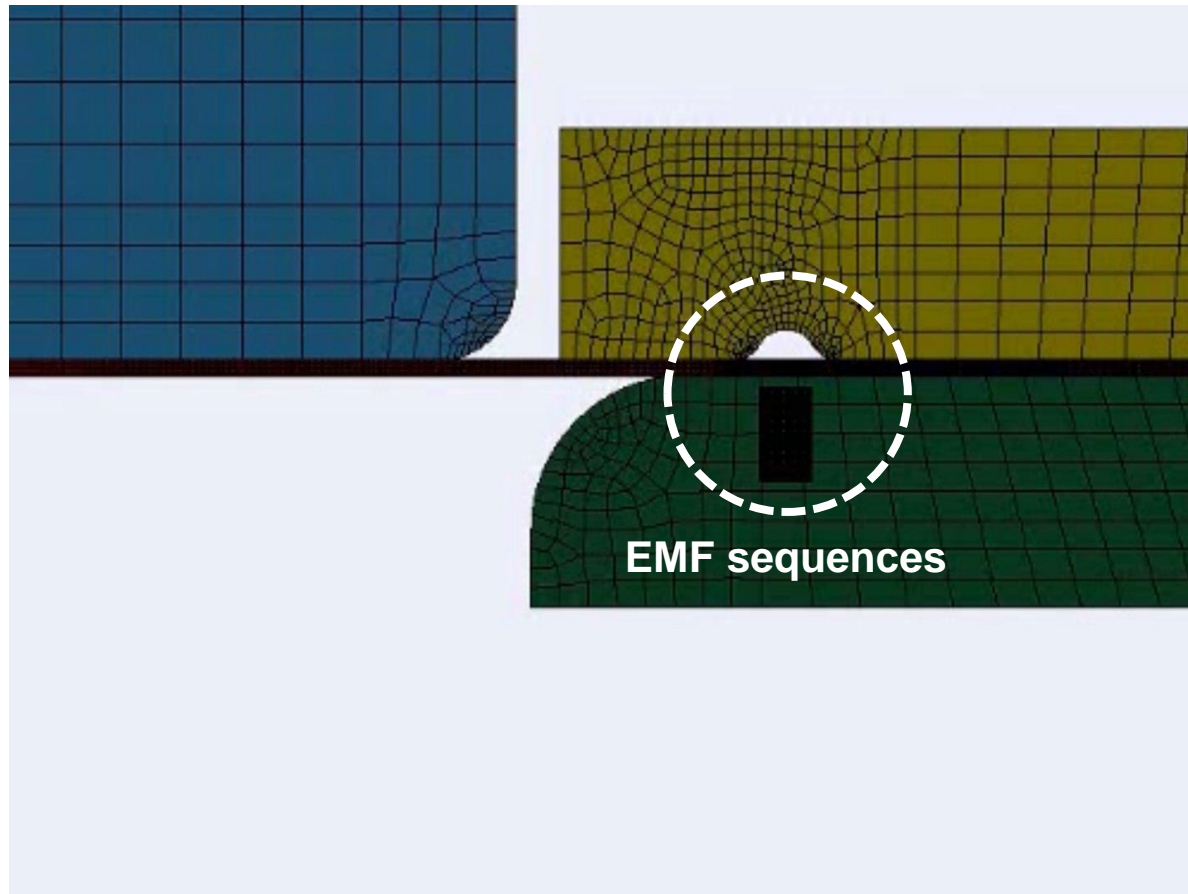


Concept based on:  
**Shang, J., 2006**, Electromagnetically assisted sheet metal stamping, Dissertation, The Ohio State University

## 2. Funding period: Approach

### Example:

Deep drawing with integrated electromagnetic forming



## Process development for combined deep drawing

### Technology

Parameter identification  
Cause and effect relationships  
Die technology  
Process sequence  
Application

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 Leibniz  
Universität  
Hannover

### Simulation

Anisotropic damage  
Element technology  
Contact process  
Optimization  
Adaptive model reduction



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### Material behavior

Damage modeling  
High-speed forming limits  
Non-linear loading  
Hardening behavior

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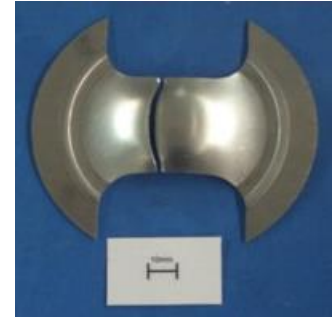
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# Subprojects

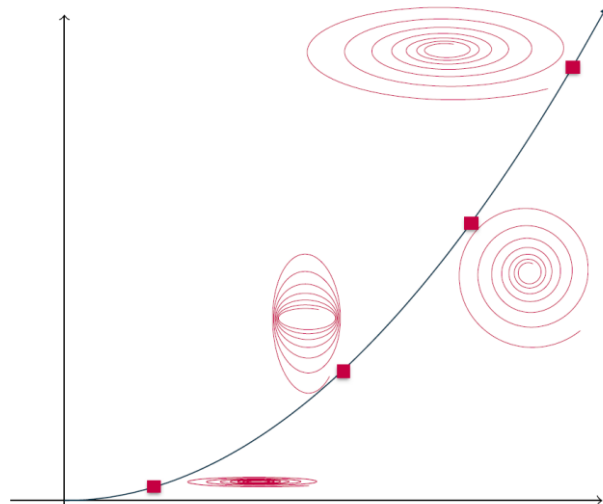


Method planning  
for combined quasi-static –  
dynamic forming processes



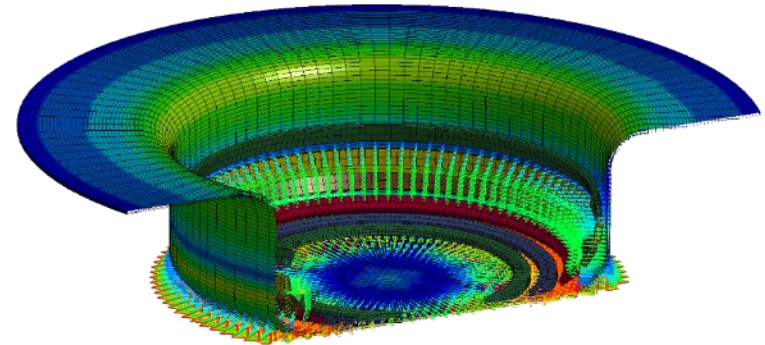
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**Thank you for your attention!**

**And now:  
Presentations of the 4 subprojects...**