The Material Competence Center

André Haufe

Kleine Gelegenheiten sind oft der Anfang zu großen Unternehmungen.

- Demosthenes

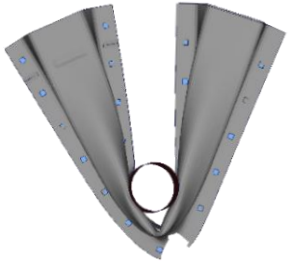
»Wir strampeln uns wie verrückt ab, um neue Ideen so schnell wie möglich zu entwickeln. Einfach, weil wir nicht wissen, wer diese zwei Typen aus dem Uni-Wohnheim sind, die es möglicherweise schlauer anstellen als wir.«

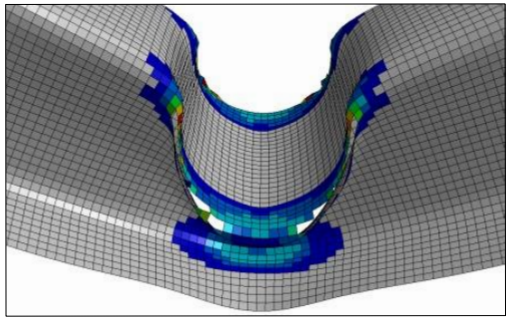
—Google-Vizepräsident Vinton Cerf

Overview

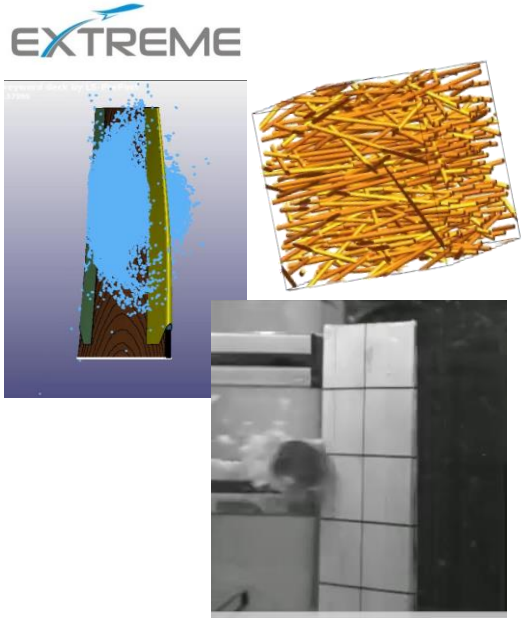
- Introduction
- Polymers – testing & modelling
  Martin Helbig
- Full-field calibration - material characterization on full-field measurement
  Christian Ilg
- Machine learning supported engineering
  David Koch
- Break the ~~ice~~ cookie - get together

Where we originate…

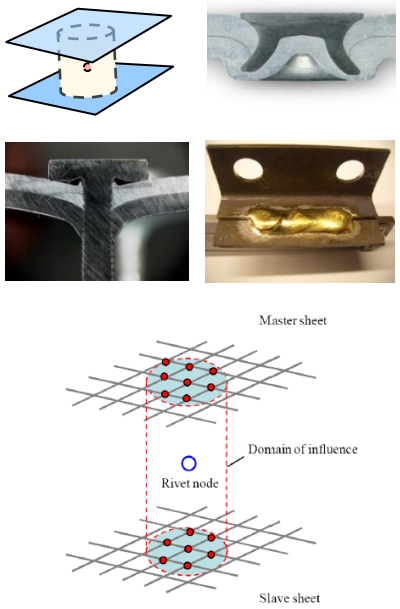




Damage and failure: GISSMO/eGISSMO



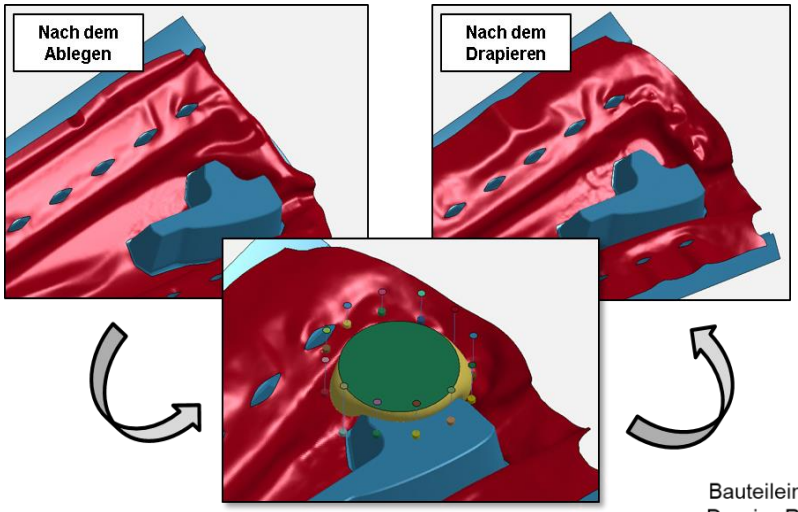
New composite models

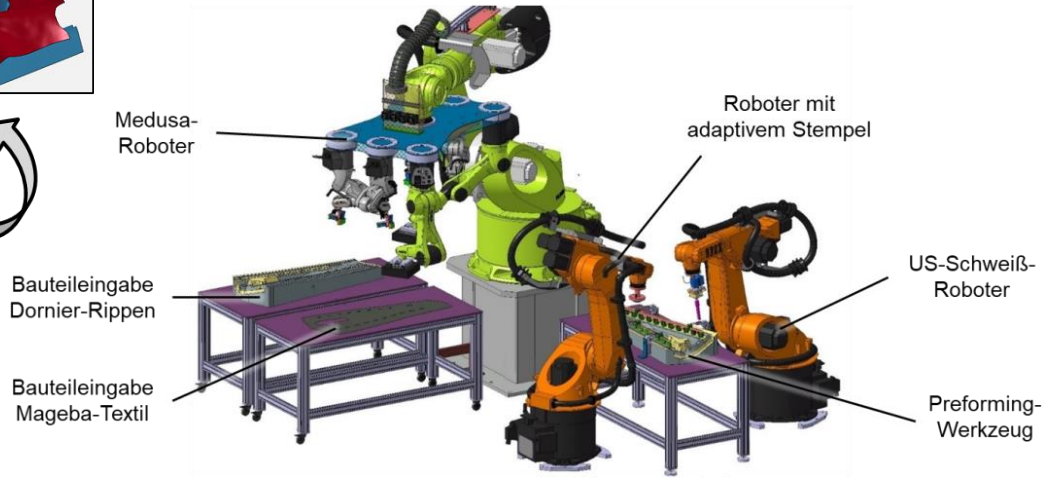


Connection modeling

Activities in automated production technology

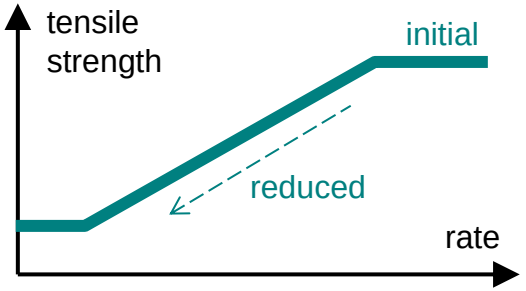
- Constitutive modelling for draping/preforming simulation

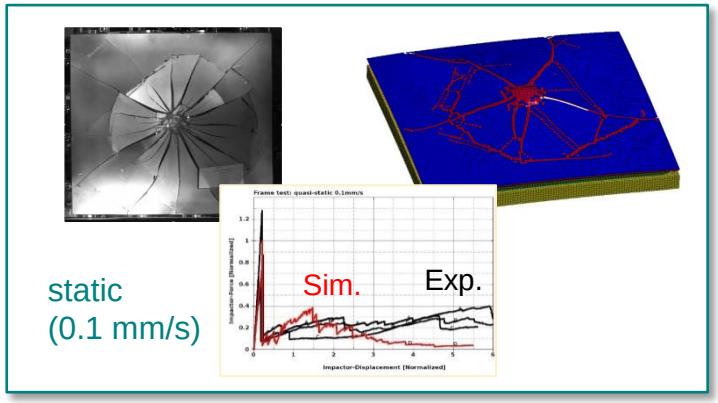


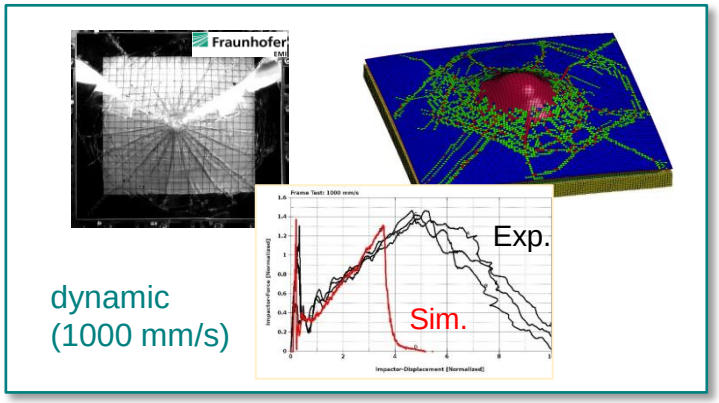


Glass

- Improvements for *MAT_280
  - nonlocal extension: rate-dependent strength reduction in elements around cracks
  - better agreement with tests (static & dynamic)





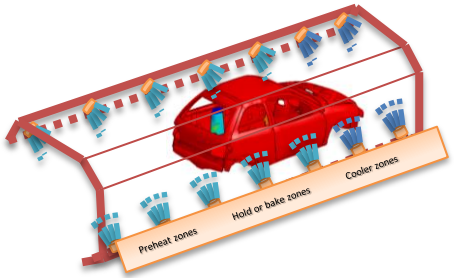


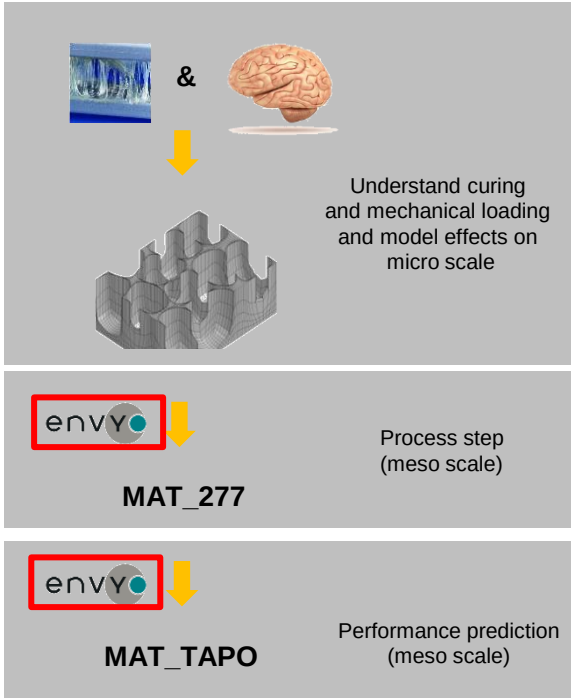
Adhesive curing process - from fluid to solid

- Digital process chain to illustrate and optimize the joining technology in automotive body-in-white

- Goals of the project:
  - Optimal combination of different material
  - hybrid lightweight construction (welding and adhesive)
  - Reduction of welding points due to adhesive technology

- Funding period:
  - 2019-2022 (3 years)



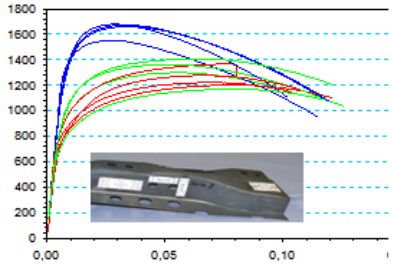


Bundesministerium für Wirtschaft und Energie
DAIMLER
DUPONT
inpro
ARENA2036
DYNA MORE
LWF
IFB Institut für Flugzeugbau
TÜVRheinland Genau. Richtig.

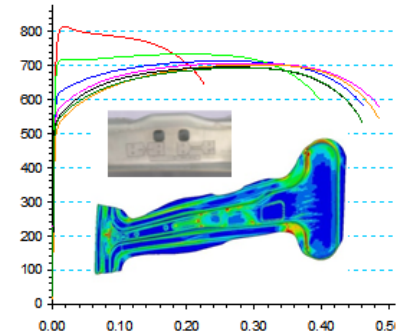
Closing the process chain

Taking process chain into account

Boron steel: 22MnB5



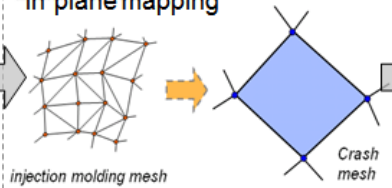
Micro alloyed ZStE340



Mapping of local properties like thickness, pl. strain, damage or stresses

envyo®

In plane mapping

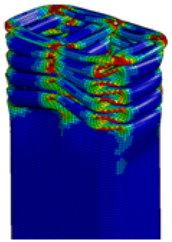


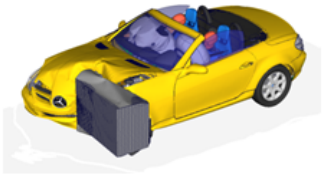
Mapping in thickness direction

Correction of history variables when discretization or constitutive model will be altered !

Crash analysis

With calibrated anisotropic plasticity model including damage & failure

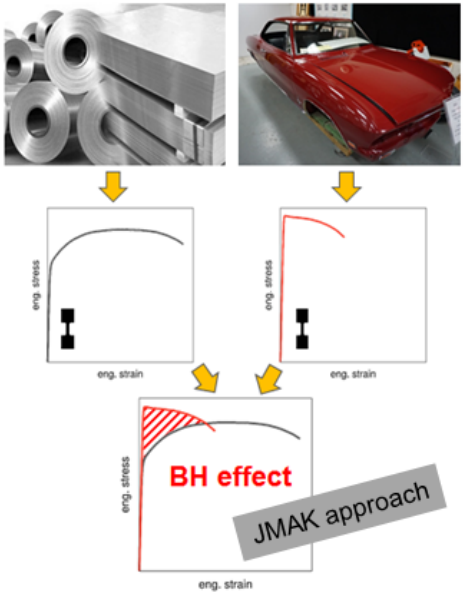




Closing the process chain

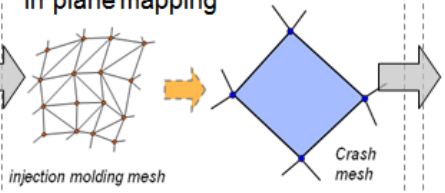
Taking process chain into account

Bake or precipitation hardening effect or dependent on temperature treatment and pre-straining!



Mapping of local properties like thickness, pl. pre-strain and temp. treatment

In plane mapping

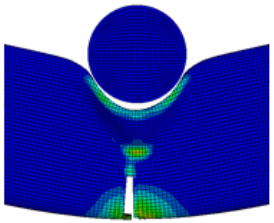


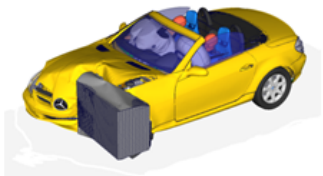
Mapping in thickness direction

Correction of history variables, yield curves when discretization or constitutive model is changed!

Crash analysis

With calibrated plasticity model dependent on locally varying pre-strain and temperature effects (plus damage & failure parameters)

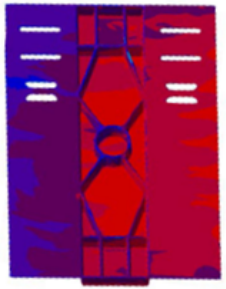




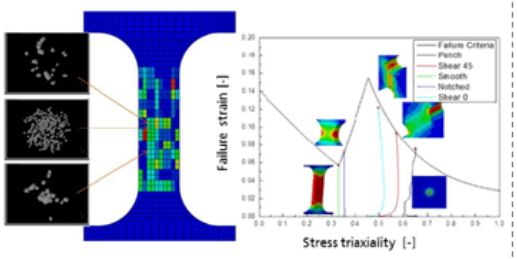
Closing the process chain

Taking process chain into account

Aluminium cast part

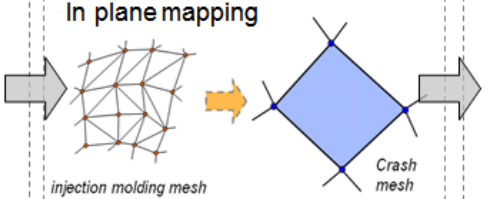


Locally varying constitutive Properties due to porosity etc.



Mapping of local thickness, voids, derived damage from flow path length & Temp. or residual stresses

In plane mapping

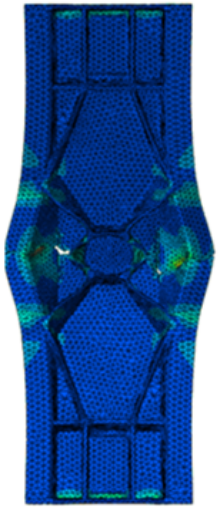


Mapping in thickness direction

Correction of history variables, & estimated damage, when discretization or constitutive model is changed!

Crash analysis

With calibrated anisotropic plasticity model including adjusted damage & failure.

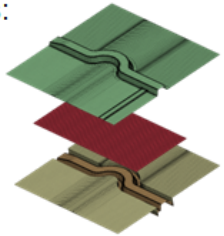


Closing the process chain

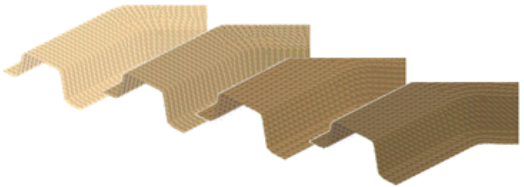
Taking process chain into account

Draping of endless fiber reinforced polymers

Dry or impregnated layups;
also organo-sheets:

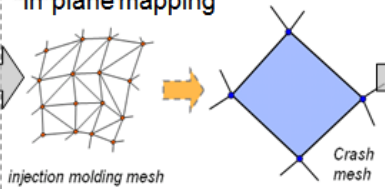


Prediction of fiber angles of woven fabrics or of stacked UD systems:



Mapping of local properties like orientation, strains, damage or stresses

In plane mapping

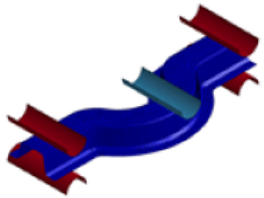


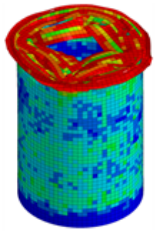
Mapping in thickness direction

Correction of history variables when discretization or constitutive model will be altered !

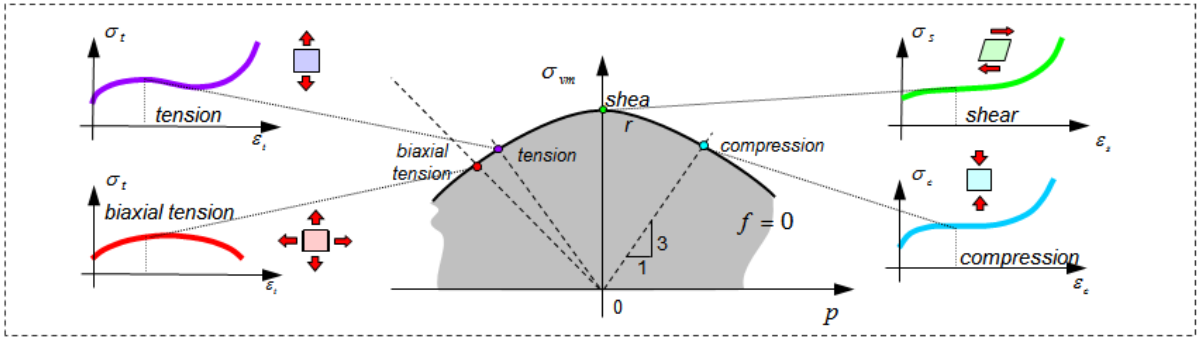
Crash analysis

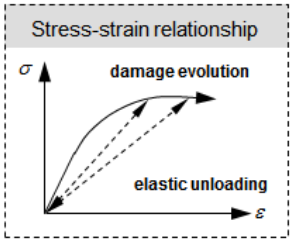
With calibrated anisotropic elastic & plastic model including damage & failure

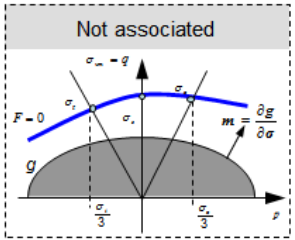


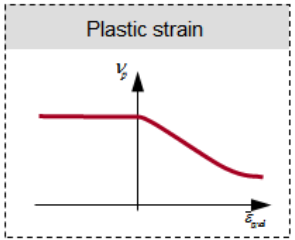


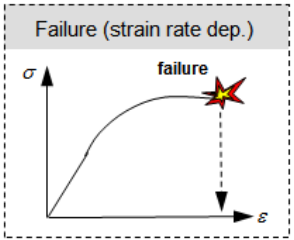
MAT_SAMP-1

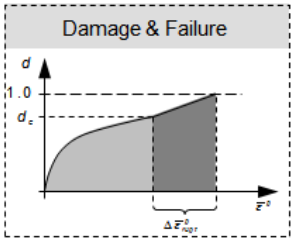

tension
biaxial tension
shear
compression
tension
biaxial tension
shea
r
compression
f = 0
3
1
0
p

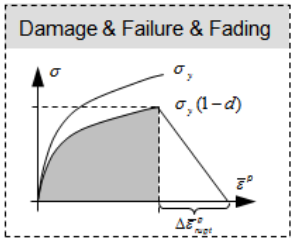

Stress-strain relationship
damage evolution
elastic unloading

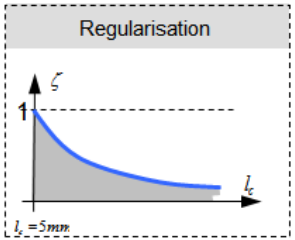

Not associated
F = 0
g

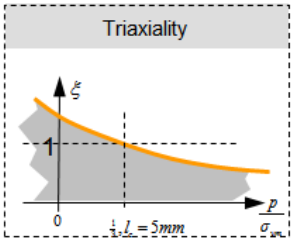

Plastic strain


Failure (strain rate dep.)
failure

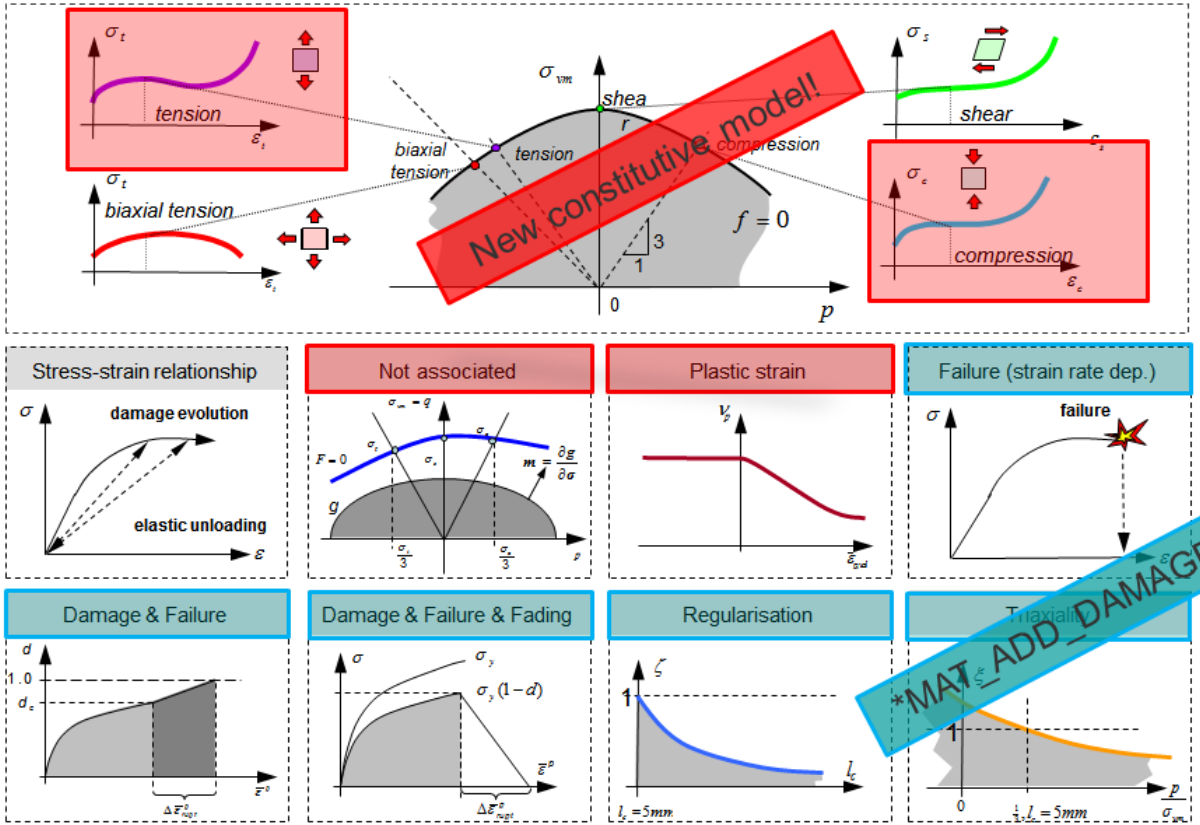

Damage & Failure
1.0


Damage & Failure & Fading


Regularisation
1
l_c = 5mm

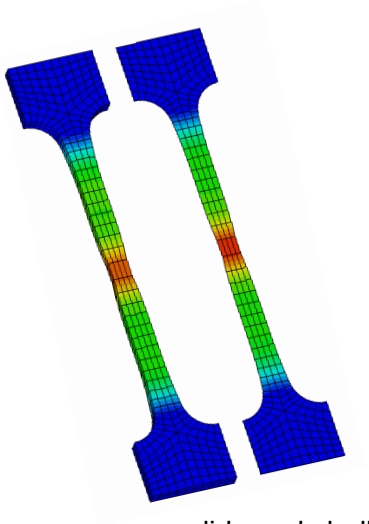

Triaxiality
1
0

MAT_SAMP-L

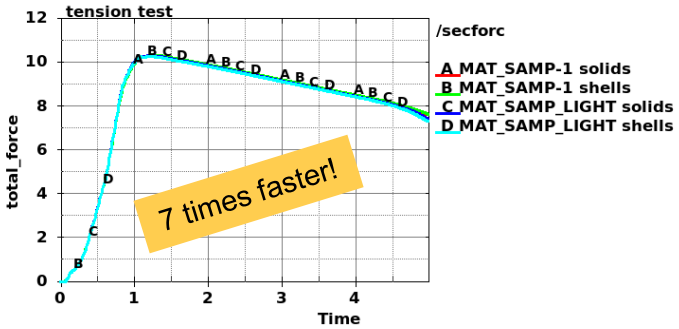

tension
biaxial tension
biaxial tension
tension
compression
shea
r
shear
compression
f = 0
3
1
0
p
New constitutive model!
Stress-strain relationship
damage evolution
elastic unloading
Not associated
Plastic strain
Failure (strain rate dep.)
failure
Damage & Failure
Damage & Failure & Fading
Regularisation
Triaxiality
*MAT_ADD_DAMAGE

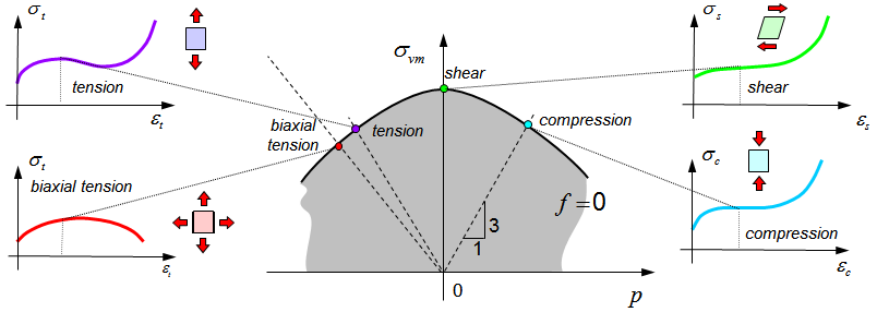
New model *MAT_187L: “SAMP_LIGHT”

- Simplified form of *MAT_SAMP-1
  - more efficient implementation (reduced CPU time)
  - filtered strain rate instead of viscoplastic

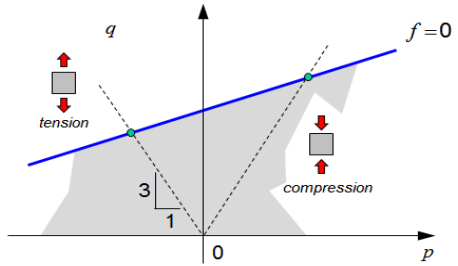


solids and shells





The good, the slow and the prima donna.



The good, the fast and the beauty.

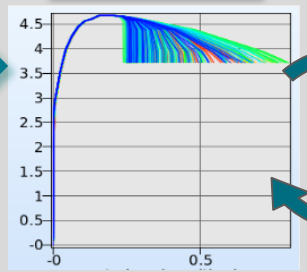
Full Field Calibration – Christian Ilg

Experiment

Measurement:
- Force
- Strain field

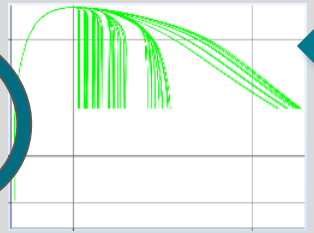
Optimization

Input from experiment



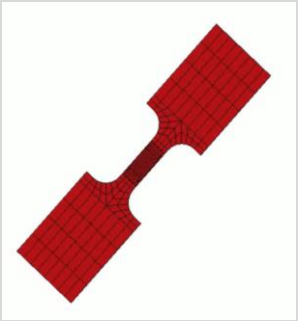
Force vs. strain

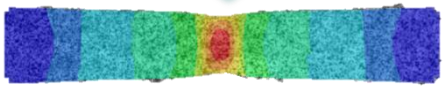
Input from simulation



Force vs. strain

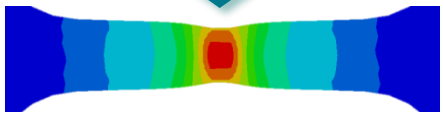
Simulation





Measured strain field

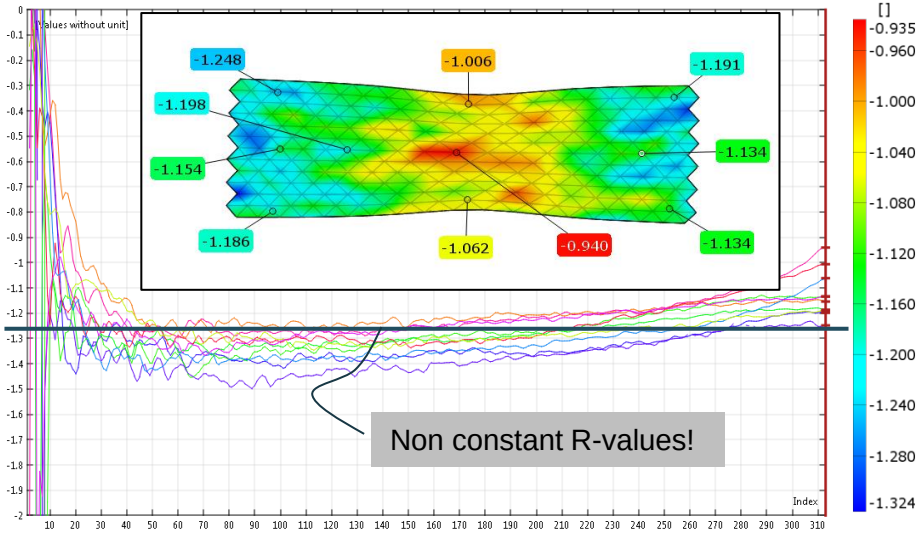
Objective:
identical strain fields in time

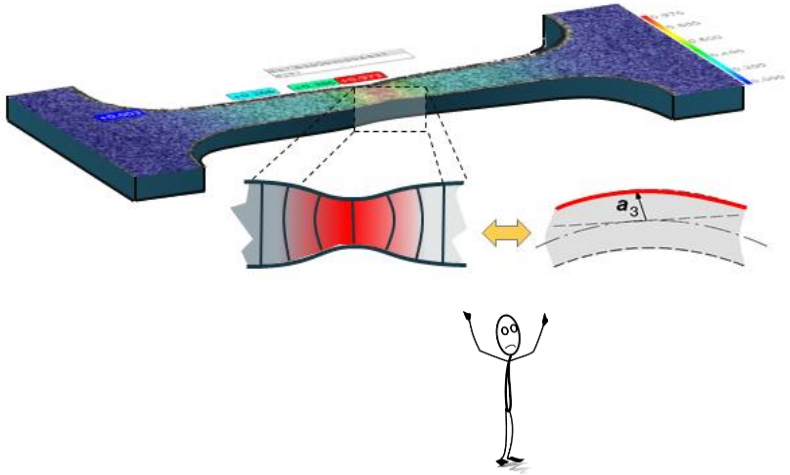


Simulated strain field

Full Field Calibration: Deviations from modelling

- Varying R-value, shell assumptions, surface measurement …



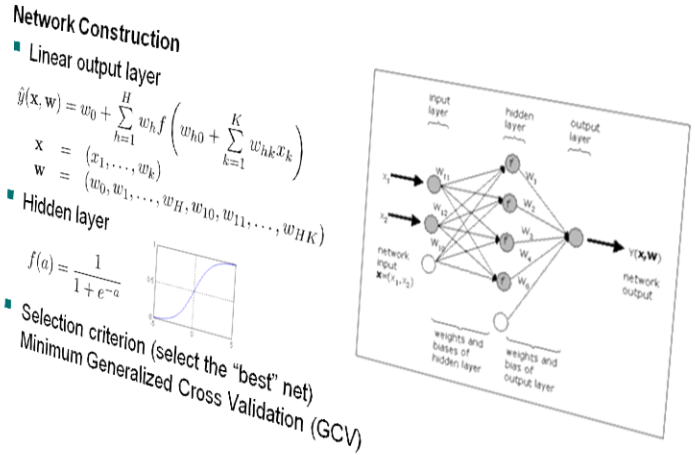


Outlook:

- Investigation of different specimen geometries
- Additional parameters for the yield locus

BMBF: Artificial Intelligence Aided x – David Koch

- Partners:
  - Mercedes-Benz
  - KIT (wbk)
  - TU Berlin (IDA)
  - E+H (Endress+Hauser)
  - USU
- Funding period:
  - 2018-2021 (3 years)
- DYNAmore main focus:
  - Data generation for ML-supported evaluation of simulation results
  - Application of ML for material parameter identification



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Bundesministerium für Bildung und Forschung

Vision for the MCC

- Development, calibration and support for all possible constitutive models or connection techniques our customers may require now or in future.
- Testing is not our main focus – but it complements our efforts to supply robust data for predictive simulation.
- We strive to use leading edge theory (classical mechanics) and data technology (ML) and do even combine the best of these two worlds.
- We touch base with key universities and major labs (FhG, MPI) to ensure LS-DYNA is able to support our users best when it comes to constitutive modelling.

[Start]