BUILDER™
Smart Software Suite
for Robust Design

Forum Ter@tec 2014

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Numerical simulation

Embedded Simulation for a Safer World

GUIDELINE

- **SILKAN Group**
- **BUILDER™ Platform**
- **Use cases**
    - Product/Process integrated design of welded part
    - Crash box connected by spot-welds with characterization of the spot-welds
- On going developments

SILKAN GROUP

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Company Facts & Figures

2007
Founded as HPC Project, became SILKAN in 2012

9 M€
2013 Revenue
70% export
.

Headquarters
Paris area (Meudon la Forêt), ideally located in the aeronautics cluster

78 people
60 high-level engineers (Engineering and PhD)

A full ecosystem
SILKAN is part of GICAT, Systematic, GIFAS, ASTECH

Worldwide locations
France: Paris Region, PACA
Canada: Montreal, QC
USA: Los Altos, CA
Italy: Milano

Our Core Competencies

The company gathers three core competencies, that are usually distinct. Thanks to our TUTOR™ architecture, such competencies can be applied in a single environment, to conceive SILKAN Solutions

Integration & Design of simulation Systems

Requires interactivity with the user. Examples include training simulators and virtual universes
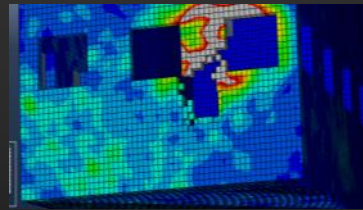
Engineering, numerical Simulation and High Performance Computing

Usually performed as batch, offline, requiring heavy computation infrastructures

Embedded computation, Command & Control, Safety

Subject to "hard real time" constraints (integrity, provability, security, performance…)

A trusted Provider

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Our Awards (2013)

2013
SYSTEMATIC CHAMPION

Champion 2013
of French Systematic
Paris-Region
Competitiveness
Cluster

2013
DELOITTE FAST 500

Technology FAST
500: 46th in EMEA

2013
DELOITTE FAST 50 – FRANCE

Technology FAST 50:
9th in France

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A Strong Commitment Towards R&D

SILKAN is involved in R&D activities with several organizations, which represents an investment of more than 1M$ per year.

> **HPC and // computing**
- Software parallelization on hybrid machines; new parallel algorithms
- Automatic Code generation and parallelization
- Automatic code migration and re-engineering

> **Big Data**
- Big Data
- Data intensive computing and scheduling

> **Simulation**
- V&V and UQ
- Process Simulation
- Interoperability between hierarchical simulation models

> **Numerical Computing**
- Development of high performance solvers
- Model reduction for multi-level and multidisciplinary optimizations

> **Cloud Computing**
- Cloud computing
- Data distribution and locality

BUILDER™ Software Suite For Robust Simulations

- A user friendly environment dedicated to design in a safe way innovative products ensuring the success of their industrialization

- Integrating the most innovative CAE and virtual prototyping tools, from numerical (simulation) to real mockup (Additive Manufacturing)

- Based on standard or Customer use-cases

BUILDER™ IS POWERED BY

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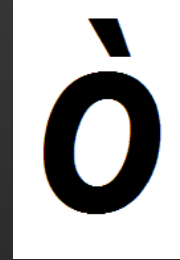
BUILDER™ OBJECTIVES

Increase the competitiveness of innovative companies,

essentially SME's by :

- Reducing "**time to market**" of new innovative products and systems
- Ensuring **quality** and **reliability** of products and systems while respecting international norms and standards
- **Optimizing** the integrated product **Design & Manufacturing** process

Ensure competitive costs without compromising the quality of products

BUILDER™ SOFTWARE SUITE FOR ROBUST SIMULATIONS

Simulation automated processes

Optimization & robustness

product Process coupling

BUILDER™

Use case database & smart WFM

Smart DoE & Surrogate models
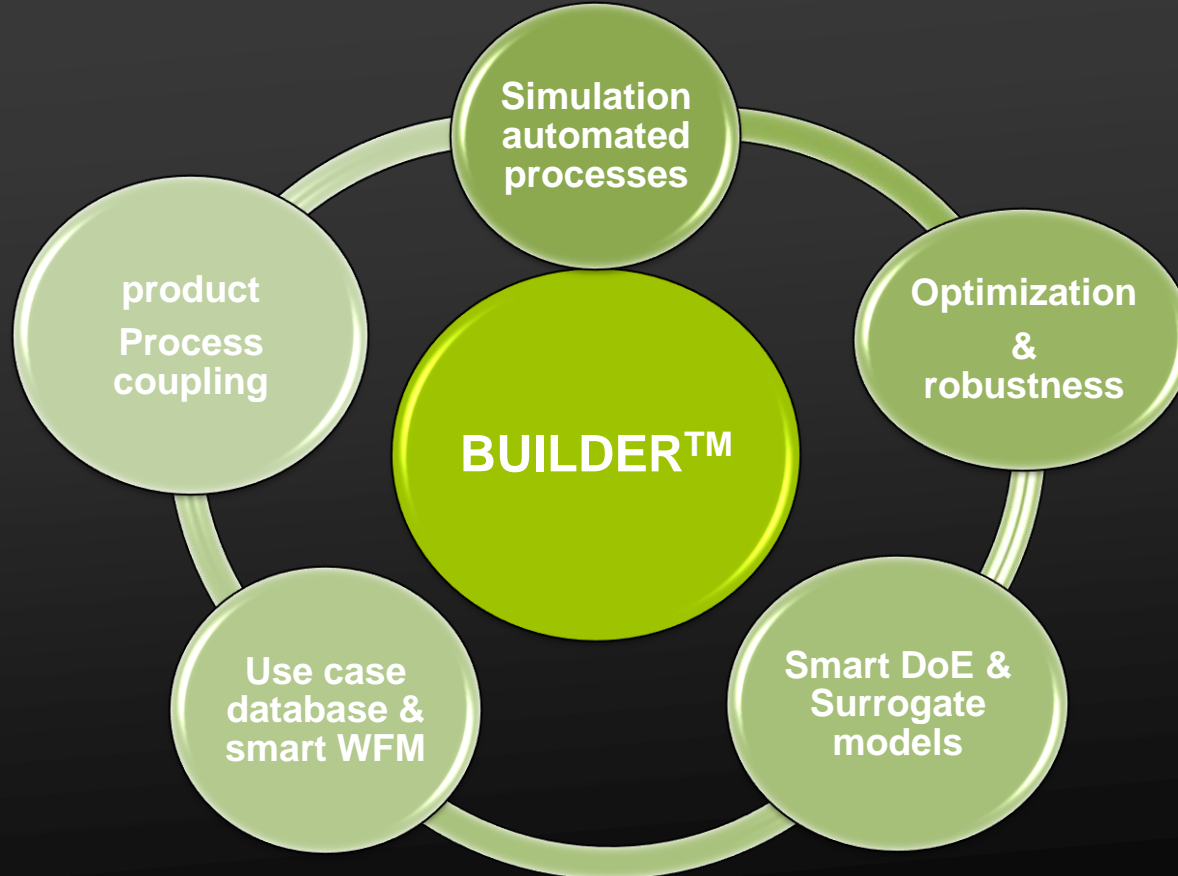
Builder™ to Provide "Simulation as a Service"

Combination

Routines

Applications

Facilitation

Automation

Processes

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Case Study #1
Product/Process integrated design of welded part

Optimization Loop

Creation/importation of geometry → Geometric, material parameters

Welding setting & simulation → Welding parameters

Structural settings & simulation → Loading & BC parameters

Global results analysis of welded part → Evaluation of objective function and constraints

Acceptable part

No

Yes

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Case Study #1
Product/Process integrated design of welded part

Creation/importation of geometry

Welding setting & simulation

Structural settings & simulation

Global results analysis of welded part

DoE

Meta Model

Sensitivity analysis

Meta model Based optimization

Uncertainty propagation

Real time adaptation of product/process parameters for quality & control

Case Study #1
Product/Process integrated design of welded part

Geometry   Creation or importation (CAD software)

- 4 parts, 8 Welding
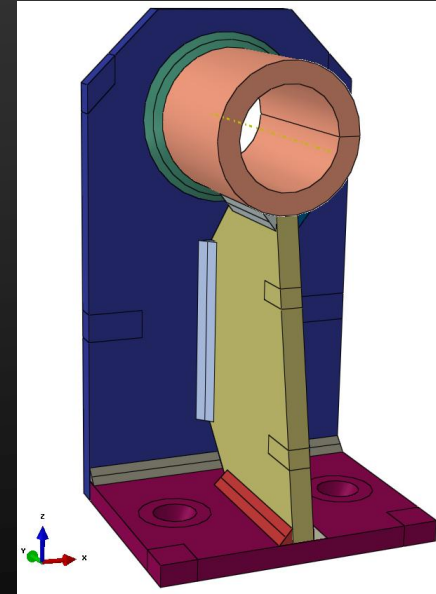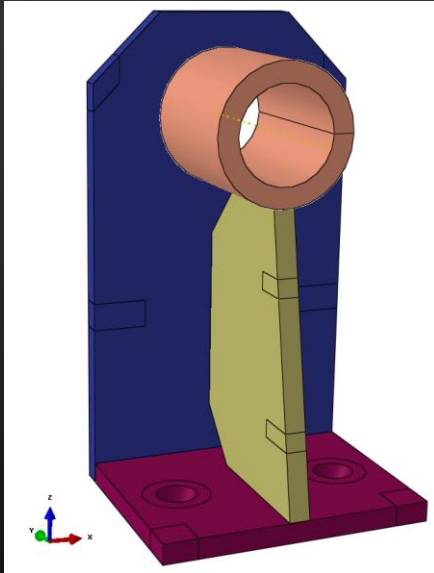
Case Study #1
Product/Process integrated design of welded part

<u>Welding settings</u> (Virfac)

- Heat flux setting, Welding speed, Welding order, Welding direction, Boundary conditions, Cooling time…
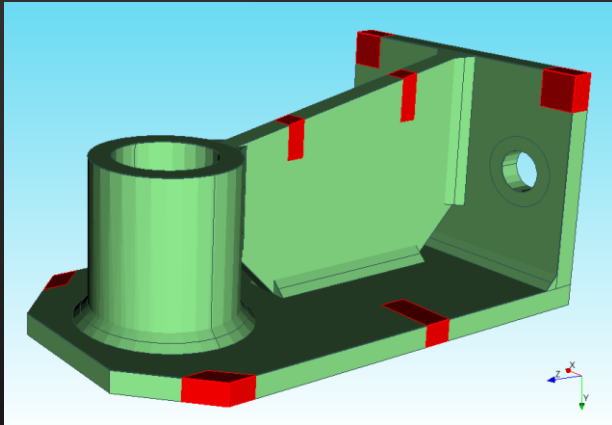
Boundary condition regions
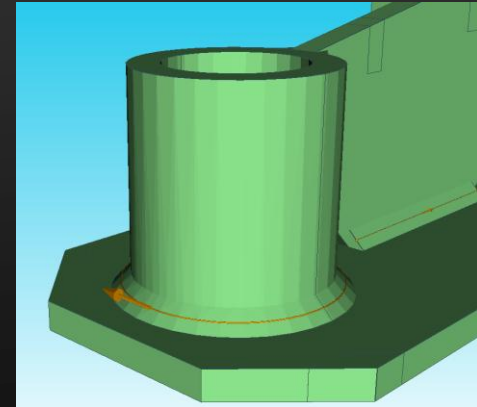
Welding direction

Mesh (VIRFAC)

- Meshing with refinement on welding
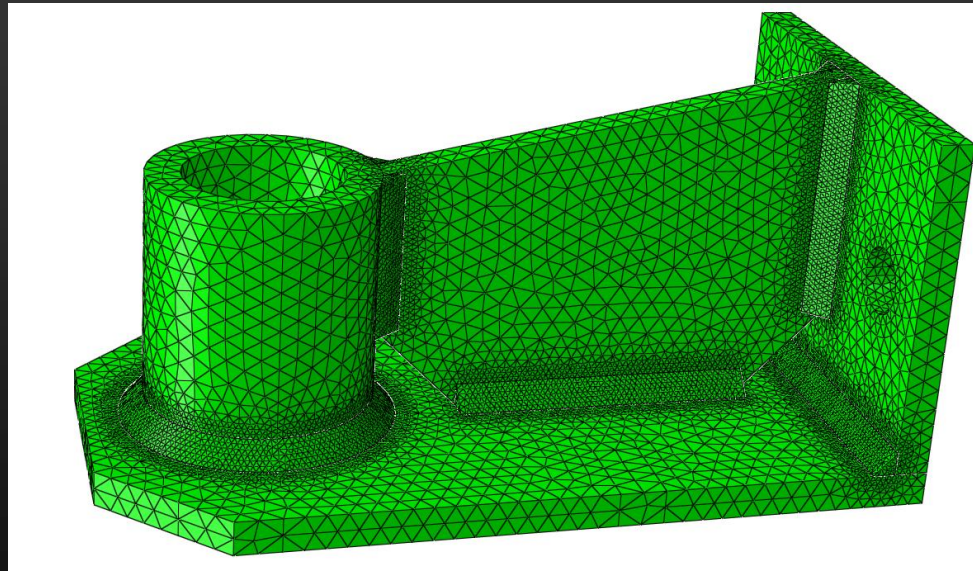
Case Study #1
Product/Process integrated design of welded part

<u>Welding results</u> (Hyperview or PARAVIEW)

- Displacement, Stress, Plastic strain
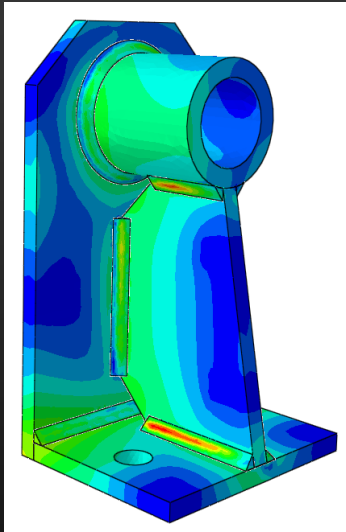
Displacement

Stress

Plastic Strain

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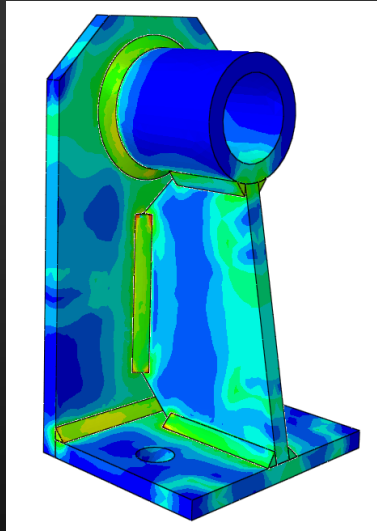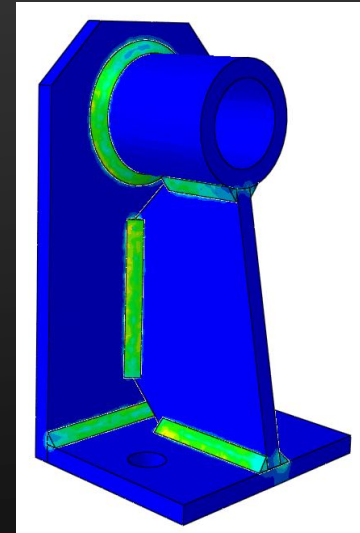
Case Study #1
Product/Process integrated design of welded part

Transfer of welding results: displacement, stresses and plastic strains to Hypermesh/Radioss

Welding Simulation

XML OUTPUT FILES

Silkan framework

Structural Analysis

Input file

STRESS & PLASTIC STRAIN

VIRFAC/Morfeo
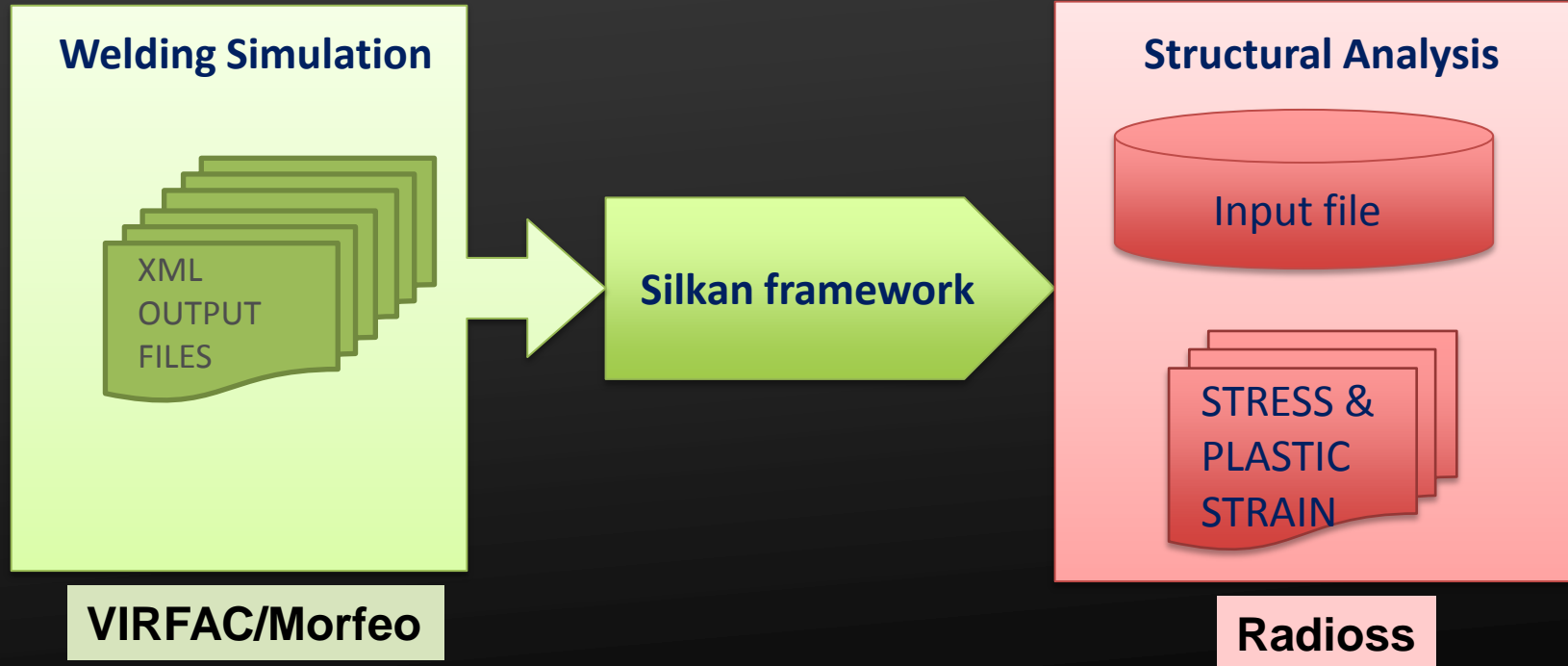
Radioss

Case Study #1
Product/Process integrated design of welded part

Loading setting for structural analysis (Hypermesh/Radioss)

- **Load steps, Boundary conditions, Welding constraints**

Welding Tie constraints
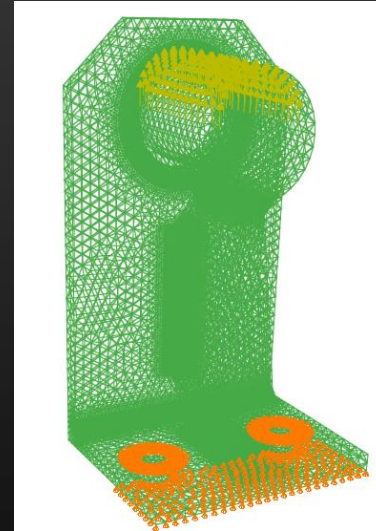
Boundary conditions & Loads

Product/Process integrated design of welded part

Displacement, Stress, Plastic strain, Welding Failure Radioss
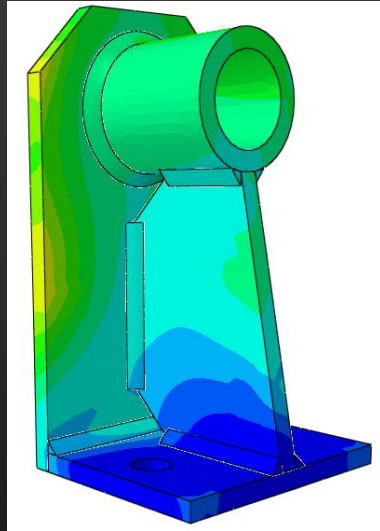
Displacement
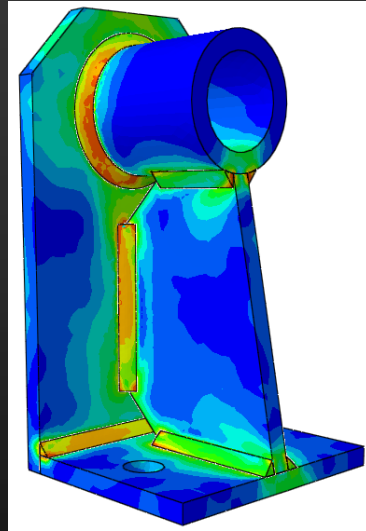
Stress
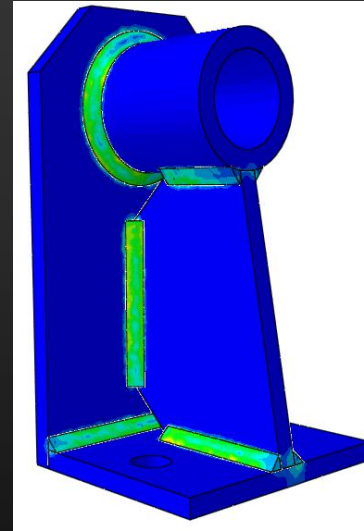
Plastic Strain
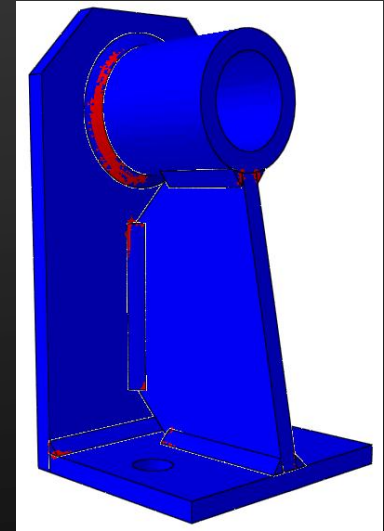
Failure locations

Case Study #2
Crash box connected by spot-welds

Simulation of Spot-weld operation using Virfac/morfeo

Spot-weld Characterization with Radioss (including the effects of the process)

Crash simulation of the box with Radioss

Optimization of the Box with respect to welding and design parameters

Simulation of Spot-Weld operation with Morfeo

Characterization of the spot-weld for Radioss including welding effects
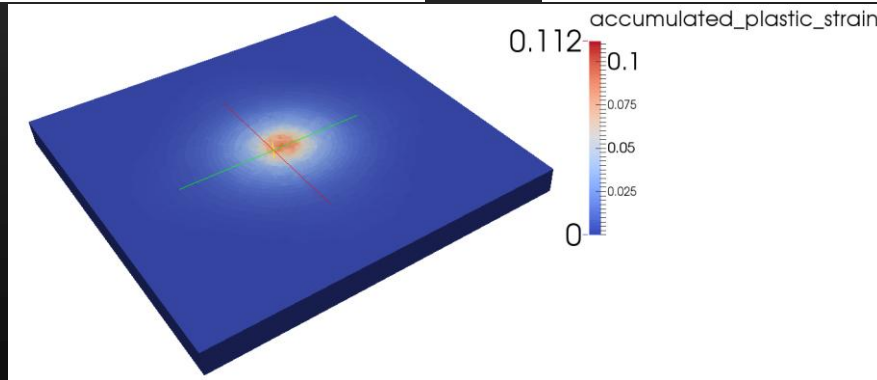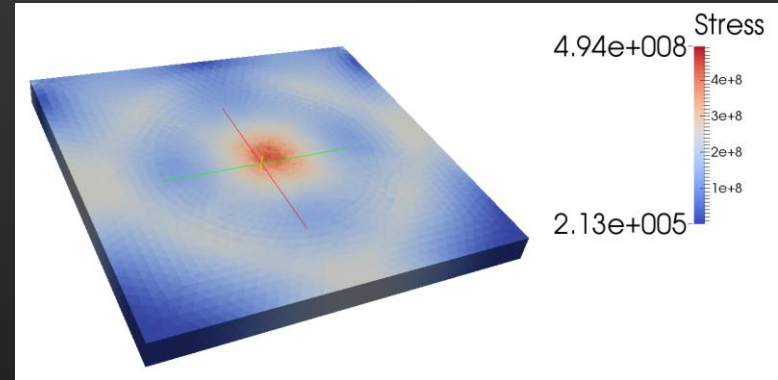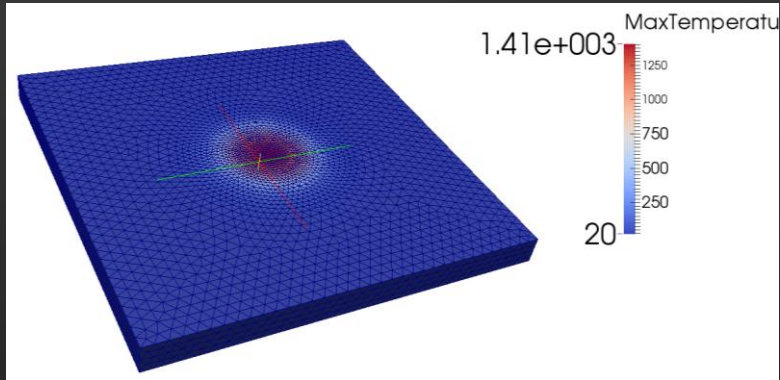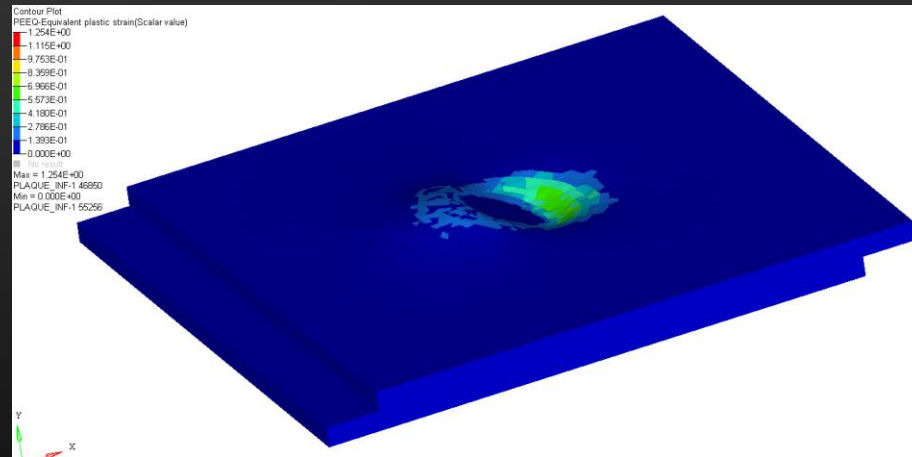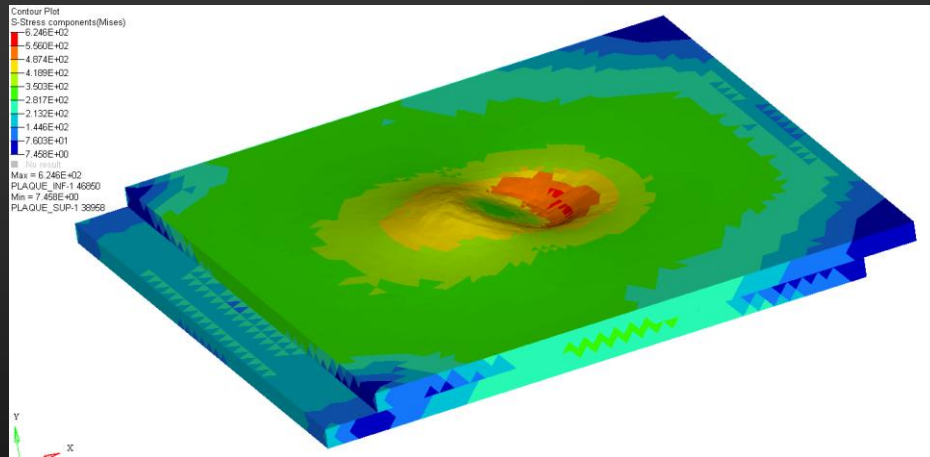
Normal loading

Crash box connected by spot-welds

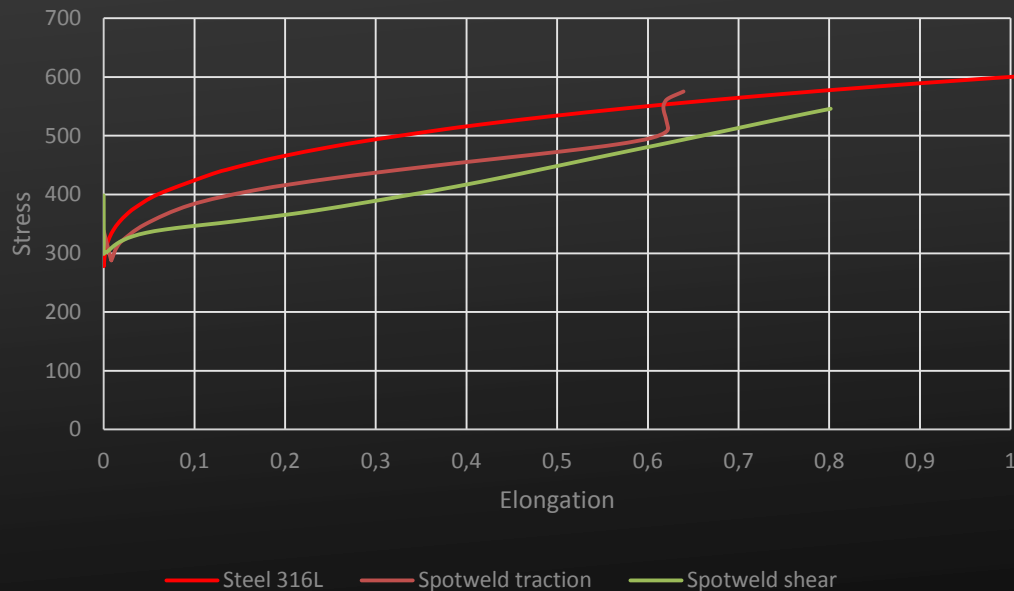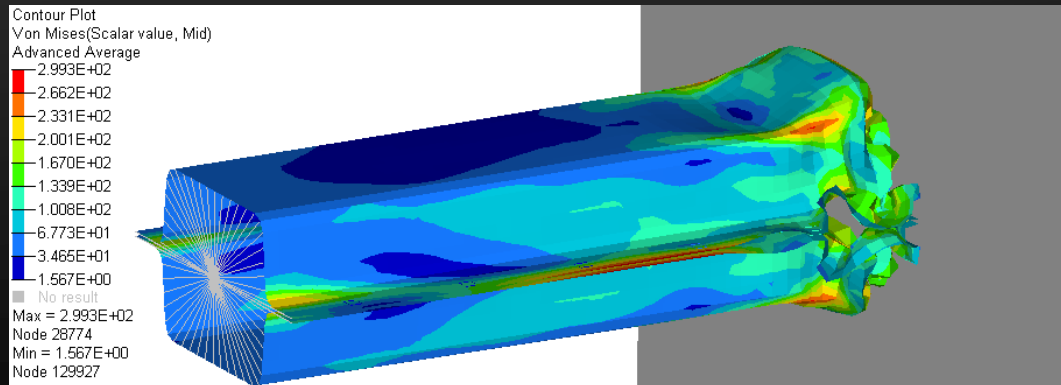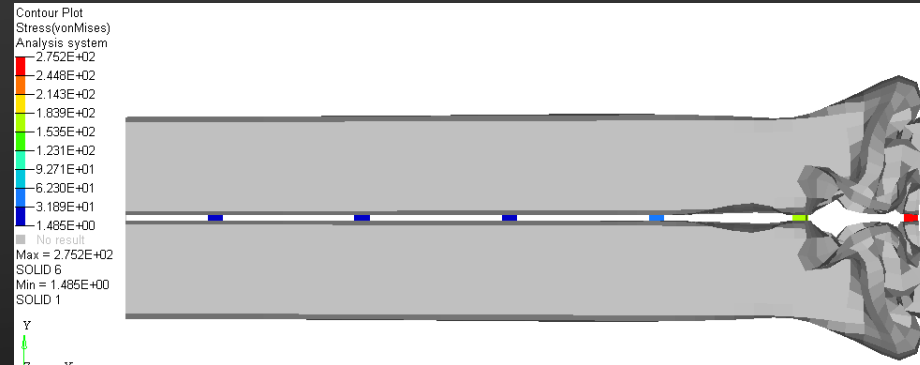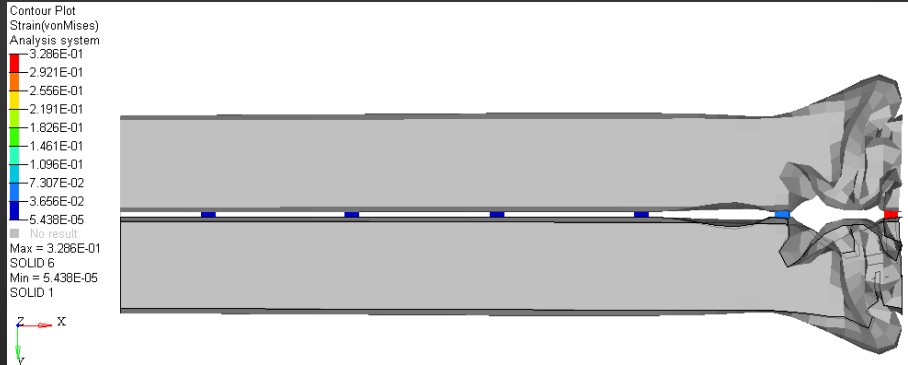Characterization of the spot-weld for Radioss including welding effects

Shear loading

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Characterization of the spot-weld for Radioss including welding effects

Legend: —— Steel 316L   —— Spotweld traction   —— Spotweld shear

(Chart axes: Y-axis "Stress" 0–700, X-axis "Elongation" 0–1)

Spot-Weld Behavior

Crash box connected by spot-welds
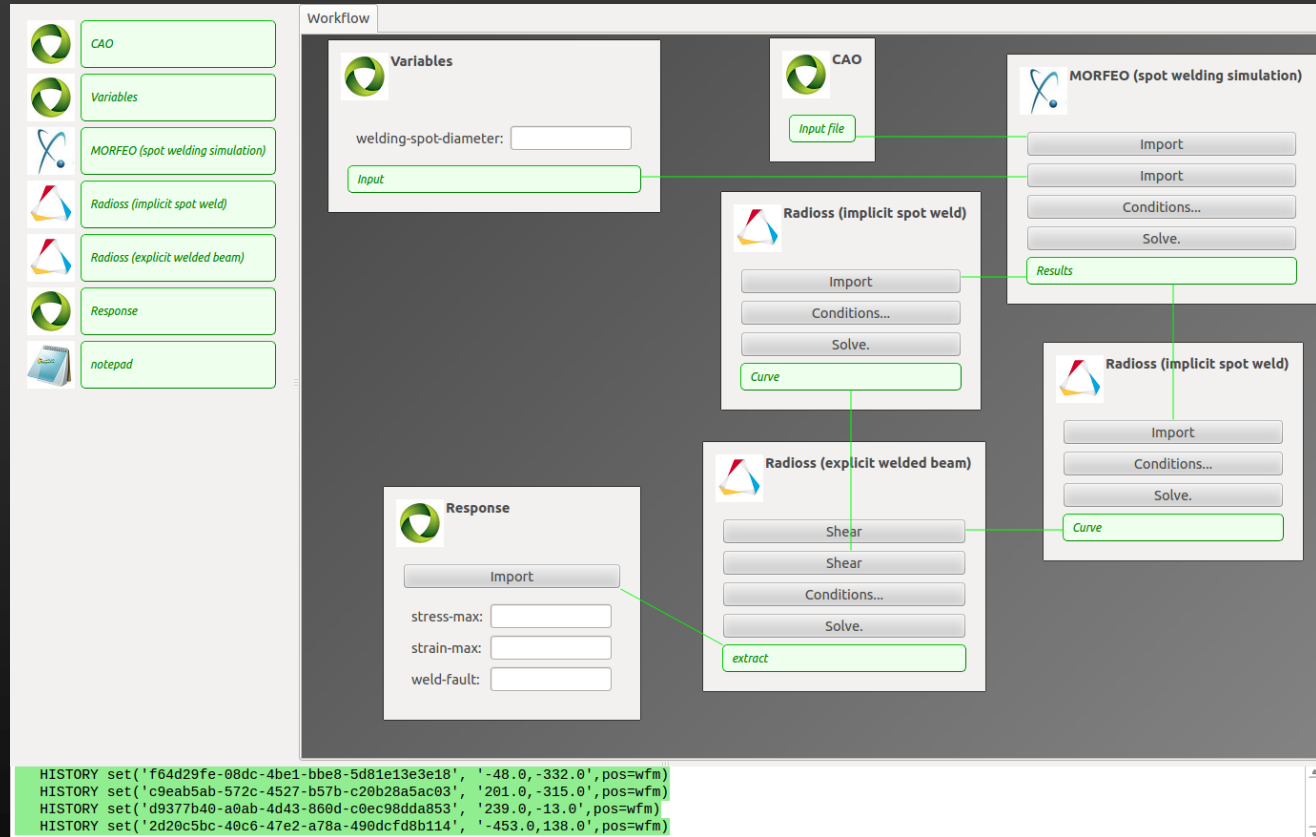
Crash simulation of the welded box

Case Study #2
Crash box connected by spot-welds

Smart Work Flow Manager

On going developments

- Creation of smart DoE using process and product parameters

- Development of Surrogate models of the welded part ➔ make possible the control of the process of welding

- Sensitivity analysis to identify most influent parameters

- Optimization of the design & the welding process

- Robust analysis guaranteeing a targeted failure probability due to parameter variations

Thanks for your Attention!

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