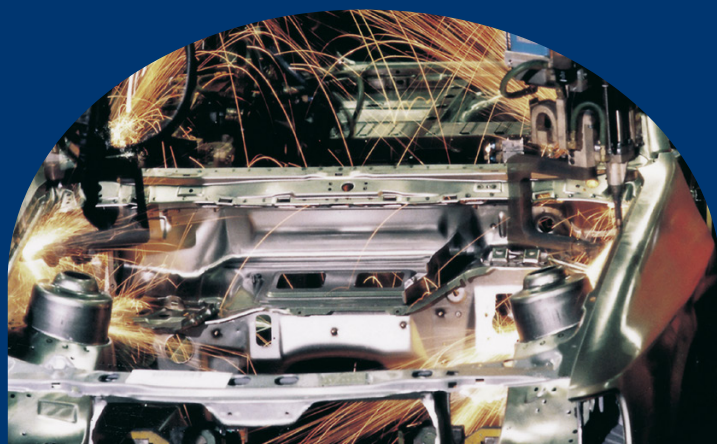# SWANTEC

The Simulation Software for Innovative Welding and Joining

sorpas®

Ensure before welding™

Proudly serving the industries since 1999

Simulation Technology from Design to Welding Production

With more than 25 years of continuous research and development and dedicated services to the industry, our innovative software solution SORPAS® has been widely adopted by industry leaders around the world.

SORPAS®

Design | Optimization | Planning | Production | Testing

Ensure before welding™
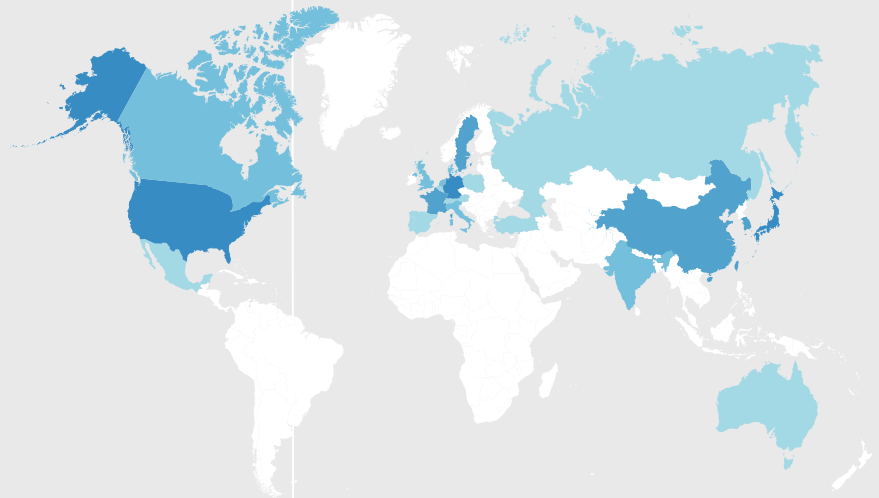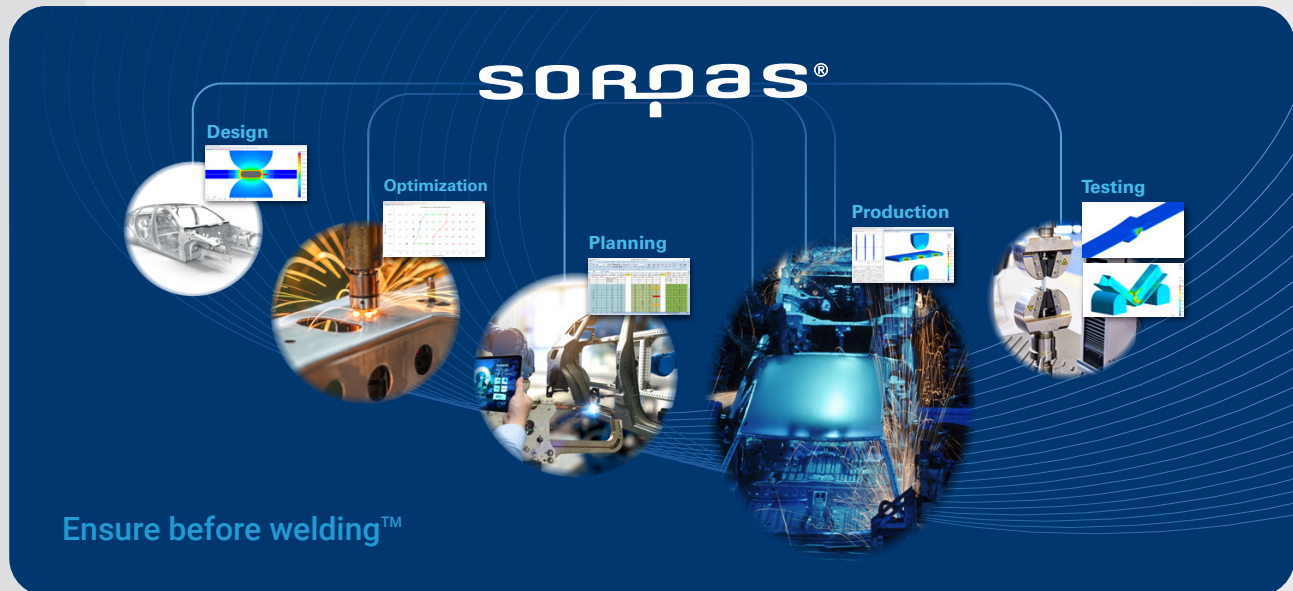
9 out of 10 top automotive OEMs and steel producers have adopted SORPAS®

- in 1999, SWANTEC established in Denmark
- since 2000, first customers in Denmark
- since 2001, first customers in Germany - then France, UK, Italy, Spain, Portugal, Sweden, Austria, Netherlands...
- since 2004, first customers in USA - then Canada, Mexico...
- since 2006, first customers in Japan - then Korea, China, India, Australia...
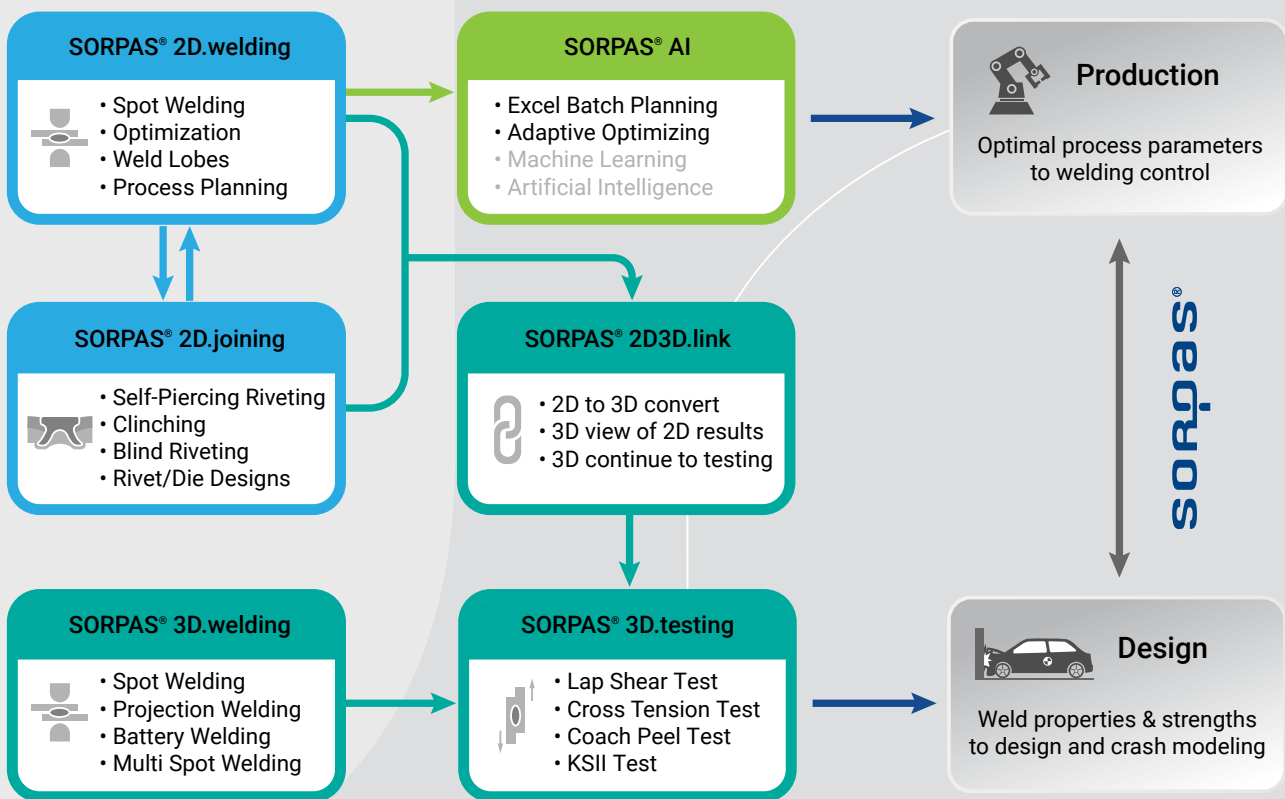
The SORPAS® Software System

The key concept of SORPAS® is to combine welding engineering expertise with numerical simulation, and provide a customized software tool for engineers to use directly in industry for resistance welding and mechanical joining.

Save time and costs

- Speed up development of new products
- Save time and costs for launching new production
- Reduce costs on production maintenance

Improve weld quality

- Optimize welding parameters on production lines
- Eliminate weld defects by optimal process planning
- Solve welding problems in design and production

SORPAS® 2D.welding
- Spot Welding
- Optimization
- Weld Lobes
- Process Planning

SORPAS® AI
- Excel Batch Planning
- Adaptive Optimizing
- Machine Learning
- Artificial Intelligence

Production
Optimal process parameters to welding control

SORPAS® 2D.joining
- Self-Piercing Riveting
- Clinching
- Blind Riveting
- Rivet/Die Designs

SORPAS® 2D3D.link
- 2D to 3D convert
- 3D view of 2D results
- 3D continue to testing

SORPAS® 3D.welding
- Spot Welding
- Projection Welding
- Battery Welding
- Multi Spot Welding

SORPAS® 3D.testing
- Lap Shear Test
- Cross Tension Test
- Coach Peel Test
- KSII Test

Design
Weld properties & strengths to design and crash modeling

Industry sectors with most customers using SORPAS®

- Automotive industry
- Electrical and electronics industry
- Material producing industry
- Welding machinery industry
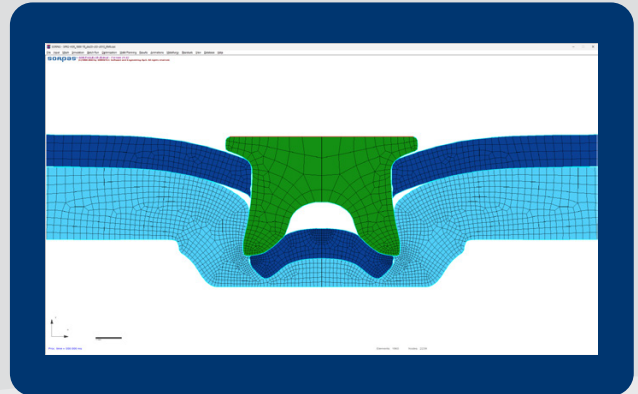- Aerospace industry

SORPAS® Industrial Applications

According to customer feedback, SORPAS® can save 80% of time for fully optimizing the process parameters of a welding production line by reducing the conventional 5 days of work to 1 day.
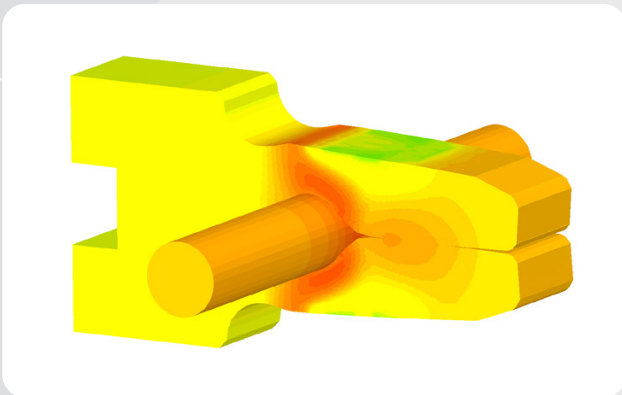
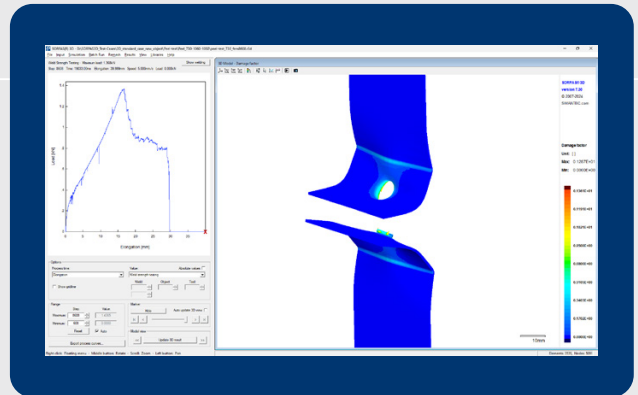## Welding and Joining Simulation and Optimization
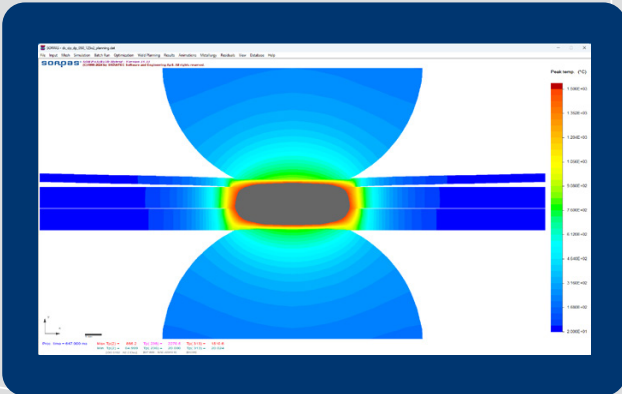
Resistance welding simulations and optimizations

Mechanical joining, SPR and clinching simulations

Resistance welding simulations in electric/electronics


Weld strength testing simulations

The competence of SORPAS®

• Spot, projection and seam welding
• SPR, clinching and riveting
• Weld/joint strength testing

Who need to use SORPAS®

• R&D and CAE engineers
• Welding process planning engineers
• Production maintenance managers

Optimal Process Planning - for the best weld quality and stable production

Step 1: Collect weld tasks into Excel file
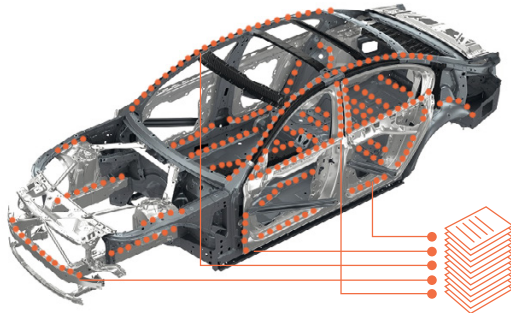
Around 4000-6000 welds with 300-500 new sheet combinations need to be tested and optimized for launching a new car production.

Step 2: Run Excel batch planning

SORPAS® makes simulation files automatically by directly reading data from the Excel file and runs all simulations and optimizations.

Acceptable weld size ✓

Expulsion zone / undersized welds ✗
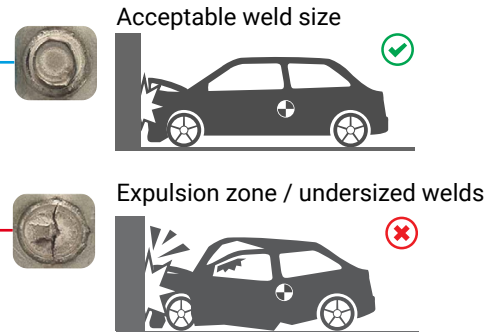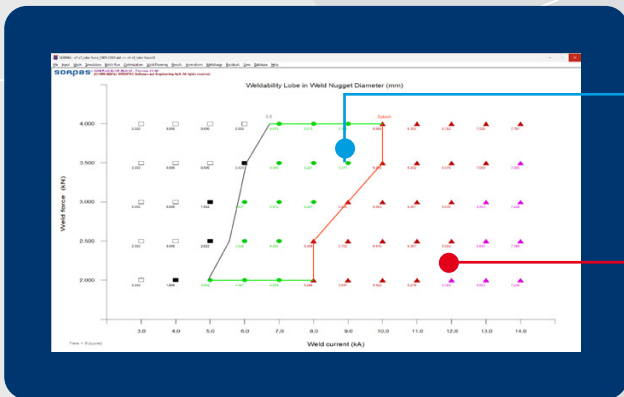
Finding the welding process window with good parameters by weld planning and optimization is the key to ensure before welding whereby to enhance the process control and production maintenance for achieving the best weld quality and stable welding production.

Benefits of optimization

- Reduce expulsion/splash
- Improve weld quality
- Increase production stability

Benefits of optimal weld planning

- Speed up launching of new production
- Increase productivity with batch optimizations
- Reduce costs of production maintenance

SORPAS® 2D.welding

With strong support of industrial leaders and professional partners, we continue to dedicate ourselves to further develop and maintain SORPAS® being a reliable software tool and promote technology advances in welding and joining.
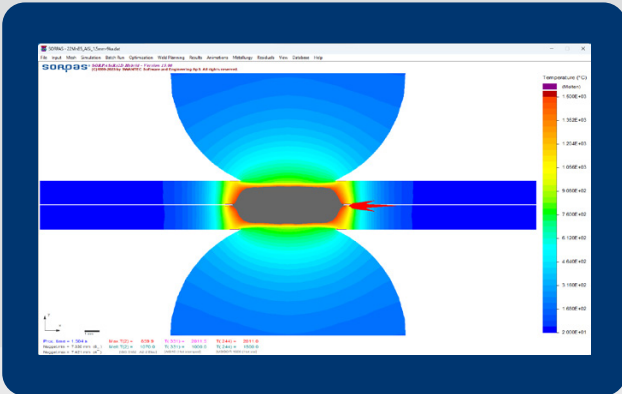

Simulated spot weld nugget formation with nugget sizes at each weld interface and in each sheet with prediction of splash.
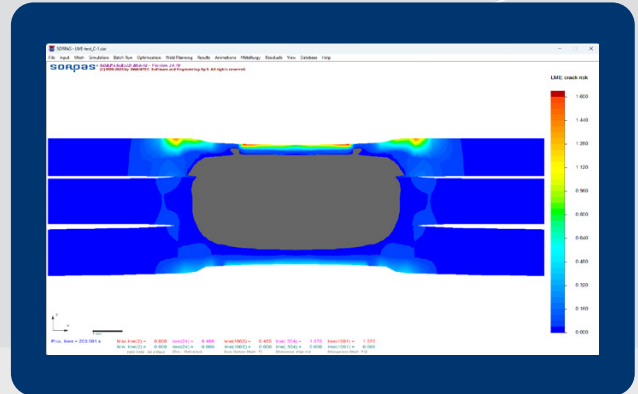
Simulation predicted LME (liquid metal embrittlement) crack risk distribution after spot welding of Zn-coated steel sheets.
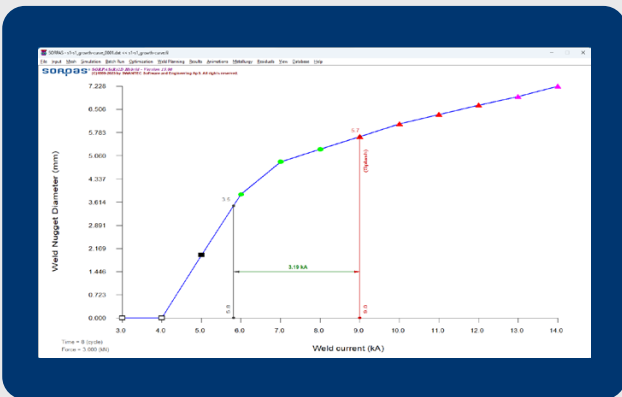
Simulated weld growth curve for prediction of process window with optimal weld current range and prediction of splash limit.
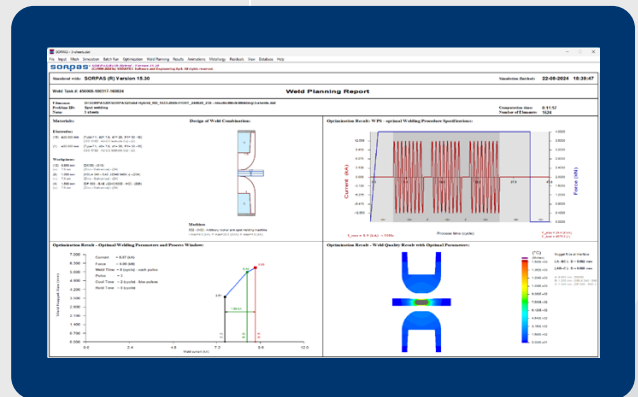
Report of weld planning optimization showing the optimal welding parameters with predicted optimal weld current range.

Weldability and weld designs

- Weld nugget size growth
- Local temperature evolutions
- Dynamic resistance curves
- Displacement of electrode
- Force increase by thermal expansion
- Weldability lobes and growth curves

## Weld quality and optimizations

- Splash (expulsion) prediction
- Welding process planning and optimizations
- Microstructure and hardness distribution
- Prediction of LME crack risk and locations
- Electrode indentation on sheet surface
- Residual stresses and weld distortions

SORPAS® 2D.joining

Mechanical joining is widely applied for joining aluminum alloys and dissimilar materials in automotive and aerospace industries. SORPAS® 2D.joining is specially developed for simulation of mechanical joining processes.
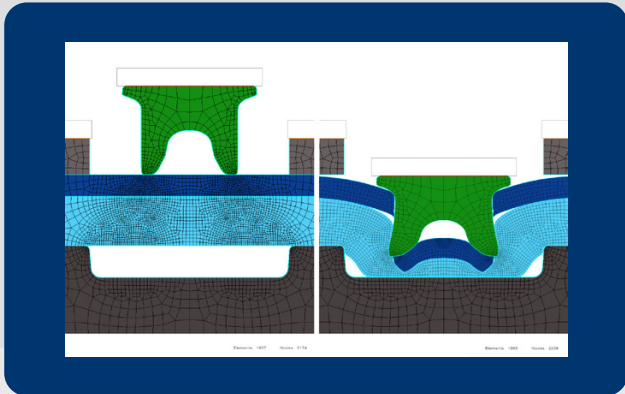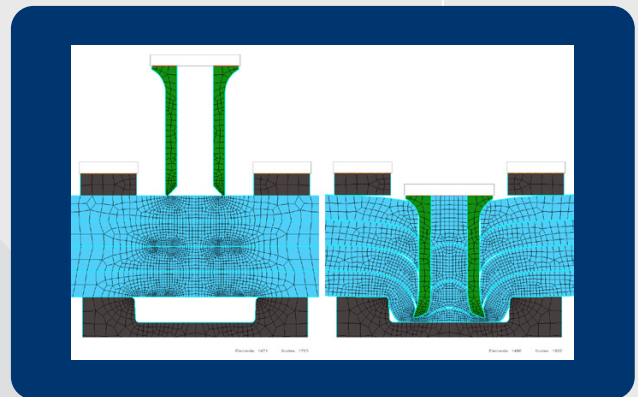

Simulation of self-piercing riveting (SPR) of ultra high strength steel (UHSS) and aluminum alloy with brittle fracture of the UHSS.
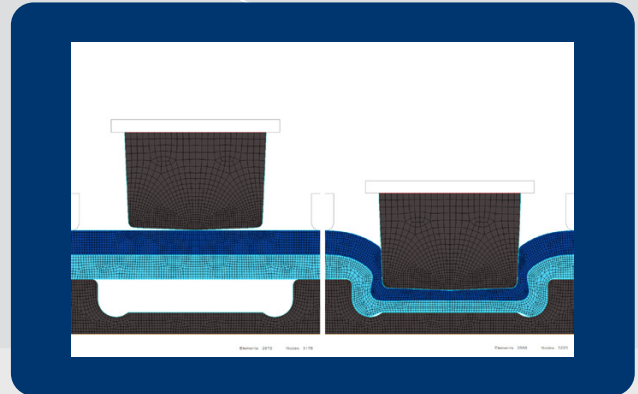
Simulation of clinching of steel to aluminum sheets with adaptive remeshing and frictional contact modeling.
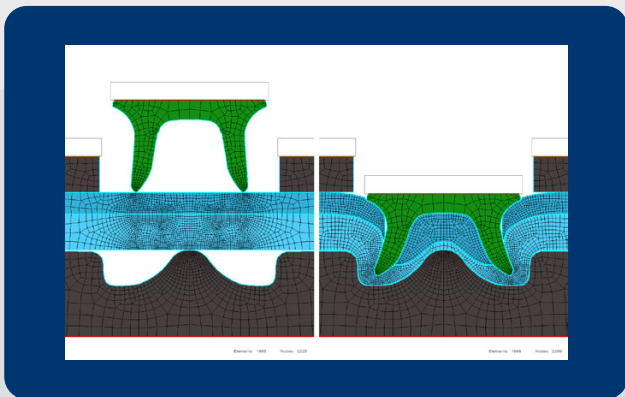
Simulation of self-piercing riveting (SPR) of two aluminum sheets with dimpled die.

Simulation of self-piercing riveting (SPR) of multi-layer aluminum sheets with a hollow tubular rivet.

Mechanical joining processes

- Self-piercing riveting (SPR)
- Clinching
- Solid riveting
- Blind riveting

Special functions and models

- Adaptive remeshing
- Damage and fracture
- Contact modeling
- Friction at contacts

SORPAS® 3D.welding

SORPAS® 3D is developed on the same concept of SORPAS® 2D with straightforward functions and easy-to-use graphic user interface (GUI) for simulations of more complex and challenging applications of resistance welding.
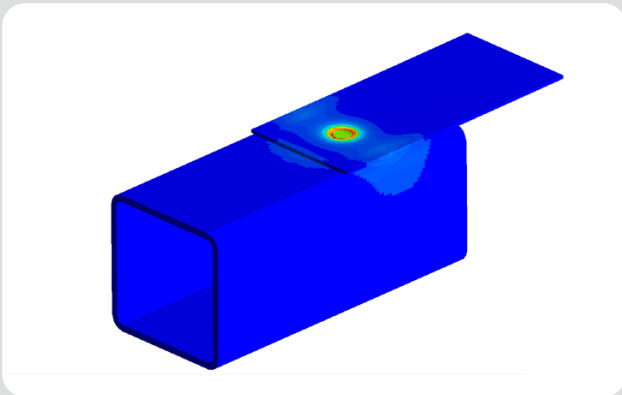
Application cases - automotive
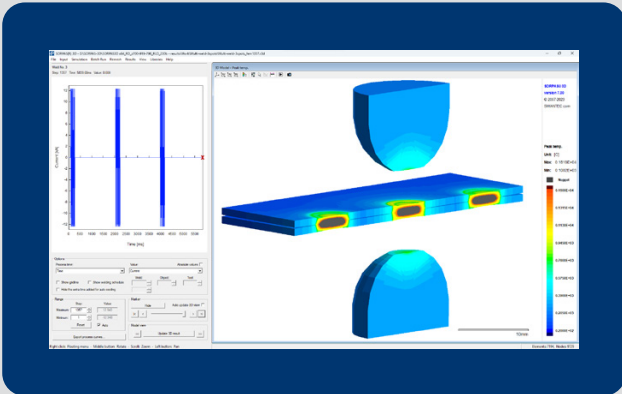
Multi spot welding with shunt effect
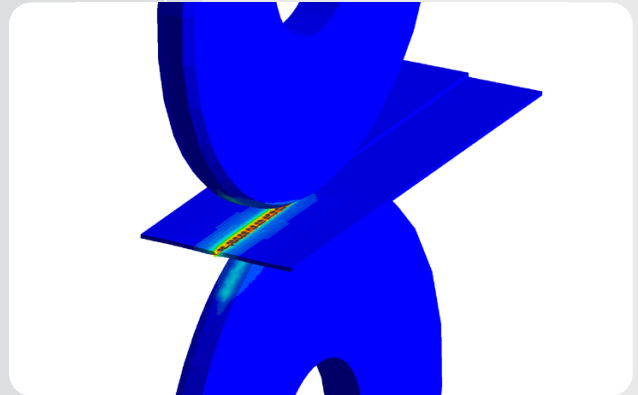3D simulation of a sequence of multiple spot welding with 3 welds to study the shunt effect.
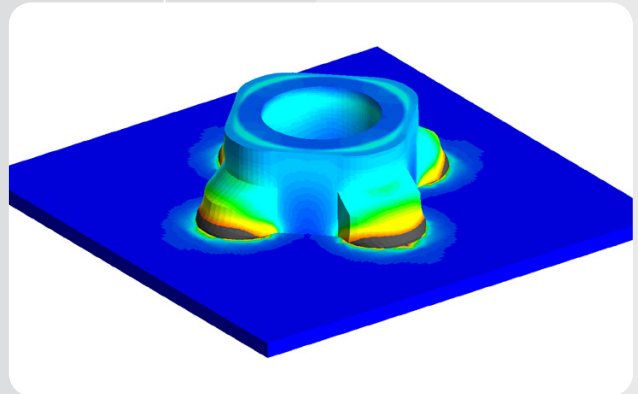
Nut welding
Square nut with corner projections joined to steel sheet showing the weld after collapse of the projections.

Single sided welding
Sheet-to-tube welding with limited access to the structure.

Seam welding
Mash seam welding process simulation with heavy deformation at the weld seam.

## Applications of SORPAS® 3D.welding simulations

- Multiple spot welding
- Electrode misalignments
- Gap between sheets
- Nut welding
- Single sided welding
- Seam welding

- Battery tab welding
- Hot staking (fusing) for joining wires
- Brazing electronic terminals and contactors
- Cross wire welding
- Parallel gap welding
- Butt welding

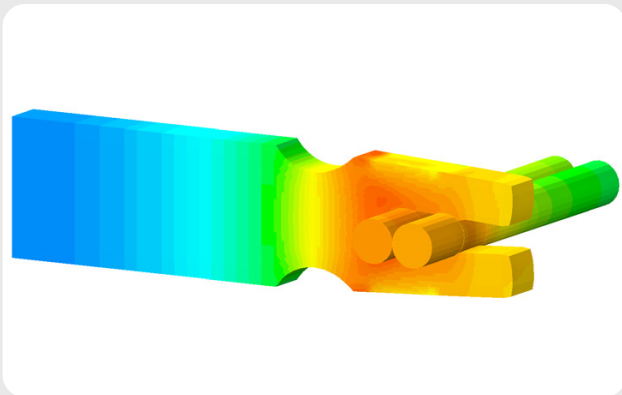## Application cases - electrical
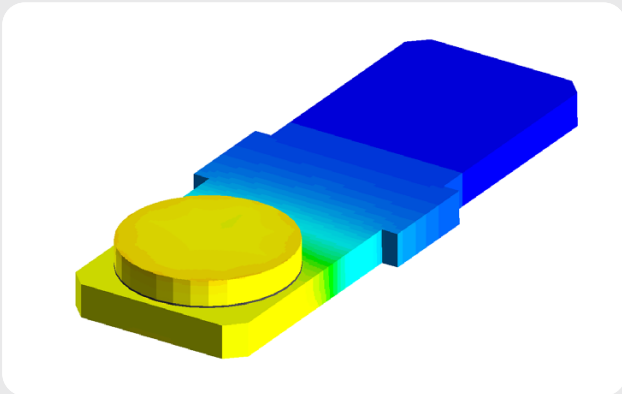
Brazing
Simulation of brazing for joining contactor to terminal with the braze alloy melted while the base metals remain solid.
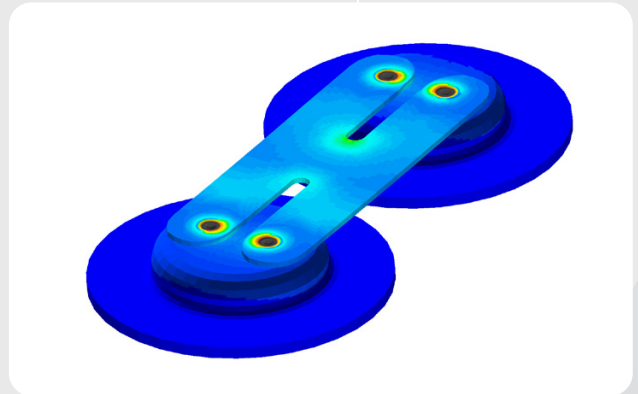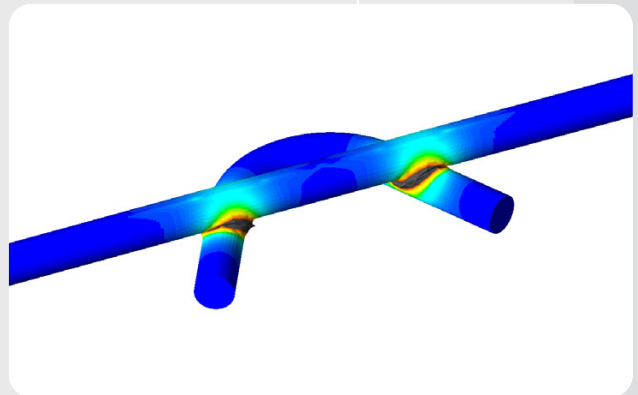

Battery tab welding
Simulation of battery tab welding for connecting battery cells with two weld points by parallel gap welding.

Hot staking (fusing)
Simulation of hot staking (fusing) for joining wires to a terminal by melting down polymer coating on wire to secure electric contact.

Cross wire welding
Simulation of cross wire welding for electrical connections, cages, fences, and reinforcing mesh in construction.

Improve quality and speed up development of electrical joints

The transition to electric vehicles (EVs) demands fast production of more battery packs, sensors, and related electrical connections often with resistance welding.

SORPAS® 3D welding simulations have been increasingly used by customers in electrical industry to speed up their work for designing joints, selecting materials and coatings, and optimizing the welding process settings.

SORPAS® 3D.testing

After welding and joining process simulation, it is possible to continue with simulation of weld strength tests based on the simulated welding and joining results. It can be done with all-in-one 3D simulation model or through 2D3D.link.
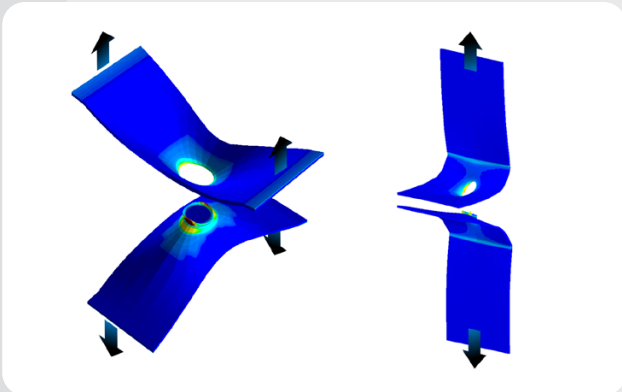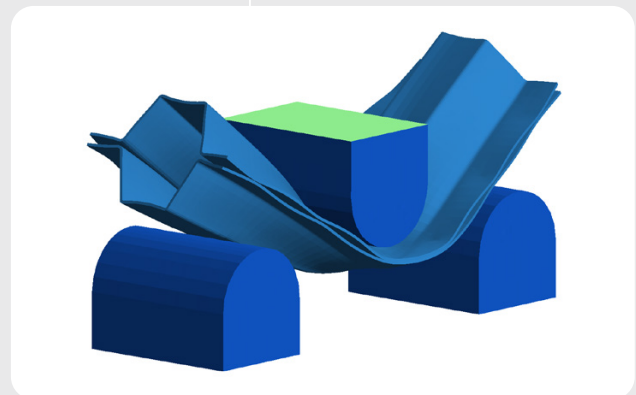

Simulations of cross tension test of spot weld with plug failure and peel test of spot weld with plug failure.
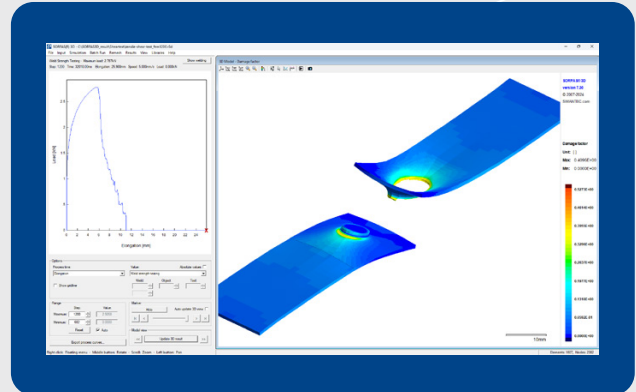
Simulation of tensile shear test of spot weld with plug failure and simulated load-elongation curve.
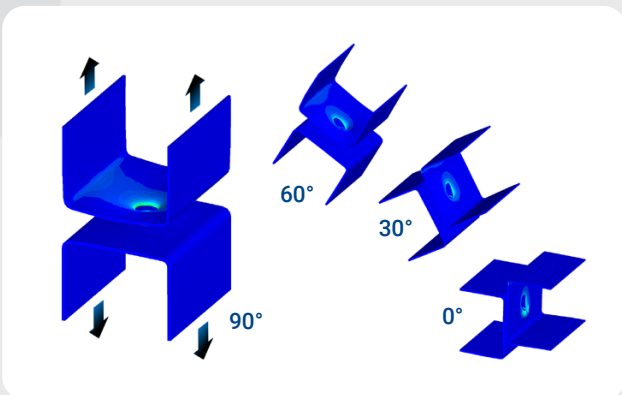
Simulation of KSII test (axial tension test) of spot weld with rotation of different angles.


Simulation of 3-point bending test of double hat beam with totally 12 spot welds.

Output of weld strength testing simulations

• Maximum weld and joint strength
• Load-elongation curves
• Failure mode with damage and fracture
• Distribution of field variables (stress, strain, etc.)

SORPAS® 2D3D.link

Taking advantage of quick 2D simulations, the add-on module SORPAS® 2D3D.link has enabled to run 3D simulations of strength testing continuing from spot welding and mechanical joining simulation results by SORPAS® 2D.
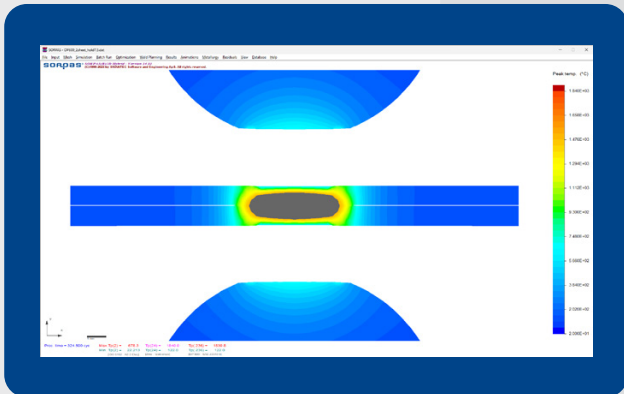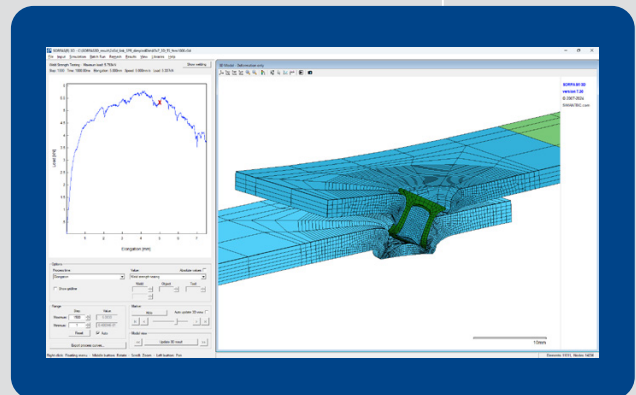

Spot welding simulation results in SORPAS® 2D.welding are converted to 3D for running 3D testing simulation.
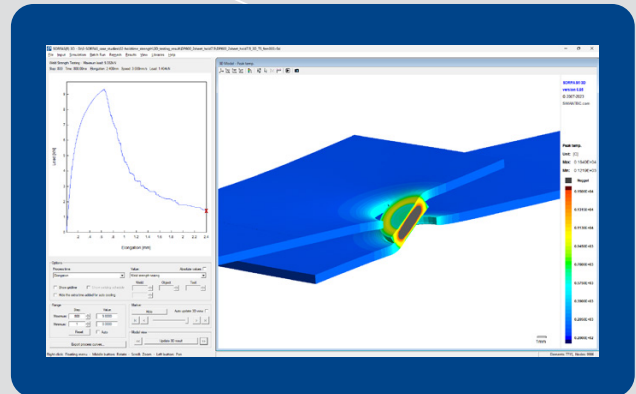
SORPAS® 3D.testing simulation of tensile shear testing of spot weld with resulted load-elongation curve and fracture of welded sheets.
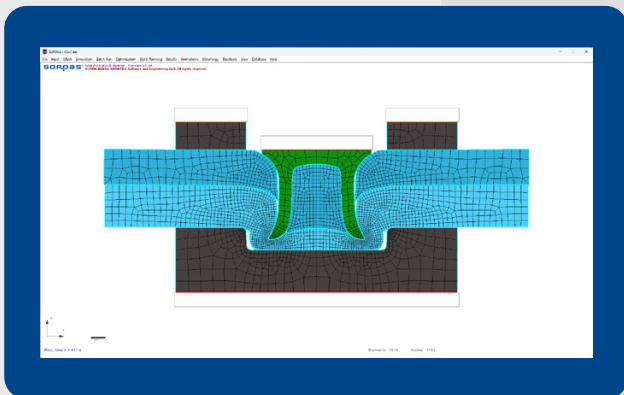
Self-piercing riveting (SPR) results in SORPAS® 2D.joining are converted to 3D for running 3D testing simulation.

SORPAS® 3D.testing simulation of tensile shear testing of SPR with resulted load-elongation curve and damage at the joint.

Applications of weld strength testing simulations

• Predict the weld and joint strengths
• Predict the failure modes (plug or interface)
• Predict the load-elongation curves
• Export weld strengths to other software for structural and crash modeling

SWANTEC

SWANTEC started in 1999 as spin off company from the Technical University of Denmark. Our software SORPAS® is now used by companies and institutes worldwide.

Automotive

- Optimizing welding process parameters
- Predicting weld lobes (process windows)
- Weld planning for optimal welding parameters
- Predicting weld properties with nugget size, microstructures, hardness, LME crack risk, etc.
- Simulating mechanical joining: SPR, clinching

Electrical/Electronics

- Hot staking (fusing) for joining wires
- Battery tab welding for battery connections
- Parallel gap welding for joining small parts
- Resistance brazing for joining contactors
- Cross wire welding for electrical connections
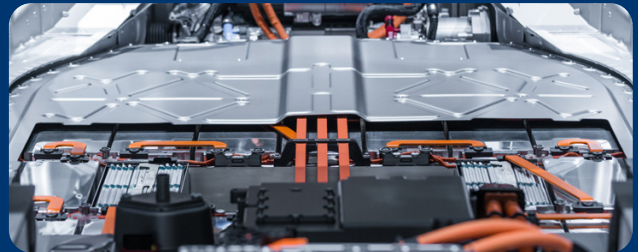
SWANTEC is always in the front line of technology with unique competence in both engineering expertise and an innovative approach in welding and joining.