



OCAS R&D Services

OCAS : a joint venture between ArcelorMittal and the Flemish Region



Examples

Material characterization – Determine Cr⁶⁺ in air

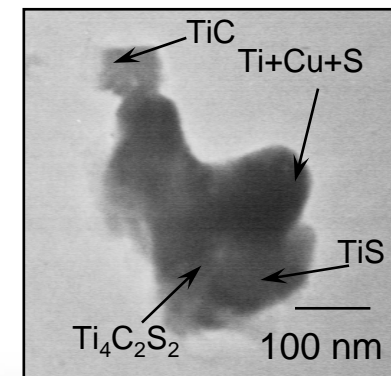
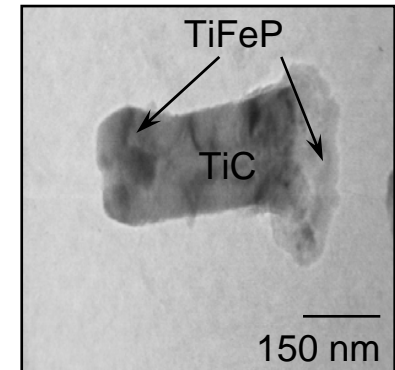
- Request
 - Assess air quality : check presence of Cr⁶⁺ in the proximity of the coating applicator of an industrial production line
 - Risk assessment : exposure level at work place
- Approach
 - Air sampling during industrial trial and analysis according to INRS 084
 - Measuring soluble Cr⁶⁺ and insoluble Cr⁶⁺
- Result
 - Ultra low Cr⁶⁺ concentrations were detected at particular stages of the coating line
 - All values were below exposure limit



Examples

Material characterization – Precipitate analysis

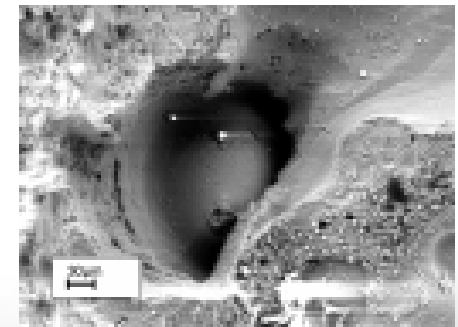
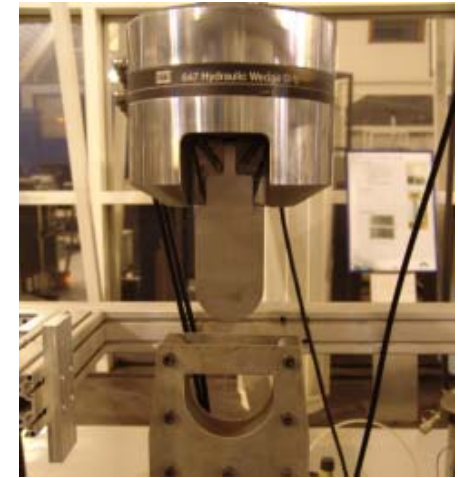
- Request
 - Identify precipitates containing Ti, Mo and/or Nb
- Approach
 - Selective extraction of Ti, Mo and Nb precipitates
 - Analysis by inductively coupled plasma mass spectrometer
- Result
 - Concentration of Ti, Mo and Nb in solid solution
 - Precipitated fraction



Examples

Material characterization - Girth welds of line pipe

- **Request**
 - Characterization of different welding techniques for girth welds using a specific line pipe grade, wall thickness up to 30 mm
 - high tensile strength steel grade tubes
 - suitable for very low temperature usage
 - showing H₂S compatibility
 - Interpretation of the results
- **Approach**
 - Tests according to API 1104 : tensile test, nick break, side bend, hardness, Crack Tip Opening Displacement, chemical composition
 - Additional characterization of the weld through: Charpy tests at different positions, cylindrical tensile tests on weld material
 - Sulphide Stress Corrosion Cracking tests according to EFC/16 to demonstrate H₂S compatibility
- **Result**
 - Two out of three tested welding processes are suitable



Examples

Metallurgical processing – Casting and hot rolling

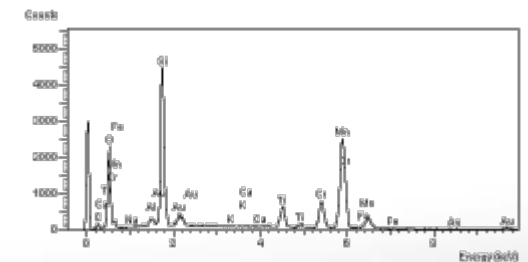
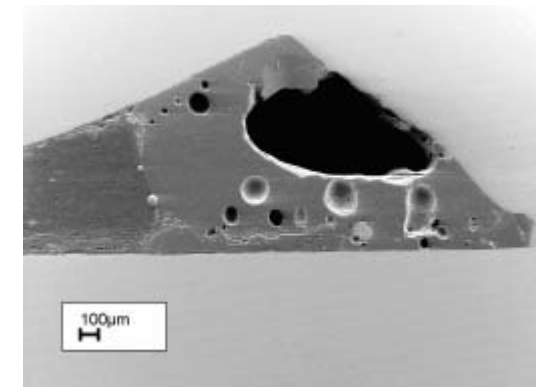
- **Request**
 - Casting of 3 alloys and hot rolling to 1.5 mm sheet
- **Approach**
 - Casting of the alloys using vacuum furnace
 - Reheating
 - Hot rolling to sheet thickness of 1.5 mm using
 - Fully controlled temperature steering
 - Mean flow stress calculation
 - Normalization treatment
- **Result**
 - Sheets all according to specs



Examples

Problem-solving – Stainless steel bike shed

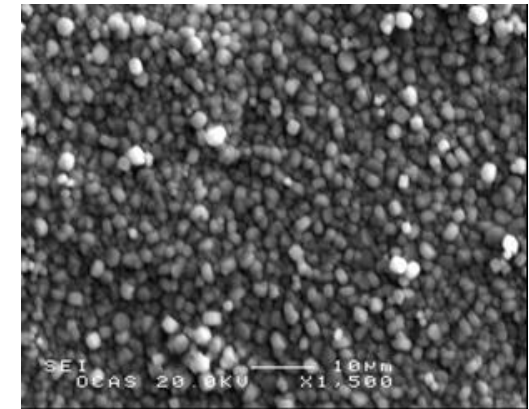
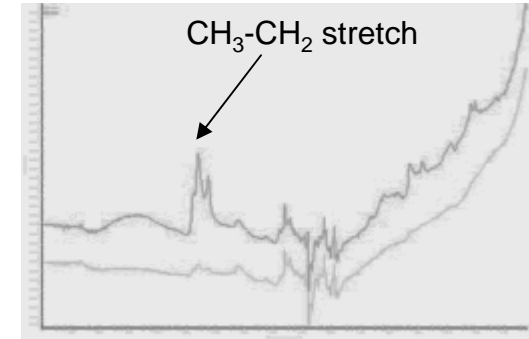
- Request
 - Identify causes for early corrosion on stainless steel bike shed in marine area
- Approach
 - Chemical analysis to determine stainless steel grade
 - Metallography to study weld quality
- Result
 - 2 different stainless steel grades were used, not corresponding to specs, causing early corrosion
 - Poor quality of welds
 - Contamination of stainless steel surface with regular carbon steel traces during processing, causing early corrosion



Examples

Problem-solving – Phosphating defect

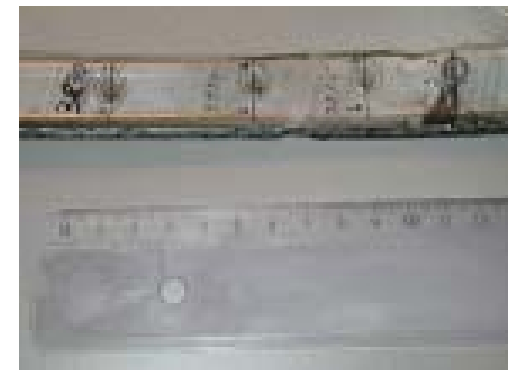
- **Problem**
 - Poor ability to phosphate and paint local areas on cold rolled sheet
- **Approach**
 - Surface characterization by
 - glow discharge optical emission spectrometry
 - fourier transform infra-red analysis
 - Determination of carbon residues by combustion
 - Simulations in our phosphate and paint lab
- **Conclusion**
 - High amounts of carbon residues remain after degreasing
 - Ageing of protective oil by air and natural UV led to poor degreasing, causing bad phosphate and paint layers



Examples

Problem-solving – Failure of spot welds

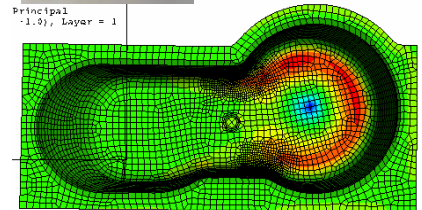
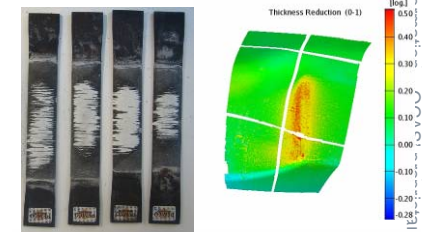
- **Problem**
 - Failure of thinnest sheet during crash test
- **Approach**
 - Spot welds were cross sectioned and investigated with the stereo- and the optical microscope
 - Several weld dimensions were measured for each spot weld
- **Conclusion**
 - Spot welds showed considerable variation in shape and size of weld nugget
 - In some cases no or only very limited nugget formation was found in the thinnest sheet



Examples

Problem-solving – Prevent enamel cracks in bathtub

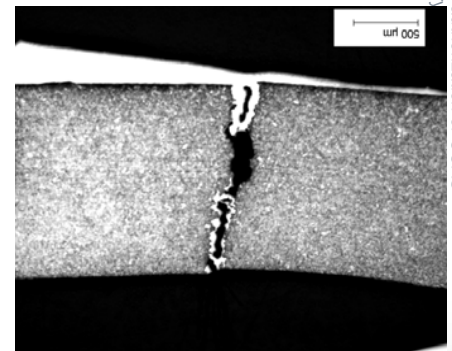
- **Problem**
 - Cracking during loading by end-user
- **Approach**
 - Strain analysis after deep drawing
 - Testing enamel flexibility as function of deformation level
 - Simulation of structural stiffness
- **Conclusion**
 - Cracking related to insufficient stiffness of integrated shower part of bathtub
 - Design problem
- **Proposal**
 - Design modifications



Examples

Problem-solving – Avoid rupture in brazed assembly

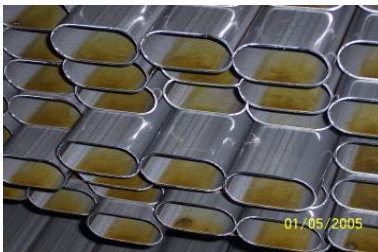
- **Problem**
 - Cracks in heat exchanger after brazing pipe and collector
- **Approach**
 - Analysis of each step of production process
 - Identification of cause : forming process induces internal stresses leading to inter-granular crack
- **Proposal**
 - Use of more robust steel grade
 - Change from flame brazing to arc brazing to minimize heat input



Examples

Problem-solving – Avoid white rust on galvanized tubes

- **Problem**
 - Occasional white rust problem on galvanized tubes
- **Approach**
 - Plant visit and analysis of each step of production process
 - Characterization of the defect
 - Accelerated lab corrosion tests to simulate the defect
- **Result**
 - Identification of cause at production process of customer



Sticky deposits



Dry spots and/or white rust



White rust

Examples

Problem-solving – Laser cutting

- **Problem**
 - Different laser cutting behaviour of 2 apparently identical samples
- **Approach**
 - Material characterization of both samples
 - Laboratory laser cutting tests
- **Result**
 - Chemical composition of both samples is different
 - Lab laser cutting trials confirm customer observations
 - S/Mn of one sample was unfavourable for laser cutting
 - In addition, differences in scale affected the laser cuttability



Poor laser cut

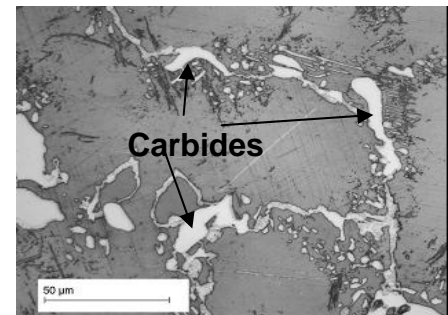


Good laser cut

Examples

Problem-solving – Rupture Hadfield steel rope pear

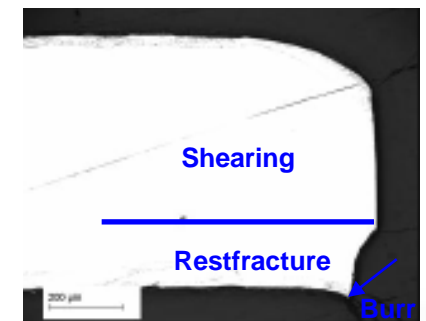
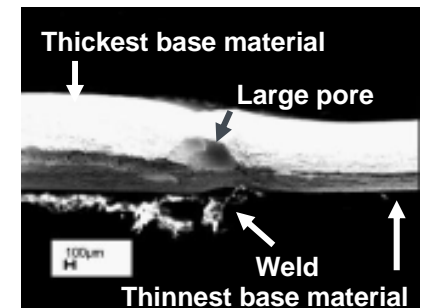
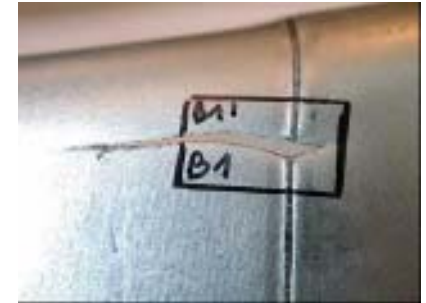
- **Problem**
 - Hadfield steel rope pear sockets show early rupture during use
- **Approach**
 - Material characterization of 2 broken and 1 new rope pear including optical microscopy of cross sections, hardness measurements, chemical analysis
 - Simulation of different annealing cycles on new rope pear
- **Result**
 - Annealing the rope pear socket after inserting the rope and fixing it with a casting mass is much more critical than instructions given by supplier
 - Recommendations for controlled heat treatment of rope pear



Examples

Problem-solving – Rupture of tailor welded blank

- **Problem**
 - Galvanized tailor welded blank shows cracks around the weld after forming
- **Approach**
 - Material characterization of welded parts as well as cut blanks
- **Result**
 - Pores were found in the weld at the side of the thinnest blank
 - No impurities were found in the base material
 - Analysis of the cut edge of the thinnest blank revealed poor cut quality
 - Poor cut edge quality caused keyhole instability trapping impurities



Examples

Rapid prototyping – Top panel washing machine

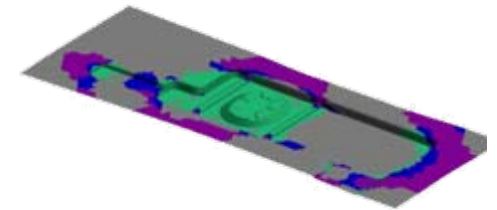
- Request
 - Decrease time to prototype from 4-6 months to 2-3 weeks
- Response
 - Investment in an incremental forming technique apparatus providing a full scale 3D prototype from a CAD file
 - Synergy with simulation of conventional forming process
- Result
 - Successful examples in appliance, auto, mechanical engineering



Design Phase: CAD drawing



Fast Prototype



Forming simulation

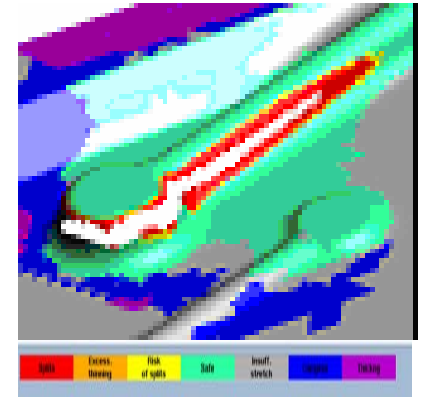


Real part

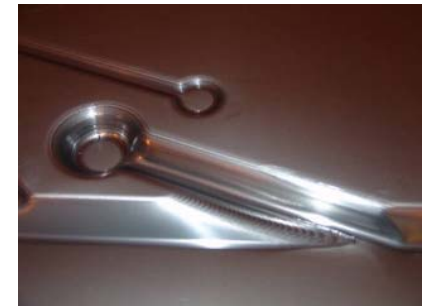
Examples

Rapid prototyping – Back panel

- Request
 - Optimise new design for stamping
 - Prototype back panel to integrate into new model
- Approach
 - Forming simulation optimising wall angle & radii to improve design for stamping, in compliance with initial requirements
 - Rapid prototyping of panels by incremental forming
 - Finishing prototypes by cutting & bending
- Result
 - Customer successfully assembled new model based on prototypes, considerably reducing development time and cost



Design & simulation results

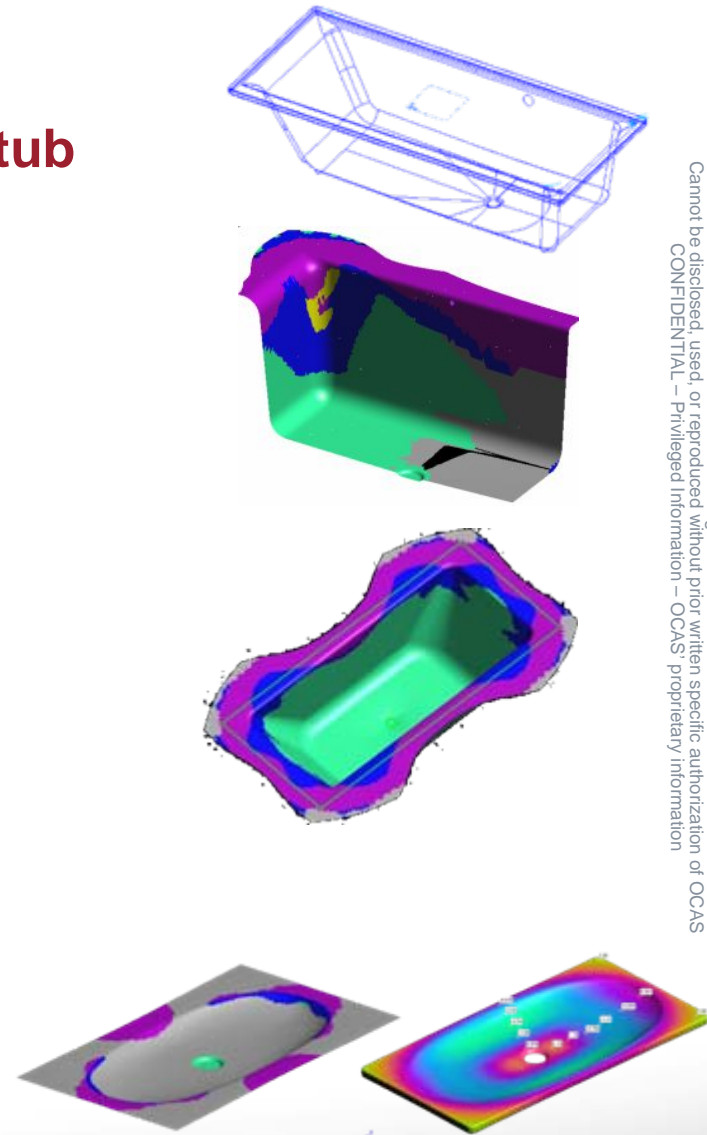


Detail of prototype

Examples

Co-design – New design steep walled bathtub New design shower

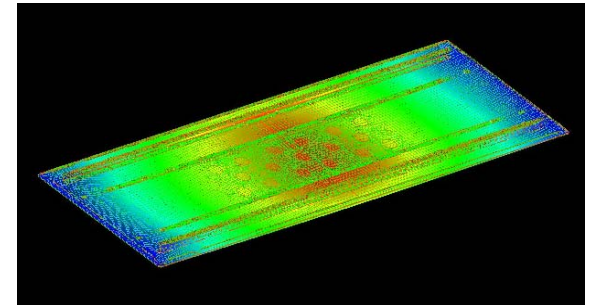
- Request
 - Deep drawing feasibility study
 - Selection of steel grade
- Approach
 - Deep drawing simulation to determine optimal
 - Steel grade
 - Geometry
 - Blank geometry
 - Springback analysis
- Result
 - Development of softer enamelling grade
 - Proposal to modify geometry in critical areas



Examples

Co-design – Optimize back panel stiffness of electrical cabinet

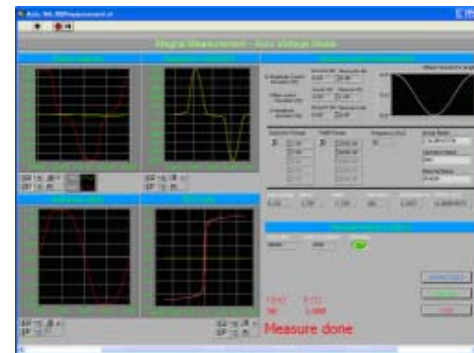
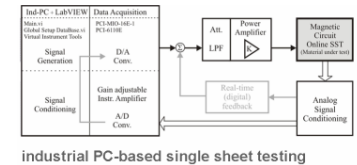
- Request
 - Optimize design for max. deflection at given load
- Approach
 - Comparison of different assemblies
 - With or without stiffening plate
 - Vertical or horizontal embossments
 - U-shaped reinforcements
 - Different sheet thickness
- Result
 - Best results were obtained with U-shaped reinforcements



Examples

Co-design – On-line system to characterize magnetic sheet

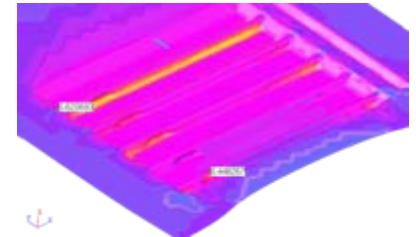
- **Request**
 - On-line advanced measuring system for 50 Hz AC properties magnetisation losses, polarisation curve, coercivity, remanent polarisation, relative permeability, relative permeability
- **Approach**
 - Development of a tailor made device in close partnership with customer
- **Result**
 - Installation of device and software
 - Training sessions
 - Helpdesk functionality
 - Maintenance plan



Examples

Co-engineering – Design of new oven cavity

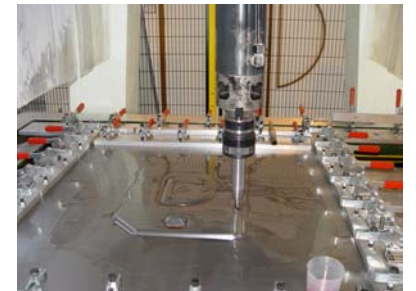
- Request
 - Design new oven cavity optimising stampability and thermal behaviour during and after enamelling
- Approach
 - Forming simulations to assess stampability
 - Thermal calculations to study enamelling behaviour
- Results
 - Customer agreed with our recommendations and asked us for rapid prototyping of final design
 - Successful assembly and enamelling of prototyped parts by customer



Stamping simulation



Enamelling simulation

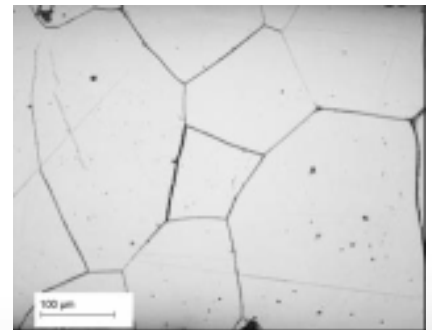
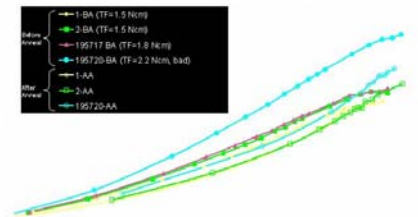
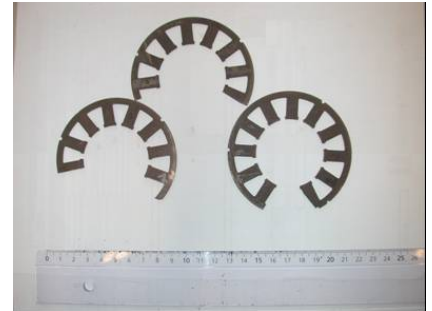


Rapid prototyping final part

Examples

Co-engineering – Improved magnetic properties of stator cores

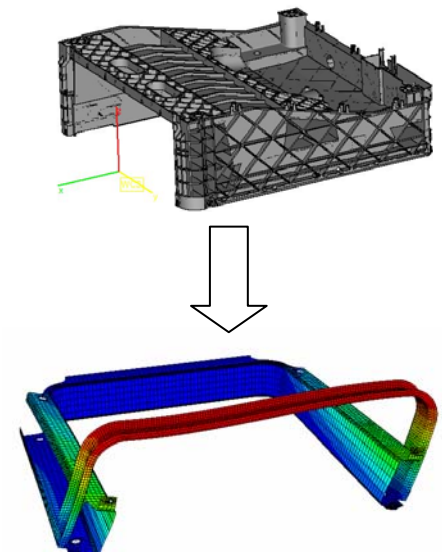
- Request
 - study annealing influences on magnetic properties of stator
- Approach
 - identify optimum annealing process for different grades
 - metallography to visualize grain size
 - magnetic measurements using versatile Magna-setup
- Result
 - improvement in hysteresis losses after annealing
 - improvement in magnetic performance allowing significant cost reduction for customer



Examples

Co-engineering – Washing machine base carrier

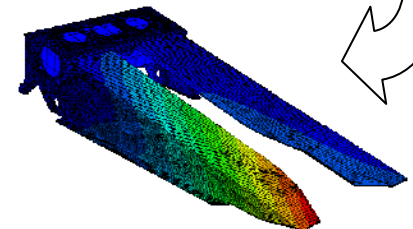
- Request
 - Replace plastic by steel for the base carrier of a high-end washing machine
- Proposal
 - Use of modern steel grades, including pre-painted
 - Integration of multiple functions
 - Cost efficient, easy assembly
- Result
 - Steel design used in future high volume types
 - Further optimization on structure including vibrational behaviour (enhance Eigenfrequency)



Examples

Co-engineering - Weight reduction of reaping arm

- Request
 - Extend the reaping arm from 8 up to 12 row units
 - Reduce weight
 - Increase payload
- Proposal
 - Change to high strength steel grade
 - Innovative design to optimize assembly
- Result
 - Weight and cost reduction
 - Easy assembly
 - Improved stiffness
 - Improved logistics
 - Customer accepted and implemented new steel solution



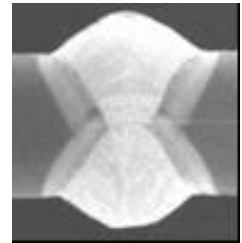
Examples

Co-engineering – Hybrid welding for crane arm

- **Request**
 - Improve total loading capacity of telescopic boom
 - Ensure overall security of crane
 - Reduce weight
- **Proposal**
 - Introduction of high strength steel grade
 - Change from conventional arc welding to hybrid laser-arc welding
- **Result**
 - Thanks to hybrid welding
 - welding speed could be more than tripled
 - less filler wire is required
 - lower heat input thus lower distortion
 - Microstructure and mechanical properties meet specs



Hybrid laser MAG
single pass



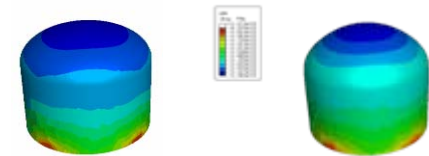
MAG process
two passes



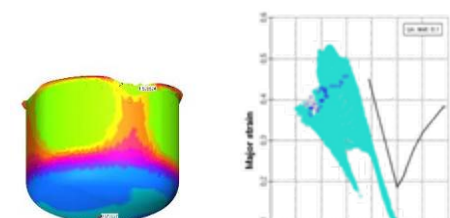
Examples

Co-engineering – Compete composite gas bottles

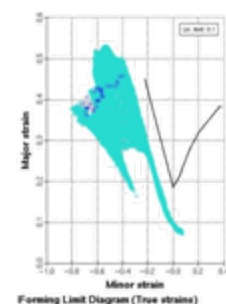
- Request
 - Innovative steel answer to composite gas bottles
- Approach
 - Reduce wall thickness by using high strength grade
 - Include beneficial effect of work hardening of selected grade to pass burst test
 - Check weldability
- Result
 - Good correlation between experimental strain analysis and deep drawing simulation
 - Successful testing at customer (weld, burst and drop test)
 - Weight of innovative steel gas bottle < composite !



Burst simulation



Deep drawing simulation

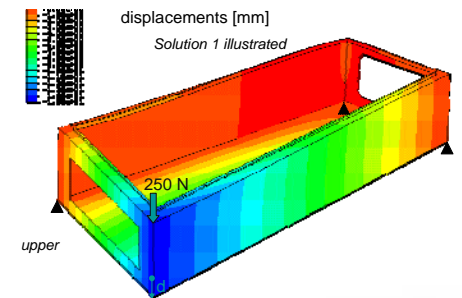
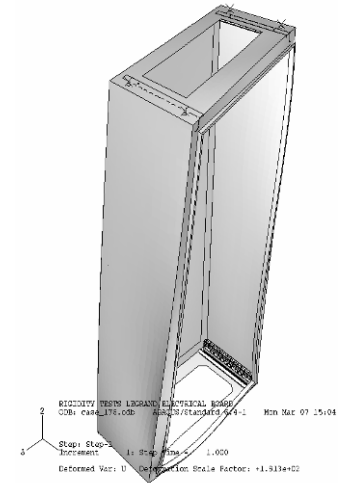


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Examples

Co-engineering – Optimize panel thickness of cabinet

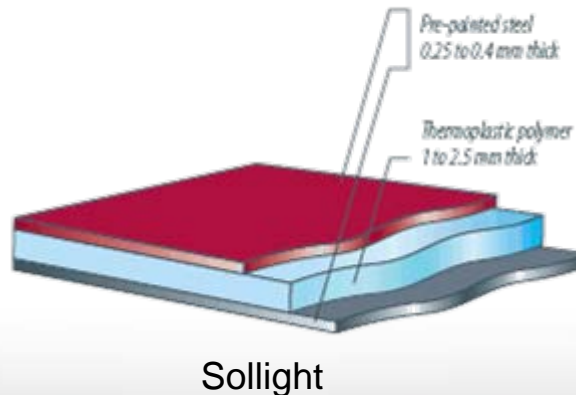
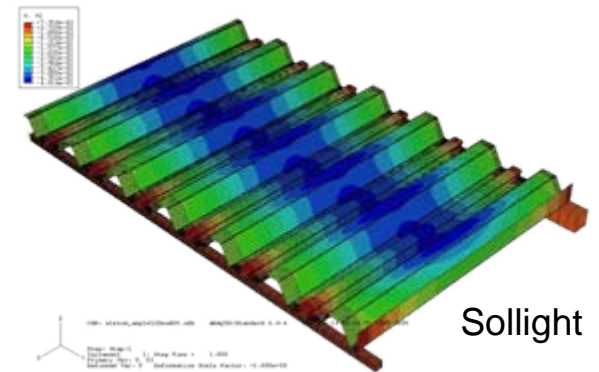
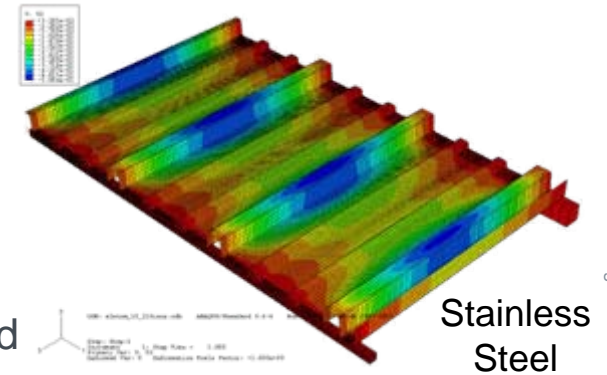
- Request
 - Thickness optimization of cabinet panels
 - Change to more cost effective steel grade
- Approach
 - Finite element modelling to simulate rigidity of cabinet
 - Check simulation results with real life tests at customer
- Result
 - Good correlation between experimental results and simulation
 - Change of steel grade validated



Examples

Co-engineering – Public transport flooring

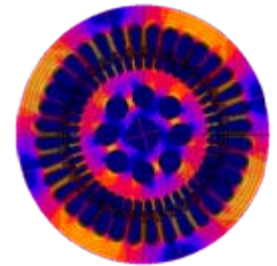
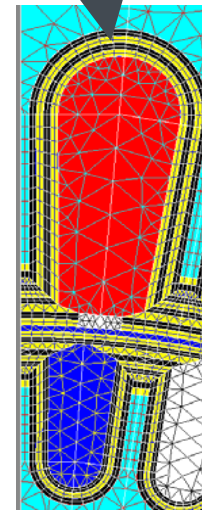
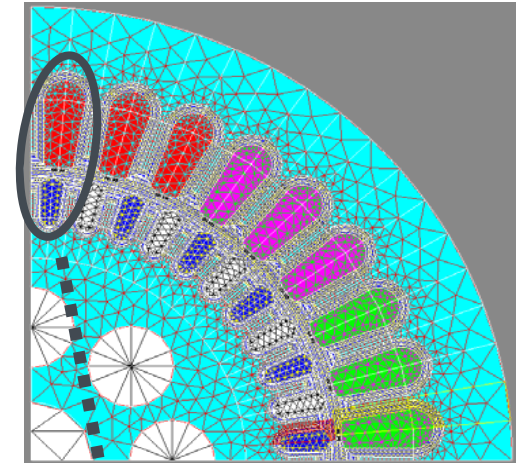
- Request
 - Weight and noise reduction
 - Deflection under vertical load : max 0.5 mm
- Approach
 - Finite element modelling on deflection for given load
- Proposal
 - Weight reduction of 30 % by
 - Implementing improved design
 - Replacing stainless steel grade with Sollight



Examples

Co-engineering – Simulation of electrical motor

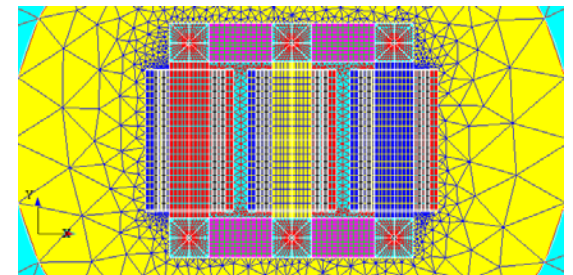
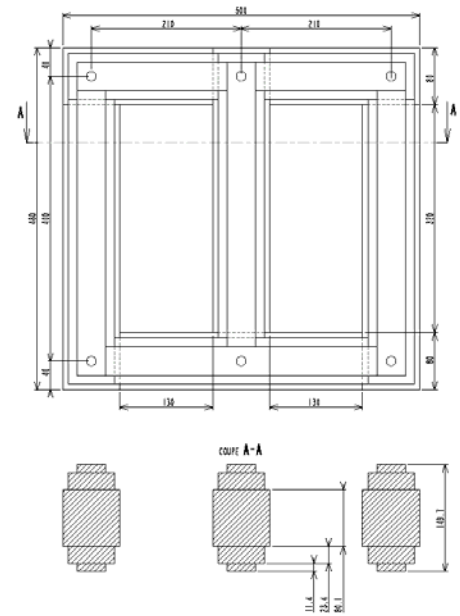
- Request
 - Improve performance of 750W 3-phase 4-pole induction machine
- Approach
 - Finite element simulations
 - Measurement of the effects of punching and mechanical press-fit of stator in housing on magnetical behaviour
- Results
 - Excellent correlation between measured and predicted current and torque
 - Clear view on potential improvement of press-fit and punching
 - Efficiency increase by using other steel grade



Examples

Co-engineering – Redesign of transformers

- Request
 - Check the possibility to use the most cost efficient non-oriented electrical steel grades in transformers, instead of grain oriented electrical steel
- Proposal
 - A transformer with identical characteristics can be made, provided design changes are taken into account
- Progress
 - Clear case of value creation for our customer, who is switching towards use of a non-oriented electrical steel grade for transformers



Examples

R&D Partnership – New steel grade for pipes

- Request
 - Study potential new steel grades for heavy duty pipes
- Approach
 - Identification of the need in close partnership with customer
 - Literature & patent survey
 - Selection of optimum chemical composition
 - Determine process parameters based on numerical modelling of metallurgical transformations
 - Casting and rolling of several heats on laboratory scale
 - Full characterization of the product
 - microstructure by metallography, precipitate analysis
 - Physical testing : charpy, tensile test, hardness,
- Result
 - Reporting to customer on more performant steel grades for heavy duty pipes
 - Plan to fine-tune and to scale up

