

Ganzheitliche Betrachtung der Verzugskompensation beim Zusammenbau geschweißter umgeformter Blechkomponenten aus hochfesten Stählen

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Technischer Arbeitskreis
„Kaltumformung moderner Stahlwerkstoffe“

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Walter Neff GmbH, Karlsruhe



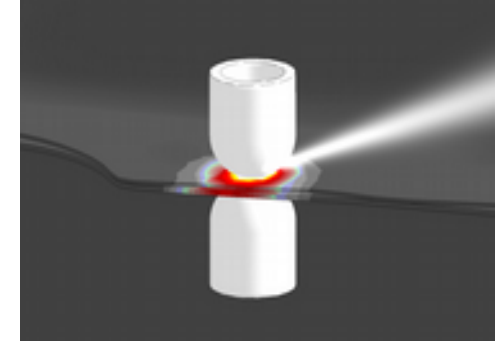
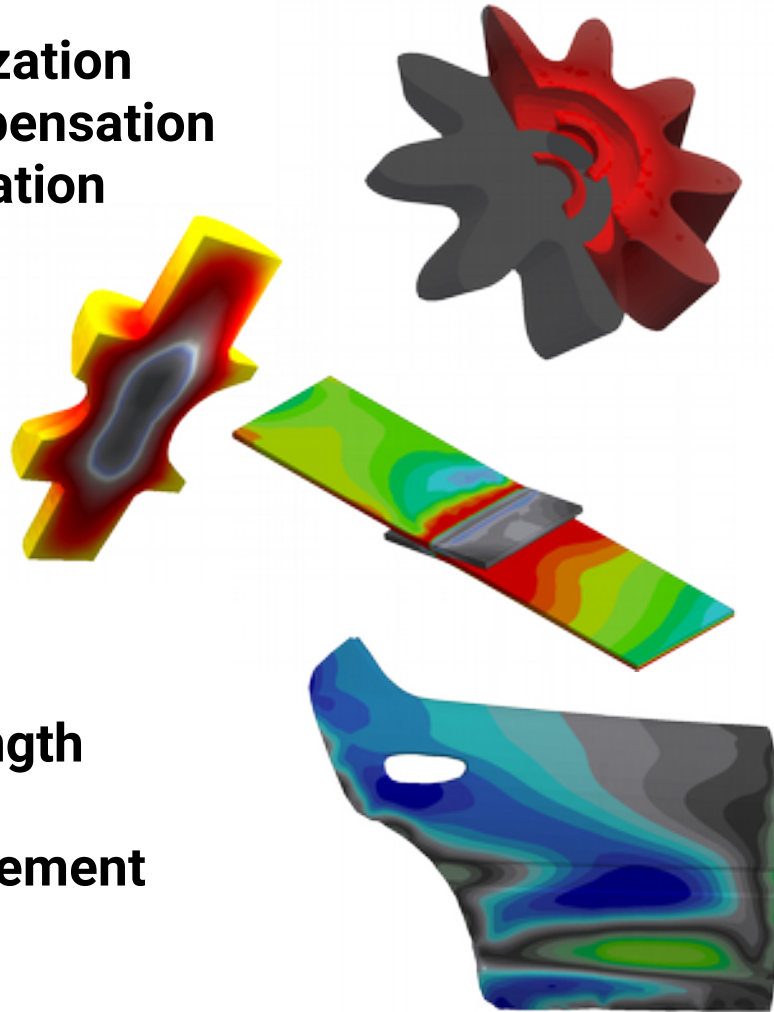
18.02.2019

- Process Optimization
- Distortion Compensation
- Quality Optimization

- Heat Treatment
- Welding
- Hotforming

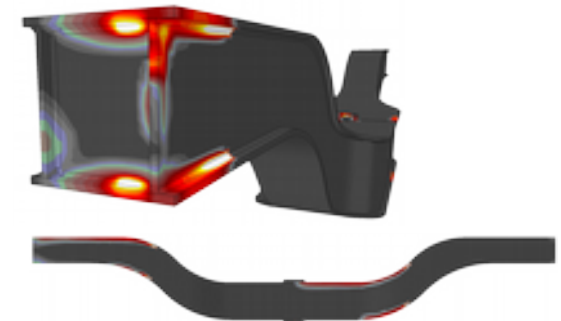
- Distortion
- Residual Stress
- Metallurgy
- Crack And Strength

- Material Management



DynaWeld is more than 20 Years of experience in

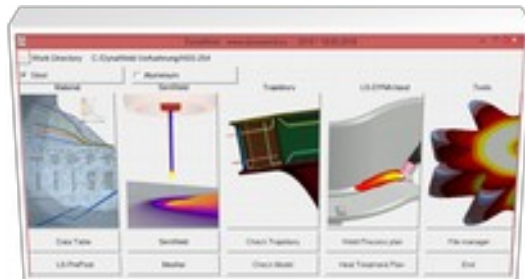
simulation of all kinds of thermal related manufacturing and material processes



Consulting And Research

DynaWeld's Development

DynaWeld®



- Preprocessor
- Environment And Material Data Manager
- Welding, Heat Treatment, Forming
- High Sofisticated Simulations
- **Simulation of Assembly**

MatplusHQ



- Simulation Tool
- Pre- Postprocessor And Solver
- Heating And Quenching
- Very Easy Usage For Everyone

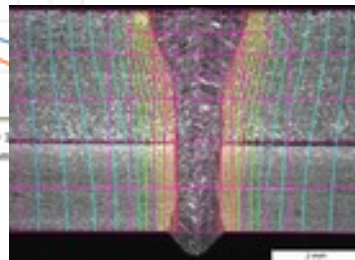
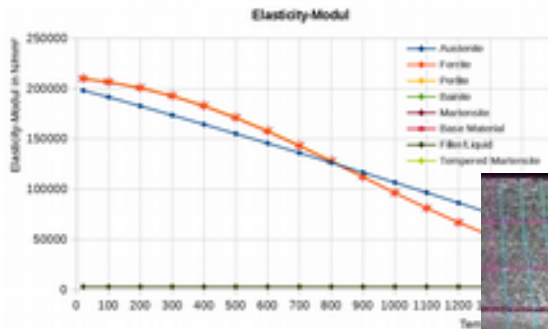
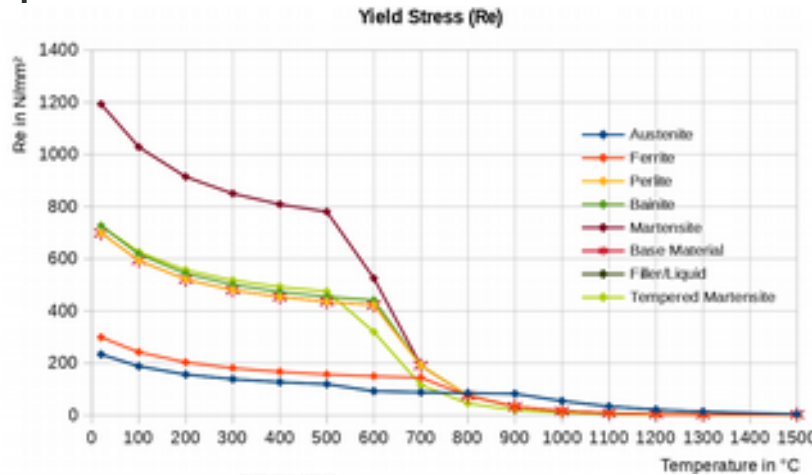
Development - Training - Support - Customer related software solutions

Material properties and material model for welding analysis needs to take into account thermal dependent behaviour,

in certain cases the metalurgical behaviour too.

Apart from expensive measurements a material simulation can provide the necessary data too.

DynaWeld Material provides import of JMatPro data from material simulation.



DynaWeld-Material - Materialparameter

HCT980X.mat

Import Parameter

Temperatur in Celsius

Werkstoff Name: HCT980X

Werkstoff Charge: DynaWeld

Werkstoff ID (1 .. 999): 1

Solidus Temperatur (Aktivierung Start): 1350

Liquidus Temperatur (Aktivierung Ende): 1400

Schmelzwärme (kJ/kg): 270

Temperatur Schmelzwärme: 1500

History Reset Starttemperatur (TASTART): 1350

History Reset Endtemperatur (TAEND): 1400

Mindest E-Modul (MPa): 3000

max E-Modul Schmelze: 3001

Plastische Dehnung bei Zugfestigkeit: 0.13

Elektrischen Widerstand aus 11-MATERIAL.csv importieren

Umwandlung anpassen (13-ZTU-Steel.csv)

Einstellungen fuer Schweißgut / Flüssig / Deaktiv

Fließkurve wie importiert

Fließkurve wie Austenit

Konstante Streckgrenze

E-Modul Schweißgut / Flüssig / Deaktiv (MPa): 1000

Schmelzen

Grundwerkstoff: Zusammensetzung aus Phasenanteil

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
1.0	0.0	0.0	0.0	0.0	0.0

Phasenzuordnung:

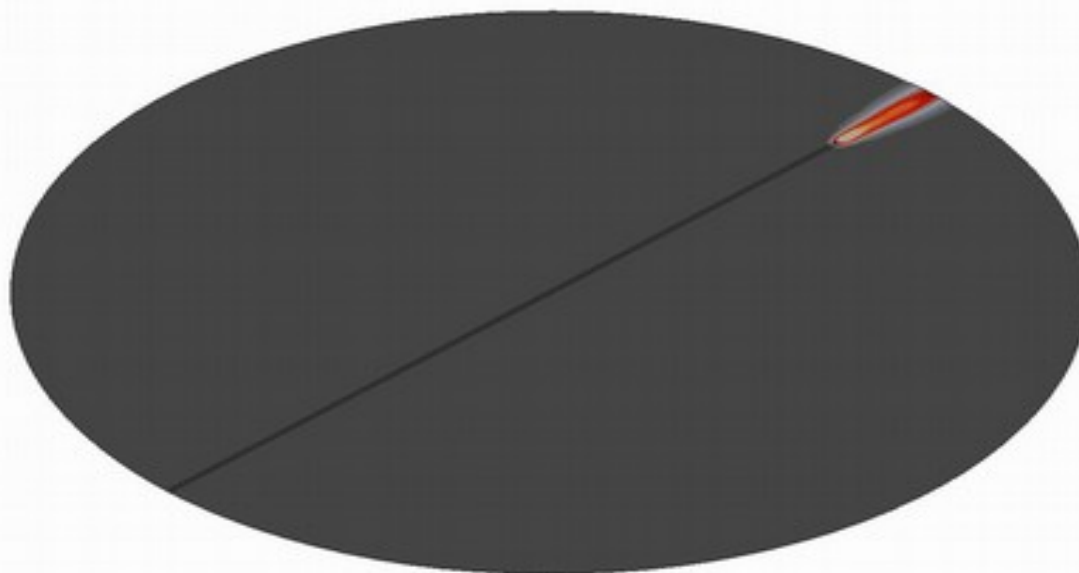
Ziel	Quelle	Streckgrenze	Zugfestigkeit	Ergaenzen
	jMatPro / Sysweld	MPa	MPa	
	P-1 P-2 P-3 P-4 P-5 P-6			
Austenit	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	233.308	596.6049	
Ferrit	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	298.832	531.6818	
Perlit	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	698.703	1119.8826	
Bainit	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	725.934	1156.12919999	
Martensit	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	1192.47	1723.8764	
Grundwerkstoff	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	698.703	1119.8826	<input type="checkbox"/>
Zusatz/Schmelze	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	233.308	596.6049	<input type="checkbox"/>
Angelassener Martensit	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	725.934	1156.12919999	<input checked="" type="checkbox"/>
Angelassener Bainit	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	-1.0	-2.0	<input type="checkbox"/>

Werkstoffgruppe:

Stahl Stahl - ohne Gefuegeumwandlung Aluminium Sonstige

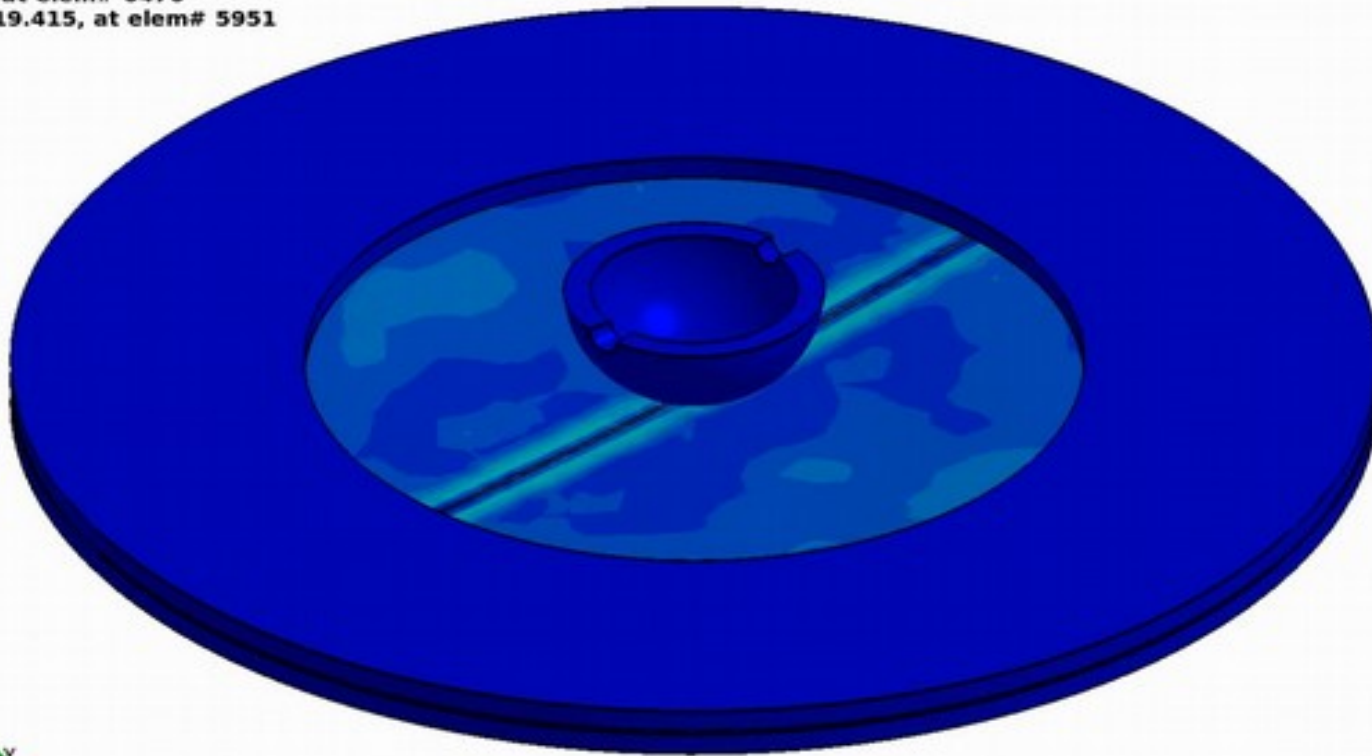
Ueberspringen Re und Rm nach Ursprungsphase aktualisieren Check und Ende

DynaWeld
Time = 0.6
max displacement factor=5

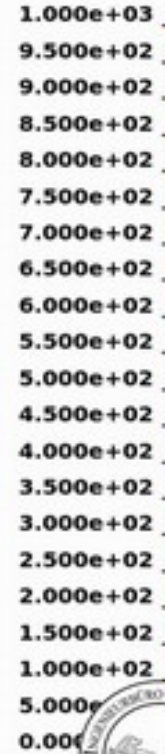


CUP

Time = 0.003
Contours of Effective Stress (v-m)
reference shell surface
min=0, at elem# 6476
max=419.415, at elem# 5951



Fringe Levels



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The old state of the art

- Forming simulation and optimization of forming process
- Welding simulation and optimization of welding process

The new state of the art

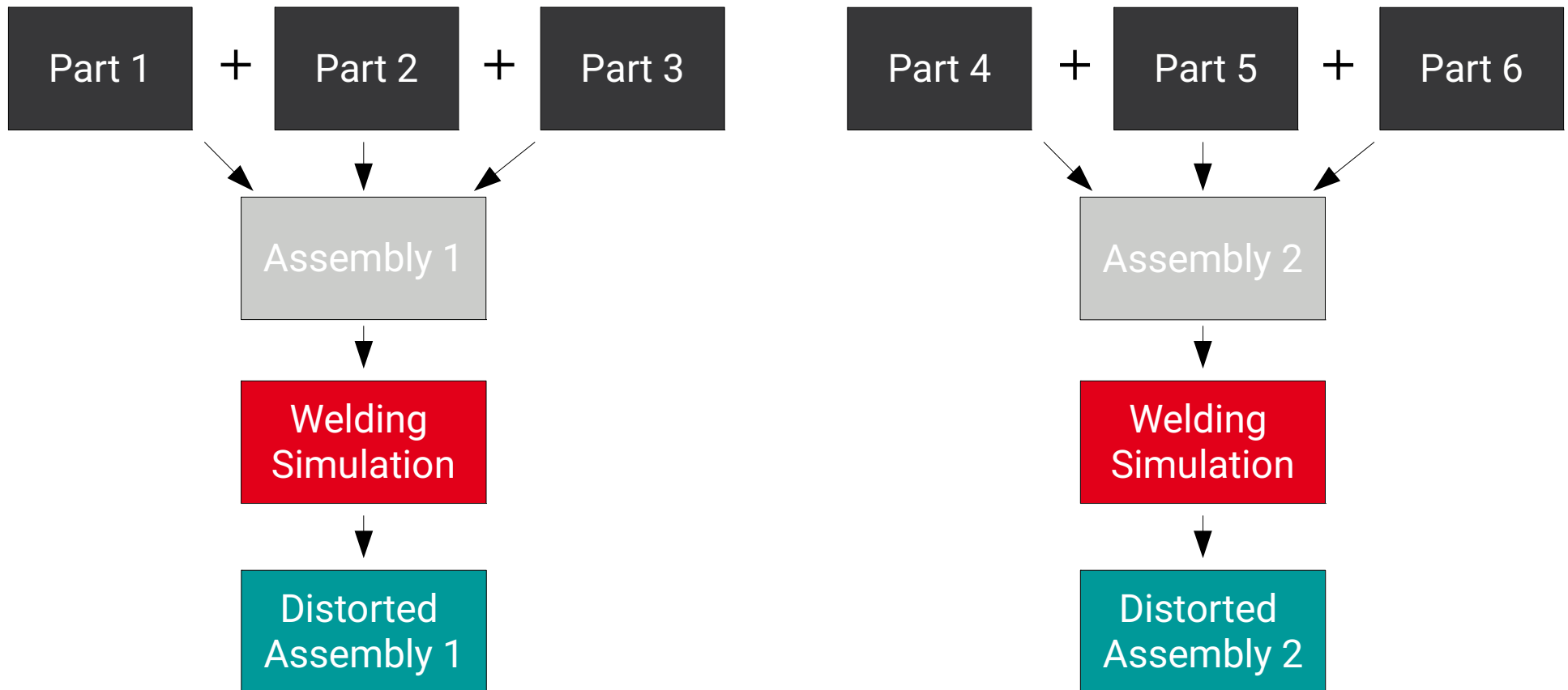
- Assembly simulation and optimization of the manufacturing process

Assembly Simulation:

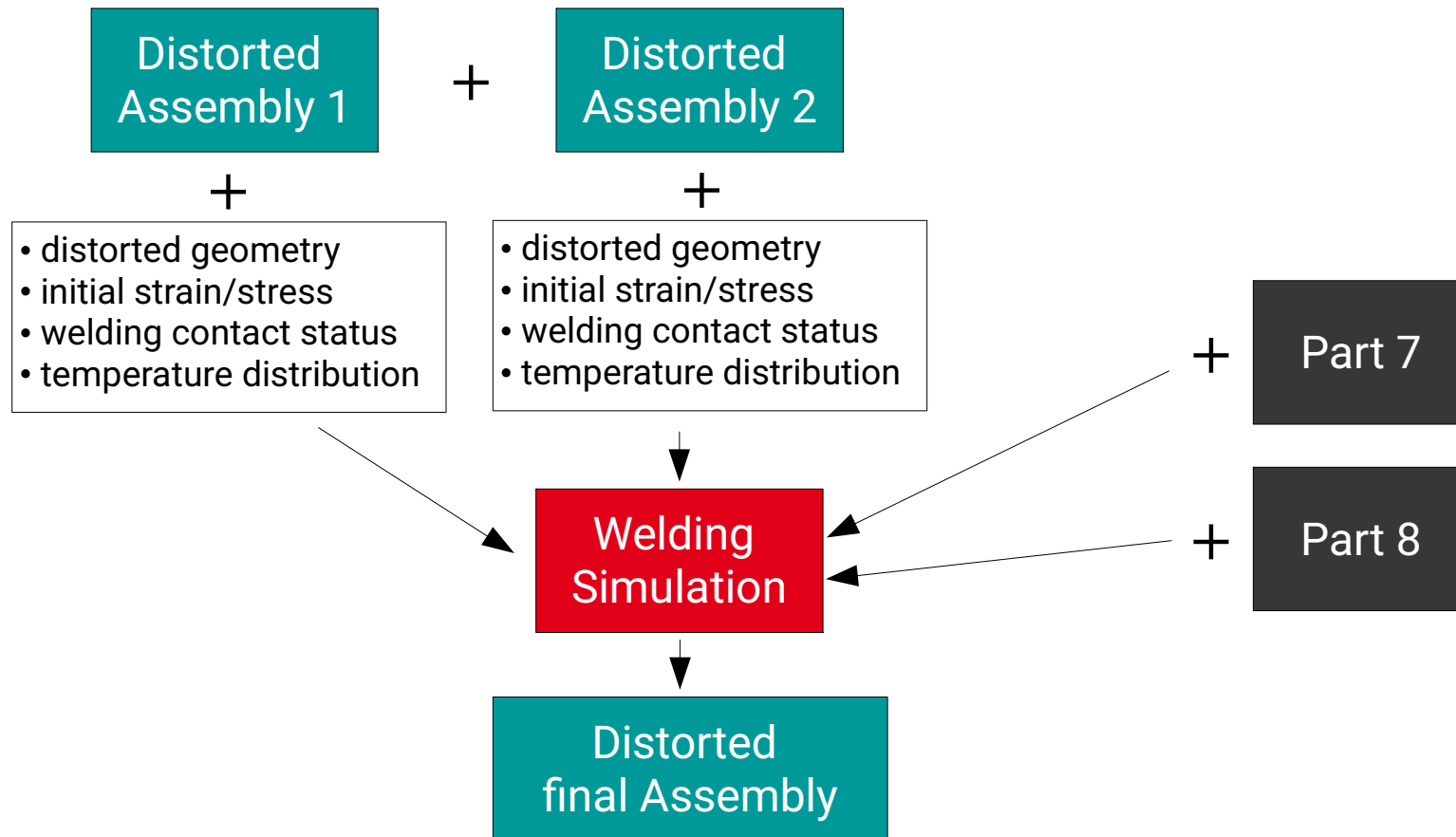
- take into account imperfect geometry of assembled parts
 - imperfect forming specimen - geometry definition by simulation
 - imperfect forming specimen - geometry definition by measurement
 - imperfect subassembly - geometry definition by simulation
- take into account
 - deformation due to clamping of imperfect parts
 - deformation due to welding
- Enables the the integrated view of process
 - optimization at stages with highest compensation effort

The assembly simulation takes into account prior stages

Assembly procedure



Assembly procedure



Assembly procedure

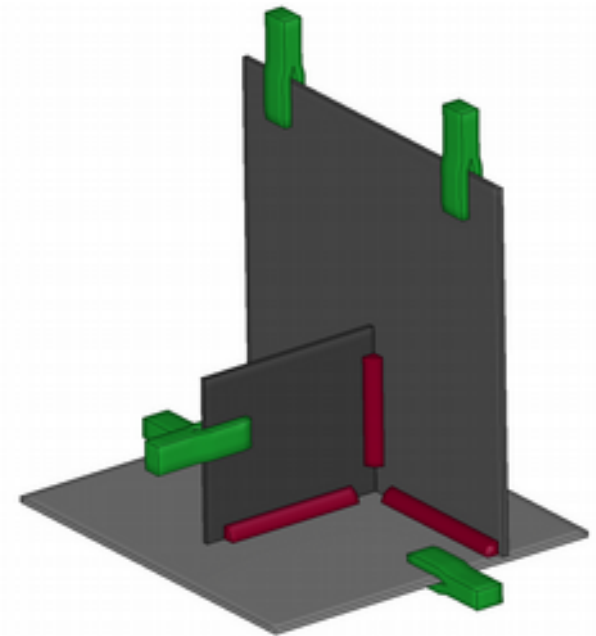
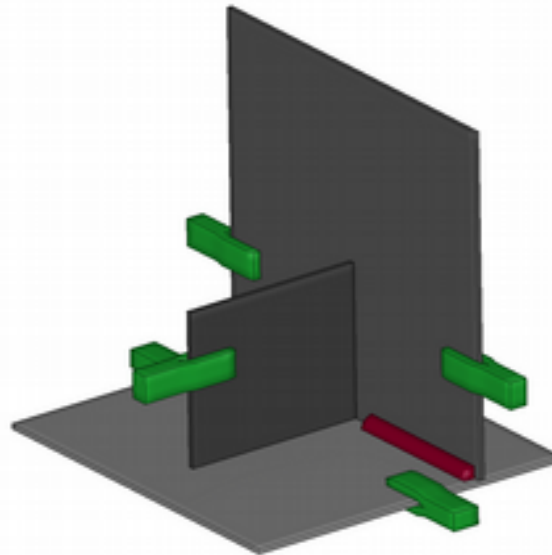
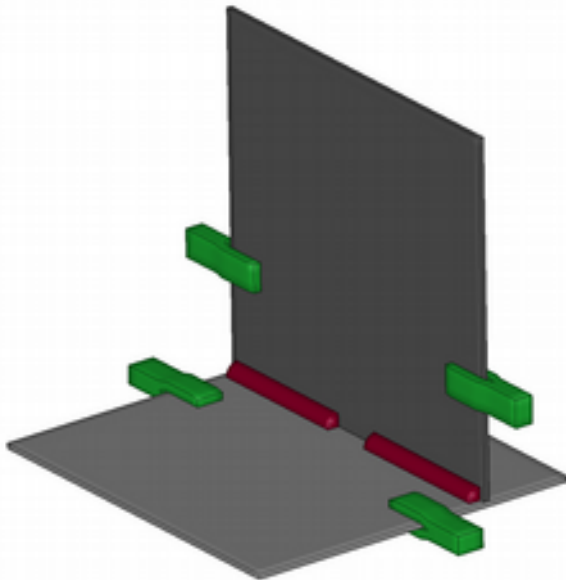
Step 1:
Welding 1,
2 weld seams

+

Step 2:
Assembly, adding a
stiffening plate

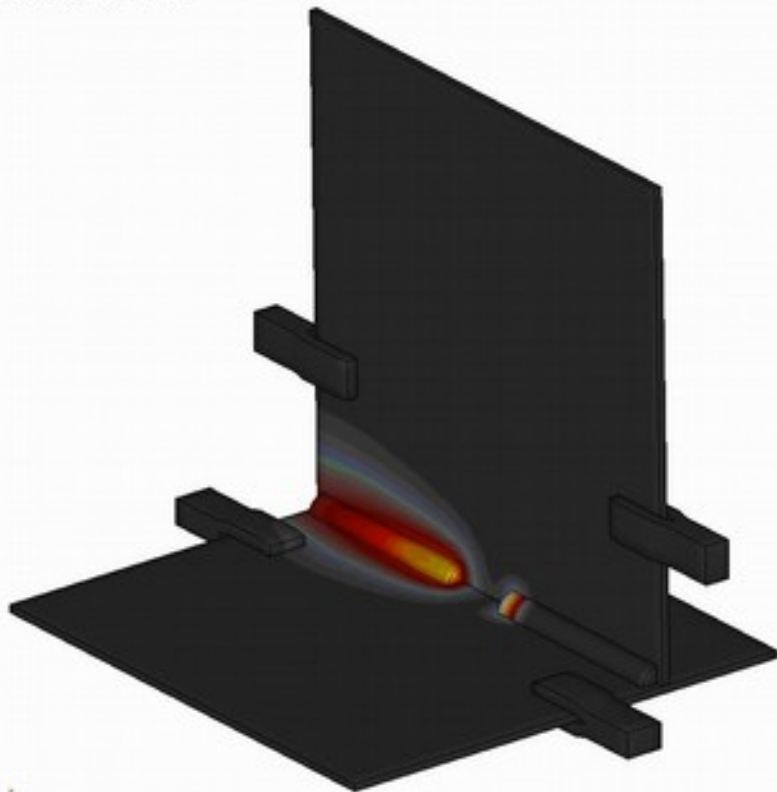
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Step 3:
Welding 2,
adding 2 new weld seams

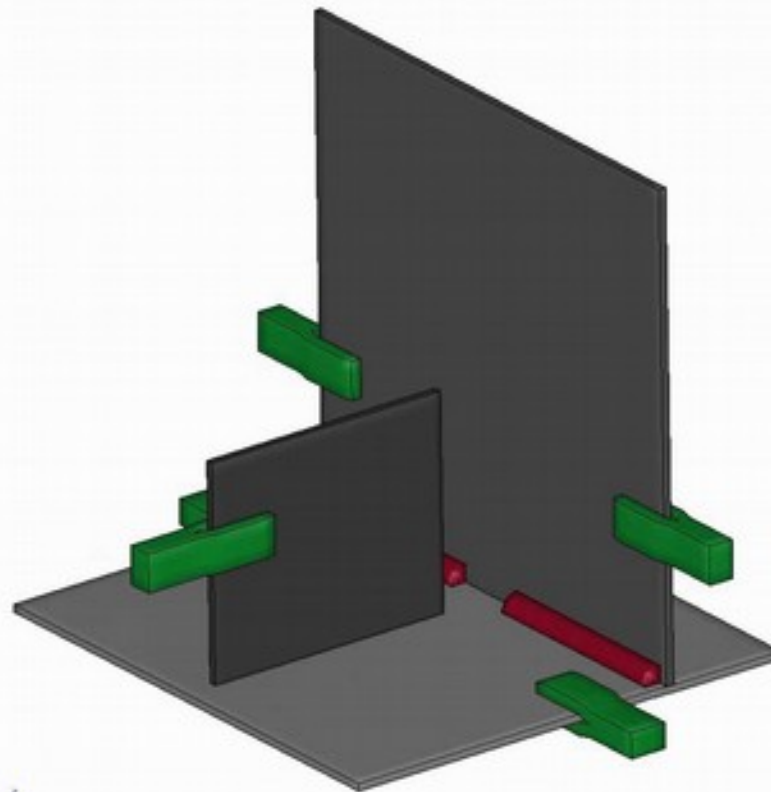


Time = 18.75
 Contours of Temperature, middle
 min=293.149, at node# 8378
 max=1881.65, at node# 4761

Temperature, middle



Time = 0.55



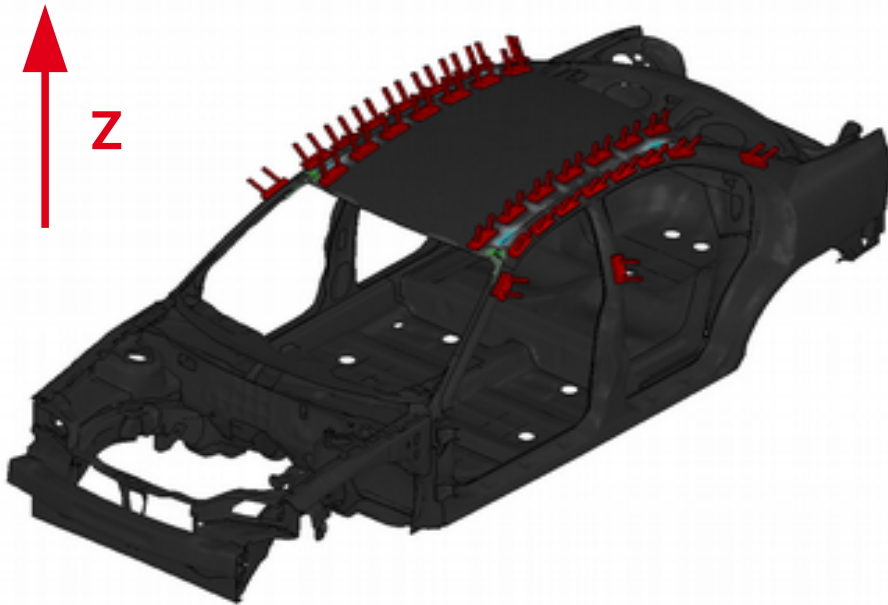
DynaWeld Car:
Welding process of the roof



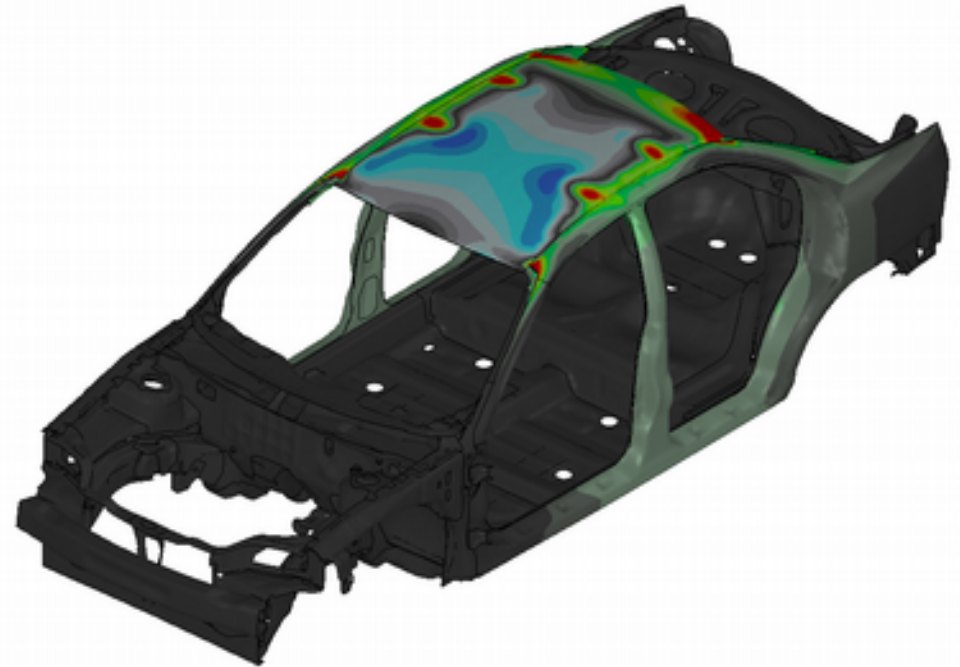
DynaWeld Car:
Motion of the clamping tools



DynaWeld Car:
Z-Distortions before unclamping



DynaWeld Car:
Z-Distortions after unclamping and cooling



Distortion Analysis Welding

- finding the reasons for certain distortion evolution
- virtual testing of variations

Best practice would be the application of simulation in earlier states for:

- improvement of the prearranged production
- intervention in early states of development, if tolerances are not reached or visible distortions problems appear

Assembly Analysis and integrated view of manufacturing

- Difference from target geometry by entire process
- Identification of the significant manufacturing steps for distortions and deviations for targeted intervention
- Design of compensation method
- Approval of compensation method or
- Approval of new designed manufacturing process

**Thank you
very much!**

