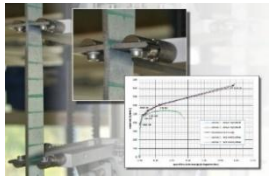
COMPANY PRESENTATION

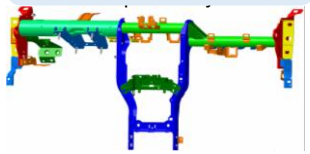
TPV AUTOMOTIVE

DEVELOPMENT CYCLE OF PART

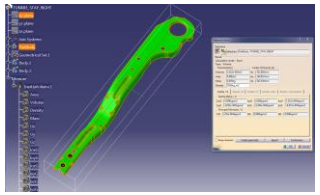
RESEARCHES



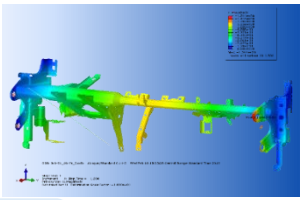
DEVELOPMENT AND CONCEPT DESIGN



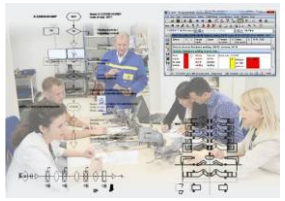
CONSTRUCTION



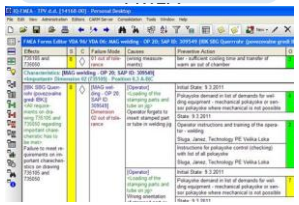
VIRTUAL ANALYTICS



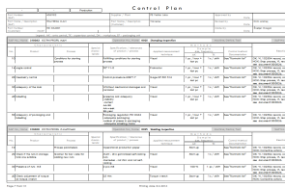
PROCESS DEVELOPMENT



FEASBILITY & FMEA STUDY

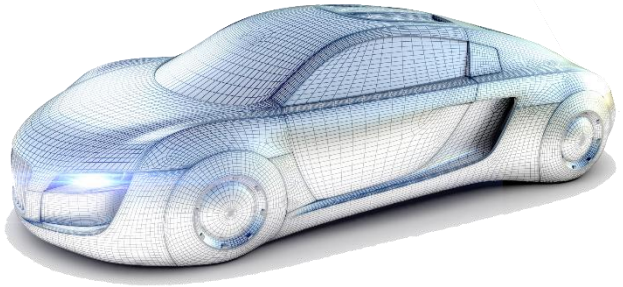


CONTROL PLAN ESTABLISHMENT



PROTOTYPING

TESTING AND VALIDATION



PROGRAMS

- Smart Factory
- Digital Twin
- Robotization simulation

SIEMENS

SIMULIA ABAQUS

- Strenght calculations:
  - Load-bearing capability
  - Deformations
  - Stiffness
- Dinamics:
  - Vibrations

ANSA PRE PROCESSOR

- Mesh preparation
- Reverse engineering
- KTL hanging optimizations (positioning) – Fluid simulations

FEMFAT software

- Predictions of life cycles (Fatigue)

CATIA

- CAD modeling
- FEM analytics

AUTOFORM *Forming Reality*

- Forming simulations

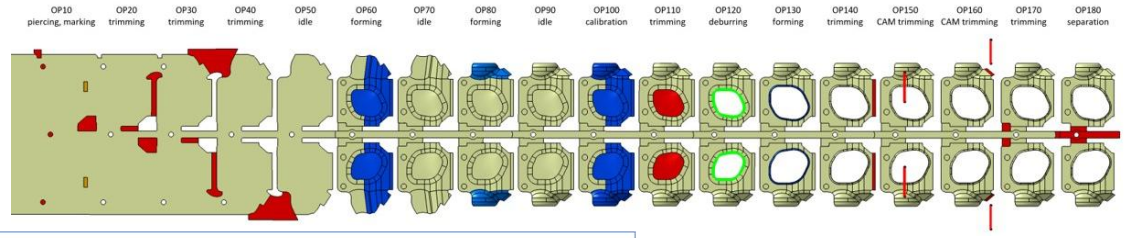
HEXAGON | simufact

- Welding simulations:
  - Welding deformations
  - Residual stresses
  - Optimizations of welding sequences

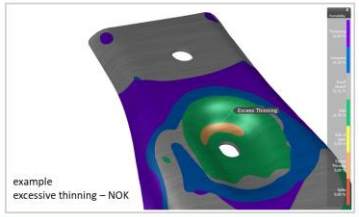
STAMPING PROCESS

Evaluation phase

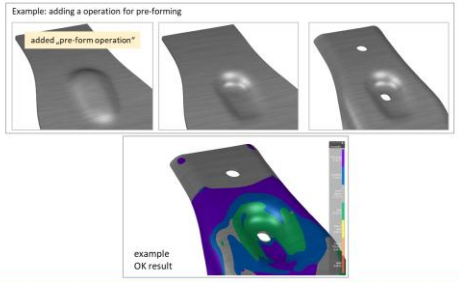
- **Blank definition**
- **Concept design of the strip layout (method plan)**
- **Forming simulation**
- **Optimisation of forming method**
- **Checking of critical area and feasibility study**
- **Robustness analysis (deviation)**
- **Tooling price evaluation**
- **FLD diagrams**
- **Material Thinning simulations**
- **Material Springback simulations**
- **Raw material & process variations simulations**

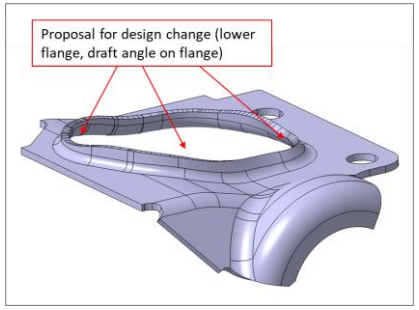


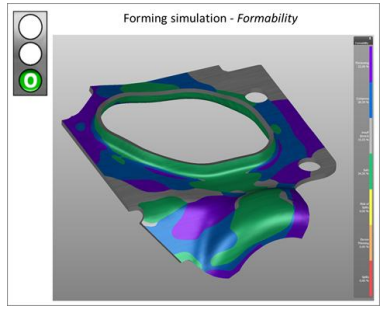
Forming simulation parameters and surfaces are prepared. At that the selection of the material card is very important for achieving a more realistic forming result.
For analysis of the likelihood of splits appearance different parameters are analysed (Formability, Max. Failure, Thinning, Strains, ...)



Forming methods and forming shapes are iterated to get an adequate result. In certain cases part design changes are proposed.



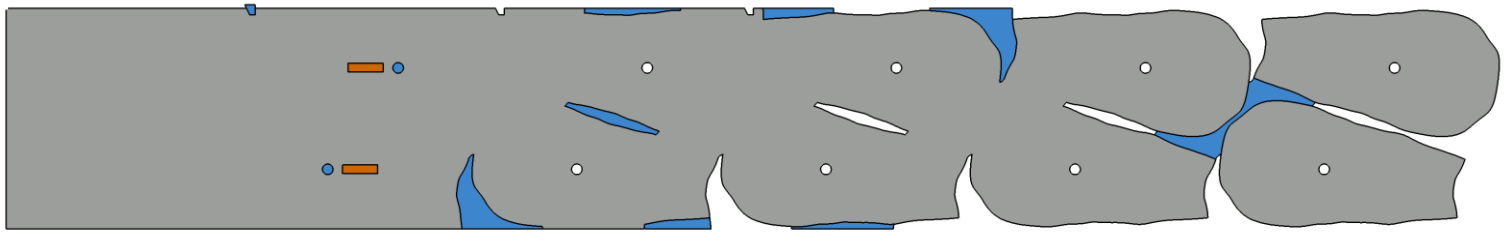




STAMPING/STRIP LAYOUT

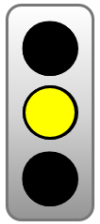
Tool type	Progressive blanking tool (~1200 t) Transfer stamping tool (~1350 t)
Press	2500 T progressive press
Parts per stroke	2 blanks per stroke for blanking tool 1 part per stroke for forming tool

Progressive blanking:

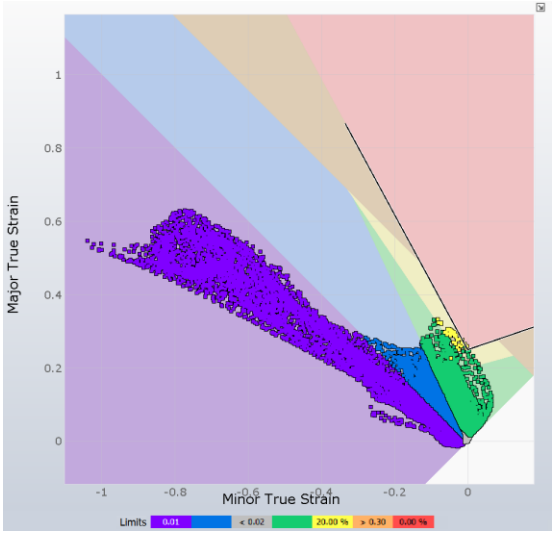


Transfer stamping:

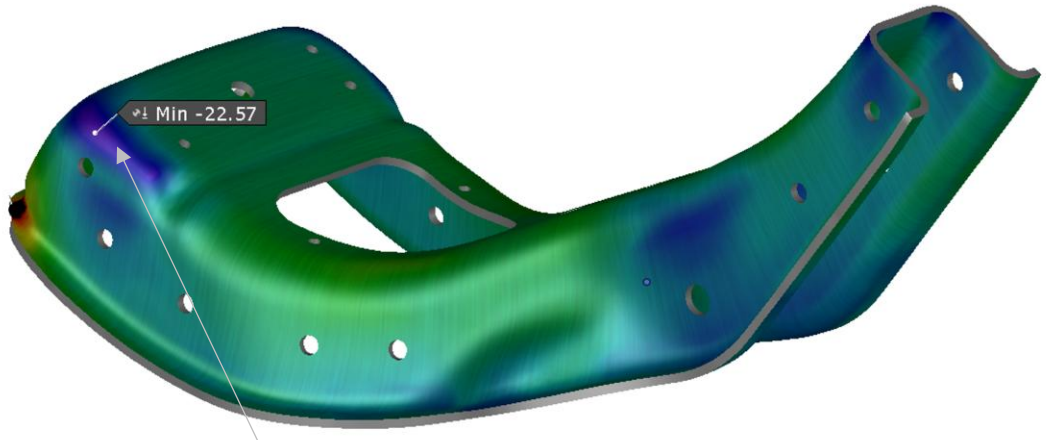
FORMING SIMULATION RESULT

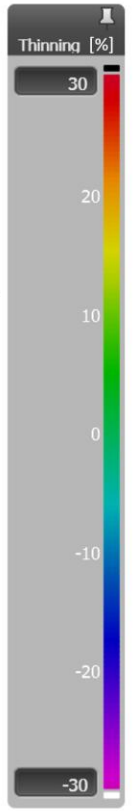


FLD result



Result of thinning (relative to the initial thickness) [%]

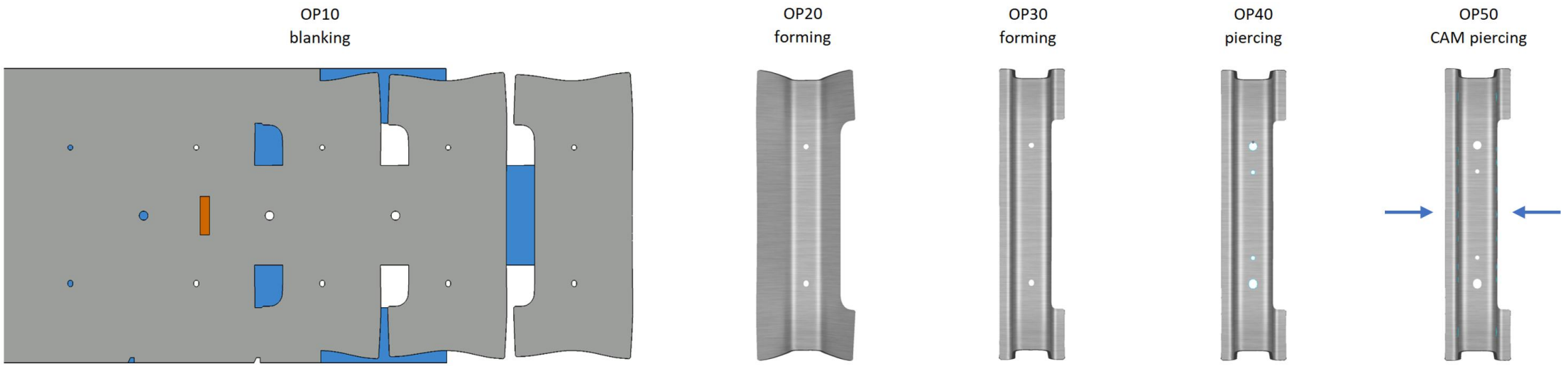




Small design change needed for better robustness in forming process.
We propose to smoothen the shape (we can prepare a proposal of 3D model).

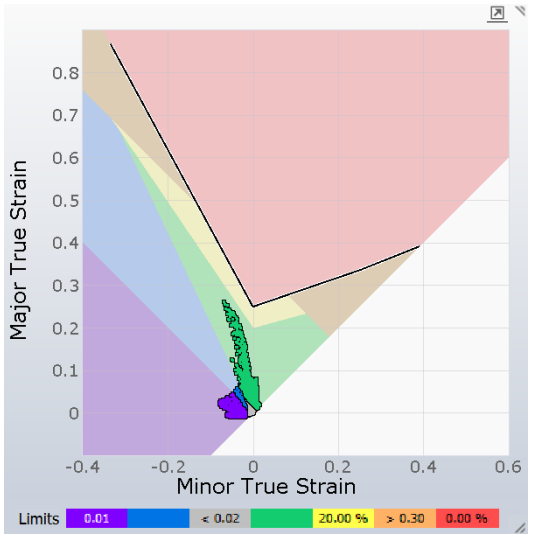
STAMPING PROCESS

Tool type	Combined (progressive + transfer) stamping tool (~1150 t)
Press	2500 T progressive + transfer press
Parts per stroke	1 part per stroke

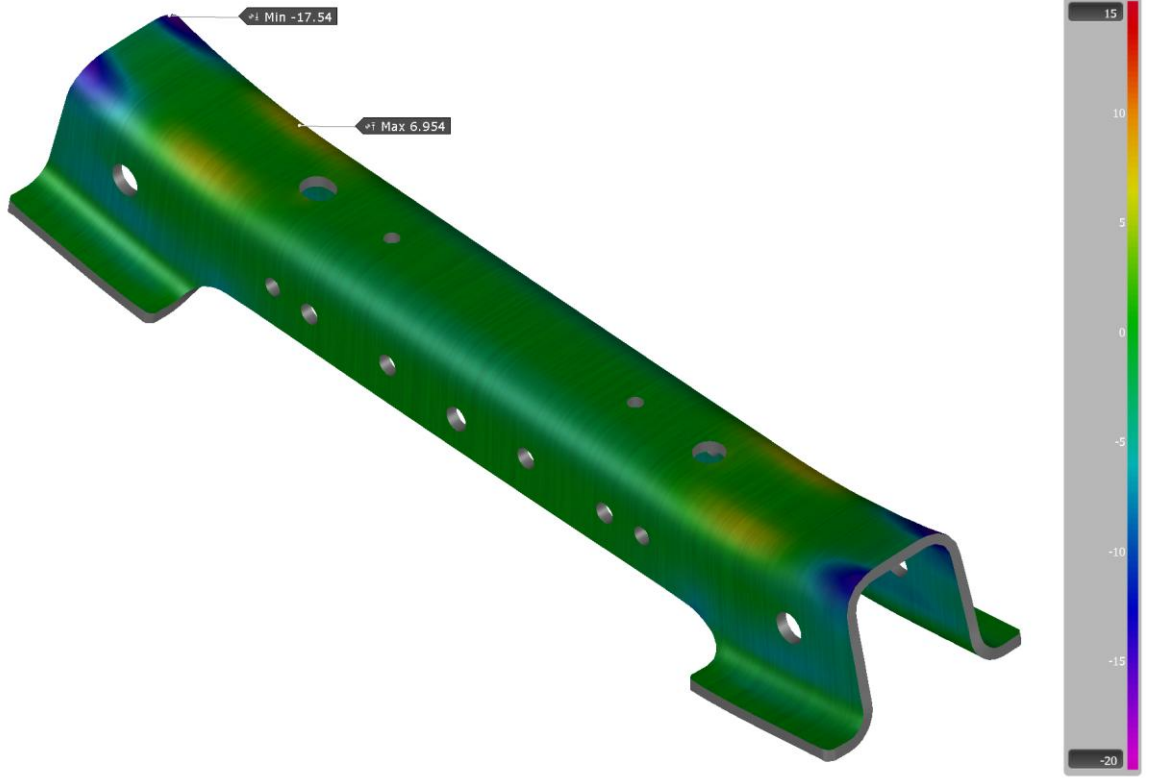


FORMING SIMULATION RESULT

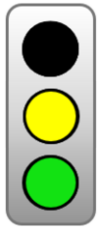
FLD result



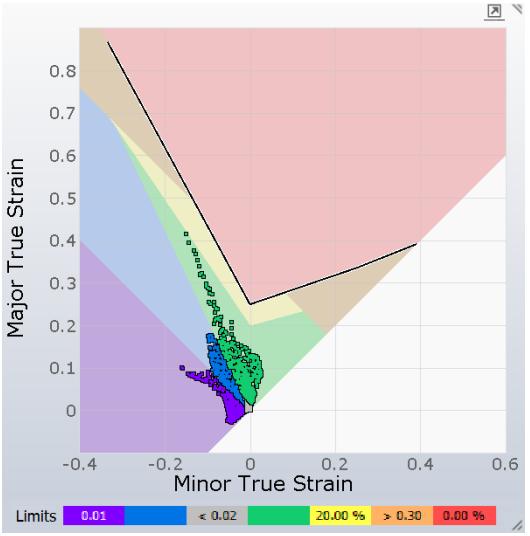
Result of thinning (relative to the initial thickness) [%]



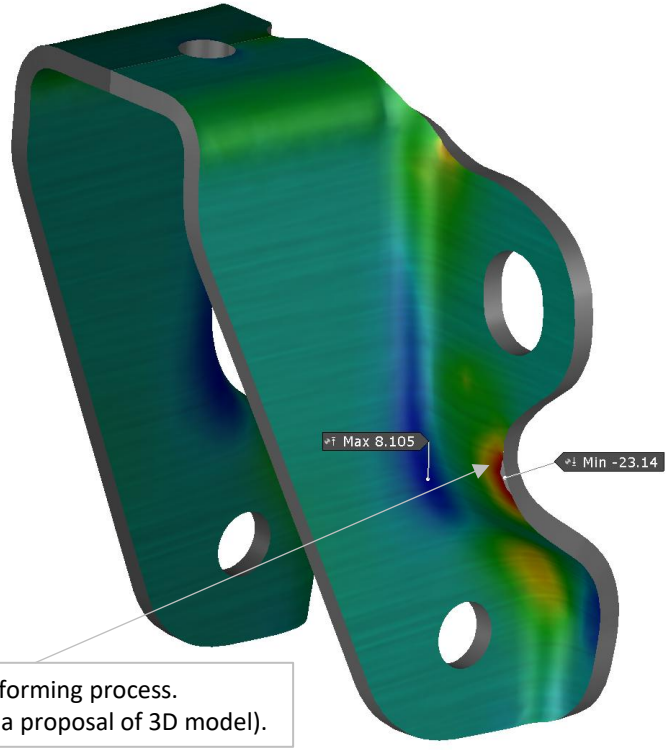
FORMING SIMULATION RESULT

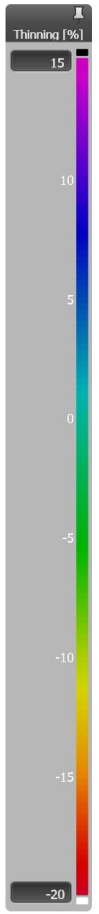


FLD result



Result of thinning (relative to the initial thickness) [%]

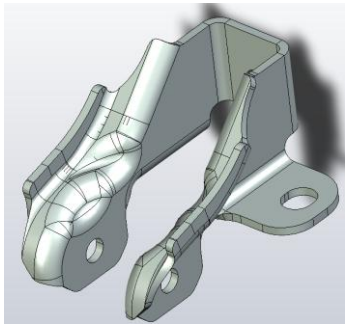


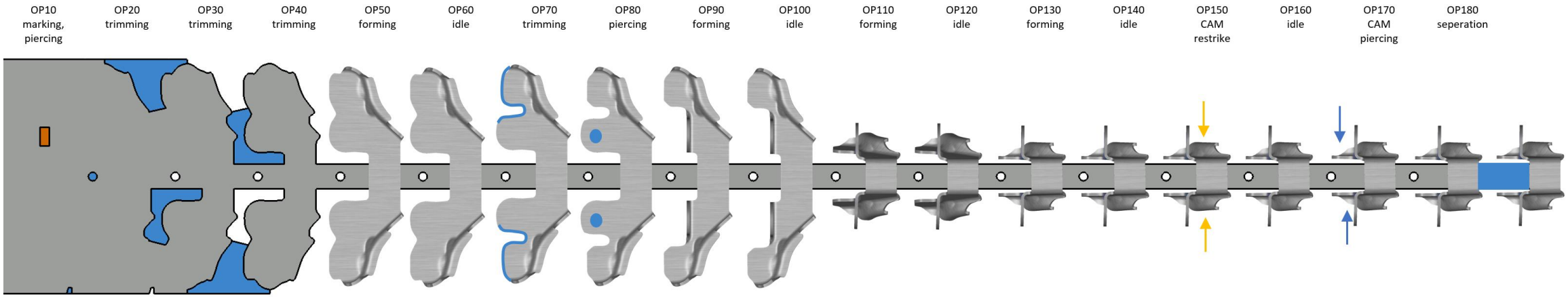


Small design change needed for better robustness in forming process.
We propose to smoothen the shape (we can prepare a proposal of 3D model).

STAMPING PROCESS

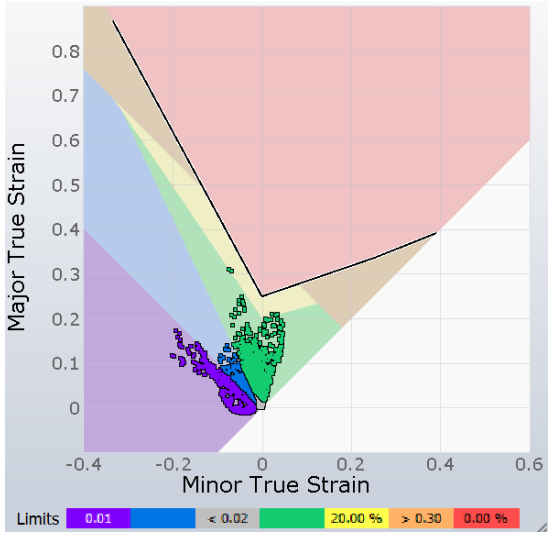
Tool type	Progressive stamping tool (~ 830 t)
Press	1000 T progressive press
Parts per stroke	1 part per stroke



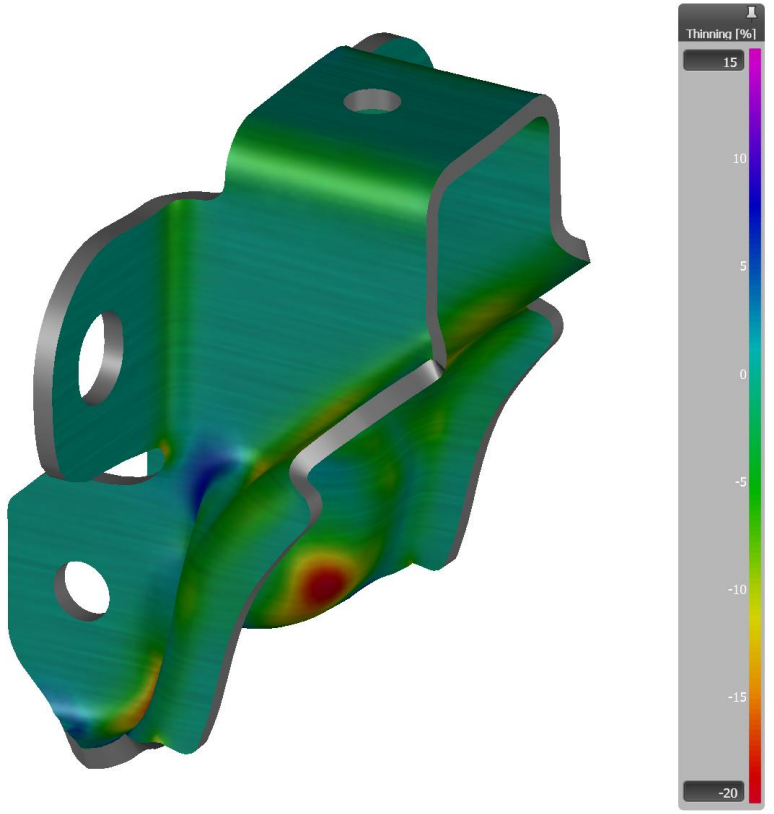


Forming simulation result

FLD result



Result of thinning (relative to the initial thickness) [%]



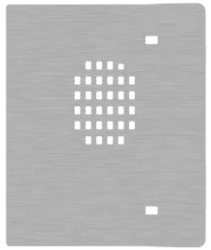
FORMING LAYOUT & SIMULATION

Material	Thickness [mm]
EN 10149-2 - **S420MC**	1,2

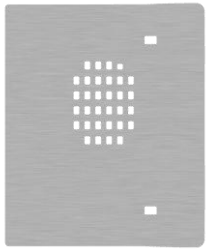
Planned stamping process	
Stamping process	Progressive
Press	2500T
Material consumption	613 x 503 x 1,2 mm

One combined stamping tool with progresive and transfer parts.
Max tool length: 7m

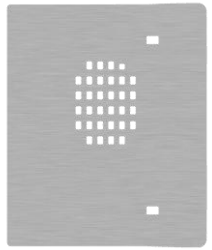
OP10
piercing + marking



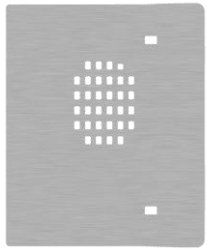
OP20
piercing + trimming



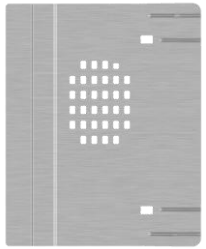
OP30
piercing + trimming



OP40
seperation

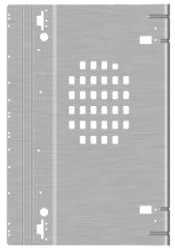


OP50
embossment + bending (down)

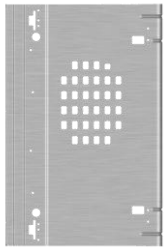


OP60
bending (down)

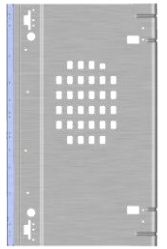
OP70
piercing + CAM piercing



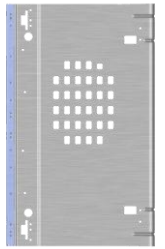
OP80
bending (up)

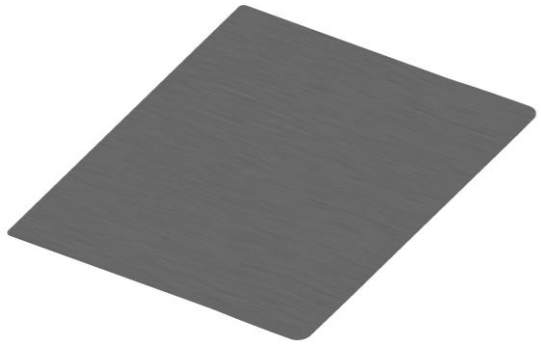


OP90
bending 45deg (up)



OP100
CAM bending + neck forming



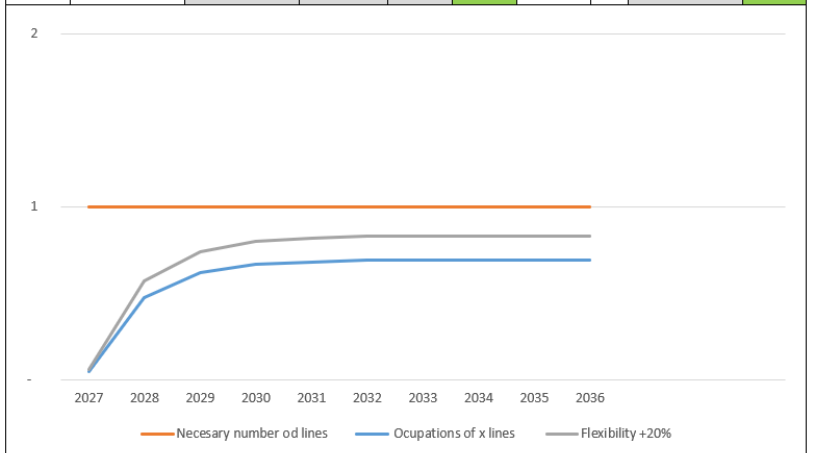


CAPACITY EVALUATION

Made by: J. Kuretič	Cycle time	75	s/part
Date: 11.02.2025	Nomber of working days	230	days/year
Index: B	Shift/day	1	shift/day
Maintanace	Meal brake (law)	30	min
	Break (law)	10	min
Preparation&maintanence	Planed Down time	20	min
	Unplaned stops	30	min
	Speed losses	20	min
	Scrap	2%	
	Number of part/car	1	part/car
	Number of lines	1	lines
	Fleksibilnost	20%	
	H/shift	8	h/shift
	Min/shift	480	min/shift
Shift lenght-break	Pland production time	420	min
Planed production time-unplaned down time	Net operating time	390	min
Used operating time / Net operating time	Performance	95%	
	Cycle time	1,25	min
	Ideal Run Rate	0,8	parts/min
	Total pieces/shift	296	parts
	Reject pieces/shift	6	parts
	Good pieces/shift	290	parts/shift
		66718	part/year
		33359	pairs/year

	OEE factors	
Operating time/planned production time	Avalability	92,86%
(Total piece/operating time)/ideal run rate	Performance	94,87%
Good pieces/Total pieces	Quality	98,00%
Availability * performance * Quality	Overall OEE	86,33%

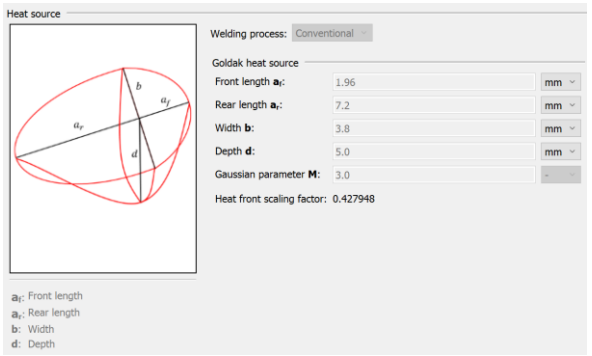
year	quantities parts/year	quantities parts	ocupation 1 line	Necesary number od lines	Ocupations of x lines	Nomber of missing days		quantities with flexibility	Ocupation with flexibility
2027	3.078	3.078	5%	1	5%	-220,00		3.693	6%
2028	31.744	31.744	48%	1	48%	-121,00		38.093	57%
2029	41.056	41.056	62%	1	62%	-89,00		49.267	74%
2030	44.432	44.432	67%	1	67%	-77,00		53.318	80%
2031	45.320	45.320	68%	1	68%	-74,00		54.385	82%
2032	46.209	46.209	69%	1	69%	-71,00		55.451	83%
2033	46.209	46.209	69%	1	69%	-71,00		55.451	83%
2034	46.209	46.209	69%	1	69%	-71,00		55.451	83%
2035	46.209	46.209	69%	1	69%	-71,00		55.451	83%
2036	46.209	46.209	69%	1	69%	-71,00		55.451	83%

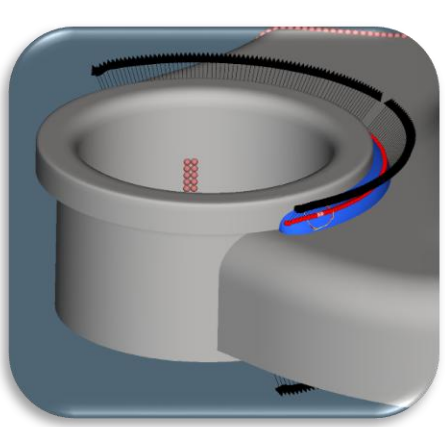


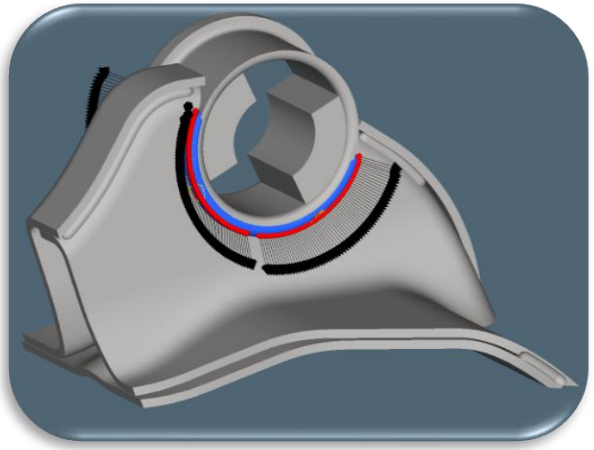
WELDING SIMULATIONS

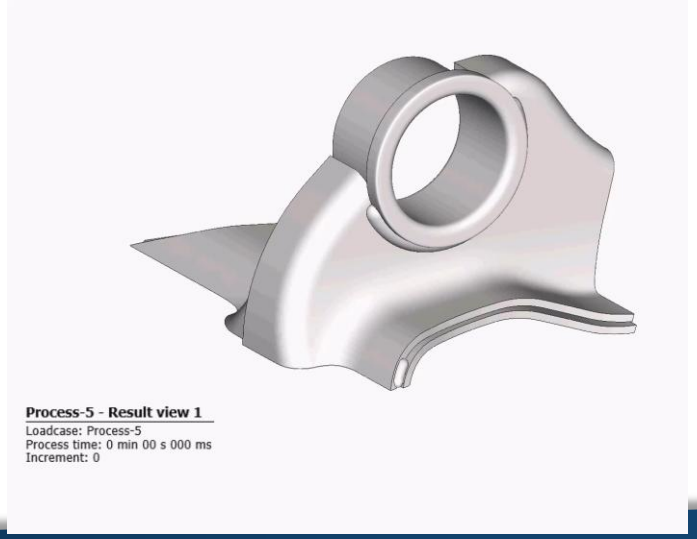
Evaluation phase
- Capacity evaluation
- Welding trajectories
- Welding parameters
- Dimensions of welding source – real macrography tests – proof of parameters
- Welding cycle
- Welding sequence

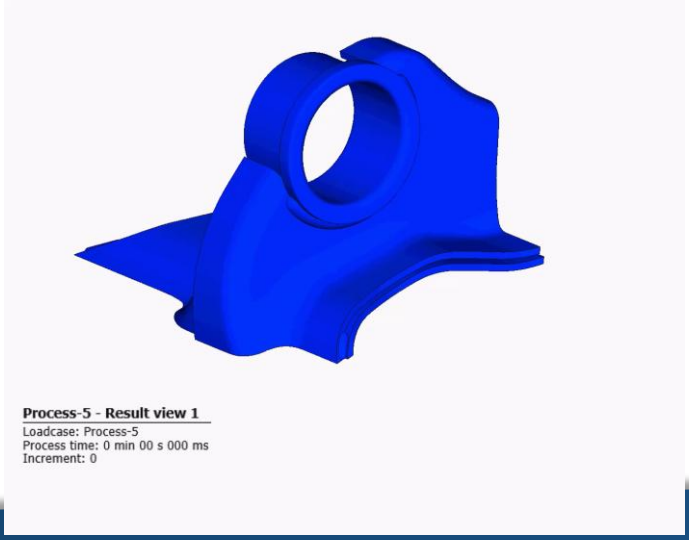
Boundary conditions:
- Welding tools concept
- Temperature
- Cooling times







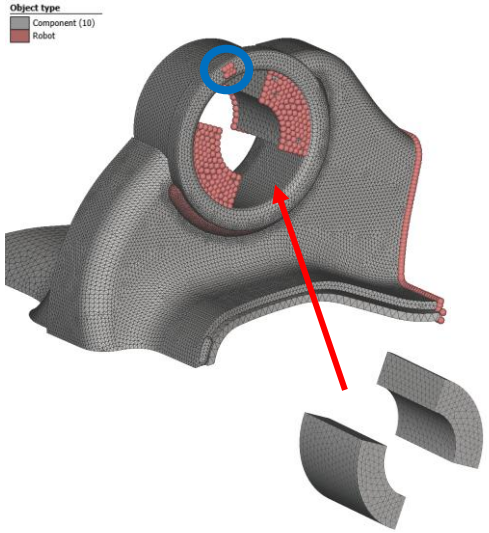




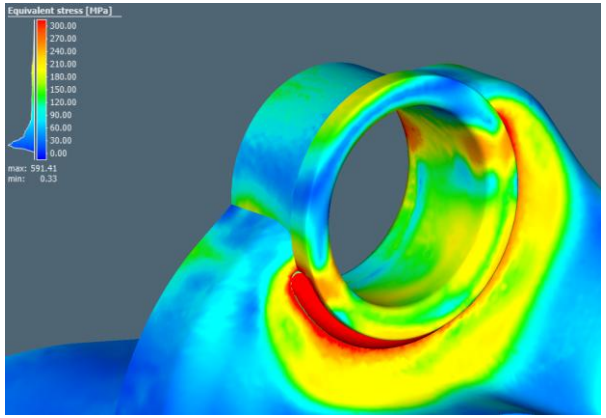
WELDING RESULTS

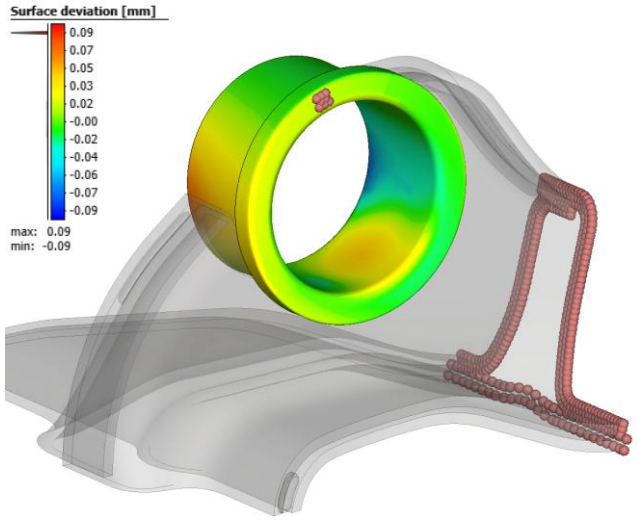
Results
- Residual stresses
- Deformations
- Welding sequence impacts
- Different tooling clamping concepts impact

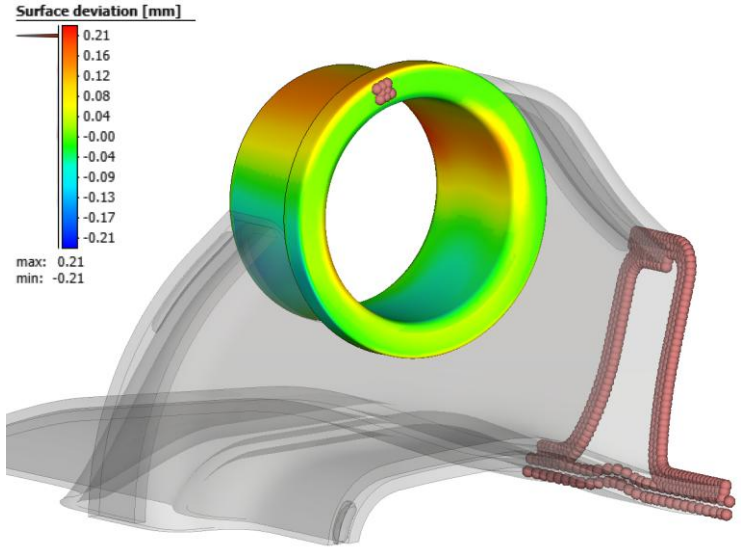
Weld with and without inserts in bushing



Deformed vs. Initial state

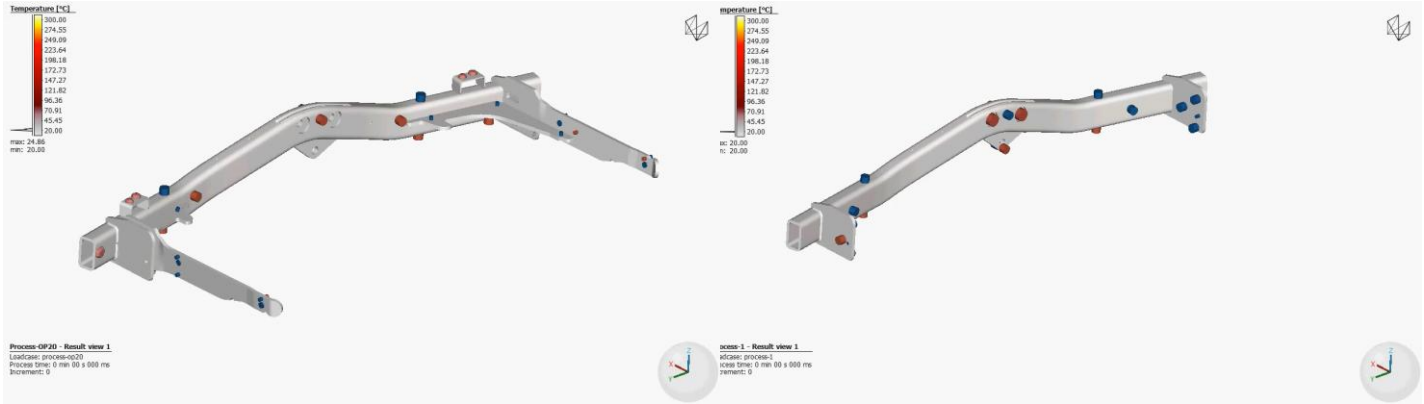


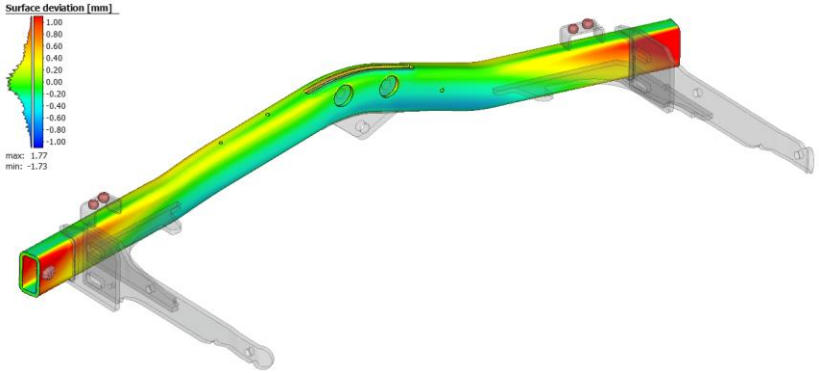


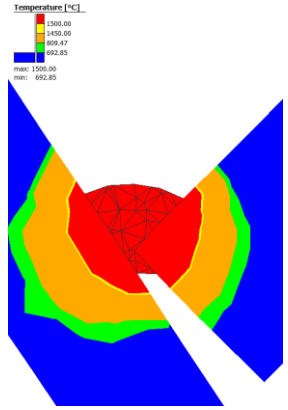


WELDING SIMULATIONS

1) Simulations of both welding operations (OP10 and OP20) were carried out using Hexagon Simufact software.
2) The simulations took into account actual welding fixtures and parameters.
3) Optimal welding sequence determined from welding simulations
4) The need for forced cooling was also identified in the simulations - we have already implemented this in the prototypes.
5) From the deformed shape, we exported the inverse shape of the tube - this was the basis for the settings in the tube bending process.







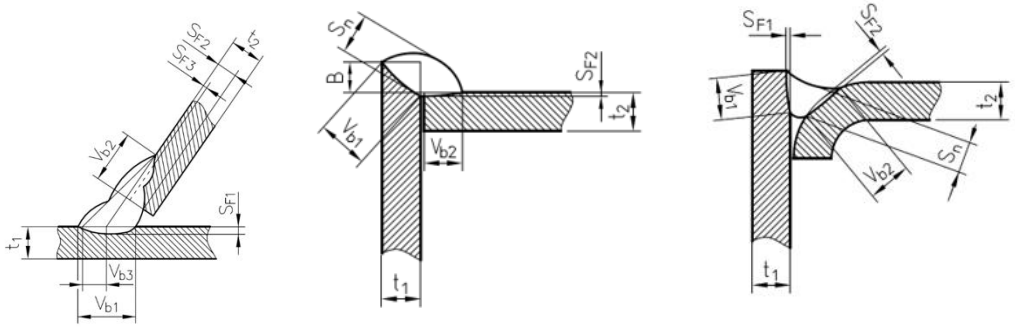
WELDING DEVELOPMENT

Validation of welded joints:

- All welded joints are frequently validated with macrography
- Validation according to customer standard
- Developed additional validation procedures for complex welds

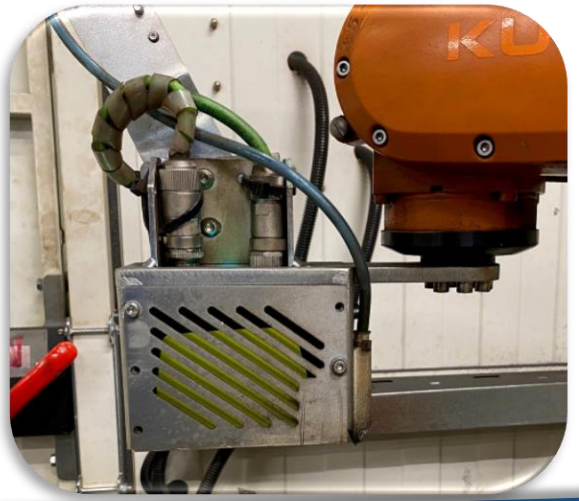
Improving the Quality of welds:

- Following welding gap – weld gap tracking system
- By scanning the welding joint robot trajectory is automatically corrected
- Used in zones where weld rework is not allowed
- Better quality of weld joint
- Reduction of emission in production



Quality control of welds:

- 100% scanning with SmartRay system
- Checking the quality of weld joint – shape, position, depth (laser triangulation)
- Shown status of welds to reworkers for determination of part status



ALUMINIUM WELDING

Challenges in aluminium alloy welding:

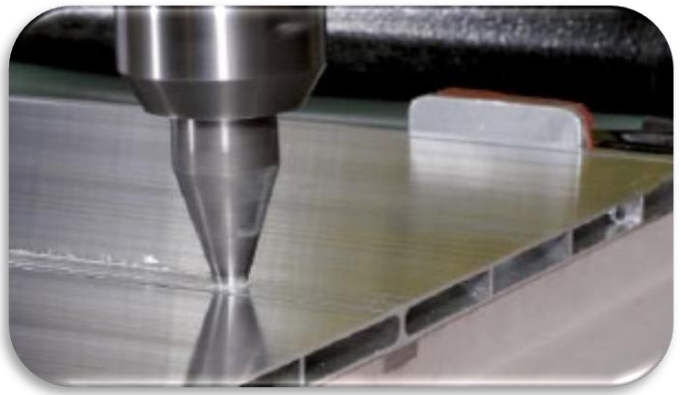
- Cracks in hot and due to internal stresses
- Porosity of welds
- Bad weld penetration
- Oxide inclusions
- Eruptions of melt
- Ensuring tight welds

Ensuring Quality of welds:

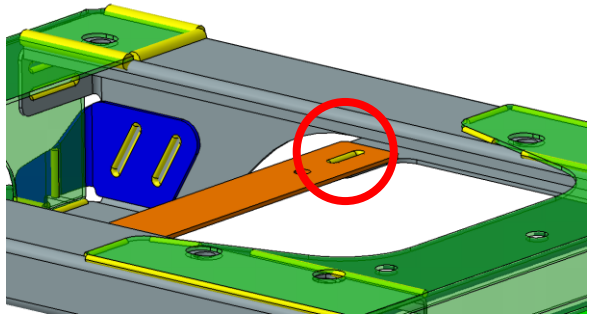
- Important surface preparation for welding
- Aluminium oxide and grease removal
- Chemical cleaning of surface before welding
- Passivation of surface for better durability prepared for welding
- Removing top layer on castings
- Mechanical processing of weld joint on casting parts
- Right filling material
- Correct preparation of welding joint
- Optimal torch angle

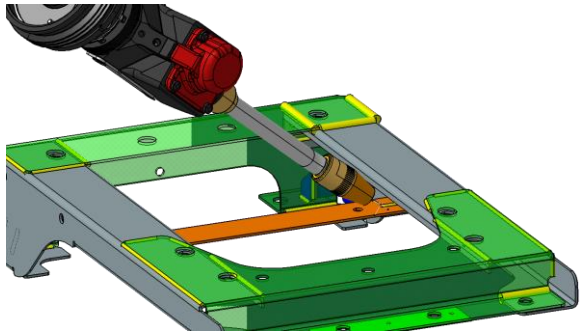
FSW:

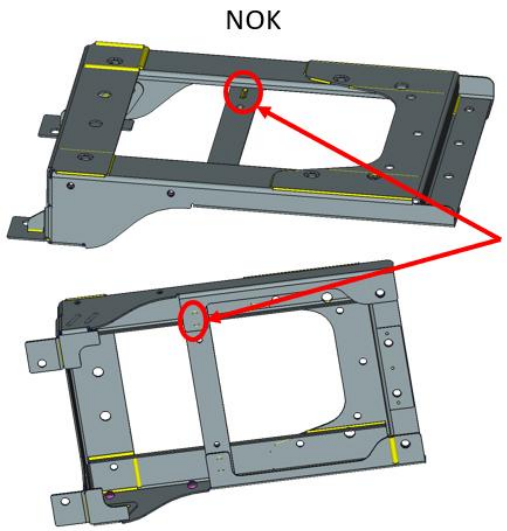
- Mandrel tool life (increased from 70 to 1400 welds)
- Very rigid fixture is required because of welding forces
- Preparation of joint with minimum clearance
- Small deviation in height of profiles
- Depth of FSW joint is 5 mm

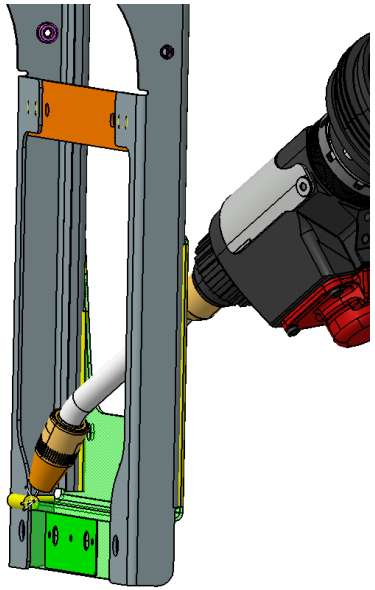


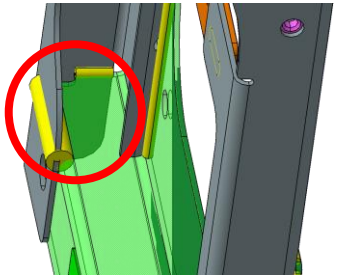
ACCESSIBILITY CHECK (Torch, Weld scanning)

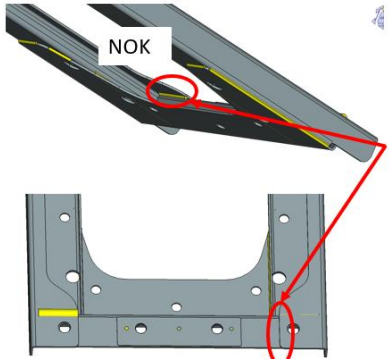


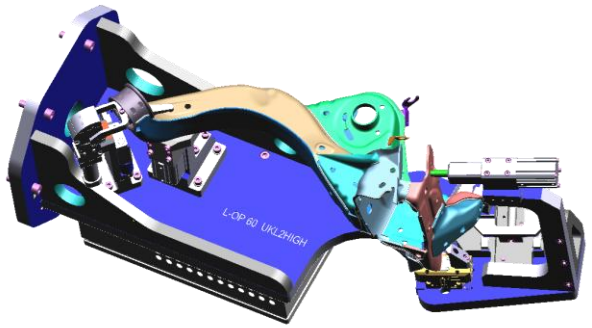




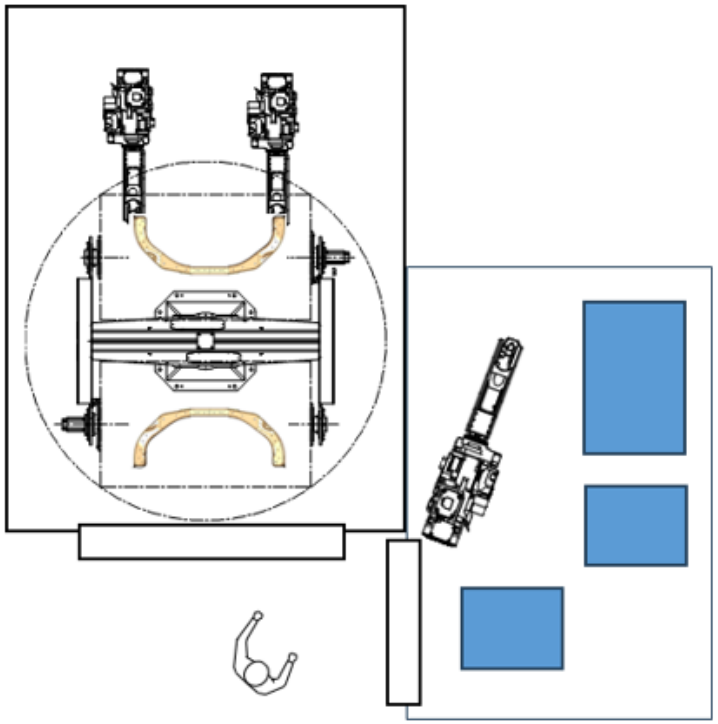








WELDING CELLS - CONCEPT

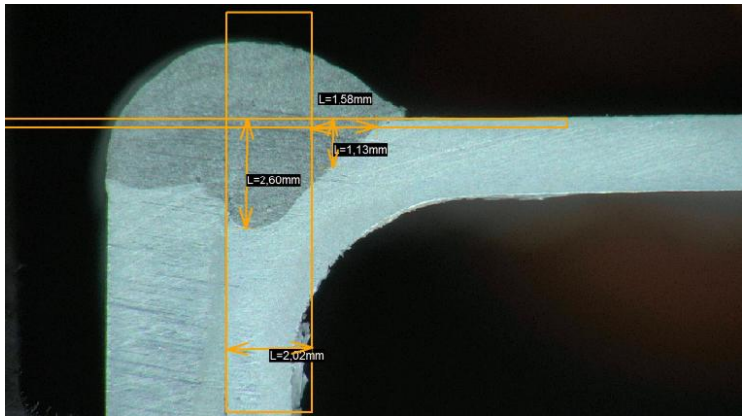


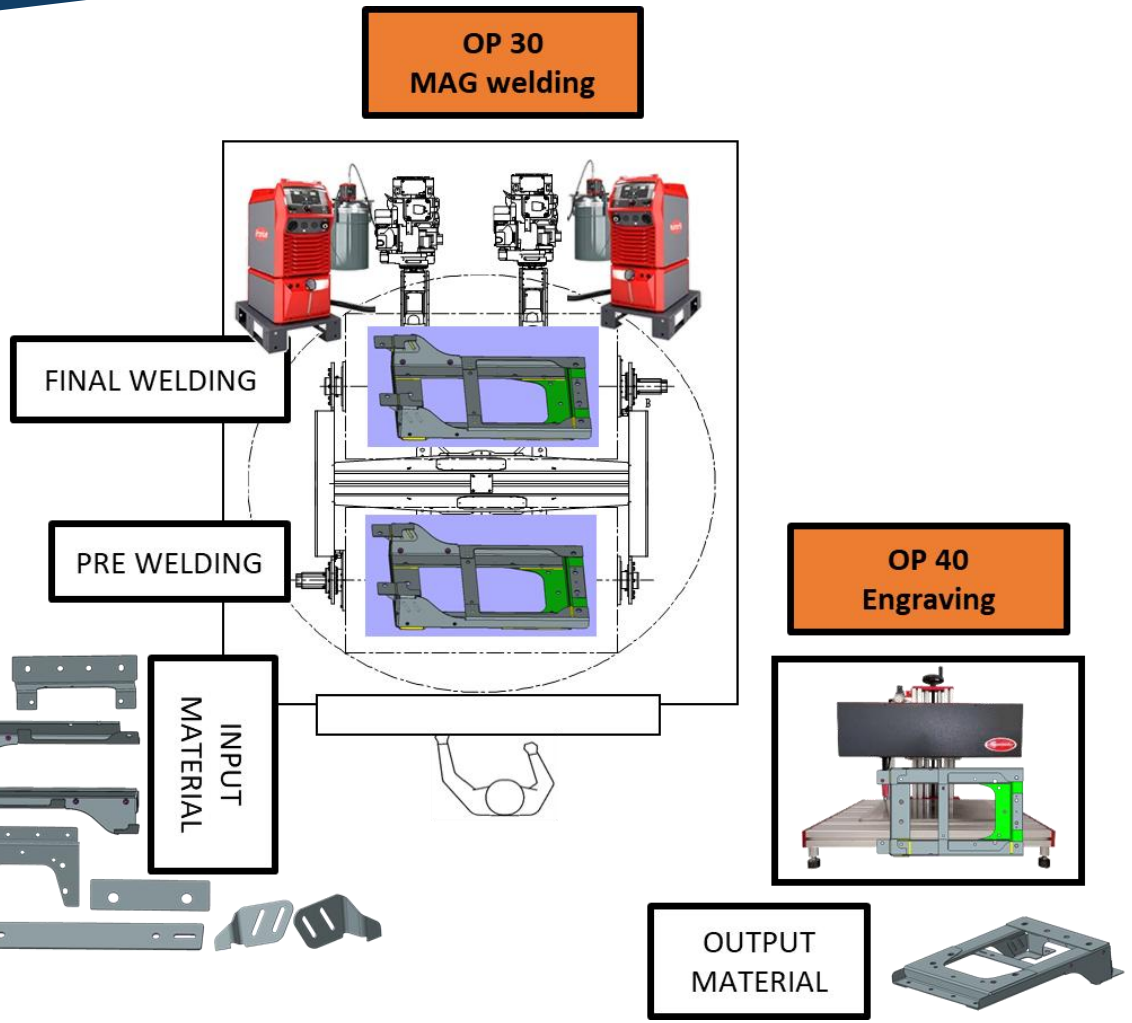
Robotic welding cell

- **2x MAG welding robots + Fronius CMT**
- **2x same welding clamping jigs (assembling all staped parts at once)**
- **1x manipulative robot + double gripper**
- **1x manual manipulatior**
- **Cooling rack**
- **100% geometry control**
- **Marking device**

WELDING CELLS - CONCEPT

- MAG robot welding
- 2x robot welding + H-turn table
- 2x Fronius CMT
- 2 welding fixtures
- 1 part / process
- 1 operator
- 1 engraving machine
- Macro section of weld (1/shift)

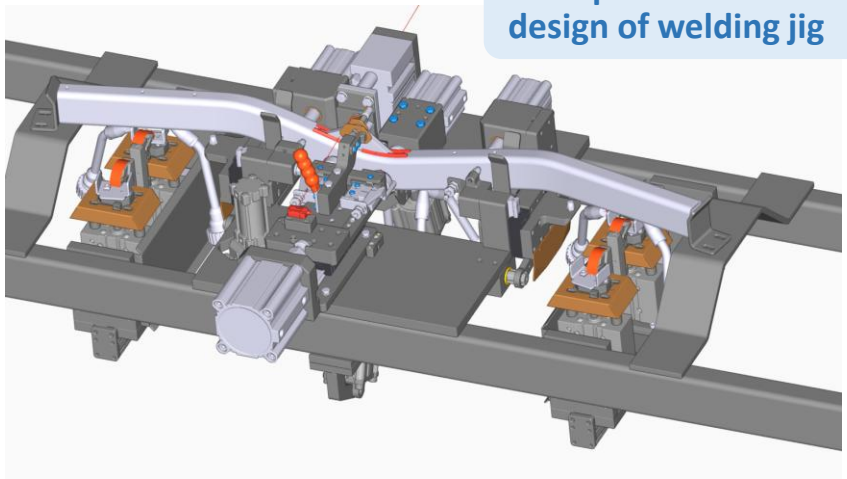




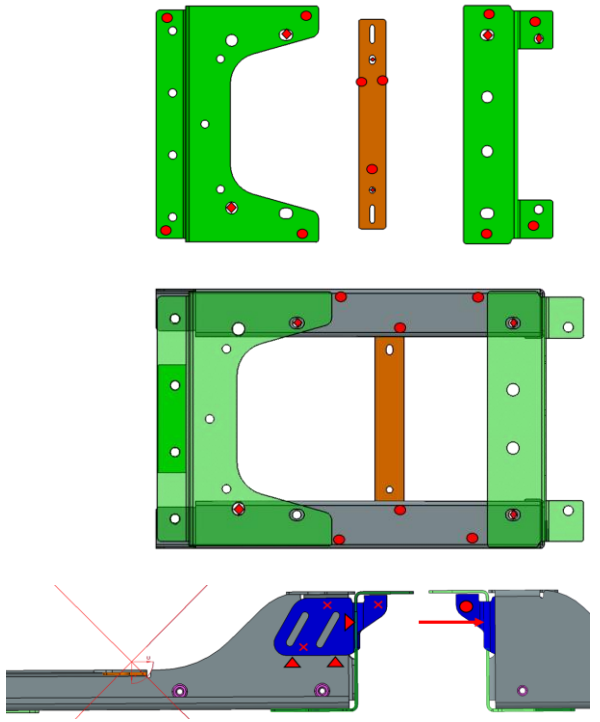
WELDING JIGS – CONCEPTUAL PHASE

- Automatic welding jigs – cylinders
- Poka – Yoke systems included
- Sensors included (part present and positions)
- Measurement cylinders optional

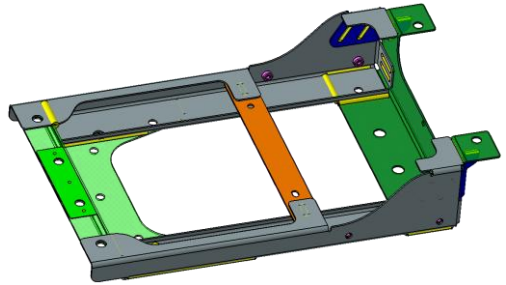
Example of CAD concept design of welding jig



1st Welding fixture - conceptual

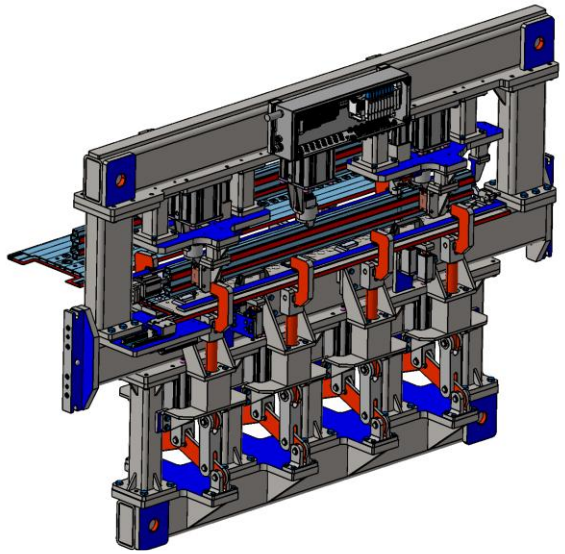


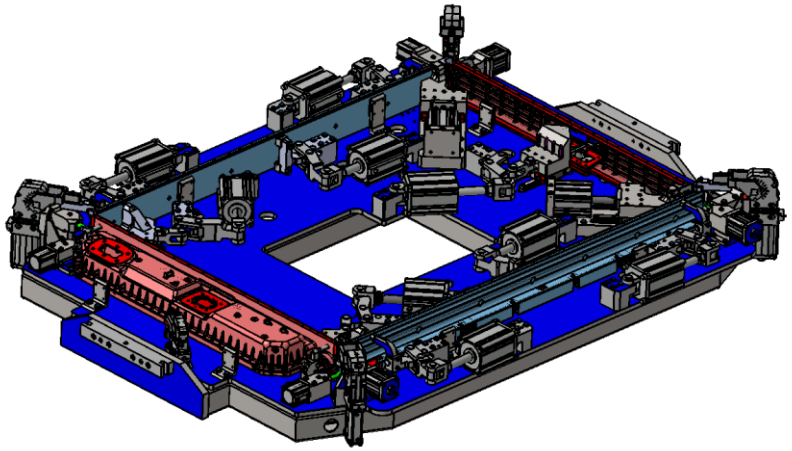
2nd Welding fixture (jigless) - conceptual

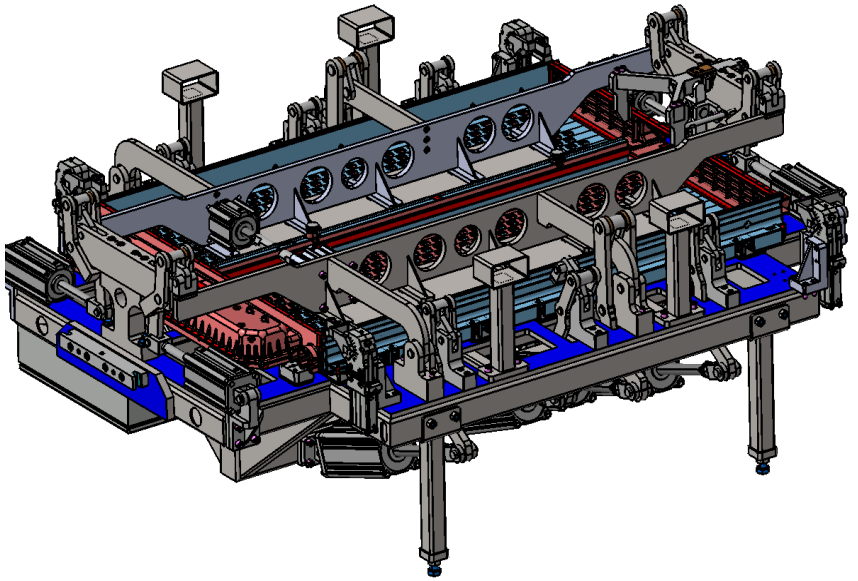


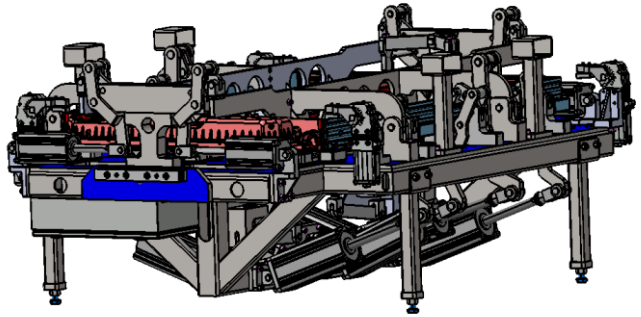
WELDING TOOLS/JIGS

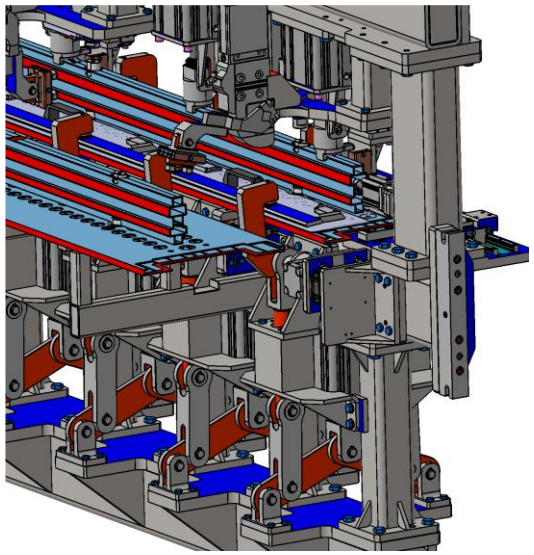
- In-house department for design, assembly, programming
- Multiple suppliers/partners for designing if needed





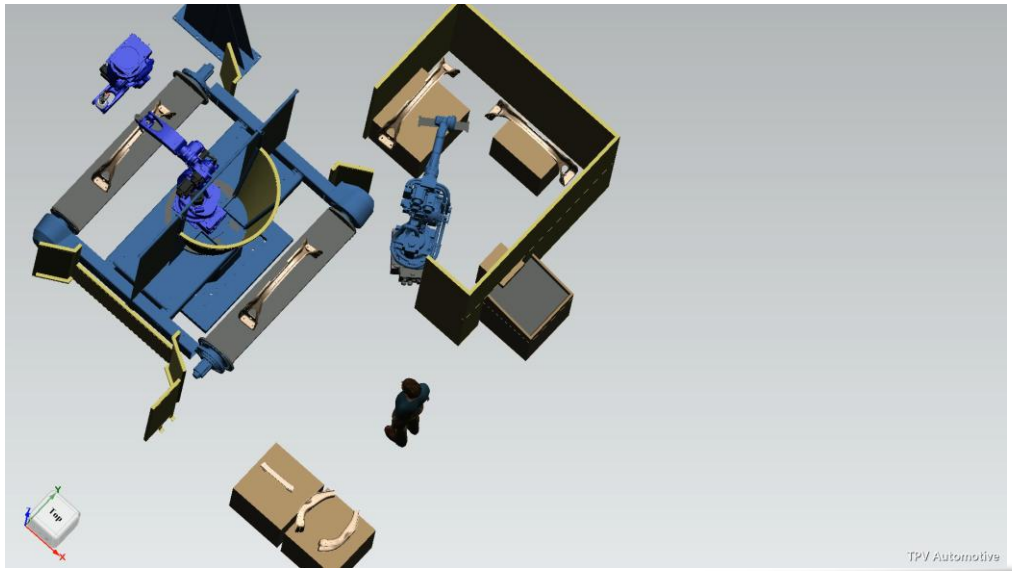


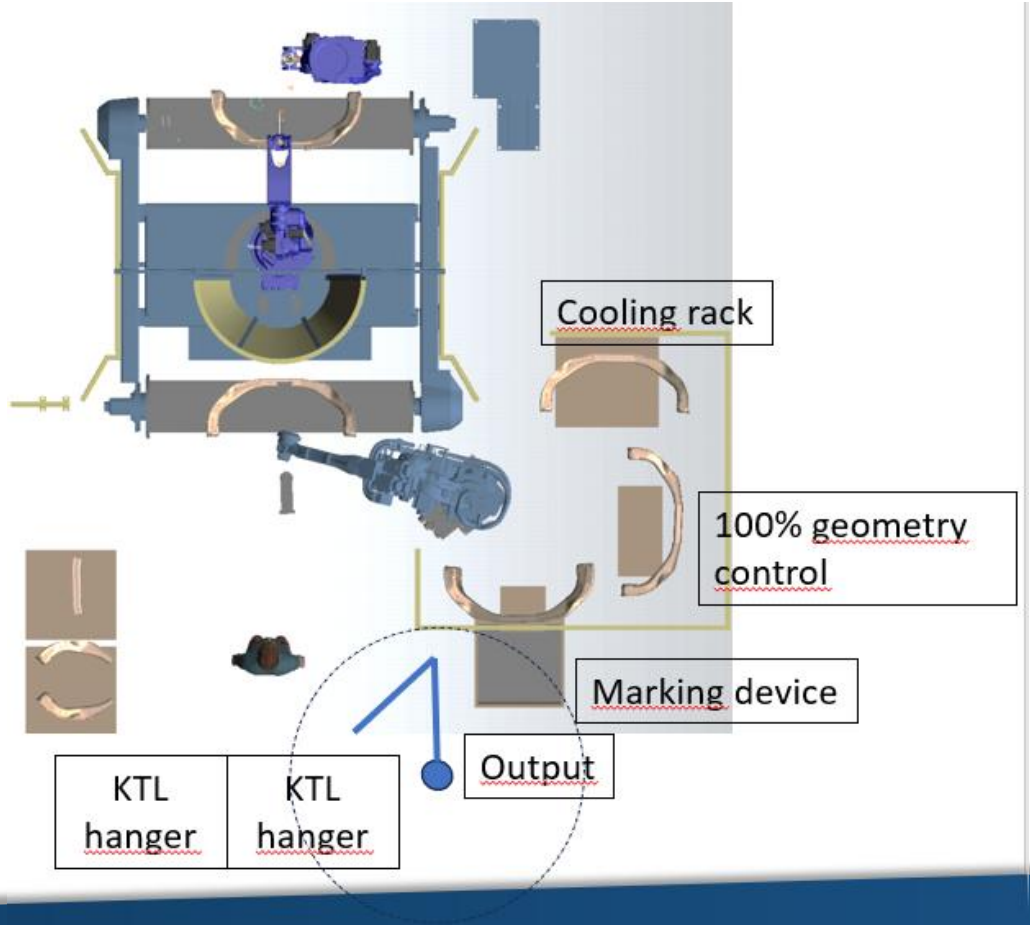




WELDING CELL SIMULATIONS

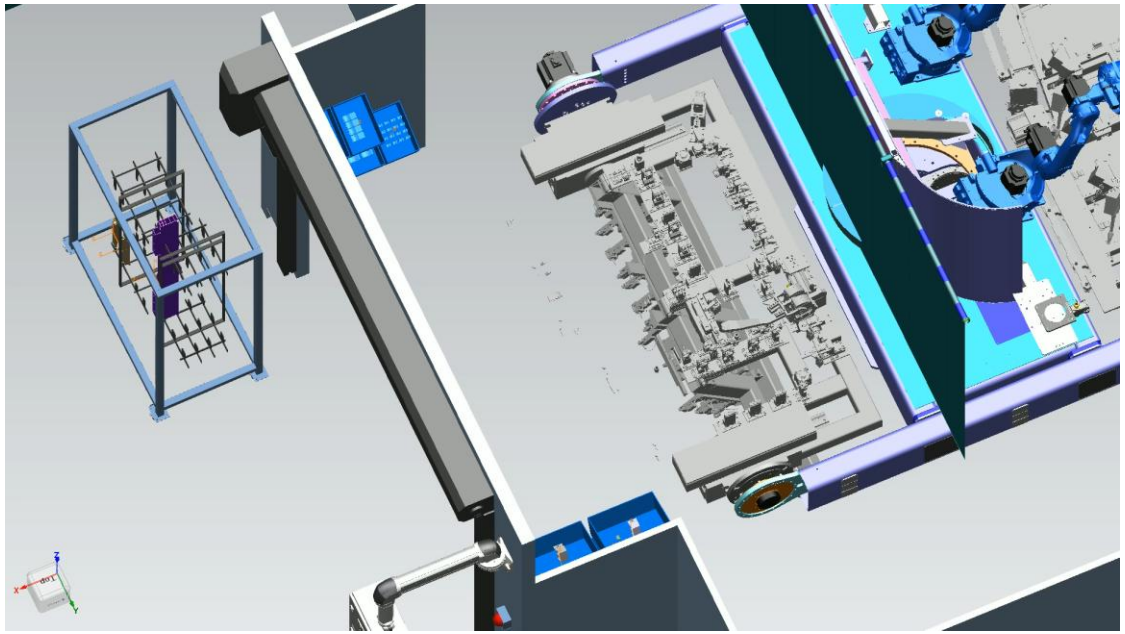
- Operator manually inserts stamping parts in welding jig
- Manipulative robot takes welded parts out of jig and exchanges parts on stations; cooling, quality control, marking and output
- Operator checks welds and put part on KTL hangers with manual manipulator



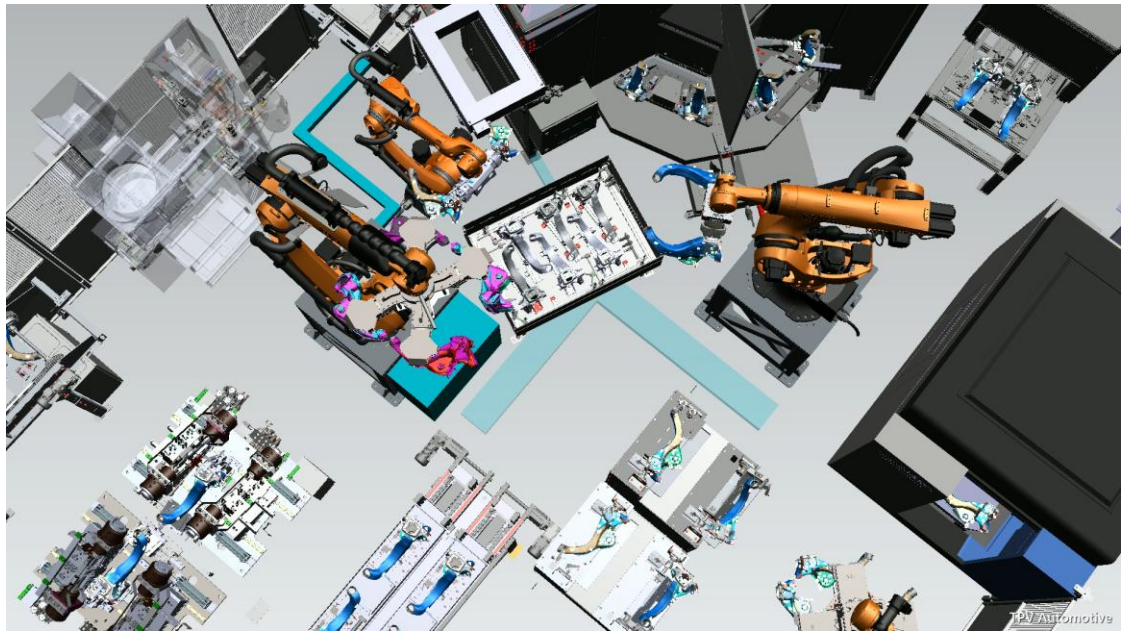


SMART FACTORY MODULES

WORKER ACCESSIBILITY

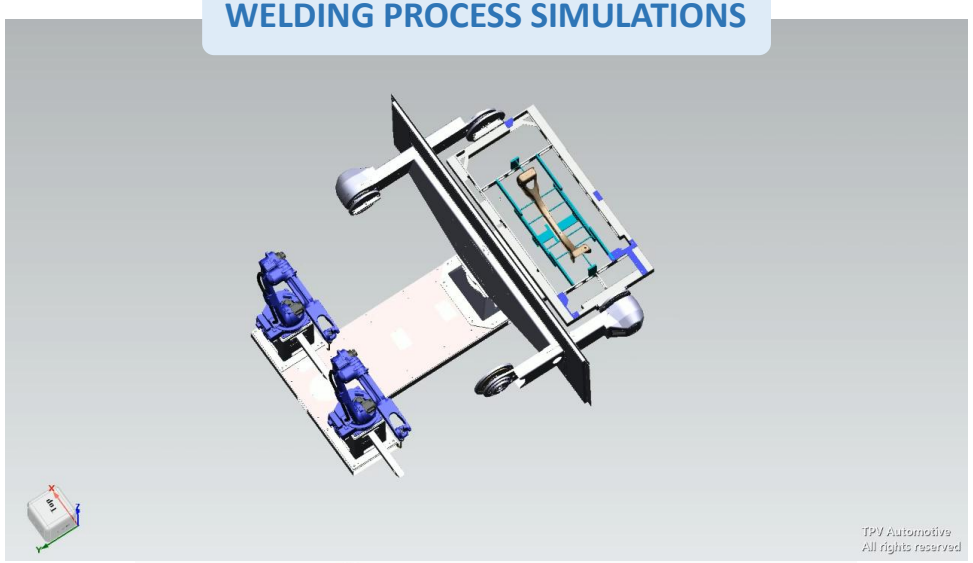


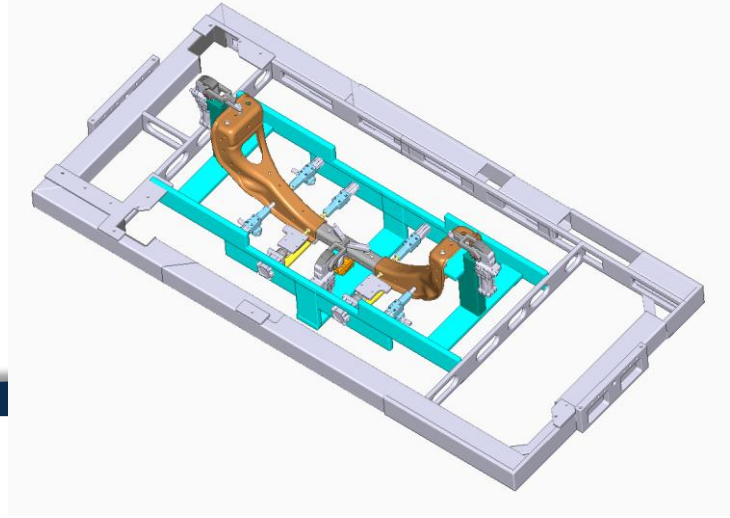
INTEGRATION OF ADDITIONAL PROCESS IN THE EXISTING SERIAL PROCESS



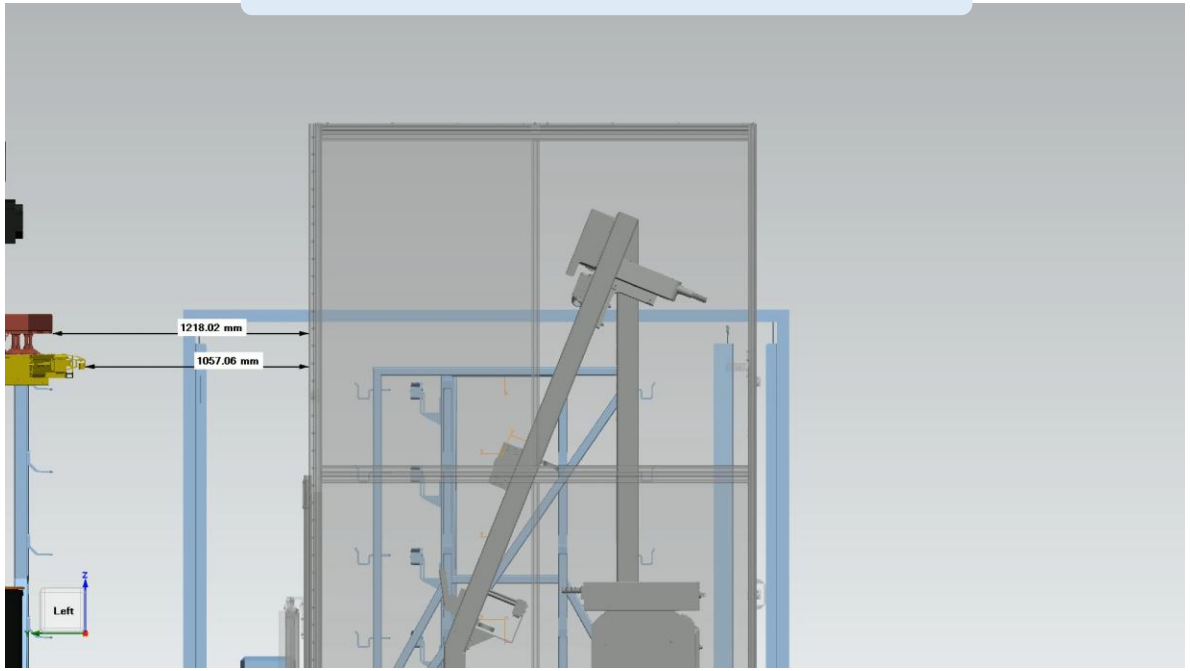
SMART FACTORY MODULES

WELDING PROCESS SIMULATIONS

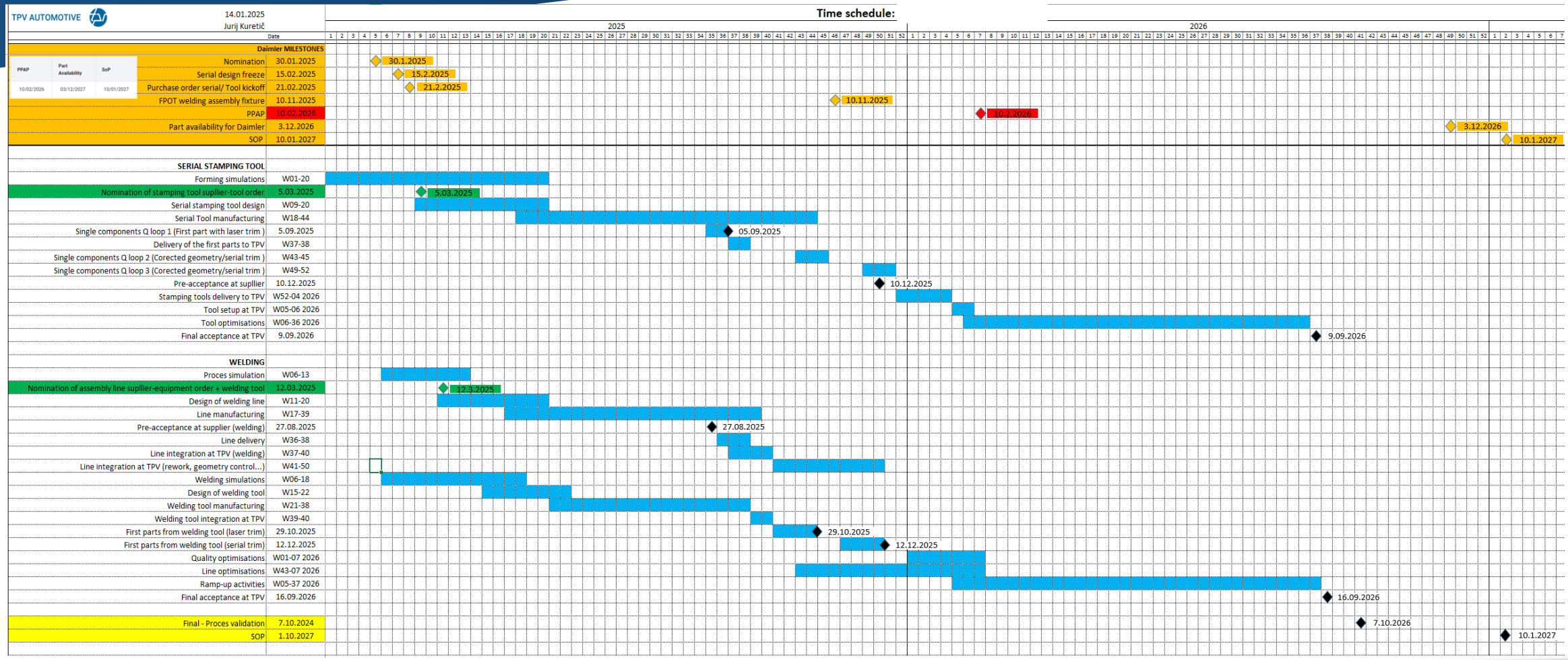




ROBOT TRAJECTORY CHECK (collision check)



TIME SCHEDULE - PLANNING



Contacts:

Domen Fink
Director of Sales
d.fink@tpv.si
Mob: +386 51 348 856

Marko Kerep
Key Account Manager
m.kerep@tpv.si
Mob: +386 41 755 884

TPV AUTOMOTIVE

Brezina 101
8250 Brežice
Slovenia

You are kindly invited to visit us ☺

www.tpv-automotive.si