Development phases of 2 high volume industrial products using high strain rates forming processes

Gilles Avrillaud et al., CTO

AGENDA

J'ADORE L'OR CAPS EMBOSSING BY EHF

- **Product**
- **Blank design**
- **Development steps of the industrial production systems**

POST FORMING OF DOOR HANDLES BY MPF

- **Product**
- **Initial validation of the postforming of a door handle by MPF**
- **Industrial validation of the MPF process on the kangoo's 3rd stop light**
- **MPF process qualification for the MEGANE E-TECH flush door handle**

CONCLUSION

J'ADORE L'OR CAPS EMBOSSING BY EHF

All Bmax employees

THE DIOR J'ADORE L'OR PRODUCT

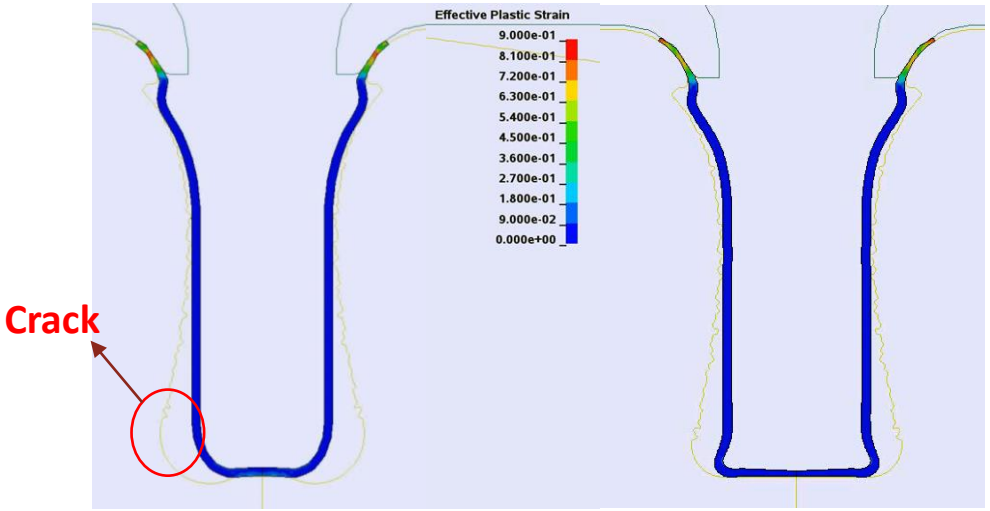
- The goal was to replace coated casted Zamak parts by anodized Aluminum formed parts
- ~ 2 millions parts produced (including ~ 1 million within the first 7 months)
- Got the award "Packaging of Perfume Cosmetics and Design" at the PCD Paris 2018 event

- Blank production, final cutting, anodization and assembly performed by a stamping company supplying goods for luxury packaging
- EHF systems were developed and the patterns are formed at Bmax

PHASE 1: BLANKS DEFINITION (1/2)

Initial blank shape

Optimized blank shape



Optimized blank shape

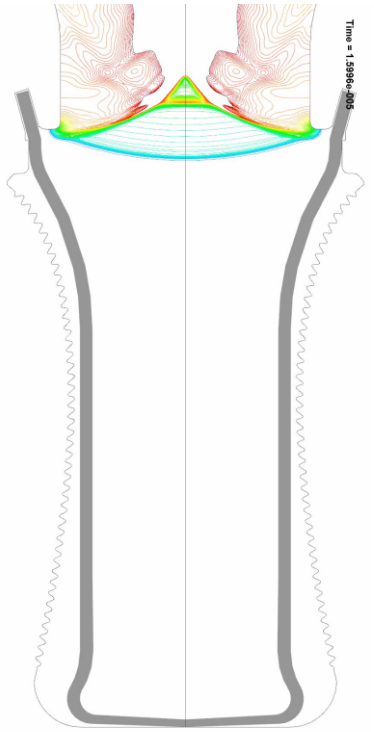
Preliminary patterns

Specific EHF modeling developed giving the electrical power as a function of time depending on generator parameters and electrodes gap → give the pressure depending on time → give the proper impact speed

Forming limit of the Al 5657

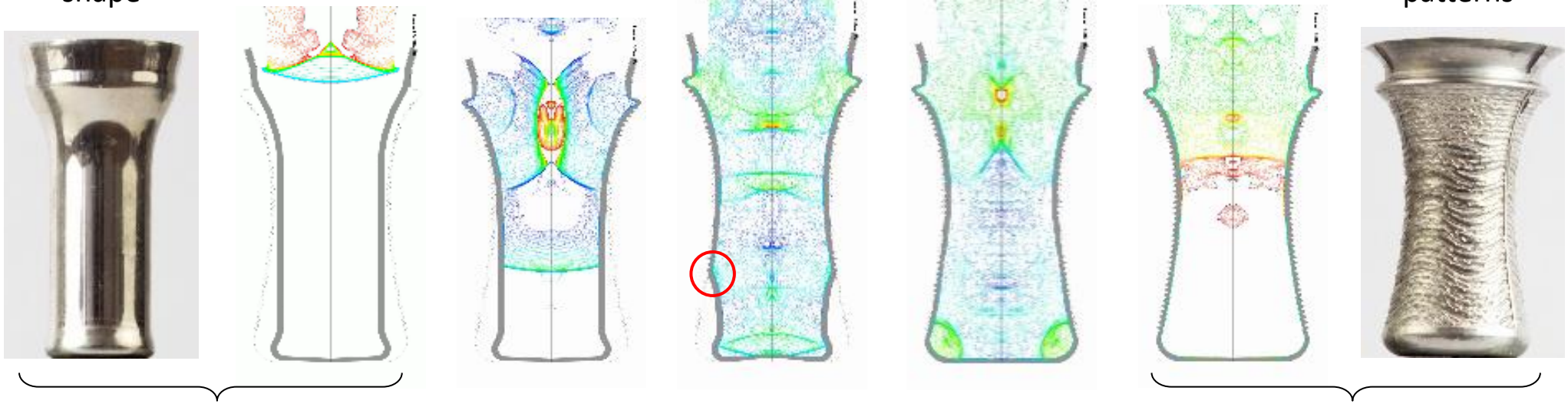
- Elongation at break at slow strain rate in tensile test: 17%
- Extrapolation in biaxial expansion at slow strain rate (Storen-Rice): 20% in major strain + 20% in minor strain
- Deformation in the top corner at high strain rates: 40% in major strain and 20% in minor strain **without rupture**

PHASE 1: BLANKS DEFINITION (2/2)



Optimized blank shape

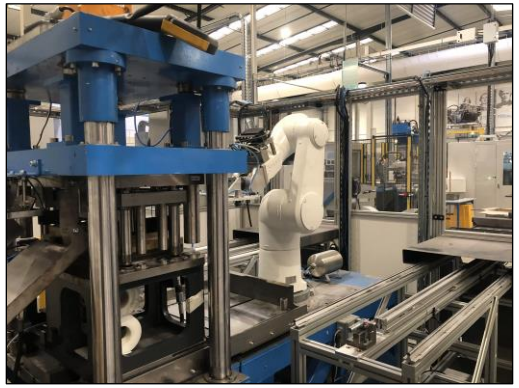
Final patterns



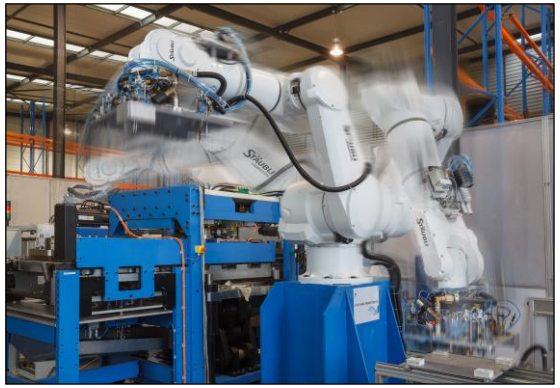
t = 0 | t = 16 µs | t = 50 µs | t = 84 µs | t = 119 µs

- Impact speed > 100 m/s
- Ironing and bending while forming (see t=50µs) → increase in formability
- Patterns properly formed once the shape of the bottom corner is complete → reflected wave with increased pressure moving up (see t = 119 µs)

DEVELOPMENT STEPS OF THE INDUSTRIAL PRODUCTION SYSTEMS



HD1: 1st automated prototype
with 1 EHF module and 1die



HD4: 2nd automated prototype
with 4 EHF modules and 4 die

PI3: 3rd automated prototype
with 1 EHF modules and 2 dies

KEY PROBLEMATICS ADDRESSED TO ANSWER THE HIGH VOLUME PRODUCTION REQUIREMENTS

- Forming repeatability ensuring tight tolerances and high surface quality → each part checked: patterns fully formed and no jetting traces
- Lifetime of the components in the chamber (insulator and electrodes mainly)
- Reproducibility of the breakdown voltage to master the impact velocity and therefore to ensure the lifetime of the die and the proper forming of the part
- Water management to optimize the production rate

IMPROVED INDUSTRIAL PRODUCTION SYSTEM

- 1 EHF system can produce up to 1 million parts per year
- Conveyer has the ability to deal with 6 EHF systems located around it
- Conveyer can deal with 2 different parts simultaneously produced on different EHF systems (automated optical detection of the parts)

POST FORMING OF DOOR HANDLES BY MPF

Matthieu Magdalena, Jean-Charles Boutin, Marc Capelaere*, Gilles Avrillaud

Renault's innovation team

All Bmax employees

* Renault

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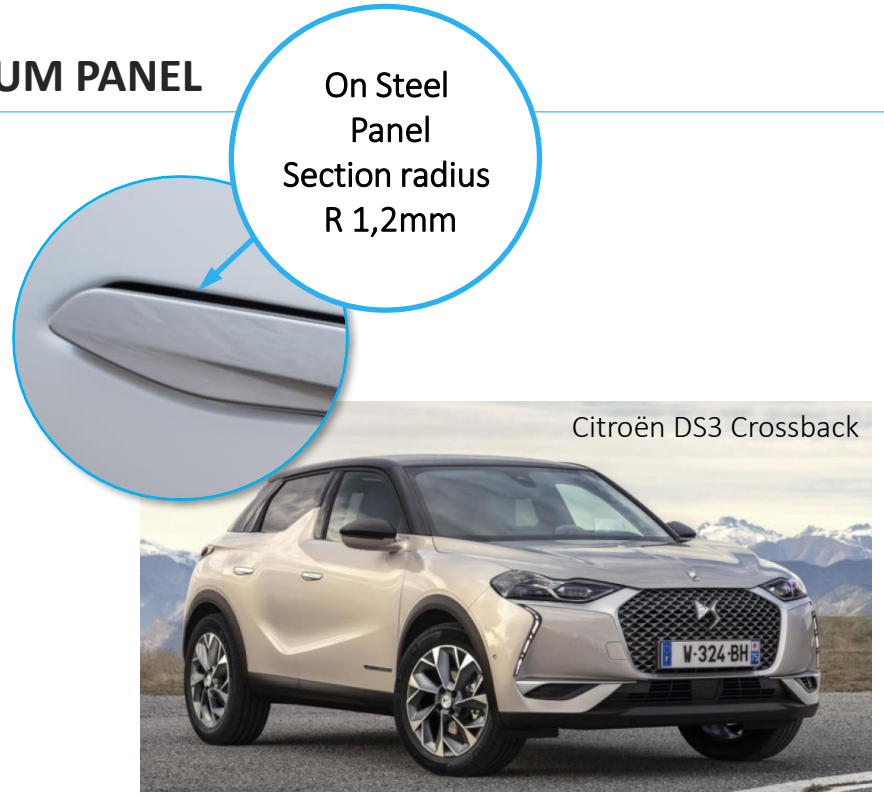
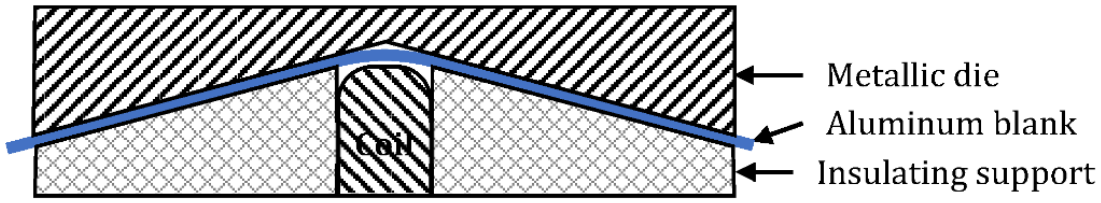
ACI conf.: Forming in car body engineering
Sept 2021

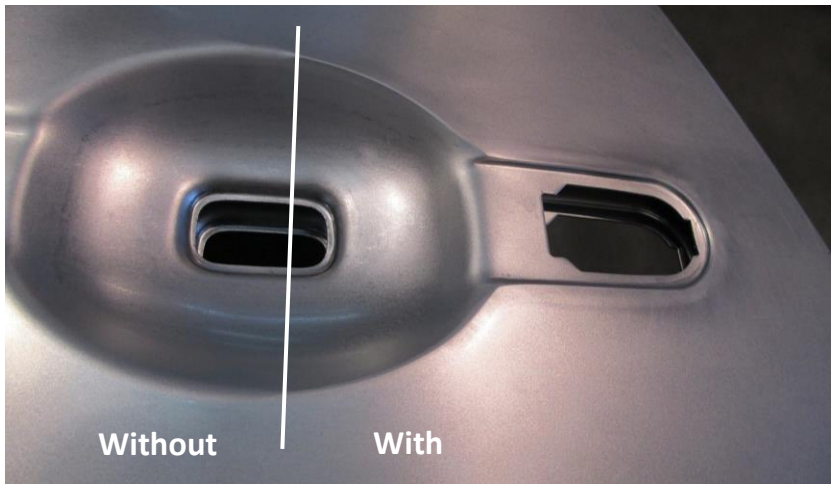
MPF TECHNOLOGY FOR RESTRIKING OPERATION ON ALUMINIUM PANEL

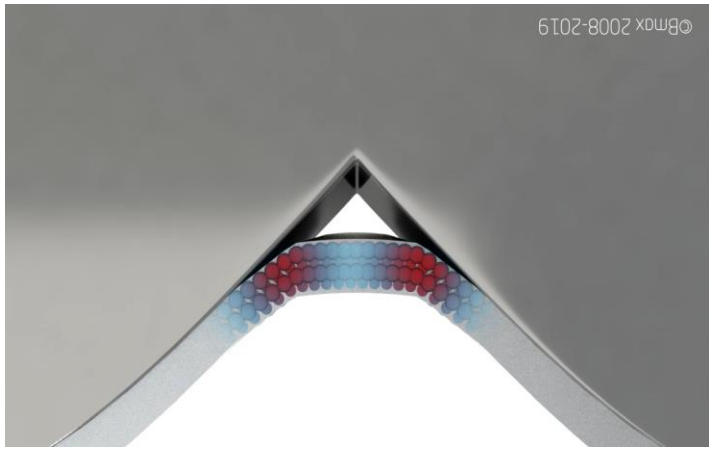


Goal: achieve a section radii below 1,2mm on aluminum panel

INITIAL VALIDATION OF THE POSTFORMING OF A DOOR HANDLE BY MPF







Material – **Al 6016 T4**

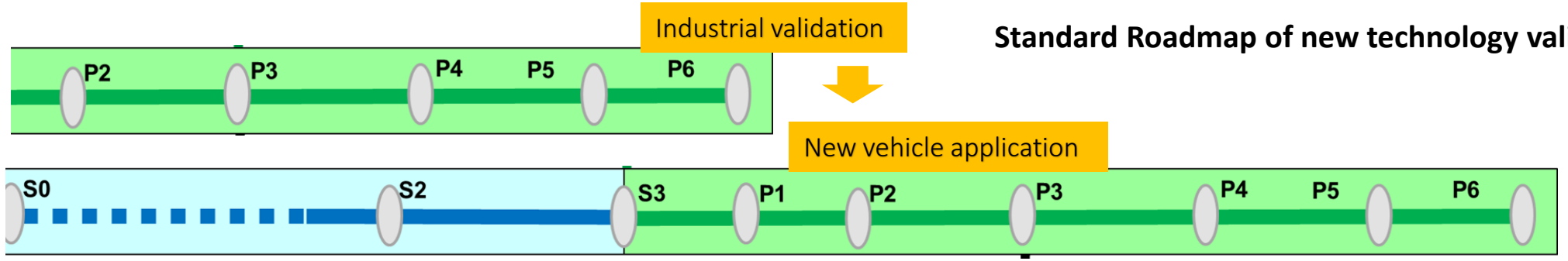
Sharping lines

Radius sharpened from 6mm (nominal in conventional) down to 1mm without failure and without surface defects like Teddy bear ears

Allow the use of Aluminum rather than Steel, while keeping designs character.

2017-2018

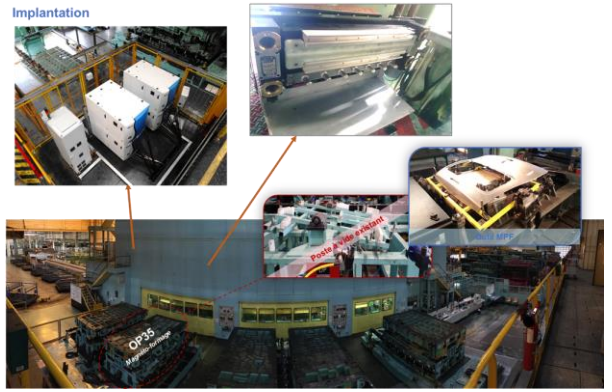
MPF PROCESS DEVELOPMENT OVERVIEW TO CALIBRATE A FLUSH DOOR HANDLE



Standard Roadmap of new technology validation

S2 Material Characterization

P1 Industrial validation



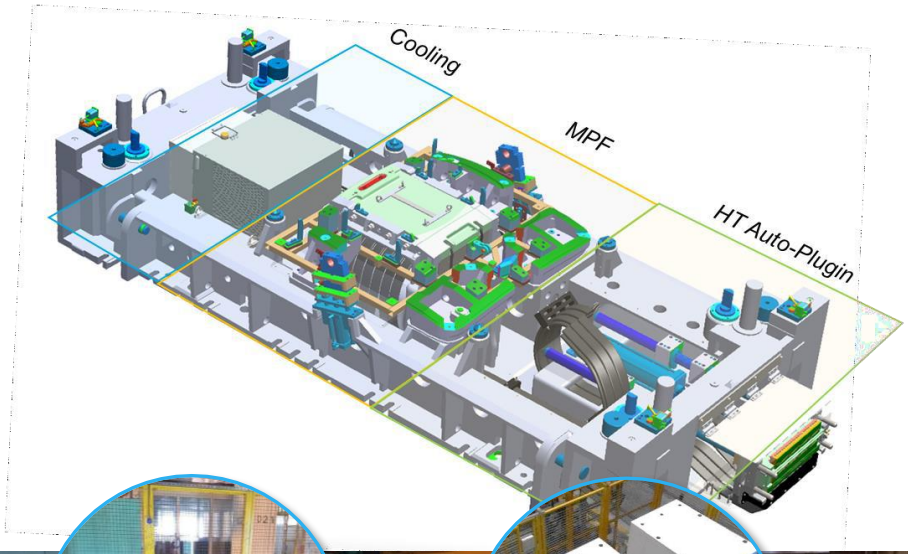
P6 Application to BCB Vehicle

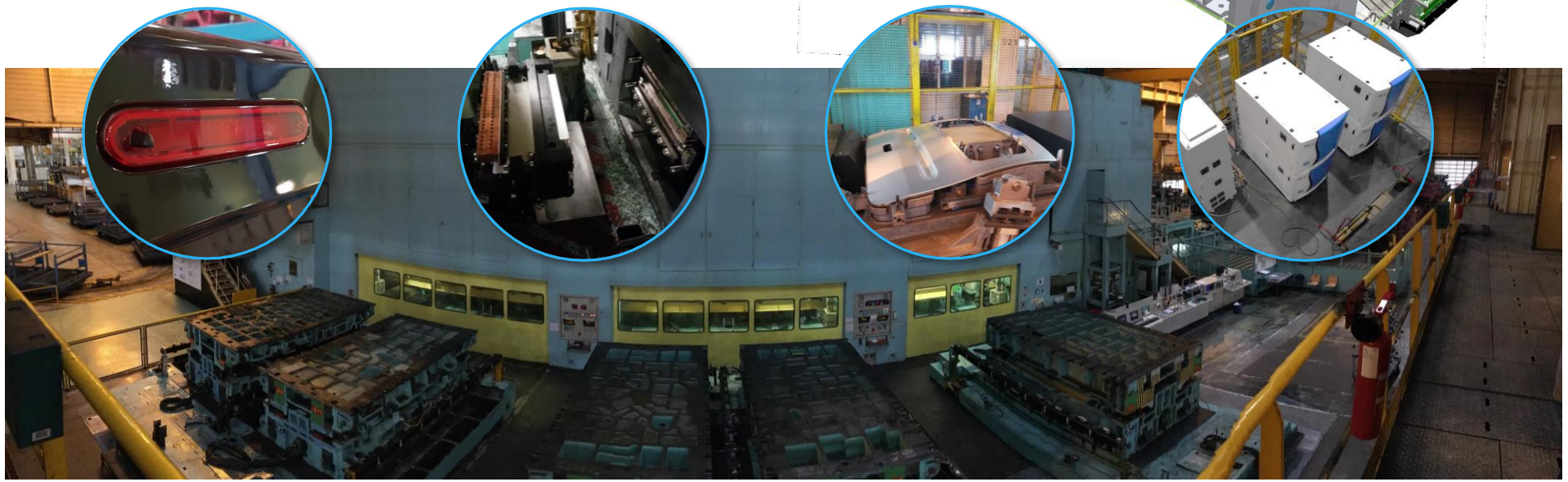
2018 - 2019

INDUSTRIAL VALIDATION OF THE MPF PROCESS ON THE KANGOO's 3rd STOP LIGHT

Industrialization step targets

- Calibration of steel panel section radii (R7 -> R3mm)
- Product quality in production
- Technology integration
- Production speed
- Repeatability of the process/results





PRACTICAL RESULTS ON THE KANGOO's 3rd STOP LIGHT (steel panel)

Industrialization validation

Industrial validation was officialized with the plant team and Nissan Team end of 2019 :

- No security issue
- No scrapped panels produced
- No performances change

• Sharp radius on steel sheet

RENAULT NISSAN MITSUBISHI

2 process drawing with Magnetoforming technology - industrial validation on Kangoo back door outer

P6 granted

Purpose of development

- First industrial test of MPF tehcnology
- No performances change
- No NG panels produced
- No security issues
- Alliance Production way

Effect	Small radius on third light emboss (but we don't care !)
Resource	1 FTEY
1st Adoption	BCB : Door flush handle
Investment Payback	No Payback : PQ improvment

Press line integration

After

KPI : Magneto-forming technology on Kangoo Back door outer panel

KPI	Target values	Results P6
Q Production level	9,5 SPM	9,5 SPM
AOC	same as others	15
Small radius	3 mm	3 mm
skin defect	D3 rotation max	Small D3
Efficiency	OEE : no change	NO stop
Maintenance cost	T & C	No data
Geometry level	same than before	stop light mounting ok
C Running cost evaluation	< 0,25 € / Vehicle	< 0,01 €
T X months after Production start	6	12

RENAULT NISSAN MITSUBISHI

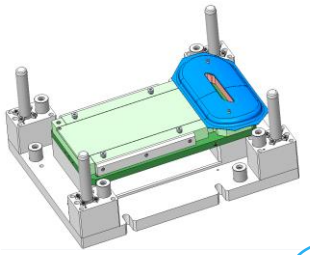
2019 - 2020

MPF CALIBRATION : PROCESS QUALIFICATION FOR THE MEGANE E-TECH FLUSH DOOR HANDLE

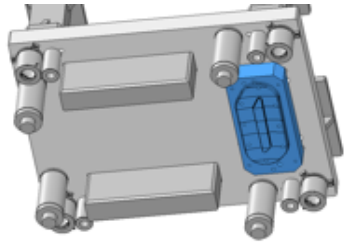
Calibrate a 1,2 mm radii on an Aluminum panel

Process qualification on small scale → S2

S2



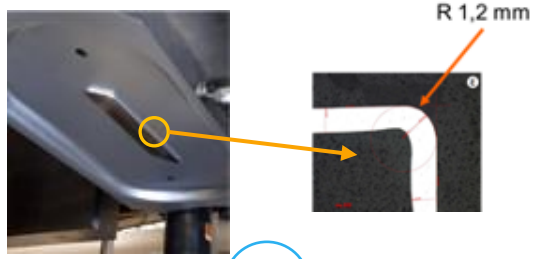
Lower tool (coil)



Upper tool (die)

1

Define and validate MPF tool design principals

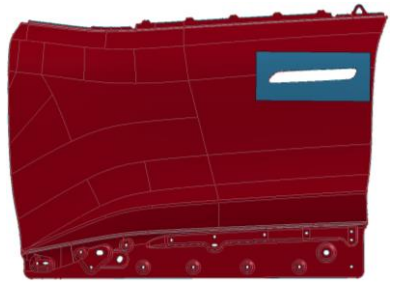


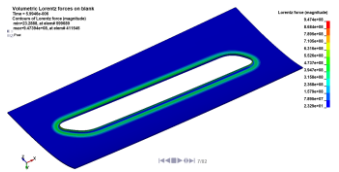
2

Set MPF process parameters

3

Door handle geometries validation





Process qualification on full scale → S3

S3

1

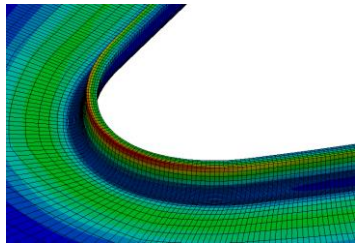
Process validation using industrial MPF tooling

2

MPF process parameters validation

3

Geometries, painting & assembly validation



Strongly coupled MPF simulation (LS-DYNA)

2020 - 2021

MPF CALIBRATION TOOLS FOR MEGANE E-TECH FLUSH DOOR HANDLE

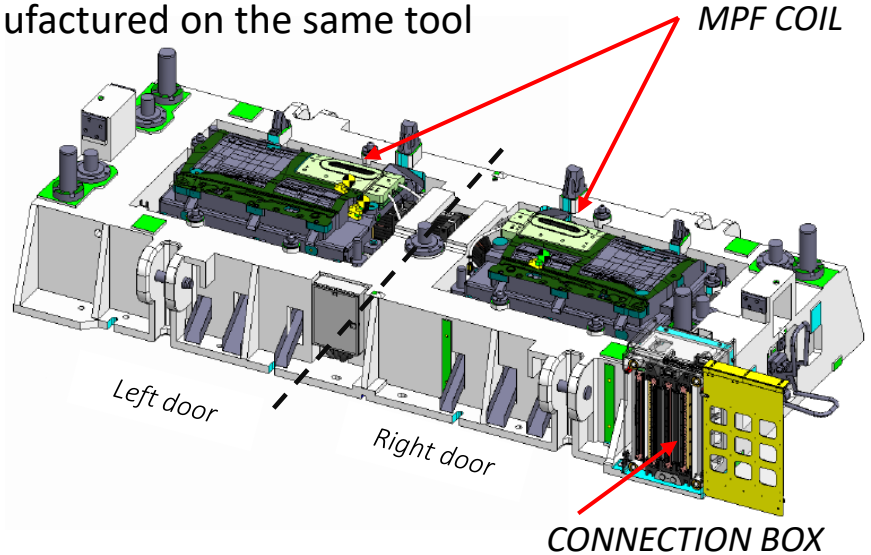
Hybrid tool : MPF system integrated in a classic stamping tool

Hybrid tool co-designed by Renault and Bmax

Simultaneous operations performed on the last tool of the door panel stamping process:

- MPF calibration
- Conventional piercing, flanging and cutting

Two doors (left and right) manufactured on the same tool



Connect the tool to the MPF generator, to provide pulsed power, cooling and sensors information from and to the press

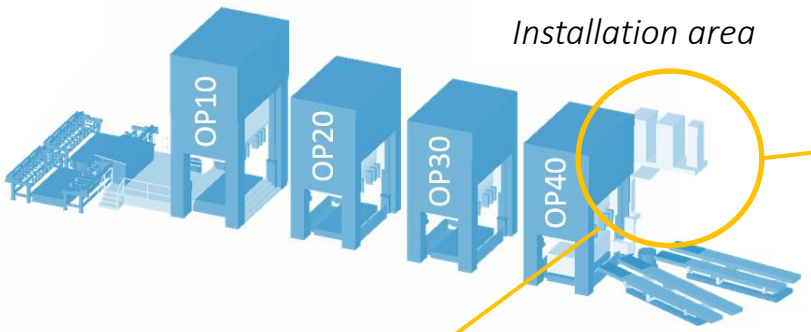
MPF system integrated

Tool ready for production @ customer plant

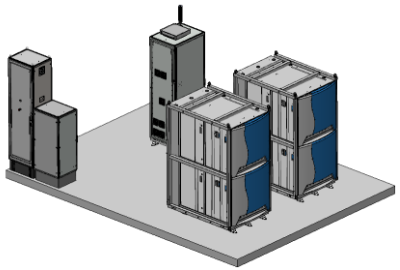
2020 - 2021

MPF CALIBRATION INTEGRATION FOR THE MEGANE E-TECH FLUSH DOOR HANDLE

From integration studies to installation on classic mechanical stamping press line



Installation area



System layout
- *Pulse generator*
- *Electrical cabinet and master unit*
- *Cooling system*

Generator integrated on top of the press line

Connexion box

Automatically connect the MPF generator to the MPF tool
→ fulfill the requirements of stamping tool changing time i.e. from 5 to 10 min depending on the press line

Current status
- Nominal production rate validated on several batches
- Parts quality validated
- Series production foreseen at beginning of 2022

SUMMARY

The presentation of these development phases of 2 high volume industrial products using high strain rates forming processes allows to conclude that:

- **EHF can be used for low and high volume production**
- **EHF is complementary to the MPF process to perform shapes that cannot be formed by conventional forming processes**
- **Lifetime of insulators and electrodes in the EHF discharge chamber can fulfill industrial requirements**
- **MPF can be integrated in a mechanical press line to postform automotive panels**
- **MPF makes it possible to get small radii on outer panels on lightweight material such as Aluminum without surface defects (like teddy bear ears or cracks)**
- **MPF has the ability to reach all the KPIs required by the automotive industry**