

# Leading Innovation with Virtual Prototyping

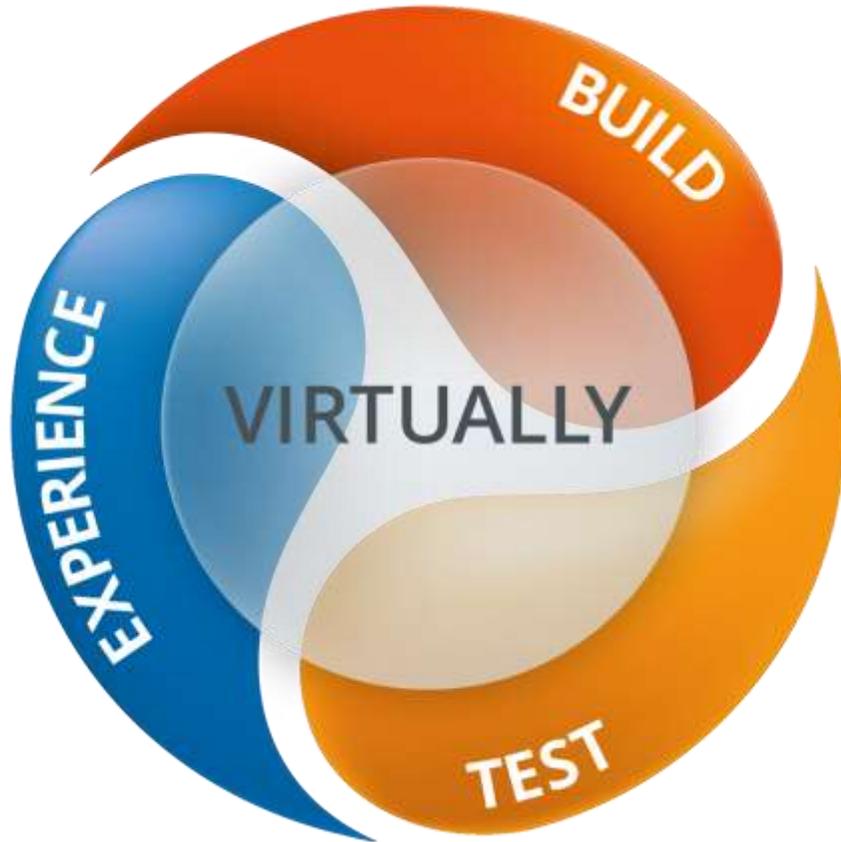


Image courtesy of Audi AG



Image courtesy of Boeing

# Mission & Vision



## ESI's Mission

Deliver Virtual Prototyping solutions that improve industrial product development

## ESI's Vision

Be the leader in Virtual Prototyping thanks to a unique knowledge in material physics

# The Story of ESI

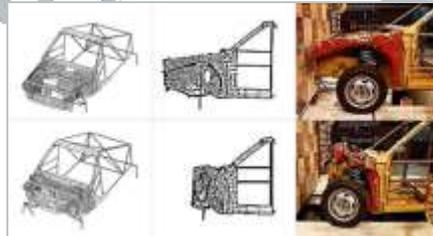
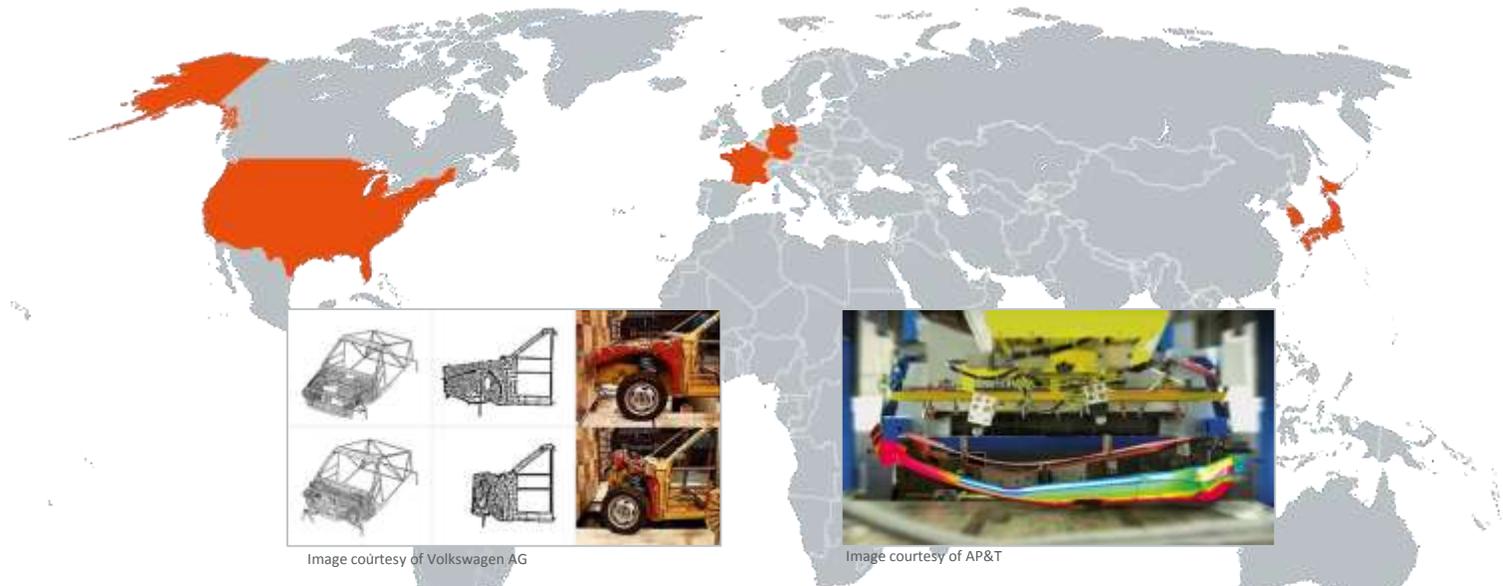


Image courtesy of Volkswagen AG

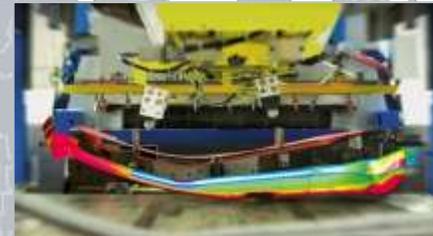


Image courtesy of AP&T

**1973**

## THE STORY BEGINS

ESI founded; expert in physics of materials

**1985**

## FIRST CRASH TEST ON FULL CAR

First Volkswagen Polo

**1999**

## VIRTUAL MANUFACTURING

- Added to the ESI portfolio:
- Casting
  - Sheet Metal Forming
  - Welding

**2000**

## NYSE EURONEXT



ESI enters the NYSE Euronext Paris stock market

## ISO 9001-2000 CERTIFICATION



# The Story of ESI



**2001**

## EXPANSION INTO MULTI-DOMAIN SIMULATION

- NVH
- Durability
- Vibro-Acoustics
- Comfort

**2011**

## ENTRY INTO VIRTUAL REALITY

ESI acquires IC.IDO



Image courtesy of Mitsubishi Hitachi Power Systems Europe

**2012**

## EMBRACING OPEN SOURCE

ESI acquires OpenCFD, the makers of OpenFOAM

**2016**

## MAKE IT SMART

ESI makes prototypes smart by integrating acquisitions in Systems Engineering, Cloud Computing, Data Analytics and Machine Learning



# ESI Around The World



More than **40** countries



**34** subsidiaries



**1100** people



MILPITAS, CA  
USA



DETROIT, MI  
USA



SÃO PAULO  
BRAZIL



PARIS  
FRANCE



FRANKFURT  
GERMANY



EKATERINBURG  
RUSSIA



BANGALORE  
INDIA



BEIJING  
CHINA



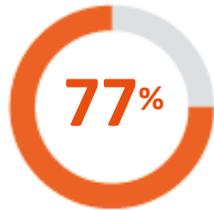
TOKYO  
JAPAN



# Key Figures - 2016

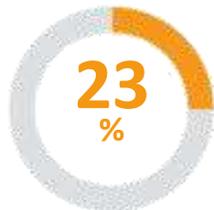
**141**  
Million Euros  
2016 annual revenues

**Licenses**  
Growth & Recurrence

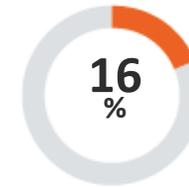


**30%**  
R&D  
investments/  
Licensing  
revenue

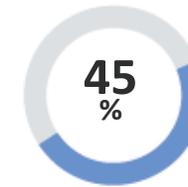
**Services**  
Innovation & Co-creation



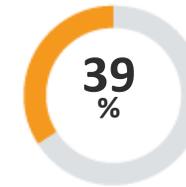
Revenue distribution  
per geographic area



Americas

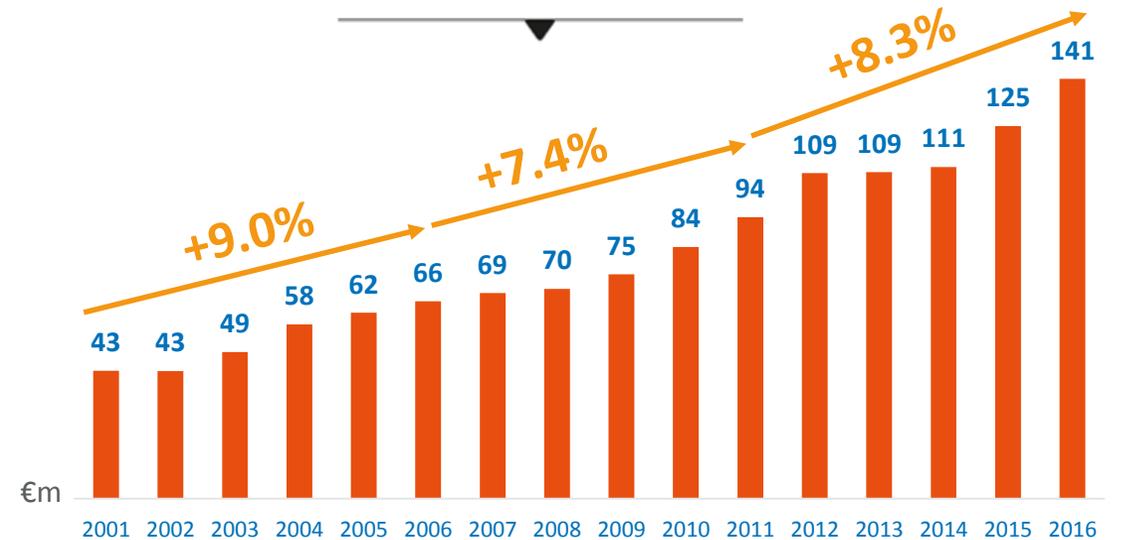


EMEA



Asia-Pacific

Continuous growth



# Long-term partnerships



Joint-Venture with BIAM  
(AVIC group)



Framework agreement  
with Renault



Multi-year collaboration  
agreement with Astrium



Exclusive partnership  
agreement with EDF EN



8<sup>th</sup> triennial contract with  
Volkswagen Group

# What our customers say



“**Virtual Prototyping** enables us to continuously offer car buyers and drivers technical **innovations and new designs at a faster pace.**”

*Volkswagen AG*



“We’re setting the scene for the next **generation of space vehicles and technologies**, while promoting Virtual Prototyping and Virtual Engineering.”

*Astrium (now Airbus Defense & Space)*



“The Ford development process for vehicles is getting faster and faster. ESI’s Virtual Reality solution IC.IDO is an efficient tool **to reduce the amount of prototypes** and mock ups.”

*Ford*



“Using guided CAE automation early in the design process enables us to identify the right concepts and verify design changes in order to **save time and cost.**”

*Samsung Electronics*



“I am convinced that ESI will continue to **provide outstanding simulation products and technical support** for the initiatives of the Electronic Testing and Research Group.”

*Mazda Motor Corporation*



# Virtual Prototyping



# ESI is expanding to make Virtual Prototyping even smarter

<p><b>1997</b></p> <p><b>SY/TUS International</b> ESI Group</p> <p><b>Framasoft</b> Mechanical simulation for energy sector</p>		<p><b>1999</b></p>  <p><b>Dynamic Software/Optris</b> Stamping simulation</p>	<p><b>2001</b></p>  <p><b>Straco</b> Vibro-acoustics</p>	<p><b>2002</b></p> <p><b>ProCAST</b></p> <p><b>ProCAST</b> Casting simulation</p>	<p><b>2002</b></p> <p><b>CALCOSOFT</b></p> <p><b>Calcom</b> Swiss distribution company</p>
<p><b>2002</b></p>  <p><b>VASci</b> Vibro-acoustics</p>	<p><b>2003</b></p>  <p><b>EASI</b> Open collaborative software environment</p>	<p><b>2004</b></p>  <p><b>CFD Research Corporation's product division</b> CFD</p>	<p><b>2006</b></p>  <p><b>IPS International</b> Virtual human models</p>	<p><b>2006</b></p> <p><b>ATE</b></p> <p><b>ATE Technology International</b> Integrated solutions in the aeronautic sector</p>	<p><b>2008</b></p>  <p><b>Mindware Engineering Inc.</b> Mindware engineering CFD</p>
<p><b>2008</b></p>  <p><b>Vdot</b> Lean process management</p>	<p><b>2011</b></p>  <p><b>IC.IDO</b> The Visual Decision Company <b>IC.IDO</b> Virtual Reality</p>	<p><b>2011</b></p>  <p><b>Efield</b> 3D analysis of electromagnetics</p>	<p><b>2012</b></p> <p><b>OpenFOAM</b></p> <p><b>OpenCFD</b> Embracing the open source business model</p>	<p><b>2013</b></p>  <p><b>CyDesign Labs</b> Systems modeling</p>	<p><b>2014</b></p>  <p><b>CAMMECH</b> ESI's new subsidiary in Vietnam</p>
<p><b>2015</b></p>  <p><b>PRESTO</b> CFD for the electronics cooling market</p>	<p><b>2015</b></p>  <p><b>Ciespace</b> Cloud computing</p>	<p><b>2015</b></p>  <p><b>PicViz</b> Big Data visual analysis</p>	<p><b>2015</b></p>  <p><b>CIVITEC</b> 3D modelling of ultra-realistic environment conditions</p>	<p><b>2015</b></p>  <p><b>Supporting your vision</b> <b>ITI GmbH</b> Simulation of mechatronic and multi-domain systems</p>	<p><b>2016</b></p> <p><b>mineset</b></p> <p><b>Mineset Inc.</b> Big Data visual analytics and machine-learning specialist</p>

# Sample Customer References

## GROUND TRANSPORTATION

ALSTOM Transport  
 AUTOLIV  
 BMW GROUP  
 BOMBARDIER  
 CATERPILLAR  
 FAW VOLKSWAGEN  
 CONTINENTAL  
 DAIMLER AG  
 FAURECIA  
 FIAT / CHRYSLER  
 FORD  
 GENERAL MOTORS  
 GESTAMP  
 HONDA  
 HYUNDAI GROUP  
 ISUZU  
 JAGUAR LAND ROVER  
 MAN  
 MAZDA  
 MITSUBISHI MOTOR  
 PSA PEUGEOT CITROEN  
 RENAULT NISSAN  
 SIEMENS  
 SHANGHAI VOLKSWAGEN  
 TAKATA  
 TATA GROUP  
 TOYOTA MOTORS CORP.  
 VISTEON  
 VOLKSWAGEN GROUP  
 VOLVO GROUP

## HEAVY INDUSTRY & MACHINERY

AP&T  
 ARCELOR MITAL  
 HONEYWELL  
 JOHN DEERE  
 NASA  
 UNITED TECHNOLOGIES

## ENERGY & POWER

ALFA LAVAL  
 AREVA  
 CEA  
 COMEX GROUP  
 DAHER  
 DOOSAN SKODA POWER  
 EDF GROUP  
 EPRI  
 GE POWER  
 IHI  
 ONET  
 SHELL

## ELECTRONICS & CONSUMER GOODS

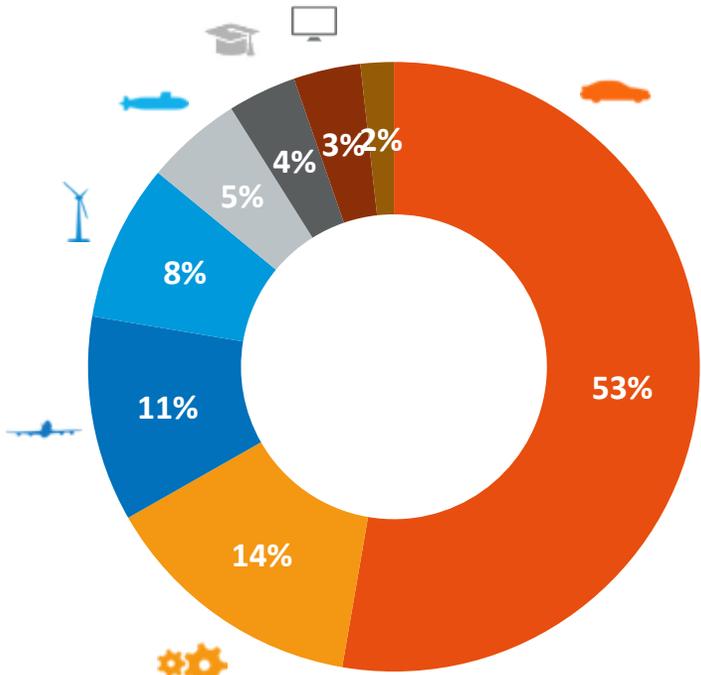
3M  
 APPLIED MATERIALS  
 BERTRANDT  
 HITACHI  
 LAM  
 LTD  
 HONDA  
 LG  
 NEC  
 SAMSUNG

## AEROSPACE

AIRBUS  
 ALCOA  
 AVIC  
 BOEING  
 BOMBARDIER  
 DASSAULT GROUP  
 EUROPEAN SPACE AGENCY  
 GENERAL DYNAMICS  
 GENERAL ELECTRIC  
 HONEYWELL  
 LOCKHEED MARTIN  
 NASA  
 NORTHROP GRUMMAN  
 PCC CORPORATE  
 ROLLS ROYCE  
 SAFRAN  
 TEXTRON AVIATION  
 THALES

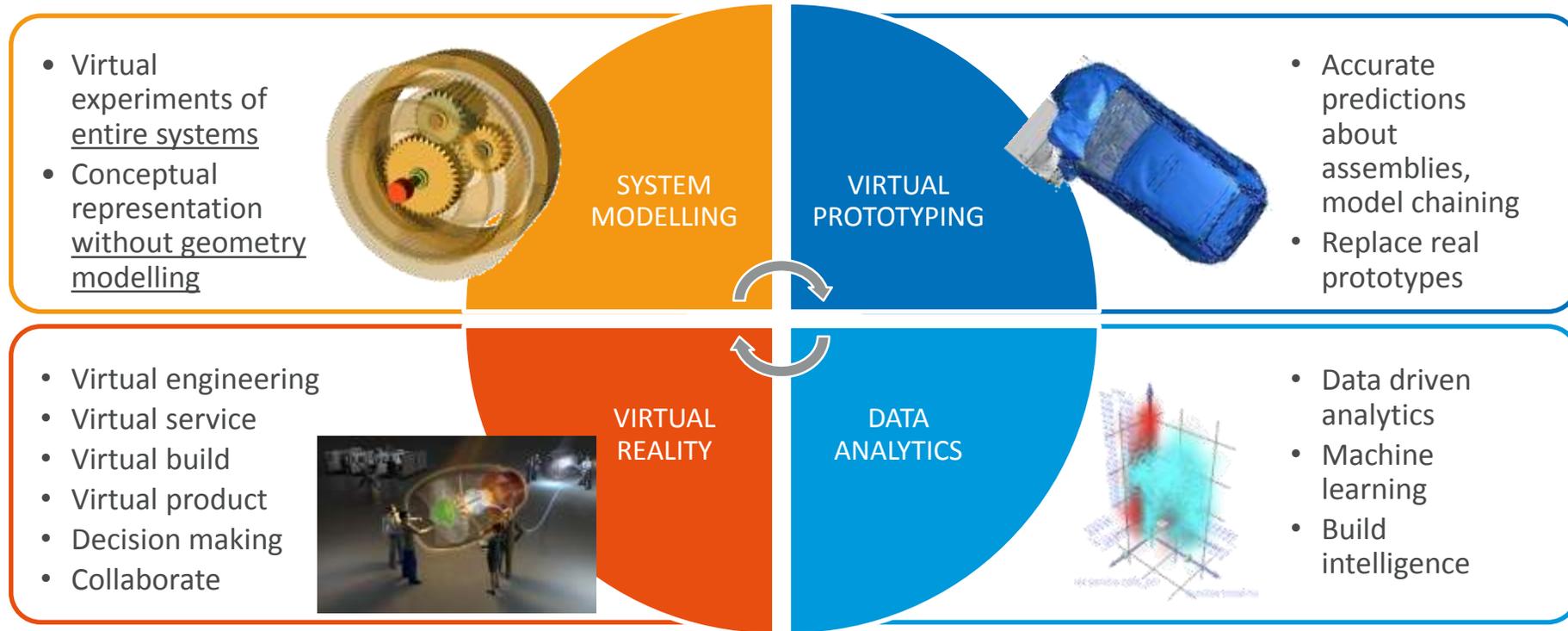
## GOVERNMENT & DEFENCE

BAE SYSTEMS  
 BOEING  
 CEA  
 DCNS  
 DGA  
 FRENCH MINISTRY OF RESEARCH  
 GENERAL DYNAMICS  
 HUNTINGTON INGALLS INDUSTRIES  
 LOCKHEED MARTIN  
 OAKRIDGE NATIONAL LABS  
 RAYTHEON  
 U.S. NAVY  
 U.S AIRFORCE  
 U.S.ARMY



Total Revenue per Industry Sector (FY15)

# ESI Foundation Technologies

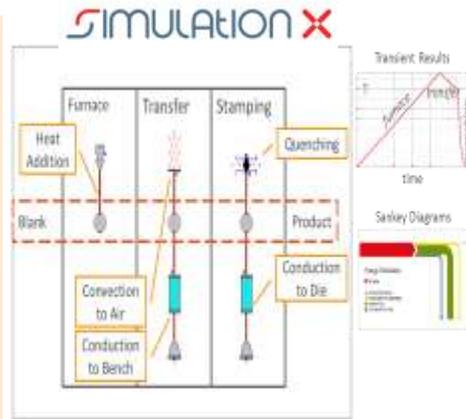


# Hybrid Twin™ Concept

## SOLUTION SKELETON



1D representation of the whole press line.  
Unlimited scenarios, assumptions and data sets (heating, transfer times, cooling, energy consumptions, ...)  
Closed loop system.



Partner / OeM data

## ON-LINE MEASUREMENTS



Possible retro-feed back of on-line available measurements into 3/4D calculations and in closed loop system as reduced flexible model.

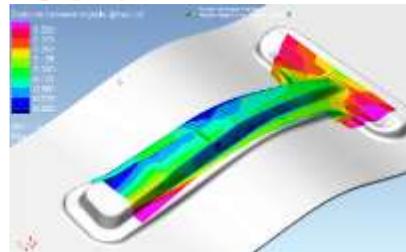
## SOLUTION MUSCLE



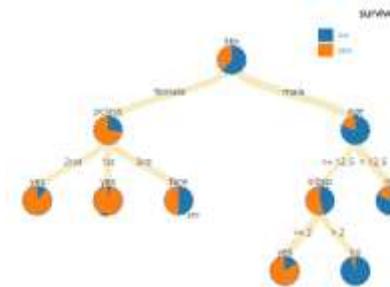
3/4D (space and time) detailed analysis of the various forming stages and creation of the dataset of operations for robustness and quality  
Creation of the data-model of operations based on selected parameters

Design space exploration

## esi | PAM-STAMP



## esi | MINESET



## SOLUTION BRAIN

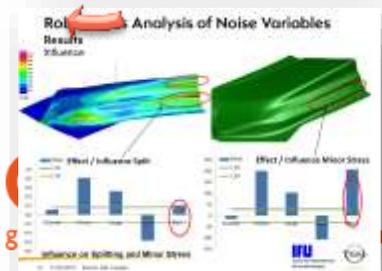
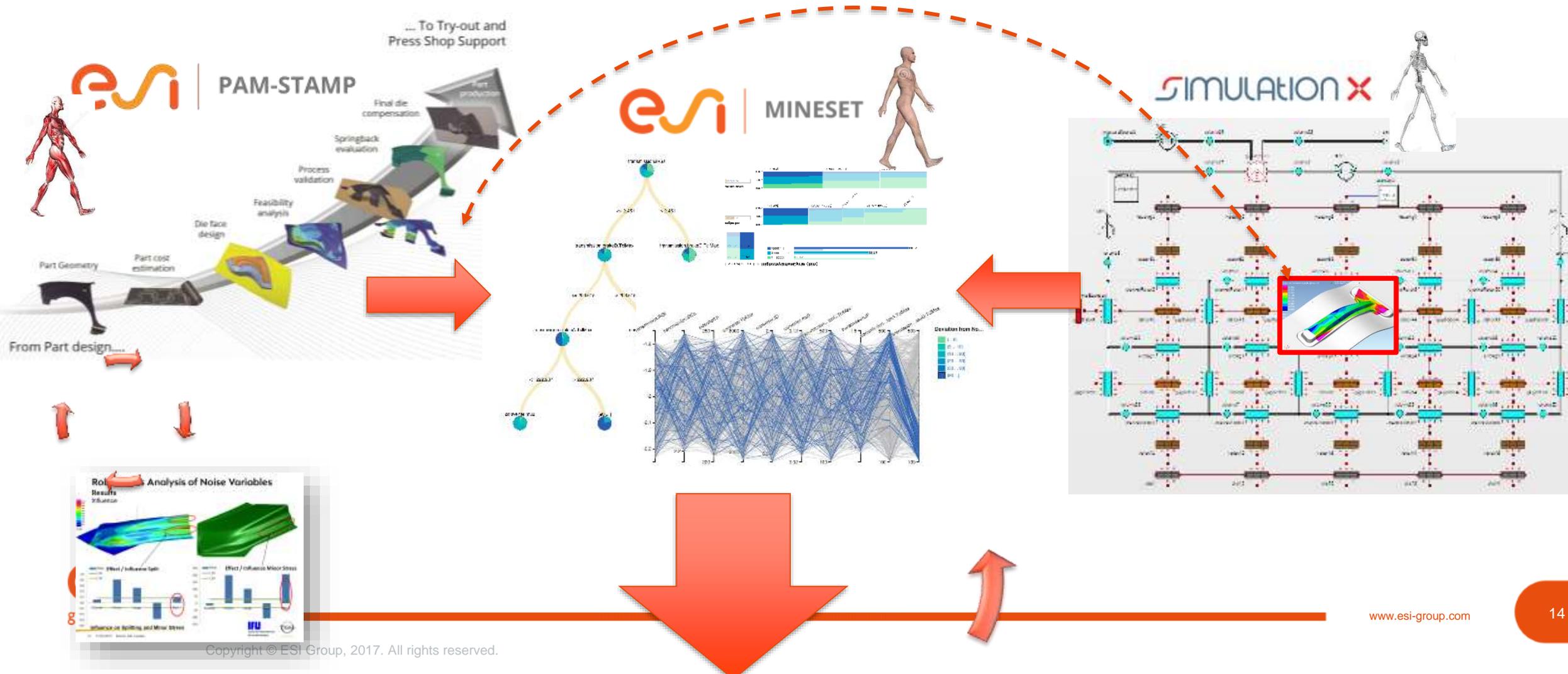


Data analytics of 3D components models, 1D system physical models and control code

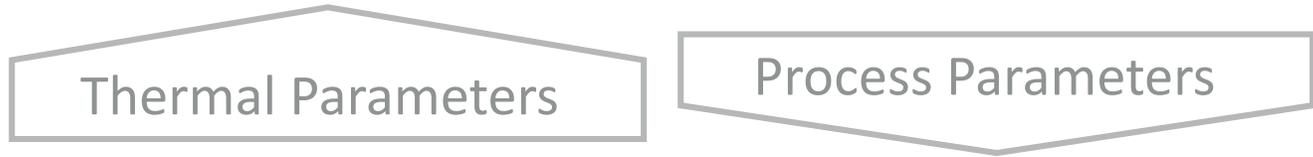
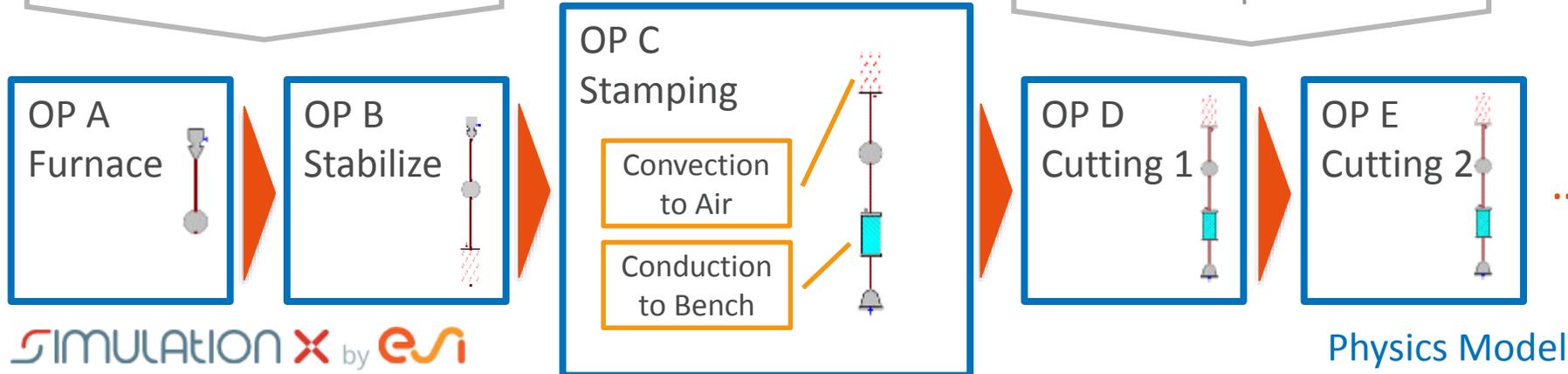
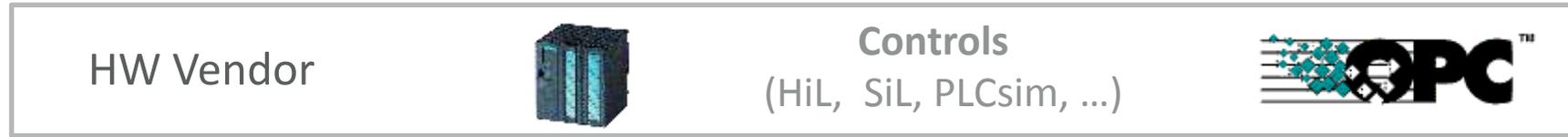
Combine simulation data with operational sensor data into a continually evolving hybrid twin model used for diagnostics and predictive maintenance of the system

# Hybrid Twin™

## Applicazione: Die Hybrid Twin™

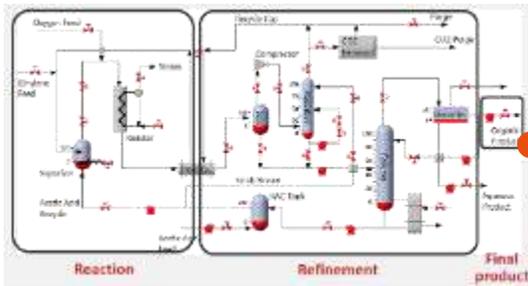


# Thermal System Level Modeling of Stamping Processes



# Aluminium plant example

Production Plant dedicated to packaging products



## Collect the information

- 2 years data historical
- < 1,000 sensors data
- Multiple format sources: MES, PLC, files
- A measurement each seconds
- 2,800 casts

## In-depth understanding

Data Cleaning  
Multi correlation  
Causal connections  
Weak signals  
Define the core determinants

## Behavior Modeling

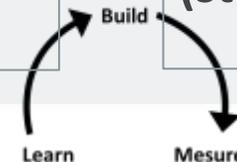
Defining the core determinants  
Configuring the relevant Machine Learning algorithm

## Model Execution

Deploying the ML algorithm  
(streaming analytics)

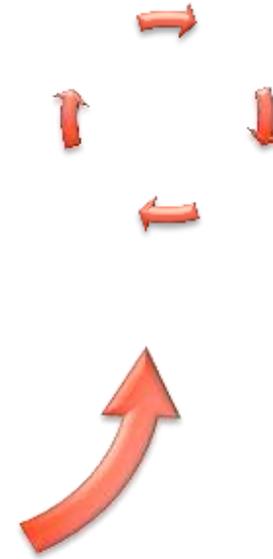
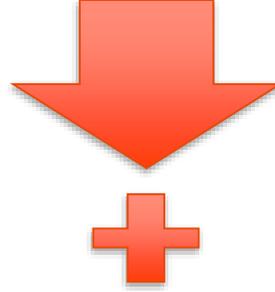
Feedback integration  
Model Evolution

New sensors, process evolution, etc



# Hybrid Twin™

Applicazione: Die Hybrid Twin™



## Die - Hybrid Twin™

- Manutenzione predittiva
- Riduzione costi
  - Consumi
  - Scarti
- Miglioramento continuo qualità

# Virtual Reality in Manufacturing

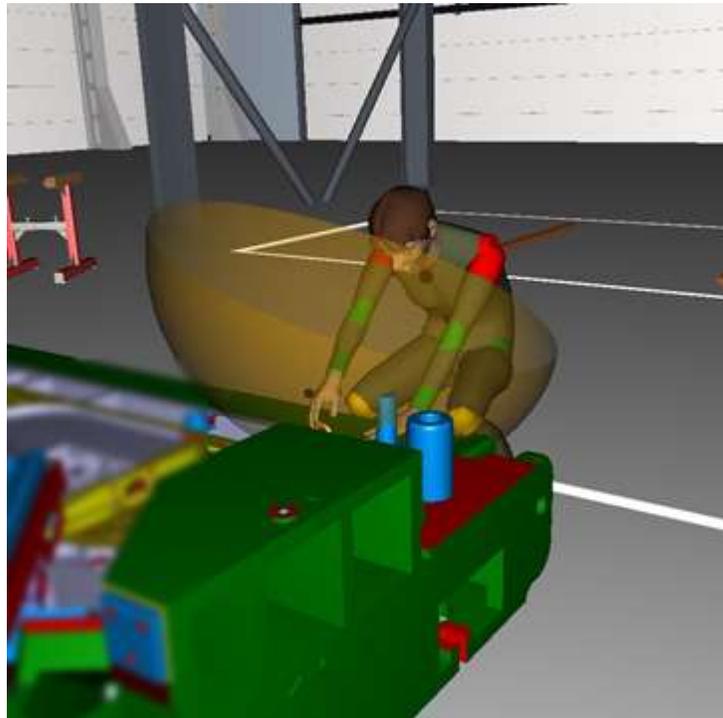
HW/SW evolution enables new applications

3D GPUs and HMD are moving from the game arena to the professional world

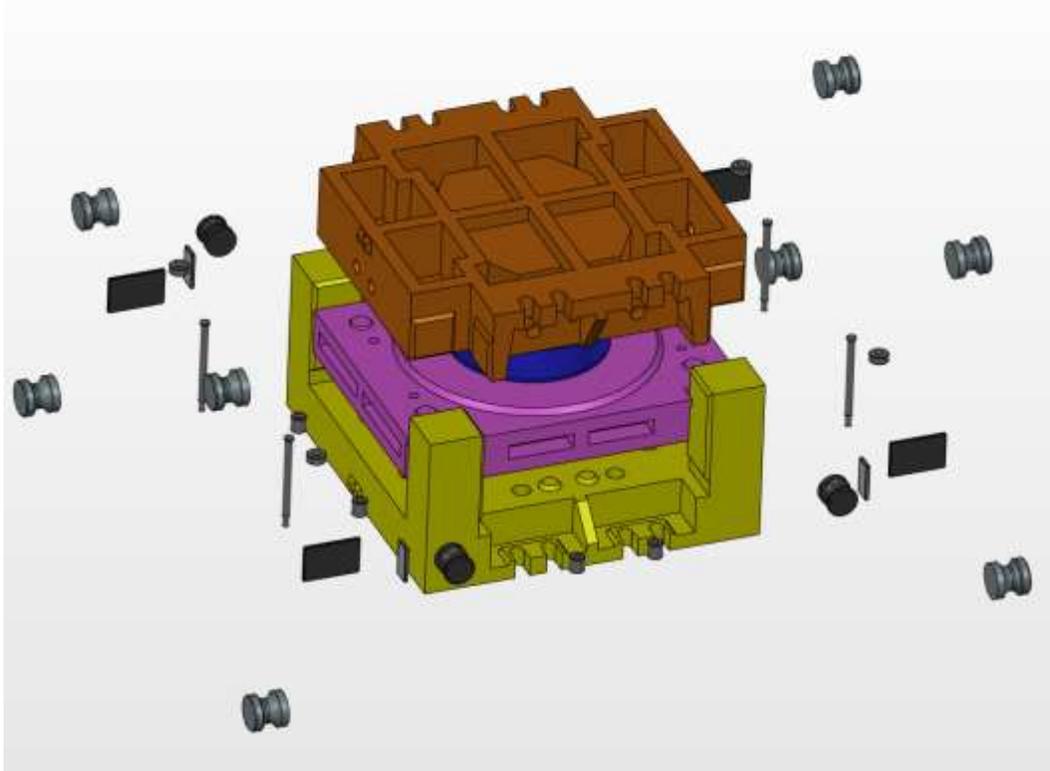
A couple of examples

- Die Assembly/disassembly validation
- Virtual Light Room for Surface Defects Assessment

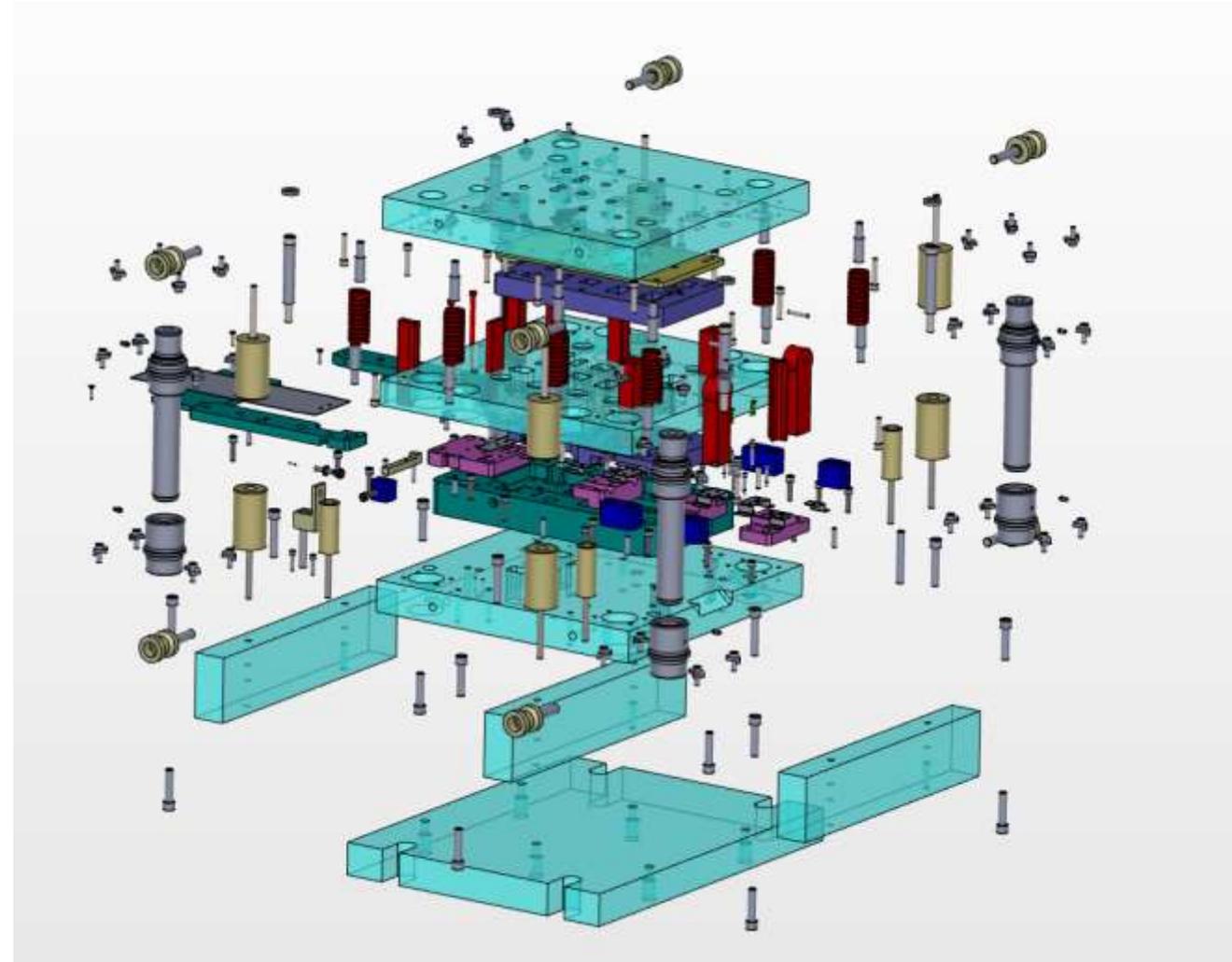
# Die Assembly/disassembly validation



# Die Assembly/disassembly validation



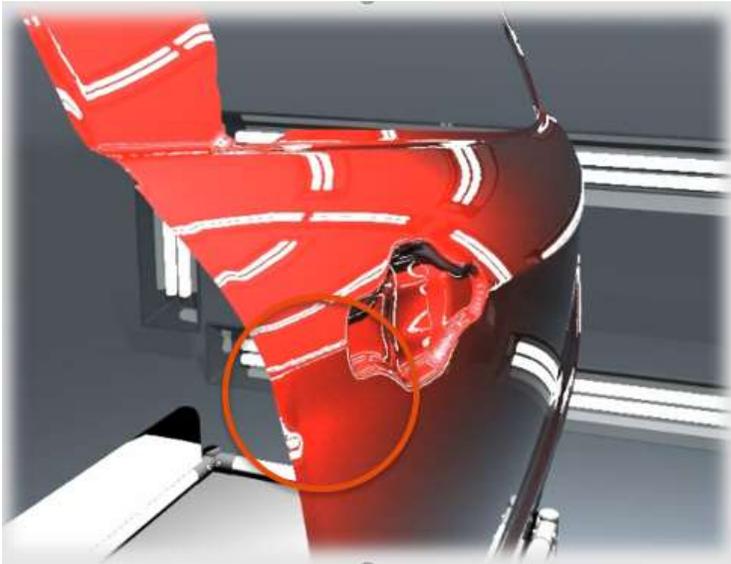
- Accessibility of components
- Line of sight for service and maintenance
- Access to replace consumables
- Access to hose junctions for pneumatics and in-die electronics



## Virtual Light Room for Surface Defects Assessment



# Virtual Light Room



- Here the final shape after springback is brought to a virtual light inspection room
- Final user is able to understand if those critical regions spotted before will be visible defects after the car is painted
- This kind of analysis can be made after springback and after assembly – since normally the assembly process has a big influence, sometimes making defects better or worse.



# THANK YOU

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