Moldex3D

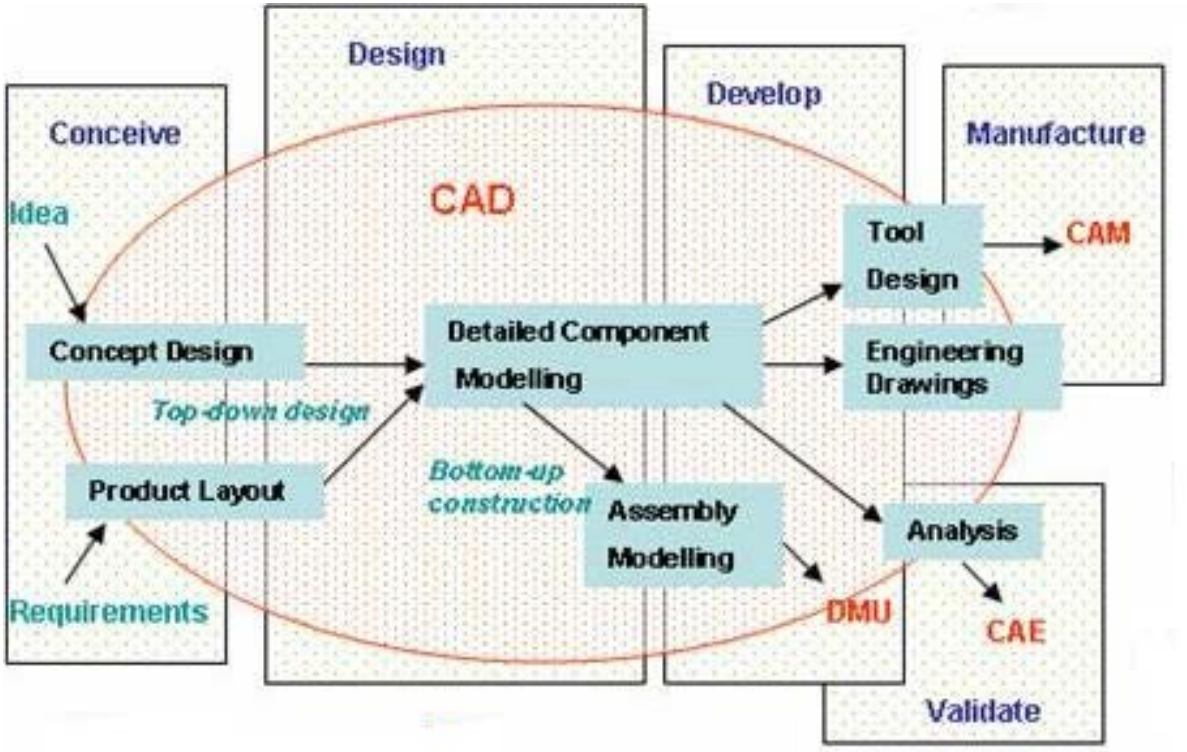
計算機試模技術在汽車產業模具設計質量管控

彭轶晖（Allen Peng）
ACMT协会 副秘书长
Moldex3D 董事長室 協理

亨利·福特（Henry Ford）有一句经典名言，他曾经说：如果我当年去问顾客需要什么，答案肯定是『一匹更快的马』

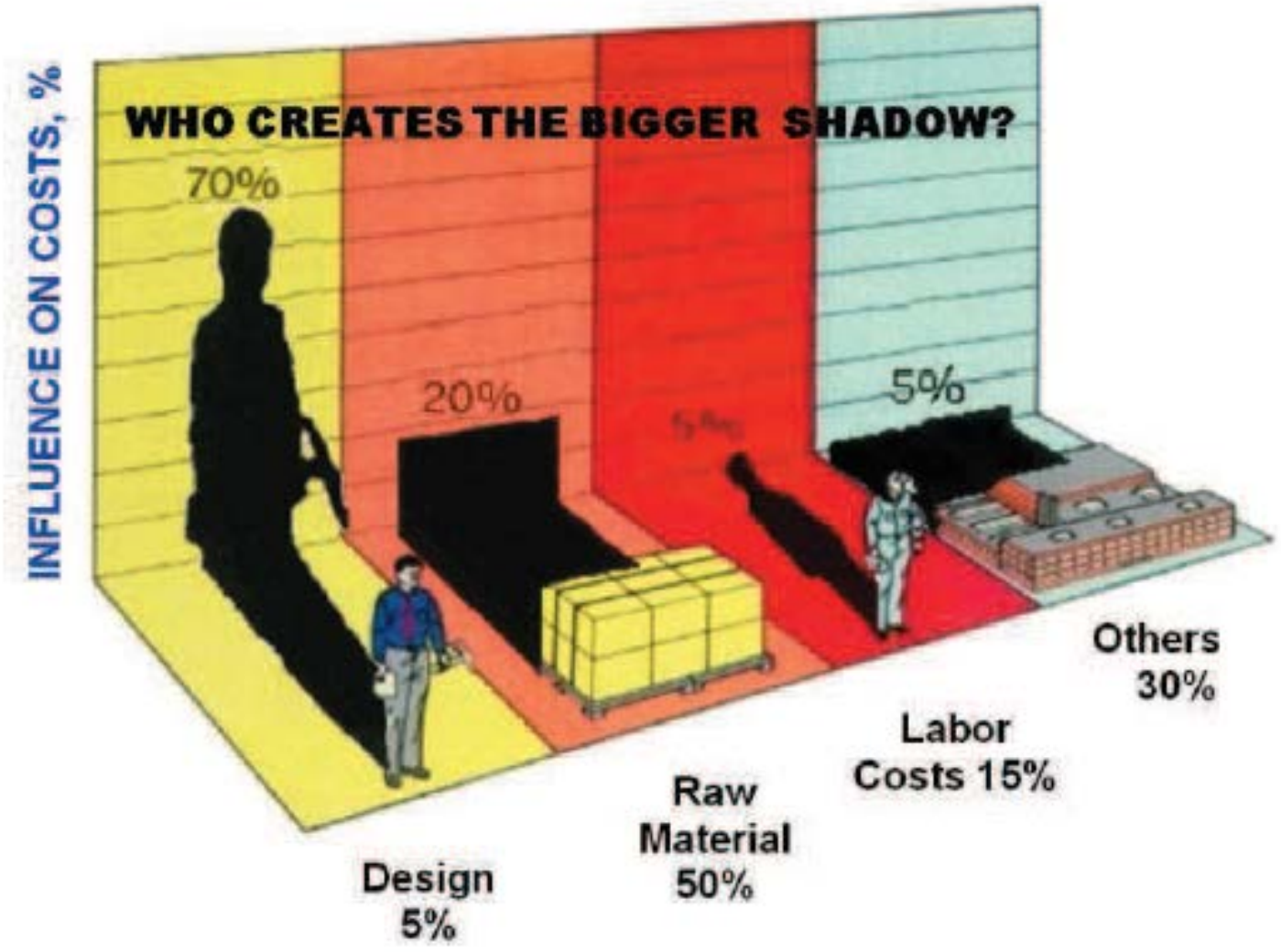
Think Different

傳統產品開發流程

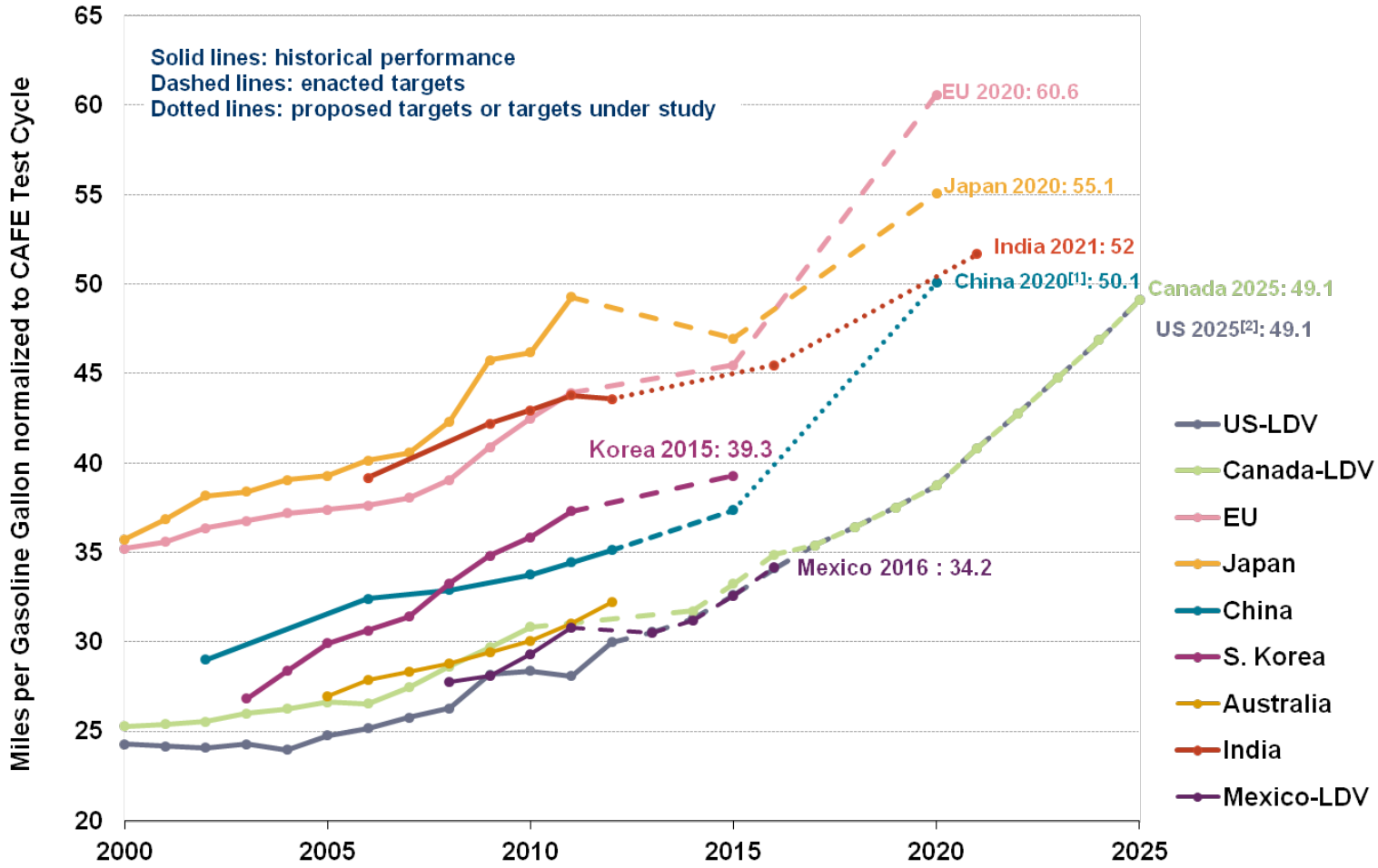


CAD: Computer Aided Design
CAE: Computer Aided Engineering (Analysis and Simulation)
CAM: Computer Aided Manufacturing
DMU: Digital Mockup

成本影響因子


INFLUENCE ON COSTS, %
WHO CREATES THE BIGGER SHADOW?
70%
20%
5%
Others
30%
Labor
Costs 15%
Raw
Material
50%
Design
5%

產業挑戰愈來愈高



[1] China's target reflects gasoline vehicles only. The target may be higher after new energy vehicles are considered.
[2] US , Canada, and Mexico light-duty vehicles include light-commercial vehicles.
[3] Supporting data can be found at: http://www.theicct.org/info-tools/global-passenger-vehicle-standards.

產業挑戰愈來愈高

plastix technology

Automotive aims to reduce car weight. This trend is conditioning plastic field to develop new materials and technologies

by Rita Simone

Car
The lightweight revolution

The light plate holders for Audi A7 were made from a special plastic developed by Bayer

PUR-RIM bumpers and body parts in and PC headlights

Toshiba Machine has developed an in-line process for the fabrication of laminate structures in preformed carbon and overmoulded with thermoplastic compound filled with carbon fibre

In the event of impact at a speed of 64 km/h, the composite compartment maintains an intact survival space for passengers

產業挑戰愈來愈高

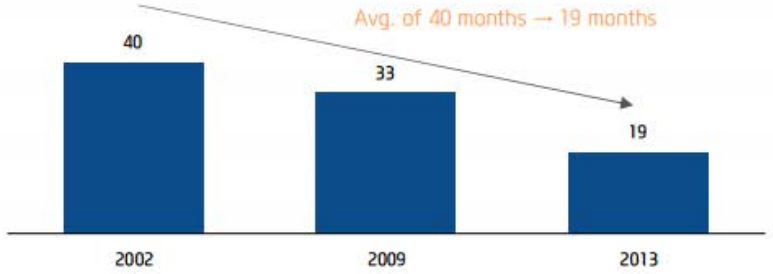
3 Cost Structure Improvement (Platform Integration)

Platform integration will reduce development cost and realize greater economies of scale per platform.

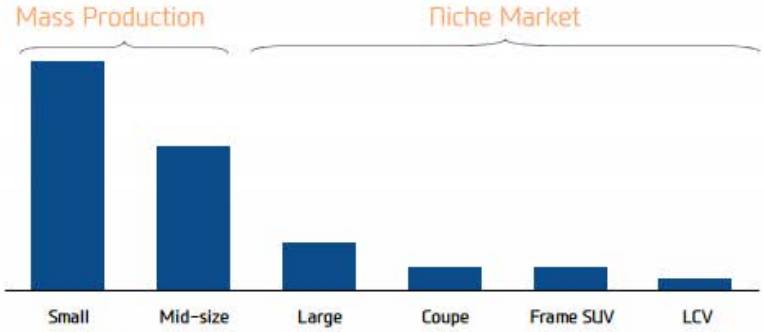
Platform Integration
Integration Schedule

	2002	2009	2011	2013
Integrated Platforms	0	6	6	6
Total No. of Platforms	22	18	11	6
Total No. of Models	28	32	36	40

Reduction of Model Development Time

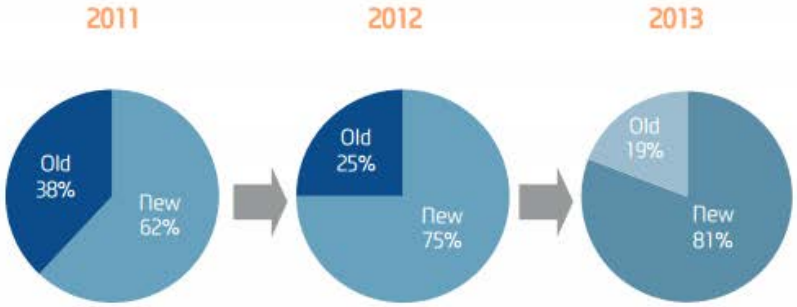


No. of Models per Type of Platform



Source: Company Data

Increasing portion of models with integrated platform




PROFIT = REVENUE - COST
TO INCREASE THIS...
... INCREASE THIS...
...OR DECREASE THIS

Trends and topics covered for today

Light weight:

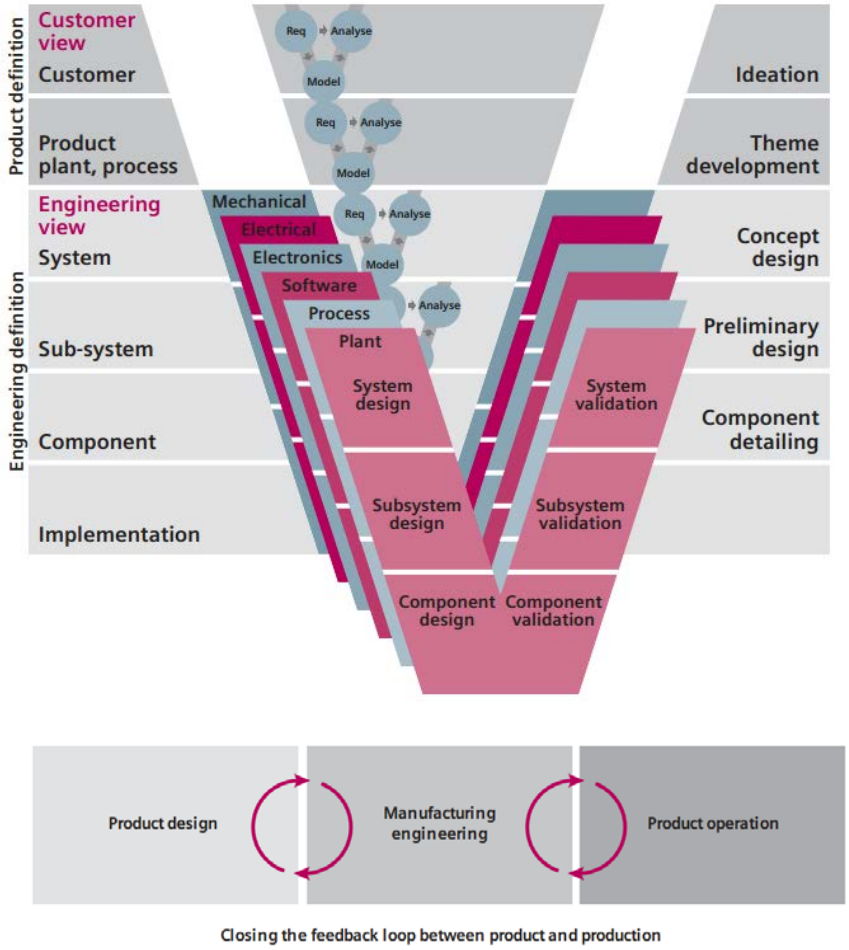
- Fiber reinforced
- Structural
- Foaming materials

Quality and Appearance:

- Variotherm
- Conformal cooling
- Hot Runner

Novel Process

新世代產品開發流程



Hot issues
> Product/Production integration
> Synchronized, cross-domain product development
> Digital manufacturing and design innovation
> Simulation driven product development

Source: Siemens HD-PLM

CAE成為新世代產品開發同步工程之重要橋梁

NISSAN汽車實例

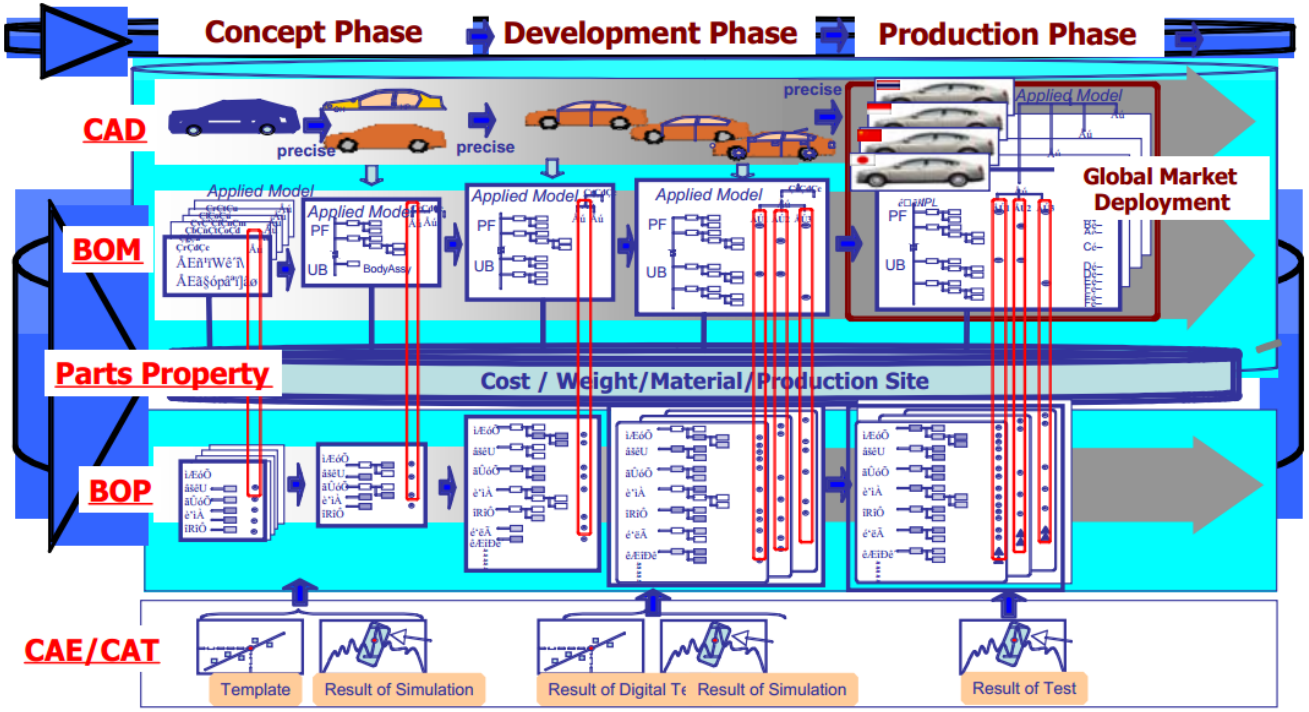


Figure 2—Nissan's PLM Concept: "Empowerment by PLM"
(Courtesy of Nissan)

Reduce the development cycle of styling to SOP(start of processing) **from 21 months to 10.5 months** …

… included a sizeable **budget** for purchasing and implementation of PLM-enabling technologies (e.g., CAD/CAM/**CAE**/CAT and PDM, and the necessary hardware)

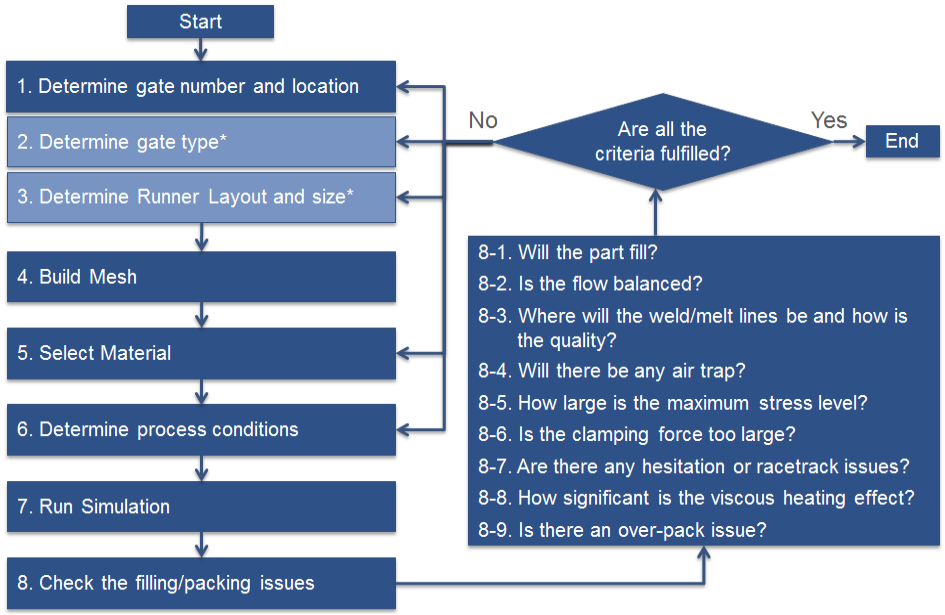
Source: CIMDATA (April 2008)

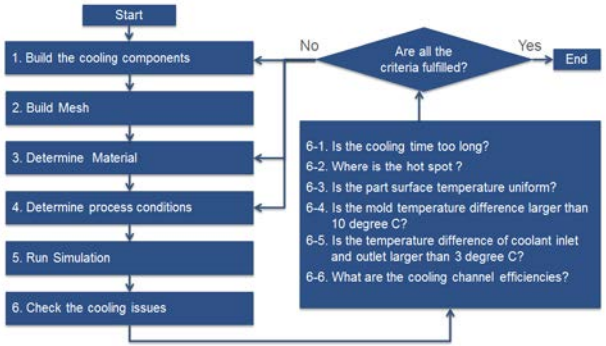
Integrate CAE in the SOP of product development

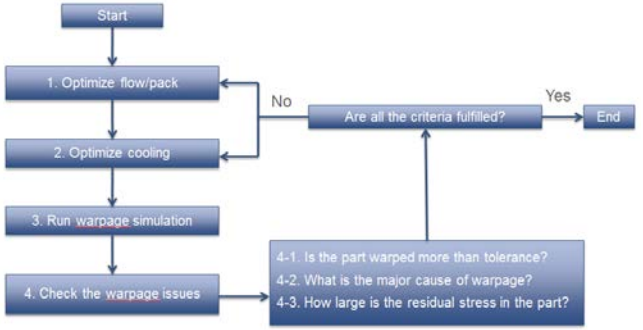
> Flow/Pack optimization

> Cooling optimization

> Part warpage optimization

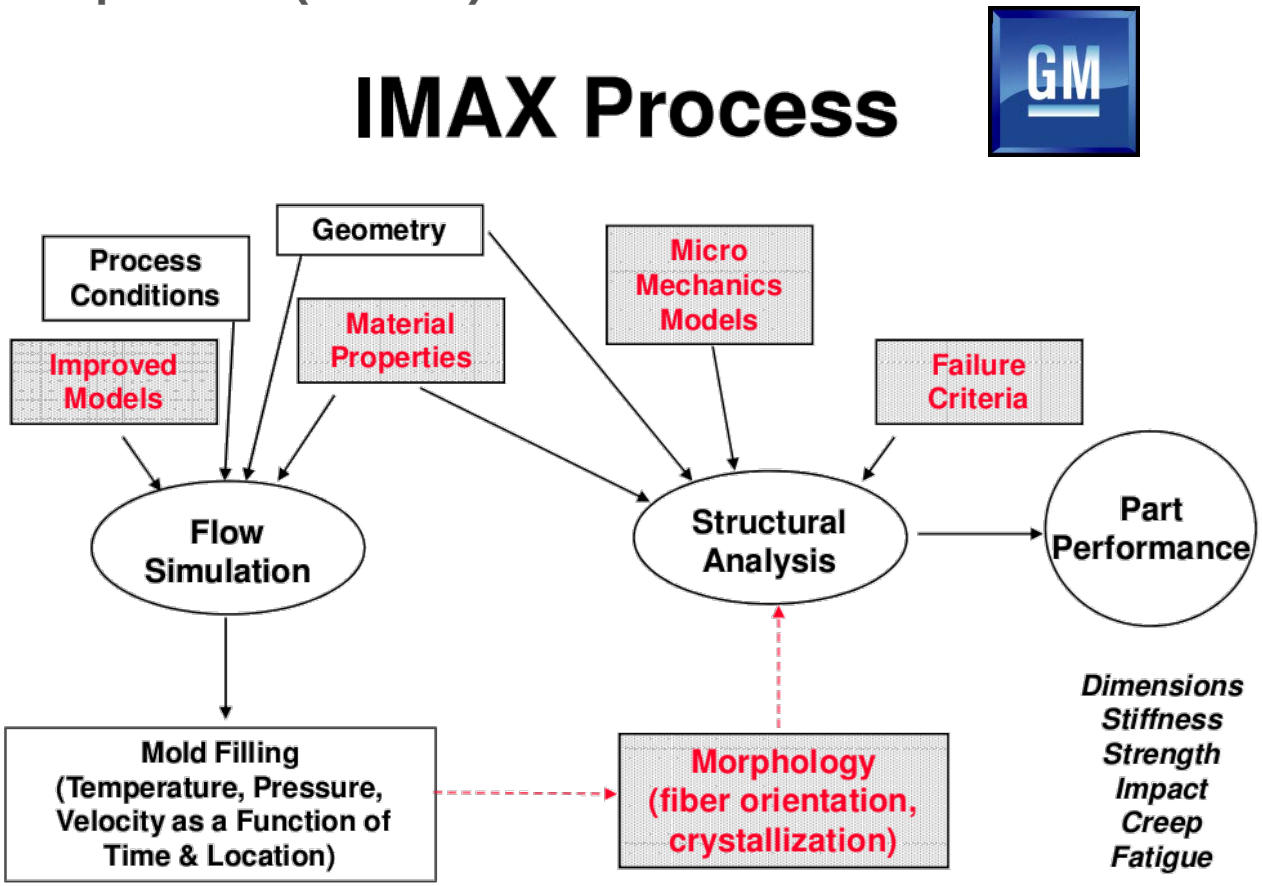






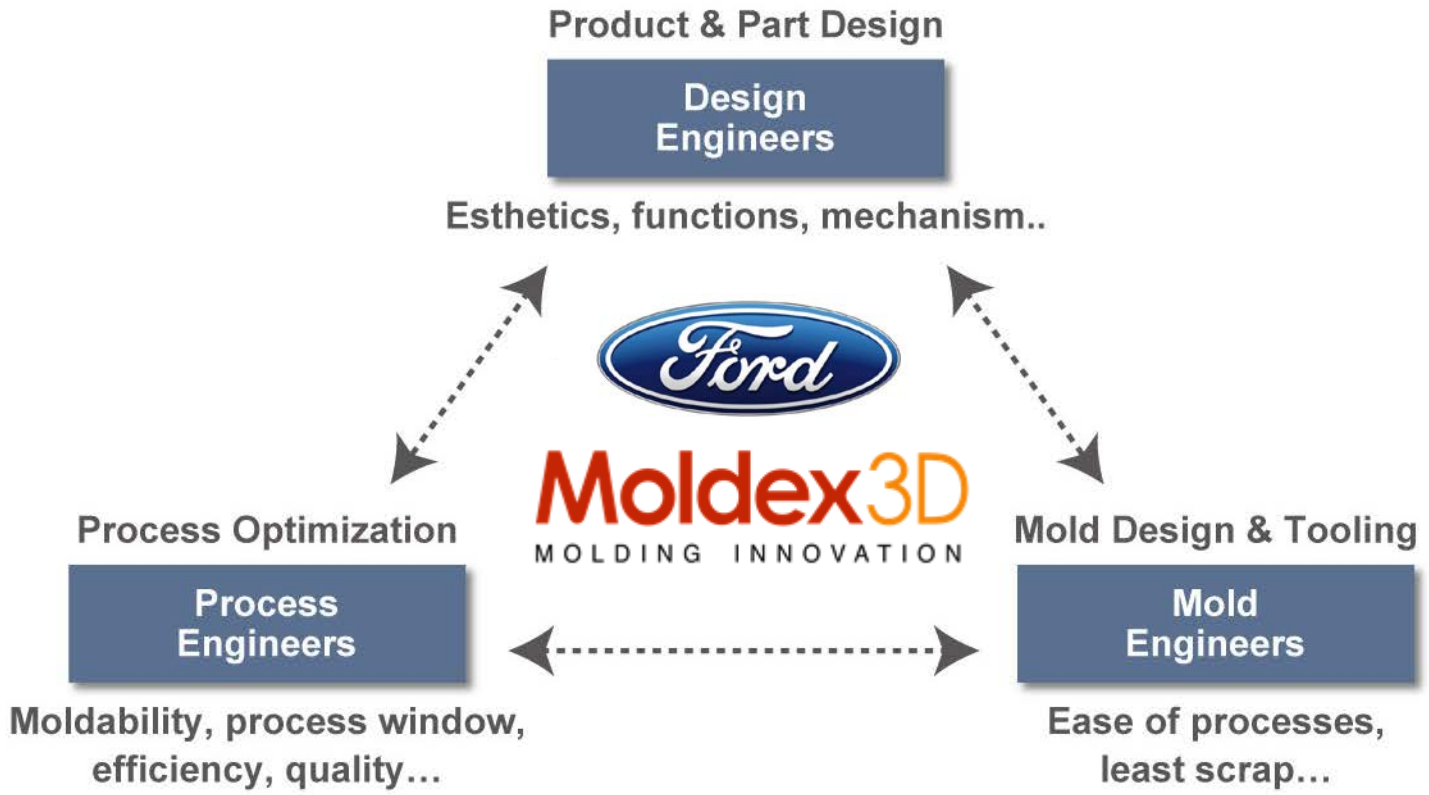
Orientation to Structural Modeling

> IMAX process (GM RD)



Source: Pete Foss, GM RD, SPE ACCE

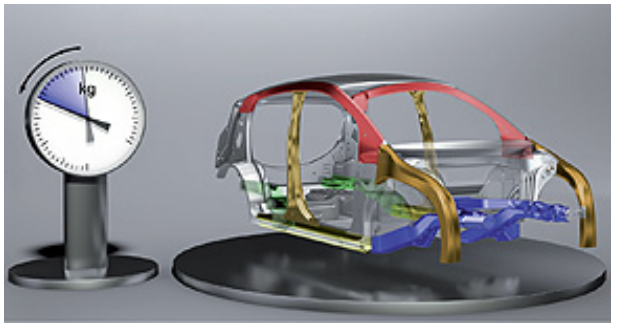
Collaborative Product Development



CAE to Help Achieve Light-Weighting

- a 10% reduction in vehicle weight can result in a 6%–8% fuel-economy improvement

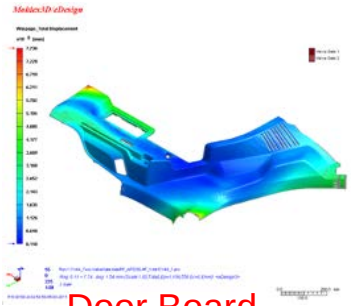
- Metal replacement (Plastic Composite)
- Thinner material
- Lighter material
- Consolidation of component



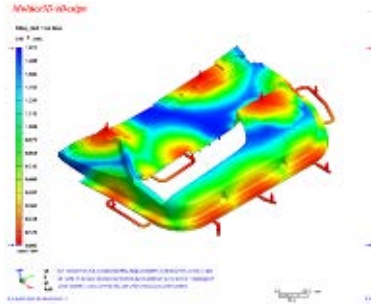
- “Utilize CAE methods to minimize part, tooling and process maturation” by Pat French, Honda NA Engineer Center

Applications of Moldex3D in Ford Interior

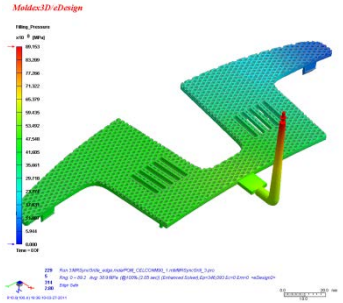
> Moldex3D has been running consulting project with Ford on a daily basis



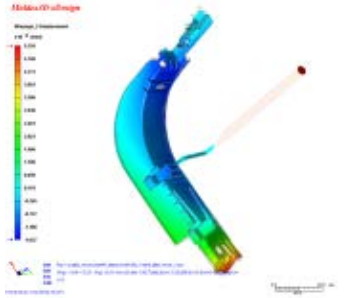
Door Board



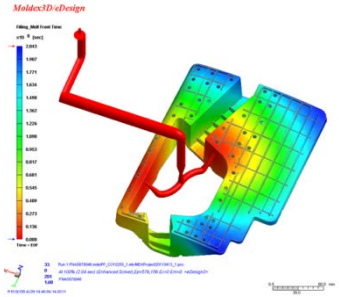
Door Trim



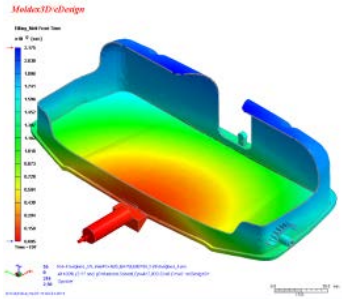
Grill Board



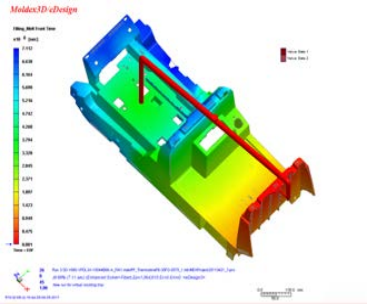
A-Pillar



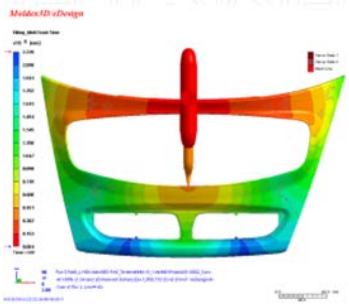
Door Handle Box



Sunglass Case

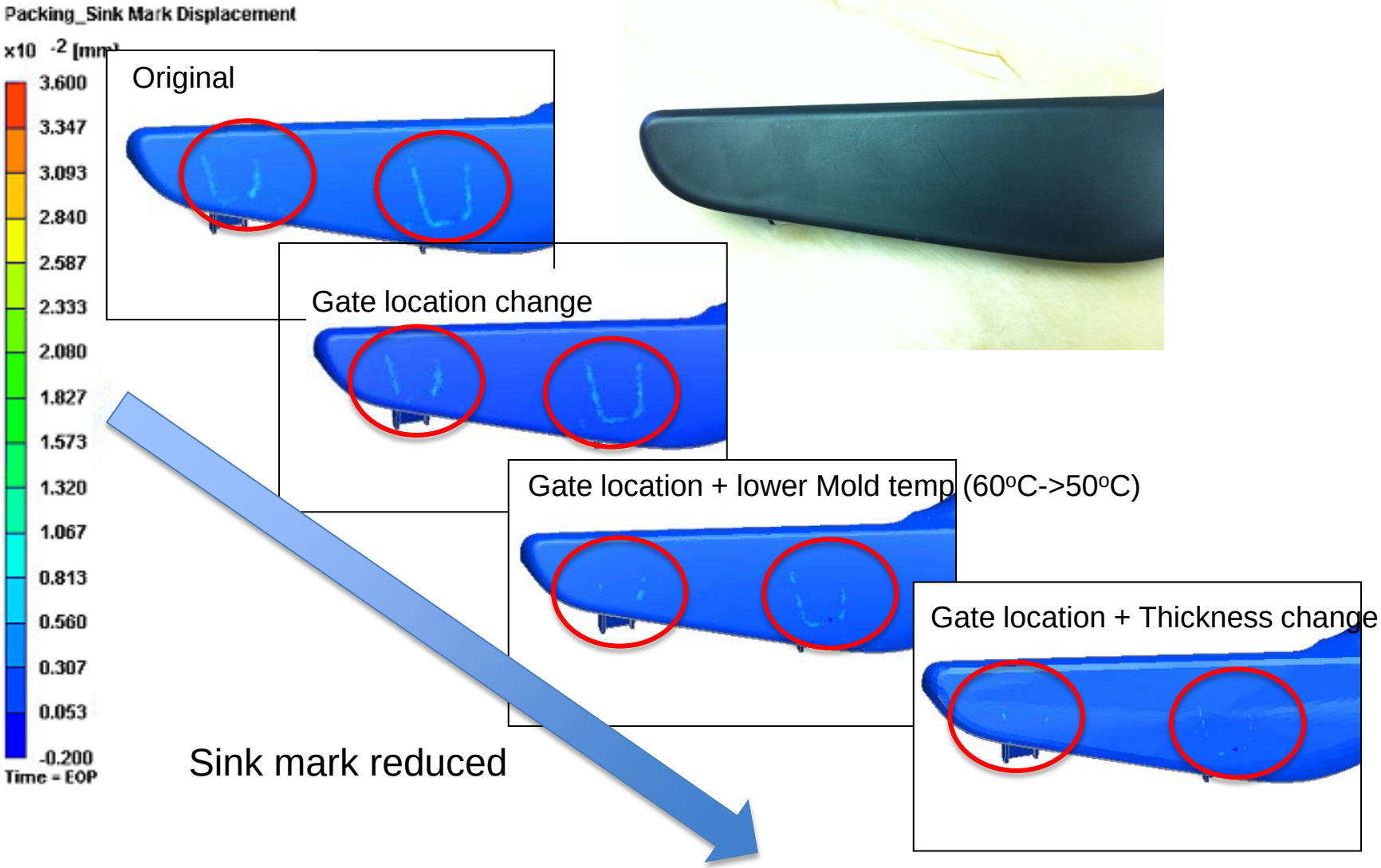


Gear Box



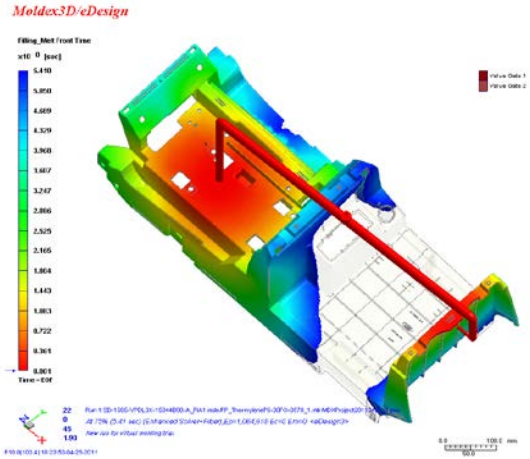
Panel

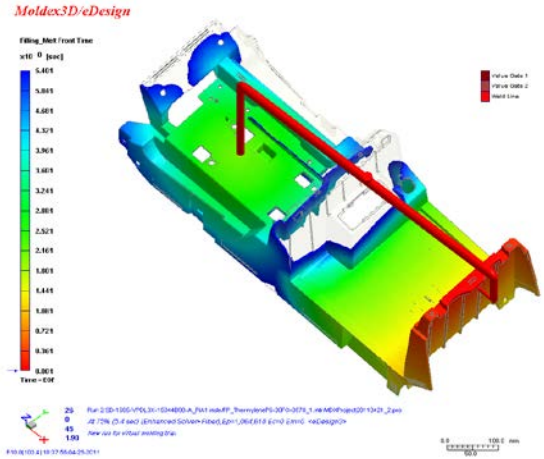
Sink mark problem imporvement

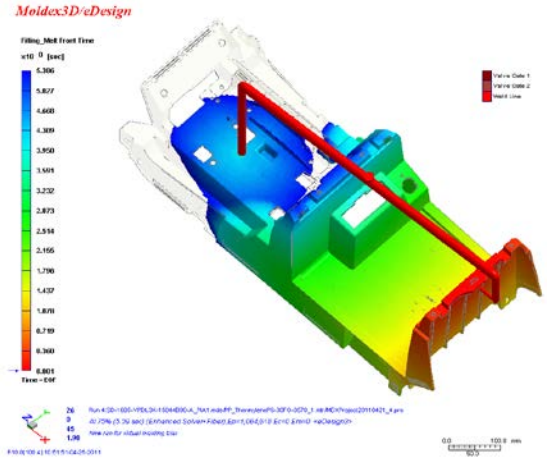


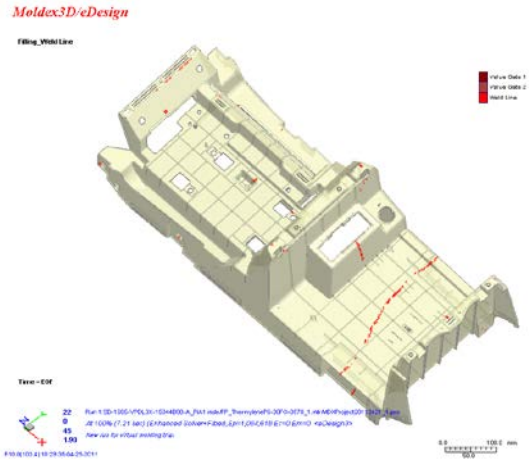
Welding Line Problem Improvement

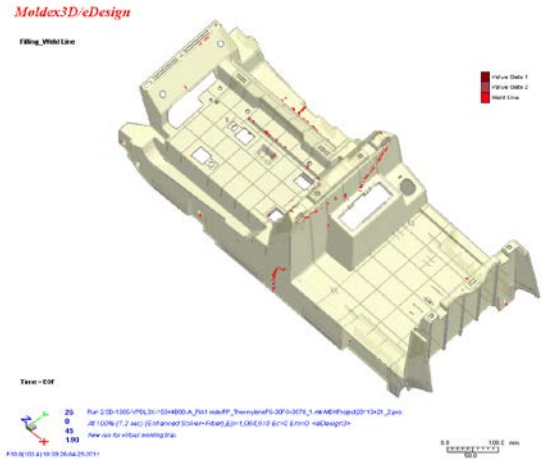
> Optimizing the runner system to move the weld line to acceptable location.

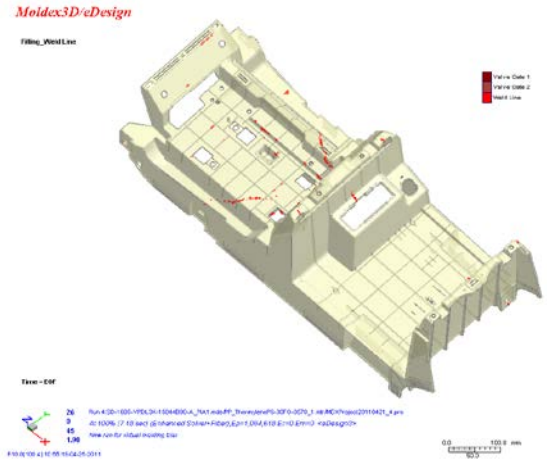










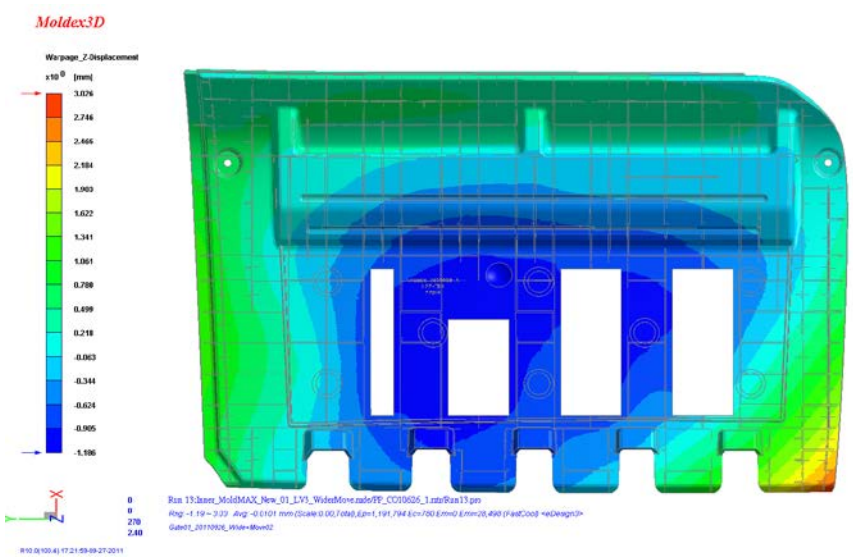


Warpage Problem Improvement

- Optimize the runner/gate design and process condition
- The warpage is improved by 30%

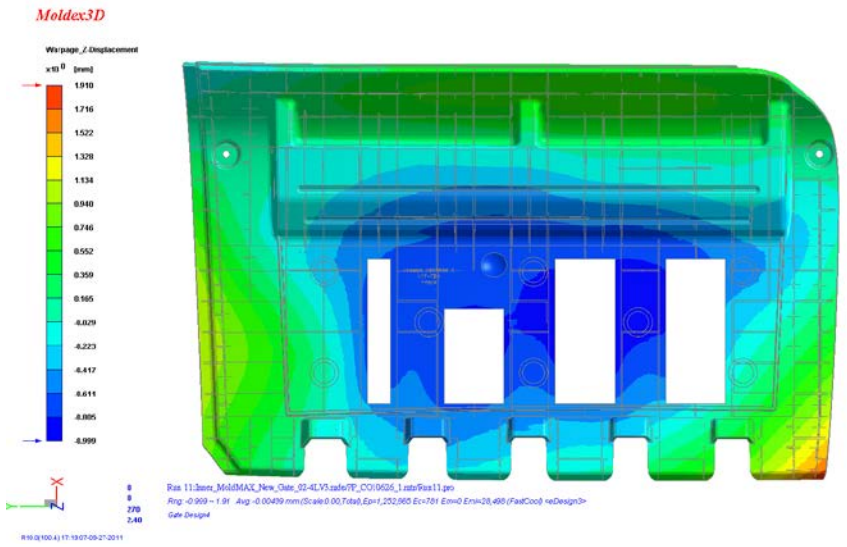
Original

-1.186 mm ~ 3.026 mm



Revision

-0.999 mm ~ 1.910 mm

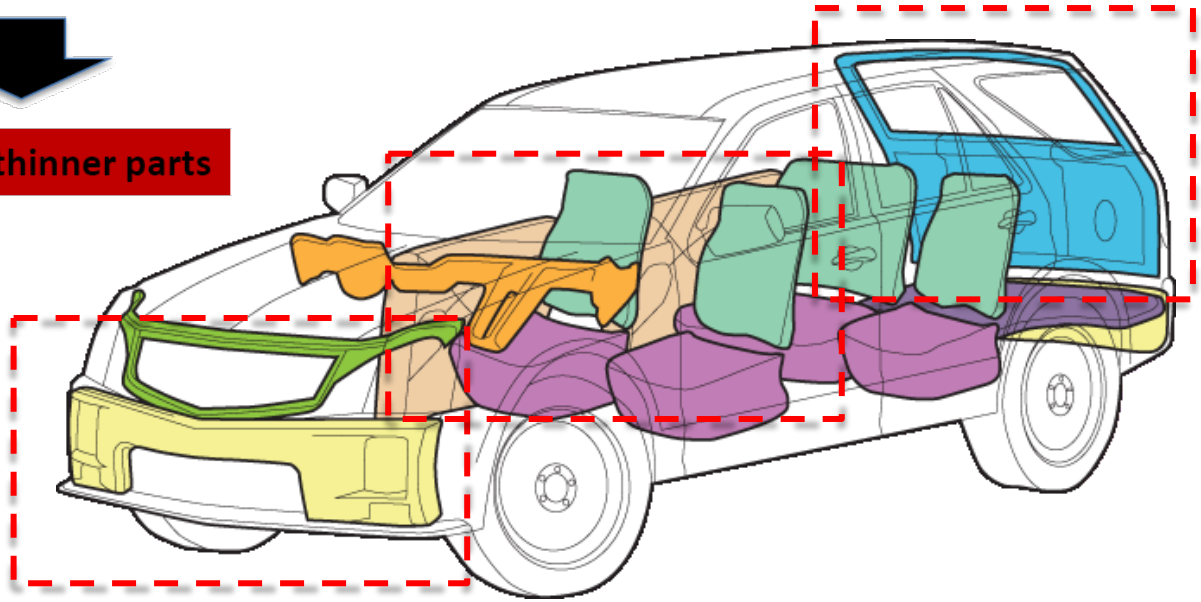


Application of Fiber Reinforced Plastic Composite

Target Value Proposition :

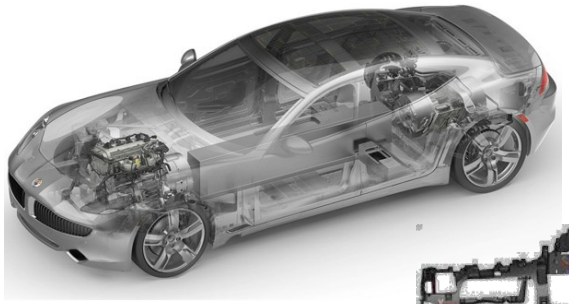
1. Higher stiffness composites
2. Higher energy absorption composites

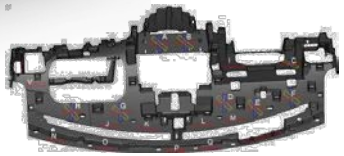
Lighter, thinner parts



"Currently, plastic materials represent only 10 percent of the weight of a typical passenger vehicle"

Predictive Engineering Tools For Injection Molded Long Carbon Fiber Thermoplastic Composites





LCFP Instrument Panel

Modeling

Moldex3D MOLDING INNOVATION

University of Illinois at Urbana-Champaign

Virginia Tech Invent the Future

Model development and integration
Prediction and validation
New model implementation

Experiments

Oak Ridge National Laboratory

BASF The Chemical Company

PlastiComp

Carbon fiber orientation distribution
Carbon fiber length distribution
Material preparation
Molding

Production

Ford

System specification
Weight and cost saving analysis
Technology implementation
Demonstration part to production

Long Carbon Fiber Thermoplastic Composites

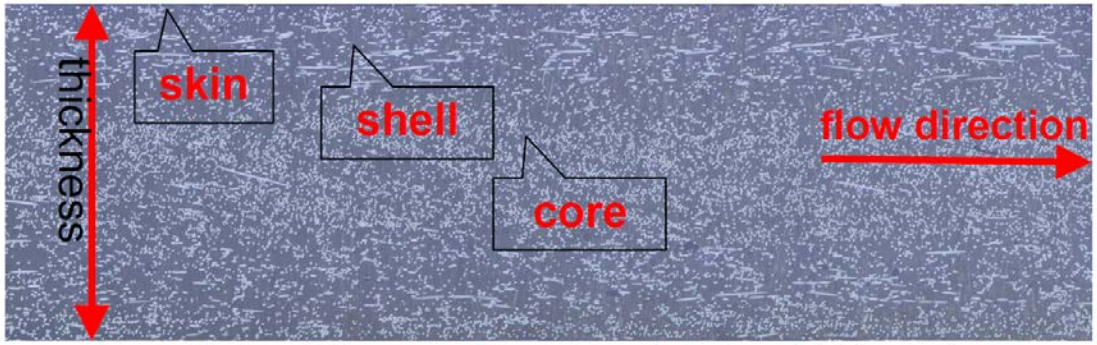
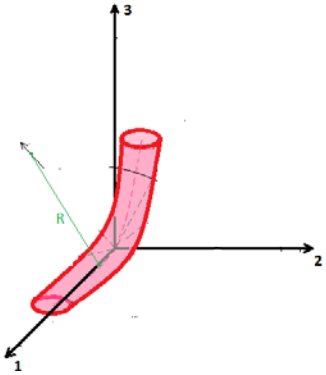
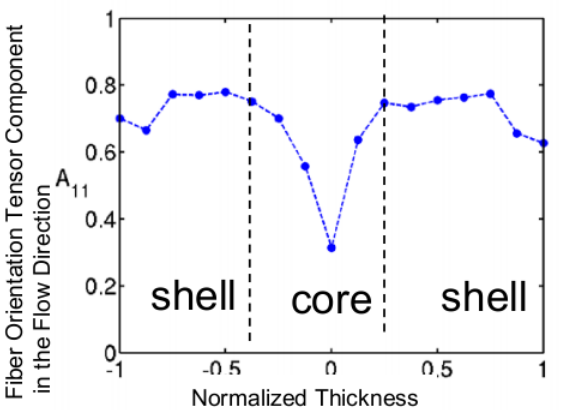


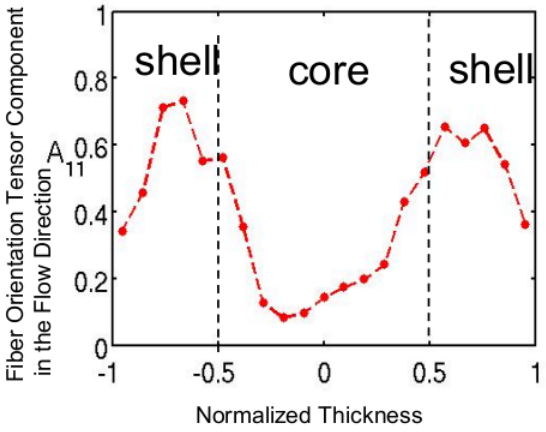
Figure 1. Skin-Core-Shell structure of fiber reinforced injection molded thermoplastics.

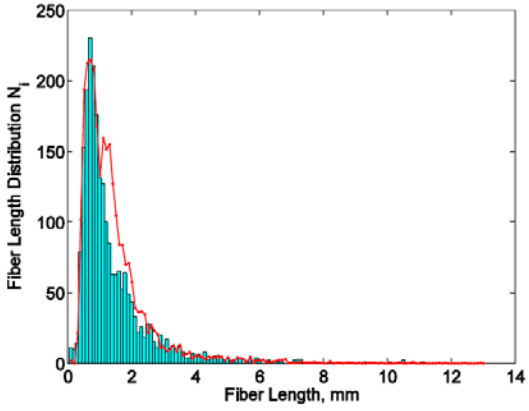


Injection-molded SFT
(short fiber 0-3mm)



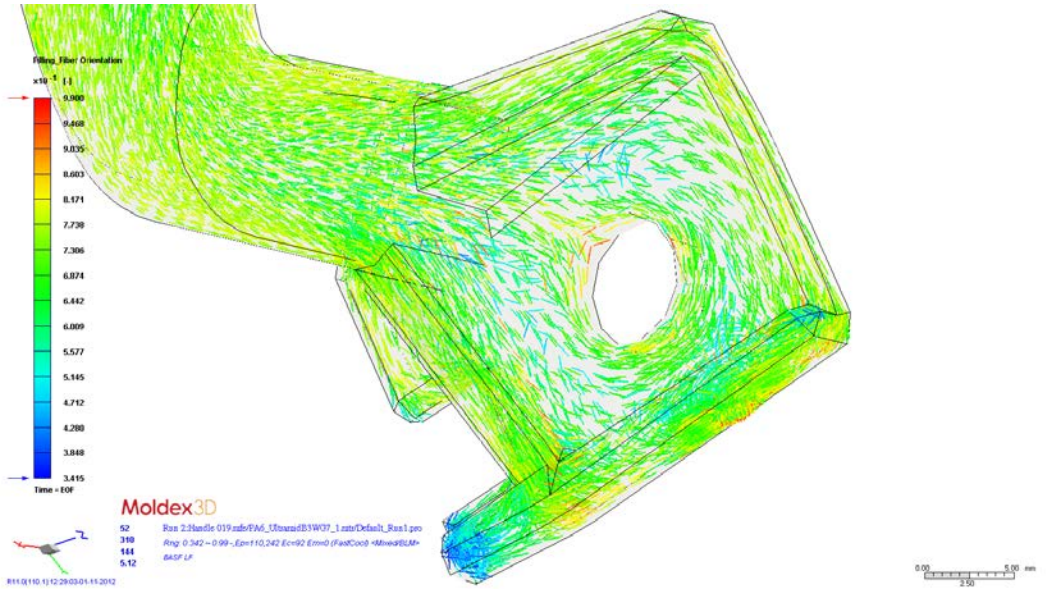
Injection-molded LFT
(long fiber 3+)





Utilization of Orientation Data

- The orientation information can be used to predict
  - Shrinkage and warpage behavior
  - Mechanical properties
  - Other anisotropic properties



Orientation to Structural Modeling

> **Advanced material characterization (Ford Interior Engineering)**

COMPOSITES TECHNOLOGY

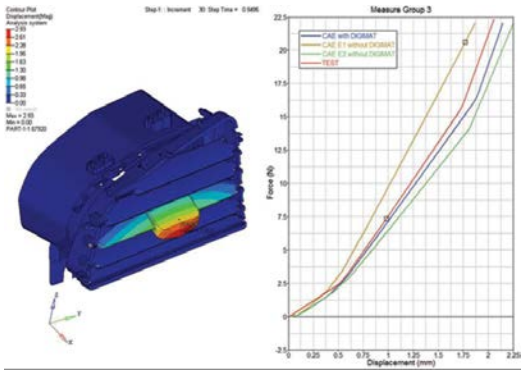
August 2012

Materials characterization: Faster cheaper, better

Ford couples commercial codes to analyze auto interior parts more accurately.

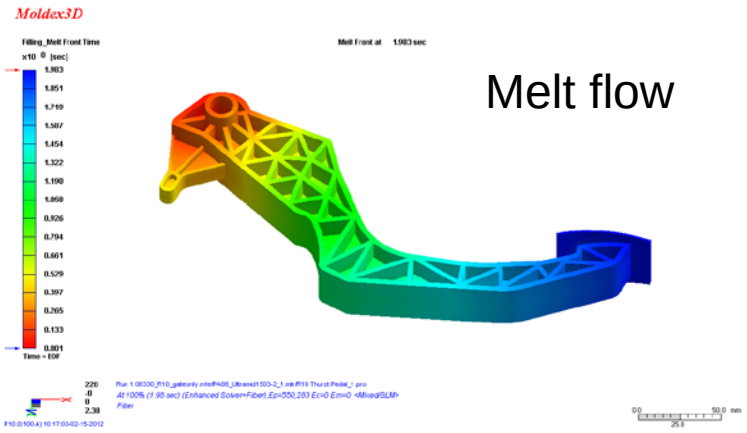
Jeff Webb, CAE Manager

With the new Ford procedure, the initial CAE analysis is performed using what the company calls its Material Data Cards, which are said to incorporate complete advanced characterization of key materials used in its vehicle interiors. These proprietary data (developed by Ford using internal testing resources and outside contracted testing facilities) are fed into a commercial mold filling code, such as Moldflow or Moldex3D. This preliminary analysis gives a design direction — that is, it helps set wall thicknesses, indicates where additional structures (e.g., ribbing) might be needed to boost stiffness, etc.

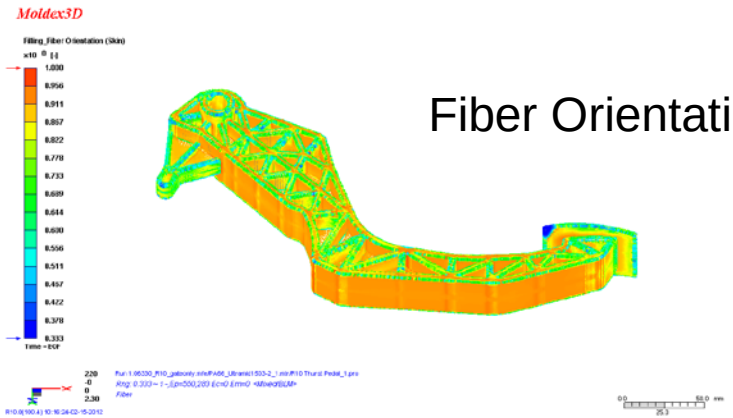


Source: composites world 2012.Aug

Moldex3D FEA Interface work flow

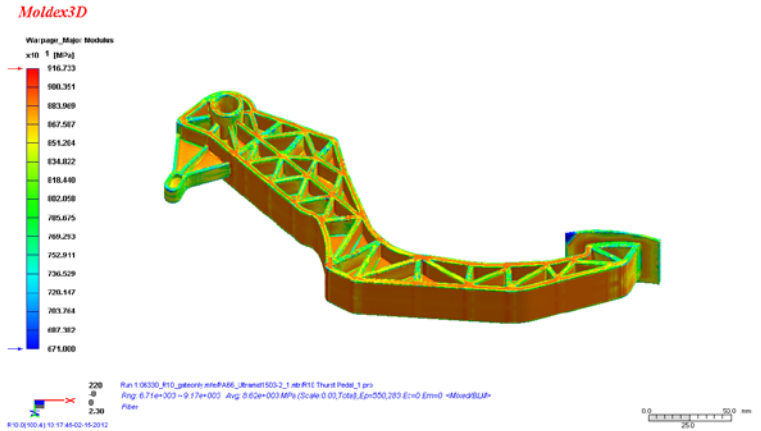


Melt flow

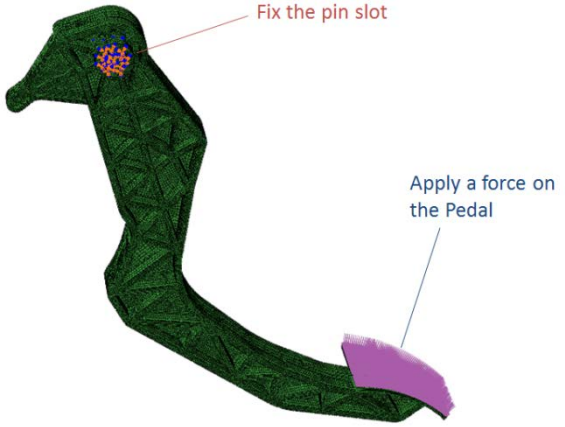


Fiber Orientation

Modulus



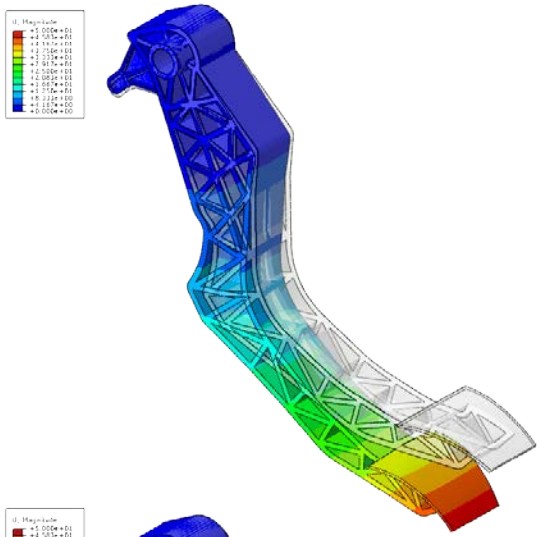
Structure Analysis



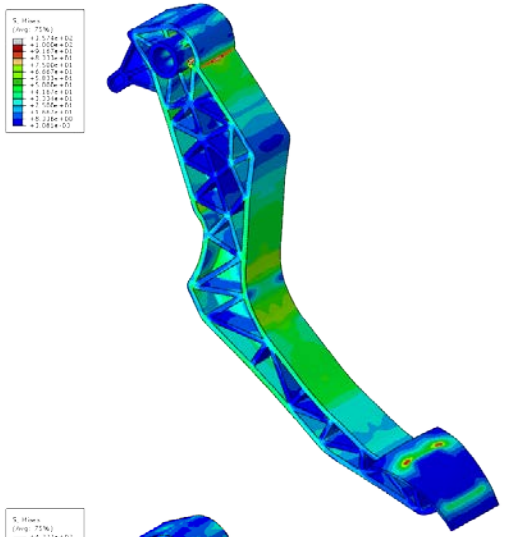
Structural Performance Evaluation: Ideal vs Reality

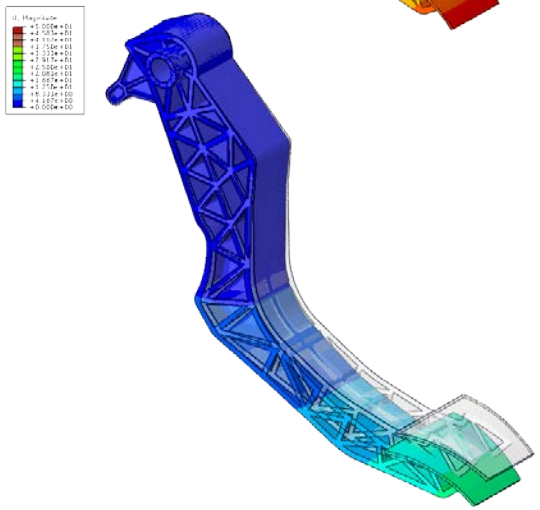
Displacement

Stress

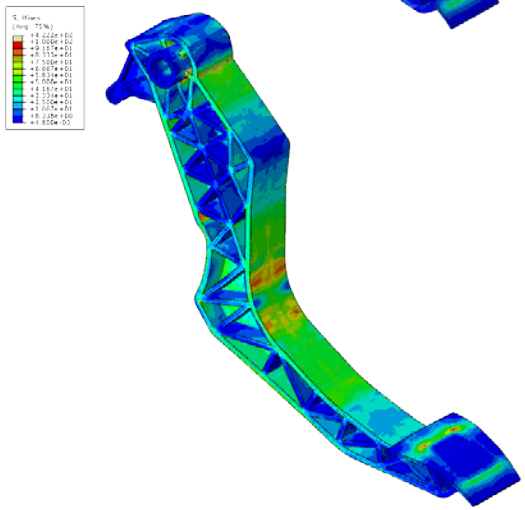


isotropic





anisotropic



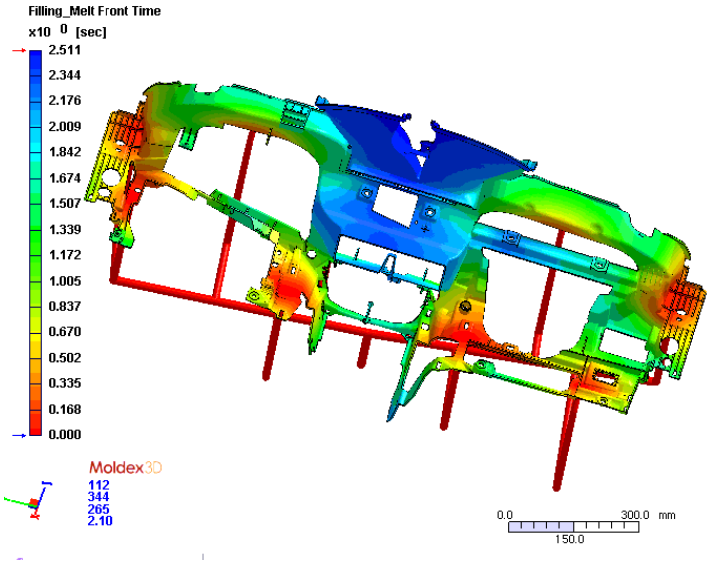
0-50 mm range

0-100 MPa range

26

MuCell® + LGFPP Instrumental Panel

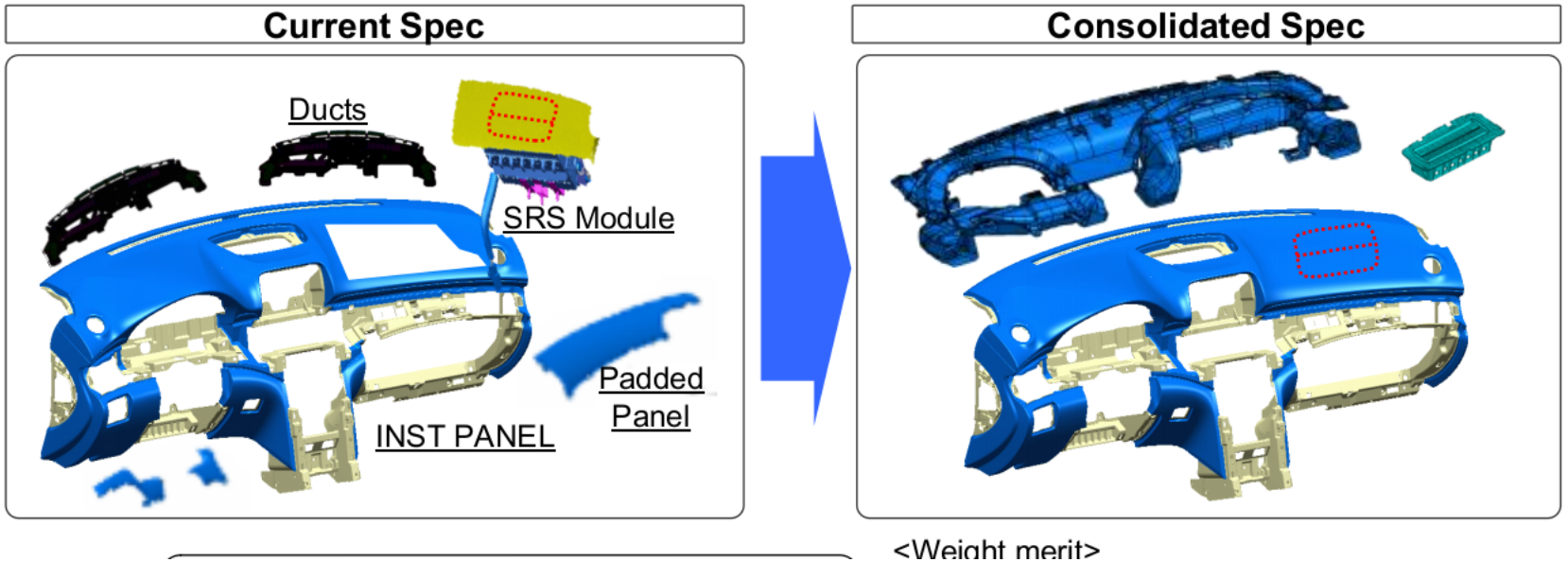
MuCell Technology Helps Ford Win the Grand Award at the 41st SPE Automotive Innovation Awards



Livonia, MI & Wilmington, MA, Nov. 9, 2011 – The Society of Plastics Engineers awarded Ford's use of the MuCell process the Grand Award at the association's 41st Auto Innovation Awards Competition, held November 9th at the Burton Manner, in Livonia, MI. The instrument panel was originally entered in the Process/Assembly/Enabling Technologies category. By creating the instrument panel structure for the new Ford Escape in microcellular foam, weight is reduced more than 1 lb, mechanical properties are improved, molding cycle time is reduced 15%, and molding clamp tonnage is reduced 45%, saving an estimated $3 US / vehicle vs. solid injection molding.

Component Consolidation

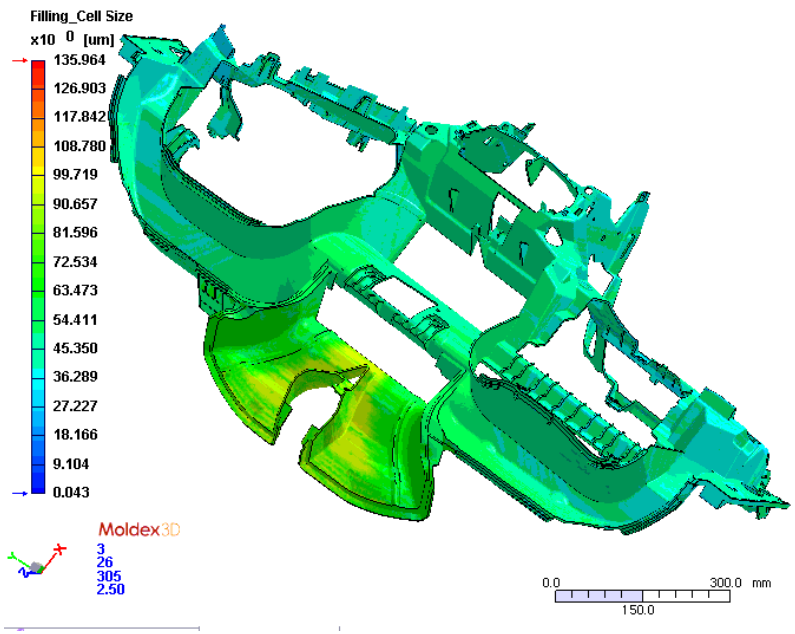
> Reduce the weight of automotive components through consolidation

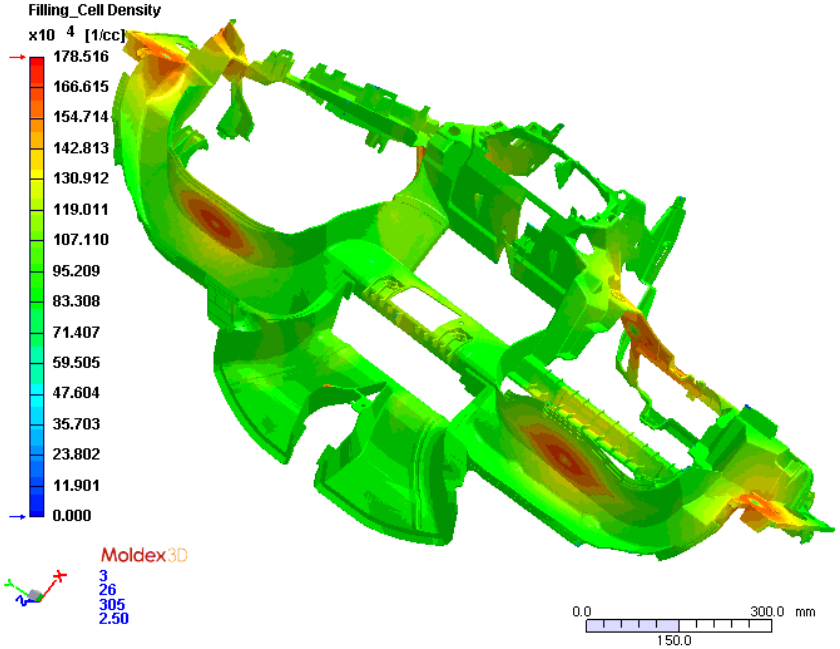


Source : Pat French, Honda NA Center, Cars of the future 2012

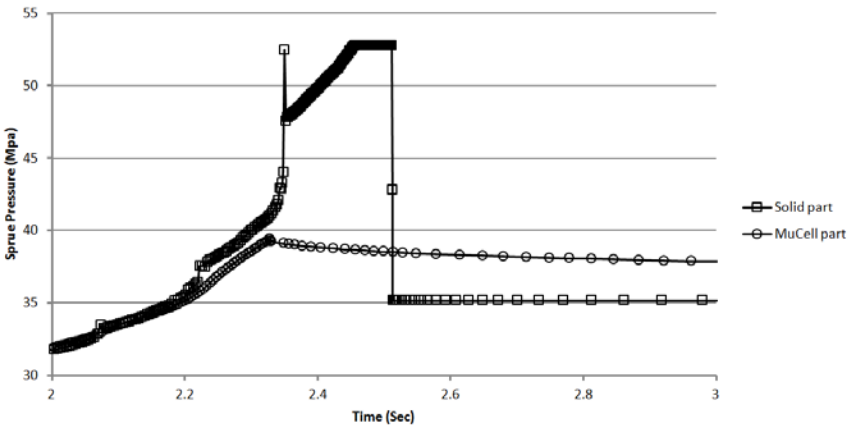
MuCell® + LGFPP Instrument Panel

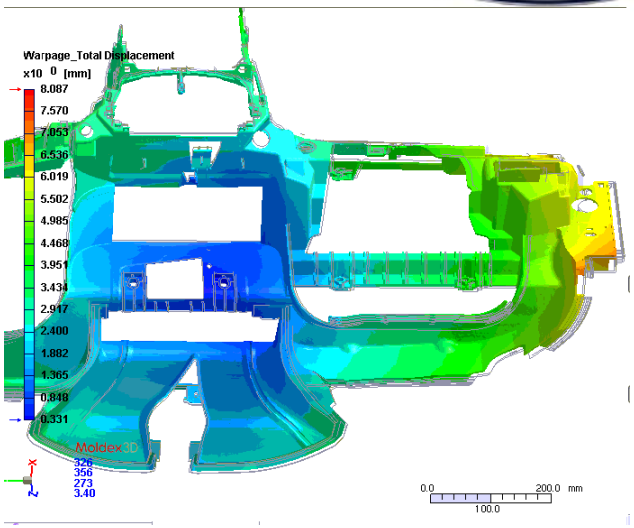
> Cell Structure

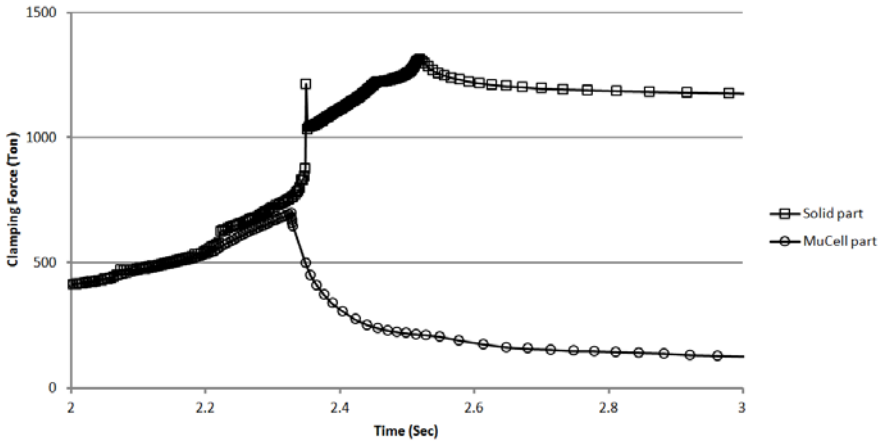




MuCell® + LGFPP Instrument Panel







	Solid Part	MuCell Part
Part Weight [g]	2724.2	2446.9
Max. Clamping Force [Ton (m)]	1579	699.5
x-Displacement [mm]	11.37	3.81
y-Displacement [mm]	15.69	6.87
z-Displacement [mm]	8.27	3.32

Part dimension: 644.5*1415.8*562.4 (mm)

Table 1 Comparisons of simulation results from conventional injection molding and microcellular injection molding. Weight reduction: 10.18%

Structural Performance Evalation of MuCell part

> Workflow for Mucell part structural performance evaluation

Measurements

σ/ε curves

Material Model

Volume fraction

Mapping

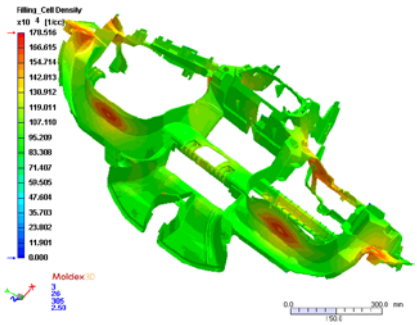
→ Structural mesh

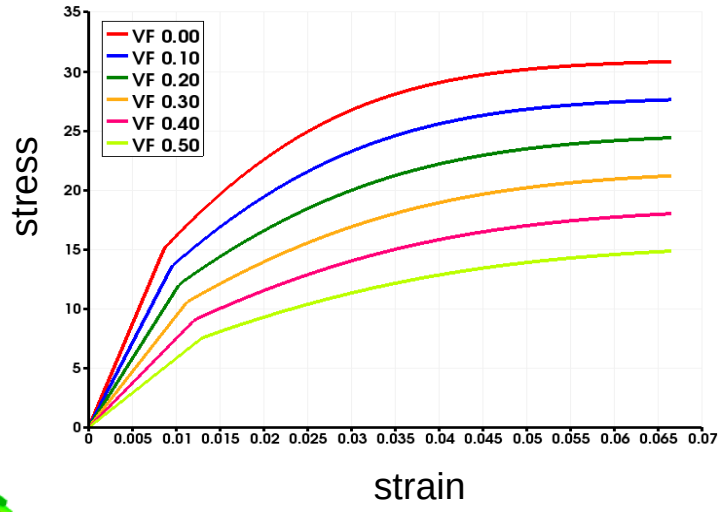
Moldex3D / MuCell

Data on processing mesh

FEA

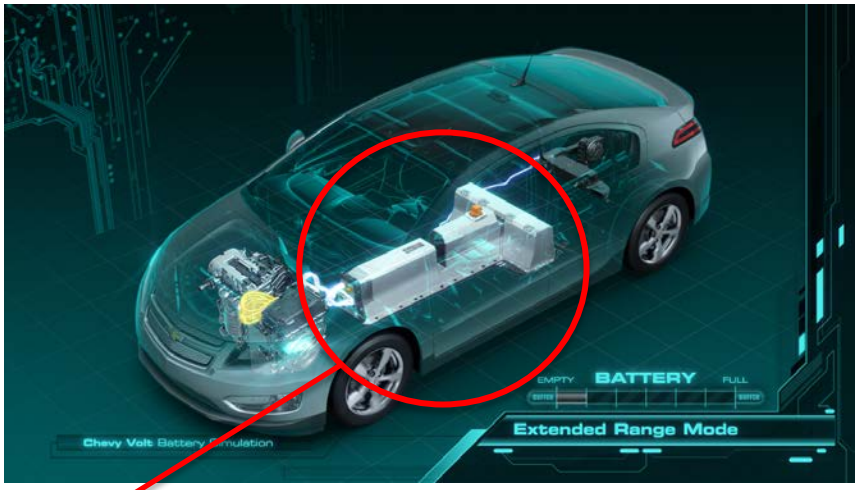
Structural analysis





Electric Car of GM : Chevy Volt

Chevy Volt

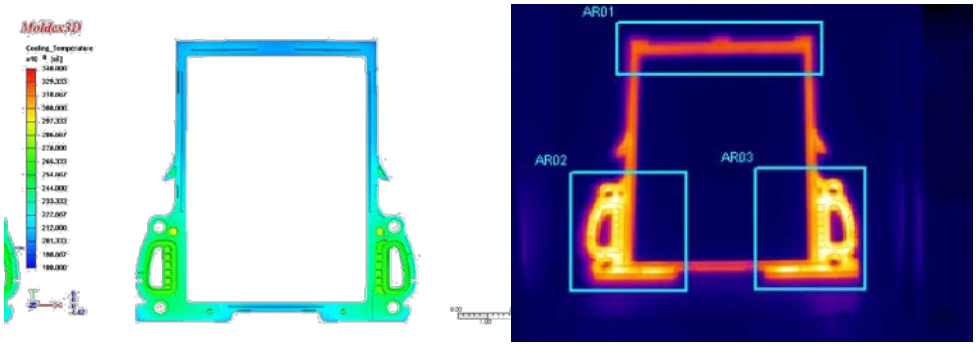


Source: Composites world

Chevy Volt Battery Frame

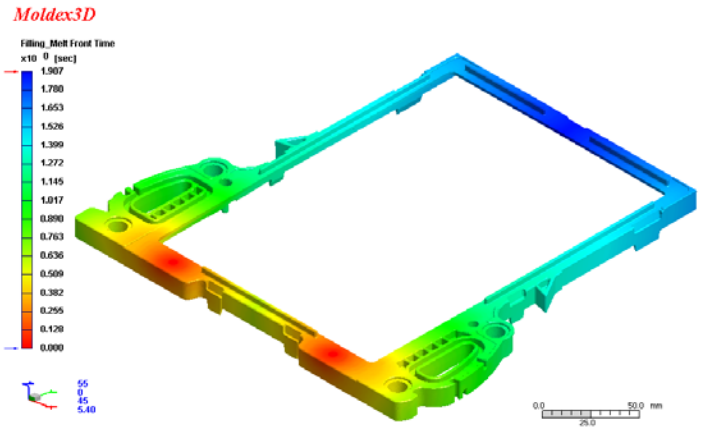
Chevy Volt Battery Frame

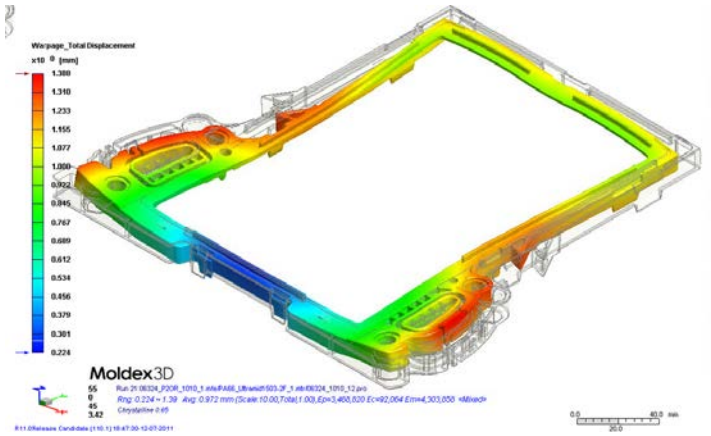
Source: BASF's website



Temperature comparison

Total Displacement x20





结语

未来？

未來趨勢

- 全電動車
- 全塑膠車
- 3D打印車
- ....

Thank you for your attention!