the autosim project

Current & Future Technologies in Automotive Engineering Simulation (CAE)

Dr. Hans Sippel, of CAEvolution and technical co-ordinator of the Autosim Project summarises the main project outcomes

The intention of AUTOSIM was to provide ideas to make more efficient use of engineering simulation techniques, particularly in structural analysis and computational fluid dynamics in the automotive sector. AUTOSIM had two complementary aims: firstly to review Best Practices, and secondly, to identify the most promising potential Breakthrough Technologies. The consortium consisted of 32 companies (OEMs, Tier 1 + 2 suppliers, software developers, researchers and consultants).

These objectives have been examined in three key technology areas (see Figure 1):

- Integration of simulation into the design process
- Materials characterization
- Improved confidence in the use of simulation.

Whilst these three key technology areas are important by themselves they are not isolated but strongly connected to each other.

Integration

Within "Integration" up-front simulation is a key driving force behind today's necessary paradigm shift in new product development. Conventional product development methods are too inefficient. The traditional "design-analyze-build & test" scenario will not remain competitive.

Today, leading organizations perform simulation at the concept stage to explore design alternatives, detect flaws, and improve product performance before a detailed design or a physical prototype is created (simulation drives design).

Materials

The main obstacles in materials characterization in the concept design phase are missing decisions about material selection including a lack of availability of relevant test data, insufficient and inaccurate geometry information, guidelines in terms of modeling techniques (Figure 3) etc.

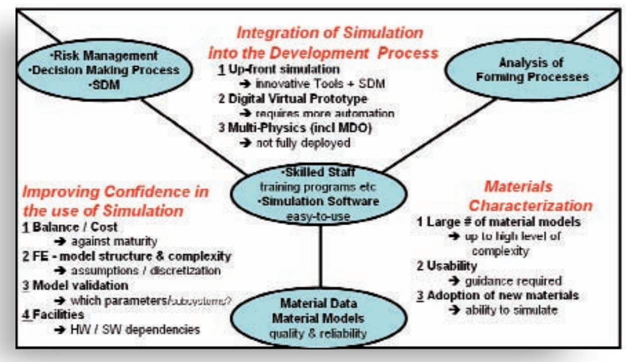

Figure 1: The interrelationship of the selected three key technology areas – Integration, Confidence & Materials – on which AUTOSIM was focused

The quality of materials characterization will increase when development proceeds. But one needs to keep in mind that "simple material models" omitting important effects might cause wrong simulation results and therefore wrong design choices. This applies e.g. to material's strain rate sensitivity in the prediction of crashworthiness behavior or the consideration of bifurcations. Involving suppliers in the earliest design phases might be crucial. Also "cost constraints" have to be acknowledged. Cost comprises of many aspects including data generation (testing, data capture and validation / QA) and material model development.

Confidence

Confidence has a significant influence on the uptake and use of CAE models. It is reliant on good material information and is necessary for the successful integration of CAE within the design and engineering process. It is also dependent on the available time, resources and budget. Without confidence a CAE model has no obvious benefit or value.

According to Figure 4, it is clear that CAE confidence is influenced by a broad variety of topics. Based on discussions within the AUTOSIM consortium the items

- Physical model
- Human resources and organization
- Data validity
- Digital model

have been prioritized and discussed in more detail.

How to move on?

Perspectives and expectations have been discussed within the AUTOSIM project which need to be considered today and in the near future. There are lots of tasks which need to be fulfilled to become more efficient in terms of making key decisions more precisely and earlier. Some of them are listed below.

1. Efficient deployment of Digital Prototypes
2. Becoming faster in the Conceptual Design Phase
3. Clearly defined Materials Characterization Methodology
4. Accelerating the Model Preparation Phase
5. Robust Design and Complexity Management

Figure 2: Up-Front Simulation and related paradigm shift

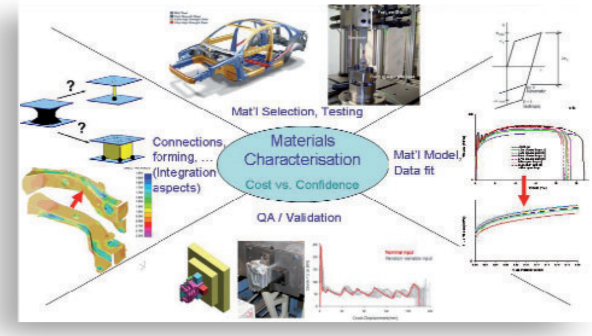

Figure 3: Key Aspects of Materials Characterization (courtesy of Dr. Paul Wood, University of Warwick)

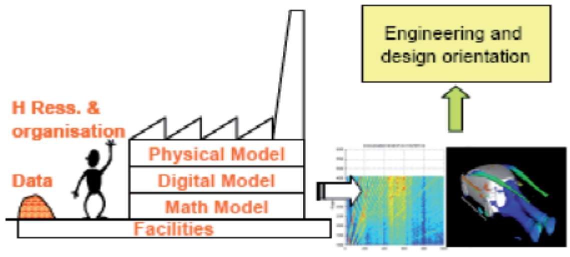

Figure 4: Foundations of CAE confidence (courtesy of Renault)

6 Current Status and Future Trends in CFD
7 Design – to – Cost

Starting with **item 1** this applies to streamlining processes in a concurrent engineering environment using digital prototypes in an efficient way. "Up-front loading" will require a paradigm shift to do analysis earlier and faster and / or to leverage knowledge from previous designs using product- and simulation data management systems. The vision: simulation drives design (**item 2**). A clearly defined materials characterization methodology would permit new materials (data and models) to be adopted with increased confidence (**item 3**). Model generation systems should provide capabilities for cleaning-up and de-featuring CAD geometry. It also should be possible to assemble and connect component models from different sources. The recognition and meshing of important features are required like boundary layer modeling for CFD. Polyhedral meshing contributes enormously to the ease of volume-mesh generation, accuracy and robustness of the CFD solution (**item 4** and **item 6**). Multi-domain meshing is essential for certain types of multi-physics analysis such as conjugate-heat-transfer or fluid-structure interaction (**Figure 1**).

Based on the results of stochastic simulations or multi-disciplinary optimization or test interactive process maps can be developed which give the user an integrated view of the degree of coupling, global robustness measures and complexity (**item 5** and **Figure 2**). The intensity of correlation between input and output parameters can be highlighted by various means e.g. different colors, line characteristics and the distinction between direct and indirect correlation.

Affordability is one of the key issues for design engineers and manufacturers of new car body models. Sometimes vehicle development projects failed to enter the production phase because cost could not meet the project financial targets. Likewise vehicle projects went into production with severe cost and manufacturing constraints but failed in the marketplace because of limited improvements in vehicle functionality or performance. Either case primarily is due to the lack of understanding of the cost and performance relationship and engineering alternatives during the vehicle development cycle (**item 7**).

Summing up: in the future, CAE needs to take into account extended distributed development environments to address Product Life Cycle Management. Tools and Processes must be integrated, with the consideration given to the OEMs and Suppliers, recognizing their knowledge and resources.

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The final report is available for download at www.autosim.org

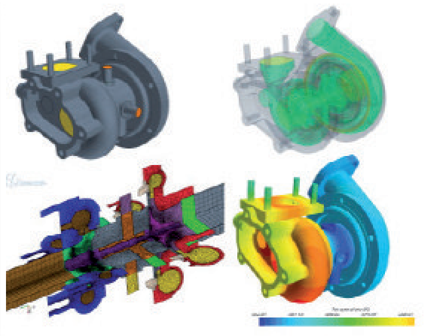

Figure 5: Turbocharger compressor and turbine complete assembly with continuous multi-domain meshing incorporating fluid-side surface mesh extrusions as well as flow & thermal solutions (courtesy of CD-adapco)

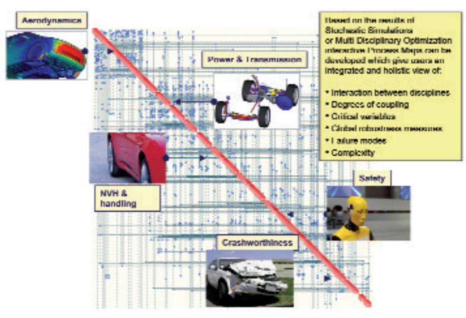

Figure 6: Complexity Management using Decision Maps for various disciplines (courtesy of Ontonix)

PROJECT MEMBERS:

NAFEMS	UK
Renault	France
Engin Soft Trading	Italy
Labein	Spain
CAEvolution	Germany
PSA Peugeot Citroen	France
Volvo Powertrain	Sweden
Faurecia	France
Herbertus	Spain
UTS-Comau	Italy
Abaqus Europe BV	Netherlands
Imamoter Institute	Italy
Cadfem	Germany
Research	Austria
TRL	UK
EASi Engineering	Germany
P + Z	Germany
Robert Bosch GmbH	Germany
Tarrc	UK
MSC.Software	France
Mecas ESI	Czech Republic
Micado	France
Pankl	Austria
DYNAmore	Germany
LMS	Belgium
Componenta Pistons	Finland
Inprosim	Germany
University of Manchester	UK
CD-Adapco	Germany
TWT	Germany
VIF	Austria

ADDITIONAL PARTICIPANTS IN WORKSHOPS INCLUDED:

Jaguar Land Rover
Porsche

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- Funded by the EC FP6 Programme
- €600,000 grant funding over three years

WORKSHOPS HELD

January 2006 – Barcelona, Spain
May 2006 – Munich, Germany
November 2006 – Lisbon, Portugal
July 2007 – Paris, France
November 2007 – Bilbao, Spain
April 2008 – Birmingham, UK