SIXTH FRAMEWORK PROGRAMME PRIORITY [6.2]
[SUSTAINABLE SURFACE TRANSPORT]

012497 DEVELOPMENT OF BEST PRACTICES AND IDENTIFICATION OF BREAKTHROUGH TECHNOLOGIES IN AUTOMOTIVE ENGINEERING SIMULATION - AUTOSIM

autosim

Issue 1 - May 2006

network bulletin

Autosim EC funded project to unite the European automotive industry has been launched

Thirty-two of Europe's leading automotive companies have joined forces to launch the EC funded Autosim project, which will ensure that the entire European automotive industry is making the most effective use of engineering simulation techniques.

The three-year project is supported by 600,000 euro of funding from the European Commission and is coordinated by NAFEMS, the International Association for the Engineering Analysis Community, an independent not-for-profit membership organization with more than 700 member organisations in over 30 different countries. The scope of NAFEMS activities encompasses all simulation technology, including Finite Element Analysis (FEA), and Computational Fluid Dynamics (CFD).

The project consortium consists of 32 companies from throughout Europe, each having a significant interest in the use of simulation within the automotive industry. They include OEMs, Tier 1 and Tier 2 suppliers, consultants, researchers and software developers.

The fundamental objective of Autosim is to promote better and more effective use of simulation technology in the European Automotive industry. It has two complementary aims: firstly to develop best practices and secondly to identify the most promising potential breakthrough technologies of the future. These aims and objectives will be examined under three primary themes:

- **Integration of simulation into the development process**
- **Materials characterization**
- **Improving confidence in the use of simulation**

In order to address these issues, Autosim has established an international team of leading experts representing much of the European automotive industry. They will develop a preliminary set of best practice guidelines, standard analytical procedures and research strategies. They will then consult with the wider automotive industry to gain feedback on these preliminary documents, in order to produce final documents which aim to provide definitive guidelines from an authoratitive and credible voice.

These final versions will be disseminated internationally throughout the automotive industry. Their adoption will increase the efficiency and improve the quality of simulation, increase the efficiency oft he supply chain, enable simulation to be practiced more effectively by a broad range of personnel, coordinate ongoing research by providing a focused set of priorities, assist industry to plan its future implementation strategy for simulation.

With these actions, Autosim will make a substantial contribution to the advance of design techniques in the European automotive industry.

For further information, visit

www.autosim.org

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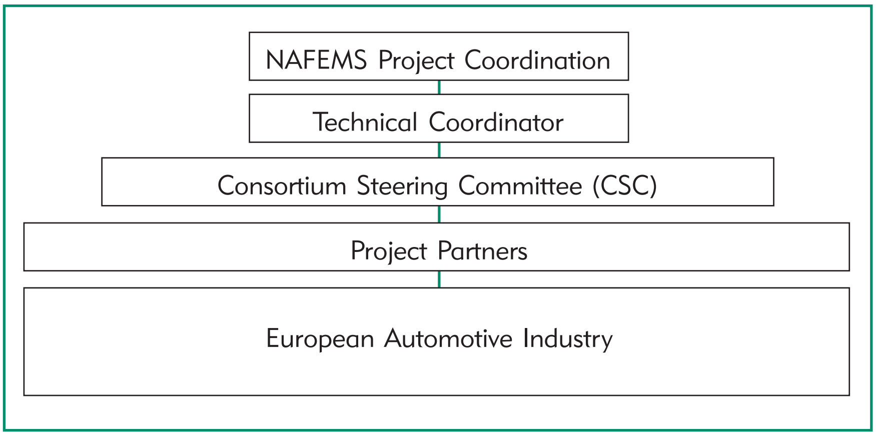
PROJECT OBJECTIVES

The broad objectives of AUTOSIM can be summarised as follows:

- To improve the quality and robustness of modelling and simulation in the European automotive industry within an integrated design and product development environment.
- To facilitate the use of advanced simulation technologies (finite element analysis, computational fluid dynamics, and related methods) within a multi-site, multi-organisational environment.
- To improve technology and knowledge transfer between engineering practitioners within the automotive industry.
- To identify potential breakthrough technologies which could have a profound effect on the use of simulation techniques for automotive applications.
- To identify technology gaps and areas where RTD activity is needed.

The detailed objectives are:

- To assemble and collate information which is focused on current practices in the application of modelling and simulation technology in the European automotive industry.
- To define best practices and standard procedures for the use of modelling and simulation.
- To identify barriers between current practices and best practices.
- To issue guidelines to help overcome the barriers.
- To ascertain areas in which breakthrough technologies could be of greatest use and prioritise their importance.
- To establish the current state of the art and its readiness to become state of practice.
- To promote RTD projects to address identified requirements.
- To actively and widely disseminate information about all the aspects listed above within the European automotive industry.



General structure of the Autosim project

CONSORTIUM MEMBERS

The Consortium members are drawn principally from industry, but there is also strong participation from research organisations, as well as representatives of the major software developers and vendors. Several tier 1 European automotive companies are represented, together with their tier 2 subcontractors and RTD suppliers. Collectively, it is estimated that their RTD spend in areas involving simulation is several hundred million euro per annum.

The consortium is comprised of companies from a wide geographical and cultural base who have extensive expertise in all of the major areas of automotive design.

NAFEMS	UK	Cork Institute of Technology	IRL
Renault	F	Robert Bosch GmbH	D
Engin Soft Trading	I	Tarrc	UK
Labein	E	MSC.Software	F
CAEvolution	D	Mecas ESI	CZ
PSA Peugeot Citroen	F	Micado	F
Volvo Powertrain	S	Pankl	A
Faurecia	F	DYNAmore	D
Herbertus	E	LMS	B
UTS-Comau	I	Componenta Pistons	FI
Abaqus Europe BV	NL	Inprosim	D
Imamoter Institute	I	University of Manchester	UK
Cadfem	D	CD-Adapco	D
Arsenal Research	A	TWT	D
TRL	UK	VIF	A
EASi Engineering	D		

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	Integration	Materials	Confidence
Best Practices	Technology Leader 1	Technology Leader 2	Technology Leader 3
Breakthrough Technologies	Technology Leader 4	Technology Leader 5	Technology Leader 6
	Rapporteur 1	Rapporteur 2	Rapporteur 3

Topics and responsibilitiy structure

TOPICS & RESPONSIBILITIES

At the first meeting of the Consortium Steering Committee (CSC) in Munich on November 30th 2005, a series of initial suggestions for topics to be convered by the project were developed.

An initial plan of the responsibilities for these topics was also drafted.

Initial Suggestions for Topics Autosim Should Cover

Integration
- Process integration
- Integration with suppliers
- Up front simulation
- Integration with CAD
- Simulation data management
- Optimisation

Materials
- Composites, foams, new materials
- Fracture mechanics & durability
- Manufacturing simulation
- Constitutive models and material data
- Modelling connections

Confidence
- Uncertainty / stochastics
- Robustness
- Validation
- How to eliminate 1 gateway?
- Correlation with test
- Standardisation

QUESTIONNAIRE

At the first workshop meeting in Barcelona (Jan 17th & 18th, 2006) it was proposed that a questionnaire would be circulated for all to comment on the issues to be addressed within the three Technology Areas defined for the Project.

Everyone with an interest in the use of simulation for the automotive industry was actively encouraged to complete this questionnaire - it was not restricted to members of the project consortium.

The worksheet set out the proposed topics; there was a separate spreadsheet for each of the three technology areas - Integration, Materials Characterisation and Confidence. You were invited to score each topic using the three indices developed in the FENET project.

The results were presented at the 2nd workshop in Sonnenhausen near Munich (May 4th - 5th, 2006) and can be downloaded from the Autosim website (www.autosim.org).

RELEVANT WEBSITES

www.fe-net.org
Website of the NAFEMS Coordinated FENet project, which was completed in July 2005. Of particular interest to the autosim project will be the findings of the Land Transport sector

www.simdat.org
SIMDAT focuses on four application areas: product design in the automotive, aerospace and pharma industry as well as service provision in meteorology.

www.eucar.be
EUCAR developed an Automotive R&TD Master Plan in 2000 in order to define a European approach to technologies for automotive development. In 2001, a Position Paper was published, presenting the major R&D challenges the automotive industry. The members of EUCAR represent the major European motor vehicle manufacturers: BMW Group, DaimlerChrysler, Fiat, Ford in Europe, Opel, Porsche, PSA Peugeot-Citroën, Renault, Volkswagen Group, Volvo.

Cars21
The CARS 21 High Level Group has adopted a 10 year roadmap for a competitive EU car industry. The Group has agreed on a number of recommendations to make cars cleaner, safer and to simplify the legal environment for EU car makers.

OVERVIEW

Project start	September 1, 2005	
1st CSC meeting	November 30, 2005	Munich, Germany
1st Autosim workshop	January 17-18, 2006	Barcelona, Spain
2nd CSC meeting	January 18, 2006	Barcelona, Spain
2nd Autosim workshop	May 4-5, 2006	Sonnenhausen/Munich, Germany
3rd CSC meeting	May 4 & May 5, 2006	Sonnenhausen/Munich, Germany
Next meetings:		
3rd Autosim workshop	November 23-24, 2006	Lisbon, Portugal
3rd CSC meeting	November 23 & 24, 2006	Lisbon, Portugal

Workshops are open to all who are involved in numerical simulation methods in the automotive industry, and contributions from industry, research and academia are positively encouraged.

1st AUTOSIM WORKSHOP

The inaugural Autosim workshop was held on the 17th - 18th of January 2006 in Barcelona, Spain

The Autosim project held its first Technology Workshop in Barcelona during January of this year. As with all the Workshop meetings of this project, anyone with an interest in the topics to be discussed was welcome to attend. In total there were nearly fifty delegates at the event, with representatives from OEMs, Tier 1 and 2 suppliers, universities and software suppliers from across Europe in attendance.

This valuable mixture of different types of organisations provided all the ingredients for much well informed debate and promises to provide an authoritative and representative view of the topics discussed.

Purpose of the First Technology Workshop

There were various objectives for this first Technology Workshop. Firstly, for the Technical Leaders of each of the themes to provide an introduction to each of the technical areas. Secondly, and perhaps most importantly, to initiate a discussion around the formation of a Technology Priority Plan which the project will develop. Finally, to familiarise all the project participants with both the details of the project and with each other.

Outcomes of the First Technology Workshop

To assist with the development of the Technology Priority Plan, the project launched a questionnaire. Following the scheme which was successfully developed during the Fenet project, respondents to the questionnaire were asked to score various topics with three indices: firstly, the technological readiness level (TRL) indicating the state of the art or technological maturity, secondly the state of practice (SoP) giving a measure of industrial maturity and lastly the priority level index (PLI) which points at the relevance for industry.

Summary and Conclusions from Barcelona Workshop

KEY TECHNOLOGY AREA 1: INTEGRATION

In the first Consortium Steering Committee (CSC) meeting, proposals were made on the possible topics that could be covered under the key technology area of integration. This initial list of topics acted as a focus for the first workshop in Barcelona, where the main objectives were to clarify the principle topics associated with integration and identify those that should be addressed and

resolved in the Autosim project.

In the first CSC meeting, the question on which simulation disciplines (structural, CFD, MBD, etc.) were to be covered within Autosim had surfaced, and it was decided to get feedback on this during the Barcelona workshop (this affects all 3 Key Technology Areas).

From the presentations and discussions at the Barcelona workshop a number of issues and questions were raised on integration in numerical simulation. From these discussions the principal topics for Key Technology Area Integration include:

- Up-front Simulation
- Digital Virtual Prototyping
- Decision Making Process (link to Confidence)
- Multi-disciplinary Optimization and Multi-physics

Disciplines within AUTOSIM

The issue on which simulation disciplines should and could be covered, within the given project constraints, was discussed early on during the workshop. Based on the definition "CAE = simulation of physics", it was decided to cover all disciplines. However, there was some evidence that structural and CFD simulation will be the main focus.

Generic Product Development Process (PDP)

Based on presentations and discussions during the workshop, the decision was taken to define a generic PDP, which can be clearly described, from which bottlenecks can be identified and break-through technologies derived. The following top level scheme is a first attempt to summarize the discussion as a base for further refinement.

Up-front Simulation

There was wide agreement that 'upfront simulation' through activity (performing more simulation at the early development stage) and knowledge (knowledge capture from previous designs) front-loading within the product development process is one of the most important aspects of the Key Technology Area of Integration. There are various sources available which describe the benefits of front-loading (reduced development time, lower decision risks through increased product knowledge, improved product quality, etc.).

While there was agreement on the overall importance of Upfront simulation, further discussion on available and required tools & technologies , methodologies, upstream data flow (from previous designs), downstream data flow (granularity of data), CAD/CAE integration, and others are necessary in subsequent workshops. An interesting discussion developed around the question whether Design Engineers are or will perform rapid turn-around simulation in the early design stage. There were different opinions ranging from
a) the designers may be able to perform (simple) linear analysis only due to time and experience constraints
to
b) on the longer run it does not matter who performs the simulation, as the tools have to take care (have to be suitable) in the future

More the 40 delegates have been at the 1st Autosim Workshop in Barcelona

A final conclusion could not be reached during this first workshop, but it is certainly important to continue this discussion, as it offers the opportunity to describe current best practices (a) and derive break-through technology requirements for future tools.

There was agreement that, though not a pure technical issue, the integration of simulation into the early design process will have an effect on people and that this has to be seriously considered (change and skill management).

Virtual Prototype

Virtual prototyping is part of the series development stage, where simulation has reached a higher maturity level during the past. Improved process integration requires automation of model building tools, simulation (solver) tools, post-processing tools, and application of an optimization framework for multi-disciplinary simulation.

It has been noted that automation and optimization reduces man efforts and increases computational efforts (larger models, optimization loops), i.e. increasing need for high-performance computing. In this context there were good discussions on whether or not currently used hardware (and software?) performance is adequate. The initial discussion on this issue suggests that current hardware is adequate if modelling time is sufficiently high (several weeks), but that higher performance is required if modelling time will be significantly reduced (day or few days level). In-depth further discussion on this seems to have the potential to deliver best practices versus breakthrough technologies conclusions.

Another topic which has been touched upon and requires further consideration is the question if one unified simulation model (one model for various attributes like durability, NVH, crash behaviour) will be the future (what are the enablers/breakthrough technologies?) or if we need to continue to have different simulation models (best practices).

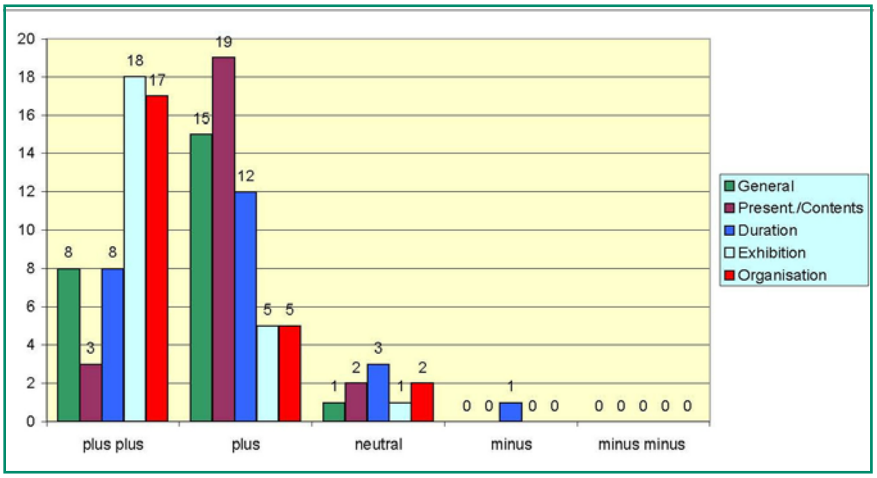
During several discussions, the importance of data correlation between simulation data, results from previous simulations (plausibility of results), and test data has been stressed. This issue has to be be tackled in more depth in future workshops.

Decision Making Process

It was determined that the decision making process is vital for the overall development process, and that this topic is closely related to the Key Technology Area of Confidence. The decision making process is strongly related to the confidence level which is necessary to move from one development gate or subgate to another. In order to avoid unnecessary duplication of report generation, we refer to the section "Process and implementation (integration)" within the report of Key Technology Area Confidence for further detail.

Multi-disciplinary Optimization and Multi-physics

The discussions and presentations on this topic demonstrated the great significance of integration in terms of integration of simulation disciplines and potential for automation. Multi-disciplinary optimization and multi-physics have received high attention, and there has been tremendous progress in these areas during recent years, but they are not yet fully deployed in mainstream simulation. This suggests that we should elaborate on guidelines for further dissemination of these key technologies, and potentially define break-through technologies.



Results from the Barcelona feedback form

Proposed issues to adopt/tackle in Autosim

Within the meeting the following two recommendations were made on points that should be addressed and adopted by the key technology area of Integration:

- It was proposed that the initial work should be the description of the current best practices process and the definition of a revised generic product development process (PDP) which includes upfront simulation, virtual prototype, multi-disciplinary optimization, and (strongly coupled with confidence technology area) decision making process.
- It was further proposed that, following this first step, the aim of the integration part of the project should be the identification of bottlenecks within the revised PDP and, based on those findings, break-through technologies to support the revised PDP should be defined.
- After the meeting the decision has been made that the Technological Readiness Level (TRL), State of Practice (SoP) and Priority Level Index (PLI) scales developed in the Fenet project will be used to assess the most appropriate topics to address in the key technology area of integration.

Topics to address in integration

For consistency reasons between the key technology areas within Autosim, it was agreed between the two technological leaders and rapporteur of the integration technology area that a provisional list of integration topics to address in the Autosim project should be developed. This would then be distributed to all Autosim members for comment, before a final decision is made on the list of integration topics to address in the Autosim project.

KEY TECHNOLOGY AREA 2: MATERIALS CHARACTERISATION

At the first Consortium Steering Committee (CSC) meeting the following topics were initially proposed for consideration under the key technology area of material characterisation:

- Composites, foams, new materials
- Fracture mechanics & durability
- Manufacturing simulation
- Constitutive models and material data
- Modelling connections

These topics were introduced to the workshop meeting at Barcelona as initial suggestions for discussion. The overall objective of the workshop was to refine the topics to be addressed during the course of the Autosim project.

To assist in the discussion, a number of papers were presented (the full presentations are available on the website); some of the important points noted relating to material characterisation are noted:

- Presentation of Fenet Automotive Findings
  (F Espiga, Labein)
  - Fenet provides a set of topics for consideration in Autosim and emphasises the need for smart use of materials and innovations based on new materials
  - Fenet also provides a method of classification (technology readiness, state of practice and priority level)
- Characterisation and Modelling of Dynamic Properties for Reliable Integrated System Simulation
  (S Oyadiji, Univ of Manchester)
  - There are a range of models developed or under development with varying demands on data
- Modelling for Elastomeric Automotive Components using FEA and Multi Body Dynamic Analysis
  (H Ahmadi, TARRC)
  - Similar points on variety of models and available data as noted in the previous paper, with a consideration of complexity vs. acceptable accuracy in the results
- Material Characterisation for Accurate Simulation of new Metal Forming Processes
  (M Gutierrez, Labein)
  - New materials require new pro-

cesses
- To understand how these materials behave after forming we need to be able to confidently simulate these processes; N.B. especially TRIP steels which show phase change with temperature and work hardening
- Again the question of balance between complexity and accuracy (and also computational cost) was noted

- Forming Simulation and the Effects of Forming (T Dutton, Dutton Simulation)
  - The importance of including the effects of manufacturing processes to correctly predict component performance (in crash especially) was noted
  - The choice of simulation method was also discussed; consider software usability vs. user skill/ knowledge

Discussion

There was much discussion following on from these presentations; some of the key points were as follows:

- Materials Characterisation issues will naturally arise from aspects of the other two technical areas (Integration and Confidence) in the Autosim project, e.g.:
  - Effects of Forming is an issue for Integration requiring analysis of forming processes and a method to pass the relevant data to the functional model
  - A key question for Confidence is the quality of the material data and models
- Large number of material models
  - There are a great many models available, many highly complex with multiple (and relatively obscure) parameters
  - However, the relevant data can be very difficult to obtain; little data is freely published, data on the web may not be reliable and testing can be time consuming and expensive (and there are commercial considerations; material suppliers are expected to provide data with no guarantee of winning the contract to supply!)
  - Role of optimisation methods in data fitting
  - Micro-characterisation; new types of material models at the micro level may eliminate dependency on testing to generate empirical parameters
- The desire to innovate by adopting new materials also depends on an understanding of (and ability to simulate) the relevant – novel – forming processes; the connection and assembly processes must also be considered
- Usability of both material models and the applicable data was also discussed:
  - What are the training requirements?
  - Are new Benchmarks required?
  - Software design implications? Codes should offer more guidance to users on the selection of models, possibly offering default values, depending on the level of detail required; software scalability may be important (the latter point led into discussion of integration of CAE tools within the CAD systems which, it was agreed, falls into the Integration topic – which also served once again to emphasise the degree of interrelation).

Way Forward

It was proposed that the Materials topic can be used to explore specific technical gaps determined from both the Confidence and Integration topics, picking up on the inter-related nature of the three areas being addressed. In order to explore further the topics to be considered for further review and more detailed presentation and discussion at future workshops, it was proposed that a Questionnaire be distributed for all project partners and any other interested parties to record their assessment of the importance of materials-related issues.

It was proposed to adopt the three categories and associated 10 point scoring system developed in the Fenet project. In this way it is hoped to identify both Best Practice and Breakthrough Technology topics for the next and future meetings.

KEY TECHNOLOGY AREA 3: CONFIDENCE

In the first Consortium Steering Committee (CSC) meeting the following proposals were made on the possible topics that could be covered under the key technology area of confidence:

- Uncertainty and stochastics
- Robustness
- Evaluation
- How to eliminate uncertainty
- How to eliminate gateway/options
- Correlation/validation with test results
- Standardisation
- Quality Assurance procedures
- Certification of engineers/training

This initial list of topics acted as a focus for the first workshop in Barcelona where the main objectives were to clarify the principle topics associated with confidence and identify those that should be addressed and resolved in the Autosim project.

From the presentations and discussions at the Barcelona workshop a number of issues and questions were raised on confidence in numerical simulation. These were initially collated into the following generic categories relating to confidence in numerical simulations within the automotive industry:

- Facilities
- Staff skills and training
- Model structure and complexity
- Validation of the model
- Process and implementation (integration)
- Proposed issues to adopt/tackle in Autosim

Facilities

- Hardware/platform dependencies
  - Predictions from models can be influenced by the type of IT hardware/platform on which the model is run. Further factors influencing a model's predictions include the number of processors on which a model is solved. Such considerations need to be managed and controlled in order to improve

confidence in models.

- Software – It is recognised that a number of factors associated with the applied software will influence model confidence, such as:
  - The type of software, its stability and accuracy
  - Software upgrades which can result in different predictions for the same model
  - The coding and numerical methods built into the software can influence model predictions and confidence
  - The detail, variety and accuracy of the constitutive laws available in the software may limit the types of structures that can be modelled and as such the accuracy of its predictions. These factors need to be managed and controlled in order to maintain repeatability and confidence in a model's predictions.

Staff training and skills

- Staff training – Training is necessary to ensure that staff are adequately skilled to develop accurate models that are representative of the physical structure and that staff are able to competently interpret model predictions. Is there a need to clarify the type and amount of training that is needed in order to have confidence that staff are armed with the necessary skills?
- Staff skills – Is there adequate confidence in the abilities of existing staff to develop models and interpret their predictions? Are there any requirements to ensure that staff have the necessary skills to develop models and interpret model predictions?

Model structure and complexity

A number of factors associated with the structure and complexity of a model will influence, the confidence in, and accuracy of, a model's predictions, such as:

- **The discretisation of the model** - The refinement and quality of the mesh used in the construction of the model.
- **Choice of elements** – This will include the choice of the elements used to represent the physical structure, such as shells (Hexagons, Triangular) or solids (hexahedral, tetrahedral) and the choice of element formulation (fully-integrated, single point, Hughes-Liu, Belytschko-Tsay). How representative are these mathematical methods compared with the physical structure?
- **Model data** – Adequate and representative geometrical and material data needs to be available in order to have confidence in a model's predictions and its accuracy. Is this achievable?
- **Model assumptions** – What assumptions have been made in the construction of the model? How much do these influence the accuracy of the models predictions and the confidence in the behaviour of the model? Assumptions may include the modelling approaches that have been used to model cracking and the heat affected zones around welds. Are the modelling assumptions adequate for the global response of the model and its predictions, or are the assumptions going to be detrimental to the eventual confidence in the model's behaviour?

Model validation

Validation can be used to improve confidence in the predictions of the model. The extent of the validation required, the adequacy of the validation and the approaches used to validate models is dependent on a number of factors as follows:

- **The application the model** – The required validation necessary for a model will be dependent on the eventual use of the model and what the predictions will be applied to answer. Concept models may require less validation by virtue of their use to test principles and investigate trends. To this end the validation may be limited to checking that the fundamental physics of the model are correct (conservation of mass and energy). A model developed to predict accurate behaviour should be validated against physical tests and it may be necessary to test the robustness of the model under a broad range of impact conditions to assess the overall stability of the model.
- **The reliability of test data** – Repeated tests typically result in variations in test results. As such it is not appropriate to compare a model's predictions against a single set of test results. Ideally, to assess the robustness of a model, predicted scatter (Stochastic modelling) should be compared against test scatter. Alternatively, the scatter in model predictions should be compared against known or expected test corridors rather than against single test responses.
- **Which test parameters should a model be validated against?** – The most appropriate parameters to validate the model against will be specific to the eventual use of the model and its predictions. Questions that need to be considered are where and how should measures be performed so that model predictions can be reliably validated against test results? Occasionally it may not be possible to measure in tests the physical parameters that the model should be validated against. Under these circumstances what is needed to ensure confidence in the behaviour of a model?
- **Methods of validating models** – Subjective methods of comparing a model's predictions against test results have typically been employed to confirm the accuracy and confidence of a model's behaviour. However, such methods are influenced by personal interpretations of a model's accuracy and as such it is difficult to rank and compare the accuracies of different models. Alternative validation methods include rational and probabilistic methods on which acceptance criteria can be developed to rank a model's abilities and confidence in its predictions. Standardised procedures and acceptance criteria are needed in order to implement these rational procedures.
- **Sub-system validation** – Greater

confidence in the predictions from a large global model can be achieved if sub-system validations of the model components have been performed. Having confidence in component features of a large model that have been validated in isolation makes it easier to identify areas of concern in the structure and performance of a global model.

- **Better integration with test departments** – Often tests to gather physical data against which model predictions are to be validated against are planned and conducted without sufficient input from the model developers. This can lead to poor and inadequate test results against which to validate models. How can this process be better integrated and managed?
- **Description of a model's validation** – Validation, evaluation and verification are common terms used to describe the processes used to check the behaviour of a model. Each term has a different meaning but in practice the terms are not applied correctly to describe the checks that have been completed on a model's behaviour. This can lead to confusion and a lack of confidence on the exact abilities of a model. It is felt that better clarification of these terms is needed to clarify the level of a model's abilities.

Process and implementation (integration)

- **Risk management** – What are the risks associated with using a model and its predictions and how should this be managed? Based on discussions within the meeting it was considered that this is already implicitly considered in the analysts understanding of the model structure and the interpretation of the model predictions. It is not considered possible to have 100% confidence in a model's predictions. However, actions such as model validation and staff training should help to improve confidence levels.
- **Integration and materials** – Within the context of the project it is important to consider that confidence is linked to and overlaps with the other two Autosim key technology areas of integration and materials.
- **Benefits of confidence** – It was determined that confidence in model predictions will offer the following benefits:
  - Reduce the number of prototypes
  - Lead to less testing of prototypes and parametric test programs
  - Virtual testing and certification that would reduce the need for testing
  - Better understanding of physical phenomena such as material behaviour, cracking and connections such as welds. All these benefits should lead to reduced costs and development times.
- **Balance of confidence** – Often there is a need to balance the level of desired and achievable confidence against the maturity and extent of the knowledge and tools that are available. Appropriate material models may not be developed or available to represent the exact material behaviour to be modelled. There may also be limitations of processing power to develop highly complex models and some confidence may have to be sacrificed in a model to allow for these deficiencies.
- **Cost of confidence** – It is important to note that all of the above issues of confidence have associated costs. It is important to realise that confidence can always be improved in a model's behaviour, but this will have associated costs. Confidence needs to be balanced against these costs and the possible diminishing returns in improving confidence.
- **Data management** – It is important to ensure that the correct information and data is used in the construction of the model such as the most up-to-date version of a modelled component is used in the construction of a global model. What and how should simulation be implemented within the working environment to ensure that the most up-to-date geometrical and material data is being used in the construction of models?
- **Standardisation of models to ensure repeatability** – This will include management of model versions and updates.

Proposed issues to adopt/tackle in Autosim

Within the meeting the following two recommendations were made on points that should be addressed and adopted by the key technology area of Confidence:

- It was proposed that the aim of the work should hopefully lead to determining rules and guidelines necessary for confidence.
- It was proposed that the Technological Readiness Level (TRL), State of Practice (SoP) and Priority Level Index (PLI) scales developed in the Fenet project should be used to assess the most appropriate topics to address in the key technology area of confidence.

Topics to address in confidence

Following the Barcelona meeting it was agreed between the two technological leaders and rappoteur of the confidence technology area that a provisional list of confidence topics to address in the Autosim project should be developed. This would then be distributed to all Autosim members for comment, before a final decision is made on the list of confidence topics to address in the Autosim project.

Based on the „Report from the 1st Autosim Technology Workshop, Barcelona, January 18th 2006
T. Morris, H. Sippel, R. Schweiger, T. Dutton, M. Neale„

Please download the complete report at www.autosim.org