NEWS FROM THE VIRTUAL TRY-OUT SPACE

PAM TALK

ISSUE 31

SPRING 2006

Success Story

Boeing adopts ESI Group's AutoSEA2 Shock Analysis to secure operations on the International Space Station (ISS)

Special Report

Multi-Model Coupling for PAM-CRASH
a New Way for Crash Simulation

Vehicle Trim Modeling with RAYON-VTM

Product News

ESI GROUP
THE VIRTUAL TRY-OUT SPACE® COMPANY

contents

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Executive Editor: Nathalie David-Franc
Editor-in-Chief: Rita Tronel
rita.tronel@esi-group.com
ESI Group Marketing
PARC D'AFFAIRES SILIC
99 RUE DES SOLETS - BP 80112
94513 Rungis Cedex - FRANCE
Tel: +33 (0) 1 41 73 58 00 - Fax: +33 (0) 1 46 87 72 02
www.esi-group.com - info@esi-group.com

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New Way of Crash Simulation with PAM-CRASH 2G

editorial

Our customers deal with real life. They design and produce manufactured goods for real people. Therefore they have a responsibility towards these people to ensure the reliability and the safety of their products in real life situations. Until now, industrial companies have validated their design essentially by inflicting extreme conditions upon their products. Jet engine manufacturers actually throw geese into turbines to make sure a plane can withstand the occasional sparrow. Car companies crash dozens of cars with catapults to maximize the safety of the occupants.

But now the world is accelerating: new models that please customers must come to the market faster; energy has a cost, so we need to make cars lighter or to use new strategy for new design. Safety has become a marketing argument in a world where speed has a value on a racing track but loosing life at low speed in a city is now unacceptable.

But to face these challenges, customers need new materials, new designs with attractive shapes, new manufacturing processes to elaborate those materials, to fit those shapes and to test virtually against stricter regulations to gain 5 stars (NCAPP), in order to produce a "star" car.

This is where PAM-CRASH 2G's multi-scaling solution comes in. By allowing a specific zone to be isolated to test a casting or a stamping process, taking into account the interaction of two models in the same simulation at the click of a mouse, by focusing on a specific effect for head impacts, we can evaluate the injury to a pedestrian in the middle of a global evaluation.

With the global and local model, PAM-CRASH 2G allows us to cross the limits of larger and larger models with the highly scalable distributed version and with multi-scaling version, we come against to achieve a real level of Realistic Simulation never achieved before.

Vincent Chaillou
President and Chief Operating Officer
Product Operations, ESI Group

Multi-Model Coupling for PAM-CRASH: a New Way for Crash Simulation

Multi-Model Coupling is a new way for crash simulation, considered very promising for extensions toward multi-program and multi-physics applications. The implementation of the concept was the result of a fruitful partnership between ESI Group and Volkswagen Group research teams.

The main idea of the Multi-Model Coupling is to have two distinct standard PAM-CRASH models which will interact in order to compute a solution for the total structure consisting of the union of the two models. The multiple benefits from this coupling process are the following:

- The user can define a first model with a relatively coarse mesh, often called the "global" model, which corresponds to the bulk of the structure. A second model can be made with a fine or very fine mesh called the "local" model which represents only the small, significant part(s) of the initial total structure for which a detailed, deep analysis will be done (e.g. fracture prediction). These two different models can "collaborate", i.e. interact to give an accurate result with an efficient usage of computation resources. The end-result is a combination of two distinct simulations functioning together.

- Each model has its own time step. Time step is a crucial parameter of the simulation time, and therefore significantly influences the overall performance. An integrated algorithm allows the use of a different time step for each model. Thus the "global" model, consisting of many coarse elements, can use a larger time step, while the "local" model uses a smaller time step to ensure its stability. This scheme, called "sub-cycling", allows the simulation to run more efficiently as the "global" model is computed with the larger time step, avoiding the use of the smallest common time step as would be imposed if the whole model were computed in a unique PAM-CRASH run. This optimization dramatically reduces total clock elapsed time.

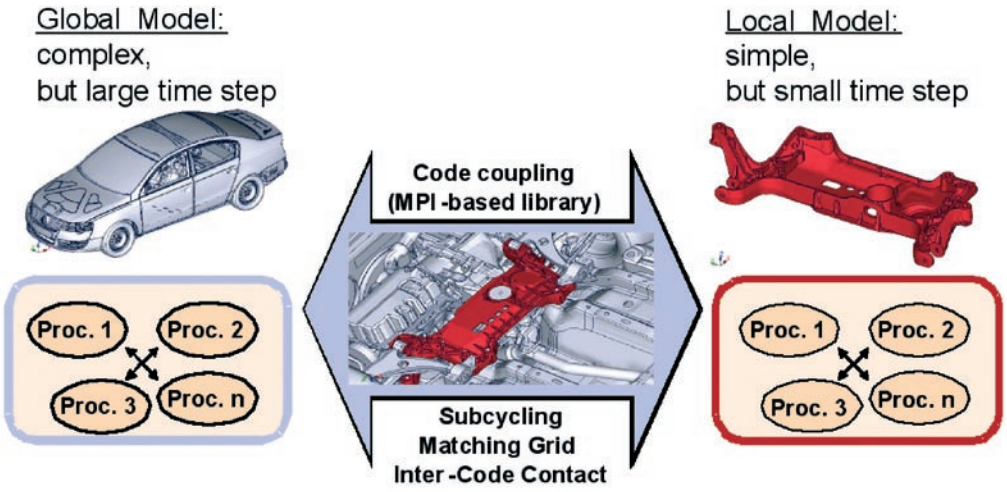


Figure1: Model partitioning and coupling
Courtesy of Volkswagen Group

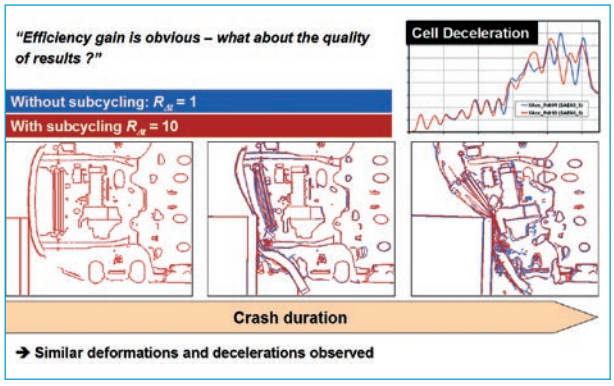


Figure 2: Comparison of deformations of a coupled and a standard uncoupled PAM-CRASH application
Courtesy of Volkswagen Group

> "Multi-Model and Multi-Code Coupling opens a new era for the numerical simulation of ESI Group software."

Dr. Stefanos Vlachoutsis, Advanced Projects Group Leader, Computational Solid Mechanics (CSM) Solvers Developments ESI Group

- The two-distinct-models method also allows a better handling of the simulation. Two models, which are prepared by the Computer Aided Design (CAD) procedure and should be parts of a larger unique structure, can have the same numbering. Indeed, nodes or elements in a model are typically numbered from one to, say, a million. The coupling method allows their use without renumbering, while a unique PAM-CRASH model would need to renumber one of the models. The handling of output files is also made easier: should special attention be paid to a parcel of the complete structure, the user can focus his analysis on this parcel since the separate output files can be handled more easily and faster than the model of the complete structure.

- To have two separate models can also improve some PAM-CRASH options for the Distributed Memory Processing (DMP) computing.

Each DMP run can accomplish its own internal-code tasks without any interaction with the other DMP.

The interactions between two PAM-CRASH models for the DMP run can be summarized in the following points:

- **The Matching Grid nodes:** the two structures can have coincident finite element nodes, and quantities are exchanged at these nodes in order to take into account the forces due to the other – remote, part. The connection is established by geometrical proximity considerations and the nodes can (or not) have the same number identifiers.

"The Multi-Scale modeling technique now enables more accurate failure analysis of refined solid element structures which are efficiently integrated in typical shell type vehicle crash models used at Volkswagen and Audi."

Dr. Lars Greve, CAE Engineer,
Volkswagen Group Research - CAE Methods

- **The contact between the two models:** the simulation of the contact mechanics is applied between the two different DMP PAM-CRASH models. The fact that the contact surfaces are distinct makes the contact modeling easier. The basic algorithm used is that of the node-versus-element type which is well known to PAM-CRASH users and have already been tested over many years, guaranteeing the robustness for contact simulation.

- **The sub-cycling technique:** provides the possibility to use different time steps for each model, where the time step ratio of both models can take arbitrary integer values. Thus the first model can use a time step which is, for example, ten times the time step of the second model. This allows different meshes to be used without running the coarse mesh with a too small time step, and hence can save a significant amount of computing time.

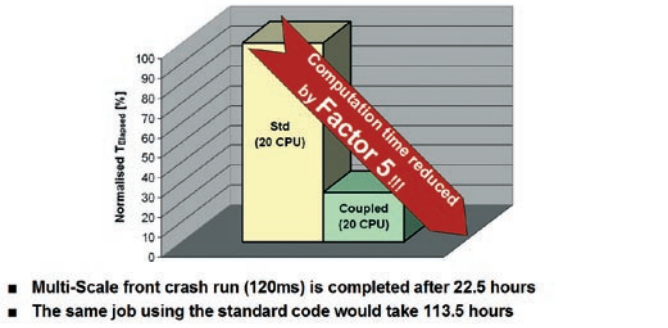


Figure 3: Comparison of computation times
Courtesy of Volkswagen Group

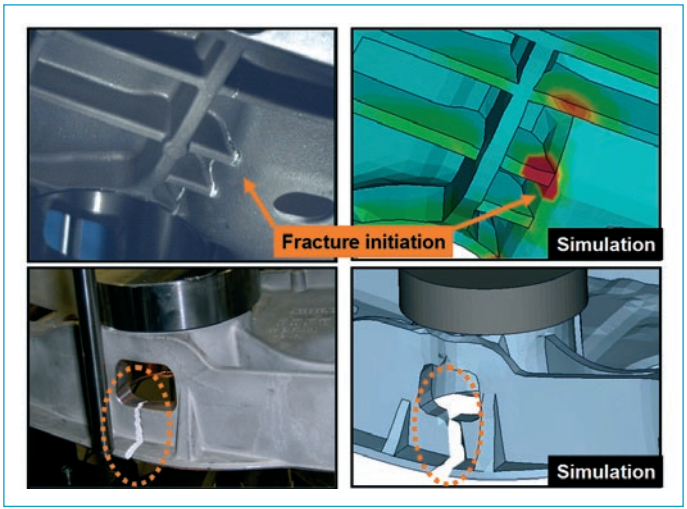


Figure 4: Validation test of the suspension subframe: Comparison of crack initiation and final fracture of experiment and corresponding simulation (Experiment was performed by the Fraunhofer Institut für Werkstoffmechanik, Freiburg)
Courtesy of Volkswagen Group

Multi-Model and Multi-Scale Coupling

The Multi-Model Coupling can be considered as a Multi-Scale Coupling if the attention is focused on the different mesh scales of the two models. In the perspective of using three or more models, the multi-scale character could be viewed as a multi-scale analysis of a complex system. For example a big structure is modeled by three different sub-models: a coarse-meshed model that includes an intermediate-meshed model which includes a very fine-meshed model. Thus there are three levels of analysis. To run three DMPs is a future development which will allow enhanced engineering flexibility.

Multi-Code Coupling: further extension of the Multi-Model Coupling

The extension of the Multi-Model and Multi-Scale Coupling is the Multi-Code Coupling where different programs are coupled and run together. As an example, one could be PAM-CRASH and the other a customer program. The interaction between these two different programs would be made by an interface – like the Matching Grid entity, and the exchanges would take place via a complete library based on the Message Passing Interface (MPI) which will be called ESI Coupling Library (ECL). By using this library the coupling will be done in such a way that one program will have a very limited access to the source code of the other. The collaboration between software vendors will be easier and each partner retains the confidentiality of its program. A successful test case of Multi-Code coupling has already been accomplished between ESI Group and an automotive partner. The Multi-Code Coupling could also be used in the frame of a Multi-Physics context like the Fluid-Structure Interaction or the Thermal-Structure Interaction or any other type of coupling. This demonstrates the tremendous potential for this "new way" in the Try-Out-Space World.

From the practical point of view the user runs the coupled application using n1 processes for the first model and n2 for the second model. After an initialization phase the solution procedure runs, and necessary data echanges for code coupling are performed. Each model has its own output files which are the usual text (ASCII) and mesh and time history information (binary) files. The usual tool for the launching of the uncoupled DMP PAM-CRASH can also be used for the coupled applications. Multi-Model Coupling will be a functionality of PAM-CRASH from version 2006 and will provide two-model interaction analysis.

The Volkswagen Group – ESI Group collaboration

A common project between Volkswagen Group and ESI Group spanned from October 2002 to September 2004, providing the opportunity to implement the Multi-Model and Multi-Scale Coupling concept. A special version of PAM-CRASH adapted for the coupling was used to run real industrial cases for which models were made by Volkswagen Group. The results of this work were first presented by Dr. Stefanos Vlachoutsis from ESI Group and Dr. Lars Greve from Volkswagen AG Research, at Euro PAM 2005 in October at Potsdam.

An important example of a typical vehicle crash analysis is given here: a suspension subframe is the "local' model while the rest of the car represents the "global" model. Details are given in the EuroPAM presentations and here, only four important figures illustrate the success. Figure 1 illustrates the coupled models for this case.

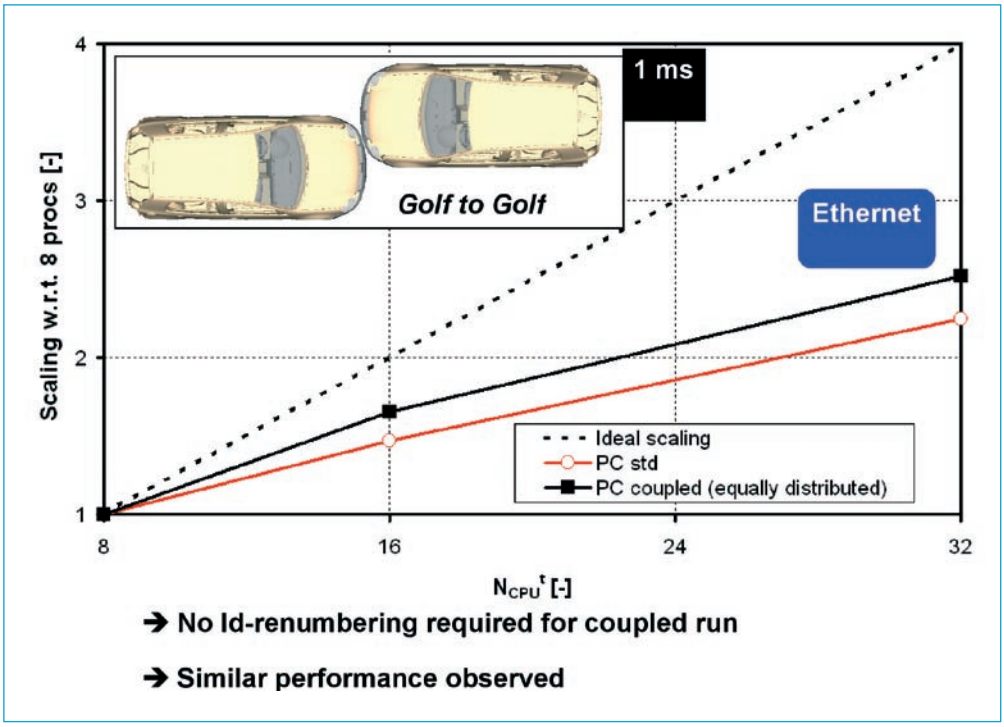


Figure 5: Golf to Golf front crash and comparison of model scalability
Courtesy of Volkswagen Group

The deformation pattern of the coupled and standard (uncoupled) application are compared, Figure 2, showing very similar results. The coupled run is roughly 5 times faster than the uncoupled run, Figure 3! Figure 4 shows the accurate correlation between simulation and validation test of the suspension subframe: the fracture is predicted precisely and the analysis is very satisfactory.

Another example of the coupling is the car-to-car crash (Figure 5), where the sub-cycling will not play a role, but a better handling and the per-model DMP running make the coupling interesting also for this case.

About Volkswagen Group

The Volkswagen Group with its headquarters in Wolfsburg is one of the world's leading automobile manufacturers and the largest carmaker in Europe. The Group increased the number of vehicles delivered to customers in 2005 to 5.243 million (2004: 5.079 million), corresponding to a 9.1 percent share of the world passenger car market. In Western Europe, (the largest car market in the world) nearly every fifth new car (18.9 percent) comes from the Volkswagen Group.

Group sales rose in 2005 to 95.3 billion Euros (2004: 89.0 billion Euros). Profit after tax in the 2005 financial year amounted to 1.12 billion Euros (2004: 0697 billion Euros). The Group operates 44 production plants in eleven European countries and a further seven countries in the Americas, Asia and Africa. Around the world, nearly 345,000 employees produce over 21,500 vehicles or are involved in vehicle-related services on every working day. The Volkswagen Group sells its vehicles in more than 150 countries.

Poncin Yachts optimizes its manufacturing processes with Resin Injection Simulation software, PAM-RTM

Today, 95% of the leisure sailing market is made up of 30 to 48 foot long (9 to 15 meter) sail boats. However harsh the competition on this segment, Boat Industry System, subsidiary of Poncin Yachts Group, a French company based in Marans near La Rochelle, has chosen to launch on this market its range of general public sailing boats: Harmony boats.

Poncin Yachts saw the opportunity to infiltrate this segment with high quality at a competitive price through the use of Resin Transfer Molding (RTM) and Vacuum Assisted Resin Infusion (VARI) in "closed molds" simulated with ESI Group's innovative PAM-RTM software. This process combines the use of resin transfer molding and vacuum infusion, both pushing and pulling the resin within the mold over glass fiber networks. Often used in the aeronautics industry, this process was never used for leisure boats because of the technical difficulties due to its complexity and the size of the products. Poncin Yachts is the first group worldwide to achieve a deck and a hull of such dimensions.

"Since we did not have PAM-RTM, we subcontracted all simulation work to the 'Pôle de Plasturgie de l'Est cluster' (PPE), explained David Etien, Director in Poncin Yachts. "Starting from scratch, we have taken the option to work properly and to operate a technological transfer with the PPE".

"The preparation phase should not be underestimated", warns Jean-Pierre Cauchois, Technical Director of the PPE, which makes considerable use of resin injection simulation on fibrous reinforcements with PAM-RTM. "Indeed, the software is well designed and meets the market requirements.

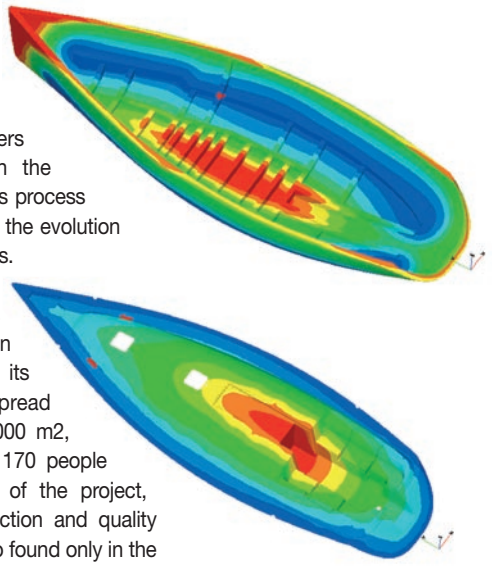
PAM-RTM software has made it possible to design and develop new tooling for composite materials production lines by using "closed mold" technology. This innovative technique enables parts of an enhanced quality and a very shiny final appearance to be obtained. The combined use of resin transfer molding and vacuum infusion guarantees an excellent degree of homogeneousness of the resin in all the compartments of the mold for greater rigidity and a constant weight. All the parameters are managed by automated controllers connected to sensors which provide continuous monitoring of temperatures, pressures, volumes, etc.

It took Poncin Yachts about three years to design its project and as much with its partners to carry out the study. The design of the machines and molds, as well as the study of resin flow and optimization of the glass fiber layout, have all been simulated with PAM-RTM. Indeed, when such a hull is produced for the first time there is no room for improvisation. Simulation optimizes parameters that directly impact the pressure distribution during the mold filling such as injection pressure, flow rate, molding temperature, closure forces, and the position of injection gates and vents. It also predicts the curing evolution inside the mold. Visualizing the flow front in the mold cavity helps prevent filling problems such as dry spots.

A welcome side effect in the use of "closed molds" is that it is particularly environment friendly: the resin is injected under vacuum, avoiding any spreading of harmful or noxious products. The emanations from harmful volatile organic compounds (VOCs) are contained and dealt with at a later time, thereby allowing a reduction in the emanation rate estimated between 5 and 10 PPM, which is less than half the requirement of the future European standard effective in 2007. This production tool is today considered to be the best available in Europe for its performance.

Patrick de Luca, Head of Composite Materials Solutions in ESI Group declared that "With PAM-RTM, Poncin Yachts is henceforth able to anticipate potential manufacturing problems which could not previously be simulated when voluminous parts were being designed."

Simulation, first used as validation tool has definitely become a tool for design. Today David Etien considers that the success in the implementation of this process will be a milestone in the evolution of leisure sail business.



Poncin Yachts has invested more than 17 million euros in its modern factory spread over an area of 10,000 m2, recruited more than 170 people since the beginning of the project, and set up a production and quality control model hitherto found only in the automobile and aeronautics industries. This model, the only one of its kind, makes it possible to reduce costs and development lead times as well as optimize industrial capacities by operating around the clock.

Simulation showing the filling of a "Harmony" sailing boat hull by RTM process with PAM-RTM software

For more information on PAM-RTM:
www.esi-group.com/SimulationSoftware/Resin_transfer_molding/

About Poncin Yachts

Poncin Yachts specializes in the design, building and marketing of yachts and pleasure boats. The group also operates a port concession in the Var department of France (Port Pin Rolland). The annual sales turnover per business activity can be broken down as follows:

- *new boat sales (46.6%): general public sailing boats (Harmony range), luxury catamarans (Catana), single-hulled sailing boats (Diva);*
- *second-hand boat sales (29.1%): mainly Catana and Harmony boats.*

More information: www.poncinyachts.com

About Pôle de Plasturgie de l'Est cluster (PPE)

PPE
PÔLE DE PLASTURGIE DE L'EST

The PPE is an international technology transfer center specialised in composite materials, long fibers reinforced with thermoset and thermoplastic matrix. It provides solutions to companies from training to technology transfer.

The PPE thanks to his professional team is able to provide help on material choice, technology choice, mold design, simulation, lab characterization, permeability measurements, prototype manufacturing and production launch.

More information: www.ppe.asso.fr

Boeing adopts ESI Group's AutoSEA2 Shock Analysis to secure operations on the International Space Station (ISS)

The International Space Station (ISS) is the largest and most complex international scientific project in history. Led by the United States, the ISS draws upon the scientific and technological resources of 16 nations: Canada, Japan, Russia, 11 nations of the European Space Agency and Brazil.

The ISS has a mass of about 1,040,000 pounds, measures 356 feet across and 290 feet long, with almost an acre of solar panels to provide electrical power to six state-of-the-art laboratories.

The solar panels of the ISS are connected to a Sequential Shunt Unit (SSU). The function of the SSU is to eliminate the excess current from the solar array. Indeed, just enough current must be provided downstream to meet the power load demand for the laboratories and to recharge the batteries.

NASA has requested Boeing to perform assembly and operational assessments for the ISS. Some of the station assembly operations require either direct astronaut participation in Extra Vehicular Activity (EVA) or robotic assistance with the Space Station Robotic Manipulator System (SSRMS) to move components from a Space Shuttle to their final locations on the ISS structure. Activities during which parts are in movement in the vicinity of the SSU must be considered potential threats to this vulnerable but critical component. As such, Boeing has had to evaluate the capacity of the SSU to withstand a wide spectrum of mechanical shocks and subsequent vibrations.

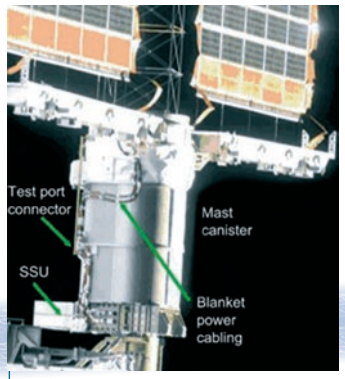
The shock frequencies of interest ranged from low frequencies where Finite Element Analysis (FEA) methods were appropriate, to high frequencies where Statistical Energy Analysis (SEA) methods were needed. NASA and Boeing proposed a dual analysis approach using both FEA and SEA methods to span the frequency range for the SSU.

The analysis tool of choice for this task was the AutoSEA2 Shock Module, an analysis module that is contained in ESI Group's AutoSEA2 software. The SSU model (Figure 1) was taken from the FEA model (Figure 2). Potential robotic and astronaut impact loads were applied to determine maximum SSU shock response.

Technically, the AutoSEA2 Shock module is not a SEA method. It uses the method of virtual mode synthesis. The AutoSEA2 model only provides a transfer function to which an equivalent dynamic system is matched. Once a set of virtual modes is available, a transient, time domain solution can be obtained for the system to recover both subsystem response time histories as well as Shock Response Spectra.

The vibration test levels initially used to qualify the SSU were then compared to the AutoSEA2 predicted shock response. The comparison ascertained that the vibration levels used for the initial qualification were greater than the predicted SSRMS or EVA shock vibrations. NASA was thus able to conclude that the SSU would not be affected by accidental impacts during robotic or human activities.

ESI Group's AutoSEA2 Shock Module results provided NASA the confidence that assembly operations would endanger neither the station nor the astronauts.



Sequential Shunt Unit (SSU) mounted on the beta gimbal platform

Courtesy of Boeing

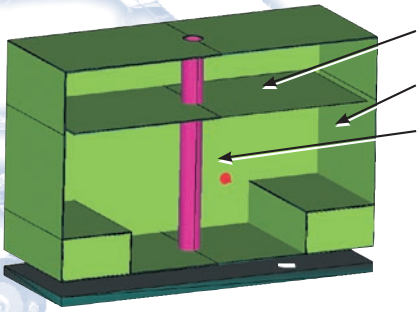


Figure 1
AutoSEA2 model of the SSU electronics box for the shock analysis

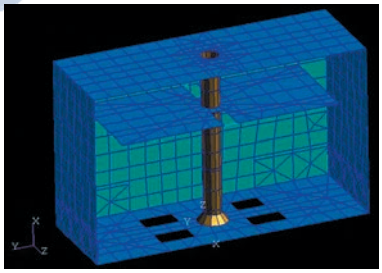


Figure 2
FEA model of SSU electronic box

"The AutoSEA2 Shock Analysis tool enabled Boeing and NASA to assess potential damage to Space Station electronic boxes that might occur from inadvertent impacts during on-orbit assembly. The AutoSEA2 Shock Module ensured that the current assembly operations would not affect critical Space Station hardware, and eliminated the need to implement expensive operational and hardware changes."

Ed O'Keefe, Associate Technical Fellow in Noise and Vibration – Boeing

About Boeing Integrated Defense Systems

Boeing Integrated Defense Systems, a unit of the The Boeing Company, is one of the world's largest space and defense businesses. Headquartered in St. Louis, Boeing Integrated Defense Systems is a $30.8 billion business. It provides network-centric system solutions to its global military, government, and commercial customers. It is a leading provider of intelligence, surveillance and reconnaissance systems; the world's largest military aircraft manufacturer; the world's largest satellite manufacturer and a leading provider of space-based communications; the primary systems integrator for U.S. missile defense; NASA's largest contractor; and a global leader in sustainment solutions and launch services.

EASi-Process: a high performance CAE application automating processes for better productivity and return on investment

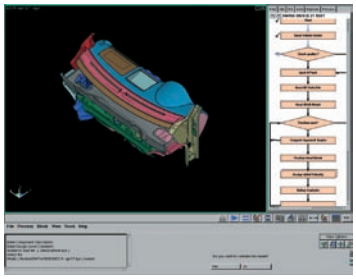
ESI Group's EASi-Process tool is an advanced Computer Aided Engineering (CAE) pre-post environment which captures the best practice in order to automate for productivity, streamlined modeling and simulation processes. EASi-Process, with its intuitive 'process guidance' approach, brings the end user to understand the CAE modeling and simulation process itself. It guides the user step by step from Finite Element (FE) model building to Automatic Report Generation (ARG). ESI Group has been successfully delivering process automation as an individual CAE process. Regulatory test procedure driven 'process templates' have successfully been distributed as add-ons within EASi-CRASH MAD, EASi-CRASH DYNA, EASi-CRASH RAD to automotive OEMs and their suppliers.

Velayudham Ganesan,
Business Development Manager,
ESI Group North-America

"ESI Group's Open VTOS solution encompasses this process automation technology as Visual-Process in the new Visual-Environment seamlessly integrated with pre-post processors. The engineers will have more advantages by detailing and building the CAE models and simulation post processing within this single environment for CRASH, SAFETY, NVH, CFD, MANUFACTURING etc. Visual-Process, not only allows the user to build the process template by capturing the session but also will apply as a Time Saver for high productivity throughout the environment due to its seamless nature" explained Velayudham Ganesan, Business Development Manager, ESI Group North-America.

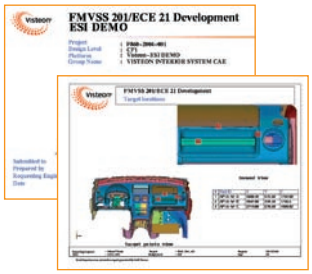
One of the major automotive suppliers, Visteon Corporation in Detroit, USA, has successfully implemented EASi-Process for FMVSS201 process to automatically create multiple FE models for any set of head impact target points on Instrument Panel (IP). The tool automatically positioned the head impact points on the IP according to regulation procedure and created the data to feed in the solver, including ARG.

"Automating Instrument Panel head impact simulation using EASi-Process has helped us ensure process standardization while reducing analyst-induced errors, and increased productivity: 5 min. vs 1 hr…", says **Mr. Srikanth Krishnaraj of Visteon Corporation** (for additional information, please refer to SAE2005 article #2005-01-1221, "Automating Instrument Panel Head Impact Simulation", Mike Keranen, Srikanth Krishnaraj, Kumar Kulkarni, LiLu, Ravi Thyagarajan and Velayudham Ganesan)



Visteon's FMVSS201-IP Head Impact Process

Automatic Report generated by EASi-Process



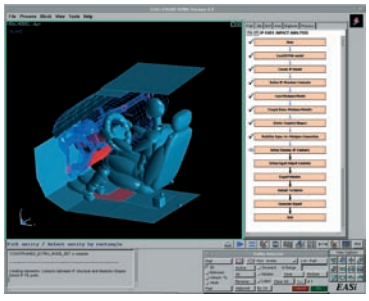
Courtesy of Visteon Corporation

About Visteon Corporation

Visteon Corporation is a leading global automotive supplier that designs, engineers and manufactures innovative climate, interior, electronic and lighting products for vehicle manufacturers, and also provides a range of products and services to aftermarket customers. With corporate offices in Van Buren Township, Mich. (U.S.); Shanghai, China; and Kerpen, Germany; the company has more than 170 facilities in 24 countries and employs approximately 50,000 people. Please find further information at www.visteon.com

A knee bolster CAE simulation template was developed into EASi-Process template through a pilot project with Ford Motor Company, North America Safety Group. This process guides the user to feed both the FE model of the IP from LS-DYNA, and multi-body knee impact model from MADYMO. It then performs the coupling analysis leading to more accurate results. The coupled models (LS-DYNA and MADYMO) are created in less than 5 minutes as apposed to the conventional approach. The process tool can also be integrated in Ford's post-processing tool.

"The use of process automation tool allows repeatable process in generating the coupled decks (LS-Dyna3D & Madymo3D) and is a time saver. It has been exhibited that with the use of an automation tool like EASi-Process, users can maintain their quick running multi-body Madymo3D models. At the same time, multi-body model component part(s) could be replaced with finite element model with speed and consistency." mentions **Dr. James Cheng, NAE Safety Manager, Ford Motor Company**.



Ford's IP-Knee Impact Process

Courtesy of Ford Motor Company, North America Safety Group.

About Ford Motor Company

Ford Motor Company, a global automotive industry leader based in Dearborn, Mich., manufactures and distributes automobiles in 200 markets across six continents. With about 300,000 employees and 108 plants worldwide, the company's core and affiliated automotive brands include Aston Martin, Ford, Jaguar, Land Rover, Lincoln, Mazda, Mercury and Volvo. Its automotive-related services include Ford Motor Credit Company. For more information regarding Ford's products, please visit www.ford.com.

Microsoft® Windows® Server System

Microsoft® Windows® Compute Cluster Server 2003

For customers solving complex computational problems, Windows® Compute Cluster Server 2003 (CCS) will accelerate time-to-insight by providing a High-Performance Computing (HPC) platform that is simple to deploy, operate, and integrate with existing infrastructure and tools.

In 1991, a 10-Gflops supercomputer was a Cray computer that cost approximately $40,000,000. Today, that same computing power can be achieved by combining four x64 computers for a cost of roughly $4,000, bringing the hardware acquisition cost of supercomputing down to the personal desktop level.

Windows Compute Cluster Server 2003 will include prescriptive setup procedures, a complete suite of management tools, and an integrated Job Scheduler. CCS is integrated with Active Directory® and uses Microsoft® Management Console (MMC) and Microsoft Operations Manager® (MOM) along with tools like Visual Studio® 2005 which supports parallel job development and debugging.

For more information about Windows Compute Cluster Server 2003 and High-Performance Computing see the Windows High-Performance Computing Web site at http://www.microsoft.com/hpc.

Benefits of Windows Compute Cluster Server 2003

Windows Compute Cluster Server 2003 will provide a cost-effective and powerful High-Performance Computing solution that runs on commodity x64-based computers. It can be easily and quickly expanded and deployed by using familiar tools and technologies.

Faster time-to-insight

Wizards simplify and speed the initial installation of the head node. And the use of Remote Installation Services (RIS) makes adding a compute node as simple as plugging it into the network and turning it on.

Better integration with IT infrastructure

Windows Compute Cluster Server 2003 uses Active Directory and MMC 3.0 to provide a simple and familiar interface for managing and administering the cluster. Integrating with Active Directory enables easy, role-based cluster management with Cluster Admin and Cluster User roles.

Familiar development environment

Developing applications for Windows Compute Cluster Server 2003 allows developers to use existing Windows-based skills and experience. Visual Studio is the most widely used integrated development platform (IDE) in the industry, and Visual Studio 2005 includes support for developing HPC applications including parallel compiling and debugging. Windows Compute Cluster Server 2003 supports the industry-leading MPI2 standard.

MPI

The Microsoft Message Passing Interface (MS MPI) in Windows Compute Cluster Server 2003 is derived from the Argonne National Labs implementation (MPICH2) of the MPI2 standard. MS MPI uses the WinSock Direct protocol for best performance and CPU efficiency. MS MPI can utilize any Ethernet interconnect that is supported on Windows Server™ 2003. Support for low-latency, high-bandwidth interconnects, such as InfiniBand or Myrinet is enabled through Winsock Direct drivers provided by the hardware manufacturers.

Scheduler

Windows Compute Cluster Server 2003 includes both a command-line job scheduler and the Compute Cluster Manager. The Command-Line Interface (CLI) supports Perl, FORTRAN, C/C++, C#, and Java. Key scheduler features include error recovery, automated clean-up, and security.

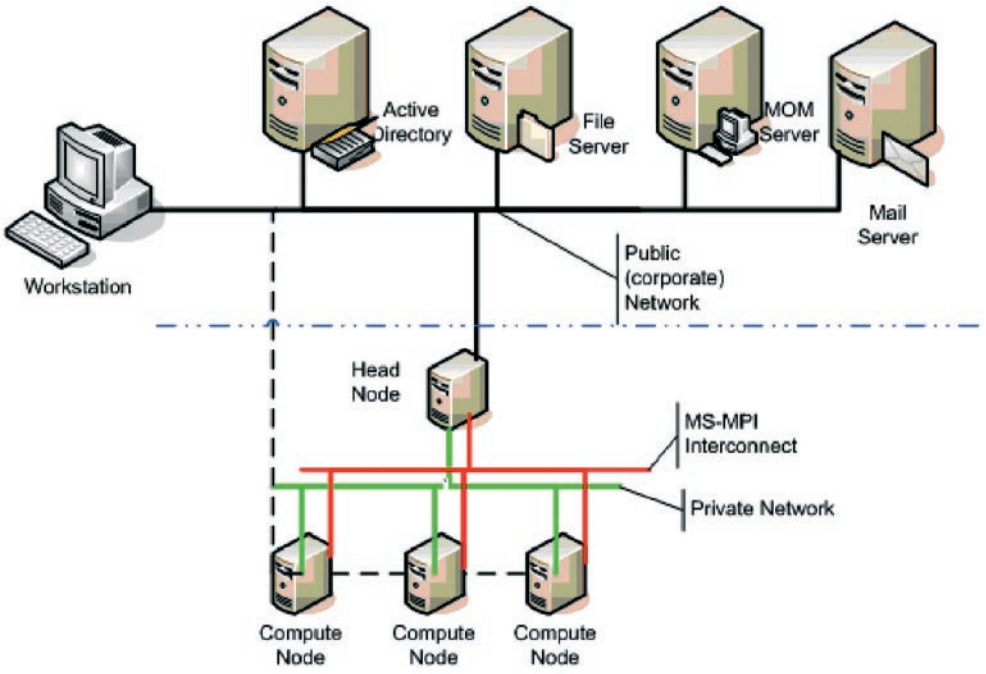
Security

Windows Compute Cluster Server 2003 uses Active Directory to enable role-based security for all cluster jobs and administration. All jobs run under the context and credentials of the submitting user and all credentials are stored with the job and deleted at the completion of the job.

Architecture

The Windows Compute Cluster Server 2003 head node:

- Controls and mediates all access to the cluster resources
- Is the single point of management, deployment, and job scheduling for the compute cluster. Windows Compute Cluster Server 2003 uses the existing corporate infrastructure and Active Directory for:
  - Security
  - Account management
  - Operations management using tools such as MOM 2005 and System Management Server (SMS) 2003.



ESI Group's PAM-CRASH simulation is ported to Windows Compute Cluster Server 2003 x 64 edition and integrates with Microsoft MPI in Microsoft Windows Compute Cluster.

"The release of the **PAM-CRASH solver on Windows Compute Cluster Server 2003** enables our customers to benefit from the increased headroom provided by Microsoft Windows Compute Cluster Server 2003," says Raymond Ni, Solver CSM Development Manager ESI Group.

"This version allows our customers to benefit from **the performance of the DMP (Distributed Memory Processing) version of PAM-CRASH on clusters of industry standard 64-bit hardware**," adds Vincent Chaillou, President and Chief Operating Officer, Product Operations ESI Group.

Requirements

The minimum system hardware requirements are similar to the hardware requirements for Windows Server 2003, Standard x64 Edition. Windows Compute Cluster Server 2003 supports up to 32 gigabytes (GB) of RAM. Supported processors include AMD Opteron, AMD Athlon 64, Intel Xeon with Intel EM64T, and Intel Pentium with Intel EM64T.

Windows Compute Cluster Server 2003 Requirements[1]	
Requirement	Windows Server 2003, Compute Cluster Edition
CPU Requirement	64-bit architecture computer Intel Pentium, or Xeon family with Intel Extended Memory 64 Technology (EM64T) processor architecture, or AMD Opteron family, AMD Athlon family, or compatible processor(s).
Minimum RAM	512 MB
Maximum RAM	32 GB
Multiprocessor Support	Up to 4 processors
Disk Space for Setup	4 GB
Disk Volumes	Head node requires a minimum of two volumes (C:\ and D:\). For additional roles, additional partitions are recommended. Compute node requires a single volume. RAID 0/1/5 may be used, but is not required.
Network Interface Cards	All nodes require at least one network interface card. Each node may require additional network interface cards as appropriate depending upon network topology or for public network access or in support of an MPI network.

[1]Requirements shown are for prerelease code. Final requirements are subject to change.

Microsoft

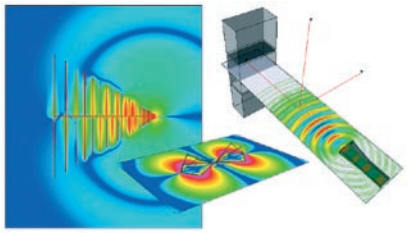
PAM-CEM Solutions 2006

Originally developed with the aim of addressing fully equipped automotive models in their early design stage, PAM-CEM Solutions are also focusing on Electro Magnetic Compatibility (EMC) simulations for Defense and Aeronautics, Telecommunications and Electronics. When designing PAM-CEM Solutions 2006, special attention was paid to enhance the efficiency of the new version, whatever the objective being targeted, i.e. realistic large scale models, exciting and/or radiating antennas, on-board wiring or integrated electronic components.

■ In close partnership with major Automotive makers, electromagnetic modeling of vehicles was improved through dedicated new features allowing to account for always more realistic virtual testing conditions: earth or metallic floors as managed in semi-anechoic chambers, radiating test antennas, coaxial or shielded cables.

■ When managing highly sophisticated models featuring thousands of cables, the CRIPTE coupling procedure offered by PAM-CEM Solutions was significantly improved through automatic connecting capabilities for all wires' terminals, thus avoiding long and tedious modeling work.

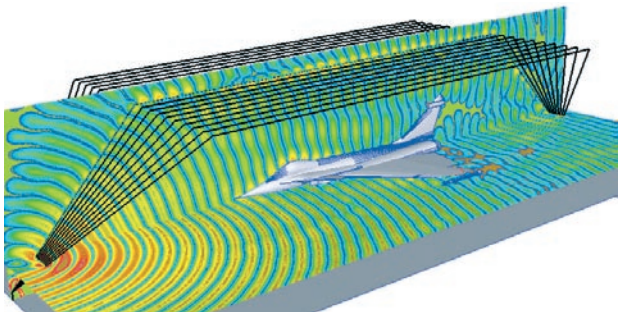
■ In addition to standard UNIX platforms (SGI, SUN, HP), PAM-CEM Solutions 2006 are also available in 32 and/or 64 bits versions for most common LINUX based systems dealing with either Itanium 2, AMD Opteron or Intel Xeon processors.



Within the AMELET project gathering major players such as RENAULT, PSA Peugeot Citroën or ALSTOM Transport, the demonstration has proven that PAM-CEM Solutions can address all relevant issues EMC experts have to face.

In these fields, computational methods and techniques were extensively investigated and the demand is now relying on large scale application cases. In other industrial sectors such as Aeronautics and Defense, similar trends for fully equipped and highly detailed models can be noticed.

As far as industrial deployment is targeted, the objective remains the management of always more realistic models to ensure the related predictivity. At the same time, one additional key feature remains the ease-of-use of the solution. Combining both advantages, PAM-CEM Solutions were integrated in the EMC dedicated modeling platform developed by THALES Group for the French Department of Defense.



Crash Simulation 25 And 20 Years Ago...

Over the past 25 years, ESI Group has contributed to crash simulation, which has become standard practice. To celebrate this fact, and in symmetry to the existing keyword 'Crash test', the keyword 'Crash simulation' is now added as an article (kicked off by the author in March 2006) in the internet encyclopedia for the general public "Wikipedia, the free encyclopedia that anyone can edit". Extracts are given below. The reader is invited to browse the full article and to contribute his or her modifications.

(http://en.wikipedia.org/wiki/Crash_simulation)

Crash simulation

A crash simulation is a virtual re-creation of a destructive crash test of a car using a computer simulation in order to examine the level of safety of the car and its occupants. Crash simulations are used by automakers during Computer-Aided Engineering (CAE) analysis for crashworthiness in the Computer-Aided Design (CAD) process of modeling new cars. During a crash simulation, the kinetic energy, energy of motion, that a vehicle has before the impact is transformed into deformation energy, mostly by plastic deformation (plasticity) of the car body material (Body in White), after the impact.

Data obtained from a crash simulation indicate the capability of the car body structure to protect the occupants (as well as pedestrians) against injury during a collision. Important results are the deformations (e.g., steering wheel intrusions) of the occupant space (driver, passengers) and the decelerations (e.g., head acceleration) felt by them, which must fall below threshold values fixed in legal car safety regulations. To model real crash tests, today's crash simulations include virtual models of crash test dummies and of passive safety devices (seat belts, airbags, shock absorbing dash boards, etc.).

Origins

In the 1970s attempts were made to simulate car crash events with non-linear spring-mass systems after calibration, which require as an input the results of physical destructive laboratory tests, needed to determine the mechanical crushing behavior of each spring component of the modeled system. «First principle» simulations like more elaborate finite element models, however, need only the definition of the structural geometry and the basic material properties (rheology of car body steel, glass, plastic parts, etc.) as an input to generate the numerical model.

The origins of industrial first principle computerized car crash simulation lie in military defense, outer space and civil nuclear power plant applications. In a meeting organized by the Verein Deutscher Ingenieure (VDI) in Stuttgart, on May 30th 1978, ESI Group presented a simulation of a military fighter plane crashing into a nuclear power plant. On this occasion, car makers became alerted to the possibility of using this technology for the simulation of destructive car crash tests (Haug 1981).

In the following years, German car makers produced more complex crash simulation studies, simulating the crash behavior of individual car body components, component assemblies, quarter and half car bodies in white (BIW). These experiments culminated in a joint project by the Forschungsgemeinschaft Automobil-Technik (FAT), a conglomeration of all seven German car makers (Audi, BMW, Ford, Mercedes-Benz, Opel, Porsche, and Volkswagen), which tested the applicability of two emerging commercial crash simulation codes. These simulation codes re-created a frontal impact of a full passenger car structure (Haug 1986) and they ran to completion on a computer overnight. Now that turn-around time between two consecutive job-submissions (computer runs) did not exceed one day, engineers were able to make efficient and progressive improvements to the crash behavior of the analyzed car body structure.

Application

Author's appeal: *Those of you who own generic crash simulation graphic and descriptive application output (car, dummies, passive safety systems, etc.) and who want to see it included here, are kindly requested to either directly edit the Wikipedia article (you can!), or to send me the material with the proper permissions for publication.*

Crash simulations are used to investigate the safety of the car occupants during impacts on the front end structure of the car in a "head-on collision" or "frontal impact", the lateral structure of the car in a "side collision" or "side impact", the rear end structure of a car in a "rear-end collision" or "rear impact", and the roof structure of the car when it overturns during a "rollover". Crash simulations can also be used to assess injury to pedestrians hit by a car.

Benefits

Crash simulation produces results without actual destructive testing of a new car model. This way, tests can be performed quickly and inexpensively in a computer, which permits optimization of the design before a real prototype of the car been manufactured. Using simulation, problems can be solved before spending time and money on an actual crash test. The great flexibility of printed output and graphical display enables designers to solve some problems that would have been nearly impossible without the help of a computer.

Analysis techniques

The analysis techniques used in crash simulation belong to the Finite Element Analysis techniques, which use the numerical techniques of the Finite Element Method (FEM). The dynamic explicit FEM time integration method sub-divides material-filled space into 1D, 2D and 3D polygons ("finite elements"), and solution time intervals into finite increments of time ("time steps"), each small enough to assure accurate tracking of all physical and material processes during the time duration of a crash simulation, including collision or contact events and material fracture and damage (damage tolerance).

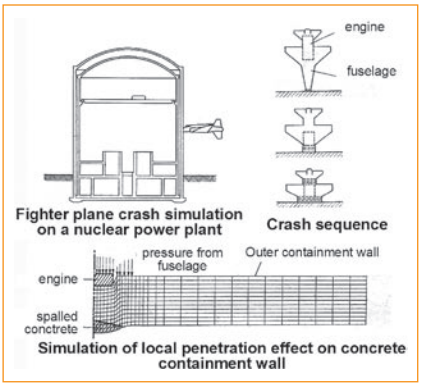


Figure 1: Simulation of an airplane impact on a nuclear power plant (program HEMP - ESI Group 1981)

References

Haug, E. (1981) "Engineering safety analysis via destructive numerical experiments", EUROMECH 121, Polish Academy of Sciences, Engineering Transactions 29(1), 39–49.

Haug, E., Scharnhorst, T., Du Bois, P. (1986) "FEM-Crash, Berechnung eines Fahrzeugfrontalaufpralls", VDI Berichte 613, 479–505.

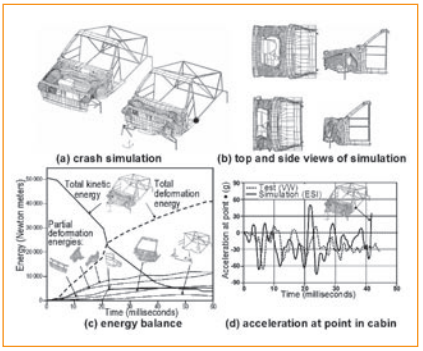


Figure 2: The first successful frontal full car crash simulation: a Volkswagen Polo collided with a rigid concrete barrier at 50 km/h (ESI Group 1986)

Courtesy of Volkswagen Group

Dipl.-Ing. Eberhard Haug Ph.D. (Berkeley)
Scientific Director (Retired)
Eberhard.Haug@esi-group.com

Multidisciplinary Process & Design Optimization with PAM-OPT

PAM-OPT is an advanced tool for design optimization, material fitting and robust design. Among its innovative numerical methods, PAM-OPT has a revolutionary algorithm that frees users from optimization convergence problems. Due to its robustness and its reduced CPU (Central Processing Unit) usage, the performance of this algorithm is yet unmatched on the market. These properties make the optimization process accessible to non-specialists.

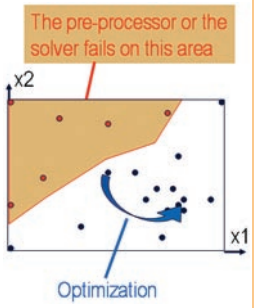
The optimization software automates the costly, time-consuming trial and error process for design and manufacturing optimization. Taking a conventional approach, engineers iteratively use simulation or analysis software to check design performance. Once this is completed, they proceed to analyze the results, make decisions, modify the model and must check the new design again until an optimal solution is reached. PAM-OPT automates this loop, handling the decision-making concerning design changes and the job submission process on a network of computers.

PAM-OPT uses a series of algorithms which handles the decision-making steps regarding design changes. It also manages compute models parameterization, and launches pre-processing, solver and post-processing software modules. By leveraging available computer and manpower resources, PAM-OPT helps manufacturers in the design of better products with a reduced time-to-market.

PAM-OPT has unique optimization properties (Fast and Robust)

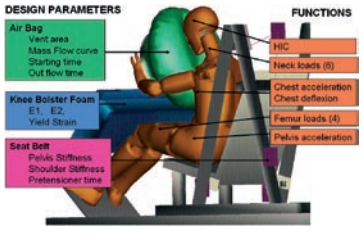
No user tuning:
- Robustness (cannot diverge)
- Accept inaccurate function values
- Handle design areas where solver calls fail

Small number of solver calls: (reduced CPU cost is needed)
- Similar to the gradient methods (better on non-linear problems)



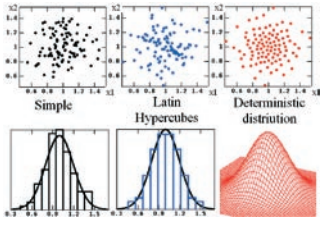
PAM-OPT helps identify values for the restraint system parameters that minimize a combination of injury functions

The Articulated Rigid Body dummy model is restrained by seatbelts, airbag and knee bolsters. Based on a PAM-SAFE model of a sled test, PAM-OPT minimizes 15 injury criteria.



PAM-OPT is an advanced stochastic analysis tool

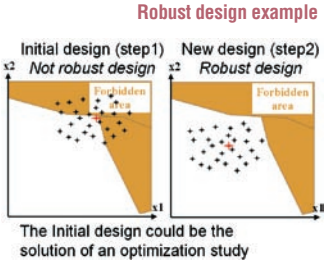
PAM-OPT is an advanced tool for stochastic analysis and robust design. Its deterministic distribution of points allows the use of a smaller number of points than when using classical random based distribution of points.



Robust design improvement

Using stochastic analysis results, PAM-OPT can improve a design in order to make its robust face to uncertainties.

Coupling between optimization algorithms and stochastic analysis results leads to a robust design.



Computer network resource management

Users need to maximize their available hardware resources in order to address critical simulation issues. Program chains can be launched simultaneously on several computers.

PAM-OPT manages computer networks in order to launch program chains on several computers simultaneously. Batch queuing systems and encrypted connections are also available. After the initial settings, transfers of small files are used only when necessary, in order to use remote platforms without suffering from network latency.

PAM-OPT has been linked to a wide range of solvers

- ESI Group products: PAM-CRASH, PAM-SAFE, PAM-SHOCK, PAM-MEDYSA, PAM-FLOW, PAM-STAMP, PAM-QUIKSTAMP, PAM-FORM, PAM-TUBE, PAM-QUIKCAST, ProCAST, SYSTUS, SYSPLY, SYSWELD
- Other products: ABAQUS, ANSYS, AutoForm, DYNA, FLUENT, MADYMO, MARC, NASTRAN.

Ongoing projects

PAM-OPT is involved in DESSOS European project (biomechanical field) and SYTEM@TIC French competitiveness cluster (multi-physic, multi-scale simulation fields).

These projects will use its push-button optimization possibilities to make industrial applications possible. PAM-OPT will be integrated as a hidden optimization tool.

Integration of PAM-OPT in ProCAST, PAM-QUIKCAST and PAM-STAMP 2G is currently on-going in order to optimize manufacturing processes. The optimization characteristics of no user tunings and reduced CPU cost contribute to make optimization simple and user friendly.

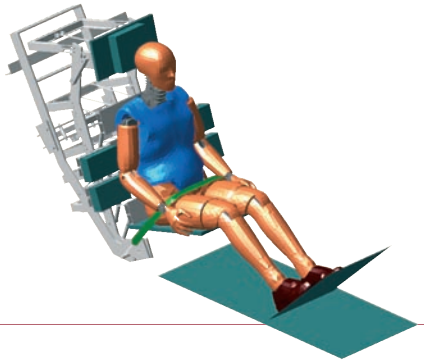
On the way to 3G PLM

PAM-OPT advanced features will allow the integration and optimization of second-generation (2G) solutions in all ESI Group products. That enable users to make the input without specific optimization knowledge and to steer the optimization process. Further, PAM-OPT multi-physic capabilities lead to global integrations within the third-generation (3G) Product Lifecycle Management (PLM) solutions.

PAM-OPT is available on UNIX and LINUX versions from Compaq, HP, IBM, SGI and Sun PC.

For more information, please go to:
www.esi-group.com/SimulationSoftware/Optimization/

Industry Validated Dummy Model Library

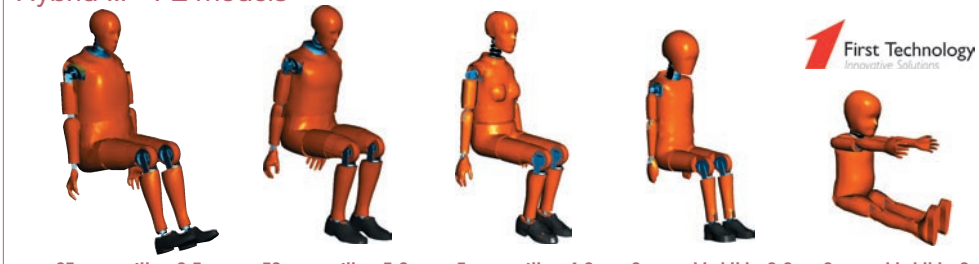


Virtual prototyping plays an increasingly important role in vehicle development processes. The elimination of physical prototyping phases calls for predictive models of a vehicle, its restraint systems, and its occupant surrogate, the crash test dummies.

ESI Group offers a library of dummy models that covers the current safety standards as well as the most important up to date research tools. These models are built by using state-of-the-art Finite Element or Multi-Body modeling techniques. They result from years of collaboration with the leading dummy manufacturer, FTSS, and user groups such as FAT in Germany that have ensured extensive experimental validation. The library keeps developing to include new dummies, improve correlation, or reflect hardware and software improvements.

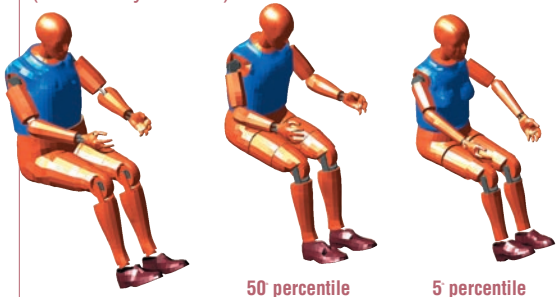
Frontal impact dummy models

Hybrid III - FE models



95th percentile v 2.5 | 50th percentile v 5.0 | 5th percentile v 4.2 | 6 year old child v 2.2 | 3 year old child v 3.4

Hybrid III - MBS models (multi-body models)

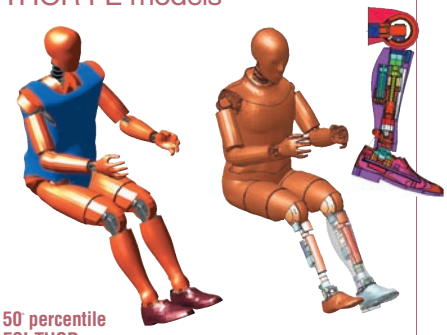


95th percentile v 3.0 (FE thorax and pelvis)

50th percentile v 3.2 (FE thorax and pelvis)

5th percentile v 1.0 (rigid body segments)

THOR FE models

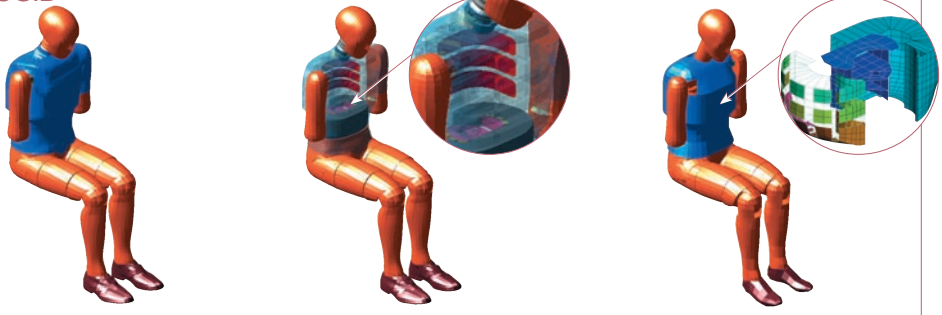


50th percentile ESI-THOR-Alpha v 1.0

FTSS H350-THOR-LX

Side Impact dummy models

EUROSID

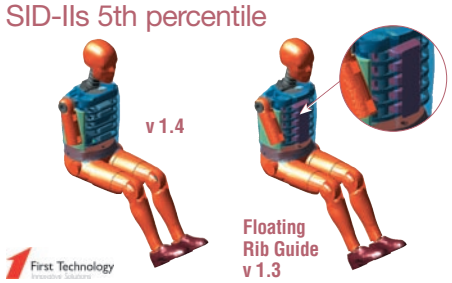


EUROSID 2 v 3.0 | EUROSID 2 RE v 2.0 | EUROSID 2 MBS v 2.0

US DOT SID

50th percentile US-SID v 3.0

SID-IIs 5th percentile



v 1.4

Floating Rib Guide v 1.3

WORLDSID

WorldSID Model 50th percentile v 1.0

Rear Impact

BioRID II

BioRID II Model 50th percentile v 1.0

More information on:
www.esi-group.com/SimulationSoftware/Occupant_Safety/features.html

About FTSS

First Technology Safety Systems (FTSS), a subsidiary of First Technology PLC, was founded in 1988 and is the world's largest developer and manufacturer of sophisticated crash test dummies and computer crash simulation models. First Technology (FT PLC) is an International Group quoted on the London Stock Exchange, specializing in the automotive industry with products in sensing, safety and comfort.

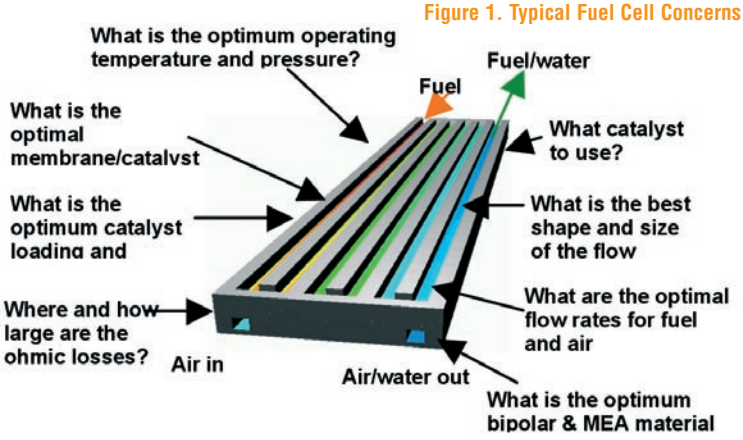
Information about First Technology is available at www.firsttech.co.uk.

Multi-Physics Modeling

ESI Group's Solution to Faster and Better Design of Fuel Cells

With gas prices skyrocketing and dependence on fossil fuels at an all time high, the need for alternative energy sources has never been greater. While many different alternative energy sources have appeared in the recent past, none has possessed the potential that fuel cells have in areas such as transportation, portable devices, stationery power generation and military applications. As fuel cells evolve and become more complex, new tools are needed to help engineers design, test, evaluate and deliver their products to the market in record time.

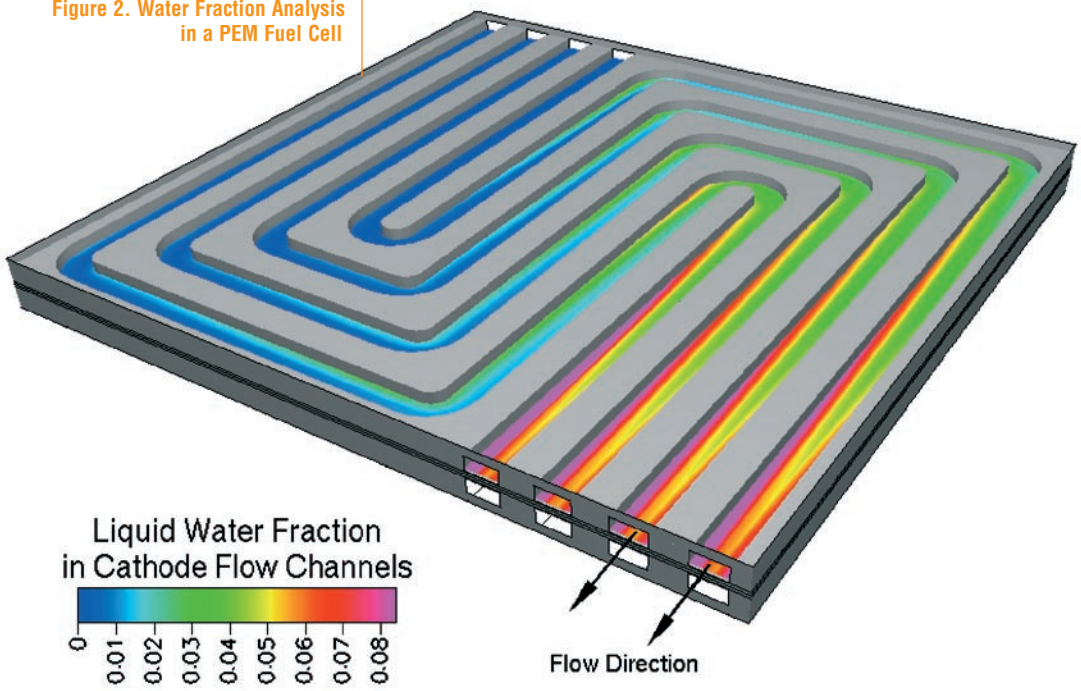
Figure 1. Typical Fuel Cell Concerns



Software products, such as ESI Group's CFD-ACE+, are attacking these issues by allowing engineers to perform advanced CFD simulation without the need for a physical prototype. Designers can use a native CAD model to examine critical fuel cell issues such as voltage and current characteristics, overpotential and mechanical loss, temperature distribution and thermal stress and many others.

As more and more companies turn to computer simulation, the cost and quality benefits are becoming too clear to ignore. This approach easily allows for multiple "what if' scenarios where several different iterations of a model can be simulated. This simply is not feasible for experimental study due to cost constraints and fabrication time. Computer simulation also provides the unique benefit of non-intrusive insight into the detailed phenomena of a fuel cell without the perturbation of physical probing. All of these advantages allow engineering teams to meet their 3 critical design goal: better products, shorter lead times, and lower costs.

Figure 2. Water Fraction Analysis in a PEM Fuel Cell



Multi-Physics Modeling of Fuel Cells

The physical phenomena of a fuel cell are complicated by the non-linear dynamic interactions among porous media fluid flow, heat transfer, species transfer, ionic and electronic conduction and electro-chemical reaction in the catalyst layer. ESI Group's software product CFD-ACE+ incorporates proper mathematical models for the relevant physics and numerically solves the coupled equation set using a finite-volume based methodology. Currently three

different types of fuel cells can be simulated using CFD-ACE+: Proton Exchange Membrane (PEMFC), Solid Oxide (SOFC), Direct Methanol (DMFC).

Proton Exchange Membrane Fuel Cell

One of the critical design issues surrounding PEMFCs is water management. Experimental studies have shown that high relative humidity causes significant liquid water formation and clogging, while low relative humidity makes the membrane non-conductive. By running a software simulation of the system, the engineer can vary the humidity in the model and view the results in the post processor. The post processor not only allows the user to view numerical data, but also provides clear visual feedback using color to distinguish between various data regions.

Solid Oxide Fuel Cell

Due to their unique makeup and operating conditions, SOFCs face completely different issues than those of PEMFCs. Thermal stress, temperature distribution and heat transfer become much more critical parameters for this type of cell. SOFCs operate at high temperatures and are composed of ceramic materials. As temperature and pressure rise, the chance of a structural failure increases. A structural analysis can be performed to determine the maximum stresses and whether those loads exceed the material properties. Additionally, a thermal simulation can be run in order to determine the performance and efficiency of the cell. Figure 3 shows a cross section of a planar SOFC.

By viewing the simulation results it is very easy to see that as the fuel and air are introduced into the system, the greatest reaction is occurring at only one corner of the cell. Digital models allow the engineer to easily make changes to the input locations, directions, and fuel quantities to produce a more efficient product.

Direct Methanol Fuel Cell

For DMFCs one aspect of particular interest is parasitic reactions and how they affect performance. When these reactions occur, they rob the system of valuable fuel and drastically reduce the overall power output. While parasitic reactions cannot be completely removed from the system it is important to understand this process in order to reduce the occurrences. If these reactions are not accounted for in the simulation the results will only show how the system reacts under ideal conditions and not in the real world. Figure 4 shows the simulation results for a particular DMFC.

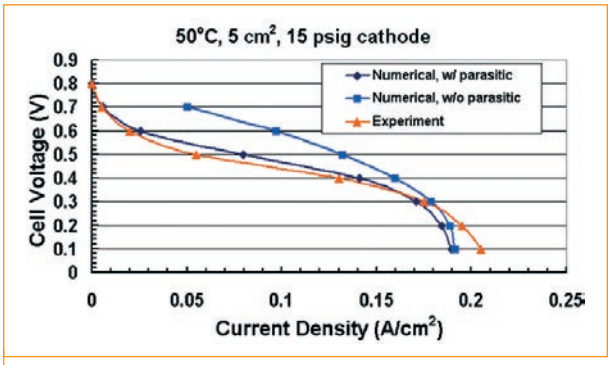


Figure 4. V-I Curve for DM Fuel Cell

The trend line created by numerical prediction without parasitic reactions shows a much more efficient system that produces greater power. When parasitic reactions are introduced into the numerical model the predicted results very closely reflect the data obtained through physical measurement. The engineer now has the tools to optimize his design under true working conditions.

With the current energy situation there is no doubt that fuel cells will be a key part of the future, alternative energy strategy. As the demand for power increases, so will the pressures to deliver quality products to the market on shortened time schedules. Needless to say the price points will have to be lower with each successive generation. In order to accomplish all of these tasks, engineers are going to have to improve their tools and CFD simulation software, such as ESI Group's CFD-ACE+ with built in fuel cell physics, makes too much sense to be ignored.

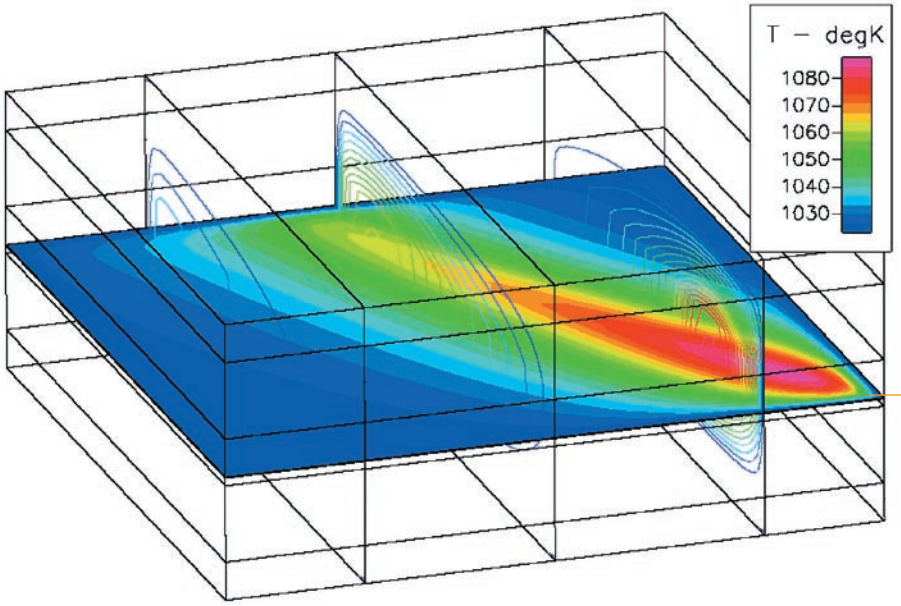


Figure 3. Thermal Analysis of SO Fuel Cell

Key Points for CFD Simulation

- Allows for iterative "What if scenarios"
- Reduces need for physical prototypes
- Shortens design cycles
- Produces better products
- Reduces cost

All images are ESI Group source

Vehicle Trim Modeling with RAYON-VTM

RAYON-VTM (Vehicle Trim Modeler), ESI Group's leading-edge technology allowing low frequency analysis of fully trimmed structures, represents one of the latest innovative solutions for vibro-acoustic simulation, analysis and design.

RAYON-VTM is a unique simulation software in the market that provides a full interior acoustic analysis.

Today, in order to reduce the number of physical prototypes necessary, companies use simulation based on Finite and Boundary Elements Methods (FEM, BEM) to predict the vibro-acoustic (VA) performance of vehicles at an early stage of the design cycle.

This software is the result of a close collaboration between Renault, a leading car manufacturer, Trèves, a trim manufacturer and ESI Group. This teamwork has led to an efficient tool that offers not only engineering but also cost savings and time-reduction benefits.

In the vehicle industry, refinement and sub-assembly trim models are required early in the design cycle to meet competitive engineering time constraints.

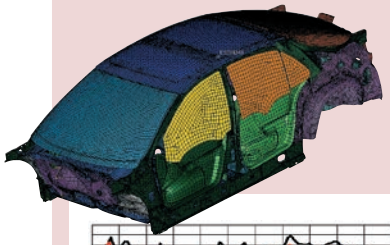
The flexibility and speed of the software allow several simultaneous analyses without repetition of the entire process. The user now has the possibility to modify the interior elements of the vehicle as necessary, and then to analyze the consequences of the modifications. Thus, low frequency trim analysis and NCT (weight, cost and effectiveness) optimization can now be part of the VA refinement process thanks to RAYON-VTM.

This exclusive product, already used by some of the largest companies worldwide, is valuable to improve the comfort and safety of the acoustic environment in an enclosed space as in cars, industrial cabins, tractors, and so on.

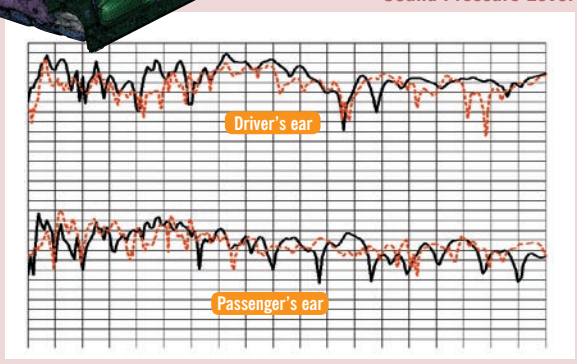
As the only company that can offer a complete range of simulation software in vibro-acoustic from low to high frequency range, **ESI Group proudly added in March 2006 RAYON-VTM to its product portfolio.**

Benefits of RAYON-VTM:

- *Full vehicle model of trimmed structure.*
- *Automatic harmonization of structural, fluid and trim meshes.*
- *Overnight computation to facilitate model refinement.*
- *Accurate interpretation of the influence of poro-elastic components on vibration and interior acoustics.*
- *Optimization of the design and positioning of trim inside a vehicle.*



Courtesy of Renault



Virtual prototyping solutions reduce reliance on costly and time-consuming physical testing, speed up the product development process, and optimize the use of noise and vibration control materials.

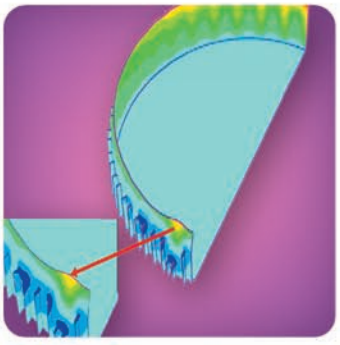
ESI Group's vibro-acoustic software portfolio now includes:

- **RAYON**, a low-frequency solution for characterization of complex noise sources and prediction of acoustic performance.
  Vehicle Trim Modeler - VTM: an automation module used for low frequency full vehicle sound package design.
- **AUTOSEA2**, the classic solution for high-frequency prediction of acoustic and vibration behavior of complex industrial systems.
- **FOAM X** identifies the acoustic properties of poro-elastic materials from impedance tube measurement.
- **NOVA** is an easy-to-use, flexible and powerful solution used to predict and optimize the acoustic absorption of acoustic materials and their integration into multi-layered structures.
- **VA One**: a newly integrated tool for the simulation and prediction of low, mid and high frequency vibro-acoustics response that combines statistical and deterministic simulation methodologies in a common environment. VA One integrates work developed under the Structure-Borne Noise Module Consortium, an unprecedented full spectrum analysis that rigorously combines Finite Element Analysis and Statistical Energy Analysis (SEA).

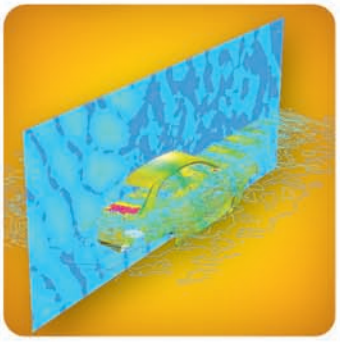
EuroPAM 2006

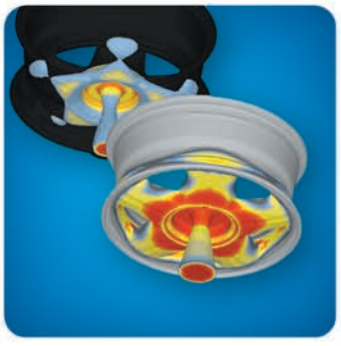
16th European Conference and Exhibition on Digital Simulation for Virtual Engineering

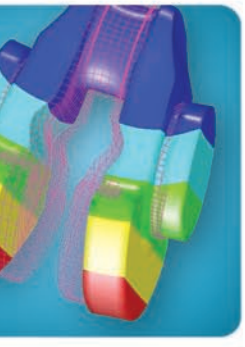
TOULOUSE

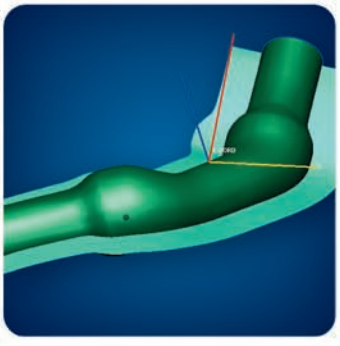


enterprise engineering simulation solutions



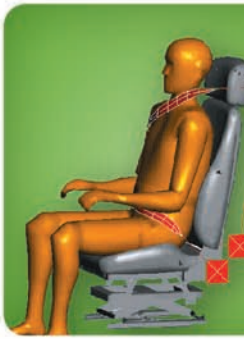






EuroPAM 2006 includes three conferences on:

- Oct 10 Users Meetings
- Oct 11 Industry Day
- Oct 12 Enterprise Engineering Simulation Solutions



www.esi-group.com/EuroPAM2006

europam2006@esi-group.com

ESI GROUP
THE VIRTUAL TRY-OUT SPACE® COMPANY

ProCAST 2006, the new version of the leading finite element solution for casting simulation

ProCAST 2006 version has undergone numerous changes. More robust, the new scalar and parallel version is now available on selected Unix platforms (HP, IBM, SGI, Sun), Linux and Windows. Three of the main improvements are described below.

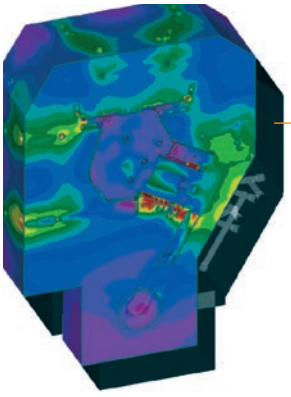
PARALLEL PROCESSING

Parallel processing of mold filling and solidification was already included in the previous ProCAST release. With this new 2006 version, the stress module is now fully parallelized, allowing the complete casting process to be simulated in hours.

Scalability performance reported below for a coupled thermo-mechanical calculation in high pressure die casting (elasto-plastic models used both in the part and in the mold, 330'000 nodes in total) is remarkable: speeds-up of 8 (for 8 processors!) and of 12 (for 16 processors) are obtained. In this specific case, the total simulation time can be reduced from 38.7 hours down to 3.2 hours on a 16 processors computer with a Gigabit Ethernet configuration.

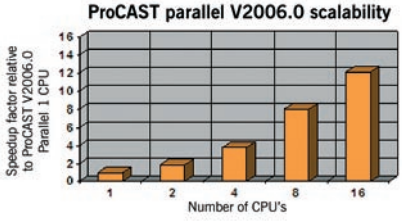
Plot of porosity and piping when considering graphite expansion (a) and not considering graphite expansion (b) for a nodular cast iron part.

ESI Group source

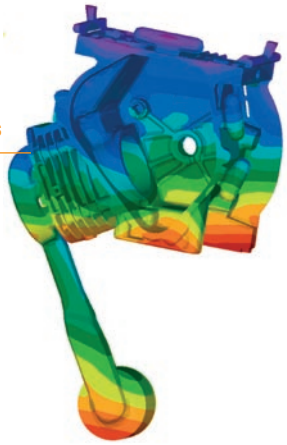


Mold – Von Mises stresses

Courtesy of NADCA



Speed-up factors for a thermo-mechanical simulation of a complex casting assembly modeled with 330'000 nodes



Part – X displacements

MICROSTRUCTURE – POROSITY MODELING IN NODULAR CAST IRON

Most metallic alloys have a liquid density which is lower than that of the solid phase. Accordingly, the metal contracts during solidification resulting generally in porosity formation.

The case of nodular cast iron is interesting because in this specific material, the formation of graphite nodules during solidification leads to a volume expansion. However, contrary to what is commonly thought, porosity can nevertheless formed because when the cast iron nodules form a coherent network, deformation and expansion of the solid are transmitted and can even break the sand mold (similarly to a sponge whose solid skeleton would expand in water).

All these phenomena have been taken into account in ProCAST 2006.0 and allow this new version to predict porosity with graphite expansion for nodular cast iron. This is a major achievement in porosity modeling.

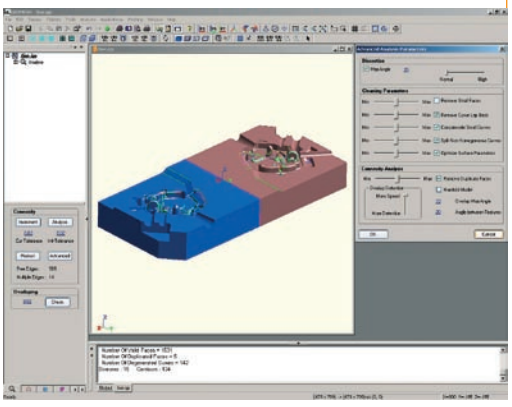
MESHING

Meshing is an integral part of the casting simulation process and the time it takes to create a mesh model was often a significant portion of the total time necessary to get results. With the delivery of ProCAST 2006 an important progress has been made: the surface meshing time for models that took days to mesh previously, takes only minutes with the new version. The two main reasons for this improvement are:

- GEOMESH[1] specific readers for most CAD file formats (IGES, STEP, VDA, Unisurf, Acis, CATIA, UG and Autocad) are now used to read the geometry.
- GEOMESH files are then exported by a single click to MeshCAST where added functionalities executed during the reading allow obtaining automatically suitable geometries for surface meshing.

(1) GEOMESH, the ESI tool for geometry analysis and repair is offered free of cost to all ProCAST users with a valid maintenance plan – not valid for the CAD translators.

GEOMESH interface allowing the use of major industrial CAD translators



ESI Group's casting solutions displayed at EUROGUSS 2006

EUROGUSS exhibition is the central forum for experts from the pressure die casting foundries and the associated industries. As leading international trade fair for pressure die casting, this highly specialized event offers the setting for the international exchange of knowledge, know-how and dedicated information.

ESI Group presented the complementary strengths and benefits of the ProCAST and PAM-QuikCAST solutions. In particular, the new version of ProCAST was demonstrated to a large audience of visitors.

The booth was attended by Sven Mauer, from ESI GmbH, Marco Gremaud, Ole Köser and Danièle Saugy from Calcom ESI. Over 6,400 international pressure die casting experts met 324 exhibitors at the sixth EUROGUSS 2006 event.

Casting Solutions Group Meeting on April 4-7, 2006 in Maryland, USA

ESI North America held the 2006 US Casting Solutions Group Meeting in Annapolis, Maryland on April 4-7, 2006. The first two days featured customer presentations, ESI Group presentations and round tables. The third day was devoted to a ProCAST update training class mainly devoted to the new capacities of ProCAST 2006.0.

The meeting was an excellent opportunity for the customers to share their needs with the product manager and to meet the development team members. The future directions of ProCAST and QuikCAST development were discussed and found very promising by the US installed customer base. A lot of interest was expressed in the new stress and microstructure modules of ProCAST.

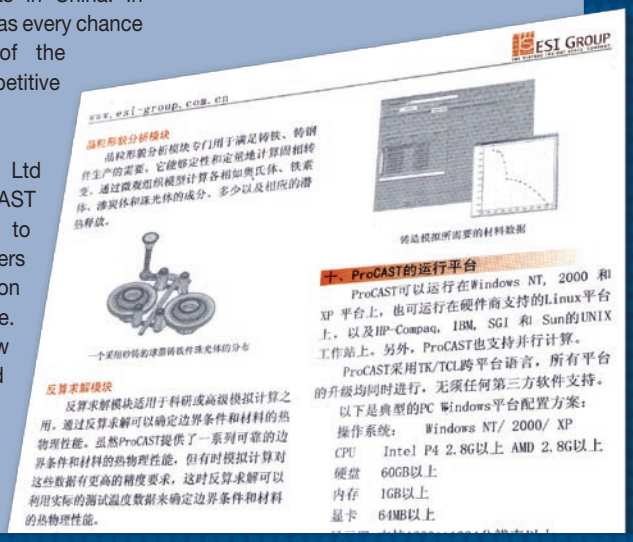
Casting Solutions Group Meeting in the USA (ESI Group)

ProCAST in China

The automotive industry is the largest market for ESI Group products in China. In the long term, China has every chance of becoming one of the most open and competitive markets in the world.

Zhong Guo ESI Co., Ltd has edited a ProCAST brochure in Chinese to provide local customers with updated information in their own language. In 2005, eleven new customers joined the well established Chinese ProCAST community.

A dedicated website is also available in Chinese: **www.esi-group.com.cn**


ESI GROUP

www.esi-group.com.cn

十、ProCAST的运行平台

ProCAST可以运行在Windows NT, 2000 和 XP 平台上，也可运行在硬件商支持的Linux平台上，以及HP-Compaq, IBM, SGI 和 Sun的UNIX工作站上。另外，ProCAST也支持并行计算。

ProCAST采用TK/TCL跨平台语言，所有平台的升级均同时进行，无须任何第三方软件支持。

以下是典型的PC Windows平台配置方案：

操作系统： Windows NT/ 2000/ XP
CPU Intel P4 2.8G以上 AMD 2.8G以上
硬盘 60GB以上
内存 1GB以上
显卡 64MB以上

ESI Group extends its production services offers in South Korea

From February 1st, 2006, ESI Group is pleased to announce the acquisition of a branch of activity from IPS International, a South Korean company. This acquisition concerns IPS International's digital simulation services for engineering applications (CAE), as well as intellectual property rights to their virtual human models "H-Models". Within the framework of the agreement, this activity will be integrated in the Group's Korean subsidiary, Hankook ESI.

Engineering Consulting Division Workshop (IPS International Co. Ltd., Winter of 2005)

IPS International, with its advanced CAE software and hardware helps industry leaders to shorten their development time while dramatically reducing costs.

"As a venture firm in the field of mechanical engineering consulting services, we have extensive experience in various "computer-aided" engineering solutions and unique expertise. Our knowledge includes full vehicle crashworthiness, occupant safety, process engineering, drop simulation of electronic and electric devices, etc, which requires highly nonlinear solutions." says Jin-Hee LEE, Ph.D./Representative Director of Hankook ESI, Engineering Consulting Division.

IPS International is presently focusing on the development of FIRST human-like FE dummies (H-ModelTM), which can be used commonly in automotive industries, medical science applications, and ergonomics.

IPS International was founded in 1997, as HANGIL Engineering, an engineering services company. The company completed about 300 projects with leading customers such as Hyundai, GM-Daewoo, Renault, Toyota and BMW.

This acquisition allows ESI Group to strengthen its presence in South Korea with 14 highly qualified engineers, including technical advisors with diverse engineering backgrounds from the automotive industry and universities.

ESI Group participates in the following events:

Date	Event		Place
June 4-6	9th LS-DYNA User's Conference	Conference on the latest LS-DYNA enhancements and future developments	Dearborn, MI, USA
June 4-9	Solidification Course 2006	The 15th course focusing on the application of solidification theories to industrial casting processes	Les Diablerets, Switzerland
June 5-8	36 AIAA Fluid Dynamics Conference and Exhibit	CFD Show	San Francisco, California, USA
June 5-8	MD&M East	Trade Show for Medical Device Design & Manufacturing	New York, NY, USA
June 5-8	ARC-CSI Crash Conference 2006	Conference on crash testing	Las Vegas, NV, USA
June 13-14	VA One Training Course	Training course on VA One theory and usage concepts	San Diego, CA, USA
June 20	Vibro-Acoustic Seminar	Free Vibro-Acoustic Seminar on new technologies and solutions for solving vibro-acoustic problems	Bad Soden, Germany
June 20-22	Spacecraft and Launch Vehicle Dynamic Environments Workshop	Workshop on the best approaches for designing, modeling, analyzing, and testing modern space systems for loads, acoustics, vibration, and shock	El Segundo, CA, USA
June 28-30	6th International CTI Forum on Automotive Seats	Forum on automotive seat designs and concepts	Nürnberg, Germany
July 4-6	2006 Digital Human Modeling for Design and Engineering Conference	International forum on digital human modeling developments and applications	Lyon, France
July 10-14	Semicon West	CFD Semiconductor Show	San Francisco, California, USA
July 16-22	7th World Congress on Computational Mechanics	Congress on Computational Mechanics	Los Angeles, CA, USA

Information and registration on www.esi-group.com

What's new at www.esi-group.com?

Hydroforming is an advanced forming technique that provides the possibility to form complex parts and improve surface quality. As the demand to form complex parts with small bend ratios is currently increasing, ESI Group has developed PAM-TUBE 2G: the new product of the stamping trade for bending and hydroforming processes. A new dedicated website gathers information on features and specifications, compelling benefits, system requirements and product brochure.

ESI Group's ProCAST 2005 software for foundry simulation was awarded by Frost & Sullivan's 2006 European Technology Leadership of the Year Award in digital simulation for prototyping and manufacturing processes. The detailed Press Release can be found in the What's new section. Also, come and browse our 2006 Training Catalogue in order to learn more about ESI Group's virtual manufacturing and prototyping solutions from our experts.

In the Projects section, you can read an article about ESI Group's participation in different innovative European Projects.

A series of press releases has been posted in the News & Events section. PAM-RTM, ESI Group's simulation software for resin injection and infusion on fibrous reinforcements enabled Poncin Yachts to optimize its manufacturing processes.

CFD-CADalyzer 2006, a coupled design and analysis tool, eliminates pitfalls associated with translation between different geometries. What's more, ESI Group has acquired IPS International in Korea, and ATE Technology International in China. The FY2005 final results have been published online.

ESI Group Conferences & Exhibitions section is updated with EuroPAM 2006, the 16th European Conference and Exhibition on Digital Simulation for Virtual Engineering which will be held on October 10-12, 2006 in Toulouse, France. EuroPAM 2006 features conferences on Crash, Safety & Impact, Stamping, Casting, Vibro-Acoustics and CFD. Make sure to book your hotel before September 5th! Other worldwide PAM events are coming up: HanPAM 2006 will be held on November 7, 2006 in Seoul, Korea. PUCA will take place in Tokyo, Japan on November 9-10, 2006. ChinaPAM 2006 will be held on November 13-14, 2006 in Wuhan, China. Visit the www.esi-group.com website regularly in order to get the latest information on these events.

The latest issues of PAM-TALK and ESI Group's electronic newsletter are available for download or online subscription on the homepage.

Come and visit www.esi-group.com often to get the latest news.

For more information, please write to info@esi-group.com

FY2005 Sales in line with market expectations +7% organic growth

ESI Group FY2005 sales totalled EUR 62.2 million, up +6.7% on the previous year (+6.3% at constant exchange rates). Q4 accounted for 40% of the Group's consolidated annual sales, again showing strong quarterly growth and intensification in the activity's seasonality. This significant increase in activity was achieved with constant perimeter.

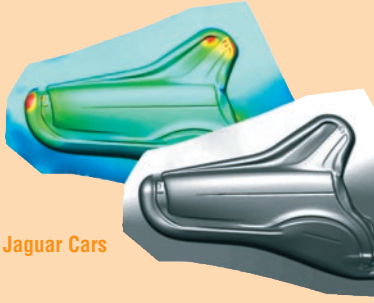
Sector diversification continued, to the benefit of the energy and aeronautical sectors. Geographically, the worldwide activity broke down as follows: America: 17%; Asia: 33%; Europe: 50% and maintained an 80% ratio of sales recorded outside France.

Licenses growth

License activity recorded a purely organic growth of +7.5% (+7.0% at constant exchange rates). In particular, growth of PAM license sales was +9.2% over the year. The significant growth of the recurrent installed base, up 12%, confirms its excellent consolidation, associated with the previous year's buoyant growth due to acquisitions (+26% of license sales growth between 2003 and 2004). Moreover, license activity recorded particularly strong growth in Europe, notably in France and in Germany, where the company achieved market share gains. The renewal rate of license sales, which is a major indicator of ESI Group's activity, was up a percentage point, to 88% from 87% in 2004.

Significant acceleration in the adoption of PAM-STAMP 2G

The adoption of PAM-STAMP 2G licenses accelerated substantially, illustrating the suitability of the second generation offer to the evolution of client expectations, whether it be in Asia, America or Europe.



Courtesy Jaguar Cars

Services

Service business confirmed in Q4 the turnaround trend noted the previous quarter, showing a growth of +4.3% over the year (+3.9% at constant exchange rates). France saw high growth (+23%) for this activity, in particular in the energy sector.

Outlook

Alain de ROUVRAY, ESI Group's Chairman and CEO, concludes: "Steady organic growth, highly-recurrent licensing sales, acceleration in the adoption of PAM-STAMP 2G, growth turnaround of services, are all significant factors that confirm the relevance of the Group's strategy and the credibility of our medium and long-term objectives. With 2005 essentially dedicated to finalizing the integration of our acquisitions to ensure the consolidation of the acquired installed base, 2006 should see further revenue growth and a reinforcement of our presence in high-potential areas. Announced in January, the development by acquisition of our high end services to support innovation and simulation adoption with South Korean clients is a positive illustration of this".

Confused by the dizzying choice of new computing solutions?

***Leave the blur behind**—partner with HP and AMD. Our knowledge, experience, and innovation will lead you to your ideal CAE computing solution.*

Innovation—HP develops integrated clustering solutions that deliver superior results. For example, HP-MPI transparently supports multiple interconnect technologies, automatically providing the highest level of application performance.

Choice—HP offers a broad range of computing choices, including operating environment (Linux™, Microsoft Windows CCS), cluster interconnect, and integration services—ensuring the optimal solution for your CAE applications.

Performance—The collaboration between HP and AMD produces highly scalable, distributed-memory clusters for exceptional CAE simulation results—on time and on budget.

AMD 64 Opteron

Information: www.hp.com/go/CAE
Contact HP: www.hp.com
Visit: www.hp.com/country/us/en/wwcontact

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