## success story
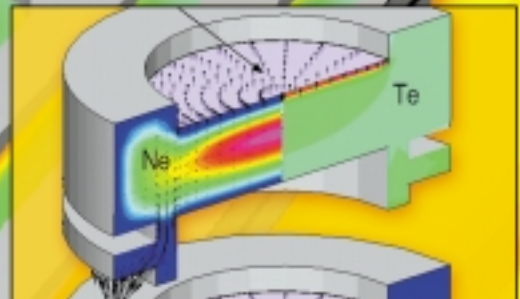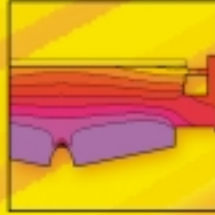BMW is experimenting the H-Model to optimize occupant protection in car crashes

## focus on
EASi-CRASH DYNA

↘ product news
# CFD-ACE+
covers a wide and expanding range of high-tech applications

EuroPAM 2004,
pioneering concepts in Virtual Engineering

**ESi GROUP**
THE VIRTUAL TRY-OUT SPACE® COMPANY

Precision Design
Precision Engineering
High Speed Performance

Generating Performance with POWER4+™ Technology

Empower simulation with powerful
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# contents

**PAM TALK**

ISSUE **25**

SPRING 2004

# editorial

## Experience and expertise

How can we qualify the difference between expertise and experience? Expertise is mostly a frozen experience, in other words, something that may quickly become obsolete. Expertise is a rear view mirror that allows us to see what is happening behind us, but not ahead of us in our rapidly changing world. Hence, there is a need to facilitate access to experience by documenting the best available practices, while leaving engineers free to forge their own new experiences by running multiple "what-if" test cases.

How can this be made possible? Definitely not with physical prototypes! Not only are they costly, but also time and energy consuming. Furthermore, they only allow you to understand a fraction of what you want to know. When a component is physically crashed, what do you learn about the safety coefficient, or where the rupture actually started? In the same way, when a blank sheet is physically stamped, what do you learn about the way the wrinkles started, the thinning process, or the spring-back? Very little! You just see the end results, but not the way these results were obtained.

Industry now needs to move away from the traditional trial-and-error methodology, which is supposed to place increased confidence in physical prototypes, and move towards a new paradigm, called *simulation-based design*, more favorable to innovation, more effective and less expensive. Simulation-based design means that many of the decisions affecting the final design configuration are taken as a result of computer simulations of the model's physical properties, leading to the replacement of physical prototypes. This is not only because a physical prototype cannot be used, but simply because, in some situations, it cannot exist! For example, in this edition of PAM-TALK, you will learn how BMW uses simulation-based design to get more insight into possible human injuries in car crashes, which perfectly illustrates a situation where a physical prototype would be impossible to create. You will also discover how Micronics has developed a "laboratory-on-a-card" using CFD-ACE+, the new advanced multiphysics software product acquired from CFDRC, and now part of ESI Group's product portfolio.

Simulation-based design is no longer a technology for early adopters. Simulation-based design brings the affordable and proven means to accelerate the introduction of innovative, high quality and more reliable products to the market today.

*Alain de Rouvray*
*Chairman and Chief Executive Officer, ESI Group*

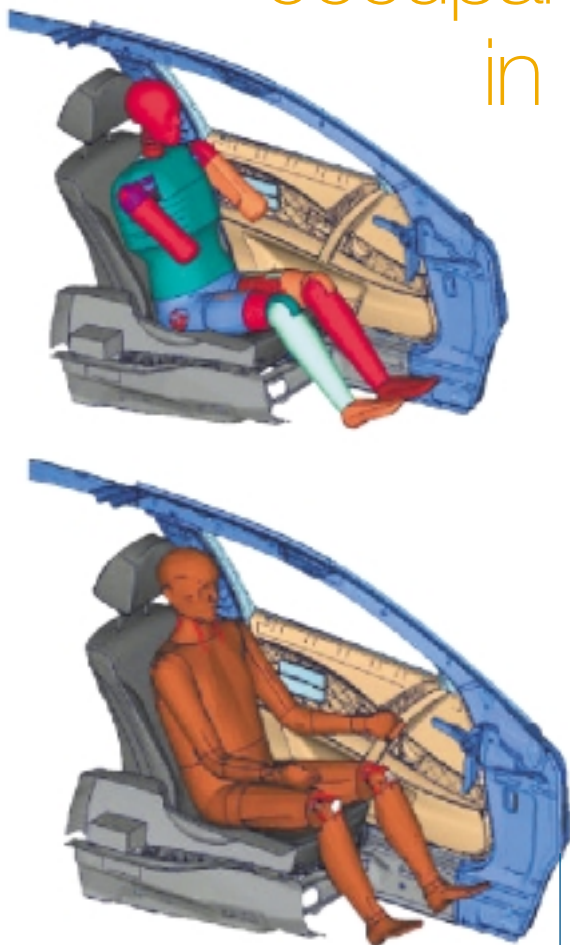# BMW is experimenting the H-Model to optimize occupant protection in car crashes

*BMW is carrying out scientific tests to study the response of both dummy and human models in side impact scenarios.*

*Current investigations should greatly enhance future safety design for improved human occupants' security.*



**Fig.1 : Simulation set-up with the EuroSID (high) and the H-Model (low)**

How to get more insight into possible human injuries in car crashes? How to reproduce the complex interaction of the human body with the vehicle to design safer restraint systems? All of these issues are at the heart of BMW Group's research for optimized protective equipment.

Full-scale crash tests use dummies to assess the likelihood of injury to a human occupant. Providing valuable insight into crash dynamics and occupant kinematics, digital simulation with dummy models is commonly used for safety features design. But as dummies have to fulfill the requirements of technical measuring devices, like durability and repeatability, they do not always adequately reproduce the complexity of the human body, and its interaction with the vehicle.

In a joint effort to improve the biofidelity of design tools, BMW and the Institute for Forensic Medicine in Munich are using PAM-SAFE and finite element models to investigate the differences between the physical dummy and the human body.

BMW first evaluated the response of a FAT EuroSID I v.3.1 dummy model and compared it to the the ESI Group H-Model 2003.1 for a complex impact configuration. The human model is developed by ESI Group and IPS-I. It contains a deformable skeleton with thoracic and abdominal organs, flesh, skin, muscles, and ligaments. Hard and soft tissues are modeled by various

types of finite elements and material properties to represent adequate mechanical behavior.

Then, the human model is used to compare the effect of the barrier geometry on rib cage and pelvis loading for a sled-test configuration.

## Lateral EuroNCAP Barrier Test

A validated PAM-CRASH finite element vehicle model of a BMW is used to simulate vehicle motion and intrusion in a standard side crash test scenario, with airbag, at 50 km/h (according to the EuroNCAP barrier testing protocol). In a first step, a simulation with the EuroSID dummy model is performed to evaluate loads, accelerations and injury values. In a second step, the dummy model is replaced by the H-Model, with the same output values as the instrumentation channels in the physical dummy (Fig.1). Rib deflections, shear force and acceleration of the twelfth thoracic (T12) vertebra, and the acceleration of the pelvis, are specifically analyzed.

The behavior of the dummy and of the H-Model are comparable and show a lot of similar responses, such as lower rib deflection, T12 and pelvis acceleration (Fig.2, a, b, c). Some other parameters are significantly lower with the H-Model, such as upper and middle rib deflection, and T12 shear force (Fig.2, d, e, f).

## Glossary

- **FAT:** Forschungsvereinigung Automobiltechnik
- **EuroSID:** European Side Impact Dummy (SID)
- **EuroNCAP:** European New Car Assessment Program
- **IPS-I:** Integrated Professional System International
- **NHTSA:** National Highway Traffic Safety Administration
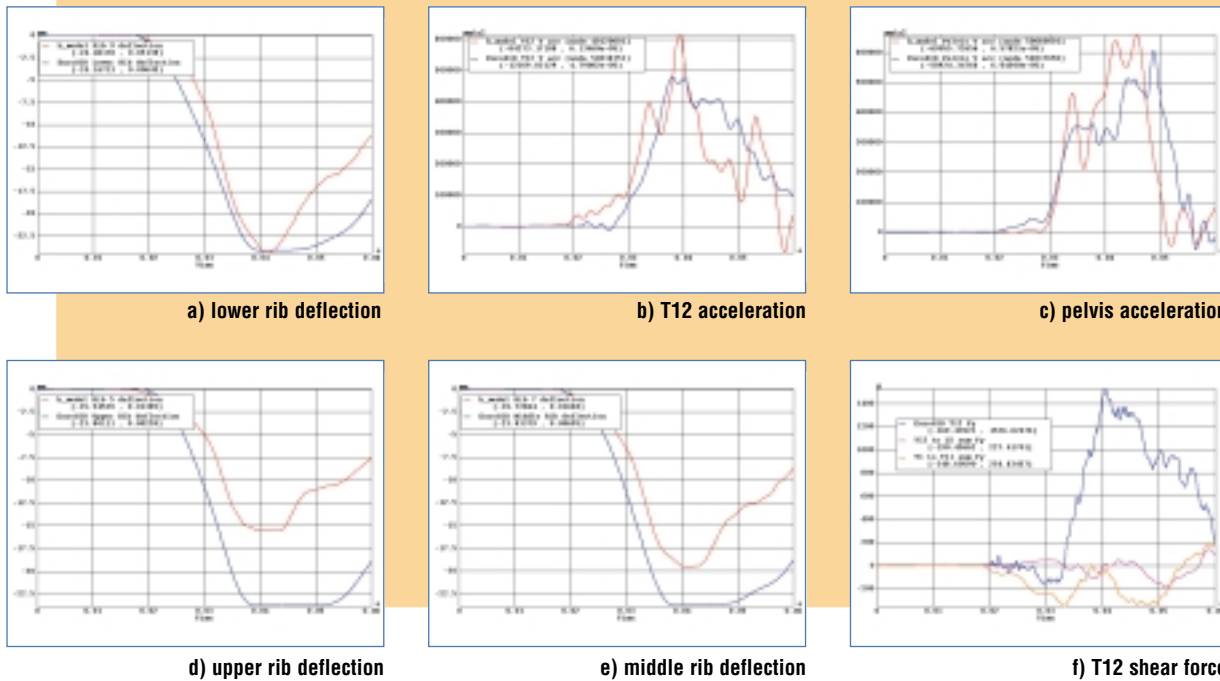
**Fig.2
Output signals
versus time:
red curve
H-Model,
blue curve
EuroSID Model**



a) lower rib deflection



b) T12 acceleration



c) pelvis acceleration



d) upper rib deflection



e) middle rib deflection



f) T12 shear force
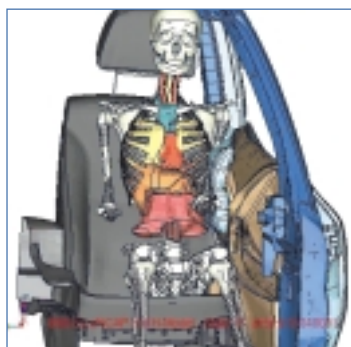


a) front view
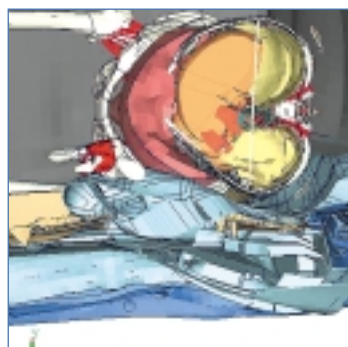


b) cut view

Fig.3 : Interaction between the airbag, the arm and the rib cage of the H-Model

" The behavior of the dummy and the H-Model are comparable and show a lot of similar responses, but the H-Model gives more information about the injury mechanisms and the complex interaction of the human with the vehicle. "

*BMW's head of occupant simulation in side crashes and roll over*

Upper and middle rib deflections in the H-Model may be influenced by the biofidelic arm position, more than in the EuroSID (Fig.3 a and b).

Another reason for differences may be the way rib deflections are measured, only in the lateral direction, whereas

the human thorax exhibits more complex deformations modes (Fig.4 a and b).

The higher T12 shear force in the dummy may be due to an artifact of the dummy design, in which a rigid thoracic spine is attached to a stiff

lumbar spine. In the H-Model, all vertebrae and in-between joints are modeled, leading to a more progressive curvature (Fig.5 a and b).

a) initial, undeformed state



b) after 37 ms
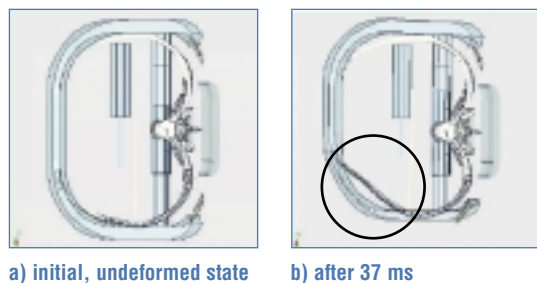
Fig.4 : Comparison of the middle rib deflection of the dummy with the complex 7th rib deformation of the H-Model



T12

Fig.5 :
Comparison of
dummy spine
(left) and human
spine (right)
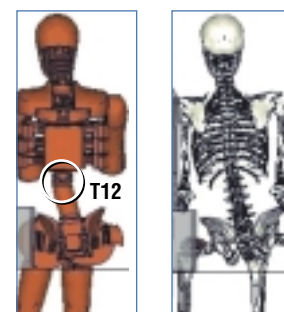
**Fig.6 : H-Model behavior without (left) and with (right) pelvis offset**

## Modified NHTSA lateral sled test

Sled-test simulations are performed with the H-Model according to a modified NHTSA procedure. The barrier has a mass of 1,000 kg and a velocity of 18 km/h. Two barrier shapes are investigated: one flat wall, and one wall with an offset of 70 mm in the pelvis area. The kinematics of the H-Models with and without pelvis offset are shown on Fig.6.

Comparison between the two shapes for all 12 ribs (Fig.7) shows that the pelvis offset improves the rib deflections and the viscous criterion withou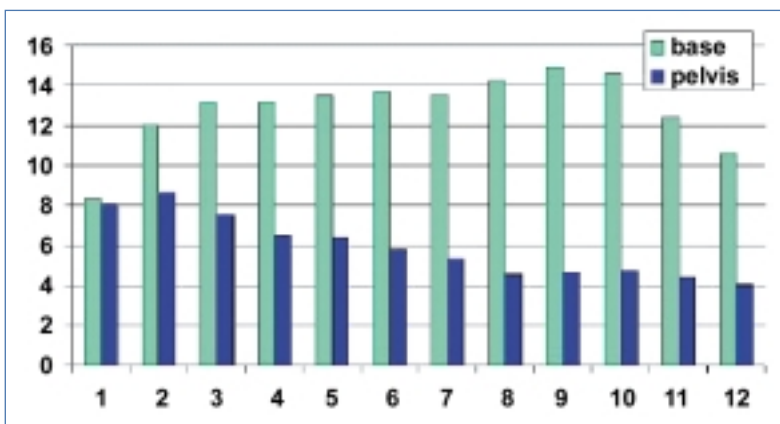t increasing the pelvis load. Lower rib deflection decreases by 62%; upper rib deflection, which is influenced by the contact of the shoulder with the upper wall, is unchanged; viscous criterion decreases by over 90%.

Initial simulations carried out with the H-Model in complex load cases, such as side crash tests, yield promising results. According to the head of occupant simulation in side crashes and roll over at BMW: "We get more understanding about the crash, the dummy and the human. The dummy is a reproducible measurement tool which cannot show any injury, whereas the H-Model allows valuable insight into possible injury mechanisms."



**Fig.7 : Rib deflection (in mm, for each rib) with (blue) and without (green) pelvis offset**

## Conclusion

Optimizing occupant protection in side impact scenarios requires valid information about occupant behavior. Resulting from long-term partnerships with research institutions, laboratories and industries, ESI Group's H-Model helps to provide realistic kinematics as well as access to injury mechanisms and classical injury criteria.

Considering the complexity of the human body, future BMW investigations will focus on the further validation of the H-Model, using injuries produced during well documented real-world accidents.

## About BMW Group

*The BMW Group is a leading high standard German car manufacturer, representing 1.7% of the worldwide automotive market, with more than 1.1 million vehicles sold. The BMW Group's market position relies on its business strengths which are high-performance, safety, innovation and precision. Its product line portfolio, falling into two main automotive sectors: cars and motorcycles, inspires seduction, sport, power and harmony. The BMW Group also owns the Mini and Rolls-Royce brands.*

# Extreme simulation power in a Unix workstation

*New PA-RISC HP workstation to enable running large tests in the minimal period of time, directly from engineers' desk*

**HP C8000 64-bit workstation brings 2-way and 4-way computing power to the desktop**

Flexibility and capacity to react quickly with many sequential runs are key factors in most of stamping, casting, or forming simulations. While large, shared SMP or cluster systems deliver the required computing power, engineers also need personal dedicated systems that can combine reliability, graphic capabilities and total availability.

Designed to address the most demanding technical workloads in automotive, aerospace and electronic design enterprises, with 4X processor and memory I/O bandwidth and 25% lower memory latency of previous generation PA-RISC workstations, the newly available HP C8000 brings leadership performance for traditional UNIX® applications. It supports the latest industry-leading AGP 8X graphics and can easily handle the complexities of large models, system assemblies, design analysis and simulations.

## Reduced computation times in real industrial test-case

As an example, a PAM-STAMP simulation of a car front fender is carried out to evaluate the performance improvement.

The fender model contains 50,800 elements and 27,858 simulation cycles.

Using the new platform helps reduce computation times nearly by a factor of 4, as detailed below:

- New HP C8000
  (2 PA8800 cpus / 2GB RAM):
  **510 seconds !**

- Previous HP J6750
  (2 PA8700 cpus / 2GB RAM):
  2,027 seconds.

This PA-RISC workstation thus delivers greater than clock rate performance scaling, industry-leading graphics performance and a large 16 GB memory footprint, all with renowned reliability and support from HP.

*Find more information at:
www.hp.com/workstations*

# ESI Group participates in the following events:

| Date | Event | | Place |
|------|-------|---|-------|
| June 7-12 | BIEMH 2004 | 23rd Spanish Machine Tool Biennial Exhibition | Bilbao (Spain) |
| June 12-15 | 108th Metalcasting Congress | Largest annual meeting of metal-casters in the USA | Rosement, Illinois (USA) |
| July 5-8 | ICSV11 | 11th International Congress on Sound and Vibration | St Petersburg (Russia) |
| July 12-14 | Noise-Con 2004 | 20th national conference held by The Institute of Noise Control Engineering of the USA (INCE/USA) | Baltimore, Maryland (USA) |
| August 22-28 | Inter-Noise 2004 | 33rd International Congress and Exposition on Noise Control Engineering | Prague (Czech Republic) |

*Information and registration on www.esi-group.com*

Temperature Profile for
Monopolar Asymmetric Configuration

# CFD-ACE+ covers a wide and expanding range of high-tech applications

*CFD-ACE+ is used throughout the public and private sectors to both model and optimize fluid flow, fluid structure interaction and chemical reactions in semiconductor, biotechnology and nanotechnology, as well as general mechanical designs*



**Performance simulation of a clot filter inserted into a blood vessel**

**Custom-developed lab-on-a-card solutions for pharmaceutical, biotech, diagnostic and reagent companies**



## Micronics Inc.

### Applied understanding of the sensitivity of parameters for product design optimization

CFD-ACE+ is a useful design tool in providing custom-developed laboratory-on-a-card ("lab card") products. Micronics, Inc. has been using CFD-ACE+ to better understand experimental data. According to Dr. Fred Battrell, Micronics' VP of Operations, "We find CFD-ACE+ especially useful as a predictive tool of laminar flow properties in the micro channels we devise on lab cards. This allows Micronics and its clients worldwide to save both time and prototype production costs."

Micronics' work is at the micro to picoliter level of volume control within its disposable lab cards that typically are the size of a credit card. In addition to the built-in modeling capabilities of CFD-ACE+ for determining the desired channel flow regime and understanding the effects of surface tension, surface adsorption, bind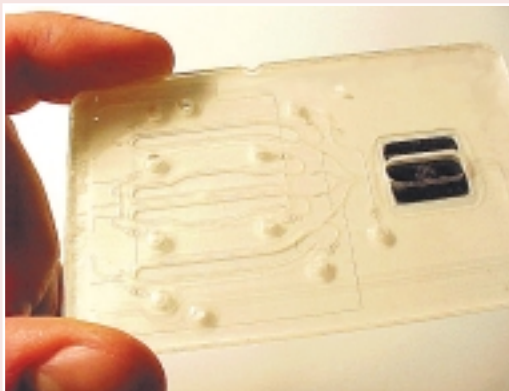ing, and reaction, the software's User Subroutines allows Micronics great flexibility in modeling diverse phenomena. "With CFD-ACE+ we can model parallel streams in which viscosity changes with both position and time as multiple components in the fluid diffuse across the channel at different rates."

### About Micronics

*Based in Redmond, Wash., Micronics is a leading developer of custom lab card devices for applications ranging from on-card immunoassays, nucleic acid assays, protein crystallography, particle separation and mixing, and other analyses in the life sciences, genomics, proteomics, diagnostics, drug discovery and analytical chemistry markets.*
**www.micronics.net**

With the integration of major CFDRC software products, ESI Group is pioneering promising new application areas. CFD-ACE+, the flagship advanced CFD and multiphysics software package allows to solve the most challenging problems involving fluid, thermal, chemical, biological, electrical or mechanical phenomena.

### Biomedical & biotechnologies

Today's modern device design requires the incorporation of complex physical interactions. Through CFD-ACE+ simulations, designers can conceptualize, analyze and optimize the performance of vascular devices; such as catheters, grafts, stents, filters and blood pumps; simulate drug delivery, test devices for biodiagnostics and model complex physiological processes.

> Using CFD-ACE+ allows us and our customers to save both time and prototype production costs for our lab card products

## MEMS and microfluidics

Micro-Electro-Mechanical Systems (MEMS) is the integration of mechanical elements, sensors, actuators, mirrors, and electronics on a common silicon substrate through microfabrication technology. MEMS and microfluidics devices, like integrated circuits can be manufactured in high volume at low cost and promise to revolutionize telecommunications, biology and precision tools by making possible the realization of complete systems-on-a-chip. CFD-ACE+ helps analyze, design and optimize BioMEMS, lab-on-a-chip, and microfluidic devices by rigorously simulating the complex interacting physics (fluid flow, heat transfer, chemical reactions, electrokinetics, stress, etc.) that govern biochip performance.

## Semiconductor processes

Optimizing semiconductor processing requires high fidelity three-dimensional simulations of heat and mass transport with complex multi-step gas-phase and surface reactions for a wide range of semiconductor reactor types.
CFD-ACE+ provides accurate representation of real world effects of semiconductor manufacturing equipment and processes for the three major markets of the semiconductor manufacturing industry. Equipment manufacturers, integrated device manufacturers and pure play foundries are conducting CFD-ACE+ analyses for every key aspect of the device fabrication process.

Using CFD-ACE+, process engineers can analyze the effect of key parameters that determine the speed and quality of etching and deposition processes. Through the understanding of important characteristics, such as thermal uniformity and aspect ratios, they can assess the scalability of processes and determine the impact of each process step. These capabilities help save time and money by significantly reducing the need for physical testing of fabrication processes and reactor prototypes.
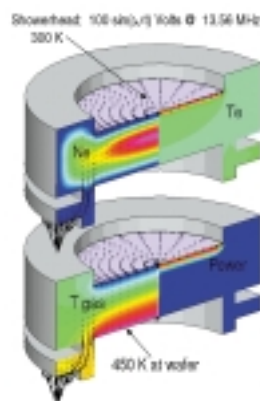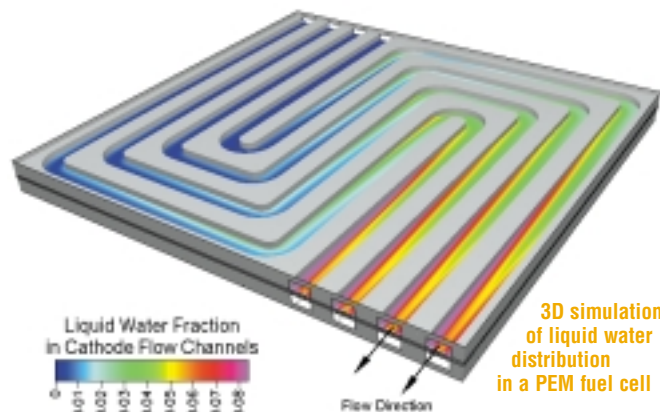
## Plasma

CFD-ACE+ allows users to simulate the behavior of plasmas for semiconductor processing. The Plasma option combines plasma chemistry and transport with electrophysics in an easy-to-use, integrated environment for a wide range of semiconductor applications, from low-pressure non-equilibrium to thermal atmospheric plasmas, all with 3D capability. CFD-ACE+ Plasma handles most types of semiconductor plasmas using structured and unstructured grid methodologies in full 3D. It also simulates flow effects between gas flow and plasma transport. This module enables engineers to calculate the heat transfer and thermal balance of the entire plasma reactor as well as the deformations and stresses of the wafer and chamber. Finally, CFD-ACE+ simulates electromagnetic power deposition, RF/DC (Radio Frequency/Direct Current) bias and plasma enhanced reactions for plasma systems.

## Fuel cells

Clean, quiet, reusable and efficient are words used to describe fuel cell technology as an alternative power source in transportation, power generation and consumer electronics. CFD-ACE+ provides the ideal environment to conceptualize, analyze and optimize the fundamental fuel cell components and systems. CFD-ACE+ is successfully used to model Proton Exchange Membrane (PEMFC), Solid Oxide (SOFC), Direct Methanol (DMFC) and Alkaline Fuel Cell (AFC). CFD-ACE+ is also used to design and optimize reformers. The software product brings an adequate answer by modeling the fundamental physics of fuel cells including: flow, heat transfer, thermal stress, mass transfer, current transfer and electrochemistry in porous media.

Tailored toward specific disciplines, CFD-ACE+ addresses also combustion, propulsion, materials, defense, aerospace, automotive, chemical, electronics and environmental industries. With advanced physical models, CFD-ACE+ provides powerful multiphysics solutions to a wide variety of organizations worldwide, helping them to increase their productivity through reduced fabrication time and cost.



**3D simulation of liquid water distribution in a PEM fuel cell**



**CFD-ACE+ 3D simulation of capacitively coupled plasma reactor**

**CFD-ACE+ process chamber model of a Metal Oxide Chemical Vapor Deposition (MOCVD) Reactor**
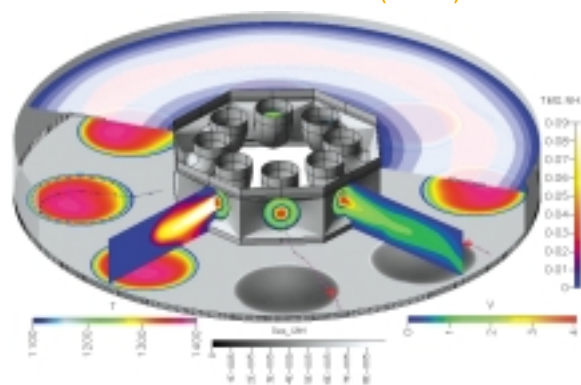


## Computational fluid dynamics and multiphysics solutions

***CFD-ACE+:*** *advanced CFD and multiphysics software for bio and microfluidics, semiconductors, plasma, fuel cells*

***CFD-FASTRAN:*** *powerful software for high speed flows with moving bodies and aerothermochemistry*

***CFD-VisCART:*** *adaptive viscous, Cartesian mesh generation system for use with the CFD-ACE+ and CFD-FASTRAN flow solvers*

***CFD-CADalyzer:*** *new CFD software enabling design engineers to perform virtual try-out early in the design cycle while also providing a portal to CFD-ACE+ with multiphysics*

# PAM-CEM Solutions 2004 reduces physical tests in automotive electromagnetic compatibility

*New version of the computational electromagnetic simulation software package gives engineers the ability to predict real world conditions in the early design stage*
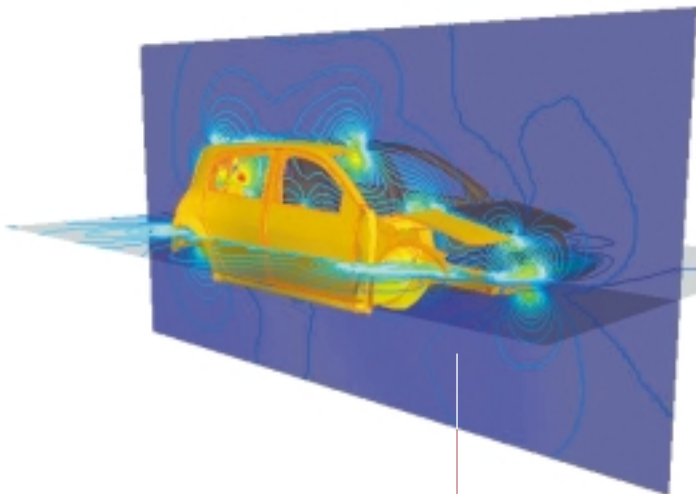


**Simulation of the environment of a Renault vehicle under external electromagnetic aggression**

PAM-CEM Solutions 2004 features a comprehensive family of software for virtual testing of complex electromagnetic phenomena. PAM-CEM Solutions 2004 analyzes electromagnetic compatibility and interference problems in a wide frequency range. PAM-CEM Solutions includes CRIPTE, for induced phenomena on cable networks, and SYSMAGNA, for low frequency analysis.

PAM-CEM Solutions 2004 meets automakers' requirements for a fully realistic EMS (Electromagnetic Susceptibility) analysis in the early design stage, including simulation of 3D radiated fields and induced effects on the vehicle cable networks. With the proliferation of complex on-board electronic equipment throughout the transportation industry, controlling electromagnetic disturbance is more critical than ever to meeting performance and security objectives.

"This new release is a real breakthrough towards the deployment of digital Electromagnetic Compatibility

(EMC) in the automotive industry. Only a close collaboration between ESI Group and leading car manufacturers such as Renault or Nissan could make it happen", says Jean-Claude Kedzia, PAM-CEM Solutions product manager. "PAM-CEM Solutions gives EMC experts the ability to manage very sophisticated cable networks. Complex electromagnetic phenomena can be investigated in depth very early, long before the first physical EMC prototype is available. The results of simulations powered by PAM-CEM Solutions provide a better understanding of how the car will perform, helping engineers to evaluate rapidly various options in the vehicle electrical design."

With the new release, time domain radiated fields can be either calculated through finite difference algorithms for fast evaluation or accurately computed using advanced modeling with 3D finite element formalism. Both options are automatically coupled with CRIPTE. Antenna radiation simulation is one of the main areas where PAM-CEM Solutions 2004 brings full understanding of the phenomena. Several levels of accuracy are available to the user for the analysis of wired antennas. For example, the expert can select a fast evaluation to optimize the performance of traditional antenna devices and their location on-board, while an accurate simulation will be required to analyze sophisticated rear or side window antennas, which are

known to be sensitive to their operating environment.

Other new features of the 2004 release include a user-friendly environment with enhanced modeling capabilities for on-board antennas and cable networks, from their placement in the vehicle to the specification of the related electrical architecture.

## PAM-CEM Solutions

*ESI Group provides a complete EMC/EMI solution aiming at evaluating the electromagnetic environment of fully equipped realistic car models for very wide frequency range.*

*In addition PAM-CEM Solutions is able to serve as the virtual laboratory for electronic components and cable bundles characterized by reduced test set-up facilities, and to check the EMC compliance of on-board equipment and wiring systems.*

*The range includes:*
- *PAM-CEM for accurate 3D analysis,*
- *CRIPTE for cable networks,*
- *CEM3D for fast evaluation,*
- *SYSMAGNA for low frequency characterization.*

## AVAILABILITY

*PAM-CEM Solutions 2004 is available on Unix workstations from HP, IBM, SGI, and Sun, as well as Linux hardware vendor supported platforms*

# Focus on…
## …EASi-CRASH DYNA

*EASi-CRASH is a high performance CAE environment software for LS-DYNA, RADIOSS and PAM-CRASH users.*

*EASi-CRASH captures the process of model building, dataset preparation, results evaluation against regulatory requirements and design comparisons into a single complete package.*

Interview with ShivaKumara Shetty
Product Manager EASi-CRASH DYNA
(shiva.shetty@esi-group-na.com)



EASi-CRASH DYNA increases productivity through fast performance, essential functionality and extreme user-friendliness

**PAMTALK: Last December, ESI Group acquired the intellectual property rights of EASi-CRASH simulation environments. How will EASi-CRASH take place within the current portfolio?**

**ShivaKumara Shetty:** With this integration, the company is opening its overall Virtual Try-Out Space environment. ESI Group now offers a common user environment as well as simulation design and control tools for the automotive industry, in particular in the area of safety.

EASi-CRASH gives the users full access to complex and powerful simulation codes, supporting their dedicated crash simulation capabilities. In addition to PAM-CRASH, EASi-CRASH is the only environment solution which combines both pre and post-processing in a seamless package enabling a continuous calculation loop. EASi-CRASH industry-proven simulation environments thus deliver extreme productivity to the user for structural crash and coupling with rigid body for crash synthesis simulations.

**PAMTALK: Can you tell us more about EASi-CRASH DYNA's features speeding-up the process from dataset preparation to crashworthiness results exploitation?**

**ShivaKumara Shetty:** The success of EASi-CRASH DYNA stays in its ability to quickly address the users' needs through the customizable Time Saver programs.

For dataset preparation, engineers follow a guided approach to quickly and easily detect and correct intersection/penetration. They can also use a smart tool to replace parts and resolve connections and references. This feature boosts productivity gains by helping engineers to quickly understand and sanitize the model. Other major advances lie in didactic tools for seat belt creation and dummy positioning in just a few mouse click, as well as welding capabilities to validate the welding from CAD to FE data.

User-friendly EASi-CRASH data model allows intelligent sorting and global control of CAD and CAE data. A plugged "CHASE Iterations" function helps performing recurrent actions for both test and CAE data. It generates productivity gains up to a factor 10.
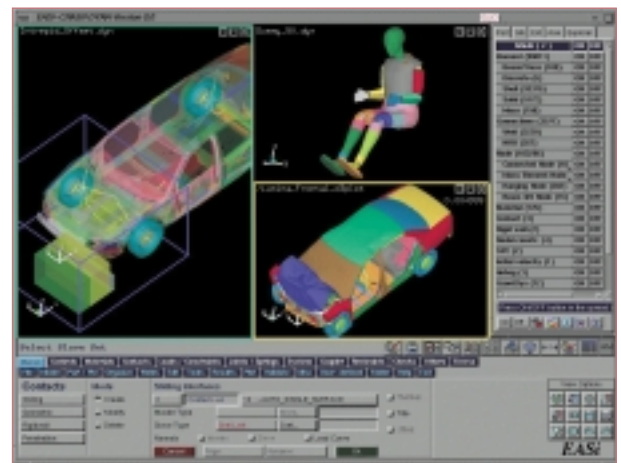
To conclude, EASi-CRASH data model and post-processor yield significant time and cost savings with respect to competitive offer by simplifying data management and automatic reporting. Overall, this CAE environment software roughly grants a 25% time saving on solver data processing.

## Key features

- *Full capability to handle IGES, CATIA and NASTRAN files*
- *Powerful mesh editing features, such as automesh and remesh*
- *Complete support of LS-DYNA 970*
- *LS-DYNA 970/MADYMO 6.X coupling*
- *Part Replace, Penetration and intersection removal*
- *Powerful welding utility*
- *Simple dummy positioning and seat belt routing*
- *Animation and Plotting ( EASi-PLOT) support*
- *Transfer of data from one model to another*

# Modeling of the Vacuum Arc Remelting process at Böhler Edelstahl GmbH

*CALCOSOFT-2D provides for a better understanding of the coupled phenomena occurring in the remelting process*

**M**ore than 250 steel grades from Böhler Edelstahl are used in the production of goods which we use every day. They can be found, for example, in moulds for the production of plastic goods, in cold work tool steels for punching, bending and cutting applications, in hot work tool steel, in die casting or in special materials for turbines, automotive and aircraft industry, etc.



**950 mm diameter ingot**

## Advanced technology for high quality products

Böhler Edelstahl combines the latest vacuum-melting technologies and a range of Electro Slag Remelting facilities enabling the manufacture of materials with a high metallurgical degree of purity. Three VAR-furnaces, capable of producing ingots up to 950 mm in diameter, are mainly used for the production of special steels and nickel-based alloys.

"We have been using CALCOSOFT-2D for two years to simulate solidification and optimize the process," says Christof Sommitsch, Project Leader, Böhler Edelstahl GmbH. The company considers CALCOSOFT-2D to be an efficient tool providing:

- Better process understanding,
- Process optimization and parameter studies such as cooling, melt rate and geometry,
- Increased material quality through analysis of macro and micro-segregations and non-metallic inclusions,
- Better customer service thanks to detailed specifications and qualifications.
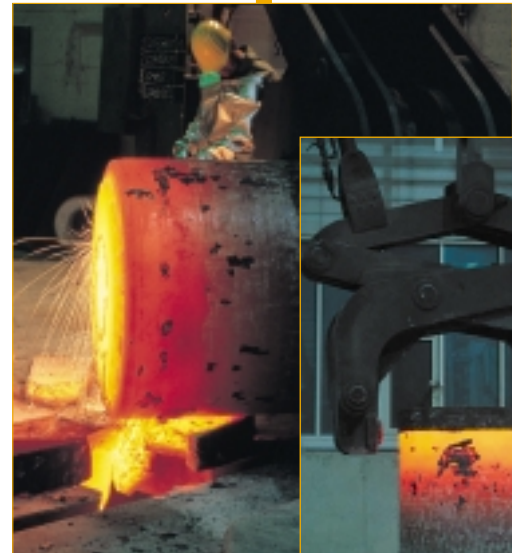
## CALCOSOFT simulation of the VAR process

The difficulties involved in simulating Vacuum Arc Remelting (VAR) processes are directly linked to the wide range of physical and chemical phenomena which occur simultaneously and are often coupled in such remelting processes. "CALCOSOFT brings the necessary knowledge for a deep understanding of the VAR process," adds C. Sommitsch.

A comprehensive digital simulation should incorporate fluid flow, heat and mass transfer, electromagnetic effects, solidification (including microstructure prediction) and macro-segregation. The modeling of heat transfer, fluid flow and solidification, including grain structure prediction, solid-state transformation, hot tears, porosity and macro-segregation, is already available in CALCOSOFT-2D.

Moreover, CALCOSOFT-2D also includes an induction heating model which allows magnetic stirring to be modeled. However, due to the geometry of the VAR furnace and its power supply, a new axisymmetric electromagnetic solver which takes into account both Lorentz's forces and Ohm's law heating, was developed to simulate the VAR process.
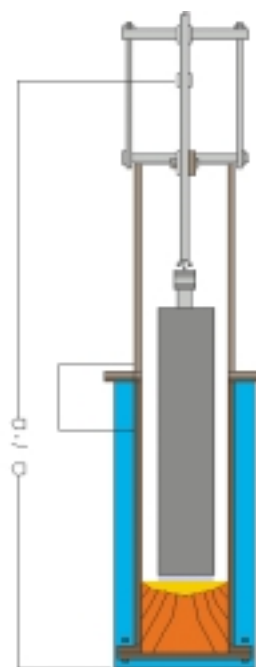


**Vacuum Arc Furnace**

## Analysis

The VAR process is characterized by an axisymmetric geometry, so all calculations are carried out in a 2D axisymmetric system. The model used in the simulation contains the ingot and the copper mould; the electrode and the electric arc are not directly considered. Heat flow, transport of the solid phase, fluid flow and the magneto-dynamic effects in the pool due to the melt current are taken into account by the calculations.

Trials are carried out for three different dimensions, a 310 mm, a 410 mm and a 510 mm diameter ingot, all made of Alloy 718. The geometry of the mould, the electrode dimension and process parameters such as melt rate and melt current correlate to those used for industrial production. The total energy coming from the droplets and from the radiation of the electric arc is represented by a constant temperature at the pool surface (given by the liquidus temperature and superheat), and a constant flow of material according to the melt rate. The superheat is estimated by multiplying the fraction of arc energy that goes into the melt by the power of the arc per electrode cross-section.

Starting from fictitious initial conditions, the heat balance of the system is calculated until stationary conditions are reached with a sufficiently high number of time steps. Transient process phases, such as changes in the melt rate and phases of the process, which are transient by nature, for example hot topping or the start phase, are not taken into consideration.

Because of the shrinkage of the solidifying material, a gap appears between the ingot and the mould. The gap formation, as a function of the ingot height, can be calculated and equivalent heat transfer coefficients between the ingot and cooling water are derived as a function of the gap width.
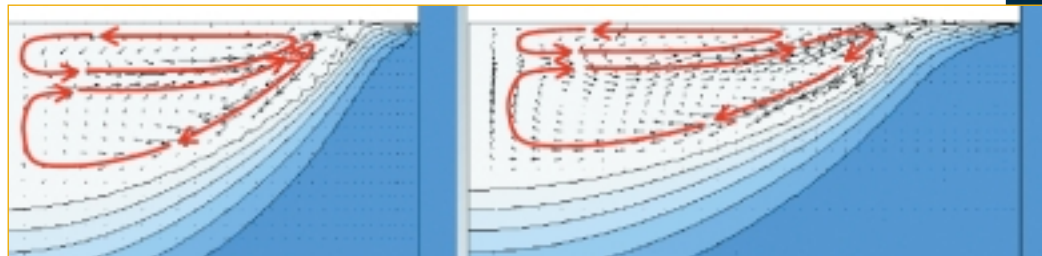


Flow distribution for various ingot diameters (from 310 on the left to 410, then 510 mm on the right)

## CALCOSOFT helps to improve the quality of ingots

The main results obtained with CALCOSOFT-2D are: the temperature distribution, the distribution of the fraction of solid in the ingot and the fluid flow in the liquid pool.

The comparison between measured and simulated pool profiles shows good correlation for the pool profile of the 510 mm ingot.

The different flow regimes obtained for various ingot diameters can be related to the different acting forces. At the top of the pool, where the current density is very high, the flow is mainly driven by Lorentz forces which lead to the flow pattern observed. Further below the surface, the current density decreases and the flow regime is mainly driven by buoyancy forces.

Based on these promising initial results, Böhler Edelstahl GmbH now plans to extend its simulation activities to microstructure and segregation predictions. CALCOSOFT will also be used to analyze the simulation of the solidification behavior of other alloys. Finally, the possibility of simulating other production processes, in particular the Electro Slag Remelting process, is also being investigated.
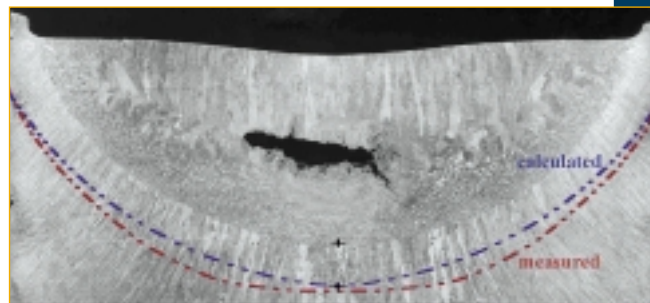


Validation of pool profile: comparison of simulated and measured pool profile

## BöHLER Edelstahl GmbH

*BÖHLER Edelstahl GmbH is one of the most important suppliers of high speed steel, tool steel and special materials worldwide. The company was founded in 1991 and is a 100% subsidiary of the BÖHLER UDDEHOLM AG group in Vienna.*

*Yearly producing 126,000 tons of special steels, BÖHLER Edelstahl concentrates on materials for highly demanding applications in the aeronautics and aerospace sectors, automotive, energy, medicine, or in oil and chemical industries. Finally, not only the Austrian Mint but a lot of other renowned mints around the world are using the hardest BÖHLER steel to produce billions of coins.*

*The latest vacuum-melting technology and an ever-increasing metallurgical expertise guarantee the highest standard of quality – from melting to delivery.*

*More information on: http://www.bohler-edelstahl.at/*

> Using CALCOSOFT-2D, we will be able to improve the quality of our remelted ingots by an optimization of the melt rate, the fill ratio, the cooling system and the current and voltage definitions.

# ProCAST 2004.1, updated version extends performances for shape casting simulation

*ProCAST's new release brings new features and numerous improvements in processing capabilities*



**Velocity magnitude and new particle tracing display for an aluminum high pressure die casting application**

ProCAST 2004 version, released at the end of last year, featured a completely new user interface offering a fast and intuitive environment to the user. Following that path, an updated version is now available, bringing even more new features in processing capabilities and numerous improvements in product performance.

ProCAST 2004.1 is the second release delivered by ESI Group since its acquisition from UES Inc. ProCAST precision solution addresses a wide range of casting processes and includes capabilities for automatic meshing, thermal and flow analysis, stress and deformation, microstructure analysis and radiation effects. Extensive validations complying with ESI Group's ISO 9001 procedures have been conducted to assess the reliability and consistency of the simulation results obtained from the software product.



**Improved porosity predictions, respectively above 0.8%, 0.9% and 1% from top to bottom, for an aluminum high pressure die casting application**
**Courtesy of Injecta Druckguss AG, Switzerland**

## ESI Group's casting solutions

*Casting process simulation is now widely accepted as an important tool in product design and process development to improve yield and casting quality. ESI Group's casting portfolio includes:*

- *ProCAST, CALCOSOFT, for fast and efficient modeling of continuous casting processes and,*
- *PAM-CAST/PAM-QUIKCAST, the finite difference software package for filling and solidification.*

## New features

Several significant enhancements have been implemented in the 2004.1 release. These new features will facilitate the product customization allowing specific user preferences to be defined for material databases and icons.

Pre-processing includes new features for:
- Definition of cycling analysis,
- Automatic mesh optimization including interface definitions,
- Easy set-up of inverse calculations for material data and boundary conditions,
- Set-up and visualization of advanced microstructure predictions,
- New filter permeability model.

Thermodynamic material databases were already available to calculate the enthalpy and solid fraction based on the alloy composition. With ProCAST 2004.1, it is now possible to directly obtain temperature dependent viscosity and density properties for aluminum, magnesium, titanium, nickel and cast iron alloys. For aluminum alloys, conductivity calculations have also been added.

Post-processing has also been significantly enhanced. Particle tracing is now available and directly computed by the solver for improved accuracy. Finally, a dynamic update of available post-processing steps has been introduced to visualize results while the calculation is running.

## Major improvements

Numerous improvements have also been made in the processing capabilities of ProCAST. Limitations on memory and file sizes have been removed with new memory allocation and input/output operations management.

Porosity models have been revisited for improved accuracy and complemented with up-to-date on-line documentation. Also, porosity predictions can now be activated during a mold cycling analysis.

Based on extensive validations from various industrial applications, the filling algorithms were further refined and parameter settings tuned so as to accommodate for all metal flow regimes arising in lost foam, gravity, low pressure and high pressure die casting.

With an efficient and intuitive visualization environment, ProCAST 2004.1 offers speed, accuracy and processing capabilities for a wide range of casting processes.

This updated version highlights ESI Group's strategy for providing high added-value solutions to the casting industry.

### AVAILABILITY

*ProCAST 2004.1 is available on Windows NT and Windows 2000 platforms, Linux hardware vendor supported platforms as well as UNIX workstations from HP-Compaq, IBM, SGI and SUN.*

# ESI Group's extended casting solutions on show

**EUROGUSS 2004:** *the entire process chain for pressure die casting in one place*

At EUROGUSS 2004, the international trade fair for pressure die casting, ESI Group introduced the latest versions of its casting solutions, with the support from HP. Many group managers and decision-makers from the die casting foundries and the automotive industry visited the booth.

Outstanding demonstrations of CALCOSOFT, ProCAST and PAM-CAST were performed; first steps of new business relations and projects were outlined.

Engineering and simulation methods captured interest from 20% of visitors. Virtual simulation is now occupying an established position and is no longer an innovation. The high pressure die casting experts are increasingly using casting simulation tools not only to optimize casting designs by defect elimination but also to better predict fatigue life of the tooling.

EUROGUSS welcomed over 5,300 visitors from 29 countries. Manufacturers of cast parts and components, equipment manufacturers and suppliers, machinery manufacturers and process engineers were present in Nuremberg, Germany. EUROGUSS 2004 was the forum for the entire field of high pressure die casting in Germany and Central Europe.

Bringing together supply and demand, the 5th International Die Casting event gathered 271 exhibitors on a 10,800 sqm exhibition area.

**EUROGUSS 2004, a growing exhibition with impulses for a growing market**

# Professor Wilfried Kurz honored at TMS 2004

A special three-day symposium in honor of Prof. Wilfried Kurz was organized in March 2004, on the occasion of the 133rd TMS annual meeting, in Charlotte, North Carolina. Headquartered in the United States The Minerals, Metals & Materials Society (TMS) is an organization that encompasses the entire range of materials and engineering.

Prof. W. Kurz officially retired from the Swiss Federal Institute of Technology (EPFL, Lausanne, Switzerland) in 2003 at the age of 65.

Wilfried Kurz, is above all, known for his book *Fundamentals of Solidification*

and for many papers and ideas he has contributed in the area of solidification processing. Member of numerous materials societies, W. Kurz has received many prestigious awards, including the Bruce Chalmers Award of TMS in 1994 and the European Materials Medal for his outstanding contributions.

He was also, from the first stages, a passionate supporter for the creation of Calcom SA in 1991 and a faithful shareholder. Professor Kurz was also a key lecturer for twelve years in the annual solidification course co-organized by Calcom ESI, the ESI Group casting business unit.

Calcom ESI was invited to present a lecture at the TMS symposium. The paper on: "Introducing casting simulation in industry: the steps towards success" written by Drs M. Gremaud and M. Gäumann can be found at the following address: **www.calcom.ch/News/Articles.html**

The Calcom ESI team, having closely interacted with W. Kurz since 1984, wishes him a nice and active retirement.

**Prof. Wilfried Kurz, a figure in the area of solidification**

# EuroPAM 2004, crossroads of innovations, information and pioneering concepts in Virtual Engineering

*14th European conference and exhibition will be held October 11-13, in Paris, France*





**Intense two-day conference with parallel sessions covering the full scope of virtual testing and analysis**

High-level conference focused on digital simulation software for prototyping and manufacturing processes, EuroPAM will welcome hundreds of attendees next October. Gathering from all over Europe, delegates will exchange ideas, discuss real world user cases, listen to various technical and scientific presentations and share the latest visions and technologies in digital simulation.

## Innovation through simulation

Client presentations and ESI Group's executive workshops will draw an overview of current stakes and innovative process methodologies. The lectures will provide more insight into ESI Group's extended simulation portfolio now including computational fluid dynamics and multiphysics solutions from CFDRC. The strategic addition of the EASi product portfolio within the overall Virtual Try-Out Space simulation environment will also be largely discussed. This powerful CAE software solution will allow users to build the foundations of an open 3G PLM solution. Finally, new ESI Group CAAV5 based products will take major steps toward a realistic PLM simulation in the VTOS, giving proper credit to the essential influence of material physics and manufacturing processes in evaluating and predicting the "as built" product performance.

## Dedicated user sessions on October 11

The first European Stamping User Conference, held on October 15, 2003, was a successful inaugural user meeting with more than 60 participants. Based on its success, this year's EuroPAM program has been expanded to include one day dedicated to specific user meetings.

**EuroPAM 2004 venue: La Villette Conference Center in the heart of La Cité des Sciences et de l'Industrie**

The first day of the event, users will have the opportunity to participate in one of four parallel user conferences on:

- Crash and Occupant Safety
- Stamping
- Casting
- Vibro-Acoustics.

These specific sessions are intended to let users express their development needs and to learn about the best in-class developments through dedicated expert presentations and demonstrations.

## State-of-the-art conferences on October 12 and 13

First held in 1990, EuroPAM is the unique venue where the latest developments in digital simulation are presented, explained and demonstrated by and to global industry leaders. EuroPAM 2004 will once again feature an extensive program emphasizing the real-life simulation behavior of industrial products subjected to a wide range of phenomena. The high-tech La Villette congress center is the ideal place to learn and debate on current and future industrial challenges.

Recent progress in hardware and system developments will also be discussed with the participation of HPC experts from ESI Group and from the Industry.

As in previous years, an exhibition area will be opened during the two days of the congress to facilitate talks with hardware and systems experts and see



**Sharing experience with peers**

how HPC is making Virtual Engineering more affordable each year.

Join us to learn how today's digital prototyping is meeting industry's most pressing requirements to shorten product development cycles and to manage increasing model complexity, variety and quality.

*Please visit the EuroPAM website regularly: http://www.esi-group.com/EuroPAM2004/*





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# EuroPAM2004
## PARIS

**14 TH** European Conference and Exhibition on Digital Simulation for Virtual Engineering

La Cité des Sciences et de l'Industrie
**LA VILLETTE CONFERENCE CENTRE**

**Oct 11: Users Conferences**
- Crash & Occupant Safety
- Stamping
- Casting
- Vibro-Acoustics

## Innovate with Simulation

## October 11-13, 2004

## Book These Dates!

**Oct 12-13: Industry Sessions**
- Automotive Testing
- Environment Interaction
- Fabricated Materials
- Automotive Manufacturing
- Aerospace
- ...

www.esi-group.com/EuroPAM2004/

# CFD-CADalyzer recognized as one of the most innovative products in the field of design engineering

*CFD-CADalyzer wins*

*Desktop Engineering*

*readers' choice award*

*by enabling design*

*engineers to easily*

*simulate and optimize*

*fluid flow behavior*

Newly acquired by ESI Group, CFD-CADalyzer was the winner of *Desktop Engineering* readers' choice award for December. Each issue, the American MCAD magazine *Desktop Engineering* gives the readers' choice award to the product that has received the most reader interest.

Thanks to the recent acquisition of CFDRC's product division, ESI Group has enhanced its product portfolio with new virtual engineering software including CFD-CADalyzer, Computational Fluid Dynamics (CFD) software for design engineers, CFD-ACE+ for advanced CFD and multiphysics simulation, CFD-FASTRAN, CFD software specifically designed for the aerospace industry, and CFD-VisCART for the generation of viscous, Cartesian meshes.

Mike Nieburg, business development manager, ESI Group, said: "CFD-CADalyzer is a dramatically different CFD simulation package. Combining design and analysis, this product will catalyze the increased focus on "getting it right the first time" at the early conceptual design phase of

**Mike Nieburg, business development manager, ESI Group, receives award from Tony Lockwood, editorial director for *Desktop Engineering***
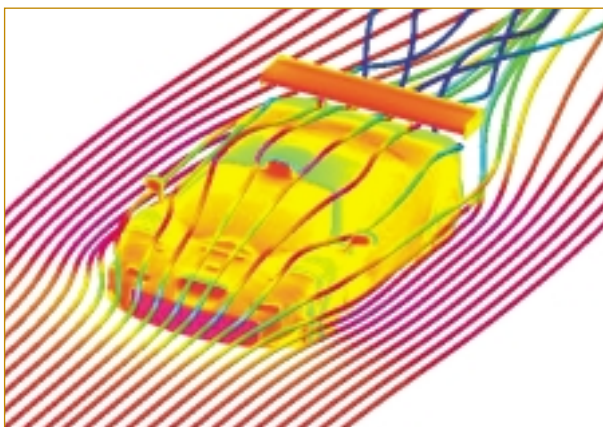
product development. Design engineers and analysts need not just finite element analysis, but CFD to create winning products".

"From my initial work with CFD-CADalyzer, I really like it. The ability to work with my 3D modeler and then generate a mesh with CADalyzer is outstanding", said Craig Lanning, Professional Research Assistant at the Cardiovascular Flow and Imaging Research Laboratory at Denver's Children's Hospital.

## CFD-CADalyzer for rapid sequential or parallel CFD simulations

CFD-CADalyzer provides an enhanced decision-making tool that can be used at the early conceptual and detailed design stages of product development. The product allows parametric studies using the CAD system for geometry changes, letting

designers assess the potential performance of multiple design variants.

Main capabilities include modeling of 3D fluid flow and heat transfer in fluids, solids and porous media with complex geometry; laminar or turbulent flow; and compressible and incompressible fluids. Other features include automatic mesh creation and compatibility to CFD-ACE+ for advanced multiphysics simulations. CFD-CADalyzer works with ACIS- or Parasolid-based Mechanical CAD applications, such as Autodesk Inventor, SolidEdge, SolidWorks and Unigraphics.

**CFD-CADalyzer modeling the air flows around a race vehicle**

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



T he layout of ESI Group's website has just been redesigned. The front page of the site features a modern look and feel with graphics and colors. Latest product releases are advertised through a flash animation with direct access to corresponding pages. The product section is organized by analysis field and software solutions are easily navigated, thanks to directory pages with pictures and animations.

Among other improvements, the new site now includes detailed information about EASi's CAE software products. Dedicated e-flyers have been posted in particular on EASi-SEAL, the integrated design-verification environment that rapidly evaluates multiple seal system and closure designs. Similarly, an e-flyer is available for download to give more insight on EASi-PROCESS, the

advanced technology for creating, automating and standardizing CAE processes.

The casting website now displays a new section called 'casting news', available from the introductory page. Please visit these new pages to be updated on the latest news from the casting line. Finally, the latest issues of ESI Group's electronic newsletters, PAM**TALK** and "News on-line", are posted at the bottom of the page for download or on-line subscription.

*Please come and visit the ESI Group homepage frequently to get the latest news. If you have any suggestions, please do not hesitate to use the info@esi-group.com e-mail address or the contact web page.*

## ESI Group's annual revenue 2003 up 15% in real terms

E SI Group's 2003 annual revenue reached 49 Million Euros, up 15% in real terms, 22% at constant exchange rates. Alain de Rouvray, Chairman and CEO of ESI Group, said: "What makes revenue growth especially significant is that it is supported by increased activity and the gradual adoption of 2G/3G solutions at OEMs and Tier 1 suppliers, particularly in the automotive industry.

### Highlights of the year 2003/2004
The year was marked by an excellent stability of the installed base and a highly recurrent license revenue (88%).
- The breakdown of annual revenue remained stable with 73% from licenses and 27% from services.
- New Business increased by 12% (5% without acquisitions). New Business accounted for 24% of license revenue.
- 79% of total turnover is generated abroad as follows: Europe accounted for 50%, Asia/Pacific for 34% and America for 16%.
- The major acquisitions made in 2002 and 2003 accounted for 15% of revenue growth and took part in the strengthening of the group's position on the American market.



**CFD-FASTRAN, computational fluid dynamics software from CFDRC**

Alain de Rouvray concluded: "Taking into account the impact of software acquisition costs write-offs and the slight delay in expected services' sales particularly in the United States, the management will take the necessary steps to leverage the positive synergies generated by the acquisitions in order to record an operating profit in the current fiscal year. Our recent acquisitions, however, position us in new sectors, such as the biotechnologies and the microelectromechanics (MEMs) industries, where tests are particularly costly and delicate and the physical part is hard to check. Lastly, this year we expect to start marketing the first CAAV5 solutions developed in partnership with Dassault Systèmes. All of these factors are part of the strengthening of ESI Group's leadership and its utmost role in the adoption of PLM solutions."

### Simplification of the organisational structure
The merger between ESI Group and ESI Software took the form of a universal asset transfer, completed on April 30, 2004. The purpose was to simplify its administrative, legal and accounting organization while optimizing flow and staff management. This simplification is part of the ongoing process to rationalize costs and also complies with ANVAR criteria for renewal of ESI Group's qualification as an Innovative Enterprise.

### Renewal of innovative company award
The French Innovation and Research Agency, ANVAR, has already awarded ESI Group the label of "Innovative Enterprise" in recognition of the company's major R&D activities carried out since its creation to develop solutions with very high added value.

corporate

# hp

## HP Workstation c8000
## Extreme UNIX power, whisper quiet

The HP Workstation c8000 is a 64-bit workstation that brings 2-way and 4-way computing power to the desktop, supports the latest industry-leading AGP 8X graphics and is compatible with existing HP-UX application environments.

The HP c8000 is designed to address the most demanding technical workloads in automotive, aerospace and electronic design enterprises, with four times the processor and memory I/O bandwidth and 25 percent lower memory latency of previous generation PA-RISC workstations. It is ideal for handling the complexities of large model, system assemblies, design analysis and simulations. The HP c8000 also features breakthrough graphics performance with industry-standard AGP 8X graphics on a UNIX workstation. No longer are you captive to antiquated, proprietary graphics cards that trail industry innovation.

**HP Workstation c8000**

2 or 4-way system using dual core PA-8800 processor modules at 900 MHz or 1.0 GHz with 32 MB of L2 cache

HP Scalable Processor Chipset zx1

HP-UX 11i TCOE or HP-UX 11i MTOE

Up to 16 GB PC2100 registered ECC DDR-266

ATI FireGL T2-128p and ATI FireGL X1-256p AGP-8X graphics

## For more information, visit **www.hp.com/workstations**

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