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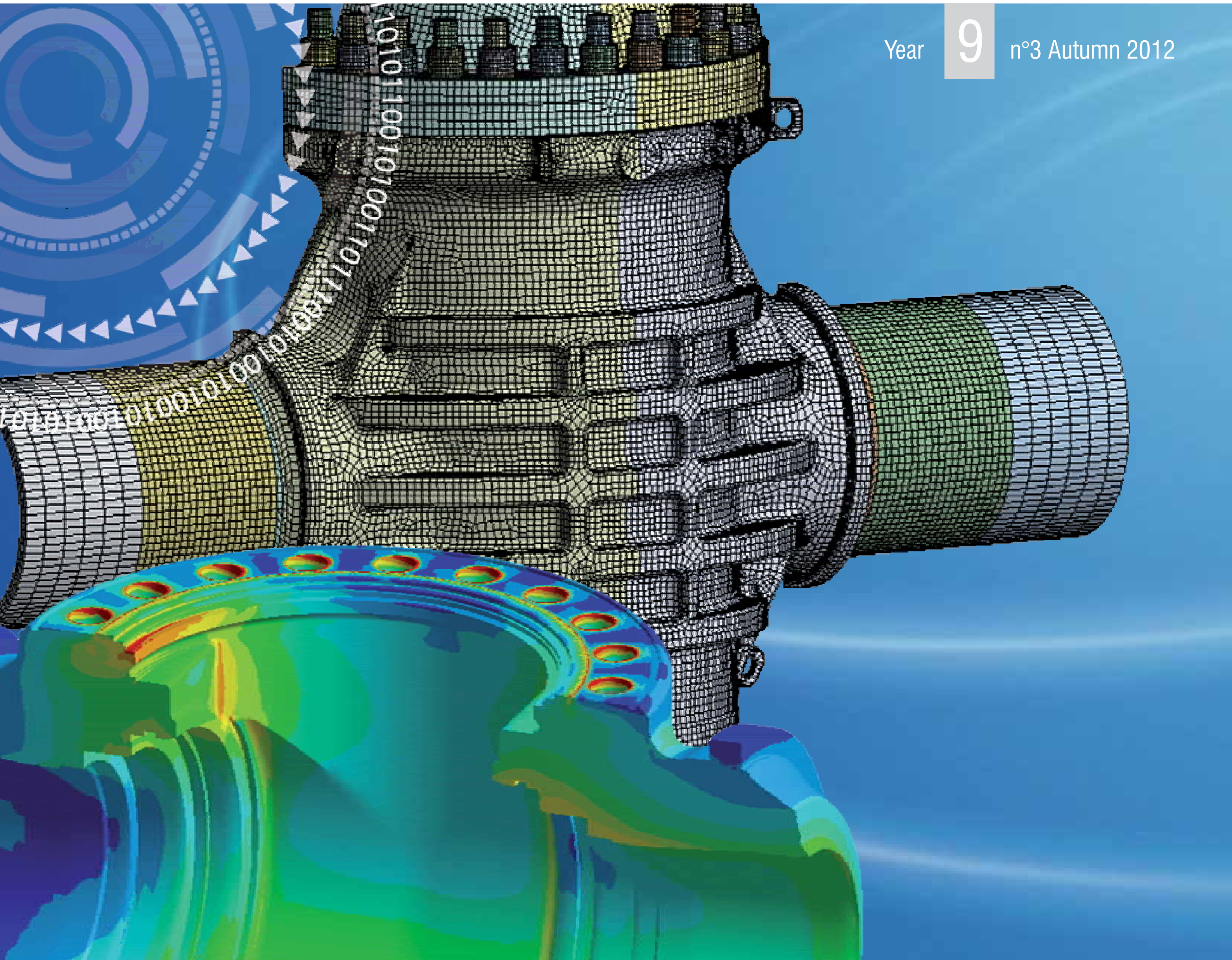
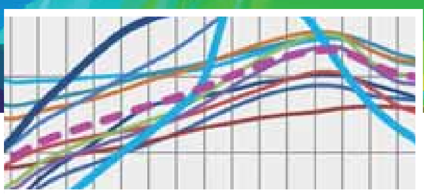
Newsletter

Simulation Based Engineering & Sciences

Year 9 n°3 Autumn 2012





Prevent Pressure Surge for **Water Injection Systems** in the Offshore Oil&Gas Industry

Reliability Analysis of **Offshore Structures** and Inspection Planning

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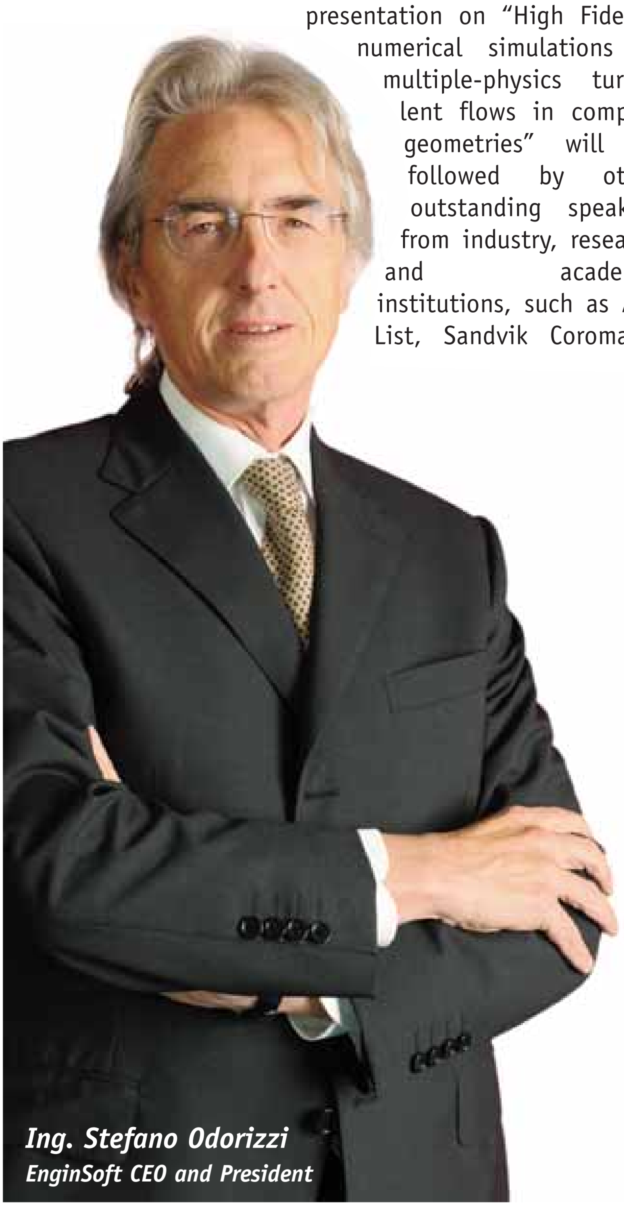
By nature, engineers are thought-leaders, creators and innovators.
We focus on safety, realizability, and applicability. Our designs are brought to life based on the sound knowledge of engineering science, materials, technologies and our ability to collaborate with other experts and highly specialized providers.
The International CAE Conference on 22nd and 23rd October is a gathering of the people and brains behind much of today's leading engineering simulation. This annual knowledge-platform brings together diverse expertise, state-of-the-art software, from the comprehensive ANSYS product suite to a number of complementary technologies and hardware solutions.
We are delighted to welcome Professor Parviz Moin from the Center of Turbulence Research of Stanford University whose presentation on "High Fidelity numerical simulations of multiple-physics turbulent flows in complex geometries" will be followed by other outstanding speakers from industry, research and academic institutions, such as AVL List, Sandvik Coromant, Cascade Technologies, IMS, SINMEC Brazil, Volvo Cars, Ansaldo Energia, Ferrari, Magnetti Marelli, General Electric, Tetra Pak, Thales Alenia Space, University of Twente Netherlands, University of Catalonia (UPC) Barcelona, the Universities of Milan, Padua, Trento and many others. Henrik Fisker will present his Karma, the world's first premium electric plug-in hybrid car in the exhibition, the traditional meeting and networking platform of the event!



Ing. Stefano Odorizzi
EnginSoft CEO and President

We invite you to check the Conference Program on the last pages of this Newsletter for a detailed overview of the agenda. Many of the articles in this edition offer a foretaste of the topics that will be presented and discussed live at the Conference.
You will read about CAE applications in the offshore oil&gas sectors, about composite design and modeFRONTIER in systems engineering. We present ADVENTURECluster, an innovative structural analysis software and PlanetsX, an injection molding CAE system which is fully embedded in ANSYS Workbench. Our case studies outline the use of LIONsolver, Scilab and the Benimpact Suite, a tool for the assessment of the performance of ZEB Zero Energy Buildings which EnginSoft introduced also at the ZEMCH 2012 Conference in Glasgow.

Moreover, this edition includes interviews with Massimo Verme of Verme Projects, an Italian yacht consulting company, and Marie Christine Oghly, the president of EnginSoft France.

We would like to update you on the ESASIM and EASIT2 projects, this year's Transvalor Users' Meeting, the 3rd Dolomites Workshop on Constructive Approximation and Applications, the new features in ESAcomp, a software for analysis and design of composite structures and on other CAE-relevant topics.

We look forward to welcoming you to the Conference in Pacengo del Garda – Please share with us your knowledge and thoughts about the present and future of CAE and Simulation!

Stefano Odorizzi
Editor in chief

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Contents

Applicazioni CAE per le Valvole nel settore Oil&Gas

Le valvole, organi meccanici diffusi in tutti i settori ingegneristici, sono in particolare componenti fondamentali nel campo impiantistico dell'oil&gas, petrolchimico ed energetico.
Adibite all'intercettazione e regolazione del flusso di fluidi potenzialmente pericolosi, spesso in condizioni ambientali ed operative critiche, richiedono ai produttori una progettazione che assicuri i massimi livelli di affidabilità e durabilità con un livello di manutenzione per quanto possibile ridotto.
Poter assicurare un elevato livello qualitativo è dunque un vantaggio competitivo a cui gli strumenti di prototipazione virtuale (CAE) contribuiscono in modo fondamentale.
Le applicazioni del CAE sono svariate e coinvolgono sia aspetti strutturali legati alla resistenza e corretta funzionalità e durabilità del prodotto che di ottimizzazione fluidodinamica rispetto a dissipazioni e rumorosità.
Più specificamente, l'analisi strutturale permette di dimensionare, accuratamente e nel rispetto dei requisiti normativi, corpi e coperchi rispetto alle principali condizioni operative, generalmente governate dai carichi di pressione interna e da coazioni di origine termica.


Fig. 1 – Simulazione di un contatto seggio-sfera

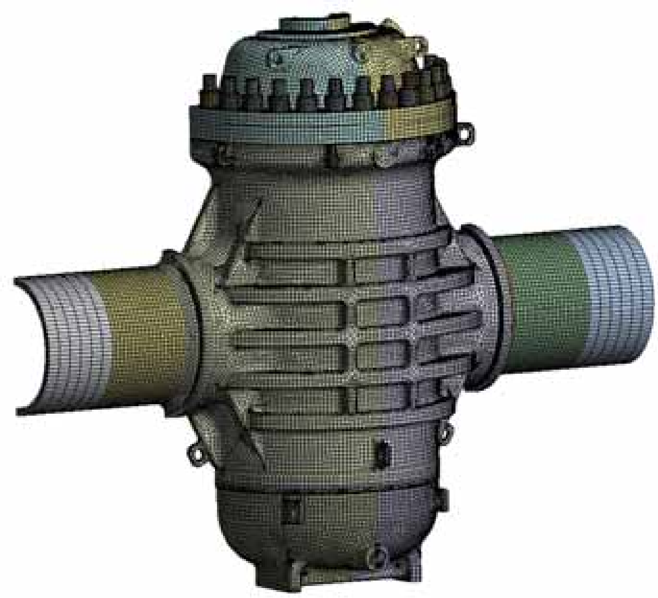
Fig. 2 - Mesh di una valvola gate

Il dimensionamento ottimizzato, rispetto a quello conservativo offerto da un approccio convenzionale "by rules", consente, in particolare su valvole di grosse dimensioni ed elevato rating, consistenti riduzioni di peso con evidenti benefici sia sui costi diretti di materiale che indiretti di lavorazione, trasporto ed installazione.
Le simulazioni traggono notevoli benefici dalla possibilità di poter operare direttamente sulla geometria CAD riducendo la necessità di semplificazioni geometriche e di ipotesi di modellazione a tutto vantaggio dell'accuratezza delle previsioni.
Accanto a valutazioni di tipo "globale" come quelle sopra accennate, le tecniche numeriche permettono di indagare in modo accurato anche aspetti "locali" altrettanto fondamentali per garantire il successo della progettazione.
Un aspetto basilare, connaturato alla finalità del prodotto, è la verifica delle tenute; l'esempio più classico è il dimensionamento degli accoppiamenti seggio-sfera in cui è possibile affinare il profilo dei seggi, e conseguentemente la

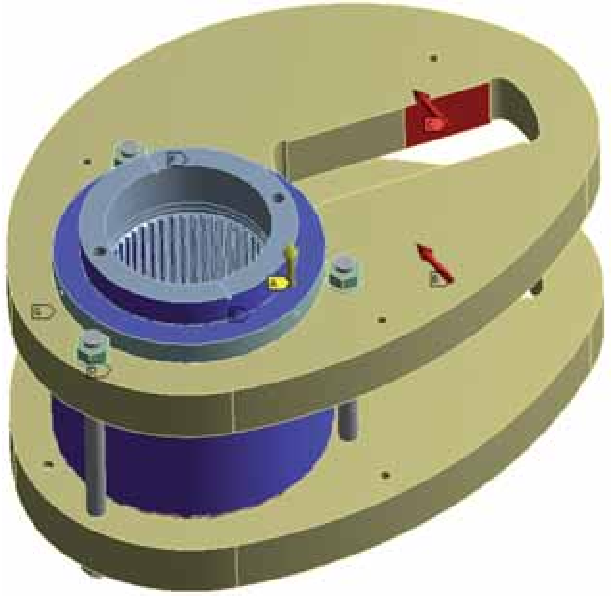

Fig. 3 - Modello FEA di Glifo per attuatore valvola

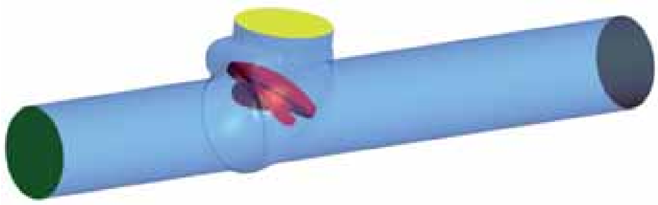

Fig. 4 - Analisi CFD di un otturatore per valvole di controllo

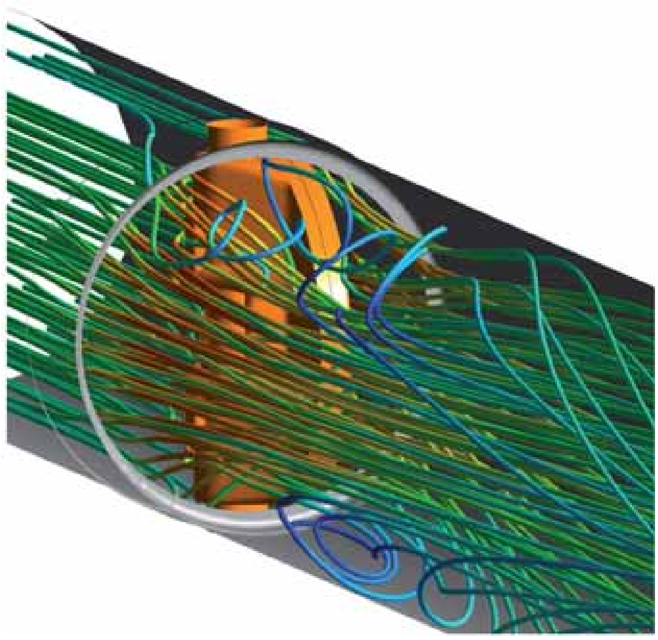

Fig. 5 - Visualizzazione linee di flusso – Analisi CFD

loro rigidezza, in modo tale da assicurare ovunque la condizione di contatto e reazione adeguata ad assicurare la tenuta.
In questo tipo di valutazioni è fondamentale accedere ad algoritmi di simulazione non banali -perché caratterizzati da diversi aspetti non lineari- che devono risultare robusti ed efficienti per mantenere i tempi di simulazione compatibili con le tempistiche della progettazione. Altri aspetti che sono analizzati riguardano verifiche deformative rispetto a giochi e tolleranze disponibili, l'ottimizzazione dei valori di serraggio degli accoppiamenti flangiati, la verifica dell'adeguato dimensionamento degli organi collegati ai meccanismi di attuazione che devono poter trasferire le coppie di manovra.
Anche le analisi Fluidodinamiche (CFD – Computational Fluid Dynamics) sono utilizzate in svariate applicazioni: le più comuni riguardano la valutazione di parametri di prestazione quali caduta di pressione e il coefficiente di pressione cv.
Altre simulazioni sono dedicate all'ottimizzazione di layout rispetto all'instaurarsi di fenomeni di turbolenza e della rumorosità da essa generata, o di cavitazione o, ancora, alla ricerca della posizione di equilibrio di organi sotto l'azione del flusso fluido (es. valvole swing check) dove le simulazioni traggono ulteriori vantaggi dalla possibilità di interazione

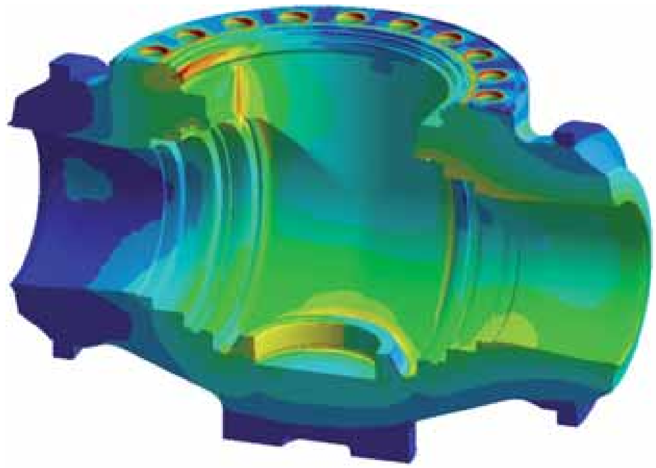

Fig. 6 - Sollecitazioni calcolate sul corpo di una valvola top-entry – FEM Analysis

con il calcolo strutturale (FSI- Fluid Structure Interaction) permettendo l'analisi di fenomeni dinamici quali la chiusura impulsiva della valvola generata da rottura della linea.
Come per il caso strutturale l'efficacia delle tecniche numeriche è recentemente aumentata grazie al notevole impulso ricevuto dalla disponibilità di ambienti di lavoro che combinano facilità operative ed estrema efficienza numerica (es. disponibilità di solutori paralleli e ad alte prestazioni).
Le applicazioni sopra citate rappresentano alcuni esempi di quelle su cui EnginSoft ha sviluppato una notevole attività di ingegneria e trasferimento tecnologico verso numerosi produttori italiani. Grazie alla pluriennale esperienza acquisita, EnginSoft si candida quindi come partner per tutte le aziende che intenzionate ad affinare il livello della propria progettazione intendano ricorrere alla prototipazione virtuale potendo fornire oltre ad attività di ingegneria anche la tecnologia di simulazione leader nel settore (ANSYS) e tutte le attività di formazione e di trasferimento di tecnologie di simulazione consolidate e validate.

Per ulteriori informazioni:
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Reliability Analysis of Offshore Structures and Inspection Planning

The need for risk assessment and reliability criteria is becoming the major requirement for offshore structures, where probabilistic analyses are achieving progressively greater importance.

EnginSoft, always committed in research and training, is collaborating with Padua University on the reliability analysis of offshore structures, including the support of a PhD. grant within the Industrial Engineering Department. Typical offshore platform components include "steel jackets" (those parts of the structure immersed in water) and "topside components" (those parts above water). Within this assembly, the most critical elements are the welded tubular connections.
The main objective of the research project lies in the development of routines to assess structural reliability based on unambiguous and scientifically-recognised criteria, with a view to the accurate quantification of operational life and the planning of appropriate inspection protocols.

The aforementioned issues deal with probabilistic structural design field, where both loads (dependent on wave and wind forces) and geometrical parameters and materials resistances are described in terms of stochastic quantities. To cope with this type of problems it is necessary to make use of specific regulations which describe the random nature of the problem. These standards(based on the LRFD approach described below) have been developed according to a probabilistic logic and provide a valuable tool for the verification of the structural components, ensuring predetermined reliability levels. Within the research project, the concept of the reliability of a single component has been reviewed and the process further developedto address systems level performance. The principal Operations Research strategies have then been implemented to identify the dominant failure modes of the structure. Finally, these issues ahve been reviewed in the context of inspection planning, with the ultimate aim of increasing system safety and reducing the costs connected with offshore structures construction and maintenance.

WSD and LRFD Standads
The design approach of the structures in general and those which, in particular, work and live in the offshore environment, is governed by two distinct design philosophies, identifiable in WSD approach (Working Stress Design) and LRFD approach (Loading and Resistance Factor Design).

The first methodology considers the combined effect of the forces acting on the component or on the structure, reducing, by a factor of safety Ω, the ultimate resistance Rn of the member in such a way that the state of resulting effort is comparable with a reference limit (allowable stress) below the yield point of the material. Although this is a relatively simple method, there is no universal method for determining the coefficient Ω, which is mainly based on past experience and on the need to remain 'far-away' from the materials performance limits.

Otherwise, the LRFD approach provides a more rational and rigorous design alternative. According to this methodology, the overall effect of the load combination acting on a member is determined by amplifying the characteristic value of each load with a load factor γ_S, that depends on the load type and the likelihood that

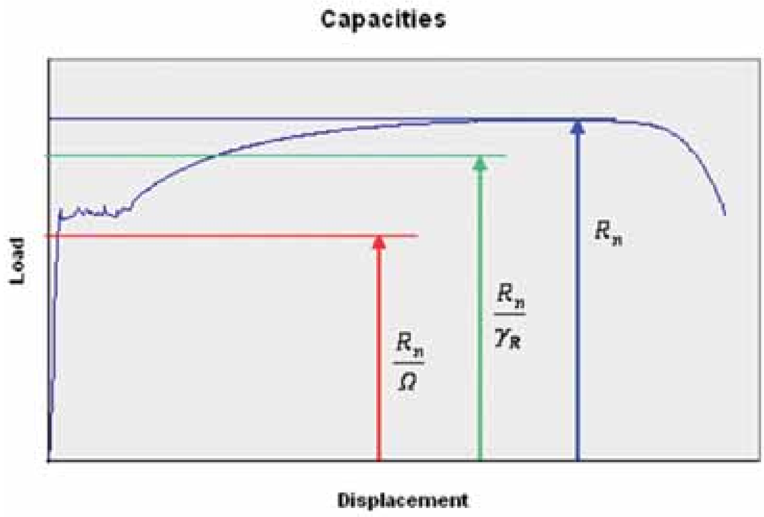

Fig. 1 - Difference between WSD and LRFD standards.

verification for safety and serviceability with respect to limit state criteria. The term "serviceability” refers to all those issues (vibration, deformation, etc.) that reduce system performance but do not represent a security threat. The term “safety” refers to the absence of collapse or damage in the structure. Safetyis ensured by applying design criteria defined by limit state equations for ultimate failure and fatigue.

Introducing an Ultimate Limit State function, g(X), as the difference between the resistance R of the member and the stress (or loads combination) S acting on the member (in other words, g(X) = R-S), it is possible to see that the component is safe when g(X)> 0. Thus, the probability of failure P_f is equal to the area subtended by the distribution of

more loads are present simultaneously. Thus, the overall effect is maintained below a certain reference value, related to the ratio between the nominal resistance (characteristic value) R_n and the resistance factor γ_R (see Fig.1)

Through the introduction of the load and resistance factors, the uncertainties resulting from applied loads and those related to the resistance characteristics of the member are treated separately. These coefficients are determined in a semi-probabilistic way, through a procedure known as "design code calibration" (or also "calibration of partial safety factor").

Conversely, the WSD approach is largely dominated by the deterministic philosophy, whose intrinsic characteristic is the presence of high safety factors, with consequent oversizing and high associated costs of realization. Moreover, the determination of Ω based on the behavior of existing structures can lead to the adoption of inappropriate or even obsolete solutions for new generation structures, thus representing a potential source of danger.

Hence the development of a branch of civil engineering based on probabilistic codes, known as “structural reliability analysis”. It is particularly important to develop this approach for structures which operate in highly random environments, and especially so where their failure might have serious repercussions for security, cost and the environment. Offshore structures are therefore exemplary candidates for such an analysis approach.

Component Reliability Analysis

Ensuring the high performance of an offshore structure requires its

g(X) for values less than zero (see Fig.2). Given the joint probability density function $f_{R,S}(r,s)$, the probability of failure P_f is defined by the following expression:

$$P_f = 1 - \mathcal{R} = P[g(R,S) \le 0] = \int_{g \le 0} f_{R,S}(r,s)\, dr ds$$

Otherwise, the reliability $\mathcal{R}$ is defined as the probability of the resistance being greater than the applied stress. In the hypothesis of independence between R and S the following well-known formula can be derived:

$$\mathcal{R} = P(R \ge S) = \int_0^\infty f_R(\sigma) \left[\int_0^\sigma f_S(s) ds \right] d\sigma$$

The difficulties associated with the calculation of P_f are numerous. Generally, the limit function g(X) is a nonlinear function of X and consequently the domain of integration g(X)<0 is not linear either. Moreover, in real problems, the number of random variables involved is high, so that a multidimensional integration is required, which may have a high computational cost. To overcome this issue numerous methods have been developed for the approximate calculation of P_f. Of these, the "First Order Reliability Method" (FORM) is the most frequently used.
The FORM method operates in the U-space of uncorrelated standard normal variables, obtained through the

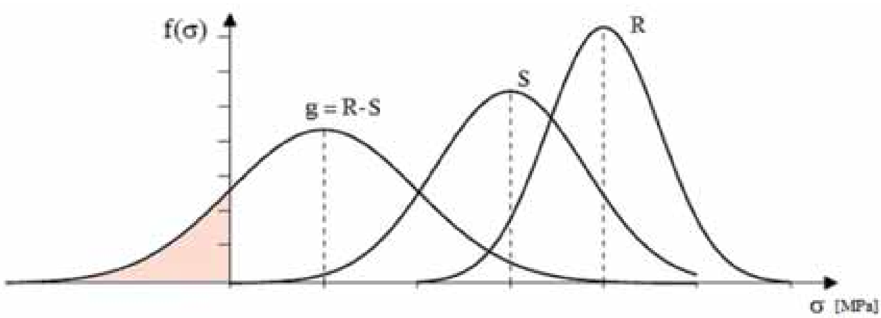

Fig. 2 - Probability density functions relative to material resistance, stress in the member and their difference, i.e. the ultimate limit state function.

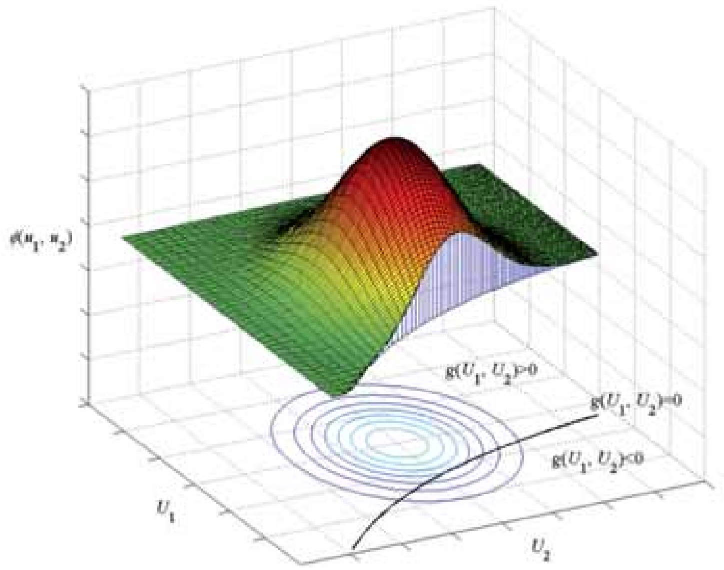

Fig. 3 - Space of uncorrelated standard normal variables: Rosenblatt transformation

Rosenblatt transformation of the original X-space, as illustrated in Fig.3. The reliability is then calculated by linearizing the limit state curve in the neighborhood of the most probable point (MPP, see Fig.4) and using the following analytical solution for linear limit functions:

$R=\Phi(\beta)$

where β is the reliability index, defined as the distance of the MPP from the U-space origin, i.e. the minimum distance of the curve g(U)=0 from the origin. Consequently, the calculation of R is reduced to a minimum optimization problem (HLFR algorithm, see Fig.5).

Fatifue Analysis of Tubular Welded Joints

The aforementioned Ultimate Limit Strength criteria can be applied to the study of the fatigue failure of a component. In the present case the component is a welded tubular joint.

In a steel jacket type platform, tubular joints connect the main elements of the structure (bracing and legs) and represent, as always, the critical factor in relation to the fatigue behavior. As for the latter, it has a significant impact in all structures characterized by persistent and extreme dynamic loads (North Sea), or when there are no dominant high load design events such as hurricanes or typhoons (Arabian Gulf, West Africa).

The importance of fatigue as a key design consideration has been emphasised by the increasing use of higher strength steels and welded connections. In the earlier offshore platforms, steel strengths were low and the connection were riveted or bolted. These resulted in larger member cross-sections, highly redundant connections and lower cyclic stress. Since the fatigue strength of steel is not strongly correlated with its yield strength, fatigue was a lesser problem for the members and connections in such structures. This is not the case with more recent platforms that use steel yield strengths as high as 700 MPa Such designs typically deploy smaller member cross-sections and are inherently more vulnerable to fatigue failure.

Limit State Criteria are based on experimental data characterising SN-curves, and on the Miner-Palmgren hypothesis (the linearity of cumulative damage):

$$g(t) = \Delta - D \quad and \quad \mathrm{D} = \sum_i \frac{\mathrm{n(s_i)}}{\mathrm{N(s_i)}}$$

where Δ describes the damage at fatigue failure; D is the cumulated damage up to the actual time t and it is defined by the ratios between the stress cycles number *n* with amplitude s_i applied to the member, and the stress cycles number *N* with the same amplitude needed to lead it to failure.

Instead of the SN-curve approach (Miner's rule) a fracture mechanics approach (Paris' law) needs to be adopted to assess more accurately the different stages of crack growth, including the calculation of residual fatigue life beyond through-thickness cracking.

$$g(t) = R(a_c, a_0) - S(t, t_0) = \int_{a_0}^{a_c} \frac{da}{\left[Y(a)\sqrt{\pi a}\right]^m \cdot G(a)} - CA^m \Gamma\left(\frac{m}{B}+1\right) v_0(t-t_0)$$

The above expression defines the difference between the crack growth from ao to ac (resistance), and the crack growth corresponding to a number of cycles N_o to N (load effect). These terms depend on the following parameters:

- Y(a) is the crack geometry function;
- C and m are material parameters;

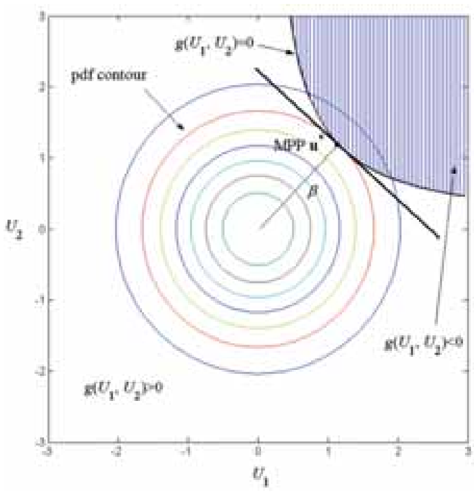

Fig. 4 - Graphical representation of the reliability index.

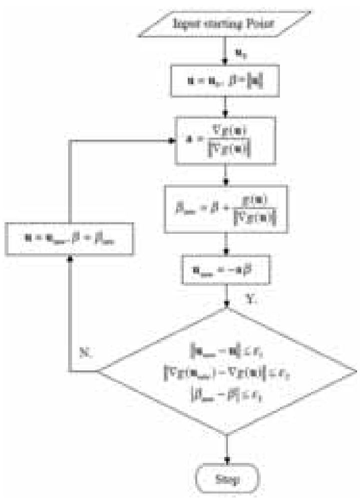

Fig. 5 - Hasofer-Lind and Rackwitz-Fiessler (HLFR) algorithm

H_m Significant Wave Height (ft)	T_n Zero Crossing Period (Seconds)								Total Probability
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14+	
0-3	0.114	0.225	32.551	16.810	0.105	0.001	0.000	0.000	49.806
3-6	0.000	0.002	7.951	30.110	2.575	0.003	0.000	0.000	40.641
6-9	0.000	0.001	4.255	3.250	0.006	0.006	0.000	0.000	7.518
9-12	0.000	0.000	0.080	1.450	0.150	0.003	0.001	0.000	1.684
12-15	0.000	0.000	0.000	0.006	0.125	0.075	0.015	0.000	0.221
15-18	0.000	0.000	0.000	0.000	0.050	0.010	0.010	0.000	0.070
18-21	0.000	0.000	0.000	0.000	0.010	0.045	0.000	0.000	0.055
21-24	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.005
24-27	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27-30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30-40	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total Probability	0.114	0.228	44.837	51.626	3.021	0.148	0.026	0.000	100.000

Table 1 - Two-dimensional scatter diagram for significant wave heights and zero crossing periods: P(Hm,Tn).

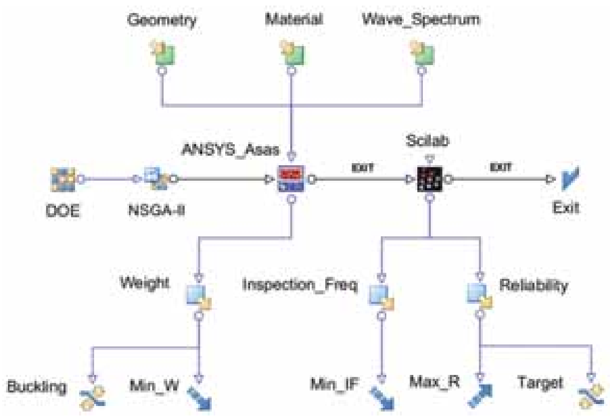

Fig. 6 - Sample modeFRONTIER workflow for multi-objective optimization

- v_0 is the average stress cycle frequency, so that $v_0(t-t_0)=N-N_0$;
- $E[S^m] = A^m \Gamma\left(\frac{m}{B}+1\right)$ is the expected value of the long-term stress range, from which the function G(a) depends and the major uncertainties are related to.

It is crucial that the fracture mechanics approach is calibrated to the SN-approach for the initial stage of the fatigue life, to ensure that the initial crack size and the local geometry are properly represented.

Generally, while the fracture mechanics approach is used for inspection planning, the S/N approach is used for the standard fatigue analysis of tubular joints, which involves the following steps:

1. Prediction of the fatigue design wave parameters and their likelihood of occurrence (see Table 1)
2. Calculation of the nominal cyclic stress ranges and number of cycles at the brace ends
3. Calculation of the stress concentration factors (SCF) and the hot-spot stresses range (HSSR)
4. Selection of the applicable s-n fatigue design curve
5. Calculation of the fatigue damage ratio (miners fatigue damage ratio)
6. Demonstration

System Reliability Analysis and Failure Modes Identification

The main applications of structural reliability analysis can be summarized as follows:

- Optimization of design solutions, e.g. the fatigue life factor can be estimated and combined with the frequency of in-service inspections so that an expected lifetime cost is minimized. See Fig.6.
- Reliability updating of a structure based on new information obtained during the service life. In this context, reliability methods can also be an efficient tool for assessment of lifetime extensions of structures beyond their original design lives.
- Inspection planning at the design stage. Here, the probability of a fatigue crack is linked to the probability of detecting a crack in a considered structural detail. Reliability methods are used to estimate the time to first inspection and to determine the interval between subsequent inspections.

The structural system reliability analysis plays a crucial role in each of the aforementioned applications. For a structure with a high degree of redundancy, the failure mode approach is used to evaluate system reliability. That is, all the potential failure modes (mechanisms) in a structure are modeled as elements of a series system (MCS, Minimum Cut Sets representation). See Fig.7.

An offshore structure has numerous failure modes, but only some of them actually contribute to the system reliability, while others have very low probability of occurrence. Depending on the complexity of the structure and the accuracy required, several methods have been developed for the identification of the dominant modes, which can be divided into three basic categories:

1. Simulation-based approaches (directional simulation)
2. Plasticity-based approaches (β-unzipping method and linear programming)

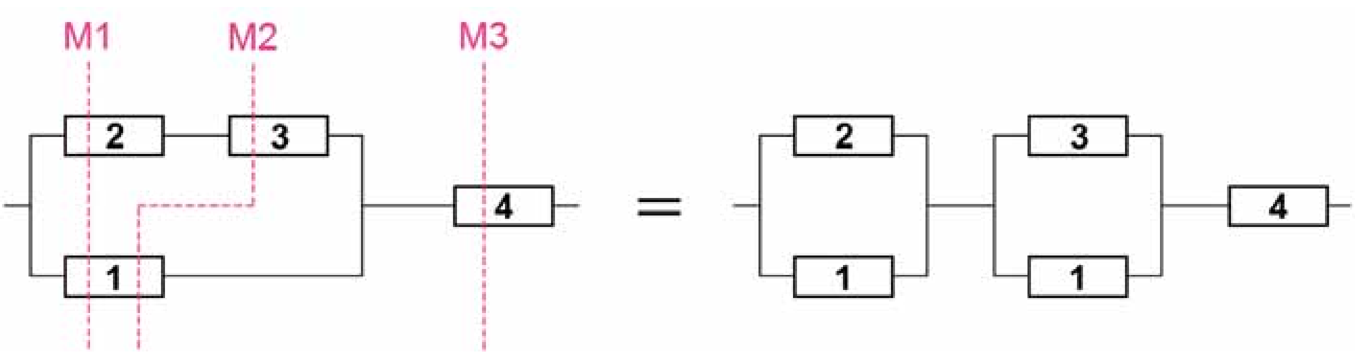

Fig. 7 - Minimum cut set representation of a system with three failure modes.

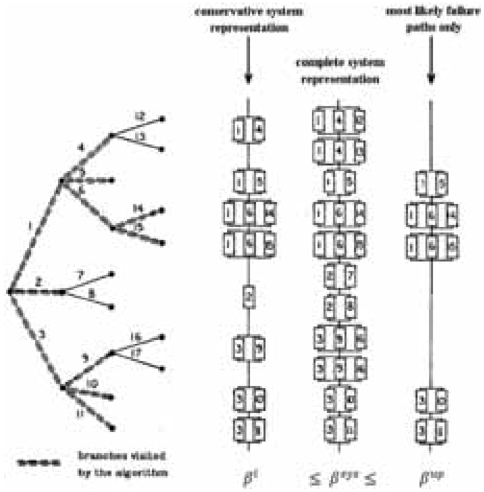

Fig. 8 - Truncated enumeration of dominant failure modes through branch and bound method.

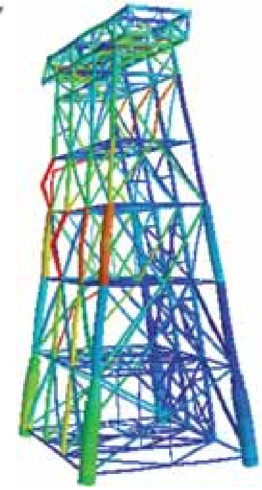

Fig. 9 Dominant failure modes in a steel jacket.

3. Enumeration approaches (branch and bound method and incremental loading method)

The branch and bound is the most commonly used method in the offshore field. See Fig.8-9.

The branch and bound method uses a probabilistic research algorithm for the identification of failure paths, i.e. the failure paths are enumerated depending on their probability of occurrence. In the process of path enumeration, many paths have common elements and are highly correlated.

For the above reasons, the branch and bound method, although theoretically rigorous, is very expensive for large structures. To speed up the search, various deterministic approaches are used (incremental techniques and plastic mechanisms analysis), by replacing the random variables of stress and resistance by their characteristic values.

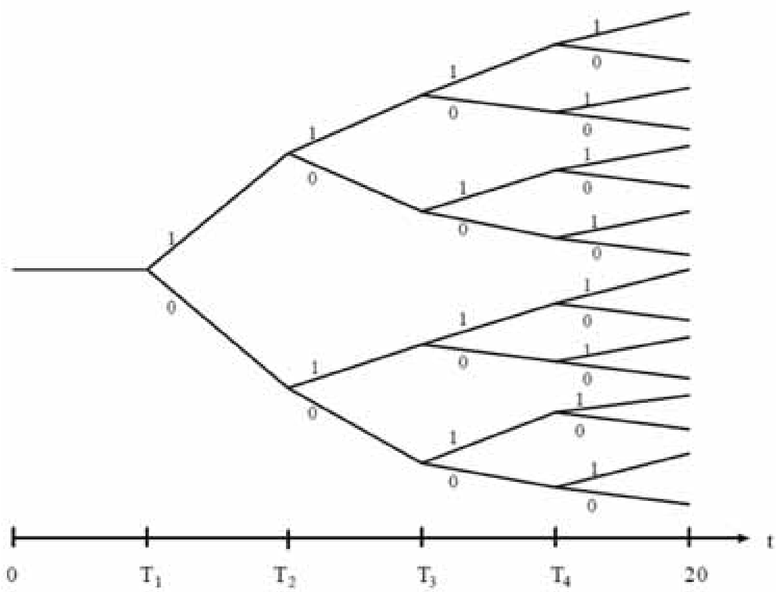

Fig. 10 - Fig. 10 . Inspection and repair strategy for event tree analysis considering 4 consecutive inspections with a frequency of 4 years []

These methods are faster, but do not ensure the effective identification of all probabilistically dominant modes. To combine the demand of accuracy and computational efficiency, research undertaken in the last decade has addressed the use of genetic algorithms.

Reliability Updating and Inspection Planning

Although the main application of reliability based methods has been in requalification of existing offshore structures, it is also feasible to apply fatigue reliability analysis at the design stage to optimize inspection, maintenance and repair (IMR) strategies by using an event tree procedure (event 1 = “crack detection and repair”, event 0 = “no crack detection”, see Fig.10).

Given the inspection event IE, the fatigue failure probability of a joint can be updated based on the definition of the conditional probability,

$$P[g(t) \leq 0 \mid IE] = P[(g(t) \leq 0) \cap IE] / P(IE)$$

where g(t) is the fatigue limit function according to Paris' law.

The inspection event IE is defined by an expression similar to that of g(t), where the upper limit of integration ac in the resistance term is replaced by the minimum detectable crack size aD, and the lower limit depends on the repairs history, as shown in Table 2.

This definition implies that IE is positive when the crack size developed up to the time of inspection is smaller than aD, thus, the event IND = IE>0 means "no crack detection" while the complementary event ID = IE<0 stands for "crack detection and repair".

$$IE = R(a_2, a_1) - S(T_b, T_a) \begin{cases} > 0 & \text{no crack detection} \\ < 0 & \text{crack detection and repair} \end{cases}$$

The fatigue failure probability of a joint can be evaluated using the law of total probability; e.g. referring to Fig. 10, the probability of failure for time T1<t<T2 is given as follows:

$$P_f(t) = P_f(0, T_1) + P[g(0, T_1) > 0 \cap I_{ND} \cap g^0(T_1, t) < 0] + P[g(0, T_1) > 0 \cap I_D \cap g^1(T_1, t) < 0]$$

To perform an inspection implies the reduction of the uncertainty associated with the knowledge of the system. In mathematical terms, this fact is reflected in Fig.11 by an increase of the index of reliability β both in the case of in-service inspection (green curves), and in the case of inspection planning at the design stage (red curve).

Time	Branch	Fatigue Limit Function		Inspection Event	
		Damage func. $R(a_2,a_1)$ *	Time limits T_b, T_a **	Damage func. $R(a_2,a_1)$ *	Time limits T_b, T_a **
0<t<T1		a_c, a_0	t, T_0	a_{D1}, a_0	T_1, T_0
T1<t<T2	1	a_c, a_{R1}	t, T_1	a_{D2}, a_{R1}	T_2, T_1
	0	a_c, a_0		a_{D2}, a_0	T_2, T_0
T2<t<T3	11	a_c, a_{R2}	t, T_2	a_{D3}, a_{R2}	T_3, T_2
	10	a_c, a_{R1}		a_{D3}, a_{R1}	T_3, T_1
	01	a_c, a_{R2}		a_{D3}, a_{R2}	T_3, T_2
	00	a_c, a_0		a_{D3}, a_0	T_3, T_0
T3<t<T4	111	a_c, a_{R3}	t, T_3	a_{D4}, a_{R3}	T_4, T_3
	110	a_c, a_{R2}		a_{D4}, a_{R2}	T_4, T_2
	101	a_c, a_{R3}		a_{D4}, a_{R3}	T_4, T_3
	100	a_c, a_{R1}		a_{D4}, a_{R1}	T_4, T_1
	011	a_c, a_{R3}		a_{D4}, a_{R3}	T_4, T_3
	010	a_c, a_{R2}		a_{D4}, a_{R2}	T_4, T_2
	001	a_c, a_{R3}		a_{D4}, a_{R3}	T_4, T_3
	000	a_c, a_0		a_{D4}, a_0	T_4, T_0
T4<t	1111	a_c, a_{R4}	t, T4		
	1010	a_c, a_{R3}			
(examples)	0101	a_c, a_{R4}			
	0000	a_c, a_0			

* $R(a_2,a_1)=\int_{a_1}^{a_2}\frac{da}{Y(a)^m(\pi a)^{m/2}G(a)}$ ** $S(T_b,T_a)=C\nu_0(T_b-T_a)A^m\Gamma\left(1+\frac{m}{B}\right)$

Table 2 Integral limits in fatigue limit function and IE function for the event tree defined in Fig.10

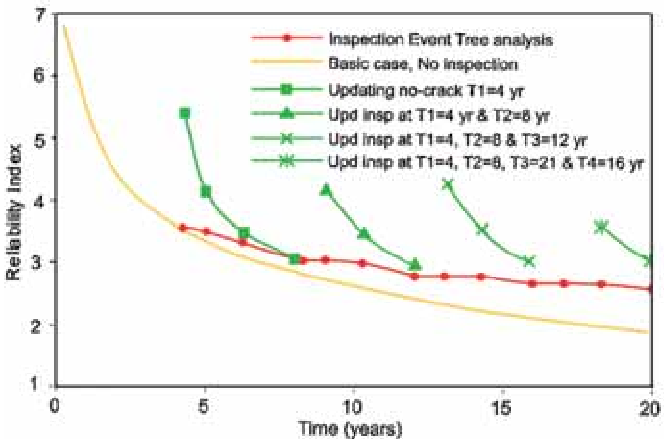

Fig. 11 - Reliability updating of a tubular joint considering 1, 2, 3 and 4 inspections with no crack found carried out at 4, 8, 12 and 16 years, respectively, compared with updating through event tree analysis

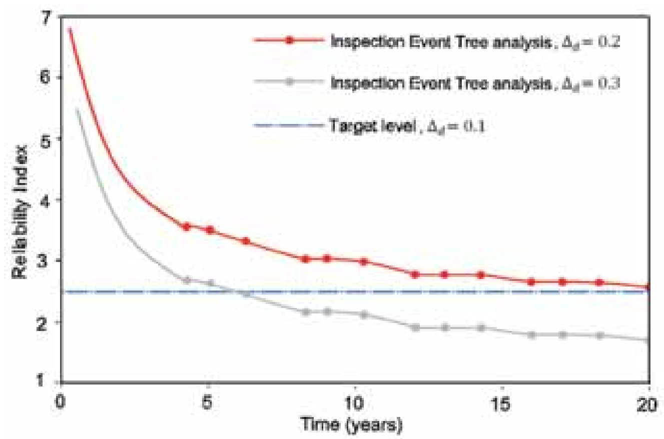

Fig. 12 - The allowable cumulative damage Δd in design can be relaxed when inspections are carried out: the target level Δd=0.1 with no inspections can be reached by a Δd=0.2 when inspections are carried out every fourth year.

Although the latter case has a smaller effect on the damage curve, it plays an important role in reducing the construction costs. In Fig.12 is shown the effect of inspection planning at the design stage on the reliability index trend: the design solution given by red curve satisfies the constraint on the allowable cumulative damage ($\Delta d = 0.1$), despite the member is the result of a non-conservative design (it is designed to reach a cumulative damage $\Delta d = 0.2$ if no inspections are carried out). This results in a lower cost design.

Reliability updating and inspection planning cannot be divorced from system reliability analysis, as the failure of redundant offshore structures may result in a sequence of overload or fatigue failures of components. Since the updating of systems reliability by inspection events may imply lengthy calculations, simplifications should be implemented, e.g. by updating the failure probability of non-inspected joints based on results of inspected joints.

This simplification is justified due to correlation between joints in complex systems, which implies similarities in load effects and resistance among the components. Thus updating the reliability of non-inspected joints may be carried out by utilizing inspection results from inspected joints and so the overall system reliability may be updated accordingly.

Conclusions and Future Research

The concept of component reliability was introduced as the cornerstone of the reliability assessment of the entire system. In particular, its importance was emphasized with reference to the issue of inspection planning. Work is underway to implement operations research strategies to identify the dominant failure modes in the structure (e.g. branch and bound) and incorporate, within these methodologies, numerical procedures for the efficient probabilistic assessment of reliability (eg. FORM).

This code will be fully developed in Scilab and integrated into a routine to calculate the reliability of offshore structures, based on their stress responses computed by the Ansys ASAS software, linked to the optimisation of inspection planning through the modeFRONTIER software tool.

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Optimised Workflows for Composite Design

Improving the efficiency of complex material design and optimization, increasing the performance of composite parts and tuning the final property profile

Advances in simulation tools provide engineers and material scientists the opportunity to streamline the computational design of complex composite materials and parts. For example they stand to benefit from the integration of optimization and material modelling software, such as modeFRONTIER and DIGIMAT. DIGIMAT is a non-linear multi-scale material and structure modelling platform. Based on the material microstructure, it predicts the non-linear constitutive behaviour of multiphase composite materials. It provides interfaces to processing software and FE solvers and enables coupled analyses giving a realistic picture of the final performance of composite parts. For advanced studies, such as dealing with the material anisotropy, temperature and strain rate dependency or creep, such coupled analyses can become challenging to setup. These are efficiently designed thanks to the integration with modeFRONTIER and its powerful optimization algorithms. Indeed modeFRONTIER together with DIGIMAT offers parametric optimization at different levels. First it drives the modulation of the required material models towards a desired optimum macroscopic response such as illustrated in the present article for the composition of a multiphase polymer composite. Secondly, it enables fitting of material models to experimental data. Furthermore, it could tackle the parameterization of the coupled analyses such as structural models. Finally, it could bring the processing step into the loop so that the processing parameters themselves become design variables for the performance of the final part. The link between DIGIMAT and modeFRONTIER thus advances the integration of computational material engineering and engineering design, supporting collaboration and faster development times.

Introduction

Composite materials are of ever increasing importance in a huge range of applications. Among others, reinforced plastics replace metal designs as they were used in the past, targeting the request to build lightweight structures, a common driver. Hence they are used in many industries including automotive and aerospace. However they exhibit highly complex material behaviours imposing the assessment of various part performances for the composite design. Covering performances means to describe properly the stiffness and failure of composites in static and dynamic load cases. Even fatigue as a topic meets increasing demand in order to approximate the lifetime of the final design.

The complex performance assessment of composite parts is due to the influence of the underlying microstructure of the composite material. The microstructure causes anisotropic and locally different material behaviour. A strong dependency on the processing conditions is observed. Commonly, the material response is non-linear as well as temperature and strain rate dependent. Hence each composite exhibits its own challenging behaviour and needs individual treatment for its description in a computational approach.

Computational modelling of composite materials

Mathematical and computer simulation models of composites date back many years, see for example the work by Fricke in 1924 (Fricke, H. A mathematical treatment of the electric conductivity and capacity of disperse systems. Phys. Rev. 24, 575-587). In this context the so-called mean-field homogenization approaches have been key to effective modelling for these materials. At the same time, the molecular

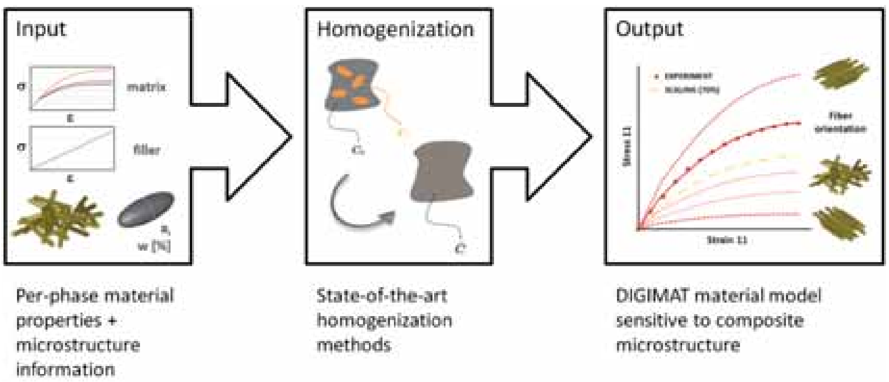

Fig. 1 - Principle approach of material modelling in the Digimat-MF module. Mean-field homogenization is used to compute the non-linear response of multi-phase composite materials in terms of mean values. A great advantage of this technology is the enormous speed of the computation which allows to use it directly as a material model to compute properties on-the-fly. The resulting material model is fully anisotropic.

and materials modelling community developed more explicit models of composites, in particular in the context of the emergent nano-composites.

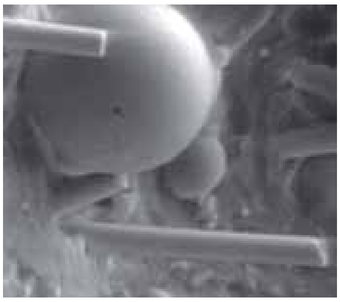

Fig. 2 - Micrograph of glass bead and fibre composite. Copyright of Sovitec & e-Xstream engineering I All rights reserved.

However, for a long time there was limited industrial impact largely due to a lack of a consistently integrated approach. Explicit finite element models of composites are expensive computationally, and more efficient methods like the above mentioned mean-field approaches were not integrated into CAE workflows. Also, the methods and functionalities offered within CAE packages do not take the intricacies of the materials into account. In particular, many industrially interesting composite materials are reinforced plastics, and thus are based on some polymer matrix. Polymers are typically non-linear, visco-elastic/plastic materials, i.e. have complex response behaviour.

A breakthrough for industrial applications was achieved through the development of mean-field homogenization in a commercially available context and the dedication of this approach to its application on polymer composites. Roughly ten years ago, the founders of e-Xstream engineering decided to develop the software DIGIMAT, which today provides an integrated strategy towards multi-scale material modelling. This includes the prediction of macroscale composite performance from the microscopic level based either on explicit finite element calculations or mean-field approaches and enables the design of composite parts by connecting to standard CAE packages. Local microstructure effects on the composite properties are taken into account by coupling to results delivered by processing software, nowadays covering more and more technologies. In the past the emphasis was on short fibre reinforced plastics and injection moulding. Today draping of unidirectional and woven composites or compression and injection-compression moulding for short and long fibre reinforced materials can be taken into account, and even exotic technologies such as the microcellular plastic foam MuCell can be covered.

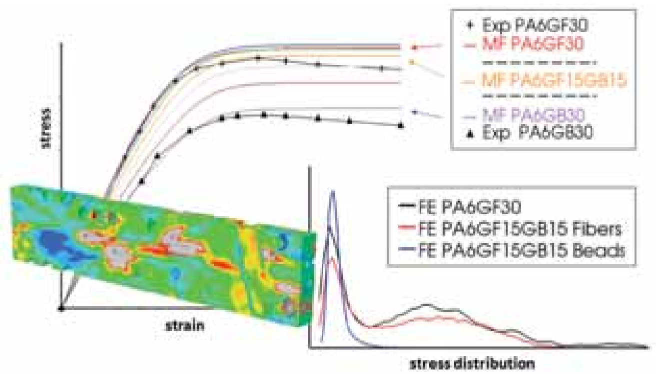

Fig. 3 - Case study for material design from collaboration between e-Xstream engineering and Sovitec. Digimat-MF stress/strain results are shown together with in-depth studies about the stress distribution based on Digimat-FE. The objective was to replace glass fibres (GF) by glass beads (GB) in a polyamide-based composite material. Targets were stiffness response along and transverse to the main fibre direction together with improvements in the failure and thermal anisotropy of the material. Among other benefits, the introduction of the new optimised material led to a reduction of 20% in price and 29% in cycle time per produced part. Copyright of Sovitec & e-Xstream engineering I All rights reserved.

In the context of the proposed workflows, we focus on the Digimat-MF and Digimat-FE solvers which enable the prediction of composite properties based on separate per-phase input for matrix and fillers combined with information about the material microstructure (shape, amount and orientation of fillers), see also Figure 1. Among a broad range of results that can be output are per-phase micro-stresses and strains for matrix and fillers as well as the macroscopic response of the composite material. Typically, the per-phase input is obtained by reverse engineering these material properties based on anisotropic measurements on the composite of interest.

A multidisciplinary design optimization for the modelling of composite materials and structures

Engineers and scientists aiming to determine the best materials choice for a particular application encounter different tasks that benefit from an integrated optimization approach along their workflow, leading to a truly multidisciplinary approach to engineering design. In the design of complex and tightly integrated engineering products it is essential to be able to handle cross couplings and synergies between different subsystems. Hence it is necessary to combine models from several disciplines in order to obtain a holistic view of the system. Furthermore, to achieve an optimal design, the product must be treated as a complete system instead of developing subsystems independently. To effectively design and develop such products, efficient tools and methods for integrated and automated design are needed throughout the development process. Multidisciplinary design optimization (MDO) is a promising technique that has the potential to drastically improve such a concurrent design. modeFRONTIER provides built-in capabilities that naturally drive the engineering design towards an MDO-based approach. MDO with DIGIMAT potentially includes coupling to the micro- and macroscale solvers available in DIGIMAT. In the context of composite material modelling in particular, three important scenarios can be devised for the integration between DIGIMAT and modeFRONTIER:

1. ***Integration of Digimat-MF***

   Digimat-MF integration enables two subsets of cases to be studied

o Parametric studies of multi-component composites
For a given composite material, parameter studies enable to find the optimal design in terms of its constitution (e.g. type & amount of fillers). Different kind of performances can be defined as a target for such an optimization (e.g. stiffness, thermal properties, ...)

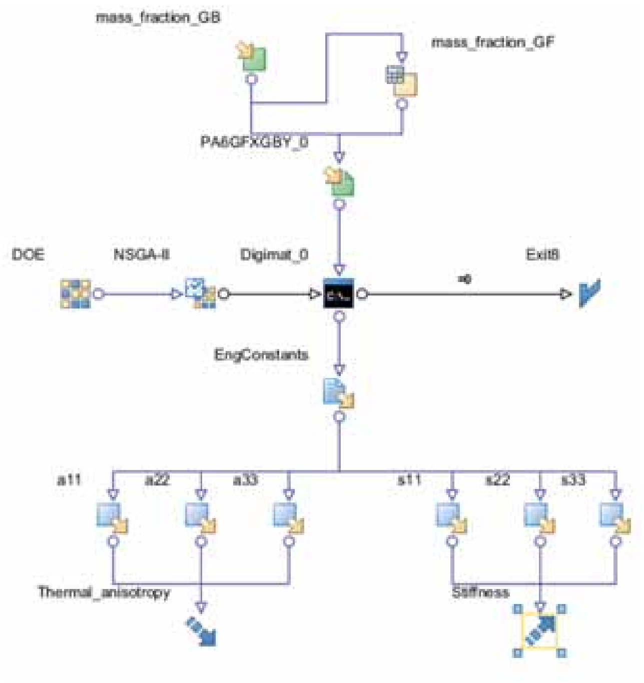

Fig. 4 - modeFRONTIER workflow, integrating Digimat-MF to determine the trade-off between different properties as a result of variations in the material composition in terms of the mass fraction of glass beads and fibres. The total amount of inclusions is kept constant, and the workflow objectives are to minimize thermal anisotropy while maximizing stiffness.

- ***Reverse engineering (RE) of materials models***
The quality of results of a coupled analysis strongly depends on the quality of the material model used. Best procedures are to reverse engineer the material model to anisotropic measurements on the composite material. Depending on the targeted performance, a large number of experimental results have to be taken into account. For anisotropy, it is common to measure at least 2-3 different orientations. For temperature and strain rate dependencies, 3 variations each can be seen as a minimum. Combining all these easily increases the number of curves targeted in the final model.

2. ***Integration of Digimat-FE***
Digimat-FE interacts with CAE software (e.g. ANSYS Workbench, Abaqus) as driver and solver, so this case would allow for optimization with a wide range of potentially complex target functions regarding the material properties (e.g. stress distribution in different phases of the material).

3. ***Integration of Digimat-CAE***
Digimat-CAE integration can be used to enhance the reverse engineering approach. Whereas Digimat-MF performs RE on the level of the material (integration) point, it can be also thought of doing the RE procedure on the level of the test specimen, setting up the full test scenario in a structural FE analysis. This can be advantageous if for example bending is the targeted performance. Bending can per-se not be computed on one material point.

In addition, with the MDO approach an enhancement to the processing and local microstructure workflow is possible where the solver of the processing software is triggered to produce these results on-the-fly. The optimization dimensions are henceforth broadened by taking into account directly the processing conditions for the composite part. However, this latter approach is very demanding in terms of computational effort and will probably only be used in some individual cases.

Application to the optimization of a multiphase polymer composite

ESTECO and e-Xstream are closely collaborating on the implementation of the MDO approach to create synergies for the design of composite materials (parametric studies) and the application of reverse engineering in complex scenarios (based on the Digimat-MF approach).
In the following, some applied example of MDO material design will be presented. It concerns the parametric, multi-objective optimization of a multiphase material, following a published case study by e-Xstream and the Sovitec company on glass bead and fibre filled nylon. A typical micrograph showing the glass beads and fibres exposed in the composite is shown in Figure 2.
The aim of this case is to screen the properties of a composite with at least two fillers, e.g. to see whether a given filler could be substituted at least partially by a cheaper option. A specific example is the substitution of glass fibre fillers by glass beads. The case was previously studied using Digimat-MF and Digimat-FE by e-Xstream and the glass-bead manufacturer Sovitec.

The aim was to replace a fraction of the glass fibre fillers in a polymer composite by glass beads. This would not only lower the price, but also improve a range of other properties such as lower the thermal anisotropy and improve processing (cycle time and durability of the processing tools), while retaining an acceptable modulus and strength (compare to Figure 3).
The key variables are the mass fractions of glass beads and glass fibres. The objective functions of the study included retaining a high stiffness while lowering thermal anisotropy. While a full investigation of all of the potential objective functions was beyond the scope of the current project, the integration of Digimat-MF with modeFRONTIER was shown to be very straightforward, and a trade-off optimization has been demonstrated.

The basic workflow is very straightforward as shown in Figure 4. Digimat-MF is run from a command line script inside of modeFRONTIER. The composite response under uni-axial strain is calculated for a range of material compositions, given by variations of the mass fraction of glass beads relative to fibres while keeping the total constant at 30%.

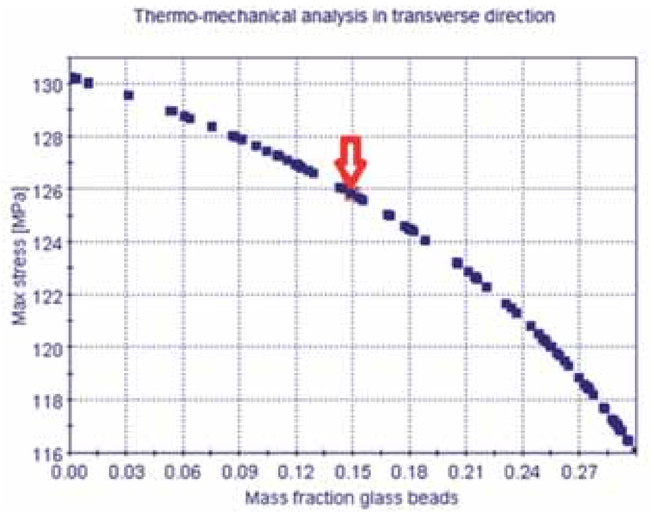

Fig. 5 - Transverse strain analysis showing the non-linear behaviour of strength

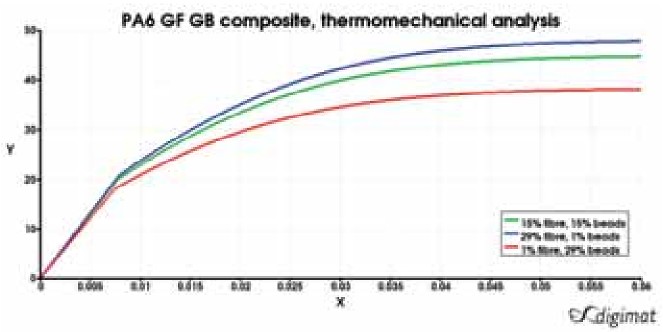

Fig. 6 - Stress (Y) versus strain (X) of PA6 polymer filled with glass fibres and glass beads showing in green the case indicated by the arrow in Figure 5.

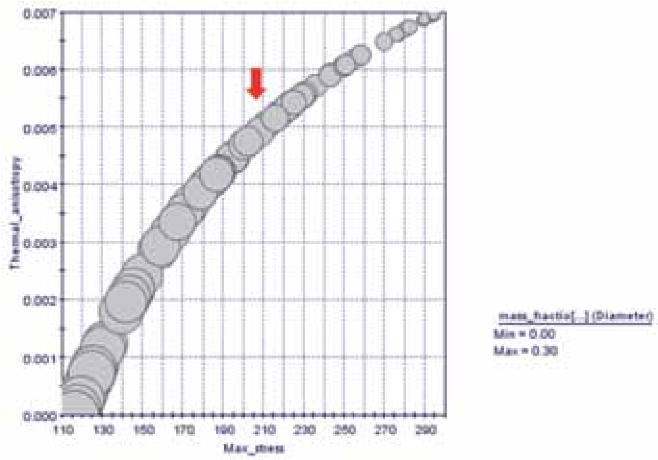

Fig. 7 - Thermal anisotropy versus the maximum stress as an indicator of failure strength. The bubble size indicates the fraction of glass beads.

The composition design space is explored by modeFRONTIER using a Design of Experiment approach (DOE) with Genetic Algorithm (NSGA-II). The objective function of the workflow is determined from the average thermal anisotropies (using the so-called relative anisotropy measure) and stiffness which are read from the DIGIMAT Engineering Constants output file.
The replacement of fibres by beads does not necessarily result in a large loss in stiffness. Figure 5 shows the non-linear response behaviour as a function of filler composition which results from strain applied in the direction transverse to the fibres. The run indicated by the arrow, replacing 50% of fibres by beads, shows only a 3% loss in the stress levels that can be sustained. These conditions and the relatively small loss in stiffness are also illustrated in the corresponding Digimat-MF stress-strain curves shown in Figure 6, and correspond well with those observed in the previous case study carried out by e-Xstream and Sovitec (compare Figure 3).

In addition, the modeFRONTIER workflows enable a trade-off analysis between different properties. For example, relationship between thermal anisotropy and stiffness as a function of the fibre and bead composition is shown in Figure 7. Note that in this case the Digimat-MF analysis was run with strain applied in the direction along to the fibres (rather than transverse as above). Indicated by the red arrow in Figure 7 is again the case of equal amount of beads and fibres, showing for example that the thermal anisotropy is obviously reduced, but only less than linearly. Hence one could conclude that replacing 50% fibres by beads retains substantial stiffness, but also reduces anisotropy by less than half.

Conclusions and outlook

The integration of DIGIMAT with modeFRONTIER provides a range of opportunities for streamlining workflows for the design of composites. Several scenarios have been discussed including parametric studies of multi-component composites and reverse engineering of material models, as well as optimization of a wide range of complex target functions. As a case study, a multi-component composite consisting of a polymer with glass fibre and glass bead fillers has been investigated.

The required Digimat-MF integration in modeFRONTIER proved to be very straightforward, and the parametric study reproduced the trends observed in a previous, detailed study very well. The modeFRONTIER workflow captures the whole design space within one range of simulations and the analysis enables the user to consider the trade-off between different target properties. The integration of DIGIMAT with modeFRONTIER is currently investigated in the framework of the second scenario, the reverse-engineering of a material model, which utilises the sophisticated optimization methods available in modeFRONTIER to fit DIGIMAT model response curve to experimental data.

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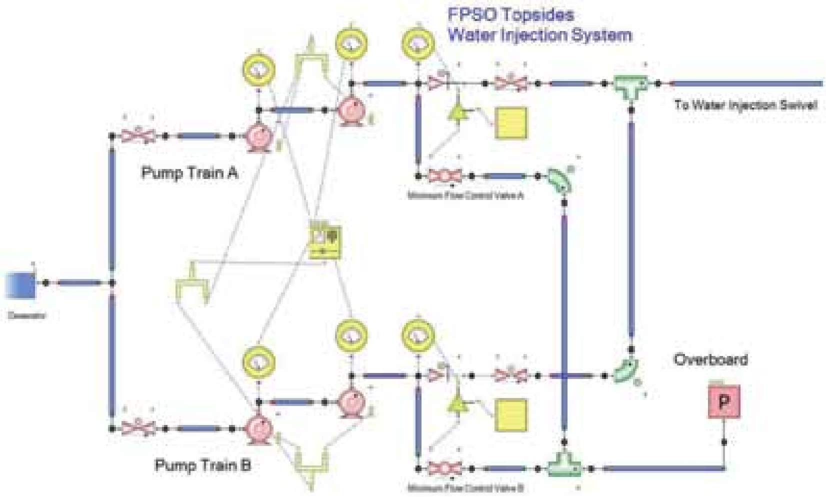
Using Flowmaster to Prevent Pressure Surge for Water Injection Systems in the Offshore Oil&Gas Industry

Surge Pressure
Surge pressure, (Water Hammer), is an important design consideration for water injection systems in the Offshore Oil and Gas Industry and the following challenges are frequently encountered:

- High operating pressures are required to inject large volumes of water into hydrocarbon reservoirs, resulting in high surge pressures, and significant costs are incurred to design a system capable of withstanding a high maximum allowable surge pressure.
- High fluid velocities are often encountered as operators try to squeeze the maximum performance from their systems, or when an existing system has been expanded considerably beyond its original scope. Higher surge pressures are generated when incompressible fluids at high velocities are suddenly halted.
- Long Pipelines, which can be several kilometres in length, are often deployed to connect offshore platforms/FPSOs to Subsea water injection equipment. When fluid is halted (e.g. by sudden valve closure) pressure energy is transferred to the pipe wall and a pressure wave is sent, at the speed of sound, from one end of the pipeline to the other. The time it takes for the pressure wave to reach the opposite end of a pipeline is increased with the length of the pipeline; additional fluid flows into the pipeline during this time must be compressed resulting in increased surge pressure.



Flowmaster screenshot of a Topsides water injection system

In this framework, the use of numerical simulation plays a fundamental role; by testing different operating and failure scenarios at an early design stage it allows to ensure safety while avoiding expenses of overly-conservative designs. In particular, the one-dimensional system-level approach provided by Flowmaster is comprehensive and effective from an engineering perspective. Indeed, it allows to study pressure surge in the entire system accounting for complex control systems in a fast and accurate manner.

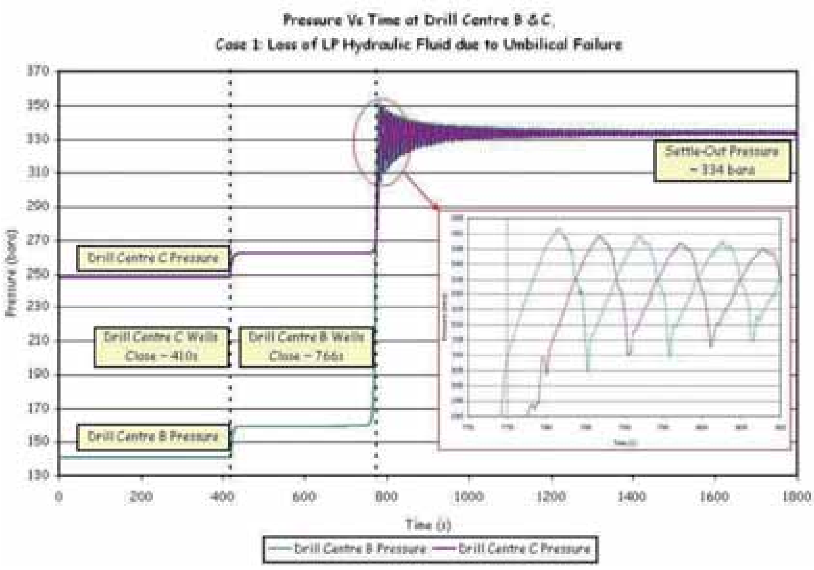
Identifying Surge Cases
Surge analysis on water injection systems is performed to determine the maximum pressure surges that can occur as a result of transient events such as rapid valve closure during pipeline operation, or pump trip and restart

operations. The first step in any surge analysis is to identify credible cases where surge can arise. For example, closure of a single valve in a complex water injection network is unlikely to be an issue; however, closure of all wells while water injection pumps continue to operate (e.g. due to malfunction of a facility's shutdown system) is potentially a serious concern.

The role of Flowmaster

After the surge cases have been identified, the next step is to build an accurate simulation model using Flowmaster. Both the Topsides and Subsea systems need to be considered to ensure confidence in any results obtained.
Water injection models usually commence at the de-aerator, which, due to the very brief nature of the transient events can be considered to be a constant-head flow source.
The water injection pumps and any major fittings are modelled downstream of the de-aerator. It is critical that control systems (e.g. minimum flow controllers), safety devices (e.g. Topsides bursting discs) and shutdown systems are included as they can have a significant impact on the results.
For the Subsea system all the pipelines and wells are included. The model usually ends downstream of the injection trees, or immediately upstream of the reservoir. Choke valves are modelled to control the flow rate to each well and the injection wing or master valves are slammed shut to create a surge event. Subsea risers, pipelines and jumpers should be modelled using the elastic pipes option to improve simulation accuracy.
When surge analysis is carried out at an early stage in the design of a water injection facility Flowmaster can be used to predict the maximum surge pressure and this can be used to select system design pressure. For surge analysis on an existing system Flowmaster can be used to investigate measures to mitigate surge (e.g. extending valve closure time) to ensure that the system's maximum allowable surge pressure is not breached. It is important that surge cases considered are realistic otherwise considerable expense may arise due to an overly-conservative design pressure on a new facility, or due to unnecessary modifications to an existing facility.
The advantages of using Flowmaster for surge analysis include:

- The fully elastic behavior of pipelines is accounted for.
- Small time steps can be used to accurately simulate fast-transients.
- Simulation times for large models, with many components and nodes, are relatively fast.
- Complex control systems can be utilized including PID controllers and advanced scripts
  (e.g. to trip water injection pumps upon detection of high discharge pressure).



Pressure Vs Time for Umbilical Failure Case

Ajmal Zia, Flow Assurance Consultant within the Offshore Oil and Gas industry explains how Flowmaster has been used for surge analysis of water injection systems, ranging from conceptual studies to detailed design.
"We recently conducted surge analysis for a Client involving the tie-in of a new drill centre to an existing system. The design pressure of the existing water injection system had to be adhered to, but significant changes to the control system were possible because a new MCS (Master Control Station) was being installed to service the new drill centre." explains Ajmal Zia.
In all cases, the mitigating measures either eliminated surge pressure entirely, or reduced it within acceptable limits.

"Flowmaster was an indispensable tool on this project. The simulations made it possible to quantify the severity of each surge case and to assess the effectiveness of each solution." concludes Ajmal Zia, Flow Assurance Engineer within the Offshore Oil & Gas industry.

For more information:
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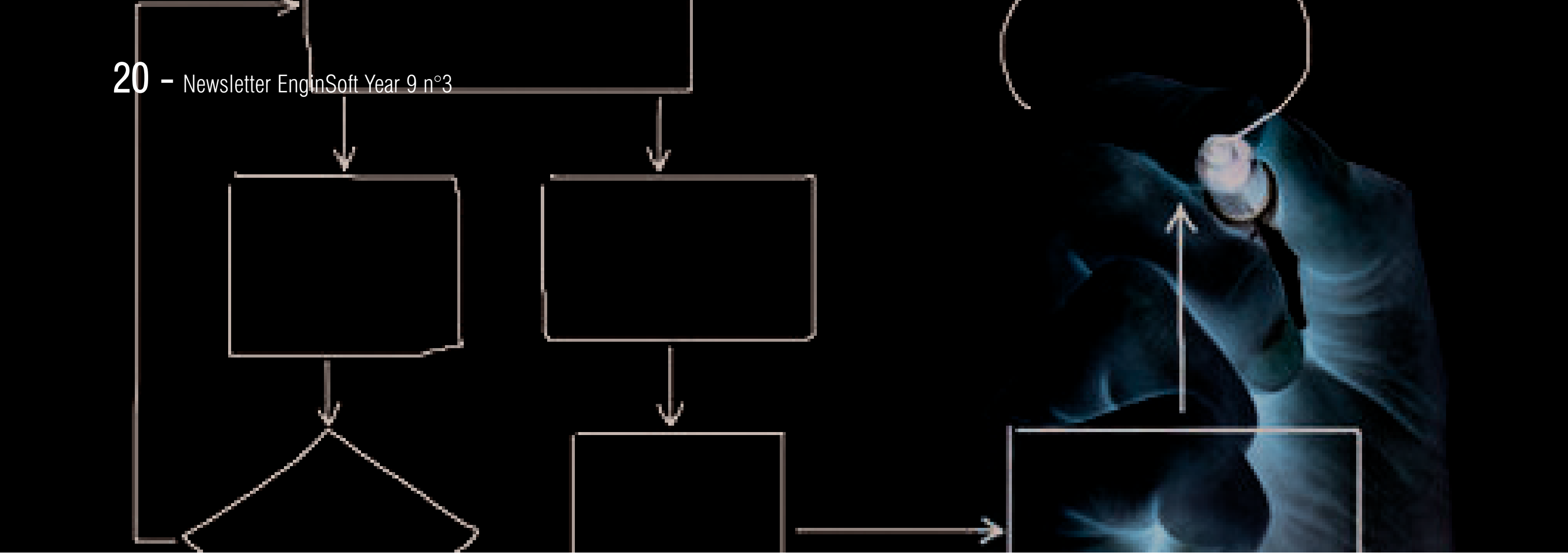
Learn more about Flowmaster at the Flowmaster European Users' Meeting in the frame of the International CAE Conference (www.caeconference.com). Key-note speakers include Morgan Jenkins (Mentor Graphics), Stefano Rossin (GE Oil&Gas), Marie-Sadako Guelle (EDF France), Gaëtan Malardé (DCNS), Javier Zornoza García-Andrade (Iberdola Ingenieria), Morten Kjeldsen (FDB), Fellin Francesco (Consorzio RFX).



INCOSE 2012
modeFRONTIER supports implementation and validation steps in systems engineering

modeFRONTIER's application range has been further expanded to the discipline of Systems Engineering owing to ESTECO's participation in the INCOSE Symposium 2012 held in Rome. The International Council on Systems Engineering (INCOSE) is a not-for-profit membership organization founded to develop and disseminate the interdisciplinary principles and practices that enable the realization of successful systems.
Every year INCOSE organizes a challenge dealing with a common use case derived from a practical problem to be solved by the participants and demonstrated in the exhibit area. This year's challenge consisted in designing a Permanent Emergency Response Coordination Center (PERCC) for wildfires, in charge of coordinating the Departmental Operation Centers (DOC). The two main expected improvements were to decrease response time and optimize resource allocation.

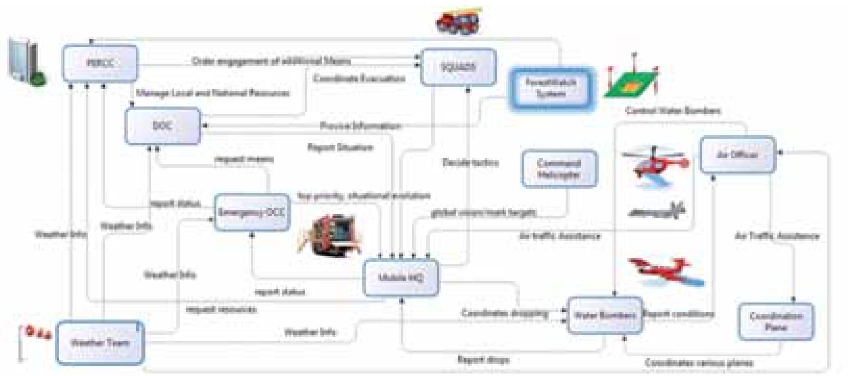


Fig. 2 - Interaction between systems and sub-systems diagram

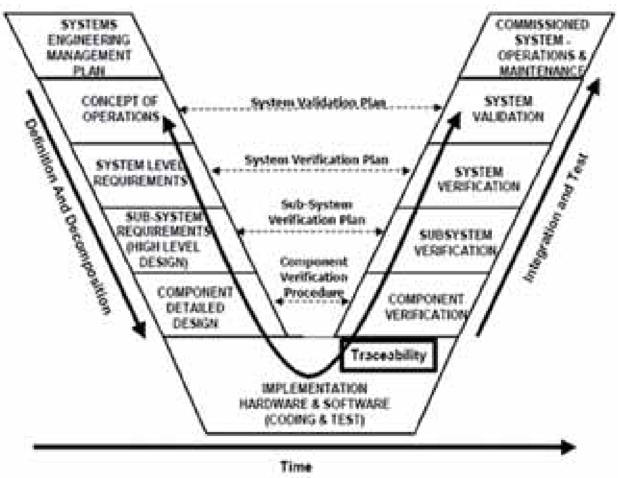


Fig. 1 - The V-model for the systems engineering process.

The solution proposal presented by ESTECO focuses on the benefits of modeFRONTIER's integration, automation and optimization tools for designing of complex systems and their deployment.

Content

System Engineering is based on a series of organized steps and procedures. The macro-steps composing this process are "Definition and decomposition" of the problem, "Implementation" of the software/hardware system and "Integration and recomposition" phase, i.e. testing and validation.
The application of modeFRONTIER proposed for the Wildfire Emergency System shows that this multidisciplinary platform can support both the implementation and the validation steps of the process.
modeFRONTIER supports the emergency management system at two different levels:

- ***At sub-system level***
  Consider a Forest Watch System composed by a network of towers, each equipped with a thermal camera with a

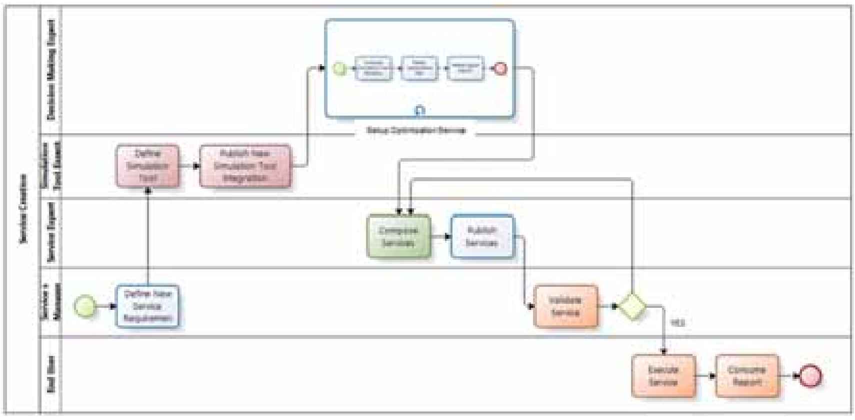


Fig. 3 - Service creation diagram

given observation radius and integrated with GPS Satellites. modeFRONTIER can find the best deployment of the Sensor network in order to maximize Efficiency and minimize Costs. The direct coupling with LabVIEW enables the integration of a number of hardware and software allowing for efficient system management. Another element to be considered at this level are the Unmanned Aerial Vehicles, which are often used to monitor and report wildfire position and extension. modeFRONTIER can be used to model and optimize UAV missions under different conditions for the purpose of covering efficiently as wide region as possible and provide valuable information about fire extension and spreading.

- ***At system level***
  At system level modeFRONTIER can be used to enhance the performance of an Emergency Coordination Center for

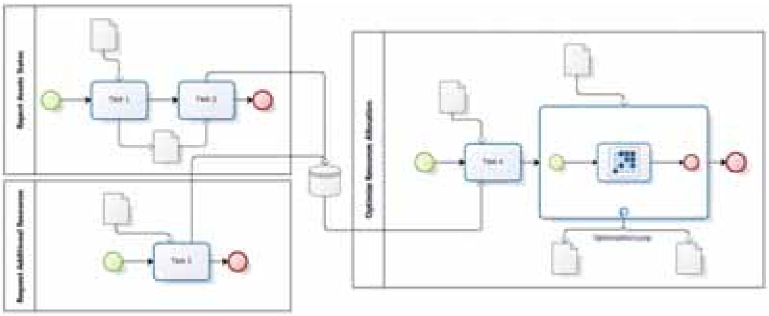


Fig. 4 - Workflow

wildfires, in charge of coordinating 11 departmental operation centers by identifying the optimal allocation of resources and minimizing the time for the resources to reach each center.
The solution can be arranged as a Web Service for PERCC to manage and automate procedures and communications, providing the decision makers with a new optimal solution generated each time the system configuration is updated.
Multiple services are set up and managed

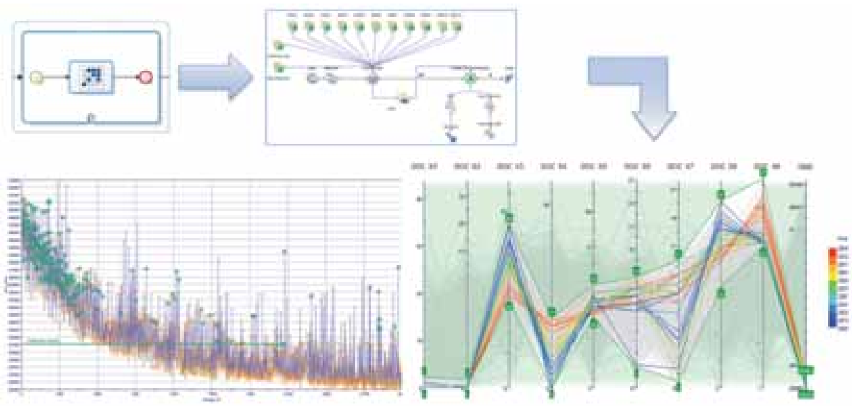


Fig. 5 - Optimal solution

through a central server in order to collect all information about the status of the assets and to simulate possible scenarios autonomously. Imagine a resource allocation problem under a massive fire alert occurring simultaneously in different regions.
Optimization is performed every time PERCC receives an update of the system status (eg. a change of risk level from any DOC on the basis of the reports of ground squads or water bombers, a change of resource availability due to holidays/illness/situational awareness, weather forecast or military/civil communications, etc.).
The model is based on a fixed distance matrix (to compute distances between each DOC center) and on a definition of initial resource allocation, which is regularly updated.
On the basis of the demand for resources from each DOC (in accordance with the reports, in particular when crises arise) PERCC uses the Optimization tool to calculate the resources that a given DOC should send to another DOC which requested additional units.
modeFRONTIER's capability to easily manage complex multi-objective problems allows finding the optimal allocation of resources, minimizing the time required for the resources to reach the DOC that requested the units.

Conclusions
The scenario outlined in this case study shows how the application of the modeFRONTIER multidisciplinary optimization platform can support both the implementation and the validation steps of a complex system engineering process. System engineers and domain experts can use this platform to execute models and check the compliance with requirements or perform trade studies throughout the design process. Executable models, even at a high level of abstraction, are cost-savers and help discover tricky problems, miscommunication issues, and missing or ambiguous requirements.

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ADVENTURECluster: An innovative structural analysis software for super large scale models

Examples in manufacturing process simulation

Simulation technologies are becoming more and more important for modern product design and development. For example simulation tools are used to predict the forming quality and thus help to significantly reduce product failures and time for changes in tool and die design. Moreover, simulation tools have a beneficial effect on searching unpredicted failures when we use new materials. For all these reasons, simulation technologies have become standard in today's product design and development processes.

However, sometimes we cannot obtain highly accurate results despite the fact that simulation accuracy has reached the limit. The reason for this is that there are some gaps between the real physical phenomenon seen in the tools and dies, in the products factory floor and the boundary conditions of the simulations. For instance, originally designed (ideal shape) rigid body models are used for tools geometry in forming simulations. However, in fact, an elastic body model should be preferred if we need higher accuracy results because the tools and die also forming machines deform during operation. The same can be seen in the structural simulation of the forming products. The homogenized material model is typically used as the material property for this type of simulation, but the real forming products sometimes have heterogeneous properties.

To solve these problems, coupled field analysis capabilities able to connect manufacturing process simulation and structural simulation have become very important and sought after recently.

The solution for technical problems

There are 2 reasons because coupled field analysis has not been so common until recently. Firstly, the data size of simulation results of manufacturing processes is too large to use for structural analysis. Secondly, the simulation data exchange between different mesh models is impossible. In this article, we suggest ways to overcome scale limitations and to execute large scale simulations, for example by including a mold assembly model within a practical speed by using ADVENTURECluster, a software which can handle super large scale models of over 100 million DOF. (Fig.1)

Features of ADVENTURECluster

The main feature of ADVENTURECluster is its capability to calculate super large scale analyses with higher speeds. This is realized by its high speed CGCG (Coarse Grid

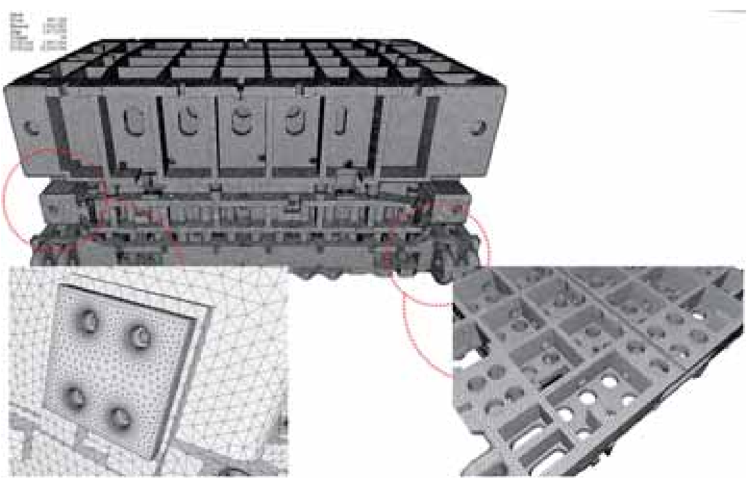

Fig.1 - An example of a large scale mesh model (20million DOF)

Conjugate Gradient) solver method, which is especially suitable for parallel processing. The CGCG is the original solver developed by Allied Engineering Corporation, the vendor of ADVENTURECluster. One of the largest scale simulation examples of the past was a drop impact analysis of a full mobile phone model with 350 million DOF. The calculation time here was about one day using the implicit method with the IBM Blue Gene/L8 rack, 8192 nodes, 8192 processes. The result was selected as a finalist of the SC06 Gordon Bell Prize (which took place in November 2006 in Tampa, Florida). Today, this solver is widely used mainly in the automotive and electrical industries in Japan, because of the model size it offers and its overwhelming calculation speed.

At the same time, coupled field analysis has become more and more important as structural analysis tasks are getting more complex and are applied in wider application areas recently.
To allow engineers to use the analysis results from different simulation products for manufacturing processes, ADVENTURE Cluster has added interface capabilities for some specific products.
In the next chapter, we present some examples of highly accurate simulations with large scale calculation and coupled field analysis of plastic molding dies, Fiber reinforced plastic products and press stamping dies using ADVENTURECluster.

Example - Coupled field analysis of plastic molding tools and die
One of the factors that causes flash or major influence to the product dimension accuracy in plastic injection molding is the deformation of molding dies and forming machines. When we consider the molding structure, it has been difficult so far to correctly take into account transient phenomena, such as filling pressure, holding condition and temperature change. However, these problems can be solved if we use coupled field analysis. As a result, it becomes possible to predict flash generation and dimension accuracy correctly, and to improve the product forming quality. In the following example, we show the simulation of a relatively large engine cover.

The simulation process is as follows:
1) Execute mold analysis to gain the temperature and the pressure condition for structural analysis, and obtain the filling pressure and the temperature distribution on the mold surface for one cycle of the forming process.
2) Define the analysis conditions, such as initial temperature and mold clamping force to the mold assembly, which represent the structural analysis model.
3) In addition to the definitions above, map the filling pressure and the temperature distribution on the mold surface obtained by the mold analysis in a chronological order, so that it can be used as input data for transient thermal and stress analysis for one cycle. (Fig.2)

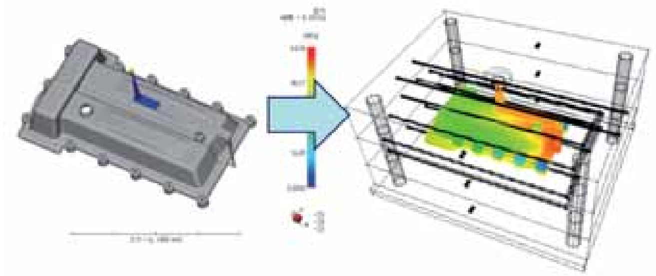

Fig.2 - Mapping of the temperature and the pressure

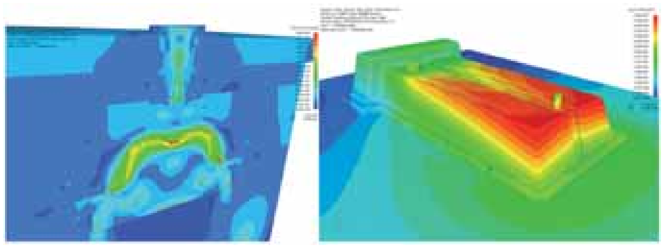

Fig.3 - Stress condition inside the molding die (left) and deformation (right)

Using this condition, we evaluated the warping on the entire mold caused by the mold clamping force, and the deformation on the forming surface by the thermal deformation and the filling pressure. Fig.3 shows the result, we can see the mapped temperature and pressure and the deformation by the mold clamping force. By analyzing each condition, we can perform the factor analysis. In the present case, it has been verified and became clear that the reason of the flash was the mold opening occurred by the packing pressure.

Example - Coupled field analysis of mold products (Fiber reinforced plastic)
In recent years, often plastic products have replaced metal products because they are lighter in weight. Along with this trend, the use of glass/carbon fiber reinforced FRP has increased with the aim to strengthen plastic products. Such composite materials have different intensities depending on the mixture condition of the different materials and the fiber orientations, which leads to new problems, such as sledge and residual stress. To simulate correctly and to solve these problems, it is necessary to consider the material properties. They may entail local changes which mainly depend on the forming conditions with micro viewpoint, not on the homogenous material properties that are commonly used. It is also important to perform quality evaluations not only for single parts but also for the assembly model. In the present example, we demonstrate a highly accurate stress analysis by means of a coupled field analysis of a mobile phone model.

The simulation process is as follows:
1) Execute the mold analysis to gain the ununiformed mechanical characteristics and the residual stress. In this process, the mold analysis is done for the assembly parts; this is necessary for the structural analysis.

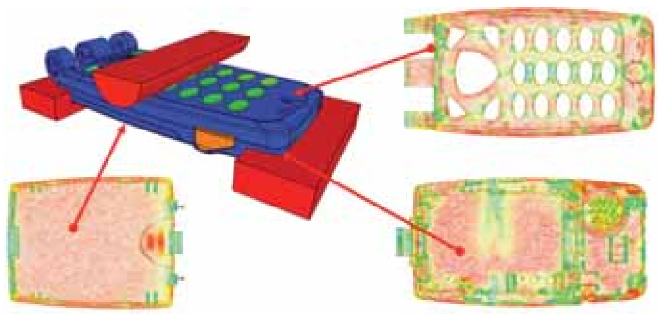

Fig.4 - Fiber orientation mapping

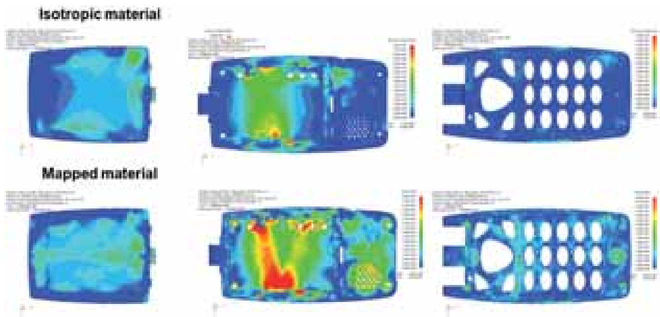

Fig.5 - Comparison of stress analysis results

2) Define the analysis conditions such as load, constraint and contact to the mobile phone assembly which is used in the structural analysis.
3) From the result of the mold analysis, map the material properties and the residual stresses of each element in addition to the current definition, (Fig.4).

Using this condition, we have evaluated the influences of the fiber orientation and the residual stress on the assembly structural analysis. Fig.5 presents the results, which show the exact difference between the stress distribution influenced by the fiber orientation and the residual stress, as well as the stress distribution using the isotropic material. From these results, we can also understand that the history information during the manufacturing process influences the product's strength considerably because of the fact that the higher stress is found near the weld line.

Example - Coupled field analysis of press tools and dies

As plastic products have replaced metal products, high tensile steel has replaced mild steel in plastic components. Due to the fact that high tensile steel requires much higher pressure during the forming process, we are facing the new problem of tool deflection, which has not been an issue before with mild steel forming. Moreover, the accuracy of the forming simulation has decreased. When we do a coupled field analysis for such problems, the press forming simulation considering the entire tool deflection and the dieface deformation, can be analyzed. In this example, we execute the forming simulation considering the die deformation by using the draw die of an automobile roof component, and we point out the influence on the result accuracy of the forming simulation.

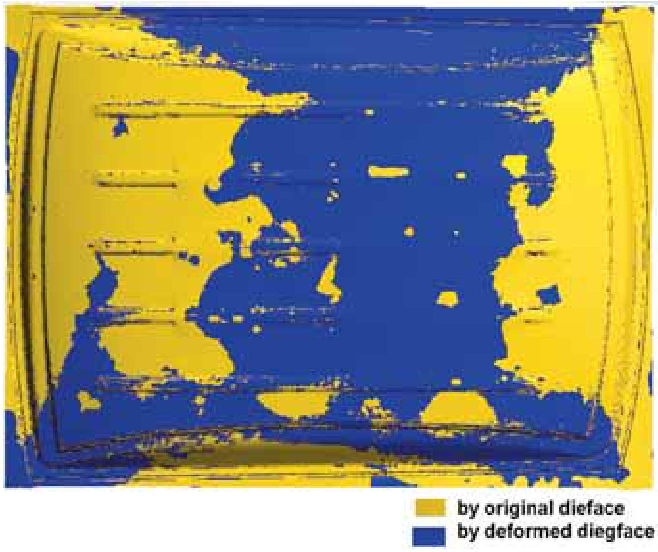

Fig. 7 - Difference of the spring back results

The simulation process is as follows:
1) Execute the press forming simulation to obtain the reaction force from the panel during the forming process.
2) In the structural analysis, define the pressure and the constraint conditions and map the reaction force from the panel.
3) Execute the structural analysis to evaluate the deformation of the dieface during the forming process, (Fig.6).

Using the deformed geometry, we have executed the press forming simulation again, and evaluated the influence of the die deformation on the forming process, Fig.7 presents the outcome. With the help of the spring back simulation that considers the die deformation, we could predict the panel dent 10 % more accurately. The observance of the entire die deformation helps to predict the impact on the panel and contributes to improve product quality.

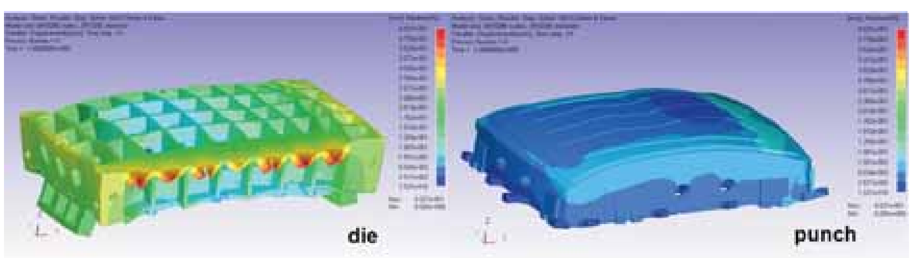

Fig. 6 - Die deformation at the bottom dead point

Other examples

A similar analysis to what we have done for plastic molding dies and plastic products can be applied to the casting process by using a simulation tool like MAGMASOFT developed by

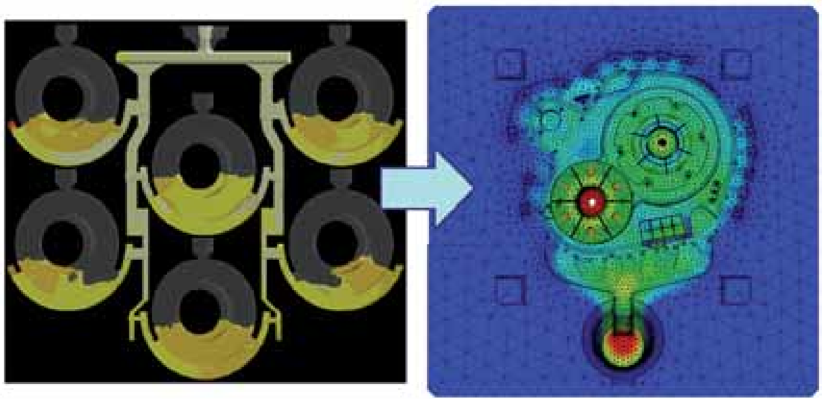

Fig.8 - Temperature mapping

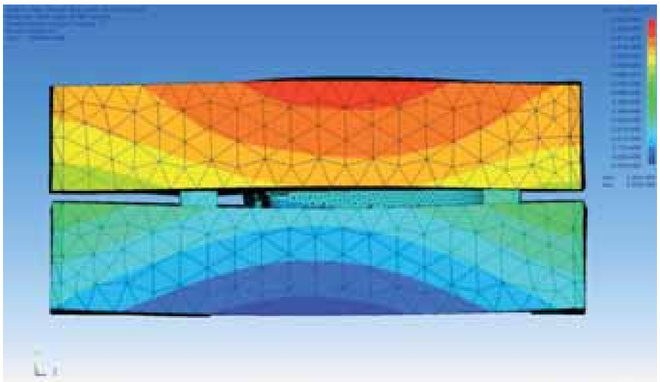

Fig.9 - Thermal deformation of casting tool and die

MAGMA in Germany. Following are the results of the analysis with MAGMASOFT.
We also have other coupled field analysis examples from using forging simulation tools, such as FORGE (from Transvalor.S.A, France) and general purpose CFD codes.

Conclusions
In this article, we have introduced some examples of coupled field analysis between manufacturing process simulation and structural simulation by presenting several topics. Without the use of CAE, it would have been extremely difficult to evaluate the deformation behavior of the forming tools during the manufacturing process correctly, as they often have large dimensions and complicated geometries, and there are limitations as far as the time to get the results and the simulation software itself are concerned.

To solve these problems, ADVENTURECluster provides efficient features for the handling of super large models and high speed calculations. ADVENTURECluster manages the important task to simulate deformation behavior and stress distribution of the entire tool assembly and returns feedback to the design and development teams within a fixed time frame.

Recent testimonials/examples show that ADVENTURECluster users can simulate the tool assembly also considering displacement of forming machines and facilities to obtain more accurate results. These approaches and the successes that our customers experience grow our expectations to expand the simulation range and scale of ADVENTURECluster constantly in the near future.

For more information, please contact:
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E-mail: advc-sales@ml.scsk.jp
http://www.scsk.jp/index_en.html

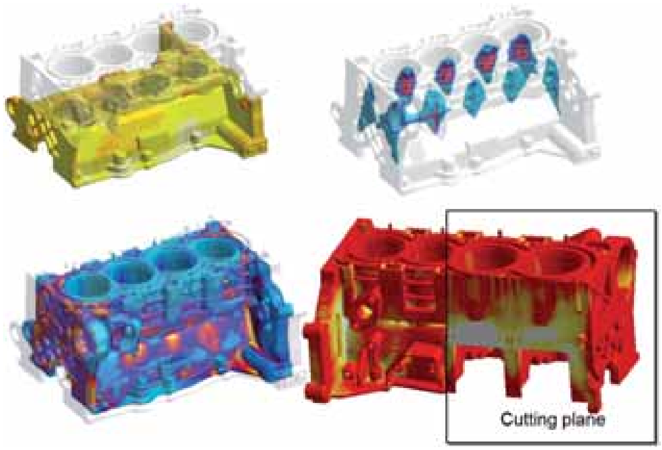


Fig.10 - Residual stress of the casting product

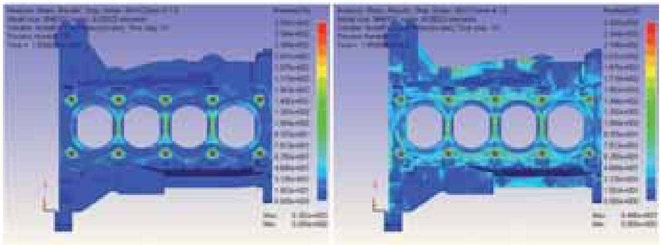


Fig.11 - The influence from the residual stress

SCSK Corporation
We can integrate the CAE solutions suitable for engineering market. Our solution provides a suite of extensive analytical results for various processes, such as casting, forging and injection molding in a very comprehensive manner. Coupled respective result obtained with large-scale structural analysis software, "ADVENTURECluster", very complex and extensive large scale die structure analysis, such as deflection, stress concentration, fatigue and etc., can be performed in a short time. We welcome you at our booth and are ready to provide intensive demonstration and introduction to our suite of CAE solution. Please stop by our booth at any time.

SCSK cordially invites you and your guests to visit their booth at the International CAE Conference on Monday, 22nd and Tuesday 23rd, October 2012 in Lazise (VR). www.caeconference.com

PlanetsX: The Injection Molding CAE System fully embedded in ANSYS Workbench

For the structural analysis of plastic products, it is common practice to treat the product material as uniform. During the manufacturing process however, most often, not even a slight non-uniformity can be found due to the resin flow in the molding step. Typical molding defects such as flow marks, silver streaks and sink marks, are the most obvious examples of non-uniformity. Furthermore, also non-uniformities which are not discernible to the eye after the molding, may have an impact on the strength of the final molded products. If we want to evaluate this phenomenon correctly by using CAE and providing feedback to our product development, the structural analysis of the material defined as uniform is not sufficient. We will have to apply a structural analysis that also takes into account the resin flow history.

However, when we execute such multiphysics analysis of resin flow and structure, very complicated operations and considerable calculation costs are inevitable in most cases. Also today lead time reduction is a crucial factor for competitive product development. For these reasons, a simulation tool capable of calculating resin flow and structural behavior in the same environment, was strongly required, to maintain competitive advantage. To meet this requirement, Cybernet Systems Co.,Ltd. whose headquarter is based in Tokyo, has developed and launched "PlanetsX", an injection molding CAE system fully embedded in ANSYS Workbench.

PlanetsX is an injection molding simulation tool that we can use in the ANSYS Workbench environment (hereinafter called Workbench), the integrated platform of the multiphysics simulation tool ANSYS. By making simultaneously full use of the characteristics of Workbench, its wide range of capabilities, easy to use GUI and flexible extensibility, engineers who start performing resin flow analysis can work with PlanetsX easily and efficiently. The key strength of PlanetsX is that it realizes not only the consistent simulation from the resin flow analysis to the warp analysis, but also the combination with structural analysis considering the flow history. Moreover, the software system is able to maintain high performance by using each different solver for resin flow analysis and structural analysis.

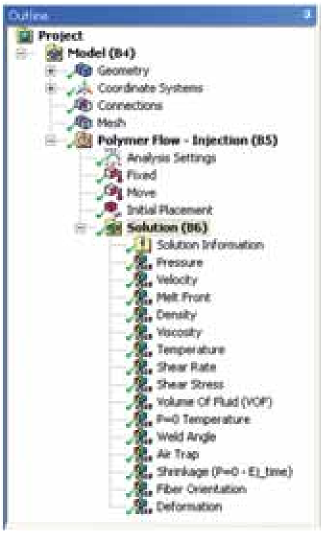


Fig.2 - Menu for the injection molding analysis added to the ANSYS Workbench project tree

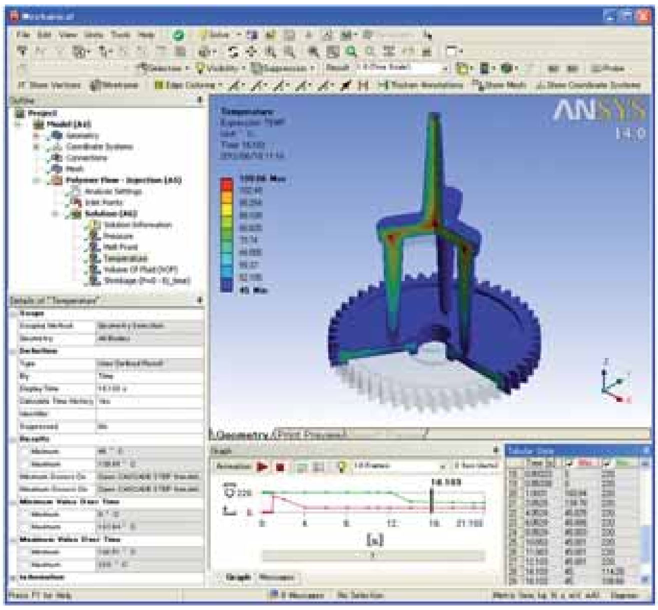
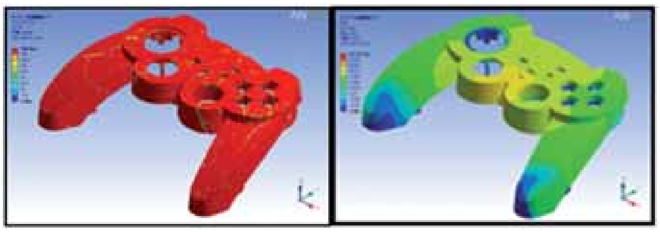
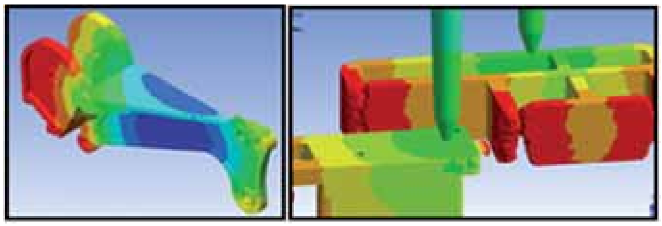


Fig.1 - The PlanetsX operating environment which is fully embedded in ANSYS Workbench



Weld angle *Pressure distribution*



Melt front *Hesitation*

Fig.3 - Various output results of the injection molding analysis

The analysis capabilities of PlanetsX

1. Packing/holding/cooling analysis:

- Packing pressure, short-shot (consideration about capability of forming machine)
- Gate balance (if there is a problem with the multi gates)
- Weld line (if there is a defect in appearance)
- Volume shrinkage ratio (in case of shrinkage and sink)
- Product weight
- Gate seal time (Is the cycle time okay?)

2. Warp analysis:

- Evaluation of deformation (warp), stress and distortion

3. Mold and structure interaction analysis:

- Deformation and stress by the external force while working
- Warp deformation analysis considering contact effect between mold and resin
- Stress relaxation analysis of the viscoelastic material
- Mold deformation

4. Mold cooling analysis:

Mold temperature, cooling balance

5. Runner wizard:

- Runner and gate geometry creation

Additionally, the following 5 optional capabilities are available.

6 Fiber orientation analysis

Predicting fiber orientation and orientation rate by calculating the orientation behavior of the reinforced fiber formed by thermal flow during the packing process. Young's modulus and linear expansion coefficient that vary depending on the fiber orientation result, will be referred to the warp analysis.

7. Thermosetting reaction analysis:

The thermosetting reaction during packing, holding and cooling processes of the thermosetting resin is calculated. Predicting heat generation and rising of viscosity, and analyzing thermal flow considering cure shrinkage.

8. Injection press/press forming analysis

Analyzing the process of the injection press and press forming, during which resin is pressed and packed by moving mold. Generally, the injection press and press forming improve the formability as the forming pressure is kept down compared to injection molding. The simulation result is used to predict the necessary pressure for forming and for choosing the right resin, and the benefits to consider in case the expected formability can be obtained.

9. Optical quality analysis:

Predicting distributions of surface accuracy, birefringence, optical path difference and refractive index, all these factors are important for the plastic lens quality. This feature can be used for the prism and light guide panel.

10. Residual flow stress analysis:

Predicting the flow stress relaxation process produced by the thermal flow in the packing process with the Leonov viscoelastic model, and evaluating residual flow stress, residual strain and birefringence corresponding to the molecular orientation conditions.

User's voice: Ricoh Company, Ltd.

One of the main reasons to introduce PlanetsX is that we can use the ANSYS auto meshing capability for its molding simulation. In the past, huge effort had to be put into creating the mesh for complicated models such as digital cameras. After we started using the ANSYS Workbench auto meshing capability, no more errors occurred in the meshing, and we could get ideal mesh models. Hence the system is very efficient and helpful for us. We also welcome and appreciate the easy to use operating environment and the coupled-field analysis with structural and thermal analysis of ANSYS.

Conclusion

PlanetsX is a powerful injection molding simulation tool, which can bring advanced plastic CAE solutions much easier and closer to the users. The primary goal of our development policy is that the proven solvers can be used for highly accurate mold and structural coupled-field analysis. This capability will improve the operational efficiency of anyone involved in the development of plastic products.
Users of PlanetsX will experience continuous enhancements in the future.

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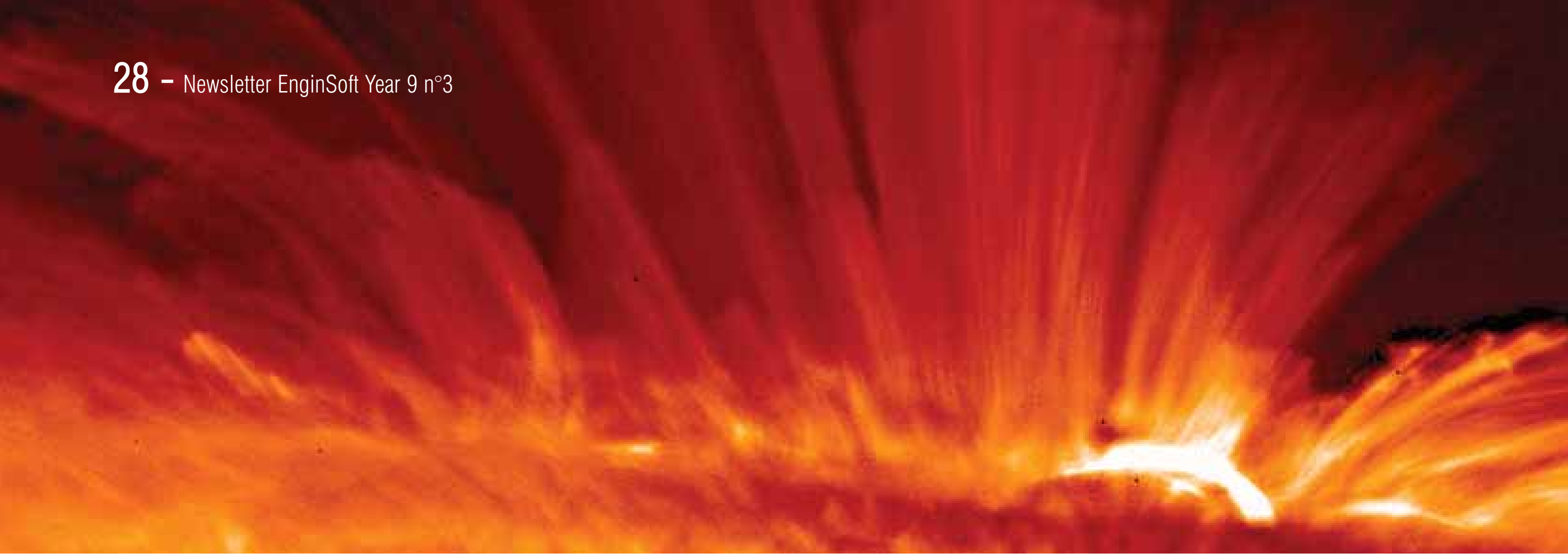

Magnetic Simulation of Toroidal Inductor using Simpleware and JMAG®

Toroidal inductors are electronic components constructed from a wire coiled around a magnetic (iron) core. They have a wide range of applications including high frequency coils and transformers. Toroidal inductors can also be used for measurement of magnetic characteristics, as an alternative to the solenoid coil.

This case study takes a high resolution scan of a toroidal inductor and builds a finite element mesh of the structure and surrounding air. High frequency magnetic simulations are performed to analyse the current and flux density, as well as distributions, through the inductor which cannot be observed directly. The simulation results are very useful for product verification and redesign, and it will help the development of high accuracy electromagnetic simulation.

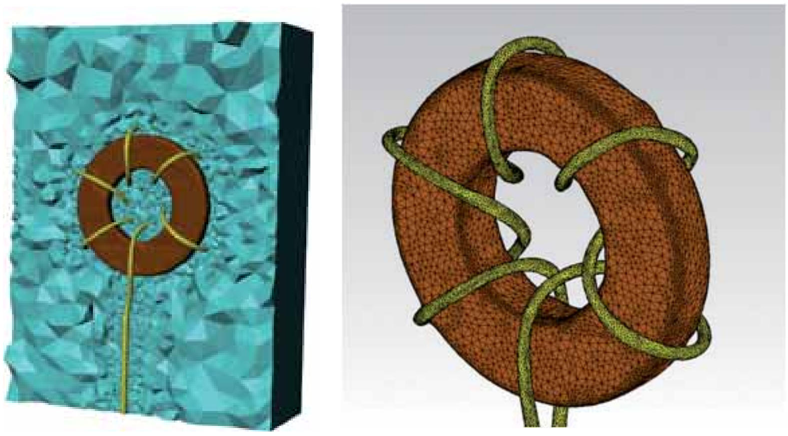

Fig. 2 - Generation of conforming multipart volume mesh of inductor core, wire and air in ScanIP+FE

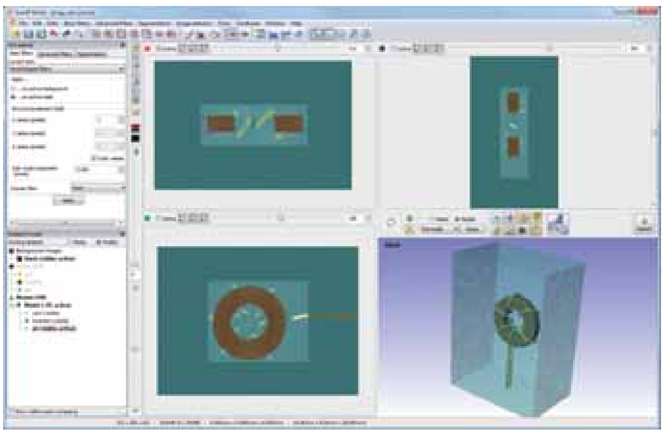

Fig. 1 - Segmentation of toroidal inductor core and wire and generation of air boundary in ScanIP

IMAGE PROCESSING

The toroidal inductor was scanned using a TUX-3200 Tohken Co.,Ltd. CT x-ray inspection machine, at a resolution of 17µm. The images were imported into Simpleaware ScanIP where the core and wire segmented and reconstructed. In addition, the image was padded to generate an appropriate air boundary for the later analysis. The size of the air region was configured by considering the leakage flux. In cases where magnetic flux has wide leakage it is necessary to expand the air region sufficiently. The wire was then artificially extended to the boundary, through this added layer of air.

MESH GENERATION

A smooth, high quality, conforming multipart volume mesh of the coil was created using the Simpleware +FE module. Initially the default coarseness slider was used to achieve the required mesh resolution. After this, some parameters were manually adjusted to tune the mesh

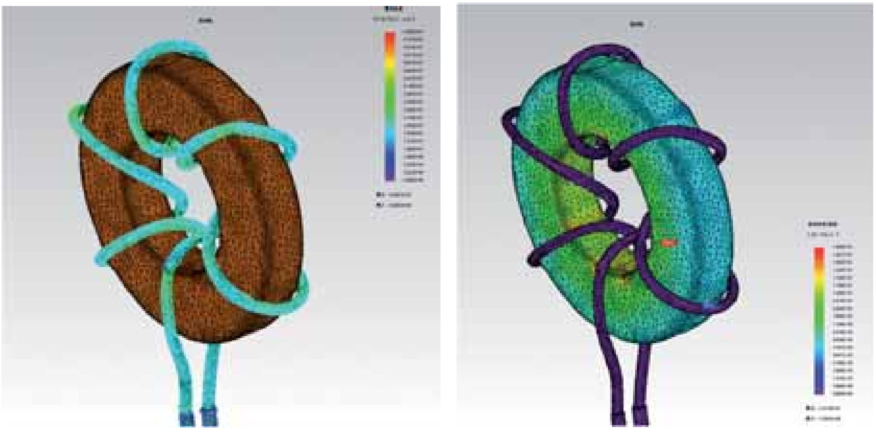

Fig. 3 - Prediction of current density (left) and magnetic flux density (right) in JMAG

further. These included the maximum allowed mesh size, the internal change rate, and the number of elements across layers. This allowed meshes to be created ranging from around 100,000 to 1,000,000 elements.

RESULTS/SIMULATION

The generated mesh was exported in Nastran format and read directly into JMAG for simulation. In order to simulate magnetic phenomenon the material data and simulation conditions must be defined within JMAG.

In this case study, a ferrite core and a copper wire were used. The permeability of ferrite and conductivity of copper were assigned. The symmetrical boundary condition was assigned at the boundaries.

From here the current density (c.f. Figure 3, left) and magnetic flux density (c.f. Figure 3, right) were predicted and visualised. The process allows the non-destructive evaluation of this small and complex component. This analysis calculates phenomena that cannot be easily measured and thus provides an insight into the operation of the coil. Conventional measurement methods have proved unsuitable for predicting the magnetic phenomena of these small components.

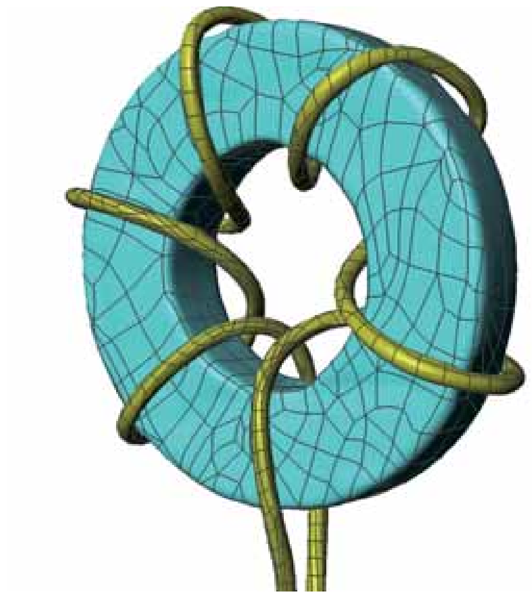

Fig. 4 - Generation of NURBS model in ScanIP+NURBS

These results can show the effect of structure design and material characteristics on product performance in more detail. Additionally, it can verify the difference between a design and an actual product, and hopefully improve the quality of products by giving feedback about variability and performance. Thus making the analysis very useful for the evaluation of products such as small magnetic components.

Using a similar technique within JMAG the analysis can be extended to investigate many other characteristics. For example, JMAG can perform thermal and structural analyses. This technique is widely applicable to the evaluation of various electronic components.

CAD EXPORT

In addition the new Simpleware +NURBS module was used to convert the segmented image data directly into CAD ready NURBS files in IGES format. This opens up further opportunities for analysis and reverse engineering of components.

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Internal communications management with LIONsolver

REASONS FOR AN INVESTIGATION

Over time developments in organization and marketing theory, as well as in operational practice, have led to the emergence of increasingly specialized fields of company communications in complex organizations, both in the public and private sectors.

There are many and diverse reasons for this interest, but it is primarily due to the increases of environmental speed and complexity, forcing companies to significantly change their approach and encouraging greater attention on personnel and the way they relate to each other, speak to each other, listen and hence how they communicate with one another.

This investigative choice has arisen from an underlying question raised by the literature (Sinergie, Conference 2011) involving organizational communication as a whole. The question regards what is the true role of communication as effective support for the corporation's decision-making processes. A variety of functions has emerged to answer this question, including value-strategic, operational, information and social, as well with regard to content, instruments and areas of competence (Di Raco, Santoro, 1996; Barone, Fontana, 2005).

In this article we provide a way to graphically depict one of these functions, the P.A.C.I. Matrix (E. Giaretta, A. Garofalo 2011), aimed at quantifying cross-departmental top management communications.

INVESTIGATION FIELD

We feel that cross-departmental top management communication is particularly relevant in terms of its impact on the decision-making process, which is part of its intrinsic nature, but also on the corporate climate and the sense of belonging, as well also on the generation of intangible resources such as knowledge, creativity and trust.

To further concentrate the field of investigation, only one, albeit important, component has been considered. Excluding the exchanges of documents, news, data and information generated by everyday operations at every level of the corporation, attention has focused on top management information flows, which could be termed the strategic decisions information flow or the decision-making communication processes.

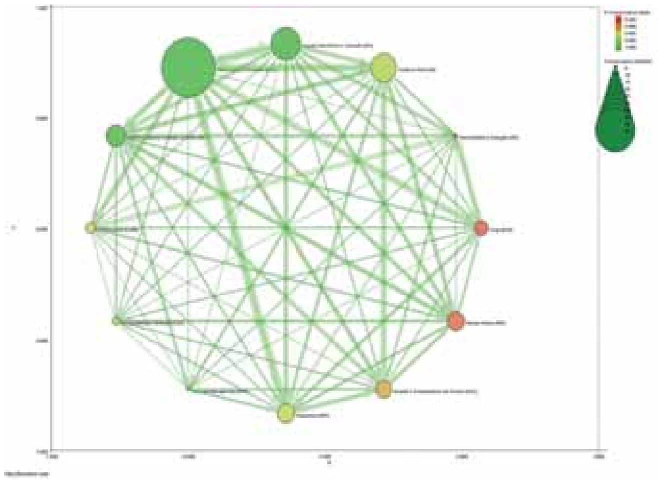


Fig. 1a – Drawing inter-department communications with LIONsolver's Flow map with bubbles. The edge's thickness represents the number of communications from the starting department to the ending department, the department colors represent the percentage of existing communications over the total, the radius of the circle represents the number of existing communications outgoing from that department.

INVESTIGATION TOOL

A way to focus on inter-departmental communication is through the P.A.C.I. Matrix.

P.A.C.I. is a tool developed to underline the communication patterns among the different company areas, and to evaluate their goodness, by the point of view of the internal customer.

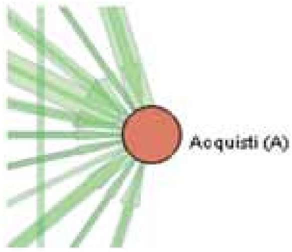


Fig. 1b – Zoom of Fig. 1a that highlights the sales department.

The P.A.C.I. output is a matrix that relates each department with all the others and provides the number of existing communications, and the number of non-existing communications among them.

VISUALIZATION TOOL

A matrix that contains a number is pretty difficult to read, especially as the number of lines (and consequently the number of columns) increases.

So we used LIONsolver to visualize a P.A.C.I. case study, with data taken from the RAI way internal organization. We built some ways to visualize the relationships among the

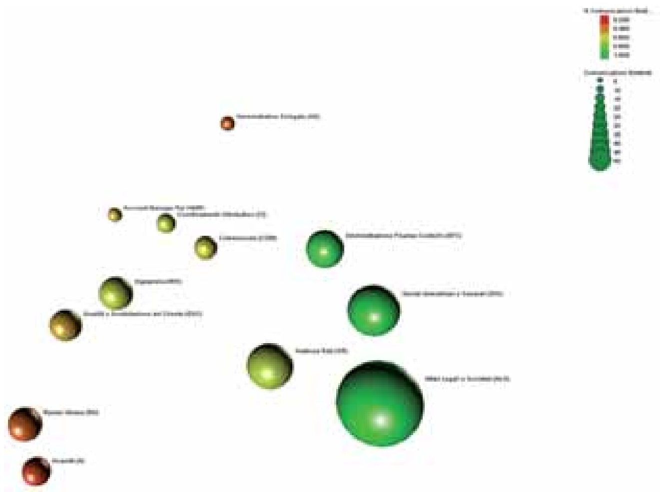


Fig. 2a – Drawing interdepartmental communications with LIONsolver's similarity map. The sphere's dimension and color represent the number of existing communications and the percentage of existing communications respectively. The distance represents the communication's intensity between the departments (the lower the distance, the higher the number of communications). In detail we used as a distance function 1/(1+c) where c is the number of communications between two departments.

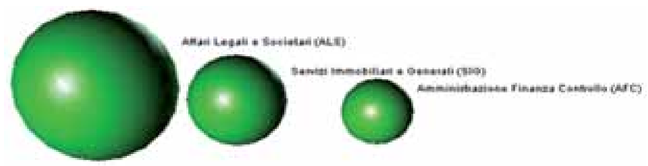


Fig. 2b – Zoom of the Fig. 2a. The three departments are depicted very closely because they communicate a lot.

departments, in order to plot numbers as colours, thickness of lines, distances and other visual ways to simplify and improve readability of the P.A.C.I. Matrix.

VISUALIZATION STRATEGIES

There are pretty many options in LIONsolver to visualize relations. We present a non-exaustive list of the main ones, with examples related to P.A.C.I., and we will discuss them shortly.

Flow map with bubbles

One of the nicest and immediate ways of visualizing relationships is the Flow map with bubbles.

It consists of a two-dimensional chart with different-sized circles and arrows.

It allows also to link to each circle a label and a color and to display a legend.

Note that each circle has an explicit position in the Euclidean space.

Similarity map

The similarity map plot renders data as a graph. It consists of a two or three dimensional chart with different-sized circles. As in the Flow map with bubbles case, different colors and labels on circles/spheres are allowed. Unlike in the Flow map with bubbles, the circles/spheres do not have an explicit notion of position, but only a notion of distance, that can be set explicitly. The distance can be used to render the similarity of the entities.

Optionally it is possible to visualize undirected edges between explicitly linked entities. In the three dimensional version this last setting improves the distance visualization.

7D plot

In the 7-d plot we can plot generic 3-d figures with different shape, size, color and blinking frequency. Also in this case we can assign labels to each rendered object.

The 7D plot is recommended if you need to summarize an high number of variables.

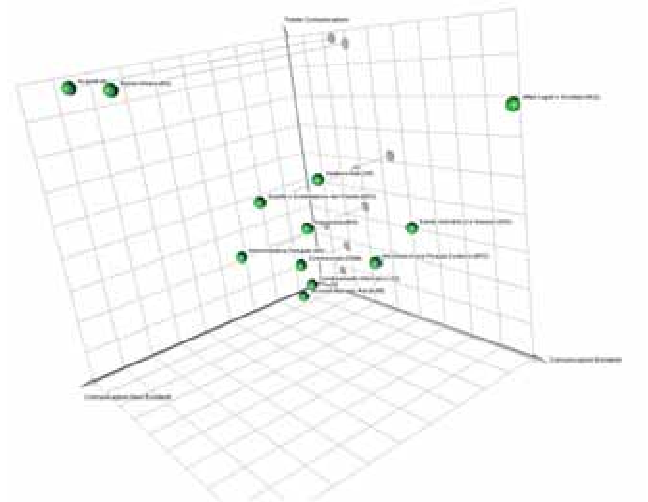
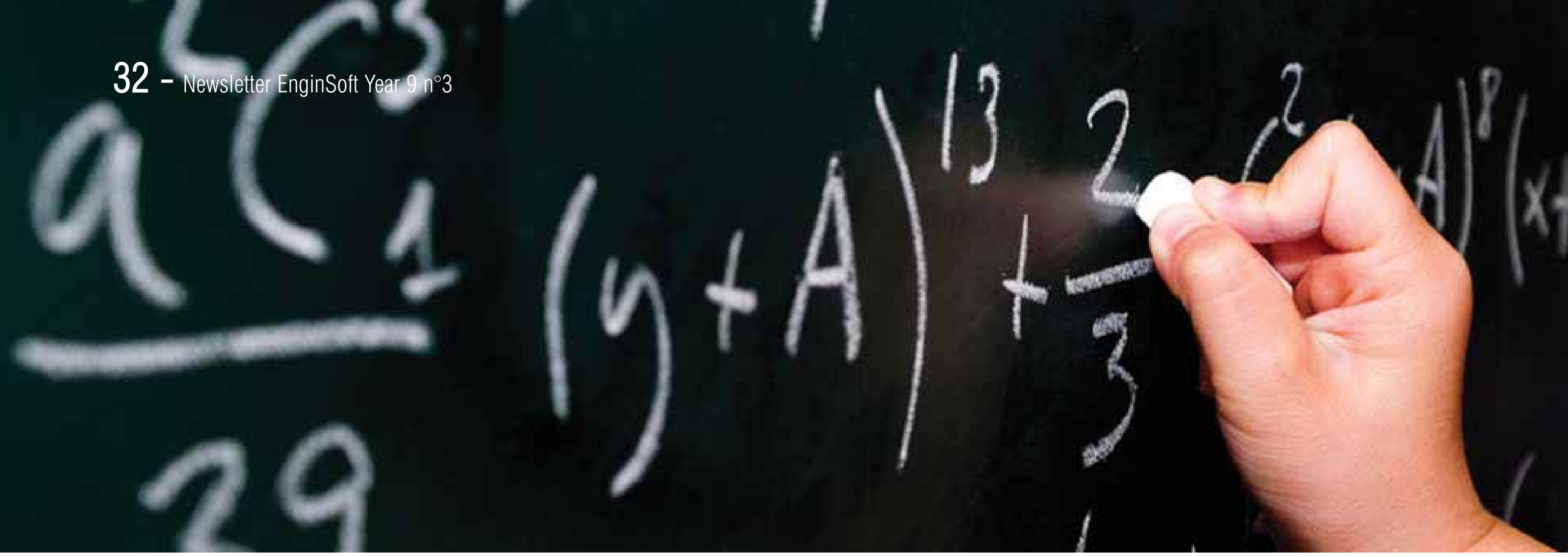


Fig. 3a – Drawing interdepartmental communications with LIONsolver's 7-d plot. On the X axis the number of existing communications, on the Y axis the number of non-existing communications, and on the Z axis the total number of communications.

An extended presentation of the P.A.C.I. approach is introduced in the paper: Elena Giaretta, University of Verona, Alessandro Garofalo, Idee associate. Informative "blockages" in top management communication: an interpretive and prescriptive model.

Alessandro Garofalo, Idee associate
Elena Giaretta, University of Verona
Danilo Tomasoni, Reactive Search s.r.l.

Fig. 3b – Zoom on the central part of Fig. 3a



Data modelling: using Radial Basis Functions in Scilab

Last July, Anna Bassi M.Sc. defended her master thesis on "A Scilab Radial Basis Functions toolbox". The thesis was done as a collaboration between EnginSoft and the department of Mathematics at Padua University.

The aim of this thesis was to develop a Scilab toolbox where Radial Basis Functions (RBFs) are used for scattered data interpolation. We shape our toolbox to be a powerful instrument to analyze data sets coming both from real life applications and industry. The main advantage of using RBFs is that this class is very large, allowing to model various situations, even highly non linear problems. The use of mathematical tools to approximate, interpolate and understand complex real world systems is widely applied in many scientific domains. These kinds of interpolation and regression methodologies are now becoming common even in engineering and the RBFs are now very popular.

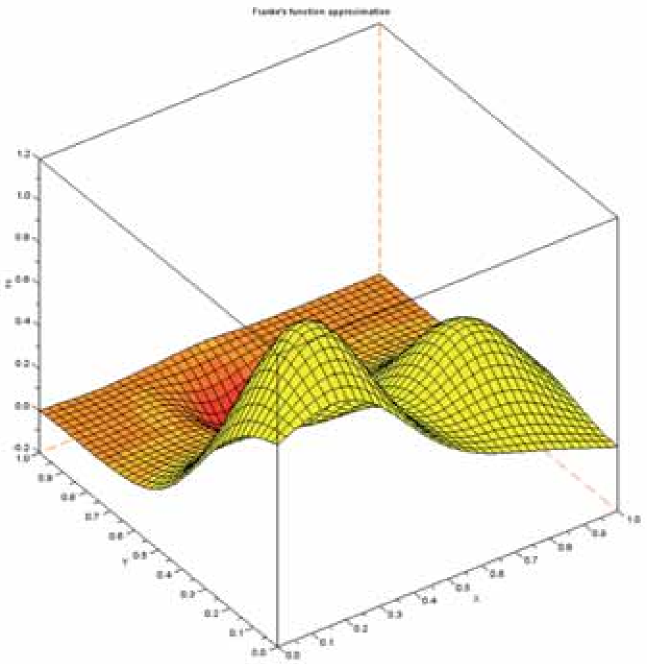


Fig. 1 - Franke's bivariate test function interpolated and plot with the Scilab toolbox.

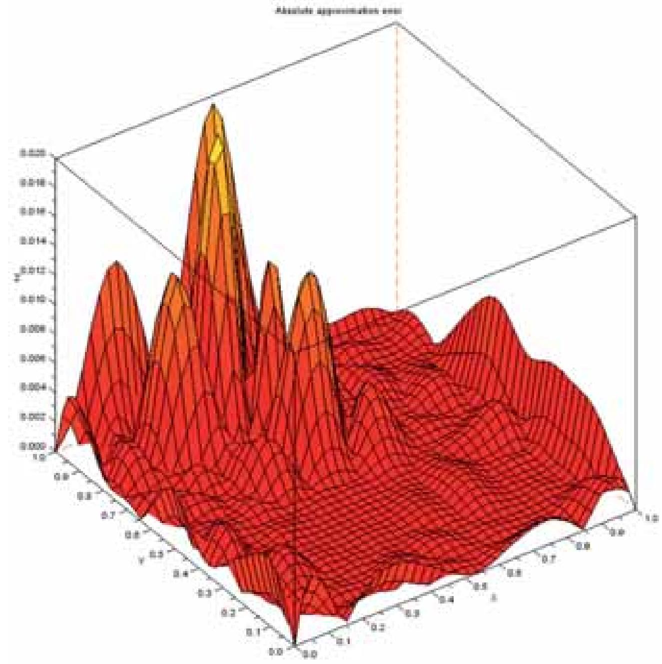


Fig. 2 - The absolute approximation error on the Franke's bivariate function. The chart is evaluated and plotted in Scilab using the RBF's toolbox

There exists a general theory that ensures high tractability of Radial Basis functions models and there is empirical evidence that such models give good predictions even with a reduced number of data. This is particularly important when the data are coming from very expensive or time consuming experiments in order to avoid the evaluation of a fine grid of points before having a good model of the problem.

When creating a interpolation model, we are trying to find a function which is a "good" fit to the given set of data measurements. The model gives us a rule which allows to deduce information about the process we are studying also at unknown points. This means that, by means of a radial basis function model, we are able to predict the value of an output in points different from those in which we obtained our

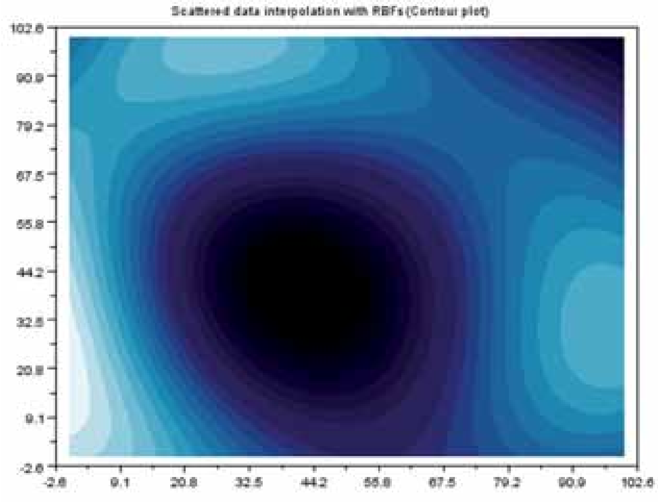


Fig. 3 - Contour plot of an interpolation model created on real scatter data. With this plot, the user can have a global view of the problem at hand even when the problem is known only by multidimensional experimental points.

initial measurements. When the points in which the measurements are taken do not lie on a uniform or regular grid, then this approach is called scattered data interpolation. RBFs can be used on scattered data and this independence from a mesh permits to eliminate the costs of mesh generation, that is still the most time consuming part of any mesh-based numerical simulation.

This toolbox allows to create an interpolation model based on scattered data from physical or computer experiments. Here, an experiment is a collection of pairs of input and respective evaluation values. The input is likely to be high dimensional, whereas the measurements have to be scalars. Computation with high dimensional data is an important issue in many areas of science and engineering in which many traditional interpolation methods can either not handle such problems or be limited to very regular situations.

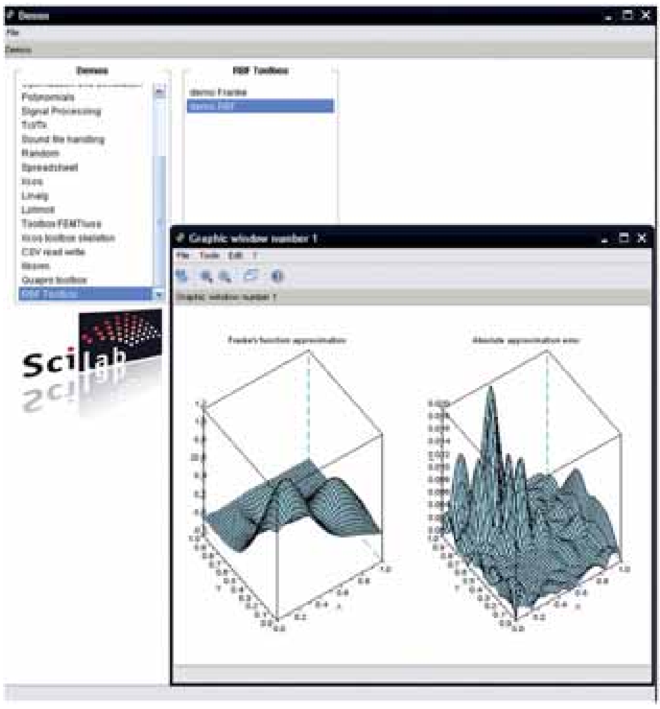


Fig. 4 - The available demos in the RBF toolbox. New users can start from these examples to learn how to use the toolbox at best.

The toolbox is easy to use and very robust. It contains several basis functions and, if needed, it checks for repeated points. As it is feasible that an experiment is repeated several times with the same input values, a problem of invertibility of the distance matrix arises, indeed in the presence of repeated points it becomes singular. In these cases, it is therefore necessary to choose a single point with the respective value given by the measurement and eliminate the remaining. In the toolbox, we give the user the ability to choose which of the data values will be used in the RBF interpolation. In particular, the eligible options are: the mode, the maximum, the minimum and the mean of all the repeated points.

The selection of the optimal shape parameter is totally automatic and transparent to the users. The strategy we chose to implement this automatic selection is a cross validation approach. In Rippa, S., "An algorithm for selecting a good value for the parameter c in radial basis function interpolation" an algorithm is described that corresponds to a variant of cross validation known as "leave-one-out" cross validation. In this algorithm the optimal value of the shape is selected by minimizing the (least square) error for a fit to the data based on an interpolant for which, at each step, one of the point was "left out". A good feature of this method is that the dependence of the error on the data function is taken into account.
By adding a loop over the value of the shape, we can compare the error norms for different values of the shape parameter, and choose the value that yields to the minimal error norm as the optimal one.
We have chosen Scilab for creating this whole toolbox with a double motivation. The first one is that it is an advanced and robust language that guarantees robustness and quick prototyping. In addition, it is an open source software, making our work available for free to any member of the community and industrial partners.
The complete Scilab toolbox is available for free at www.openeering.com. The toolbox can be downloaded and easily installed. Both the installation phase and the usage are well documented. A set of demos will be installed together with the toolbox, as shown in Figure 4.

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Benimpact Suite: A tool for ZEB Performance Assessment

BENIMPACT
Building's ENvironmental IMPACT evaluator and optimizer

EnginSoft and the University of Trento presented one of the test cases used to validate BENIMPACT Suite (Building's ENvironmental IMPACT evaluator & optimizer) energy performance evaluations at the ZEMCH 2012 Conference.

In recent years, European policies and regulations on energy saving have evolved significantly. The main reason for this is the common goal to reach the targets of 20-20-20.

Buildings consume a lot of energy, hence the legal framework related to the reduction of their energy consumption has experienced a tremendous evolution.

The "nearly zero energy building" (nZEB) concept was introduced in 2010, eight years after the release of the original EPBD directive (Energy Performance of Buildings Directive).

By 2020 all new buildings and buildings that are subject to renovation should have very low energy consumption levels, and the major part should be covered by renewable sources. Designing and realizing such type of buildings is a very ambitious task which needs to be supported by appropriate tools and software technologies.

This article introduces a new tool for the assessment of the performances of buildings: The BENIMPACT Suite (Building's ENvironmental IMPACT evaluator & optimizer), developed by EnginSoft Italy. The suite is organized in different core modules that allow engineers to verify how a building's performance level is influenced by different design choices, such as envelope shape and materials, plant systems, use of renewable sources, etc.

One of the test cases used to validate the BENIMPACT Suite energy performance evaluations is an interesting ZEB (Zero Energy Building) in Italy, it was finalized in 2010 and is called CasaZeroEnergy. It is located in Felettano, a small town in the northeastern province of Udine.

This building is an experimental house designed and monitored by the Laboratory of Building Design of the University of Trento (Italy) and built by the Polo Le Ville Plus Group (Cassacco-Italy). The energy performance of this building was modeled and evaluated using BENIMPACT Suite, the simulation results were compared with monitored data.

Barriers in achieving the nZEB target

The ZEB concept could strongly help to reduce energy consumption, environmental loads and operational costs. However, even if the development of energy efficient constructions is strongly stimulated by legislation requirements, there is still a wide range of non-technological barriers to overcome in order to reach a wide diffusion of the zero energy building standard.

First of all, extra initial costs are far from the general mindset of the construction business. Usually, both contractors and clients are mainly driven by short-term profit-making and focus on the lowest price bidding and not on the added value that can be achieved by implementing environmental friendly measures.

Moreover, ZEBs are non-conventional construction types. They require a high level of knowledge and skills which are not always available among design and construction teams.

Zero Energy Mass Custom Homes (ZEMCH) 2012 Conference

Housing is a system of energy and environment and requires to accommodate wants and needs of individuals and society, which are usually considered to be diverse and dynamic.

Albeit increasing market demands for achievement of social, economic and environmental sustainability in housing today, conventional homebuilders (and housing manufacturers alike) who are often reluctant to spending extra time, money and effort for information gathering of new products and services are still barely able to adopt recently emerging innovations including mass custom design approaches to the delivery of sustainable affordable homes.

ZEMCH 2012 aimed to establish an intellectual forum of interactive discussion on design, production and marketing issues surrounding the delivery of low to zero energy/CO2 emission mass-customisable homes being built in developed and developing countries.

www.zemch2012.org

Several professionals are usually involved in the design process, and this might lead to problems if there are lacks in the communication among the different project team members. All the stakeholders must fully understand the issues and concerns of all the other parties and interact closely throughout all phases of the project. This is why an integrated design approach is needed to achieve multiple benefits and much more efficient and cost-effective buildings.
The main problem today is the lack of tools that can support project teams to coordinate their work and to consider and evaluate different design alternatives.
In most mechanical industrial fields, from aerospace to biomechanics, sophisticated 3D computer simulation tools have been used for years to predict the responses of machines to specific loads and actions in specific environments, in order to integrate all the opportunities offered by different materials and technologies. The same kind of tools should be used also in the construction sector.
In any case, despite many trials to develop a standard Building Information Modeling (BIM) approach, currently no software is able to take into account all the features that a ZEB requires.

Therefore, there is an evident need to develop software for the simulation of buildings which can help designers to predict how the structure will perform and enable them to model economic and environmental consequences of different design choices.

Short overview of the BENIMPACT Suite

BENIMPACTSuite's primary goal is to provide an efficient tool to promote integrated design Computer-Aided Engineering (CAE) and intelligent Digital Prototyping (iDP) in the housing fields.
BENIMPACT Suite is composed of a group of software. It should turn into a complete suite whose aim is to help designers checking the quality of their solutions and finding the "optimal" set of choices between different configurations of building envelopes and energetic systems.
BENIMPACT Suite analyzes the whole life cycle of a building and searches for the "optimal" trade-off between opposing goals: energy consumption, environmental impact and cost. Today, every new building should be designed from the initial planning phase using all the resources given by nature and current technologies in order to achieve the highest level of independence from traditional fossil fuel sources and the lowest environmental impact, in terms of materials use, energy consumption and pollutant emissions to the atmosphere.
The necessity to design "environmental friendly" constructions must be compatible also with the planned investments, since our final aim is to spread the awareness of sustainable design in a spontaneous way.
Realizing sustainable buildings should be a best practice that every citizen should implement not only due to strictly and mandatory regulations, but because of our responsibility to protect our planet from excessive depletion and to allow future generations to live a good and healthy life.
For all these reasons, we believe that the opportunity to find "smart" solutions will lead to an increment of sustainable buildings (new or renewed ones), less depletion of natural resources and to a reduction of green house gas emissions.
BENIMPACT Suite is connected to databases that can be updated by developers, companies and final users in order to keep up with innovation.
Each type of evaluation belongs to a specific functional unit that can run in stand-alone mode.
For each design, the energetic unit performs an annual energetic dynamic simulation with hourly steps, and calculates annual energy consumption.
Other functional units then calculate global energy consumption, environmental impact (Life Cycle Assessment) and costs (Life Cycle Costing) for the entire life cycle of the building.
Thermodynamic performances are verified using "Energy Plus" as energy module of BENIMPACT Suite. Environmental impact and costs are calculated using specific softwares implemented by EnginSoft.
The multi-objective optimization is based on a genetic algorithm that searches for the "Pareto Frontier", which collects the best solutions and represents the ideal limit beyond which every further implementation compromises the system. Today, it runs on modeFRONTIER, a multidisciplinary and multi-objective software, which is also used to integrate the different functional units.

Validation of BENIMPACT Suite: case study selection

In order to test the validity of the project, BENIMPACT Suite was applied to different case studies, both for new buildings and energy retrofitting. The validation test in particular was performed on two concluded buildings, of which data from monitoring are available. The use of monitored data is definitely the best way to test and understand the strength and weakness of a software/tool. The availability of such data was the main criterion for the selection of the case studies.
The first case study is based on the Palazzo Kofler which was built at the beginning of the 20th century, then retrofitted three years ago with the ClimateHouse Standard and subjected to monitoring for a period of two years. The second case study presents a new building, the CasaZeroEnergy in Felettano (UD, Italy) concluded in 2010 and currently under monitoring.
The validation of the model performed on the CasaZeroEnergy can be explained as follows, the methodology has been divided into several steps:

1. analysis of the local climate,
2. analysis of the main building features,
3. decision on which monitored data are important for

the analysis and validation of the thermal behavior prediction,
4. analysis of the energetic behavior of the real building through chosen monitored data,
5. building model construction,
6. dynamic energy simulation,
7. comparison of energy simulation results and monitored values.

CasaZeroEnergy

"CasaZeroEnergy" is a detached house, finished in 2010 and located in the hills of Felettano (UD, Italy) (Fig.1).

Fig. 1 - View of "CasaZeroEnergy" in Felettano, Udine – Italy

This smart green building was designed according to the principles of bio-climatic architecture, which means that local climate conditions were studied and taken into account before the beginning of the design phase.
The site is characterized by mild and humid continental climate with an average annual temperature of 13°C. There is no dry season and the summer months are quite hot. Prevailing winds run from North to South and are useful for passive cooling (Fig.2).

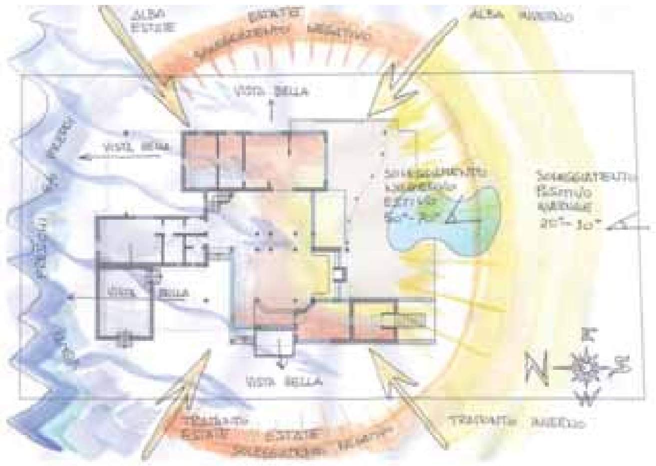


Fig. 2 - Bioclimatic concept of "CasaZeroEnergy" in Felettano, Udine – Italy

Every element of the building and the constructive solutions were designed with the aim to minimize losses and to maximize the available assets from nature using passive design strategies, both for heating and cooling.

The building has a compact shape with a reduced ratio Surface/Volume of 0,78 to reduce heat loss during winter.

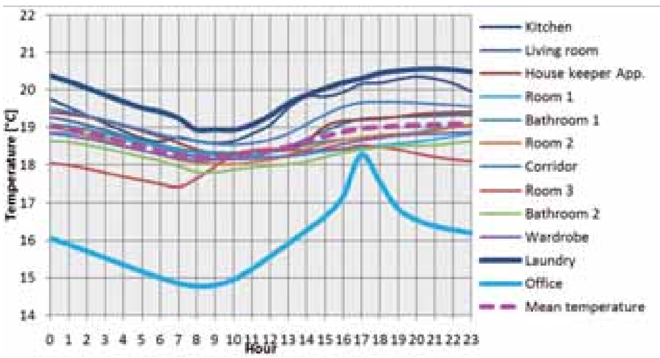
CasaZeroEnergy was built using renewable, recycled and recyclable materials to reduce the embodied energy content and the carbon dioxide emissions during the construction phase. For example, the kitchen furnishings are made from recycled glass and the walls are realized with bricks and stone slabs from the demolition of old buildings within a radius of 50 km, to avoid pollution from longer transport ways. The structure has a very low impact on the environment because of the choice to use wood as main structural material.

The U-values are really low: 0,218 W/m^{2}K for walls, 0.205 W/m^{2}K for roofs, 1,3 W/m^{2}K for windows and 1,1 W/m^{2}K for glazed parts.
One of the main features of the building is that is not connected to the gas network, it solely uses electricity produced by a photovoltaic plant of 14,6 kW of peak power. Other alternative energy systems are installed in the building.
One is the sun space on its south side, which allows solar radiation entering the building where it can be conveniently stored. The external glazes of the system are completely open and able to regulate the temperature both in summer and winter.
In CasaZeroEnergy, exhausted air is naturally replaced through the openings in the north and south facades. In this way, good indoor environmental quality can be ensured including natural day-time cooling of the living space and night-time cooling of the building elements. Shading systems are very important to avoid overheating during summer. For CasaZeroEnergy such systems were properly sized and selected, in order to control and adjust the incoming heating from lighting and solar radiation.
Moreover, on the building's roof a solar collector plant for DHW production has been installed. An under-floor heating and cooling system is connected to a geothermal heat-pump that exploits the constant temperature of the earth at a depth of 2,5 meters under the garden surface.

CasaZeroEnergy monitoring

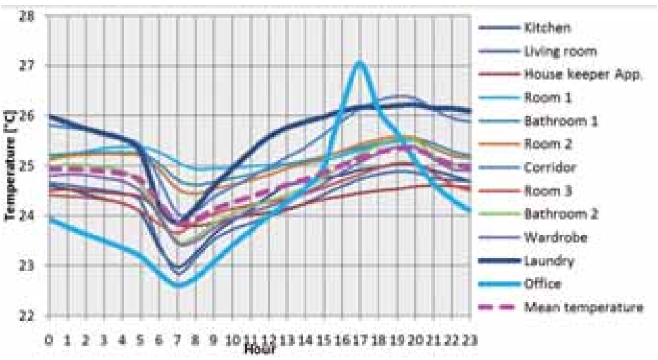
The building is currently monitored. Temperatures and electricity use are measured respectively by sensors and multi-meters in twelve different rooms of the house. The positions of the devices were selected based on the different exposition and final use of the living spaces (bedrooms, living room, kitchen, bathrooms, laundry room, etc.).

The main scope of the monitoring is to understand which is the real building behavior in order to validate the quality of the ZEB project, in light of the increasing necessity and demand for these types of houses.
Starting from monitored data, a typical day was calculated and plotted both for summer and winter periods.



Graph 1 - Monitored temperatures: typical winter day

The typical winter day (Graph1) shows that ten of the twelve monitored rooms display similar temperatures, with a difference from the average temperature of less than 1,5°C.
The two exceptions are: the laundry room and the office. Generally these rooms have a constant set-point temperature of 18°C, warmer hours depend on internal gains and solar heat gains.
Causes of the different behavior of the laundry room are higher internal gains due to the presence of several equipment, which release sensible and latent heat, and the opening of windows during the early morning hours which reduces the room temperature.
The different temperature evolution in the office is caused by a different set point and heating system. This space has a set point of 15°C and is heated during the day by an electric heater.
There is another important space, which has not been monitored yet: the sunspace. It is very important for the passive heating of the building, because of its capacity to preheat the air and store the heat. Properly managed, the green house can be used for maximizing passive solar gains from October to March, reducing the energy demand.
Also during a typical summer day (Graph2) the same two rooms, the laundry room and the office, have an inhomogeneous behavior.



Graph 2 - Monitored temperatures: typical summer day

The laundry room is still warmer due to its higher internal gains except in the morning, when the windows are usually opened to allow the entire house to benefit from the passive cooling down effect of fresh winds from the North. As for the winter day, the office curve presents an odd behavior, different from every other room. This is due to the fact that this space is not conditioned. In particular, the results show that there is overheating during the afternoon because of its west window without sun protections.
From the comparison of the two graphs (Graph1 and Graph2) it is possible to understand and appreciate that the summer and winter behavior of the office is indeed similar: the two curves have an identical shape, they are just shifted along the temperature axis. The difference of temperatures here depends on the higher amount of solar radiation which enters the room in the summer months.

Validation of BENIMPACT Suite on CasaZeroEnergy

The first step required to prepare an energy analysis model for a building is to divide it into thermal zones. A higher number of thermal zones affects the time required to run an energy simulation. Therefore, it is important to individuate the lowest number of zones in order to be able to correctly reproduce the building's behavior.
Based on the previous analysis, this model was divided into four thermal zones: sunspace, laundry room, office and the rest of the house (Fig.3).
Some hypotheses on set point temperatures, air change rates and internal heat gains were made. Set point temperature values were deduced from monitored data, while for internal gains the starting points used were values provided by Italian directives.

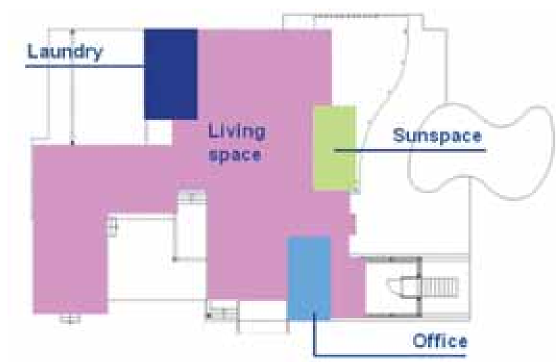


Fig. 3 - Thermal zones of the building model

As a first step, a model without the sunspace was prepared and verified using monitored data from the summer. Then, summer thermal simulations were run and the building behavior was checked by varying inputs until the model and the real building converged.
The living space was easier to adjust because it is used as a standard living space, according to the final use established in the regulation. For the laundry room, increasing internal heat gains were simulated in order to meet the real behavior of the room, strictly related to the presence of equipment.
Data from the scheduled opening of the windows, as monitored before, was then added. The introduction of this ventilation ratio was necessary for the overlapping of the model with the real building.

The sunspace was added subsequently. For modeling this element, the most difficult part was defining the air exchange rates between the living space and the sunspace and between the sunspace and the external environment. Furthermore, an appropriate schedule for the sunspace opening management had to be defined owing to the lack of real data.

When the whole building model with all four thermal zones was ready, the winter thermal simulation was verified. For performing this analysis it was necessary to complete the office thermal zone definition with the introduction of a standard electric heater. The schedule of the heater was supposed to look at the monitored data.
As shown in Graph3 and Graph4, the building model with the four thermal zones simulates well the real temperature evolution of the entire building.
Small differences are due to the faster response of the model, which has less internal mass, since most internal walls and the furniture are not simulated.

By means of the simulations not only energy consumption and temperatures were verified, but also the time constant of the entire building, which depends on the thermal capacity and thermal transmittance of the constructions.
It is interesting to see the real difference between the calculated time constant for the real building and for the model.
For performing this kind of calculation for the building, it was necessary to use monitored data of a period during which the home was empty and all systems inside were not in use (end of November – beginning of December 2011).
The time constant τ_0 was calculated using the following formula:

$$\tau_0 = -\frac{\tau}{\ln((t_f - t)/(t_f - t_i))}$$

where:

t_f is the final temperature of equilibrium between the building and the environment, and it was supposed to be equal to the average external temperature of the considered period,

t is the instantaneous temperature at the time τ,

t_i is the initial temperature of the building, when the heating system of the building was switched off.

For the monitored data, the result of this equation was equal to 100 hours and for the model the time constant resulted in nearly 70 hours.
This second value is more similar to the one calculated during the design stage using the following formula:

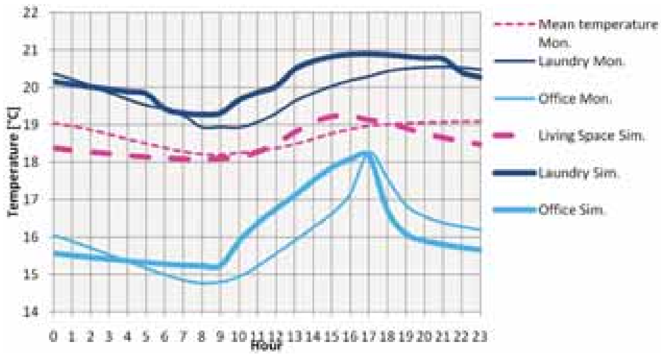
$$\tau_0 = \frac{C_m}{H_{tot}}$$

where:

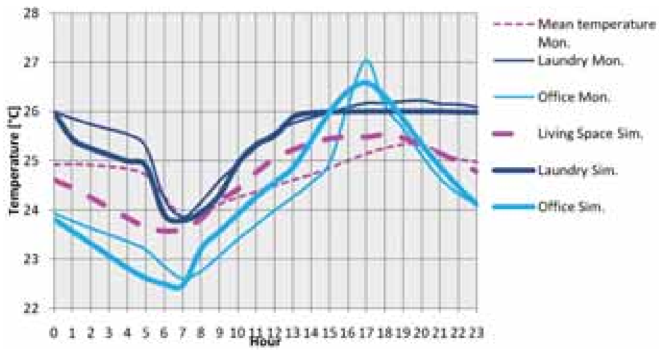
C_m is the total thermal capacity of the building,

H_{tot} is the total thermal loss coefficient.

The result was in fact equal to 58 hours with the same values for thermal capacity and the thermal loss coefficient also used for the model.
There is an evident similarity between these two results, which are both calculated without taking into account the presence of internal thermal masses, such as partitions and furniture. This confirms the hypothesis made when comparing the real behavior of the home with its simulation (Graph3 and Graph4).



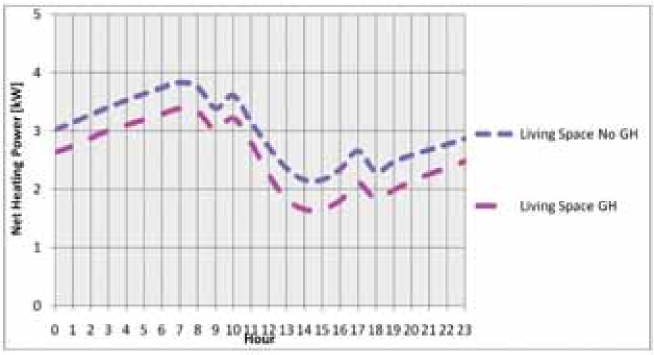
Graph 3 - Monitored vs. simulated temperatures: typical winter day



Graph 4 - Monitored vs. simulated temperatures: typical summer day

Once the model with all the considerations above is validated, it is possible to affirm that the calculated net heating and cooling needs of the building are reasonable. They are respectively 20 kWh/m^{2}year and 12 kWh/m^{2}year, and they could be even lower than expected thanks to the higher thermal mass contribution.
It is important to note that this building is not equipped with a mechanical ventilation plant with heat recovery. Therefore, the calculated energy demand is very low and the possibility to implement such a system would give greater energy results, but at the same time it would affect the concept of the bioclimatic architecture of the building.
In any case, with the current configuration, all thermal loads can be totally covered by the renewable energy produced onsite by solar collectors and PV panels.
Regarding the energy efficiency of the geothermal heat pump in both heating and cooling mode, 14 MWh are still left and they can be used for domestic electric energy needs and the left over can be sold to the grid.
Another analysis was performed to check the effective

contribution of the sunspace to reduce net heating energy consumption. The values for the average day net heating power for the living space with and without sunspace were compared (Graph5). The results prove that the green house contribution is a true asset, as it reduces the net heating need of the building by 4 kWh/m^{2}year.



Graph 5 - Net heating power required by the living space without or with the sunspace (GH)

The last analysis focused on the possibility to further simplify the energy model by unifying the zone of the living space with the laundry room and the office. The aim here was to have a model which is composed of only two thermal zones: the house and the sunspace.

For this model, standard ventilation rates and standard internal gains were used and the calculated net heating and cooling needs were respectively equal to 19 and 10 kWh/m^{2}year.
Given the the small dimension of the office and the laundry room, this model could be used to assess the building's energy needs as well as for heating and cooling plant sizing. However, due to its lower level of detail, the model is not suitable to show the inhomogeneous behavior of the two rooms.

A summary of the analysed building models and their results is reported in the following Table 1.

Model	Thermal zones				Net energy needs [kWh/m^{2}year]		Simulation results	
	Sunspace	Laundry Room	Office	Rest of the house	Heating	Cooling	Energy needs	Thermal behavior of the rooms
Four thermal zones					20	12	Adequate	Adequate
Without sunspace					24	12	Adequate	Adequate
Two thermal zones (standard input values)					19	10	Adequate	Not adequate

Table 1 - Simulations summary

Conclusions
Simulations allow to determine the thermal behavior of the building, to verify different potential design choices, possible constraints and help to find solutions to fix design errors.

To effectively reduce the energy demand of a building, both winter heating and summer cooling loads have to be considered through an integrated design process based on consistent energy concepts.
There are several design choices that affect the building's energy demand, these are mainly:
- building form (surface/volume),
- building orientation towards 4 cardinal points as well as size and orientation of windows,
- shading systems that protect against the sun in the summer and not during winter,
- building orientation towards prevailing winds and natural ventilation strategy,
- internal distribution.

All these variables also mean, reflect that each building design is different, particular, and that it cannot be defined only through statistic and scientific research.
In order to implement very good solutions, high energy performance constructions and systems are not enough as stand-alone elements. They have to work well together, as a unique organism, in the specific environment. This is why the designer has to strongly consider also the specific micro-climatic conditions and users' habits through a dynamic simulation model.

The test case of CasaZeroEnergy demonstrates that BENIMPACT Suite can be used to assess the building's energy needs, for heating and cooling plant sizing, and to verify the thermal behavior of different rooms. It also showed that it is very important to individuate parts of the house which might behave in an odd way and to separate them in the model.

In order to spread the awareness of sustainable design, "environmental friendly" constructions have to be characterized by "smart" investments. The convenience for all parties involved has to be proved in a scientific way, as done and reflected in this article by the thermodynamic performances.

The energy model is the first step of a more complex process. The other modules of the BENIMPACT Suite can then calculate the environmental impact and cost of each configuration, and search for the "optimal" trade-off between environmental and economic sustainability.

Full paper and references available on www.benimpact.it

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ESASIM Project on Electromagnetic Sensors/Actuators SIMulation

INTELLIMECH is one of the first entirely private-held research consortiums which aims at representing a benchmark for innovative enterprises, science institutes, advanced research and development organizations in the Italian panorama. It counts 20 enterprises and promotes pre-competitive projects in the mechatronics field.

The Consortium converts R&D and interdisciplinary experimental activities into pre-competitive technological platforms and pre-production prototypes in innovative cross-industry applications, involving directly the Consortium's partners.

ESASIM – Project overview
The electromagnetic simulation tools today are not very popular at the enterprise level, especially looking at the world of SMEs.

INTELLIMECH has implemented the project ESASIM (Electromagnetic Sensors/Actuators SIMulation) with the aim of promoting the knowledge and use of simulation tools for electromagnetic components in low frequency, showing their potential, deepening scientific and technological aspects in the field of technical design of electromagnetic systems and facilitating their deployment in the consortiated companies.
In addition to the initial bibliographic activities targeted to the topic of study, particular attention was paid to the choice of the simulator. A market and technical analyses of commercial software for the electromagnetic simulation at low frequency identified the software Maxwell (Ansoft / ANSYS) to support the project activities.

This choice is motivated by a series of advantages in terms of software modules as a support for the modelization of electromagnetic actuators and sensors.
These modules facilitate the setting of the solvers, and the properties to simulate both the electromagnetic phenomena and the interactions with the system including forces, both in static and dynamic mode.
Training activities have been carried out through tutorials illustrating the results from simulations of simple models developed on the basis of classical academic examples of

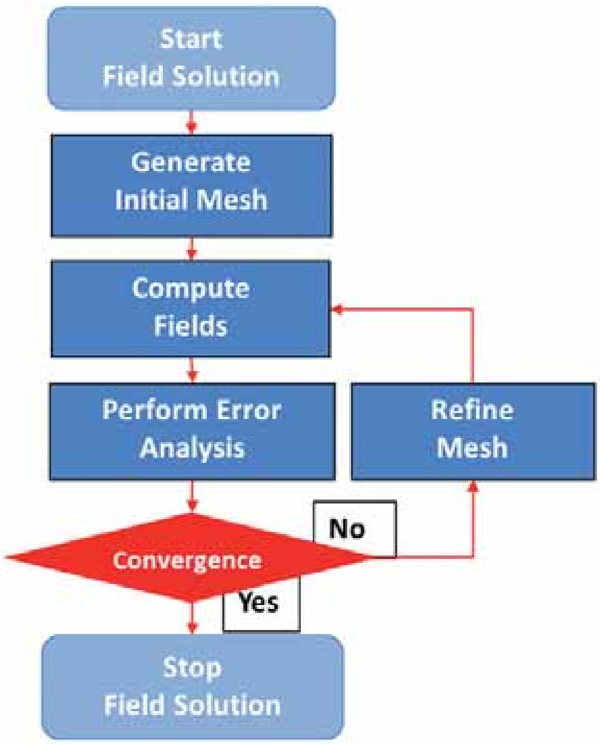

Fig. 1 – Generic cycle of operation of a simulator FEM.

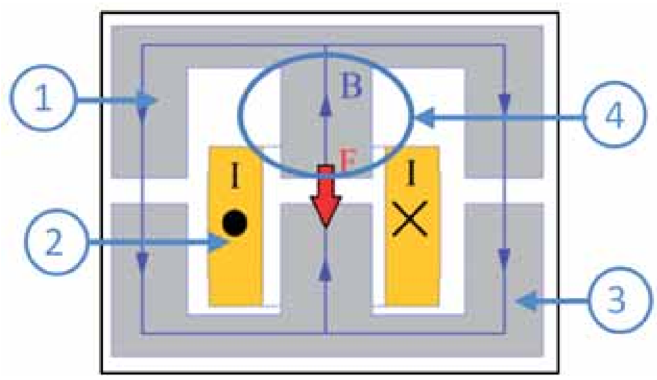

Fig. 2 – Longitudinal section of the solenoid actuator with Clapper Armature.

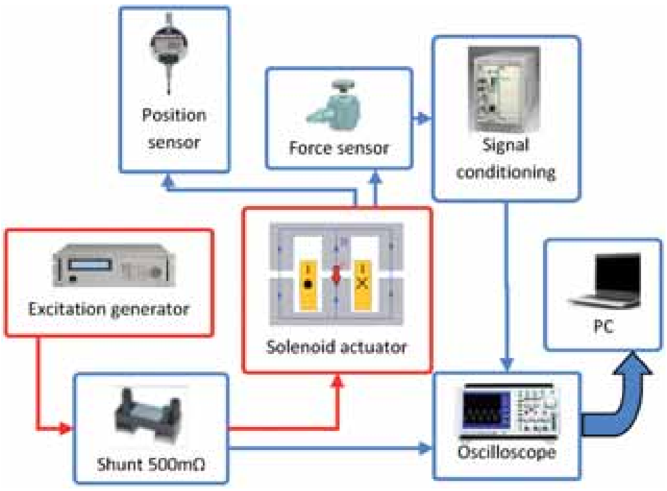

Fig. 3 – Block diagram of the measuring system for the force exerted on the armature and current absorbed by the coil.

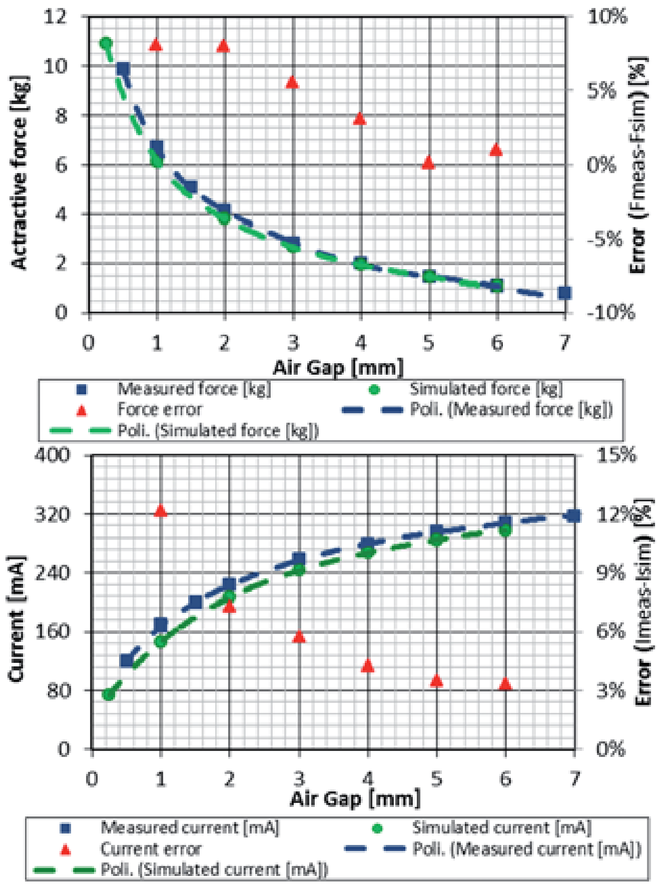

Fig. 4 - Comparison between simulation results and measurements performed on the solenoid actuator with Clapper Armature (the figure represents the attractive force exerted on the armature and the current absorbed by the coil).

electromagnetism. Finally, specific examples from industrial automation, and most of all, case studies developed on commercial devices have been examined. Here are two examples of the investigated electromagnetic actuators.

Simulation activity with experimental verification

Two different types of industrial actuators of particular interest were identified.

In the first application, the activity has been focused also on the validation of the simulated model through experimental verification.

In the second application the main theme has been the use of various features of the simulator for the design and optimization of the simulated device.

The actuator is composed of: a movable armature, a coil, a stator and a spring back (Fig. 2, marked respectively with 1, 2, 3 and 4).

The stator and the armature are made of ferromagnetic material. The block stator / coil, when the latter is traversed by current, behaves like an electromagnet which attracts the movable armature with a certain force. Regardless of the direction of the current in the coil, the force is always attractive. The spring back is used to restore the distance between stator and movable armature in rest condition.

The validation process of the model took place through the comparison between simulation data and measures. A model

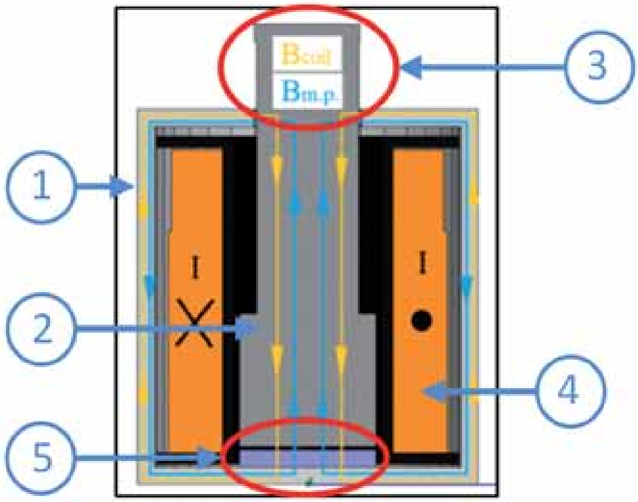

Fig. 5 –Solenoid actuator with Plunger Armature.

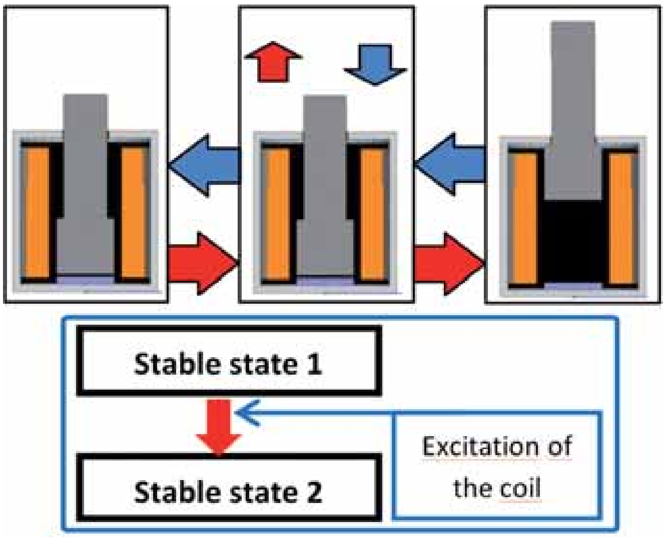

Fig. 6 – Phases of operation of the actuator with Plunger Armature.

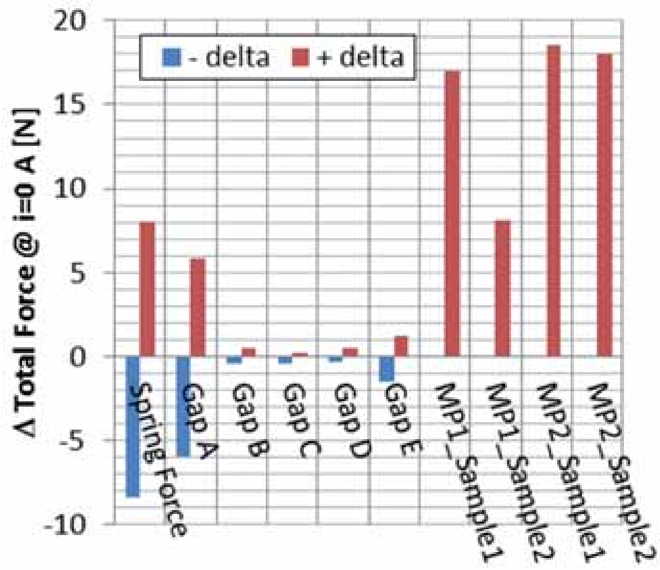

Fig. 7 – Variation of the total force agent on the plunger relative to the standard condition, following the variation of the model parameters.

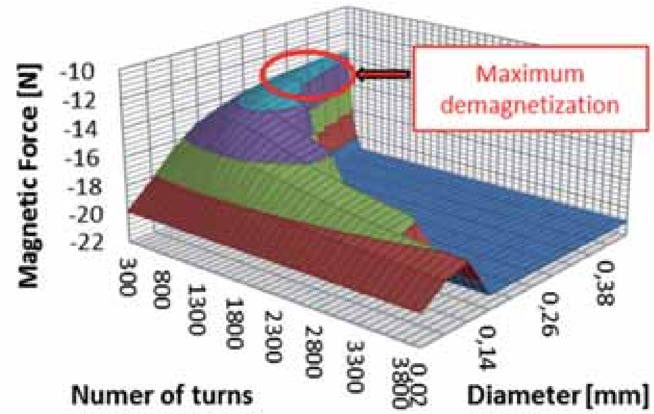

Fig. 8 – Minimum magnetic attractive force on the plunger as a function of the parameters of the coil.

of the system has been created and the data of the simulation procedure has been obtained and compared with those obtained from the experimental measurement.

A particular set-up has been implemented with the aim to measure the main parameters of interest of the device (force of attraction on the armature and current absorbed by the coil).

The test session was carried out by exciting the coil with a sinusoidal voltage of 230 Vrms at 50 Hz. The measurement procedure consisted in setting decreasing values of distance between armature and stator (air gap), and, for each air gap, acquire the rms value of the signal at the terminals of the shunt resistor, and the peak-to-peak value of the force sensor output, with system at regime. The results are shown in Fig. 4.

This actuator is composed of: case, movable plunger, spring, coil and permanent magnet (Fig. 5, marked respectively with 1, 2, 3, 4 and 5).

The actuator is a bistable device (Fig. 6). The Stable State 1 presents the plunger in low position, attracted by the permanent magnet. The Stable State 2 instead presents the plunger in high position, thrust by the spring against its upper end position. The transition takes place by means of the effect on the plunger of the demagnetizing field produced by the coil in opposition to that of the permanent magnet, which enables the spring to prevail over the magnetic attraction force, with consequent release of the plunger. The excitation takes place through a current pulse with adequate direction.
The simulation software was used to analyze different aspects of the project. First, an estimation of the effect on performance of the variability of the main design parameters has been obtained. The main parameters were: spring force, air gap (Gap) and permanent magnet (PM). The monitored quantity is the total force on the plunger (ie the sum of all the forces acting on it), with not energized coil. The test has allowed to classify the sources of greater variability, giving useful data about some critical constructive aspects (Fig. 7).

Then some parametric analyses of the model in order to optimize the device have been performed. Fig. 8 shows the results of the analysis carried out to determine the combination between the number of turns and wire diameter of the coil that generate the maximum demagnetizing effect on the armature, with no variation in the excitation of the coil.
The simulator has also been used to estimate magnitudes not measurable experimentally, such as eddy currents induced in the structure.

Fig. 9 shows the estimate of the portion of input energy into the system dissipated by the Joule effect by the eddy currents, as consequence of the driving pulse. The software

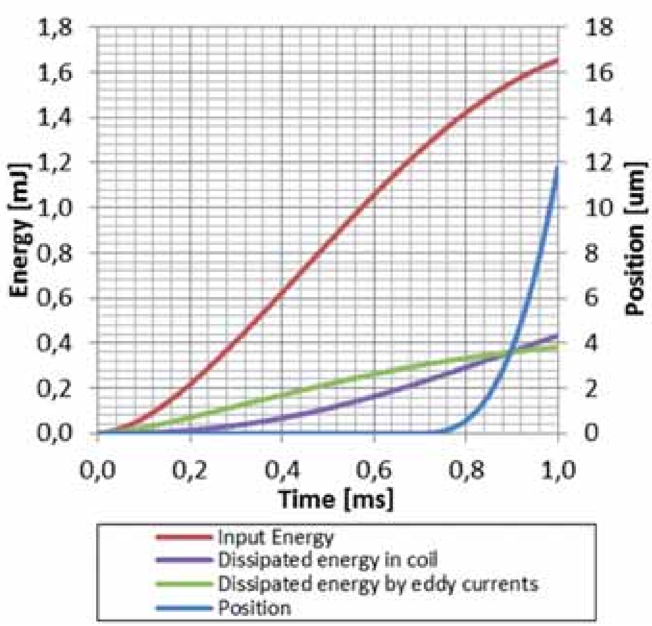

Fig. 9 – Comparison between the energy input into the system and the energy dissipated in the coil and by eddy currents (it can be seen also the vertical position of the plunger which describes its motion over time).

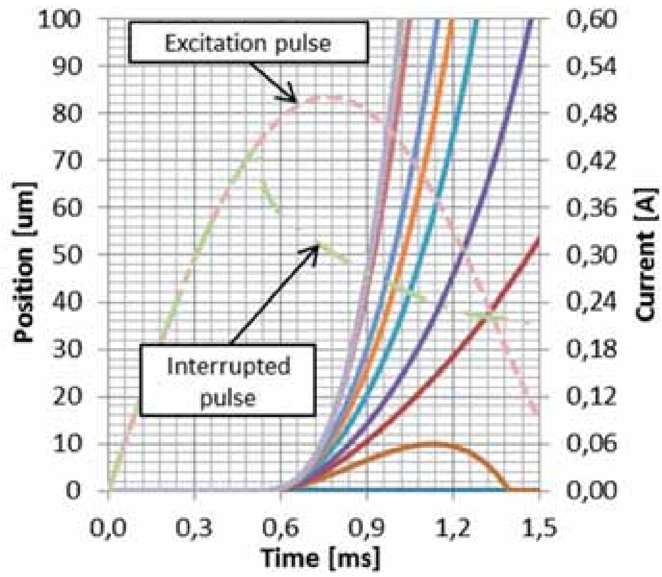

Fig. 10 – Change of motion of the plunger as function of the instant of interruption of the driving pulse.

also allows you to calculate density and direction of these currents in the volume of the device, allowing to assess any solutions to the phenomenon.
With a view to limiting consumption, it was considered useful to parameterize amplitude and duration of the exciting pulse, in order to find the most efficient combination that ensures the release of the plunger within the required specifications. Fig. 10, for example, concerns the simulation of the interruption of the excitation pulse at time intervals ever smaller.

The advantage of performing transient analysis with objects in motion through simulator, is to solve the dynamics of the moving object, coupling the forces generated by electromagnetic interactions to the inertia related to the mass in motion, and also to any external forces.

Conclusions
The case studies developed in the ESASIM project show that a correct setting of the model leads to results consistent with the real behavior of the modeled object. The analysis conducted was useful to characterize in detail the operation of the device (both in terms of static and dynamics), and to highlight inefficiencies or possible causes of malfunction. The results obtained from this series of activities have actually allowed the designers involved in the ESASIM project to deepen their knowledge both in electromagnetic devices and in advanced tools for their design and optimization.

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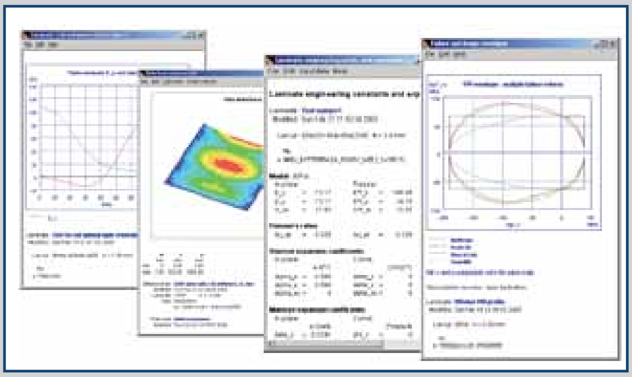
Nuova feature in ESAcomp

Le esigenze lavorative portano, oggi, sempre più persone a doversi spostare fisicamente presso un cliente od un fornitore, di partecipare ad una conferenza o di tenere una lezione in Università. È spesso necessario avere con se un portatile per dimostrare o presentare il proprio lavoro e, talvolta, i sistemi di floating licensing costituiscono un vero e proprio collo di bottiglia in questa direzione, costringendo gli utenti ad essere collegati alla rete ed al server di licenze, per poter accedere alle licenze necessarie.
EnginSoft è oggi lieta di annunciare che, dalla sua versione 4.3.1, il software per lo studio dei materiali compositi ESAComp mette a disposizione una nuova licensing feature, in grado di venire incontro proprio alle esigenze di questi utenti.



È infatti adesso possibile utilizzare un sistema di borrowing delle licenze ESAComp, tale da permettere, ad i possessori di una licenza flottante del software, di "prendere in prestito" una delle task disponibili sul server ed utilizzarla su di un qualsiasi PC come fosse una licenza Node Locked (senza più il bisogno di essere collegati al server di licenze).
Questa feature permette quindi di utilizzare il software non essendo più vincolati al proprio ufficio od alla propria rete aziendale, ma ovunque ed in qualsiasi momento.

Per maggiori dettagli su ESAComp:
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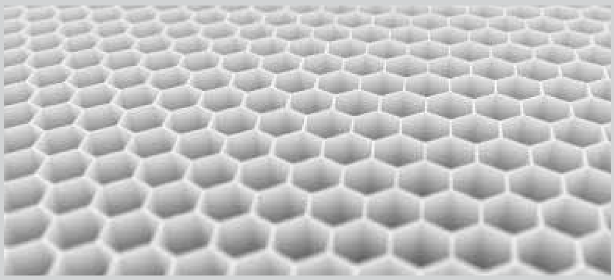


Progettazione navale: intervista a Massimo Verme della Verme Projects

Verme Projects is a yacht consulting company founded by Massimo Verme. The company, which Mr Verme started in 1996 as a freelance engineering supplier to a famous yacht designer, has become an integrated service supplier to shipyards and shipowners within the last five years. "Integration makes the difference" was the tagline in 2005, it was born from the lack of teamwork that Verme's CEO experienced at times when working with shipyard managements. Where the stylist excels, the engineer sometimes fails. Many projects suffers from this problem. Verme Projects are using their specialized engineering capabilities: hull structure FEM optimization, hydrodynamics of planing hulls, composite materials design, CFD analysis, yacht noise and vibration consultancy, together with high-end styling: both for interior decorations and boat exterior styling, plus professional consulting: yacht surveillance, yacht construction management, Owner assistance. The Verme Project idea is to offer an integrated solution which helps our customers in developing better projects.

Ingegner Verme, come è diventato progettista specializzato in Yachts?

Sono partito da tutt'altra esperienza scolastica. Si pensi ad esempio che il lavoro di tesi, durato un anno, riguardava la simulazione di impatto aereo su centrali nucleari...

Per mantenermi gli studi, ormai quasi vent'anni fa ho iniziato a lavorare in un piccolo studio che serviva uno dei guru, allora in voga, della progettazione nautica. Lì è iniziato l'amore per la nautica e per le barche. Non fu solo la passione per il mare a guidarmi. Quello che mi affascinò fu la possibilità di sviluppare e coordinare un progetto di un'imbarcazione nel suo assieme, dall'idrodinamica agli interni, ad un livello sicuramente molto più basso di altri veicoli quali l'aereo o l'automobile, ma comunque con grandi soddisfazioni per il designer. Nel progetto di un'auto o di un aereo il singolo designer al massimo può essere responsabile della progettazione di un componente o di un sottosistema. Nella nautica ancor oggi è possibile che il Progettista abbia la visione e la competenza su quasi ogni dettaglio del prodotto. L'artigianalità della nautica, vista da qualcuno come un limite, è al contrario fonte di grosse soddisfazioni per il progettista. Decisi così di dedicarmi quasi esclusivamente al mondo unico della nautica da diporto.

Lei ha una preparazione tecnica ingegneristica, come e quando ha deviato anche verso un tipo di progettazione più prettamente di design?

Fino a circa dieci anni fa non pensai mai a curarmi del design. Ero infervorato ad analizzare carene, idrodinamica, strutture in composito e quant'altro fu il mio cavallo di battaglia per cercare di affermarmi nel settore. Poi un giorno, dieci anni fa, Fernando Amerio di "PerMARE" mi chiese un giudizio su dei bozzetti di linee esterne della sua nuova barca. Io mi schermii e dissi: "Io sono un ingegnere, non so se sono in grado di dare un giudizio autorevole". Lui mi rispo-

se “Il Bello è Bello, indipendentemente da chi lo disegni o da chi lo apprezzi". Quella risposta mi colpì e da quel giorno cominciai a provare e riprovare a disegnare qualcosa di mio.

Quali sono le fasi del suo lavoro?
Il flusso di lavoro è articolato e varia anche in funzione della tipologia di progetto. La sua nervatura portante è il Concept Design iniziale, cardine di ogni progetto ed alla base del suo successo. L'individuazione delle esigenze di mercato nel caso di produzione seriale o delle esigenze dell'Armatore di una barca custom rappresenta la fase iniziale più sfidante e se vogliamo divertente dell'intero processo di progettazione. Lo sviluppo progettuale a valle di questa fase è fatto in maniera parallela ed integrata. Sia per la parte di design sia per la parte tecnica. Segue una stretta collaborazione col Cantiere, all'interno del quale spendiamo buona parte del nostro tempo in fase esecutiva. Un buon progetto non può prescindere infatti dalla conoscenza delle fasi della sua produzione.

Come integra la parte tecnica con quella di design?
Da un punto di vista informatico, e gestionale, sono all'interno del mio studio strettamente legate. Cerco insomma di far parlare la stessa lingua a tecnici e designer, facendo ragionare da designer i tecnici e da tecnici i designer. La curiosità è che nella fase di sviluppo concettuale e creativo del progetto, da un punto di vista personale, spesso perseguo l'opposto. Cerco in sostanza di dimenticare di essere ingegnere quando faccio il creativo. Mi preoccupo degli aspetti tecnici di dettaglio solo in un secondo tempo. È chiaro però che non mi dissocio a tal punto da disegnare oggetti industrialmente discutibili.

Quali sono i vantaggi e gli svantaggi di rappresentare la figura sia dell'ingegnere che del designer?
Per il Cliente e per l'Armatore vedo solo vantaggi. Ho svolto in passato funzioni di direttore tecnico in più Cantieri. Spesso si perdeva più tempo a far mettere d'accordo Designers ed Ingegneri che a sviluppare concretamente il progetto. Nel nostro caso il problema non si pone.
Gli svantaggi che ho vissuto sono stati solo a carattere personale e commerciale. Difficile far capire in maniera credibile che potevo svolgere per davvero entrambe le funzioni. Qualche premio e tanti progetti sviluppati ci stanno però dando una mano. Difficile infine proporsi quale Ingegnere in Cantieri feudi d'altri Designers...

Qual è il suo rapporto con le tecnologie informatiche in ausilio alla progettazione?
Posso dire che sono nato davanti al computer e morirò con la matita in mano. Il CAD è stata per me la partenza. Disegnavo per passione col CAD quando ancora molti, almeno nella nautica, non sapevano cos'era. Mi sono appassionato alla modellazione tridimensionale delle forme (inizi anni 90') cercando di sfruttare al massimo la tecnologia informatica dell'epoca. Poi però mi sono reso conto che il CAD portava via risorse mentali. Pensavo cioè al 50% al prodotto ed

al 50% ai tecnicismi della sua modellazione. Oggi ho deciso di pensare al 100% al prodotto, specie nella fase iniziale della sua impostazione. Se Gordon Murray, progettista vincente di una Formula 1 ipertecnologica e con risorse quasi illimitate la pensa allo stesso modo forse ci sarà un perché...
Il discorso è diverso per la fase di sviluppo di dettaglio. In quella fase il CAD, specie tridimensionale, è un aiuto insostituibile ed imprescindibile. Giocando con le parole si potrebbe dire che il “LA” lo preferisco dare a matita ma la mia orchestra deve suonare col CAD e contestualmente con il CAE per la simulazione e la prototipazione virtuale.

Lei ha un rapporto frequente con il cantiere Permare per il quale ha disegnato la nuova Amer 100. Ci fornisce maggiori dettagli sull’approccio progettuale e le soluzioni tecnologiche adottate?
L'idea dell'Amer 100 è nata due anni fa nel periodo più buio della crisi. Sembrava che l'unico tipo di barca vendibile e 'Politically Correct' per i prossimi anni fosse la navetta dislocante. Io ero invece convinto che per un'ampia fetta di clientela la barca potesse e dovesse essere sportiva ed accattivante. L'idea fu quella di vestire spazi interni da navetta con linee più sportive, per un bacino di potenziali Clienti diverso. Tale impostazione ovviamente fu estesa alle sue caratteristiche tecniche, disegnando una carena che consentisse non solo di planare efficacemente ma anche di navigare a bassa velocità con consumi ridotti. Da ultimo abbiamo voluto aumentare gli spazi a disposizione dell'Armatore realizzando una soluzione wide-body inusuale su una barca sportiva che abbiamo mantenuto omologabile come barca da diporto sotto i 24 m di lunghezza CE (prua e poppa sono smontabili).
Una volta identificato questo concept design, rigorosamente a matita, si è iniziata la fase successiva dello sviluppo di dettaglio dello styling e dell'engineering, ciascuno con le proprie sfide. Dall'armonizzare le linee esterne contenendo gli ampi volumi interni a disegnare una carena efficiente in tutte le condizioni. Dall'ottimizzare pesi e strutture ad utilizzare ogni più piccolo spazio utile senza trascurare l'aspetto legato a rumore e vibrazioni. Ci siamo avvalsi della nostra esperienza ma anche di risorse esterne e tra queste di Enginsoft, con cui collaboriamo in altri settori e che ci ha messo a disposizione importanti risorse per il calcolo fluidodinamico e strutturale. Crediamo che al momento Amer 100 possa rappresentare un prodotto unico nel suo segmento e che ci potrà dare grandi soddisfazioni.

A cura della redazione

EnginSoft Network News from France

Marie-Christine Oghly is the president of EnginSoft France and at the same time the head of the French association of female business leaders and the president of Medef's Ile de France region. Marie-Christine recently gave interviews to BBC UK and the Grand Journal on French TV. To bring some of her views to our readers, the Newsletter Editorial Team spoke to Marie-Christine before this edition went into print.

Marie-Christine, can you tell us about EnginSoft France, its background and where the company stands today?

M-C: EnginSoft France was established in 2008; since then we have become an important partner to industry, the academia and research institutes for modeFRONTIER and for optimization projects in general. I believe that we could develop our business relatively fast despite difficult times because our customers value our complete package: software, reliable support and full training for the technology, our consultancy services, and above all the expertise and dedication of our engineers. It was in 2009, when we started to offer the Flowmaster system simulation software in France, the whole of Southern Europe and in the French-speaking part of Switzerland. In the meantime, we have widened our engineering simulation portfolio, for example, we now provide the Sculptor and CHARles software to engineers in France. To complement our CAE portfolio for our customers, we also offer a broader range of consultancy services.

Marie-Christine, can you briefly summarize the goals that you and your team have for 2012 and beyond for EnginSoft France?

M-C: We want to develop our capabilities further, to exceed our customers' and our own expectations. We are observing the trends in product design and CAE usage. Our focus is on the needs of our customers and the country's emerging markets, for example, the energy sectors, specifically the renewables, and also on the biotechnology fields. Our participation in several research projects has always been and is very useful in this context. We want to expand our support, also in view of the situation that more and more of our customers operate globally. Another key topic for us is education and formation for computational engineers.

How would you assess the impact of CAE to product design and development in France ?

French Industries are nowadays using CAE across the entire design process. This is certainly the way forward for innovative design and the only one for French companies to gain competitiveness in the markets, especially for SMEs.

We see us as a reliable partner for French companies to better assess and implement CAE in their design process, through our technical competencies, our support and our diverse consulting services.

Marie-Christine Oghly, President EnginSoft France
Présidente Medef Ile de France
Présidente Nationale Femmes Chefs d'Entreprise (FCE)
Vice President World Association of Women Entrepreneurs (FCEM)

Marie-Christine, in some of your recent interviews that have been broadcasted in France and in the UK, you highlighted the idea of political union in Europe, the need for advanced education and training for the young, as well as the role of women in higher management in France. Can you briefly summarize some of your views for our readers?
Marie-Christine: France on its own is a small country acting on a global market, this applies to most European countries. All together though, the 27 countries represent one of the largest markets globally. The first step should be a real economical federation followed by a political one.
France has always been relatively well advanced in regards to social structure. However, some aspects and circumstances need to be improved. The unemployment rate among the young people is very high; we have to offer suitable and practice-oriented training, and create jobs. I believe that the best approach for this is the "Alternace" System which allows students to go to school and work in a company during the year. This model enables the students to gain experiences in industry and to receive a salary. It has already been implemented and is available to those with medium level education (below baccalauréat) and up to masters. Today, many of the Engineering Schools are adopting this system.
In France, as in a lot of other countries, women often encounter a "glass ceiling" inside the company they work for, this applies in particular to executive positions. There are few associations, such as the FCE (Femmes Chefs d'Entreprises) that are lobbying for women, to have access to promotion in the workplace and to managerial positions. A new law has been introduced, to set up quotas and to implement changes in corporate governance, for example companies with more than 500 employees should have a minimum of 20% of women in their board of directors in 2012, this should reach 40% in 2017.
When we consider that we are at 15% on average today, we know that we still have a long way to go!

If you would like to discuss with Marie-Christine Oghly directly, please contact her: info@enginsoft.com

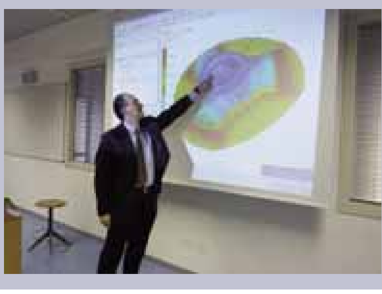
Il "Forge Italian Team" è presente a Cannes per lo Users' Meeting 2012 di Transvalor

CANNES, 11-12 Giugno 2012
Una nutrita rappresentativa di utenti italiani ha preso parte a giugno alla Conferenza Internazionale degli utilizzatori del software Forge, che ha visto la presenza di oltre un centinaio di persone nella splendida cornice di Cannes, Costa Azzurra.

EnginSoft, distributore in esclusiva dei prodotti di Transvalor per l'Italia, è presenza fissa di questi appuntamenti da ormai 15 anni. Nelle sessioni tecniche è stata presentata la nuova release del software FORGE, che migliora in modo significativo l'efficienza del lavoro di preparazione ed analisi dei risultati. Durante la serata di gala gli ospiti hanno avuto la possibilità di cimentarsi in una sfida tra i tavoli alla rolulette ed al blackjack, nella quale alcuni utenti dell'"Italian Team" hanno conquistato la prima posizione brindando con champagne.
Come di consueto, EnginSoft da appuntamento a tutti gli interessati il 23 ottobre a Lazise (VR), dove all'interno della International CAE Conference 2012 (www.caeconference.com) sarà organizzata una sessione dedicata, il "Forge Users' Meeting Italiano", nel quale verranno riassunte le novità dell'ultima release e sarà inoltre possibile assistere alle presentazioni di alcuni utilizzatori italiani.

EnginSoft insegna all'Università di Padova - DII

Lo scorso 22 maggio l'ing. Marcello Gabrielli di EnginSoft è stato invitato al corso "Progetto e prototipazione virtuale dei processi produttivi" gestito dalla Prof. Stefania Bruschi del DII - Università di Padova. L'intervento ha riguardato l'esposizione dei vantaggi ottenibili dall'utilizzo di tecnologie di simulazione nella progettazione ed ottimizzazione di particolari stampati a freddo, tiepido e caldo. Nel confronto con i 20 studenti presenti al termine dell'intervento è scaturito un notevole interesse ai temi trattati, con la possibilità per alcuni di loro di un approfondimento nei prossimi lavori di tesi e una possibile scelta di questo settore per un prossimo impiego.



Over 200 engineers joined the online EASIT2 project webinar titled "New Tools for Competence Development, Management and Recognition in Engineering Analysis and Simulation"

The EASIT2 project, a 2 year EU funded project under the Leonardo da Vinci Scheme, has come to an end on 30th September 2012. The project team, represented by Jim Wood (Mechanical Engineering, University of Strathclyde), Tim Morris (NAFEMS) and Giovanni Borzi (EnginSoft), presented the innovative project results to the international Analysis and Simulation Engineering community during a highly successful webinar titled "New tools for competence development, management and recognition in engineering analysis and simulation".
The tools presented were the Analysis & Simulation Educational Base, Competence Framework, and the Professional Simulation Engineer – PSE qualification.

About the EASIT2 Educational Base and Competence Framework
A competence framework is a structure that sets out and defines the competencies required by individuals working in a field or organization: such frameworks typically exist in specific sectors, e.g. Advanced Manufacturing, but none previously existed in the area of engineering analysis and simulation.
The EASIT2 Competence Framework is based upon a database of "standard" competencies, called the Educational Base, composed by over 1400 statements of competence subdivided into 23 areas of competence.
The benefits of the Educational Base for the individual engineer include the ability to assess his/her own existing competencies with a clear rationale to identifying development needs and training, with the aim to improve internal /external mobility and employability.

The online Educational Base and Competence Framework

Professional Simulation Engineer logo

The Competence Framework software extends the usage scenarios of the Educational Base, allowing individuals to record and track their learning progresses, and companies to tailor and/or extend the base to suit company needs, facilitating competencies monitoring, reporting and planning and providing for interfacing to broader HR systems.

About the Professional Simulation Engineer – PSE qualification
The Professional Simulation Engineer is a NAFEMS professional qualification, successor to the existing Registered Analyst Scheme. The Professional Simulation Engineer will replace the existing points based scheme with a competency based scheme, based upon a formal record of staff competence and training.
The Professional Simulation Engineer will provide to the Analysis and Simulation engineer a distinctive qualification, attesting enhanced analytical skills, able to increase value to employers and to enhance technical career prospects.
In fact, PSE employers will benefit by the formal record and independent assessment of staff competence and training, that will turn into higher productivity, less supervision, reduced risk of error and improved staff motivation.
Requirements to obtain the Professional Simulation Engineer qualification include education requirements, training formal records, appropriate simulation experience and evidence to support the competencies claimed through the Competence Framework.

For further information:
Giovanni Borzi, EnginSoft
info@enginsoft.it

Dolomites Workshop on Constructive Approximation and Applications

The 3rd Dolomites Workshop on Constructive Approximation and Applications (DWCAA12) was held in Alba di Canazei (Trento, Italy) from 9th to 14th September. It was hosted by the University of Verona in its summer courses building in the Dolomites, at about 1500 meters altitude.
More than 120 people from international Universities, research centres and private companies participated in the Workshop. EnginSoft played an important this year, by sponsoring the event and introducing a "Best Paper" prize. This award is to be given to the best paper submitted to the proceedings of the conference by either a student, PhD student or post-doc. The selection of the best paper

Figure 1: Presentation of the "best paper" prize.

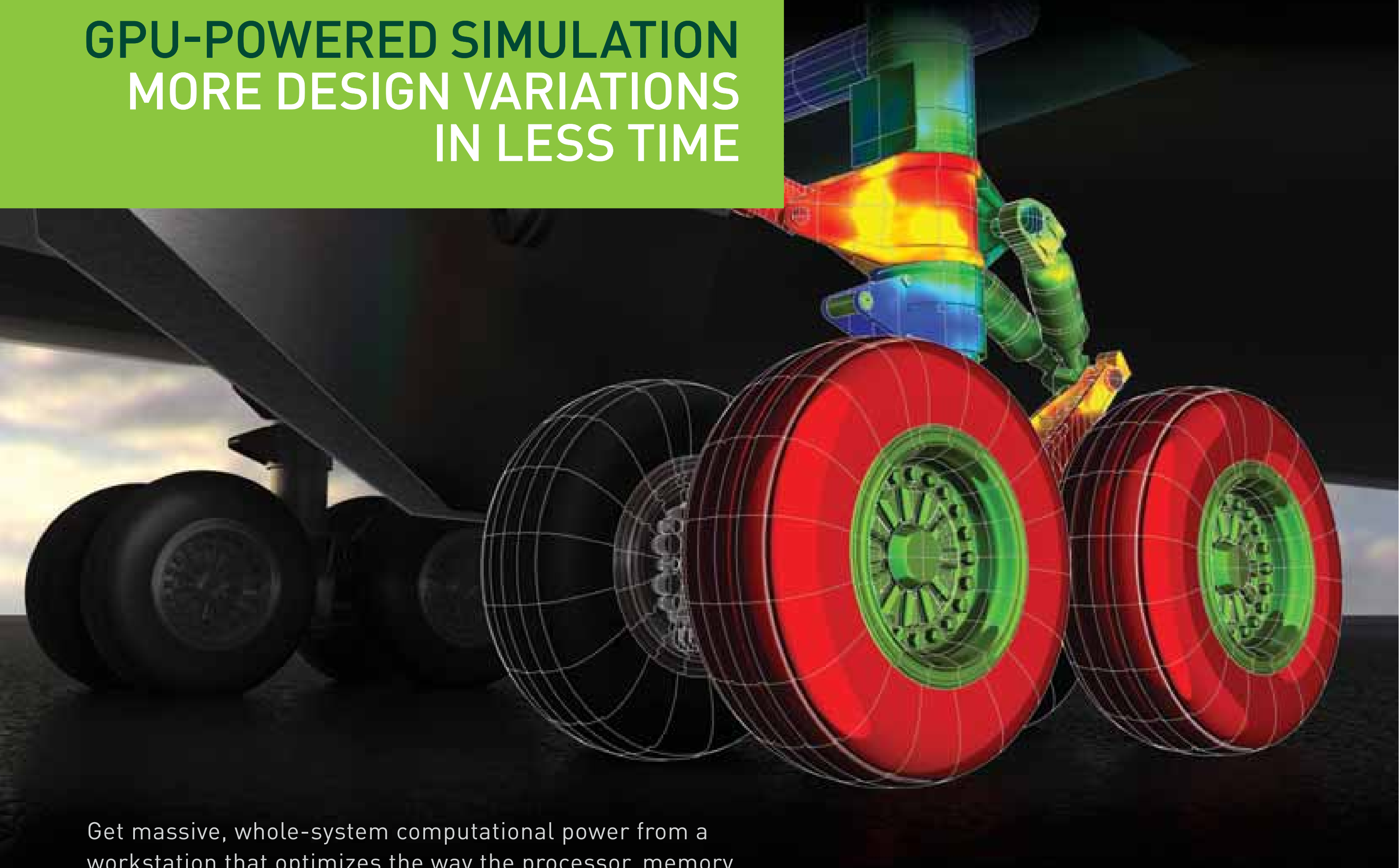
Figure 2: Silvia Poles, EnginSoft Padua presenting the "Best Paper" prize to the audience

will be made by the Scientific Committee of DWCAA12.
The program of the week included six different sessions went on for the entire week, dedicated to different methods and difficulties related to approximation (e.g. approximation in high dimension, polynomial and rational approximation, kernel methods).
EnginSoft also contributed a special session dedicated to real case applications for approximation algorithms to the organization. Silvia Poles and Vito Primavera from EnginSoft presented a couple of applications in which Radial Basis Functions were used to interpolate real data.

Alfonso Gambardella
"Innovazione e Sviluppo – Miti da sfatare, realtà da costruire"
Egea 2009

Ultimo libro pubblicato dal prof. Gambardella, docente di economia e management presso l'Università Luigi Bocconi di Milano, "Innovazione e Sviluppo" affronta, con l'aiuto di dati statistici e analisi di trend storici, alcune "certezze" che vengono tuttora quotidianamente spacciate dalla stampa nazionale ed internazionale, e aiuta l'imprenditore e il manager a guardare il tema della innovazione con uno sguardo più ampio e meno convenzionale.
Vengono brevemente introdotte alcune teorie economiche relative all'innovazione, come ad esempio il modello di Schumpeter sui processi di crescita delle imprese e dei sistemi economici, allo scopo di evidenziare alcuni concetti chiave utili per il seguito della trattazione.
Vengono poi affrontati alcuni miti relativi alla Ricerca e Sviluppo, viene espresso il ruolo della grande impresa nelle attività di ricerca, e vengono proposte strategie attraverso le quali l'imprenditore, ma anche chi ha il compito di definire politiche locali e nazionali, può cercare di sfruttare al meglio le opportunità associate alle asimmetrie esistenti, relative ad esempio alla brevettazione.
Segnatamente l'Autore, mentre ribadisce il ruolo importante del progresso tecnologico, disvela come l'innovazione si generi in realtà da un complesso di fattori, che includono ad esempio investimenti complementari, nuovi metodi produttivi ed organizzativi, nuovi modelli di business capaci di intercettare la domanda, e anche fattori finanziari. Le tecnologie quindi vengono più utilmente ricondotte al ruolo di produttrici di nuove opportunità e di idee, solo poche delle quali però saranno in grado di incontrare una domanda, di generare un mercato, e quindi di generare reale innovazione.
Nella parte finale del libro emerge centrale la figura dell'innovatore, inserito in un sistema aziendale, economico e politico in grado di stimolarne, sostenerne e amplificarne creatività ed imprenditorialità.

GPU-POWERED SIMULATION
MORE DESIGN VARIATIONS IN LESS TIME



Get massive, whole-system computational power from a workstation that optimizes the way the processor, memory, graphics, OS, and software technology work together. The dual-processor HP Z820 Workstation delivers outstanding performance, award-winning industrial design, and tool-free serviceability in the industry's most expandable chassis.

And for your truly intensive GPU computing needs, the HP Z820 supports dual NVIDIA Tesla C2075 cards as part of NVIDIA's Maximus solution to deliver incredible productivity right to your desktop.

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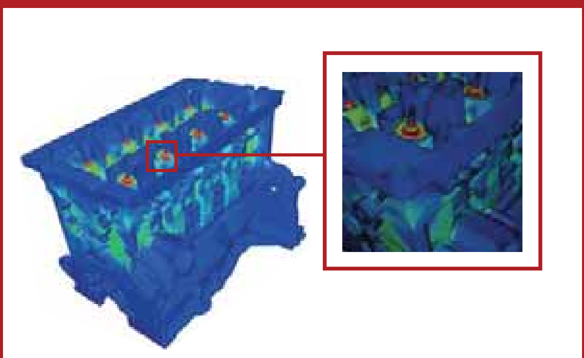

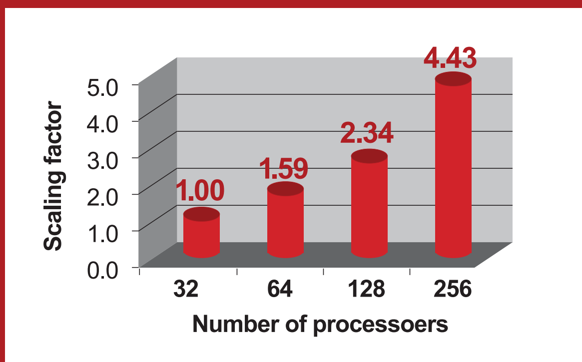

Model : automotive engine assembly (90M DOF)

Pre/Post-Processor

- Generate high quality elements without reducing designed CAD models.
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- High execution speed algorithm CGCG (Coarse Grid Conjugate Gradient) method solver.
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22-23
OCTOBER
2012

INTERNATIONAL CAE CONFERENCE

Numerical analysis technologies are more and more present in the industrial world. They are absolutely essential to the product and process innovation at each level and in every industrial sector. The International CAE Conference will present the state-of-the-art of CAE in diverse industries. Significant user testimonials will prove how such technologies help increase the product efficiency and ROI. This annual appointment is a major, an efficient platform for designers, analysts, IT managers, engineers, professors, researchers, associations and students involved or interested in virtual simulation tools.
In the field of numerical analysis, the International CAE Conference is the most important event in Italy and one of the leading conferences in Europe. It features two congress days and some Users' Meetings of the main technologies developed by the most important worldwide CAE players, such as ANSYS, Flowmaster, MAGMA, Forge, modeFRONTIER and many others.
An accompanying exhibition will run parallel to the Conference Program. The exhibition traditionally offers a networking platform, where CAE technology solution providers offer their knowledge, advice and expertise to the participants. A special section of the exhibition area will be dedicated to members of associations and scientific bodies, the technical press as well as to hardware vendors who provide the necessary know-how to implement machines and components in order to perform today's more and more complex analyses.

22 OCTOBER 2012 - MORNING

	PLENARY SESSION
	(Room Arilica)
9.30	**Stefano Odorizzi, EnginSoft -** Welcome Address
9.45	**Parviz Moin, Stanford University -** High Fidelity numerical simulations of multiple-physics turbulent flows in complex geometries
10.30	**Andreas Ennemoser, AVL List GmbH -** Help! Where are my data?" Subtitle: "Don't worry, solved. We can deliver
10.55	COFFEE BREAK
11.15	**Mikael Lundblad, Sandvik Coromant** - Knowledge driven design
11.30	**Gianluca Iaccarino, Stanford University and Cascade Technologies Inc., -** Forward and Backward Uncertainty Analysis - Tools for Engineering Design
11.55	**Thomas B. Masservey, IMS Regional Coach -** Leveraging International Collaboration through the Intelligent Manufacturing Systems (IMS) Program
12.20	**Marc Wintermantel, EVEN -** An America's Cup Engineering Story
12.35	**Clovis Maliska - SINMEC/CFD Lab Federal University of Santa Catarina -** A joint industry-academy project for the development of integrated reservoir-wells tools
13.05	BUSINESS LUNCH

INTERNATIONAL CAE CONFERENCE

22 OCTOBER 2012 - AFTERNOON

	PLENARY AND MAIN SESSION	
	(Room Arilica)	(Room Riva)
14.00	**Stefan Luding, University of Twente** - From Particles towards continuum theory: Crossing multiple scale	**Andrea Remuzzi, Ist. Mario Negri** - Clinical validation of computer based modeling for surgicalplanning of vascular access in hemodialysis patients
14.25	**Eugenio Onate, CIMNE** - Advances in the particle finite element method (PFEM) for multidisciplinary problems in engineering	**Tim Bogard & Chris Wilkes, Sigmetrix** - 7 Phases to Robust Design: How GD&T, Feature Functionality, & Exact Constraints Define Robust Assemblies
14.50	**Andreas Vlahinos, Advanced Engineering Solutions** - Imminent Advance Engineering Environments	**Tim Morris, NAFEMS** - How to Gain, Manage and Assess CAE Expertise
15.15	**Aronne Armanini, University of Trento** - Mathematical Modeling for Debris Flows and Hazard Mapping	**Michael Olsson, Tetra Pak** - The value of simulations in packaging industry
15.40	**Mikael Törmänen, Volvo Cars** - Enhancing Multi-Disciplinary Optimization by Initial Systematic Screening	**Antonio Navarra - Euro-Mediterranean Centre for Climate Changes**
16.05	COFFEE BREAK	
	(Room Arilica)	(Room Riva)
16.30	**Keith Hanna, Mentor Graphics** - Back to the future: trends in commercial CFD	**Fabio Marcuzzi, Università di Padova & Fabiano Maggio, EnginSoft** - An Innovative Simulation-Based Approach to Develop Microcontrollers Applications
16.55	**Erik Lönroth, Scania** - How we intend to pursue a market edge with HPC	**Hironori Imai, SCSK** - The approach to the reliability by coupled analyses between manufacturing and structural analyses. Realistic analysis with ADVENTURECluster
17.20	**G. Meneghetti, University of Padova, & S. Giacometti, - OZ Racing** - Design and manufacturing of a single-seat formula SAE racing car	**Jean Luc Lacome, IMPETUS** - Modelisation of blast loading on a steel structure using advanced numerical particle method
17.45		
18.30	INTERNATIONAL CAE POSTER AWARD	
19.00	COCKTAIL PARTY	

INDUSTRIES PERSPECTIVES		ENABLING TECHNOLOGIES			
INDUSTRIAL SESSION / CFD (Room Rocca)	**INDUSTRIAL SESSION/MECH.** (Room Cisano)	**LS-DYNA It. Users Meeting** (Room Laciusium)	**COMPOSITIES** (Room Bardolino)	**Scilab** (Room Vela)	
Ansaldo Nucleare - Preliminary 3D analysis of the flowfield in the steam generator of thelead-cooled ALFRED nuclear reactor with ANSYS/FLUENT	**Pierburg** - Correlation between Multibody Flex simulations and experimental measurements on a Vaccum Pump for Porsche	**Indesit** - Indesit drastically reduces the packaging cost thanks to the new CAE driven design approach	**Verme Projects** - Styling and engineering from sea to land: examples of integrated composite design development	**Scilab Enterprise** - What's New with Scilab?	14.00
Faber - Fluidodinamic optimization of a rangehood blower	**Vision** - A new wireless power supply implementation for electric vehicle batteries charging	**ZF** - Virtual Prototyping for Safer Product Development: Integrated Marine Propulsion and Steering System Example	**WhiteHead Sistemi Subaquei** - Multidisciplinary Concurrent Engineering: V-FIDES Underwater Autonomous Vehicle hull design example	**CNES** - Scilab for space mission design	14.25
Pierburg - Dynamic analysis of aVariable displacement OilPump shaft undercrankshaft torsional vibrations and internalpressure loads evaluated via CFD	**Ansaldo Energia** - Anisotropic Plastic Creep Analyses for Gas Turbine HGP Components with ANSYS	**Brabant Alucast** - Process and Product integration for High Strength Magnesium alloy components	**Componeering** - Design-Optimization of Cylindrical Composite Structures in Preliminary Design	**Università di Padova** - A Scilab Radial Basis Functions toolbox	14.50
Università di Ferrara - Numerical Analysis of aMicro Gas Turbine Can-Combustor fed by Synthesis gas: numerical evaluation of the combustor geometry influence	**General Electric** - Silence system development in oil and gas through ANSYS simulation	**Thales Alenia Space** - Inflatable Module	**EVEN Evolutionary Engineering AG** - ACP - ANSYS Composite PrePost V14.5 Special and new features for Composite Virtual Prototyping	**EnginSoft** - Solving optimization problems with Scilab	15.15
Tetra Pak - Fluid Structure Interaction of a rigid body: simulation of a floating device used to detect the liquid level inside the filling system of a packaging machine	**CADFEM** - CADFEM ANSYS Extensions - an Overview	**CRF** - An integrated approach for full process simulation aimed to PC/PD dimensional quality improvement	**WhiteHead Sistemi Subaquei** - The RubeeComp Project: composite material components incorporating unfriendly environments wireless communication systems	**Openeering** - Modeling in Xcos using Modelica	15.40
COFFEE BREAK					16.05
		LS-DYNA It. User Meeting (Room Laciusium)	**modeFRONTIER Italian UM** (Room Bardolino)	**R&D ROUND TABLE** (Room Gardesana)	
Franco Tosi Meccanica - The role of virtual analysis and new numerical technologies in turbomachinery applications	**Daunia Solar Cell** - Thermal press optimization for sealing of new generation photovoltaic modules	**DYNAmore** - New Features and Future Developments in LS-DYNA	Workshop: **Handling Uncertainties with modeFRONTIER: Introduction to Robust Design Optimization** with **FIAT** - Industrial Case History: Overview of Robust Design Optimization in Chassis and Vehicle dynamics	**Imprese e competitività: insieme per il successo** Reti, innovazione e progetti R&D: finanziare la ricerca si può! Soluzioni concrete e nuove prospettive per scoprire percorsi di successo in tempi di crisi.	16.30
	SACMI - The economical advantages of the new approach in the evaluation of the fatigue life for the new generation presses	**MATFEM** - Advanced Modeling of Metals and Thermoplastics for Crash Applications under Consideration of the Process History			16.55
Petrolvalves - Aeroacustic of the Valves: problems and solutions	**Università di Padova** - Simple solar collectors for shower	**BETA CAE** - Recent advancements in LS-DYNA pre-processing for crash simulation			17.20
Politecnico di Milano - CFD Simulations of windage losses of a gearbox	**Simpleware** - New Developments in Image-Based Mesh Generation of 3D Imaging Data	**BASELL** - Simulating Failure with LS-DYNA in Glass Reinforced, Polypropylene-based Components			17.45
INTERNATIONAL CAE POSTER AWARD					18.30
COCKTAIL PARTY					19.00

23 OCTOBER 2012 - MORNING

	ANSYS ITALIAN USERS' MEETING		modeFRONTIER Italian Users Meeting
	(Room Rocca)	(Room Riva)	(Room Arilica)
9.30	**Piaggio Aero** - Optimization of wing efficiency vs. sweep angles using mesh morphing	**Piaggio** - CAE analysis of a con rodfor motorbike application	Workshop - **Efficient Optimization with mF: how to use advanced algorithm strategies**
9.55	**CINECA** - Delayed Detached Eddy Simulation of Yacht Sails with experimental validation	**Pierburg** - Vane Oil Pump CFD ANALYSIS: pressure fluctuation and waves reflection	
10.20	**University of Pisa** - Research Activities on Slot-Coupled Patch Antenna Excited by a Square Ring Slot	**Università dell'Aquila** - Classical andscale-resolving turbulence models in wind turbine aerodynamics	
10.45	**Key to Metals** - New developments in a database of advanced material properties for cae use	**SUPSI** - CFD modeling suitable for concentrated solar power applications: thermalinsulation based on radiation shields and thermal energy storage systems	
11.10	COFFEE BREAK		
	(Room Rocca)	(Room Riva)	(Room Arilica)
11.40	**NVIDIA** - Industry Benefits of GPU-Accelerated ANSYS Software	**CYBERNET** - PlanetsX: Injection Molding CAE System on ANSYS Workbench - For all the people in the development of plastic products	**Ferrari GES** - Composite laminates optimization on Formula 1 car components
12.05	**Ozen Engineering** - How to perform electromigration simulations in ANSYS	**Università di Bologna** - Design and Optimization of bioreactors for hydrogen production by computational fluid dynamics	**Magneti Marelli** - Air intake manifold design: a geometrical dimensioning for engine performances optimization
12.35	**NICE** - Visualization Tools: remote access to your simulation	**Consorzio SIRE** - CFD transient simulation of the Piaggio P180 internal cabin ventilation	**SACMI** - Mechanical optimization of the injection system in a compression molding machine
18.30	BUSINESS LUNCH		

Flowmaster European Users Meeting	MAGMA Italian Users Meeting	FORGE Italian Users Meeting	
(Room Cisano)	(Room Bardolino)	(Room Lacisium)	
Welcome and introduction	**MAGMA** - MAGMA core and molds	**TRANSVALOR** - Roadmap & Forge New Graphical Interface	9.30
GE Oil&Gas - Enhancing design through system level simulations at GE Oil&Gas		**MURARO** - Production Process of a bearing ring	9.55
FDB - Bringing the power of expert CAE software to spread-sheets: Solutions for the study of hydropower plant performance using Flowmaster and Excel		**TRANSVALOR** - Open Die Forging Enhancements in Applications - Dual Mesh Method	10.20
Mentor Graphics - Morgan Jenkins Keynote: Keeping Flowmaster apace with Industry Trends	**MAGMA** - Hardware and Benchmark		10.45
COFFEE BREAK			11.10
(Room Cisano)	(Room Bardolino)	(Room Lacisium)	
EnginSoft - Industrial assesment of Flowmaster applications	**MAGMA** - New Release MAGMA5.2	**Feat Group** - Optimization study of a hot forged steel part: reduction of material and fatigue resistance of the dies	11.40
Flowmaster interactive workshop with John Murray		**TRANSVALOR** - Induction Heating	12.05
			12.35
BUSINESS LUNCH			18.30

23 OCTOBER 2012 - AFTERNOON

	ANSYS ITALIAN USERS' MEETING		modeFRONTIER Italian Users Meeting
	(Room Rocca)	(Room Riva)	(Room Arilica)
14.00	**ANSYS CFD Update** - Introduzione	**MECHANICAL UPDATE**: News 14.5 overview	**BETA CAE Systems** - Multi-objective optimization of a crankshaft using the efficiency of ANSA, μETA and modeFRONTIER
14.25	**ANSYS CFD Update** - Ambiente WB - Paradigmi parametrici e tools di meshatura avanzata		**Bottero** - Mold opening-closing mechanism optimization through modeFRONTIER
14.50			**Pierburg** - Integrated Procedure to Design a New VOP (Variable Oil Pump): Design Flowchart and Optimization Algorithm
15.15	**ANSYS CFD Update** - Solutori CFD-ANSYS		**EnginSoft** - BENIMPACT SUITE: Optimal Configurations of Windows and Accessories for Standard Nordic Private Modular "nearly Zero Energy Buildings" depending on the site of construction
15.40	**EnginSoft** - HPC: i vantaggi della parallelizzazione		**Linköping University** - Information Entropy based Performance Index and Meta Optimization
16.05	**ANSYS CFD Update** - Modelli fisici e numerici avanzati: Aeroacustica, FSI, Adjoint solver	**ANSYS Electromechanical Tools:** New Feature Updates and Future Roadmap.	**Politecnico di Milano** - Structural Optimization of Cable Systems
16.30	Questions & Answers		**Enginsoft UK** - Advancing the usability of automated processes in verification and optioneering studies

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(Room Cisano)	(Room Bardolino)	(Room Lacisium)	
DCNS - Flowmaster: How to migrate in Oracle version	**Centro Ricerche Fiat** - Integrated study of casting and assembly simulations for an aluminum inner door frame	**TRANSVALOR** - Rolling Ring & recrystallization	14.00
EDF France - Using Flowmaster for the EPR auxiliary system design	**Bruschi** - Pressofusi in leghe di zinco: sistemi avanzati di progettazione	**DIMEG Università di Padova** - Ductile Fracture Prediction in Cold Forging Process Chains	14.25
Iberdola Ingenieria - Nuclear Power Plant Circuit Modeling: Hydraulic and Thermal Calculations	**DTG -** Correlation between Numerical Simulation Results and Empirical Ones in Permanent Mould Gravity Casting of AM60B Magnesium Alloys	**TRANSVALOR** - Muti-Material simulation Material Data	14.50
Tristone - Automation in Flowmaster 7 : Pressure Drop Calculations Automation, Workflow and Time Savings	**iGuzzini -** Studio di fattibilita' preliminare del getto pressofuso per un vano ottico di apparecchio stradale a LED	**TECNALIA** - Rotary forging: simulations, apllications and link with microstructural calculations	15.15
Consorzio RFX - Monodimensional simulation of SPIDER Cooling Plant using Flowmaster code	Customer presentations	**TRANSVALOR** - Best Practice - Rolling Applications	15.40

Silvio Garattini al “Poster Award” promosso da EnginSoft nell’ambito dell’International CAE Conference

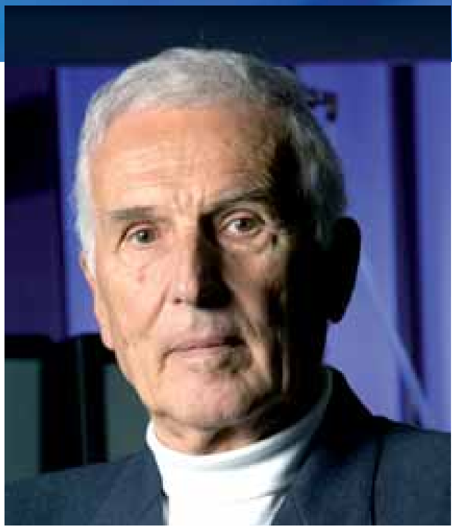

Fig. 1 - Professor Silvio Garattini

Si terrà a Lazise, Verona - Lago di Garda, Lunedì 22 Ottobre ore 18:30 presso il Centro Congressi Hotel Parchi del Garda nell’ambito dell’International CAE Conference, la cerimonia di premiazione della prima edizione del “Poster Award”. L’iniziativa, promossa e sostenuta da EnginSoft, è un concorso internazionale che premia i migliori lavori sviluppati da laureandi, dottoranti e tecnici impiegati nell’industria, che vertono su tematiche e ricerche condotte mediante l’impiego di tecniche e strumenti di simulazione computerizzata CAE.

Padrino ospite d’onore e co-promotore dell’iniziativa, nell’edizione “numero uno”, sarà il Professor Silvio Garattini, fondatore e Direttore dell’Istituto di Ricerche farmacologiche “Mario Negri” di Milano. Garattini, che in oltre 50 anni di attività ha firmato molte centinaia di lavori scientifici pubblicati in importanti e autorevoli riviste nazionali e internazionali, è considerato dalla comunità scientifica internazionale tra i più geniali e prolifici scienziati italiani. L'Istituto di Ricerche Farmacologiche "Mario Negri", sotto la direzione di Silvio Garattini, ha prodotto oltre 13.000 pubblicazioni scientifiche e circa 250 volumi, in cancerologia, chemioterapia e immunologia dei tumori, in neuropsicofarmacologia, in farmacologia cardiovascolare e renale. Sono circa 7.000 i laureati e tecnici di laboratorio, specializzati in seno all’istituto, nell’arco temporale della guida Garattini. Anche il CAE ed altre tecniche di simulazione computerizzata vengono ampiamente impiegate nei laboratori di ricerca dell’istituto: sia per simulare sistemi biologici in generale che per valutare l’efficacia del farmaco e la diffusione in organi umani “virtuali” simulati al computer.

Il Concorso si pone soprattutto l’ambizioso obiettivo di focalizzare l’attenzione di manager e imprenditori presenti ai lavori dell’International CAE Conference, sulla genialità degli individui avvicinando così l’offerta, costituita dai giovani talenti, alla crescente domanda, da parte dell’industria, d’ingegneri, progettisti e ricercatori. Il Comitato Scientifico, presieduto dal Professor Parviz Moin direttore del Centro per gli studi sulla turbolenza presso la Stanford University of California - USA, e ospite d’onore ai lavori congressuali dell’International CAE Conference, selezionerà tra i Poster ricevuti i migliori 10 provenienti dal mondo accademico ed un numero equivalente proveniente dall’Industria. Tra i 20 nominati, nel corso della cerimonia di premiazione, verranno rivelati i 3 migliori lavori per ognuna delle due sessioni: accademica ed industriale. I vincitori riceveranno in premio un Tablet Computer offerto da EnginSoft. All’interno dell’area espositiva della Conferenza sarà allestita un’area dedicata ai poster che accoglierà e renderà fruibili al pubblico tutti i 20 lavori selezionati. Gli autori avranno l’opportunità di illustrare l’originalità e il contenuto tecnico-scientifico del loro lavoro a congressisti, manager e imprenditori.
Approfondimenti su: www.caeconference.com

EnginSoft al Convegno AIM di Trento

Si terrà dal 7 al 9 Novembre p.v., al Grand Hotel Trento – Trento, il 34mo "Convegno Nazionale AIM" organizzato dall'Associazione Italiana di Metallurgia.
Il Convegno, unico nel suo genere in Italia per la vastità dei temi trattati, desidera ri-confermarsi come il momento di ritrovo e confronto per gli operatori dei diversi settori della Metallurgia. All'evento EnginSoft parteciperà da protagonista sia in veste di sponsor sia con contenuti tecnico-scientifici. Nel corso del primo giorno di lavori, infatti, Andrea Pallara e Marcello Gabrielli presenteranno un lavoro sul tema della Fattibilità produttiva attraverso la simulazione Numerica mentre il giorno successivo Giampietro Scarpa presenterà un tema d'attualità nel processo di pressocolata ovvero l'analisi delle difettologie e il contributo positivo indotto dalla simulazione numerica. L'intervento si terrà all'interno della sessione dedicata alla Pressocolata, presieduta da Piero Parona – presidente del Comitato AIM per questa tecnologia fusoria, che riunisce lavori ad alto contenuto tecnico-scientifico provenienti da importanti atenei e gruppi industriali.
L'appuntamento di Trento, perché ricco di contenuti tecnici e scientifici di alto livello, oltre a richiamare i tecnici della produzione, delle lavorazioni meccaniche in generale, è un punto di riferimento anche per docenti e ricercatori legati alla metallurgia. Per approfondimenti: www.aimnet.it

34° CONVEGNO NAZIONALE AIM

EnginSoft al Congresso Internazionale "Aluminium Two Thousand"

EnginSoft parteciperà al congresso sull'alluminio, che si terrà a Milano dal 14 al 18 Marzo 2013, con una relazione focalizzata su tematiche "Automotive" ovvero il dimensionamento ottimizzato di una biella-motore realizzata in lega leggera. L'esperienza, riassunta in un Paper a firma Gramegna- Lago – Scarpa di EnginSoft e – Luca Bellati di ABOR Spa, porrà l'attenzione sulle relazioni tra: disegno del componente, i sistemi per produrre e l'impiego di tecniche di ottimizzazione multi-obiettivo volte a realizzare il miglio compromesso tra aspetti tecnici progettuali, processi produttivi ed aspetti economico-finanziari.
Per approfondimenti: www.aluminium2000.com

Contributo scientifico di EnginSoft alla Giornata di Studio sulla Pressocolata

Enrico Boesso, esperto in processi fusori presso il Competence Center EnginSoft di Padova, interverrà alla Giornata di Studio dell'Associazione Italiana di Metallurgia in programma il 14 Novembre p.v. a Sirone (LC). In particolare l'intervento di Enrico Boesso – Product Manager della soluzione software "MAGMA" dedicata alla simulazione dei processi e fenomeni fusori, porrà l'attenzione sullo studio delle deformazioni cicliche del contenitore-pistone "con" e "senza" termoregolazione. Il gruppo Pistone-contenitore costituisce il punto di partenza del processo di pressocolata in camera fredda. Le forti sollecitazioni termiche e meccaniche al quale il sistema è sottoposto riducono la vita utile delle attrezzature, traducendosi non nel solo costo della sostituzione e nell'interruzione della continuità di processo ma anche nell'aumento di difettosità riscontrabili nei prodotti, e nei possibili danneggiamenti della macchina stessa. Partendo da queste considerazioni il Centro Pressocolata di AIM, nell'ambito del piano di formazione continua destinato agli associati, ha promosso e organizzato la Giornata di Studio sull'efficienza del sistema pistone-contenitore, anche in risposta alla sempre crescente domanda in tal senso da parte degli utilizzatori. Per approfondimenti: www.aimnet.it

Event Calendar

Italia
22-23 Ottobre 2012 – Lazise, Verona, Lago di Garda; "International CAE Conference"
22 Ottobre 2012 – Lazise, Verona, Lago di Garda; "Poster Award"
22 Ottobre 2012 – Lazise, Verona, Lago di Garda; Convegno "Imprese e Competitività: Insieme per il Successo"
7-9 Novembre 2012 – Trento; "Convegno Nazionale AIM"
14 Novembre 2012 – Torino; "Corso propedeutico all'utilizzo delle tecnologie CAE"

International
24-26 October 2012 – Kassel, Germany, ANSYS Conference & CADFEM Users' Meeting
9-12 June 2013 – Salzburg, Austria, NAFEMS World Congress


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