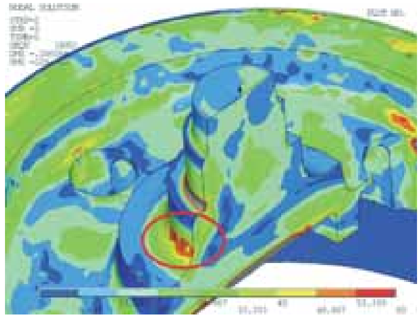
ENGIN SOFT

Newsletter

Year 6 n° 4 Winter 2009

Optimization in product development. An efficient approach to integrate single CAE Technologies across to the entire design chain



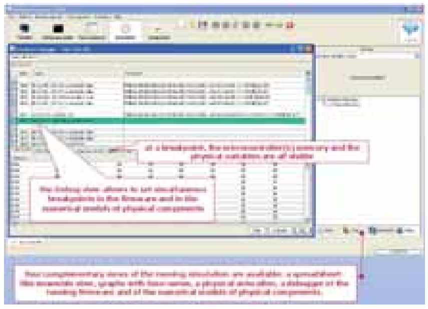
SOFTWARE UPDATE

modeFRONTIER RELEASE 4.1.2 HIGHLIGHTS

MAGMA 5: the new frontiers of process simulation

New release: FORGE 2009

Development of Digital Mechatronic Applications using Co-Simulation



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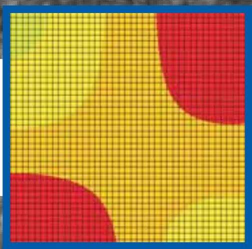
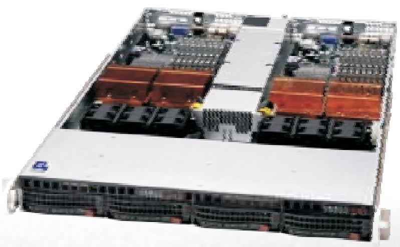


Robust Design Optimization of a Bumper System at Volvo Cars using modeFRONTIER

New trends in High Performance Computing



Aeronautical engines: reduction of emissions and consumptions with a process simulation study

Healing the swine flu with modeFRONTIER

Key partner in Design Process Innovation

EnginSoft Flash

Sometimes challenging times in business can leverage, cultivate and grow our creativity and innovativeness. They remind us on how important networking really is to develop and realize new ideas and visions and to get inspiration from other people and their views.

In early 2010, we can see a new understanding and new beginnings in many areas. It is the engineering profession that has always created jobs and projects, engineers bring things forward, they bridge many gaps and realize technological advancements.

Ing. Stefano Odorizzi
EnginSoft CEO and President

In the past year, EnginSoft has started several new initiatives and strengthened existing ties between our customers, partners, the academia, research and industry. To us, networking has never been more important. During my recent visit to Silicon Valley and the US, I have had the opportunity to meet with representatives of BAIA, the Business Association Italy America. BAIA is a political business network that facilitates the open exchange of knowledge and business opportunities. BAIA promotes a culture of innovation by fostering entrepreneurial spirit and principles, in the US and in Italy.

This edition of the Newsletter includes a review of my encounters with BAIA, the University of California at Berkeley, University of Stanford, and the University of Santa Clara in October 2009.

Our readers also hear about SimNumerica, the University Spin-Off EnginSoft has co-founded to support the development of Digital Mechatronics by using Co-Simulation. SimNumerica's joint expertise is focused on environments for the virtual prototyping of mechatronics systems based on micro-controllers

We present the modeFRONTIER 4.1.2 highlights and the successful application of the technology at Indesit Company that recently has received the 2009 Ecohitech Award for its state-of-the-art appliances. Volvo Car Corporation tells us about robust design optimization of a bumper system with modeFRONTIER. The statistical capabilities of the software, this time, are applied to the modeling of the spread of a disease like swine flu using relatively simple equations.

For those who are looking for first insights into the field of optimization, we recommend the article by EnginSoft Germany on optimization in today's product development.

Further software news feature Magma 5 for Process Simulation and Forge 2009.

Another highlight of this issue is the article on ANSYS simulation of carbon fiber and anisotropic materials in the ATLAS Experiment and the Large Hadron Collider at CERN.

We also present R&D News, current research projects, the EnginSoft Event Calendar and latest advancements in HPC High Performance Computing, as well as our Japan Column which features CADdoctor for accelerating reverse engineering and an interview with Mr Sakae Morita and Mr Kentaro Fukuta of ELYSIUM Co., Ltd. Japan, both speak about their time at our International Conference in Bergamo this year.

Akiko Kondoh, EnginSoft's Consultant in Japan welcomes us to Shogatsu, the New Year, with Osechi-ryori and best wishes from the land of the rising sun and Monodukuri.

We hope that you will enjoy reading the many contributions of this edition and that some will inspire you for 2010. As always, we welcome any feedback and ideas for future publications.

EnginSoft and the editorial team of the Newsletter would like to take this opportunity to wish you and your families a very Happy and Prosperous New Year!

Stefano Odorizzi
Editor in chief

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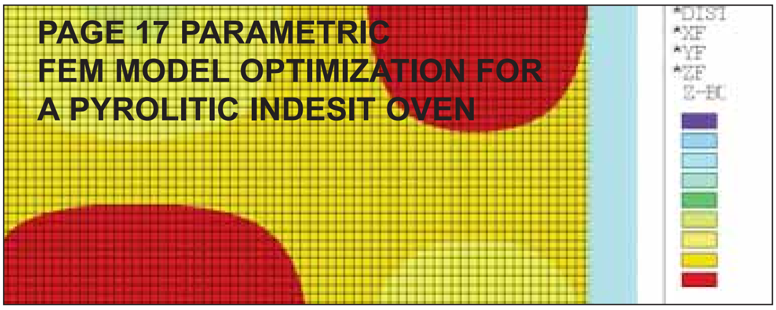

PAGE 17 PARAMETRIC FEM MODEL OPTIMIZATION FOR A PYROLITIC INDESIT OVEN

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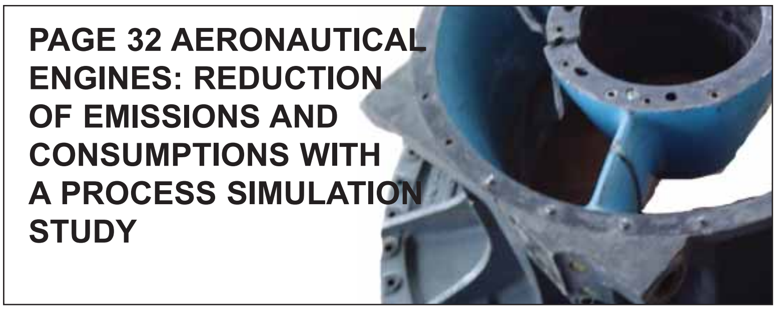

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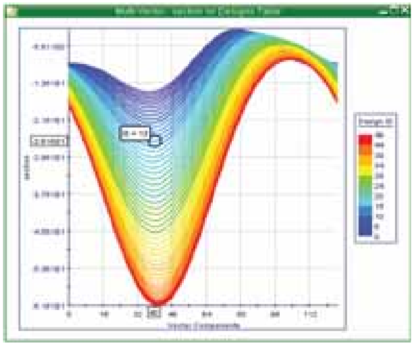
modeFRONTIER: release 4.1.2 highlights

ESTECO is proud to announce the release of v4.1 of the multi-objective optimization and design environment software, modeFRONTIER. This state of-the-art PIDO tool, written to allow easy coupling to almost any Computer-Aided-Engineering (CAE) tool, is now even more powerful and user-friendly than previous versions.



DOE Algorithms
New features have been added to the list of available algorithms in the DOE Sequence:

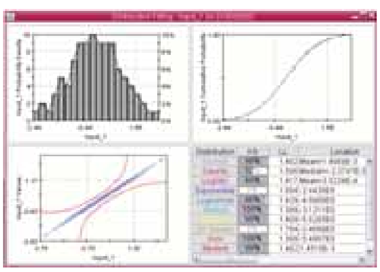
- Incremental Space Filler
- Inscribed Composite Design
- Uniform Reducer
- Dataset Reducer

Schedulers and Optimizers
New features have been added to the list of algorithms available in the Scheduler and Optimizers:

- Polynomial Chaos
- Evolution Strategy
- Lipschitz Sampling
- Mixed Integer Programming Sequential Quadratic Programming

Response Surface Algorithms
Evolutionary Design is now available, which implements a symbolic regression technique based on GP (Genetic Programming). The algorithm searches for the analytical expressions that are able to approximate the training data set. The users select the operators to be used among the basic mathematical functions (+,-,*,/,cos(),sin(),tg(),exp(), etc.) and the program evaluates the analytical expression.

Data Mining
New functions have been added to the Tools and Charts available in order to make life easier for users when exploring and assessing the data available in the Design Space tables:



Auto-Report
publishing results is just a few clicks away, thus the users can create automatic/custom report according to their needs.

Principal Component Analysis and Multi-Dimensional Scaling
Principal Component Analysis, designed to extract the significant latent variables out of a multi-dimension set of data and Multi-Dimensional Scaling, a powerful tool for exploring and analyzing sets of data have been added to the Multi-Variate Analysis Tool.

Distribution Fitting
Distribution Fitting chart has been designed for fitting univariate distributions to sets of existing data

Multi-Vector
Multi-Vector chart lets the users display vector data in a single plot

The Workflow
New features have been added to the list of CAD/CAE Nodes available in the Workflow library

Flowmaster™ V7
Moldflow MPI™
LMS Virtual.Lab™
GT-SUITE™
ANSA™
MSC Adams/View™

Design Target Node
It is now possible to easily assign an external vector as target function, by importing from an external text file or pasting the data values from the clipboard. This feature, coupled with the Levenberg-Marquardt algorithm is ideally suited for most of the common curve-fitting design problems.

For further information:
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MAGMA 5: le nuove frontiere della simulazione di processo

Con il mese di Novembre 2009 è iniziata la consegna della versione 5.0 di MAGMASOFT, denominata MAGMA5, che copre i principali aspetti dei processi di colata in SABBIA per leghe ferrose e non ferrose.

MAGMA5 è molto più di una semplice nuova release: è un ambiente totalmente nuovo, basato sulle più recenti tecnologie software, che rivoluzionerà l'utilizzo della simulazione. Con questo nuovo strumento diventa molto più semplice creare e gestire i modelli, impostare la simulazione e visualizzare in maniera efficiente i risultati.

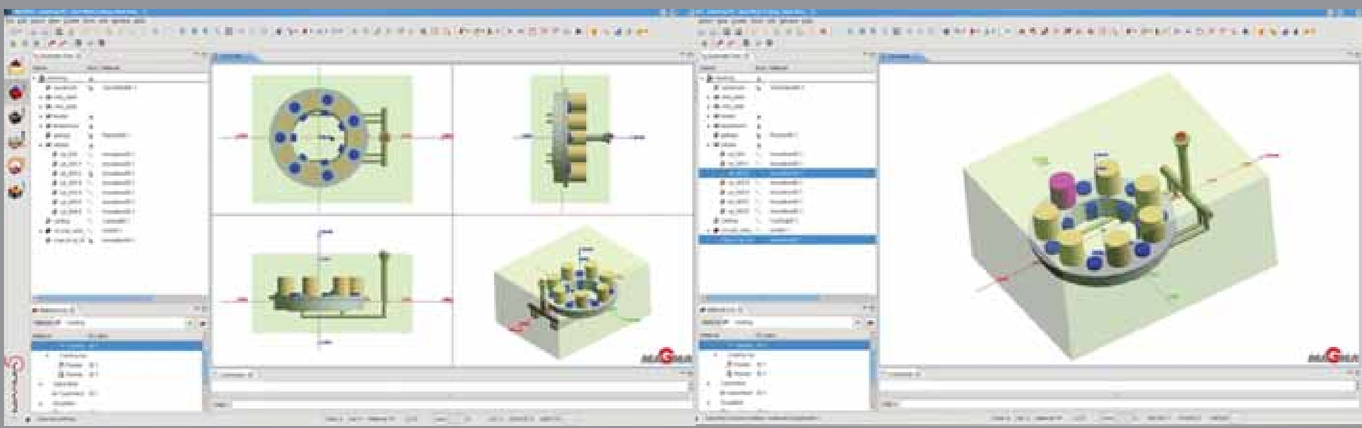

Fig.1: Esempi delle diverse modalità di visualizzazione dell'ambiente CAD

Il nuovo ambiente CAD per la modellazione solida si interfaccia con gli altri CAD commerciali, offrendo la possibilità di importare ed esportare file geometrici di vari formati: all'interfaccia STL si potrà affiancare il formato STEP per un periodo di prova di un anno senza costi aggiuntivi, mentre diventano disponibili come opzioni attivabili anche le interfacce CATIA V5 (solo per le piattaforme Windows) e Pro/E.

La manipolazione e la visualizzazione dei modelli geometrici cambia radicalmente: l'utente può scegliere di lavorare con più quadranti attivi fino ad un massimo di 9; i quattro classici quadranti del preprocessore di MAGMASOFT rimangono come una delle possibili soluzioni predefinite, anche se l'utilizzatore troverà molto comodo e intuitivo disegnare visualizzando il modello in un'unica finestra, dove i comandi di rotazione, traslazione, zoom e clipping sono utilizzabili in modo dinamico e interattivo come nell'attuale post-processore (fig1).

L'albero delle geometrie, disponibile a sinistra dell'ambiente CAD, restituisce con immediatezza la visualizzazione dei volumi creati o importati. Operazioni quali la modifica delle grandezze geometriche o dell'ordine dei volumi, la selezione, il copia e incolla di geometrie esistenti sono rese semplici e veloci attraverso l'utilizzo del solo mouse.

Il nuovo comando "copy with reference" di volumi creati all'interno di MAGMA5 lega le copie al volume originario, in modo che ogni modifica effettuata su quest'ultimo sia automaticamente applicata a tutte.

Nuove funzioni CAD sono state implementate per offrire la possibilità di modellare più velocemente e in modo flessibile modelli complessi: geometrie estruse con sezione terminale di forma differente rispetto a quella iniziale sono facilmente ottenibili con il nuovo comando skin (fig2).

Inoltre, tutti i solidi possono essere dotati di raggi di raccordo semplicemente prevedendoli nel momento in cui si disegna la sezione. Per esempio, attraverso la finestra di controllo, è possibile impostare le grandezze caratteristiche di una sezione trapezoidale: altezza, dimensione della base

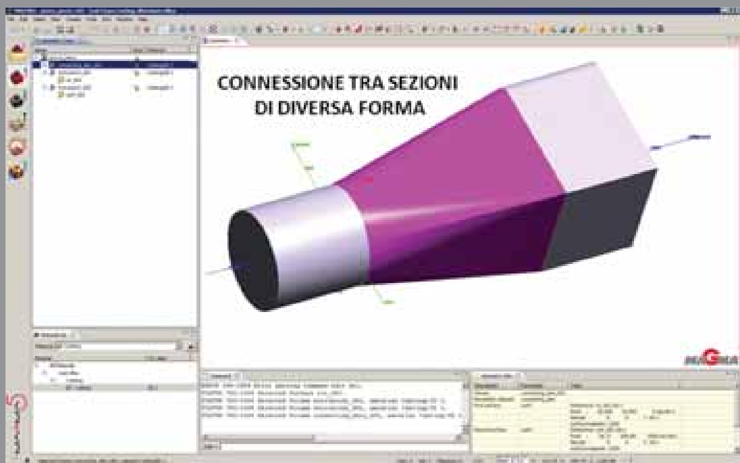

Fig.2: Il comando skin permette di estrudere volumi con sezione finale di forma diversa da quella iniziale

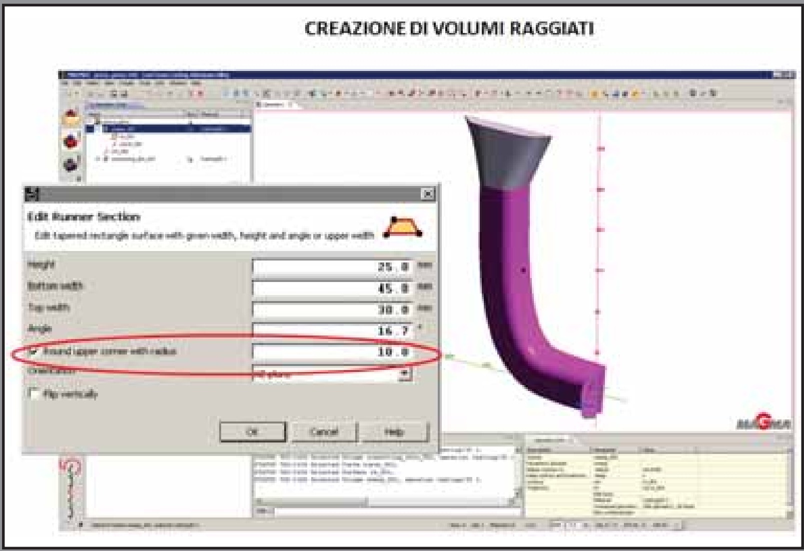

Fig.3: Esempio di impostazione di un raggio di raccordo

ciale, mentre un nuovo modello di plasticità viene implementato per un calcolo delle tensioni residue più accurato, con la possibilità di includere l'effetto del contatto del pezzo con le pareti della forma di sabbia o anima.

A completamento della previsione della qualità del getto, è possibile simulare qualsiasi trattamento termico. Per esempio, considerando il classico trattamento T6, il modello di calcolo degli stress residui valuterà il rilassamento delle tensioni dopo colata durante la fase di solubilizzazione, l'insorgere di nuove eventuali tensioni residue durante la fase di tempra e il successivo stato di tensione generato dalla fase di invecchiamento. Dal momento che le operazioni meccaniche (come per es. la smaterozzatura) mutano ulteriormente la distribuzione delle tensioni residue presenti a seguito della colata, MAGMA5 of-

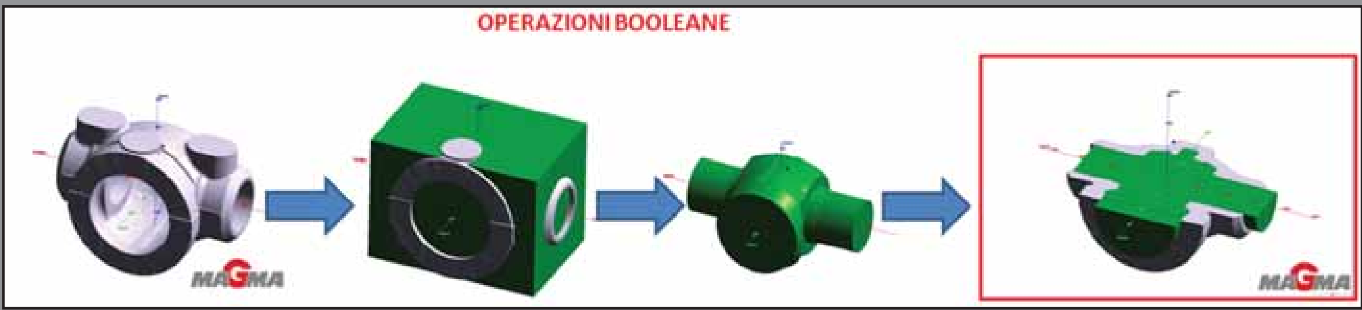

Fig.4: Generazione di anime attraverso l'utilizzo di operazioni booleane

(maggiore e/o minore) e angolo di sformo sono completati dall'opzione del raggio di raccordo (fig.3).

Operazioni booleane sono permesse tra modelli importati da CAD esterni e geometrie create all'interno di MAGMA5. Un esempio classico è costituito dalla generazione di anime di forma complessa con le relative portate (fig.4).

Al termine della progettazione, il modello CAD deve essere tradotto attraverso l'utilizzo della mesh in modello matematico. Dalla qualità della mesh dipende l'accuratezza dei risultati e il corrispondente tempo di calcolo. MAGMA5 offre la possibilità di caratterizzare i volumi necessari alla simulazione, attraverso la generazione del modello discretizzato, in un numero di livelli di affinazione scelto dall'utente (fig.5), con il vantaggio di non rinunciare alla qualità (visualizzandola istantaneamente al termine della generazione) e di minimizzare i tempi di calcolo.

Sui domini riconosciuti dalla mesh vengono risolte le equazioni relative alla fluidodinamica, alla termica e alle tensioni residue. I corrispettivi solutori di calcolo sono arricchiti di ulteriori modelli computazionali, come per esempio un nuovo modello di turbolenza per la simulazione del riempimento della cavità che considera l'effetto della tensione superfi-

fre la possibilità di includerle nell'analisi di stress. La conoscenza delle tensioni residue permette al progettista di valutare più accuratamente la resistenza in esercizio di un componente e qualora fosse di interesse, attraverso l'utilizzo di MAGMAlink, di utilizzare la loro distribuzione come stato iniziale in una simulazione strutturale.

L'impostazione del processo di simulazione può ora essere elaborato in finestre parallele agli ambiente CAD, mesh e postprocessore. Nella finestra principale coesistono, infatti, diversi menù a tendina nei quali è possibile entrare con un semplice "clic" per poter creare la geometria (fig.6a), visua-

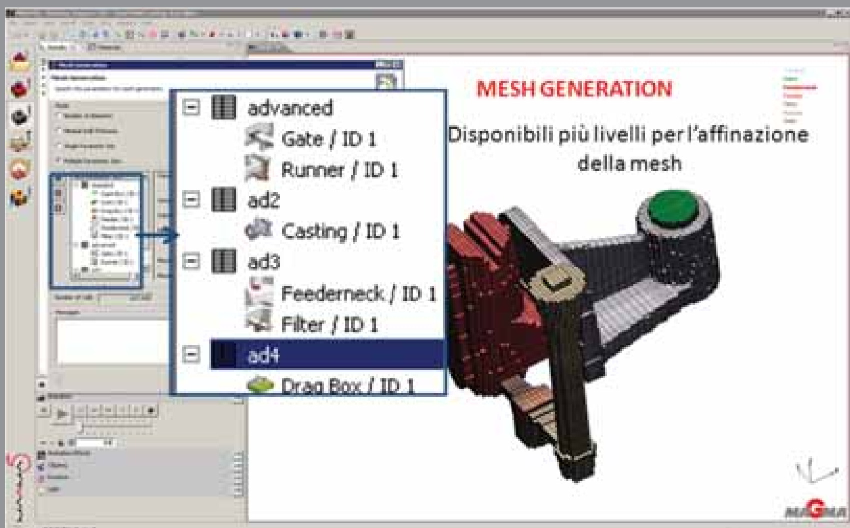

Fig.5: Pannello di generazione della mesh

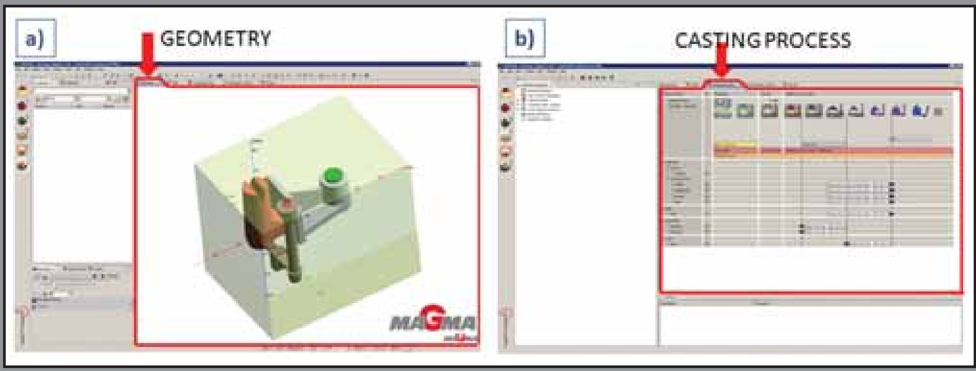

Fig.6: Pannello di gestione: a) ambiente CAD,b) visualizzatore della mesh,c) settaggio della simulazione.

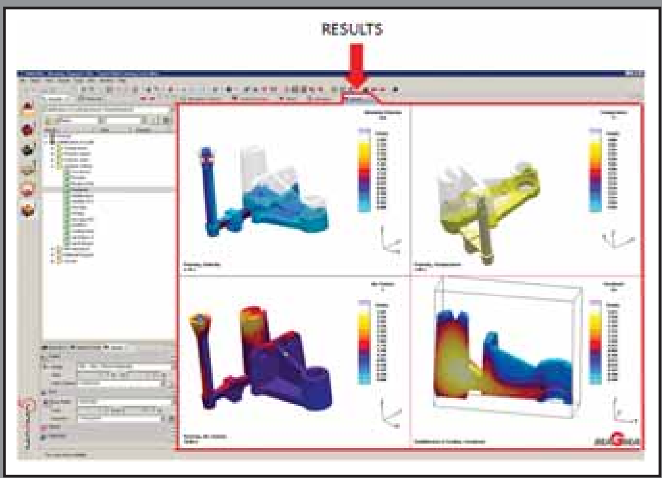

Fig.7: Previsione della qualità del getto attraverso la visualizzazione di differenti risultati contemporaneamente.

lizzare la mesh, definire i parametri di processo (fig.6b) e analizzare i risultati (fig.7.). Il veloce passaggio da una finestra all'altra comporta un notevole miglioramento nei tempi di impostazione della simulazione.
L'analisi dei risultati viene agevolata dalla visualizzazione di più finestre contemporaneamente, in ognuna delle quali è possibile analizzare un risultato diverso e usufruire dei classici comandi di rotazione dinamica, traslazione, sezione e animazione (fig.7).
L'innovativo comando "picking" permette di rilevare il valore puntuale di qualsiasi risultato con un semplice "clic" nella zona di interesse. Una finestra informativa restituisce le coordinate del punto selezionato e il corrispondente valore. Inoltre è possibile salvare in formato grafico l'evoluzione dei valori dei risultati fluidodinamici e termici dei punti selezionati per l'intero arco di tempo simulato (fig.8).

I settaggi, predisposti dall'utente (viste, sezioni, scale e risultati), per il salvataggio delle immagini dei risultati vengono memorizzati nel file MAGMASOFT.pdb che consente di richiamare le stesse impostazioni anche per le versioni successive, agevolando l'analisi di confronto di diverse simulazioni e di salvare le immagini in background.
La nuova modalità di visualizzazione e i nuovi criteri (microporosità e proprietà meccaniche) del modulo opzionale Non-ferrous permettono metodi di verifica delle prestazioni del getto più efficienti e immediati.
Tale modulo restituisce, per le leghe di alluminio, la previsione della microstruttura e delle proprietà meccaniche allo stato "as cast", calcolate sulla base della composizione chimica della lega, della velocità di raffreddamento del sistema e dei trattamenti della lega eseguiti prima della colata (es degasaggio).
I moduli MAGMAhpdc, MAGMAlpdc e MAGMAPermanent mold, oltre MAGMAlink e MAGMAdisa, sono in fase di completamento e verranno rilasciati con la versione 5.1, mentre MAGMAfrontier con la successiva 5.2.
Nel periodo di transizione, MAGMA4.4. e MAGMA5 potranno coesistere sullo stesso hardware, a condizione che il sistema operativo sia supportato per entrambe le versioni.
MAGMA5 è stato sviluppato in linguaggio JAVA per sfruttare al meglio le potenzialità di Windows 64 bit, mentre rimangono supportate le piattaforme LINUX RedHat5 e SUSE11 a 64 bit.

Per prendere visione degli hardware suggeriti e delle piattaforme supportate dal nuovo software visitate la pagina:
http://www.enginsoft.it/software/magmasoft/news/magma5.html

Le date dei corsi di formazione sono come di consueto pubblicate alla pagina:
http://www.enginsoft.it/formazione/corsi2010/processo/proc14.html

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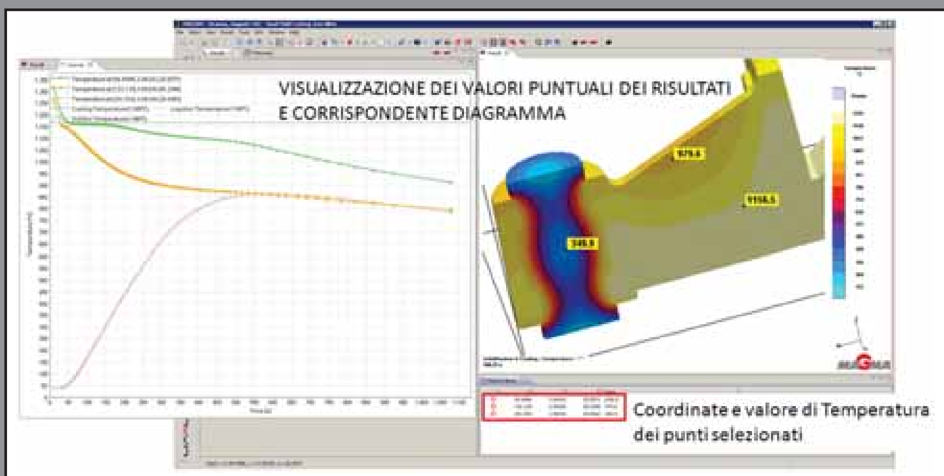


Fig.8: Visualizzazione di valori puntuali e della corrispondente curva temperatura-tempo

FORGE 2009
Release notes - dicembre 2009

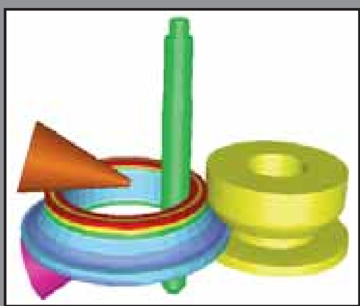
Nel mese di dicembre 2009 è stato rilasciato da Transvalor il nuovo pacchetto di simulazione Forge 2009®, lo strumento ideale per la simulazione dell'intero processo di stampaggio a caldo o a freddo dei più svariati componenti (alberi, giunti, ingranaggi, flange, raccordi, cuscinetti, bulloni, viti, fasteners, ...). È possibile simulare la sequenza completa di un processo di forgiatura multistadio con una cinematica degli stampi anche molto complessa (stampi flottanti o pre-caricati), seguita da raffreddamenti, tranciatura bave e/o trattamenti termici.
Forge 2009® è la logica evoluzione di Forge2008® ed è un software di simulazione FEM dedicato alla simulazione di processi assialsimmetrici (2D) e di qualsivoglia geometria (3D), che è stato sviluppato seguendo le indicazioni degli utilizzatori.

Forge 2009 – ottimizzazione dei processi di forgiatura
La principale novità introdotta nella nuova release è la possibilità di effettuare una procedura automatica di ottimizzazione per un determinato progetto in una o più operazioni. Già nelle versioni precedenti era stato introdotto il concetto di "chaining", che consentiva di impostare una intera sequenza di stampaggio e concatenare le singole operazioni in un unico calcolo, trasferendo in automatico i risultati tra le stazioni. Oggi è possibile definire delle variabili in ingresso sulla prima operazione, come ad esempio le dimensioni caratteristiche della billetta o altri parametri quali per esempio la corsa della pressa, chiedendo al software di ricavare i migliori risultati per degli obiettivi definiti dall'utente, come per esempio il migliore riempimento delle impronte nell'ultima operazione o la richiesta di un pezzo privo di ripieghe o ancora la minimizzazione del carico pressa. Il modulo di ottimizzazione effettua una serie di "run", valutandone i risultati e modificando le variabili in ingresso, in modo da ottenere i migliori risultati possibili. Le varie configurazioni sono classificate in funzione della combinazione di obiettivi raggiunti, consentendo di individuare le configurazioni migliori.

Interfaccia di ottimizzazione

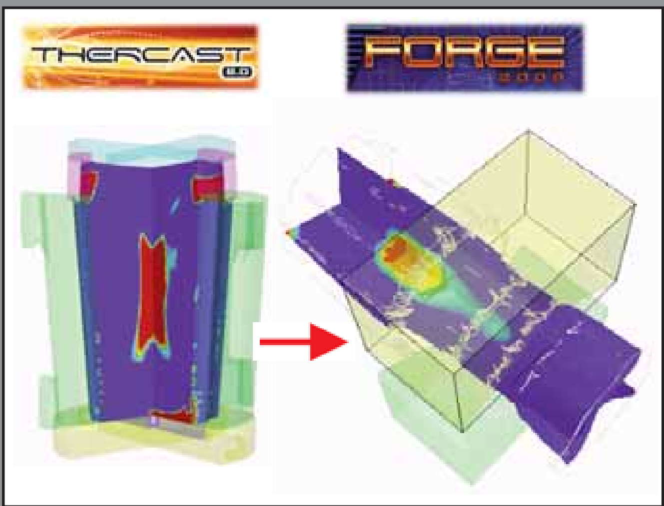
Il progettista, che in precedenza testava con Forge solo un numero limitato di ipotesi, può limitarsi ora a definire, mediante una interfaccia user-friendly, le variabili, i vincoli del processo e gli obiettivi da raggiungere, lasciando a Forge il compito di esplorare un numero decisamente maggiore di configurazioni: le migliori possono essere magari ipotesi che il progettista non avrebbe considerato. Grazie all'esperienza maturata utilizzando questo strumento, Transvalor, l'azienda che sviluppa il software, intende aggiungere altre variabili ed obiettivi che possono essere gestiti dall'utente nelle versioni successive.
In caso fosse necessario utilizzare uno strumento più flessibile ed in grado di consentire un'analisi più accurata dei risultati, è possibile interfacciare il software con il software modeFRONTIER prodotto da ESTECO e distribuito da EnginSoft; è possibile in questo caso sfruttare i nodi diretti verso i principali CAD e modificare le geometrie di pezzo o stampi, importandole quindi in Forge, per lanciare poi il calcolo ed utilizzare gli strumenti avanzati del programma per l'analisi degli obiettivi.

Il processo di laminazione circolare – ring rolling
L'esperienza accumulata grazie ai diversi utilizzatori del software per il processo di ring-rolling ha consentito a Transvalor di introdurre una serie di migliorie al modello utilizzato, che hanno portato ad un deciso miglioramento della qualità dei risultati, con una riduzione dei tempi di calcolo nell'ordine del 30% rispetto alla versione precedente. Tra le novità più significative, la possibilità di inserire la curva di laminazione che normalmente viene impostata dall'operatore del laminatoio, ed ottenere in automatico le curve di movimento di coni e mandrino per Forge. Per il mandrino, la velocità può anche essere modulata in funzione della crescita del diametro esterno dell'anello. Il nuovo modello consente ora anche di rilevare la velocità di rotazione del mandrino folle per effetto del contatto con il pezzo.
Molto lavoro è stato dedicato al miglioramento delle routine di calcolo: i nuovi algoritmi PETSC consentono di risolvere profili anche molto complessi in tempi molto inferiori ai precedenti, con una precisione di risultati decisamente maggiore grazie all'introduzione di nuove funzioni di contatto.


Simulazione processo di Ring-rolling

Il processo di fucinatura – nuovi strumenti disponibili
Il processo di forgiatura/fucinatura è caratterizzato da un numero molto ele-

vato di passate, ognuna con diversi colpi ed una movimentazione del pezzo anche complessa con dei tempi di attesa tra ogni colpo/passata. Il modello precedente, presente in Forge2008, è stato ulteriormente arricchito di funzioni, tra le quali i tempi morti tra due colpi consecutivi, nel quali viene calcolato il raffreddamento del pezzo, l'arresto del calcolo una volta che il pezzo è uscito dagli stampi, una migliore gestione degli scorrimenti del pezzo rispetto agli stampi grazie all'uso di manipolatori. Dal punto di vista operativo, la miglioria principale è una modifica e semplificazione delle modalità di definizione delle passate, attraverso un nuovo formato di file generato in automatico dal programma.
Le lavorazioni di fucinatura hanno l'obiettivo di chiudere le porosità, che sono causate dal processo di colata del lingotto e che hanno una notevole influenza sulla qualità del pezzo finito. Transvalor ha dedicato molte energie per implementare questo aspetto in Forge: è stata aggiunta la possibilità di definire sul lingotto una distribuzione iniziale di porosità e tra i risultati la possibilità di visualizzare la chiusura di tali porosità. La distribuzione iniziale di porosità può essere ottenuta anche mediante l'uso di un altro software di Transvalor, Thercast, dedicato alla simulazione del processo di colata e raffreddamento in lingottiera ed in grado di calcolare la formazione di porosità con il criterio di Yamanaka. I risultati calcolati da Thercast possono essere trasferiti direttamente in Forge, per ottenere una distribuzione molto realistica delle porosità nel lingotto iniziale.

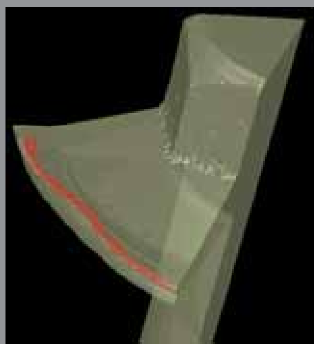


Calcolo delle porosità in Thercast e trasferimento in Forge

Altro aspetto fondamentale in questo tipo di processi è l'evoluzione del grano cristallino funzione della ricristallizzazione. Forge da questa versione è in grado di seguire l'evoluzione del grano cristallino per effetto della ricristallizzazione statica e dinamica, basandosi sulle definizioni dei materiali provenienti da prove sperimentali e dal software JmatPro: sono disponibili i dati di alcune leghe molto particolari e critiche per questi aspetti, quali: acciaio AISI316L, Inconel 718, Waspalloy ed alcuni acciai al manganese.

Stampaggio lamiere - anisotropia
Nel campo dello stampaggio ed imbutitura delle lamiere gli effetti legati all'anisotropia del materiale sono rilevanti. Nella nuova versione di Forge è stato introdotto un nuovo modello di materiale nel quale è possibile specificare i parametri di anisotropia secondo il modello di Hill. Il solutore è stato quindi adeguato per tener conto di questa nuova definizione e nel post-processore sono stati aggiunti dei risultati in grado di consentire una migliore comprensione di questi effetti

Contatto materiale-materiale e ripieghe
Grazie alle esperienze provenienti dagli utilizzatori, soprattutto nel campo dello stampaggio dei materiali non ferrosi (ottone ed alluminio), si è evidenziata la necessità di ripensare il modo nel quale il software evidenzia la formazione e l'evoluzione delle ripieghe. Sono state quindi messe a punto delle nuove funzioni di contatto in grado di gestire in maniera più efficiente le situazioni, ove il materiale ripiega su se stesso. Contemporaneamente è stato sviluppato un nuovo approccio per la visualizzazione dei difetti nel post-processore: quando due lembi di materiale vengono in contatto tra loro, si genera un tracciante, il cui movimento nel resto della corsa di stampaggio consente di valutare con una notevole precisione forma e dimensioni delle ripieghe. Oltre alla localizzazione delle ripieghe, che era già presente nella precedente versione, il progettista è in grado di comprendere se, effettivamente, il difetto interessa il pezzo e per che spessore o se esce verso le bave e quindi non è critico per la qualità del pezzo. Effetti indotti di questi miglioramenti al motore di calcolo sono stati una riduzione dei tempi di calcolo stimabile mediamente dal 20% al 30% a seconda del numero di nodi utilizzato e del tipo di calcolo impostati, miglioramento riscontrato sia sulle configurazioni singolo processore, che sulle più potenti piattaforme cluster.

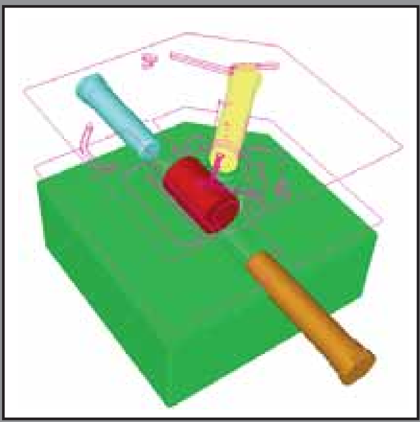

Tracciatura delle ripieghe

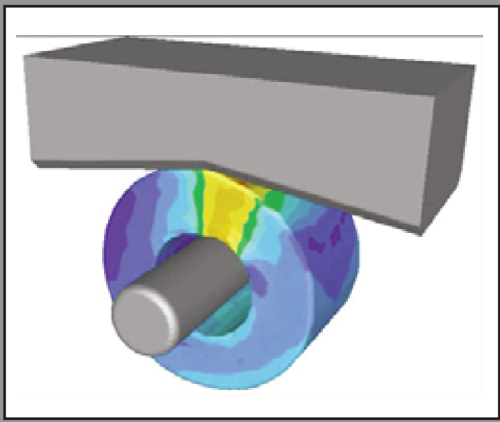
Un nuovo "wizard" per lo stampaggio a freddo
Nella versione 2008 è stato introdotto il concetto di "wizard", uno strumento in grado di guidare passo-passo l'utente nella creazione della singola operazione, utile soprattutto per i neofiti, che possono creare con pochi parametri un progetto pronto per essere risolto. Nella versione 2009 è stato aggiunto un wizard per lo stampaggio a freddo.

Molte le migliorie introdotte nel pre- e nel post-processing
Per Transvalor le linee di sviluppo del software sono sempre guidate dai suggerimenti degli utenti. Nella nuova versione diverse sono le migliorie apportate, che riassumiamo di seguito.

1. Pre-processore e template di processo
Diverse migliorie minori molto utili sono state introdotte nelle finestre di impostazione dei progetti. Nel pre-processore

l'attenzione si è concentrata, in particolar modo, sul miglioramento di alcuni template di processo, i modelli che servono da base per l'impostazione di tipologie particolari di calcolo.
Per quanto riguarda il modello delle presse ad energia, pressa a vite e maglio, è stato riformulato invece il modello in grado di tener conto dell'efficienza della macchina al procedere dei numero di colpi ed è stata aggiunta la possibilità di inserire un tempo di pausa prima dell'inizio dello stampaggio, con il risultato che ora le temperature del pezzo all'inizio del processo sono molto più precise.
Per quanto riguarda lo stampaggio di ottone, nelle configurazioni di stampaggio a forare, ora è possibile introdurre carrelli inclinati, seguire lo stampaggio di più particolari (multi impronta), valutare con precisione i carichi su ogni punzone in funzione della resistenza del cuscino. Sono in corso modifiche ancora più rilevanti per questo modello, con la possibilità di gestire configurazioni a forare più complesse o a campana. Sempre in tema di cinematiche molto complesse, sono stati messi a punto nuovi modelli di stampi flottanti in traslazione e rotazione, ma anche di stampi "slave" sia in traslazione, che in rotazione, collegabili al movimento di altri stampi "master".


Stampaggio ottone con carrelli inclinati


Bigorniatura anello in acciaio

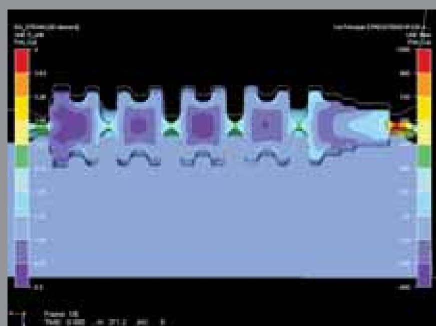
Per quanto riguarda la laminazione, sono stati sviluppati nuovi strumenti in grado di creare, per rivoluzione, il profilo dei rulli a partire da un profilo 2D, la cui forma può essere modificata direttamente nel pre-processor, muovendo o trascinando in nodi del profilo.
Parlando poi delle funzioni comuni a tutti i progetti, è proseguito il miglioramento delle funzioni di meshatura da geometrie STL, con una qualità decisamente superiore rispetto alle versioni precedenti.

2. Solutore

L'evoluzione della parte del software relativa al calcolo ha seguito due filoni principali. Le routine di calcolo sono state sensibilmente migliorate, ottenendo una migliore qualità della mesh, in grado di rispettare meglio la forma degli stampi, una maggiore stabilità del solutore soprattutto per configurazioni multi-processore e/o multi-core e, di conseguenza, tempi di calcolo significativamente minori (-20-30% a seconda dei casi) rispetto alla versione precedente. Il solutore è stato inoltre modificato per tener conto degli effetti di anisotropia del materiale e tutta una serie di nuove opzioni impostabili nei modelli dedicati ai singoli campi di applicazione: per esempio i raffreddamenti prima dello stampaggio nel modello della pressa a vite, nuove funzioni PETSC per la laminazione circolare, nuove funzioni per il tracciamento delle ripieghe. Per quanto riguarda il secondo aspetto, l'interfaccia per il lancio dei calcoli è stata ulteriormente evoluta e si presenta ora con delle nuove funzioni e scorciatoie per le operazioni più comuni.

3. Post-processore

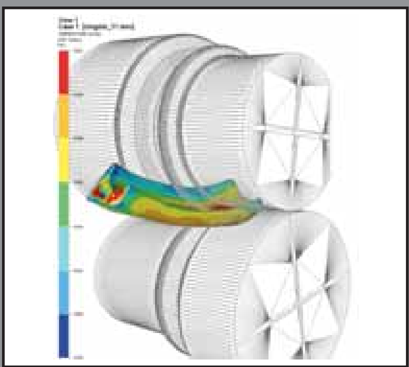
Lo sviluppo del post-processore, funzione delle richieste degli utilizzatori, ha riguardato diversi aspetti. Tra i più utili in evidenza la creazione di un cubo di navigazione, che rende immediata la rotazione del modello nelle viste ortogonali agli assi principali. Sempre nella direzione di una migliore gestione del punto di vista scelto, è stata implementata la possibilità di salvare il "workspace": l'utente carica i risultati di interesse (scalari, vettoriali, plot) anche per più progetti da confrontare, sceglie il punto di vista e le opzioni grafiche, carica eventuali animazioni e salva il "workspace". Caricando questo file, vengono quindi ripristinate tutte le scelte dell'utente, opzione che consente un notevole risparmio di tempo nella fase di analisi dei risultati.
La vista dei soli risultati in superficie non consente una valutazione di quanto realmente succede all'interno del pezzo: per questo scopo si utilizzano dei piani di sezione. Tra le nuove funzionalità introdotte per questo strumento, le più significative sono la possibilità di muovere il piano attorno ad un asse, la possibilità di selezionare dei punti sul piano, rilevandone i valori calcolati, e la possibilità di ottenere un grafico dell'area del piano in funzione della corsa impostata. Sempre per questo strumento risulta utile la possibilità di esportare il profilo del piano in formato dxf ed in coordinate XY, che può quindi essere utilizzato in qualsiasi CAD, ma anche la possibilità di salvare, in un determinato istante della corsa, una animazione che mostri il piano di taglio che scorre attraverso il pezzo in una determinata direzione, o secondo una rotazione attorno ad un asse. È così possibile valutare in una unica animazione cosa accade nelle varie sezioni del pezzo.
Sempre in termini di strumenti di interfaccia con strumenti CAD o FEM, da ricordare la possibilità di esportare in formato .STL, scegliendo quali oggetti esportare e la possibilità di generare un file .UNV (I-deas universal file), che contiene sia la forma, ma anche


Albero - Calcolo accoppiato tensione sugli stampi

tutti i risultati calcolati: è possibile quindi trasferire ad un altro strumento FEM quanto calcolato in Forge, per effettuare altri tipi di analisi, ad esempio del pezzo nelle condizioni di carico corrispondenti alla sua messa in opera.
Degno di nota è inoltre il miglioramento dell'interfaccia di esportazione .vtf, che consente di esportare l'animazione di un risultato in una forma ove l'utente ha la possibilità di cambiare il punto di vista e/o lo zoom. Con il nuovo visualizzatore GlView Express, scaricabile gratuitamente, è ora possibile visualizzare nello stesso file più risultati, rendendo decisamente più agevole la comunicazione delle informazioni tra colleghi o verso l'esterno.

Miglioramento continuo del database dei materiali
Il database dei materiali è sempre stato uno dei punti cardine di Forge, con le curve di deformazione a caldo ed a freddo, le caratteristiche elastiche e le proprietà termiche di oltre 800 leghe ferrose e non ferrose. In questa versione sono stati aggiunti una serie di materiali provenienti dal programma JmatPro, quali acciai al Boro, micro legati, acciai inox, superleghe (inconel718, nimonic, waspalloy), leghe di Titanio, per i quali sono state calcolate le curve reologiche e le caratteristiche fisiche da temperatura ambiente alle temperature di stampaggio a caldo. Da evidenziare come siano stati introdotti anche dei materiali che tengono conto dell'evoluzione del grano cristallino causato dalla ricristallizzazione e del kinematic hardening.


Simulazione stampaggio a caldo fuso a snodo

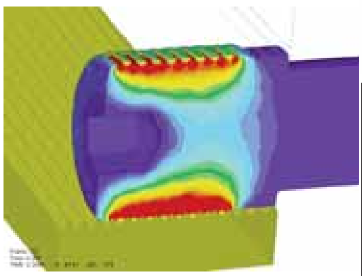

Simulazione laminazione di prodotti lunghi

Installazione – versioni disponibili
Già nella versione precedente era possibile impostare una architettura client-server, concentrando le operazioni di calcolo sulla macchina più potente e demandando alle macchine client la preparazione dei calcoli e l'analisi dei risultati. Il sistema è stato ulteriormente evoluto, aggiungendo la possibilità di una licenza "floating", che può essere attivata a turno su diverse macchine, aumentando la flessibilità di utilizzo in ambiente multiutente.La gamma di possibili installazioni di Forge è stata ampliata rispetto alla versione precedente. Oggi è possibile installare il software sia in sistema operativo a 32 o 64 bit Windows XP, Server® 2003, Server® 2008, VISTA business, Linux Red Hat Enterprise o SLES 10 64bits. In termini di piattaforme hardware, Forge sfrutta appieno la parallelizzazione del calcolo, quindi è possibile utilizzare una macchina con singolo processore 1-4core, con più processori o sistemi cluster fino a 32 core, le cui code possono essere gestite anche mediante i software pbs v5, pbs v9, lsf e sge.
Gli ultimi benchmark effettuati su piattaforme equipaggiate con i nuovi processori Nehalem i7 (serie XEON 55**), con due processori 4core, hanno mostrato una notevole efficienza, con tempi di calcolo paragonabili a quelli prima ottenibili solo con un cluster, con una semplicità di gestione decisamente maggiore. Questo rende ora possibile lanciare anche su queste piattaforme analisi molto pesanti quali la laminazione di anelli, mesh molto fini o analisi con molti incrementi.

Conclusioni
Si può quindi affermare che Forge 2009® è un programma sempre in costante miglioramento, che ha raggiunto una notevole semplicità d'uso grazie all'esperienza accumulata con le versioni precedenti e i suggerimenti provenienti dagli utenti. Molte delle novità introdotte portano la versione 2009 ad un livello di precisione ed accuratezza decisamente superiore alla versione precedente.
Dall'altra parte, la maturità raggiunta dal prodotto consente sempre un facile e rapido inserimento in qualsiasi ambiente tecnico, per la progettazione di prodotti ottenuti per stampaggio e l'ottimizzazione dei relativi processi produttivi. Con Forge 2009 è quindi possibile migliorare rapidamente la qualità dei pezzi, ridurre gli sprechi di materiale e aumentare la durata degli stampi e delle macchine di stampaggio. È possibile inoltre valutare in modo anticipato senza sorprese la stampabilità di nuove forme o di materiali poco conosciuti.
EnginSoft, distributore in Italia del software Forge, grazie a tecnici specializzati con oltre 10 anni di esperienza, offre alle aziende del settore, formazione del personale ed avviamento all'uso oltre al supporto nell'installazione, nonché attività di simulazione su commessa, con impostazione del caso, analisi dei risultati e consulenza sull'ottimizzazione del processo.


Calcolo accoppiato vite, bullone e lamiera


Stampaggio a freddo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Elysium's CADdoctor accelerating Reverse Engineering

1. 3D data utilization in Reverse Engineering

As the noncontact 3D measuring machine has become so popular, the digitalization of physical models is needed more than ever. Traditionally, the main purpose of measuring physical models was "Inspection" to determine if the products were manufactured following the original design by comparing CAD data and point cloud data measured by the contact measuring machine. However applications in "Reverse Engineering" have recently attracted a lot of attention. Typically, what we mean here is the way how to use CAD data produced from the huge

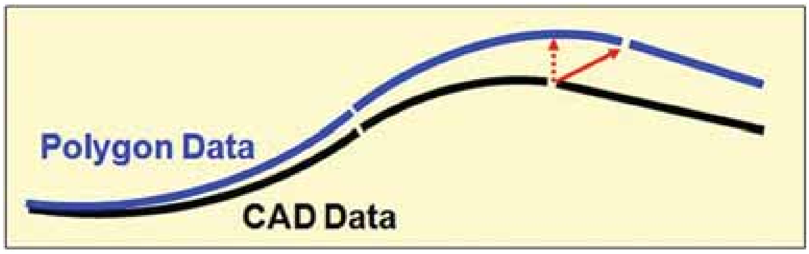

Figure1: Deformation to the nearest point (solid arrow) and the ideal deformation orientation considering feature line (dashed arrow)

number of point cloud and polygon data measured by the noncontact measuring machine. The objective of creating a CAD model from the point cloud and polygon data is either related to design purposes or to simulation purposes.

Design purposes

- Design: Creating CAD models from clay models and using them for the design
- Digitalization of CAD models from own products: Creating CAD models only from physical models and using them for the design
- Mold building: Measuring existing die to produce the second die

Simulation purposes

- Benchmark: Simulation of own products and products developed by other companies
- Simulation: e.g. Creating a CAD model of a golf bag for the design of the luggage space

The key factor for effective Reverse Engineering is the creation of a CAD model from measured point cloud and polygon data. Generally, when a CAD model has been created for reverse engineering, the measured polygon data has been divided into areas and a Brep surface was created for each area. In this process, it is important to translate the right CAD model for the purposes as the required CAD quality depends on the application of the translated CAD model. For example, if the purpose is design, high quality CAD data of class A representing exact feature lines and curved surfaces are required as they will be used for design and manufacturing later. However if the purpose is simulation, the required quality is different. Indeed, very often, it is not necessary to have the same quality as for design. The created CAD model is meshed by using CAE and in many cases, moderate quality is sufficient. (*)

(*) When we consider CAE simulation, there is a tendency to think that measured polygon data can be directly used for meshing and there is no need to create a CAD model. However, such polygon data is not sufficient for meshing and often leads to low accuracy simulation results because of the noise involved. It is also a problem to increase the number of mesh elements. Hence the translated CAD model is usually used for meshing before CAE simulation instead of using the measured polygon data directly.

Reverse Engineering performances have improved through the years, but the huge amount of man-hours to create CAD models is still a relevant matter, in both areas of design and simulation. In fact, there is no solution to create high quality CAD data automatically and efficiently enough for design purposes. In recent years, another approach has evolved, which consists in using original CAD data and transforming it to fit with the polygon data, in order to produce the final CAD data of measured polygon data. However, this is certainly not the best solution. When considering this approach, it would be better to transform the model by fitting the feature lines of the original CAD data to feature the lines of the polygon data. However, the current process is to use commercial software which only transforms by fitting the original shape to the nearest polygon. (See Figure 1).

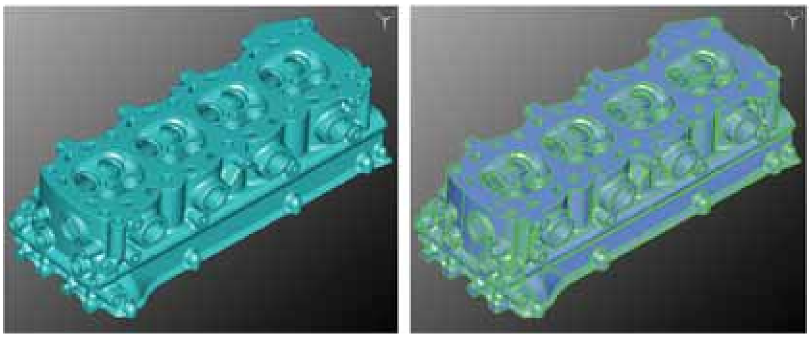

Figure 2: Measured polygon data (left) and CAD data from polygon (right)
The complicated surface including the internal opening section can be created automatically.

For simulation purposes, usually the required CAD quality is not as high as for design purposes. Though, it would be much appreciated to represent the position of the feature line to define the right boundary condition. The reduction of the number of surfaces of the CAD model is also important for the effective mesh generation, although it is not easy because the CAD model has lots of square surfaces created from polygon data. Besides, it is also important that the translated CAD model can be used in CAE. To solve these problems, the latest version of CADdoctor has the fully-automated capability to create CAD model data from polygon data by reproducing the feature line position, which had to be done manually before and it was very time-consuming. Using this capability, CADdoctor represents an extremely complex surface including an internal opening section as a face. Hence it also has the ability to produce the best model for the simulation. (See Figure 2)

2. Reverse Engineering capability in CADdoctor

2-1 Automatic CAD data generation from point cloud and polygon mesh

Point cloud data and polygon data measured by a 3D measuring machine representing physical products (prototype or commercial product) can be translated into 3D CAD data generating NURBS surfaces automatically. Prior to creating CAD data from polygon data, the surface is segmented. For the segmentation, the geometry of the polygon data is captured, fillets are automatically detected, and the range of each segment is determined automatically to approximate the surface composed in the CAD model. Planar, cylindrical, and conic surfaces for analysis representation are recognized automatically allowing a segmentation based on the surface type. If prototyping in-house design and original CAD data are at hand, the edge from the original CAD data can be copied to polygon and used as parting line for segmentation. (See Figure 3)

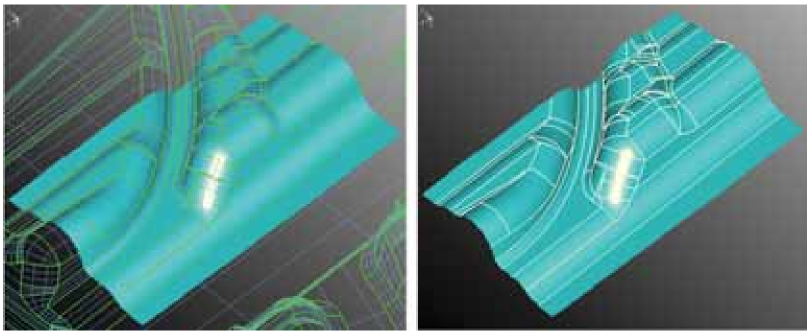

Figure 3: The original CAD data is copied to polygon (left); copied parting line (right)

Segmentation is automatic, but there are cases where the segmentation may not be adequate due to unevenness occurring from noise. Such areas can be edited to adequate segmentation by using the editing commands, such as part, merge and extend. Once the segmentation is complete, by clicking a button, NURBS surfacing will complete on each segment and complete CAD data is automatically created. With CADdoctor, surfacing is also possible on a trim surface surrounded with complex edges, allowing creation of effective CAD data with a simple surface based on segmentation. Moreover, after the batch surface generation, minor amendments, if required, can be made without re-executing the process, since partial segments can be repaired or surface types can be switched. Time spent on repair is reduced.

The advantage of the CADdoctor Reverse Engineering capability is that manual operation and data healing are at minimum and creating 3D data can be done nearly fully automatically. From Elysium's independent study, CADdoctor creates 3D CAD data from polygon data in 1/10 to 1/30 of the time needed for using other translation products.

2-2 Fitting original CAD data to polygon data

The product design in 3D CAD data can be transformed to be consistent with the polygon data taken from an actual product using a 3D measuring machine. This is the powerful advantage of CADdoctor. This capability can be applied not only to the polygon data, but also to the polygon from CAE. (See Figure 4)

When deforming actual CAD data, the distance between the CAD data and the polygon data is recognized, however, polygon data from a measuring machine has a subtle difference from the actual geometry due to noises. By setting tolerances for the differences to avoid this impact, the target for deformation will be faced larger than the tolerance, and faces smaller than the tolerance will be excluded from target.

The target face for deformation is consistently deformed with the polygon. However, if the face is deformed simply to the nearest point of the polygon data, the area of the feature may be out of alignment, creating distortion on the surface after deformation and the fillet's boundary line may be disrupted, affecting the adjacent planar surface. The Fit feature in CADdoctor determines the transformation orientation with respect to curvature change of both the CAD and polygon data and maintains the correct position of the boundary line between the fillet and adjacent surface, thus ensuring continuity between faces that are maintained when deforming.

For the specific area where the fitting is very difficult due to the large difference, the Reverse Engineering capability can only be used to create CAD data from polygon data. In summary, the fitting is completed for the polygon data and CAD data including the large difference area, by combining these methods.

For more information, please visit the ELYSIUM website:
http://www.elysiuminc.com
For further information on CADdoctor in Italy, please contact:
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This article was written in collaboration with ELYSIUM Co,Ltd.

Akiko Kondoh
Consultant for EnginSoft in Japan

EnginSoft partners with ELYSIUM Co.Ltd. Japan to promote CADdoctor in Italy

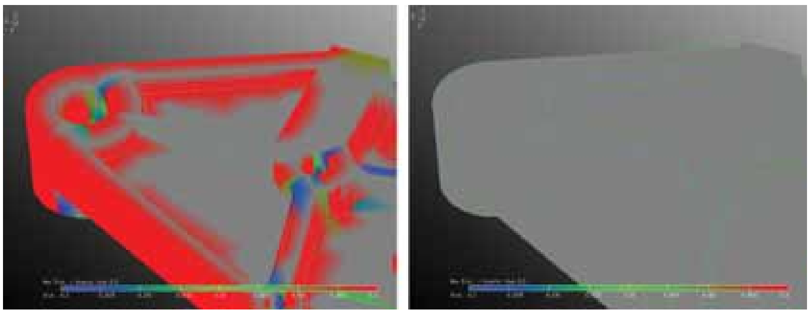


Figure 4: Distance between the original CAD data and the measured polygon data (left); distance after fitting (right)

Parametric FEM model optimization for a pyrolitic Indesit oven

2009 Ecohitech Award: Recently, Indesit Company has won the prestigious Ecohitech Award and thus earned itself an "eco-virtuous enterprise" status.

By examining only the internal glass of the pyrolitic oven which consists of visco-elastic material, the optimization process obtained the minimum stress distribution and stress gradient.
To successfully finalize the work and to deliver the best possible technical results insuring highest quality standards are met, the following analyses have been performed by Indesit and EnginSoft:

1) Parametric FEM model creation with ANSYS
2) Creation of workflow in modeFRONTIER and ANSYS integration into Frontier's loop
3) Optimization of the clamping system by an automated routine defined within modeFRONTIER
4) Results analysis and optimum design extraction according to the given objectives

The present device belongs to a new type of the Indesit domestic oven range, called Pyrolitics.
Indesit's new technology allows a fast cleaning of oven cavity, by means of a pyrolysis process that burns encrustation caused by cooking. The Pyrolysis process starts at temperatures close to 500°C which are extremely high for a traditional device considering an external temperature of 20°C. This environment produces an high thermal gradient which considerably deforms the glass.

The door structure of the oven is made of a triple-glass system, whereas each is separated by an air wall to guarantee rapid heat dissipation and to respect the safety regulations which limit the allowed external glass temperature to 60°C.
Glass stresses are derived from the thermal gradient, established between its surfaces, and produce a consequent deformation; an inappropriate glass clamping system would probably increase internal stresses and cause rupture.
From experimental tests, we have learned that the internal glass is exposed to the highest stresses; in fact, this is the component with higher thermal gradients between its faces. The aim of this work was to develop a methodology that allows to simulate the real working conditions of the glass and to find an optimal glass clamping solution that minimizes the stresses.

2 Structure of the model

2.1 Solid model

The model provided by Indesit has been made of a 3D door model of the oven with the actual glass clamping system. The door is composed of a 3 glass system, mounted on a specific structure that keeps them parallel and separated in order to allow the passage of the air cooling flow. This model has been simplified in order to obtain a complete glass clamp system to reproduce the real door-clamping solution.

Picture 2.2.1 – Temperature measuring point on internal glass

The provided material included some elements, such as, chamfer and a non-functional fillet that have been deleted in order to create a simplified model far easier to analyze. Constraints characteristics and glass geometry have been maintained in order to produce a suitable approximated model.

2.2 Experimental measures

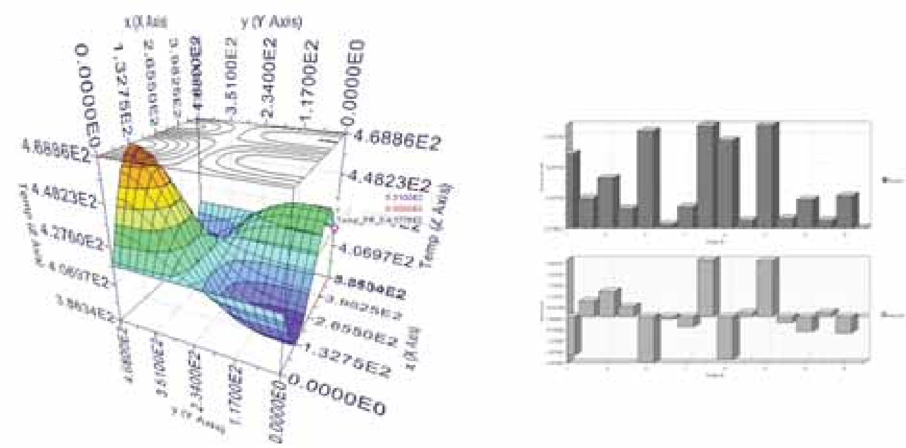
After some experimental measures, a series of grid-organized values of temperatures on the internal glass of the oven, was provided by the user.
These glass temperatures were obtained by some thermocouple probes on the point highlighted in picture 2.2.1.

Many repeated tests were performed in order to minimize the error of measure, and an average value of each measuring point was taken into account.
In this verification, we have considered the maximum measured values to reproduce the worst working condition.

3 Glass modeling

3.1 Thermal modeling of the glass

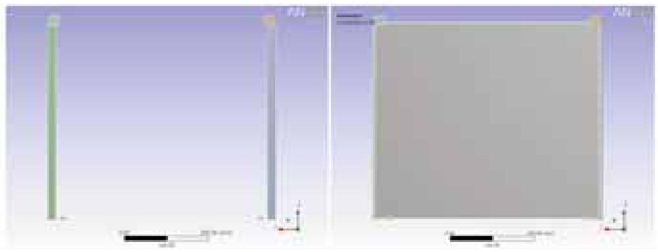
In order to perform a FEM analysis, it was necessary to assign to each node its temperature, but we had only eight measured points, that is why, the available value was modeled by using a RSM application. In fact, we used the eight measuring points to build an opportune RSM that reproduces the glass-temperature distribution with a good approximation.



Picture 3.1.1 – Approximating function and error graph (relative and absolute errors respectively)

analysis we should know the values on both glass sides.
The door of the oven is composed of three glass sheets spaced by few millimeters to allow an air cooling passage, this eliminates the installation of probes on the internal sides of the glass.
To obtain all necessary temperature values and to perform our analysis, we had to model the whole multiple glass system, considering convecting effects; the known temperatures were from the measured set on the first internal glass face and a reference temperature of 60°C was established.

A Response Surface, also called meta-model, is a post-processing tool of modeFRONTIER; in this application an approximate RSM was chosen, because all measuring points may be affected by a measuring error, due to uncontrollable thermal effects (e.g.: radiation and convection).
In picture 3.1.1, an approximate function and relative approximation error graph are shown.
Apart from obtaining a continuous tool able to estimate temperatures of all values including a variable space definition, using modeFRONTIER allows to obtain an analytical form of this surface.This expression will be used in the FEM modeler (ANSYS) to assign temp value on each node.


Picture 3.1.2 – Constraint system of the glass

The next step is the application of the analytical expression to the FEM model. In picture 3.1.2 we observe the glass with the applied temperature.

3.2 FEM Model

During the FEM modeling process, free glass deformation was evaluated firstly, or the maximum deformation reached without any constraint.
During the next step, a series of constraints was applied on the glass, in order to compare the real glass deformation with the simulation and to estimate the model reliability.

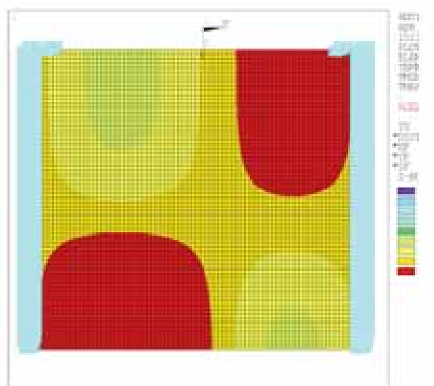
3.2.1 Free glass deformation

By using ANSYS Multiphysics as finite element solver, only a corner was bonded and thermal field was applied in order to allow any deformation due to the thermal gradient.
The thermal gradient originates from a difference in temperatures between contiguous areas; to perform the

Once the estimated necessary temperature values were defined, we have modeled a single bond on an edge of the glass. We knew that this was an unfeasible solution but it was necessary to understand the entity of the maximum glass deformation with this temperature field.
By applying the calculated temperature function on the first glass, simulating heat transfer from the oven cavity to the room and calculating the thermal gradient on the component, we were able to obtain the maximum deformation of the glass in free conditions.
The results show that the maximum deformation is concentrated in the center of the glass, as expected. The value of this deformation is aligned to the experimental results.

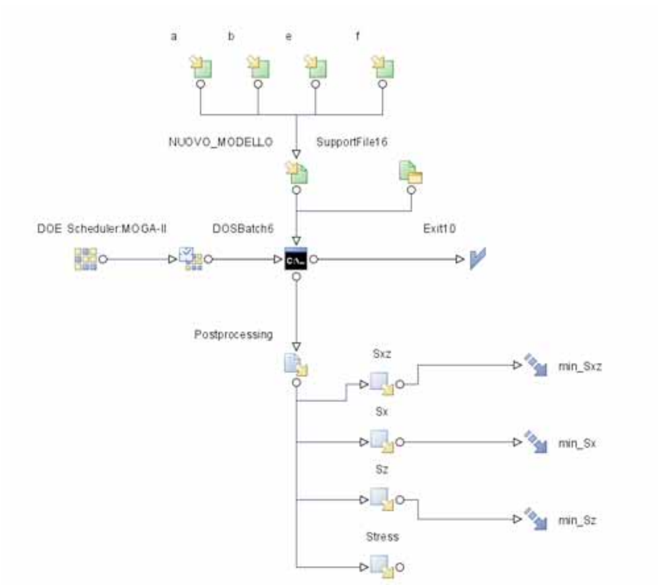
3.2.2 Constrained glass deformation

The initial complete model has been simplified in order to speed up the simulation, as detailed in par. 2.1.
The constraints applied to the internal glass for the simulation of the real condition are:

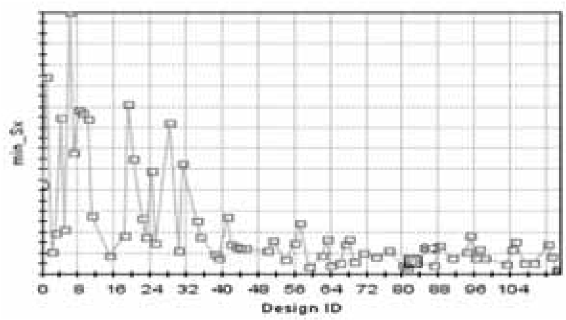

Picture 3.1.2 – Glass surface with the applied node-temperature

- Upper support
- Side support
- Back support
- Lower support

Picture 3.1.2 illustrates the constraint system with and without glass. The upper support block YZ glass displacement, the side support block XZ displacement and the lower support



Pict. 4.1.1 – modeFRONTIER's workflow



Picture 4.2.1 – History chart SX

block XY displacement. The constraint conditions have to be understood with a little tolerance in displacement. In fact, every constraint allows a clearance to avoid stress concentration due to an over- constrained condition.
Applying the temperature field to the modeled system as described before, we continue with the structural simulation to calculate the stress on and the deformation of the examined component.

In order to avoid value distortion, due to mesh problems, instead of considering maximum and minimum values, we have taken into account a mean value of this quantity close to the glass constraints.

4 Optimization of the glass support

The initial model described previously has been parametrized to allow the management by modeFRONTIER; the described parameters refer to the dimensions of the upper and lower glass constraints. While we focused on these constraints, the distances from the left and right glass edges and their width were parametrized.

The aim of this step was to define an optimum set-up of the constraint system that minimizes the glass deformations in pyrolysis conditions.

4.1 Project set-up in modeFRONTIER

Variables used in this first optimization sub-step are therefore four and each couple refers to the dimension of a constraint. The constraints on the glass are four, symmetrical, and hence it is sufficient to modify the dimensions of only one to modify the couple: these will be the variables of the optimization.
Lower and upper bounds of all the variables were set according to the customer's requirements.
By using modeFRONTIER, we want to manage the entire FEM (ANSYS) process automatically, to obtain the desired results.
To interface the FEM model with the optimizer, some macros were built, or rather a series of pre- and post-processing instructions to modify the geometry of the model during each simulation.
During the set-up of the optimization, some factors, such as time for each calculation or maximum available time have to be taken into account in order to define the best strategy.
In this project, the time for each calculation was about 75 minutes, not negligible; this made us choose a genetic algorithm that has a good robustness to find the optimum.
The objectives were:

- Minimization SXZ shear stress;
- Minimization SX normal stress;
- Minimization SZ normal.

The chosen algorithm was the MOGA (Multi Objective Genetic Algorithm), starting from an initial random population (DOE) of the input variables domain.
Simulation parameters:

- MOGA iterations: 10
- DOE dimensions: 12 - variables number multiplied for objectives

With these settings we have to do 120 runs for a total run time of 150 hours

4.2 Optimization results

After the optimization process, a good convergence of results was achieved: values of shear and stresses decreased up to 40% with respect to the original configuration.
Picture 4.2.1 shows an example of the history charts of stresses SX.
As this is a multi-objective optimization, optimum results are more than one: in fact, we could have some designs which achieve the first objective, but are very far from the other objectives. Hence we are looking for the best tradeoff!
In this job, all three objective are very correlated, so the convergence is parallel, which allows us to choose two optimal designs.
From the obtained results we can extract some important information about the component behavior in real working conditions, especially with regard to the glass constraints dimension and their dispersion across the oven door:

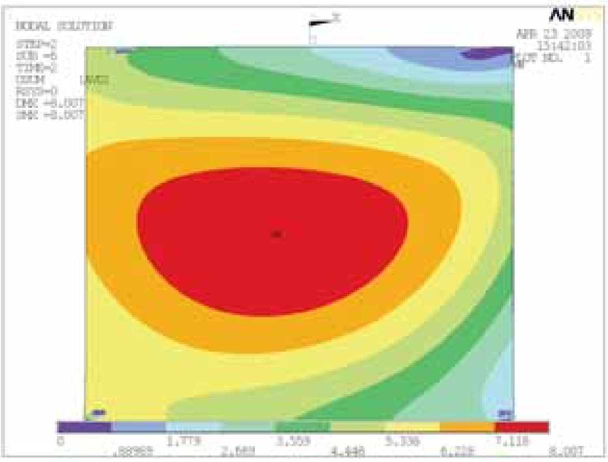
- Distance of the lower constraint from the edge of the glass seems to have no influence on stresses;
- Width of lower constraint should be bigger than original;
- Distance of the upper constraint from the edge of the glass seems to have no influence on stresses;
- Width of upper constraint should be smaller than original;

In summary, for an optimal solution, the constraints layout should encompass the upper constraint going more close with the opposite behavior for the lower constraints. In the following picture the optimal solution is graphically represented.

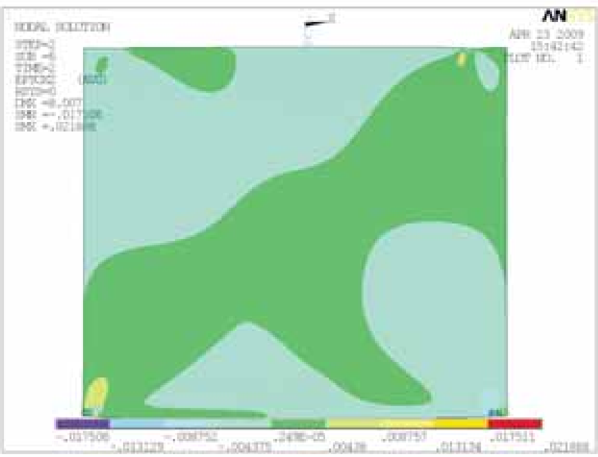
For the stresses, without having sufficient information about the glass characteristics, it is more opportune to present the deformation chart of the glass, during the pyrolysis phase.

5 Conclusions

The provided model is composed of an assembled system of three glasses, mounted on a chassis that keeps them separated to allow an air passage between them, in accordance with the regulations for this appliance.
Experimental tests performed by Indesit are focused on temperature measurement of pre-determined points located on the internal side of the first glass, in pyrolysis conditions, when the internal temperature of the oven rises to 500°C.
Punctual values of temperature, were computed with response surface modeling in modeFRONTIER in order to obtain a function that describes the temperature distribution on the entire glass, and assigns a relative value on each FEM model node.
The built map is related to the hot side of the considered glass. To calculate temperature distribution on the cold side,



Picture 4.2.2 – Displacement sum



Picture 4.2.3 – Elongation due to the shear SXZ

the entire glass system was modeled by thermal analysis. Knowing the internal cavity temperature distribution, the safety temperature on the external side of the outdoor glass and convex thermal coefficients, we were able to obtain the temperature distribution on the coldest side of the most stressed glass and hence also the thermal gradient applied to this component.

The focus of the first simulation was on examining the free constraint condition of the glass, or to verify the maximum deformation of the glass, without constraint.
In the subsequent simulations, the initial configuration, as described in the initial 3D model, was modeled with the dual purpose to validate the FEM model with experimental results, and to determine stress and deformation values of the initial configuration.

The aim of the optimization process was to find an optimal layout of the constraint system that minimizes stresses on the internal glass. To achieve this result, the FEM model was parametrized by means of a series of instructions named "macros", to allow modeFRONTIER to manage the geometry of the model.

The task of modeFRONTIER is to modify the model geometry on each run and to drive the input variables to the best set. The modified parameters are referred to as the upper and lower glass constraints dimension, and in particular, the reciprocal distance and the width of each constraints are verified.

The results were the values of stress and deformation on the model, due to the thermal gradient applied. Due to imperfections in the mesh, the mean value of stresses close to constraints, was taken into account.
Obviously, the selected area for the calculation of this mean, was related to the area affected by higher stress values, to be precautionary.

The obtained results meet our expectations: a sensible decrease of stresses was registered nearby 30-40% with respect to the customer configuration, and a good conversion of results was achieved, highlighting the good quality of the work performed by modeFRONTIER.
The deformations of the optimized configuration are bigger than the original ones, which is an indication that the obtained design provides room for a better movement for the glass.

Finally, we are certain that the obtained results are sufficient and correct, and that this work has delivered further information and details about the system behavior to the modeFRONTIER users at Indesit Company.

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Robust Design Optimization of a Bumper System at Volvo Cars using modeFRONTIER

70% are low speed crashes
According to a recent survey by Volvo Cars Brand Experience Centre, low speed crashes represent over 70% of the crashes today. Typically crashes up to approximately 15 km/h are categorized as low speed crashes and are often caused by accidents during parking, queuing and braking situations.

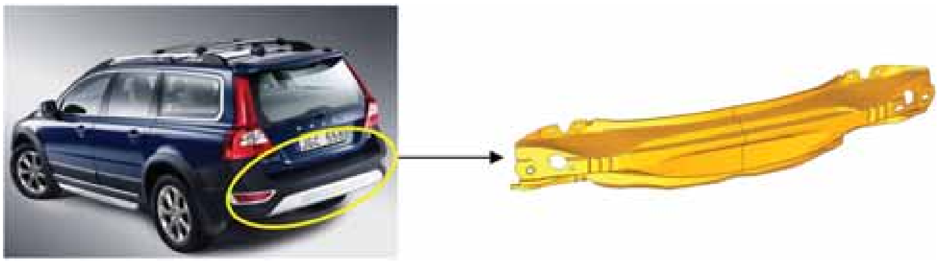


Figure 1: Low speed crashes represent more than 70% of the crashes and combined with very high costs for repairs make robust design optimization extremely important. The study focuses on the bumper beam shown to the right.

The components of the rear part of the car are highly integrated, making repairs very expensive. Therefore, both customers and insurance companies require that the damage of a low speed crash should be limited to a few components which are easy to replace. In order to minimize the damage to the car body, the rear bumper beam must be designed to absorb all the energy from a crash. Due to the complexity and cost of repairs, the optimization of the bumper system becomes a very important and challenging topic.
Ever since its establishment, Volvo Car Corporation has put safety among its top priorities and recently a thesis work [1] on best practices for robust design optimization of a rear bumper beam was carried out.

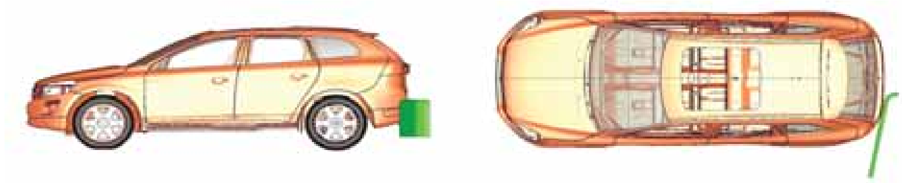


Figure 2: Driving backwards into a fixed barrier at 15 km/h, i.e. the Allianz test, without damaging the car body is one of the toughest requirements. The figure shows the CAE model built in ANSA. This model of a full vehicle was used for verification.

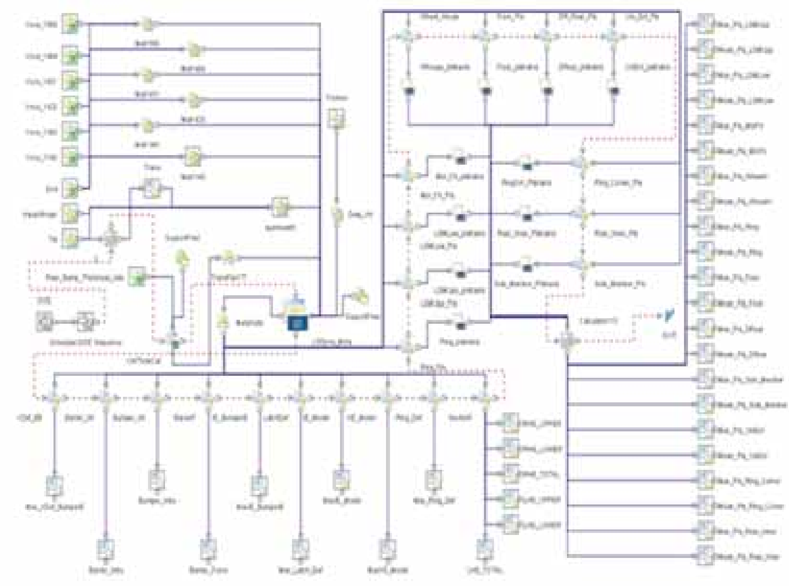


Figure 3: modeFRONTIER was used to automate the robustness study using LS-DYNA and METApost. In order to save computational cost, a submodel instead of a full vehiclemodel was used for the robustness and metamodel evaluations.

Performance varies due to tolerances in production
Using modern crash simulation software such as LS-DYNA, it is now possible to predict the behavior in a crash with good accuracy. However, everything that is manufactured has its tolerances on geometry, material properties etc which means that in practice a certain range of variation on the performance parameters always exists. Any small deviation, even a random noise, could influence the real crash, but may not be visible in the CAE analysis when nominal values are used for simulation.

A robustness study looks into groups of simulations with different combinations of input parameters, to see if they give similar responses or not. Just as with the input parameters, it is important to identify the relevant and interesting output parameters which are then traced in the robustness study. The analysis will show how the performance varies due to scatter in the input parameters.

Evaluation of robustness
Performing a robustness study is both complex and expensive. Complex, since the crashworthiness is determined by variations in a large number of parameters, such as material properties of different parts, friction, impact angle and speed. Complexity includes both choosing the most influential parameters and implementing them for automatic evaluation. Expensive, since a single simulation

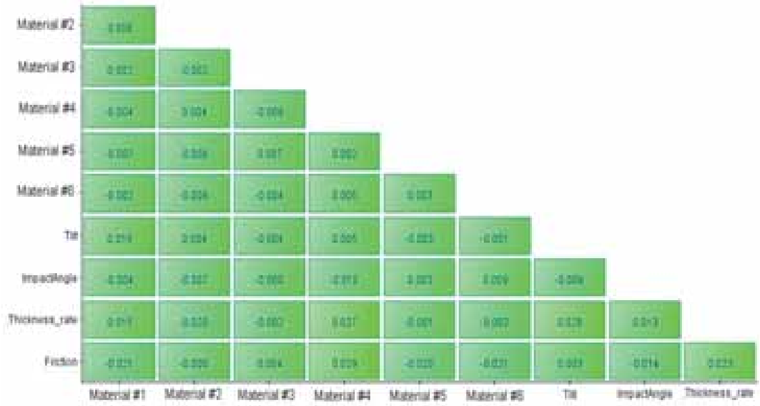
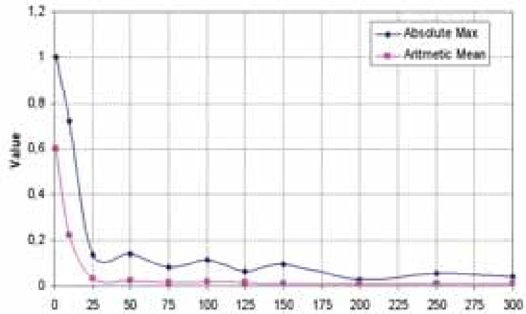


Figure 4: Linear correlations between the 10 input variables for the Latin Hypercube sampling.



# Designs	Abs Max	Arith Mean
1	1	0,6
10	0,723	0,223
25	0,134	0,033
50	0,139	0,021
75	0,081	0,015
100	0,115	0,016
125	0,062	0,012
150	0,096	0,011
200	0,029	0,009
250	0,052	0,01
300	0,042	0,008

Figure 5: Correlation between input variables approach the ideal value of zero as the number of designs grows. A maximum correlation of 0.1 between two inputs is regarded as acceptable which corresponds to a requirement of approximately 75 to 100 samples.

takes about 2 hours using parallel execution on 24 CPUs and a robustness study may need more than 100 evaluations.
The selected input parameters in this study are:

- Material properties of the bumper beam
- Thickness of the bumper beam
- Material properties of the parts behind the bumper beam
- Barrier impact and tilt angle
- Friction

The selected output parameters are:

- Maximum plastic strain in all parts except bumper and barrier
- Mean plastic strain in all parts except bumper and barrier
- Number of high plastic strain nodes in all parts except bumper and barrier
- Maximum deformation of the bumper beam
- Kinetic and internal energy of the model
- Maximum bumper beam internal energy
- Section forces of the side member
- Latch displacements

The preferred sampling method for this type of robustness study is Latin Hypercube. A central question is how many samples are needed for the chosen 10 variables in the study. A possible answer is to study the correlations between the input variables as shown in figure 4. Figure 5 shows the absolute max and arithmetic mean of the correlation versus the number of designs. It can be seen that both values approach the ideal correlation of 0 as the number of designs grow. A correlation of 0.1 is regarded as acceptable which corresponds to about 75 to 100 samples. In the crashworthiness study, the complexity of the evaluated results as well as the number and complexity of significant interactions among the input variables may require even more samples to be evaluated in order to reach converged stochastic results.

In this study, convergence of the stochastic results of the initial sampling of 200 design points is verified by an additional 100 design points. The additional 100 designs are also generated from Latin Hypercube, but from a different random seed. This means that the additional 100 designs differ from the original 200 designs and the 300 designs as a whole still follow the Latin Hypercube space filler distribution. It is observed that there was not a big difference between the output correlations or the output distributions gained from the 200 and 300 design sets.

Results of the robustness study

One result of the robustness study is a list of the main effects for each results quantity. Figure 6 shows the effect of input parameters on the maximum internal energy of the bumper beam, ranked from most to least influential. It can be seen that the maximum internal energy of the bumper beam is critically influenced by changes to the tilt and impact angle of the barrier. In addition, an increase in the friction and a decrease in the bumper beam material strength could give higher energy absorption.

Besides, the effect of each individual input parameter interactions of several inputs can be significant. As it can be seen in table 1, the combination of material properties of the rear side members and the impact angle have more effect on the results than the single factors friction or material properties of the bumper beam.

MAIN EFFECTS		INTERACTION EFFECTS	
Factors	Effect	Factors	Effect
Tilt	-1,00	Mat 5 (Side Members) * Impact Angle	0,41
Impact Angle	0,61	Tilt * BB Thickness	-0,39
Friction	0,32	Impact Angle * Friction	0,32
Mat 6 (Bumper Beam)	-0,28	Mat 4 (SM-Rear Part) * BB Thickness	0,29

Table 1: Comparison of main and interaction effects of the inputs on maximum level of the bumper beam internal energy.

The robustness study also uncovered a set of designs giving extreme results. A separate study on these outliers revealed that they all had low values of friction. The root cause of the outliers is related to the way LS-DYNA deals with friction. As a result, 200 new FE simulations were performed with the friction fixed at the nominal value. The ranking of main and interaction effects was not affected while the output values and their distributions had to be updated. Table 2 shows how the most important stochastic data changes when friction is removed as a stochastic input variable. The table also shows that the standard deviation of the internal energy is in the order of 5-10% of the nominal value. By comparison, the number of deformed elements, i.e. elements exceeding a specified plastic strain, has a standard deviation exceeding 50% of the nominal value.

The correlation chart is a versatile tool and figure 7 shows the original 10 input variables versus 4 outputs. Marked boxes are regarded to have high values of correlation. Since the variables Tilt, Thickness, Impact Angle and Friction have many marked boxes but only one box is marked for the material properties, it is concluded that variations in material properties are of less importance than variations in the loading case.

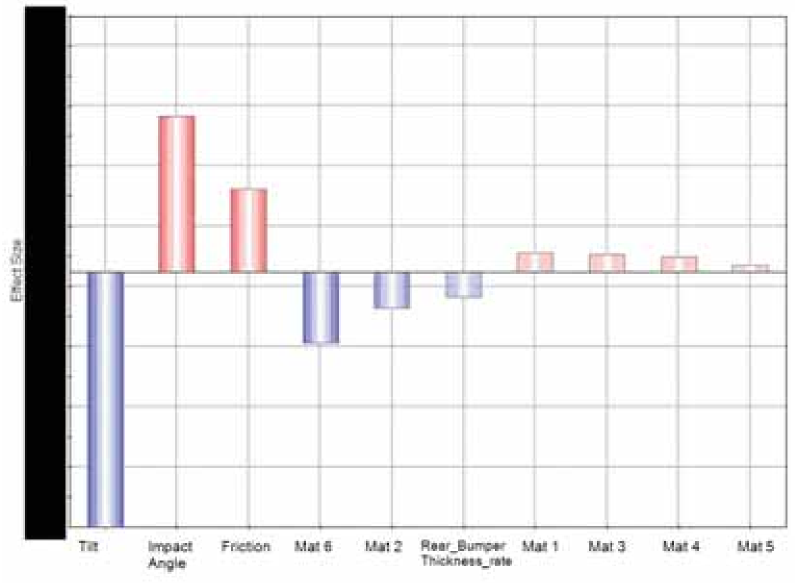


Figure 6: The main effects plot shows that the most influential parameter on the internal energy of the bumper beam is the tilt of the barrier followed by the impact angle and friction.

Another important result is the correlation between the outputs. Figure 8 shows that an increase in the maximum internal energy of the bumper beam leads to a decrease in the number of deformed elements on the ring frame.

	Bumper Beam Max IE		Number of Deformed Elements	
Nominal Value	100%		100%	
	Varied Friction	Const Friction	Varied Friction	Const Friction
Minimum	68.02%	82.21%	33.33%	62.70%
Maximum	109.59%	108.22%	557.14%	324.60%
Arithmetic Mean	96.37%	96.67%	153.17%	138.89%
Standard Deviation	7.79%	6.66%	92.86%	50.00%

Table 2: Variation of friction has a significant effect on some of the stochastic results. It is also clear that the robustness properties can hardly be ignored when the maximum value in the study exceed the nominal value by more than 5 times.

The necessity of metamodels

As seen in the robustness study, the scatter of the results cannot be neglected in an optimization. Furthermore, the computational expense makes it most desirable to find a fast replacement for the FE simulation during the optimization. In modeFRONTIER there are 7 types of metamodels which aim to replace the underlying simulation model with a very fast but approximate function. The evaluation time is in the order of 0.05 seconds, making it possible to evaluate thousands of design candidates in order to solve the robust design optimization task.

The process of using metamodels is divided into 3 steps:

- Training the metamodel
- Evaluating the quality of the fit
- Using of the metamodel

It was not obvious which metamodel would deliver the best fit so Kriging, Radial Basis Function and Neural Networks were included and evaluated. Besides the previously mentioned robustness parameters, 3 new geometry parameters, implemented through mesh morphing in ANSA, were introduced.

The training set consisted of 1000 FE simulations and another 170 FE simulations were used to check the quality of the metamodels. Figure 9 shows the difference between the Radial Basis Function and the evaluation set for one of the results. The mean residual values between the three methods were close and the response looked similar to the same design IDs. As such, all three methods in this study are considered to give equally good results. In the end, the parameters given by the Neural Networks were chosen for final verification.

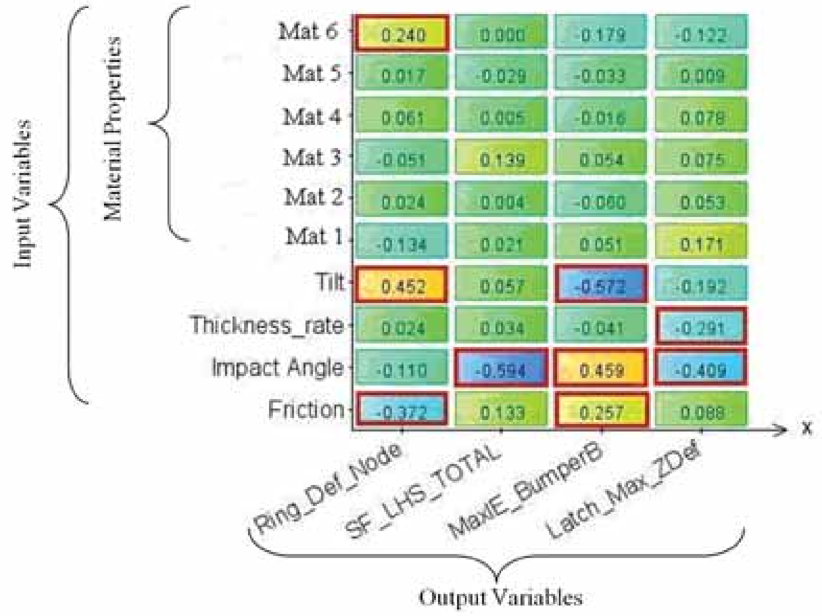


Figure 7: Correlation between input and output variables. The variation in crashworthiness due to scatter in material properties is small if compared to the scatter in the load case variables.

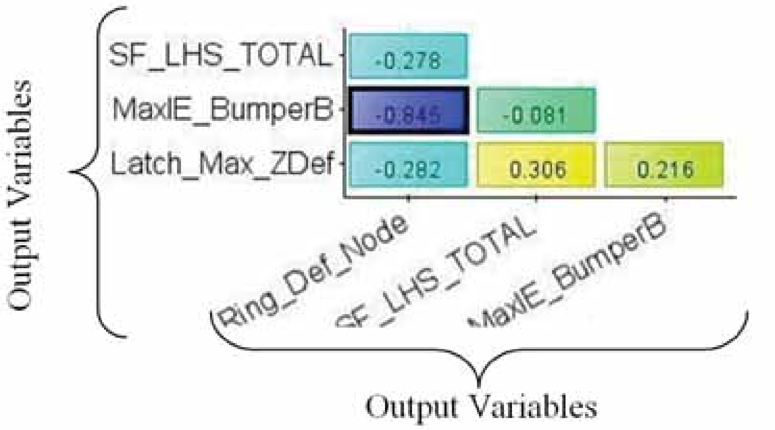
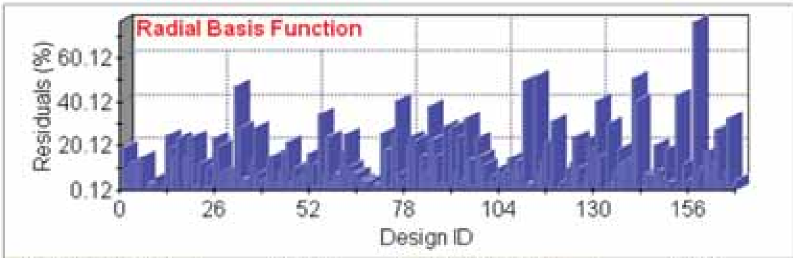


Figure 8: Correlation between output and output variables. An increase in the internal energy is strongly correlated to fewer nodes with high strain in the ring frame.



Max Abs. Error	278.42	Max Rel. Error	76.73
Mean Abs. Error	34.03	Mean Rel. Error	13.47
Regression	0.82	Error Mean	6.29

Figure 9: The residual chart shows the difference between the forecasted value by the Radial Basis Function and the FE simulations for the evaluation set.

	Number of high plastic strain elements in the ring frame	
	Original bumper beam	Optimized bumper beam
Nominal simulation	100%	71%
Minimum of stochastic simulation	63%	27%
Maximum of stochastic simulation	325%	183%
Arithmetic Mean of stochastic simulation	139%	87%
Standard Deviation of stochastic simulation	50%	32%

Table 3: The optimized bumper has been improved in all studied outputs.

Robust Design Optimization

The metamodels were used to run a multi-objective robust design optimization. A design found through optimization on the metamodels was then selected and verified using real FE simulations. Table 3 shows results for highly strained elements and it is clear that the optimized bumper beam is a big improvement over the original. Both the mean value and standard deviation have decreased. The comparison is also done for the full car model, to confirm that results calculated from the submodel can be applied to the full car, cf. figures 10 and 11.

The bumper which was optimized according to the Allianz load case was also tested in other low and high speed crashes. The results highlighted the necessity to consider multiple load cases at the same time during the optimization.

Figure 10: a) shows the plastic strain on the ring frame (i.e. a rear part of car body) in the submodel with original bumper beam. b) shows the plastic strain on the ring frame in the submodel with optimized bumper beam.

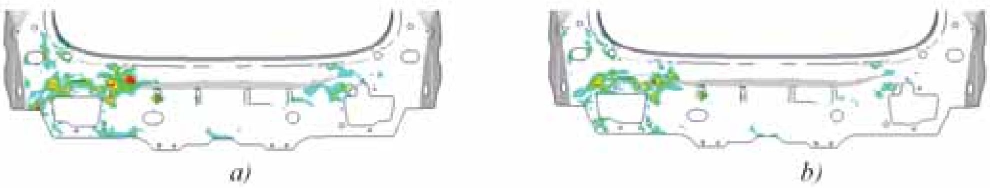


Figure 11: a) shows the plastic strain on the ring frame in the full car model with original bumper beam. b) shows the plastic strain on the ring frame in the full car model with optimized bumper beam.

Summary

Overall the results were very promising, proving the potential of running robust design optimization on metamodels for crash simulations. The initial robustness study also provided great value and insight into the dominant parameters and considerations regarding the FE simulations. The arithmetic mean and standard deviation for the stochastics simulations were improved for all studied outputs, e.g. for the ringframe the results were improved by about 50% and 20% respectively.

Reference

[1] Xin Li and Tolga Olpak, "Robustness and Optimization Study of a Rear Bumper Beam During a Low Speed Impact", M.Sc. Thesis at Volvo Car Corporation, Göteborg, Sweden, Department of Solid Mechanics at the Royal Institute of Technology (KTH), Stockholm, 2009

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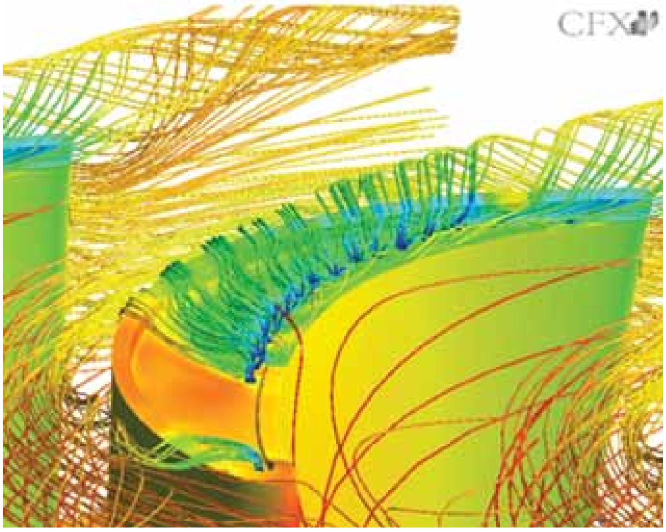
Optimization in product development - An efficient approach to integrate single CAE Technologies up to the entire design chain

Overview

In today's industrial production plants, state-of-the-art software systems are used to analyze different loading conditions in order to determine the performance and durability of a product. Similarly, production companies use simulation for manufacturing processes, such as casting and welding. Optimization techniques are widely regarded and applied as the next logical step to perfect competencies in simulation for modern product development. Possible applications of optimization techniques range from local problems with single applications up to the mapping and optimization of a large range of parameters of an entire product development process. Hence optimization can provide significant time and resources savings, opportunities that are illustrated in this article.



Picture 2: CFD simulations for a turbine blade

Introduction

Since the introduction of the computer, nearly all areas of life have changed rapidly. This applies also, and in particular, to the working environment and all professional activities of engineers. For example, engineering drawings are no longer made on a drawing board using 2D techniques; 3D models are created instead on the screen. Thus necessary adjustments to the product are realized quickly, for example the weight or the moment of inertia of complex geometries can be determined – all in an automated way. Advances in computational mechanics, such as the FEA Finite-Element Method, have also made their way into modern production facilities a long time ago. Again, clear advantages of simulation are shortened product development cycles, improved assessments of product quality and, importantly, savings in experimental time and equipment.

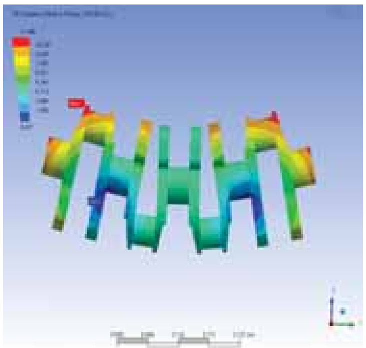
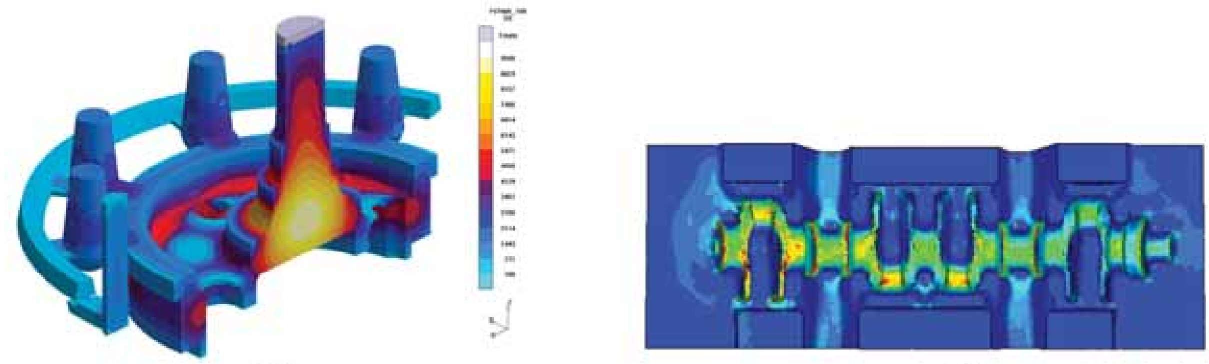


Figure 1: Stress analysis of a crank shaft

Today's status of simulation in product development covers a number of standard analyses, including:

- Strength and durability/fatigue analyses of mechanical and/or thermally stressed devices in most diverse loading conditions (Figure 1),
- Computation of characteristic measures in CFD problems as shown in Figure 2,
- Crash Simulations in the area of Safety Engineering and



(a) (b)

Figure 3 (a) Solidification stage of a casting simulation and (b) forging simulation of a crank shaft

- Vibration and dynamic analyses of complex multi-body models.

Considering its industrial infrastructure, the area of manufacturing process simulation could be regarded as a separate domain of computation. The attention here is not purely focused on the product, as also the required tools for the processes have to be taken into account. Those simulation methods comprise among others:

- Simulation of casting processes including filling and solidification processes, the resulting impacts on the material microstructure and the corresponding local mechanical properties as well as the residual stresses (Figure 3a),
- Simulation of forging processes with forming simulations performed continuously or in several steps, including material and stress-strain analyses of the device and the forging dies (Figure 3b),
- Injection-Molding Simulation of plastic-based devices including filling and solidification processes as well as joint formation,
- Simulation of machining processes including chip-forming analysis, thermo-mechanical analysis of the material removal rate of the workpiece and the tools as well as of surface properties.

If we consider the structural trends in manufacturing and R&D industries as an example - the ever-growing global competition, shorter development cycles and increasing demands on product quality to name a few - it is evident that further efforts are necessary to reduce costs and improve product quality. This is particularly important for companies whose operations are based in technologically advanced countries, such as Germany. Here, the CAE application "Optimization" is a well-known common practice and among the primary goals of technical developments.

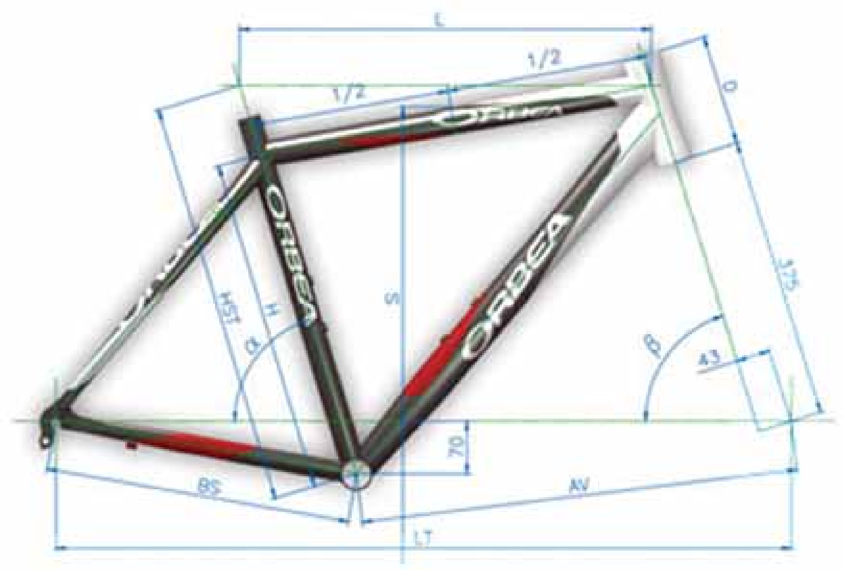
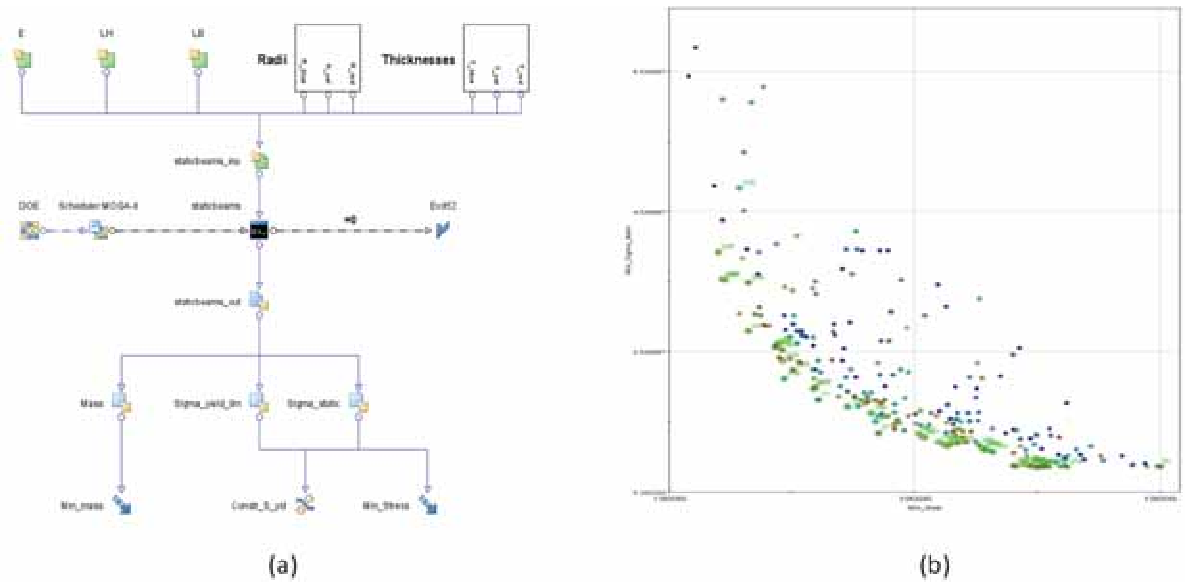


Figure 4: Parameter Optimization of a bicycle frame

Optimization

Optimization is defined as the mathematical process for finding optimal parameters of mostly complex systems with regard to a single or multi-objective functions. It is important to understand the advantages of optimization which are explained hereafter with the help of some examples:

- Target functions depend on individual problems and, in reality, often conflict with each other. Therefore, the ultimate objective of optimization is to find a solution which represents the best compromise among the different objective functions.
- Due to its mathematical background and its



Picture 5: (a) The modeFRONTIER Workflow which integrates a FEA application for a strength calculation of a bicycle frame. (b) The results of the optimization run presented in a Bubble Chart with the highlighted Pareto Frontier.

independency from respective applications, optimization is often regarded as a complex and independent field of action. Thereby, commercial tools, such as modeFRONTIER, are readily available for use since a long time. Such tools allow to setup, perform and automate optimization analyses in an easy way.

- The optimization level (and, hence, potential savings) depends to some degree on the development status of a company. On the one hand, it is possible to perform optimization on a relatively low level for the parameters of a single product. On the other hand, optimization can be considered as a tool of process integration and automation, hence, to enable the mapping and simulation of the complete process and design chain.

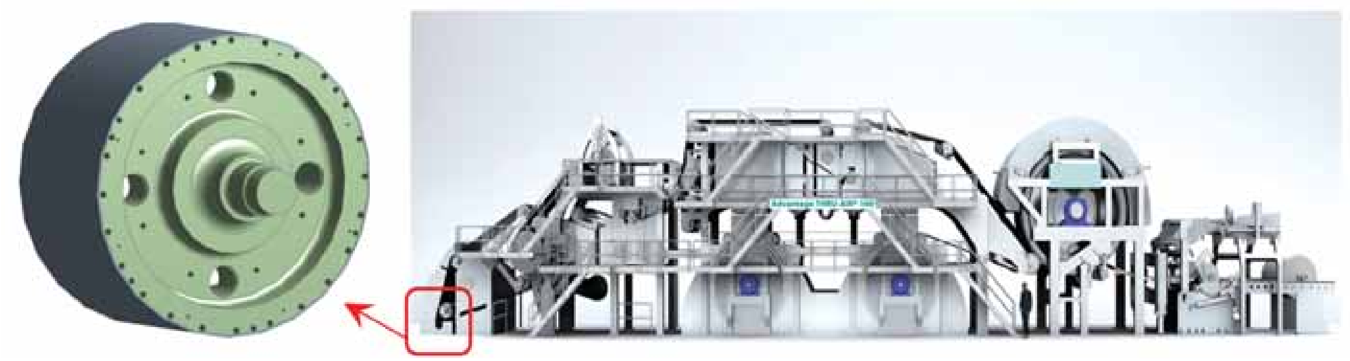


Figure 6: Optimization of a support roller of a paper machine

Optimization of a bicycle frame

Figure 4 illustrates an optimization of a bicycle frame with relatively traditional optimization objectives in structural mechanics: The goal here is to minimize the stresses caused by different loading conditions; at the same time, the weight of the frame should be minimized. Moreover, requirements regarding limits for maximum stresses (tensile strength and fatigue resistance) have to be observed.

In this example, the available geometric optimization variables are some lengths, the thicknesses of the tubes and their radial dimensions. In fact, with modeFRONTIER the present problem can be described in a single run and by integrating a single FEA application, as shown in Figure 5. Here, after an automatic analysis of the problem structure, modeFRONTIER recommends to run the optimization with a certain algorithm - in the present case a Multi-Objective Genetic Algorithm MOGA-II, with an appropriately generated DOE.

The optimization run takes place automatically and allows a systematic Illustration of the results as, for example, by using a Bubble Chart as shown in Figure 5 (b). Here, the optimal solutions on the Pareto Frontier are clearly visible. In this example, the automation enabled the engineer to compute 300 designs within a few minutes time. Hence, the design time was shortened, instead of wasting time for multiple manual variations. Additionally, the performance of the bicycle frame with respect to stresses could be improved, while achieving significantly lower weight conditions, which also led to lower material costs.

Design Chain Optimization

The relatively simple optimization approach applied to the design of the bicycle frame already delivered significant savings. This approach however is based on the (mostly feasible) assumption that existing residual stresses, σ_0, inside the device can be neglected. These stresses derive from upstream manufacturing processes. With regard to the bicycle frame, we could consider such stresses being related to welding, heat treatment, and quasi-static bending (straightening) processes of the frame. If available, this data could be used in a subsequent stress analysis to take into account real initial stress conditions and thus provide a far more accurate optimization. This way, we would obtain a process chain with four different applications which also can be mapped and optimized in modeFRONTIER.

As another similar example, we can take a closer look at a roller support of a paper machine, as illustrated in Figure 6. The roller support is manufactured by a casting process, the weight of the first design was 476 kg. The optimization goal here was to minimize the weight and deformation at the same time. In addition, the castability of the final form had to be guaranteed.

In this example, the sole and initially performed optimization of the geometry (variation of 13 parameters) with respect to the most extreme load-case delivered a weight reduction from 476 kg to 360 kg, while the deformation was reduced slightly. The verification of the castability was performed using the software tool MAGMASOFT (sand casting) in a second step after optimization.

Analyzing the casting simulation, the results additionally revealed zones with non-homogeneous microstructure and

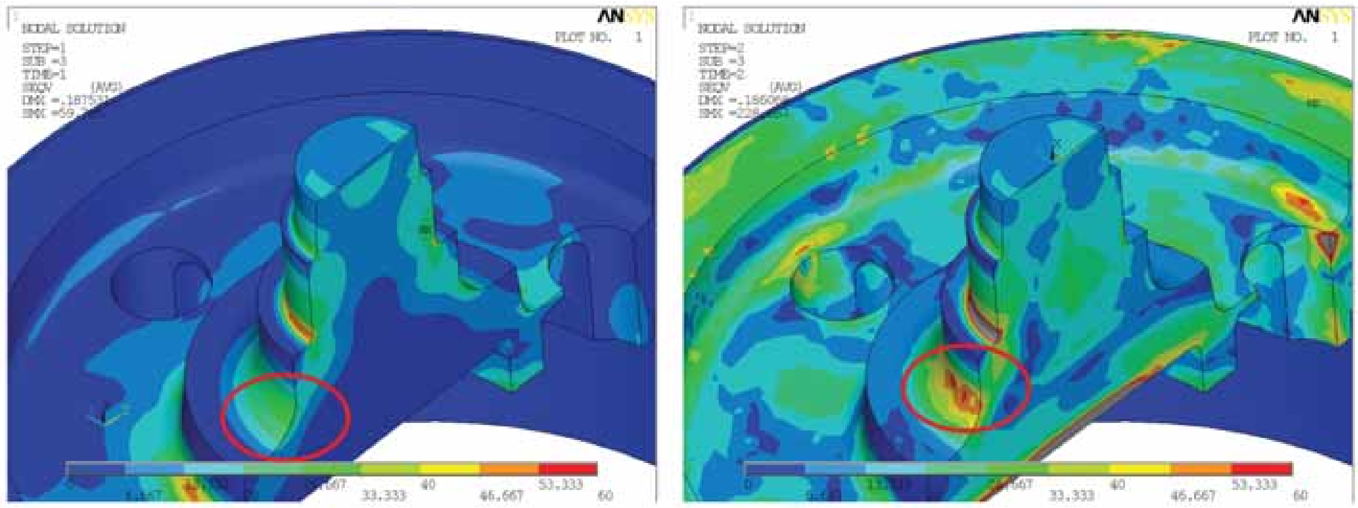


Figure 7: Standard Optimization (left) in comparison with an Optimization which encompasses the entire process chain: at the critical points, the analysis that considers casting simulation shows increased van Mises stress values.

hardness due to different thicknesses and local cooling rates. Also, local zones with high residual peak stresses were found, which have a decreasing effect on the fatigue life of the roller support.

These results gave reason to consider performing a largely extended optimization analysis that includes both the casting simulation and load-case analyses. In a tool such as modeFRONTIER, the complete process chain could be setup, in which results of the casting simulation are transferred as initial conditions to the subsequent FEM-based load-case simulation. Hence, all following steps are included in this kind of optimization problem:

- Casting simulation with MAGMASOFT to ensure the quality of the materials, to avoid casting defects, determination of local material properties (for example Young's module, fatigue and yield stress limits), as well as residual stresses on the different roller support zones.
- Transfer of the results via MAGMAlink (residual stresses and material properties) as initial conditions to be used in ANSYS.
- Load case (stress-) analysis with ANSYS.

This procedure enables also the systematic optimization of the support roller geometry with respect to the load in operating conditions, but including the consideration of residual stresses and the locally changed material properties from the casting manufacturing process. The castability could, therefore, be guaranteed reliably. Additionally, statements with respect to the fatigue life of the product could be obtained and coupled to the optimization procedure as constraints.
Figure 7 shows the original (traditional) load case analysis (left) and an excerpt of such a novel design chain approach that considers the results from the casting simulation (right). It is clearly seen that the stresses in the roller support are in no way homogeneously distributed due to different pre-stress conditions and non-homogeneous mechanical material properties. Similarly, peak stresses (van Mises) can be seen to be increased in some areas from approximately 30MPa to 50MPa (166%). Maximum principle stresses (not shown) even highlight increased values from 60MPa to 228MPa (380%). Although these values are yet far away from the materials tensile and fatigue stresses, they lead to significant reductions in the fatigue life of the product.

Conclusions
The ever growing competitive global market place will call for more and more applications of optimization techniques in various industrial sectors. In this article, we have outlined the following key points:

- The optimization of real problems most often defines solutions which are in conflict with each other. Such Multi-Objective Optimization tasks can already be solved today with easy-to-use software, such as modeFRONTIER.
- It is possible to perform automatic optimization already for simple development cases by linking standard tools from arbitrary areas (e.g. CAE tools).
- Optimization can be extended infinitely and, hence, be regarded as a tool for process integration and automation. In this way, it is possible to setup simulations of an entire process chain and, therefore, to systematically extend the optimization capabilities from single device parameters to the parameters of the entire design chain.
- There is potential for large savings. They may comprise in experimental costs and reduction of development times due to the automation of computations. Thereby, savings even go hand-in-hand with ensuring product quality.

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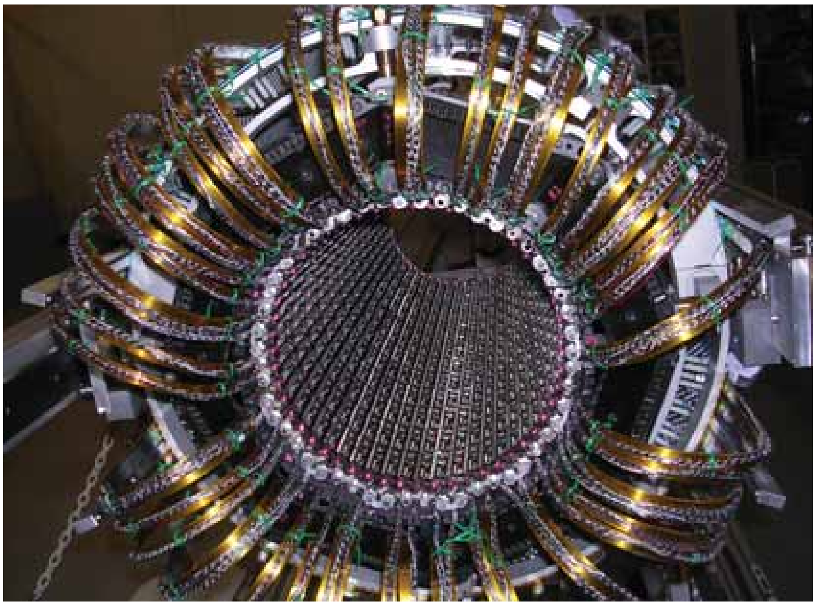
25. Schmalkaldener Fachtagung/Conference:
Die Digitale Fabrik–Module und Referenzlösungen/Digital Plant – Modules and Solutions

Case Studies

ANSYS simulation of carbon fiber and anisotropic materials

Introduction

The scope of this R&D is to develop a new support, with an integrated cooling system, for the replacement of the inner layer of the Silicon Pixel Detector installed into the ATLAS Experiment, working on the Large Hadron Collider at CERN; for details, we ask our readers to visit: www.atlas.ch/pixel-detector.html. This replacement will become necessary because of the radiation damage, with the detector being very close, about 50 mm, to the high-energy proton-proton interaction point.



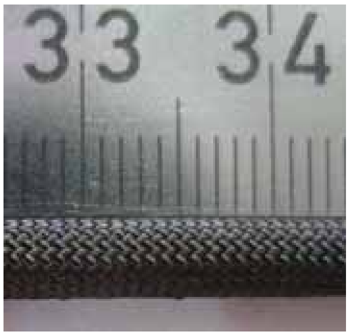
The ATLAS Pixel Detector during construction. Here we can see one of the cylindrical shells of Pixel detectors formed by the longitudinal cooled supports called staves.

The task of the support system is to hold the detector modules in positions with high accuracy, minimizing the deformation induced by the cooling; this must be done with the lowest possible mass because there are tight requirements in terms of material budget. An evaporative boiling system to remove the power dissipated by the sensors is incorporated in the support: thermal contact is made through a very conductive light carbon foam to maintain the sensor temperature sufficiently low, to limit the leakage currents and hence the thermal run-away. The coolant should be a fluorocarbons blend or CO_2. The worst case is imposing a cooling pipe design pressure of 10 MPa. The number of pipes could be 1 or 2 and the pipe material should be carbon fiber or titanium. The structural strength of the 800 mm long support stave is given from a carbon fiber "omega" shaped laminate.

Prototype of a stave with 2 carbon fiber pipes integrated into the carbon foam and attached to the structural omega shaped laminate.

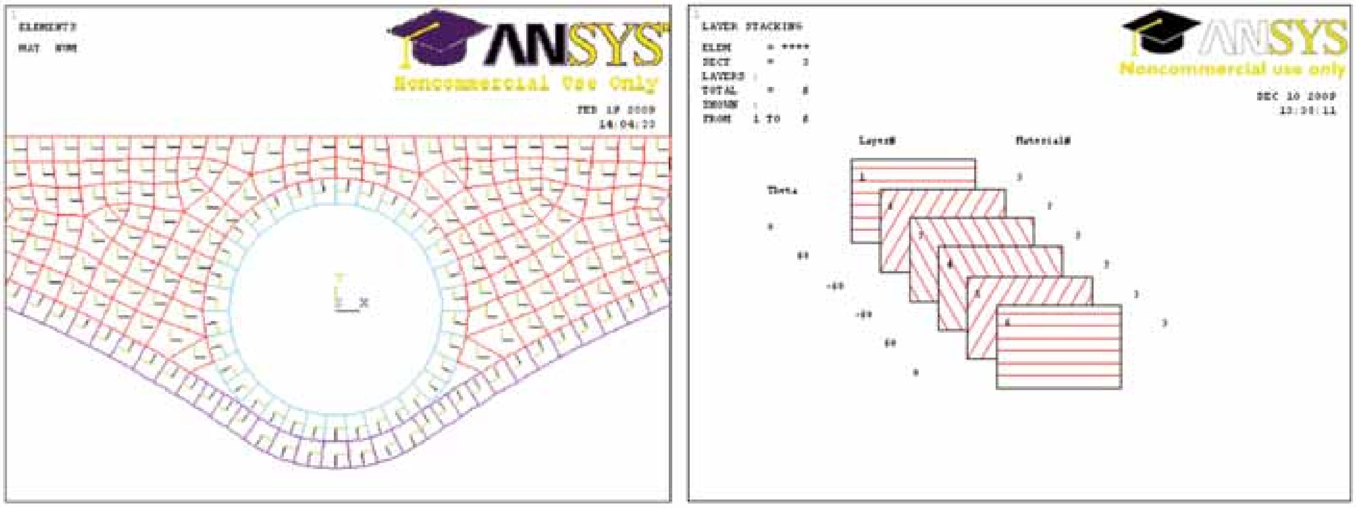
Summary of the work

The design is based on thermal, mechanical and thermo-structural analyses of assemblies made of carbon fiber composites. Calculation of the Tsai-Hill safety factors and transversal strains in the plies are required for tightness assessment of the pipe. Moreover, the pipe lay-up optimization against the internal pressure has been made together with estimations of the thermal expansion coefficient of the pipe and omega laminates. We used ANSYS and ESAComp; input figures for the ply properties, starting from fiber and matrix values, are provided by a dedicated spreadsheet. To validate the FEM simulations both Composite Laminate Theory hand-made calculations on cross-check simple models and experimental tests are used. Work is still in progress to measure material characteristics and FEM results: pull test on pipes performed with "braided" technology, burst pipe pressure, thermal transmission



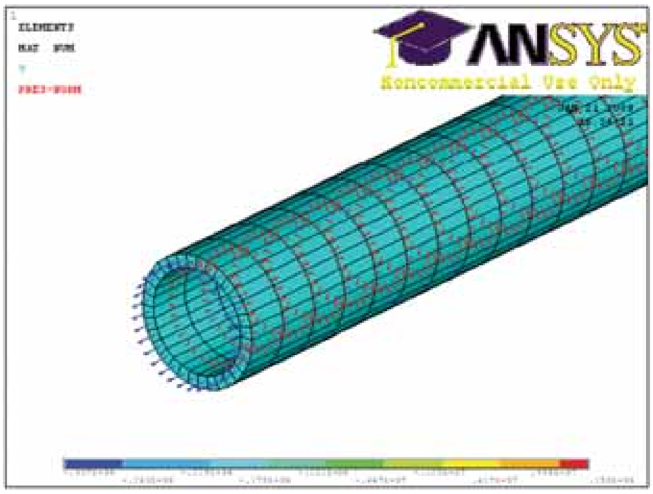
Carbon fiber pipe production test using braiding technology, before impregnation with resin

Case Studies



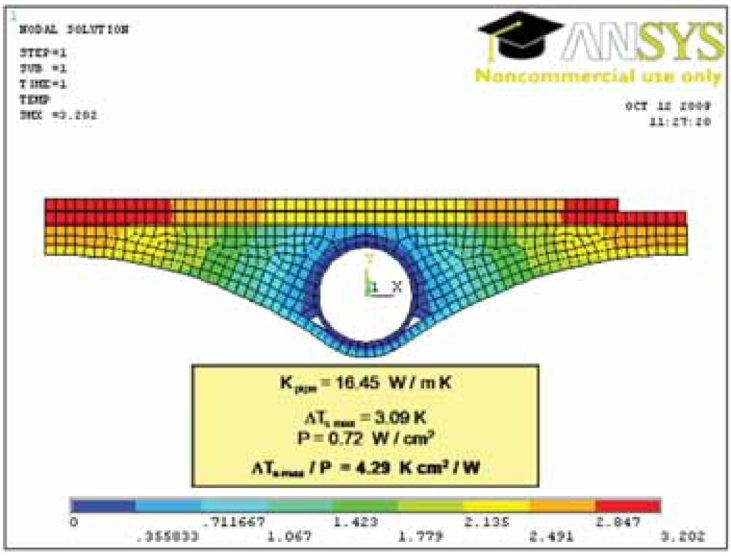
Cross section example of a finite element model. Note the mapped mesh for the laminate pipe and omega, whose one possible stacking sequence is showed.

coefficient K of the carbon pipe, CTE and deformations induced by the cooling using a Coordinate Measuring Machine.
The R&D key element is the production of the CF pipe and of the relative joints versus the external connecting piping, having suitable mechanical and tightness properties.



Internal pressure and longitudinal stress applied to the pipe

FEM of composite materials
Some assumptions are taken up in building the model and some parameters needed to run the software should be guessed as they are absent in literature (i.e. ply out-of-plane moduli and Poisson coefficient). A major problem found in building the models is the necessity to correctly orient the layered elements for the composites which turns out to be very time consuming. Moreover, in the multi-physics, during the switching from structural to thermal analysis automatically a different orientation of the thermal element coordinate systems is set; the use of dedicated APDL macro routines can be useful to optimize the FEM workflow. We used several meshing techniques: mapped mesh for composites materials and free mesh in 2D or extruded mesh in 3D for the anisotropic materials. Geometry of the anisotropic carbon foam has been carefully conditioned in order to avoid degenerated shape elements. We have chosen to assemble models, avoiding the use of contact elements between the meshed parts in order to obtain a practicable linear solution method, merging the interfacing nodes and reducing both the number of elements and the run-time. Comparisons between different sized meshes, with aspect ratio ranging from 1 to 10, and between 2D cross section and 3D solutions have been judged for time optimization and control purposes.
The use of brick elements for thin solids was driven by our specific multi-physics needs.



Thermal solution example

Note that the composite pipe produced by the "braiding" technology can only in first approximation be simulated by the laminate multi-ply hypothesis, like those implemented in the layered elements available at present. This could be an interesting ANSYS product development. We are also in contact with the DIGIMAT micro-mechanics developers to study the problem.

Thermal performance
The thermal performances of the different configurations proposed are studied with steady-state 2D simulations. Heat flux is applied while the BC is the temperature setting of the cooling pipes inner surface. We collected the resulting max ΔT across the staves in a table, using a performance parameter obtained by dividing ΔT by the thermal power flux imposed as load.

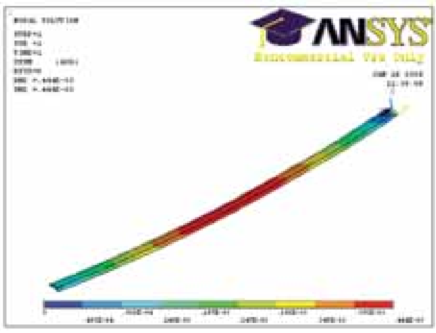
Evaluation of the thermal expansion coefficients
Longitudinal CTE is calculated for the possible configurations; the simulations are executed with the volume fiber percentage measured on the samples, ranging from 30% to 60%. The calculation procedure is to build a model and increase the nodal temperature in order to have a ΔT: the nodal displacement is evaluated and the relative CTE is then calculated. ESAComp has been used for cross check.

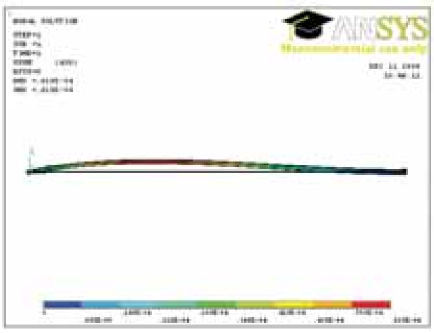
Pressurized pipe lay-up optimization
The design of the pipe laminate should satisfy these criteria: withstanding a pressure test of 15 MPa, having a safety factor of 4 on the design pressure against a Tsai-Hill failure criterion, matching the longitudinal CTE of the other materials, remaining tight under pressure with maximum transversal ply strain $\leq$ 0.1%. This is the parameter that controls the micro-cracks growth. Pipe is modelled using the element layered-type Solid186. Pressurized vessel conditions are simulated with axial force on the pipe extremities. Different pipe stacking sequences are considered for these structural simulations; for each ply longitudinal, transversal and shear stresses and strains are extracted for the result analysis, used directly or combined in the failure criteria.
Comparison between the stress values or Tsai-Hill index resulting from the simulation and the corresponding rupture stress values of the ply is done. Lastly, the best lay-up, matching the requirements and including technological feasibility, is [45/-45]s.

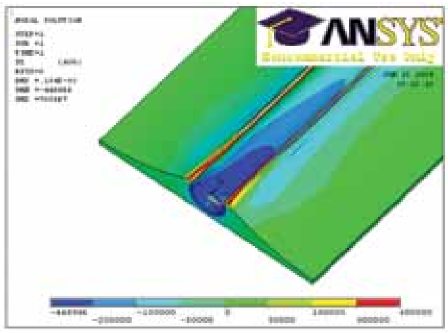
Deformations induced from gravity, cooling and pipe pressurization
To understand the thermo-mechanical effects, we first performed 3D thermal simulations using 20 node Solid90 elements, in order to determine the temperature field under defined heat flux. The resulting nodal temperatures have been imported, node to node, in the structural environment, using Solid186 elements to determine the deformations and stress of the stave components due to the thermal induced deformation, related to the different CTE values of the materials. Coefficients of thermal expansion of the ply are calculated by the Schapery formulas. In the following study the loads applied to analyse the behavior of the stave are: 1) cooling-down: ΔT = -60°C, that is the ΔT between the assembling temperature and the minimum evaporation temperature; 2) static gravity to evaluate the maximum deformation due to the weight; 3) pressure 10 MPa inside the cooling pipe.

Conclusions
A number of considerations have been taken into account in the frame of this collaboration with regard to all ANSYS silmulation results and other parameters, such as the global radiation length, to optimize the assembly properties. The final choice to be made will also depend on the measurements in progress on the real prototypes.

The ANSYS software can be used as a useful tool for the model analysis with composite and anisotropic materials. A lot of work has been devoted to understanding the method, and then to building the required models in a proper way, for achieving the various simulation goals. The real measurement performed on a pipe prototype, actually the CTE of a CF pipe, provides a first positive feedback from the R&D work which is still in progress.







Thermo-mechanical simulation results for a given configuration.

Acknowledgments
Thanks to the colleagues of the INFN Milano Mechanical Design and Workshop Department, in particular Mauro Monti, the responsible for the simulations and to Danilo Giugni and the whole ATLAS Insertable B-Layer Collaboration.

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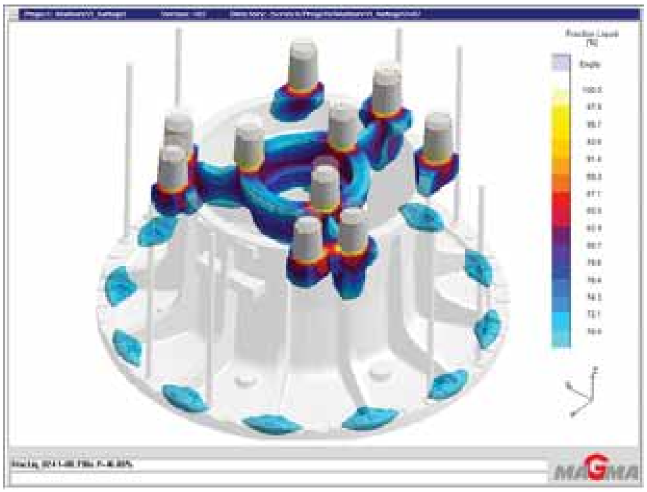
Aeronautical engines: reduction of emissions and consumptions with a process simulation study

The project "Marboré", which is promoted by the Department of Mechanical Engineering of the University of Padua, aims at offering to aerospace students a trial aeronautical engine in order to carry out tests and researches. These studies are useful both to improve the performances of turbojets according to stricter laws for the reduction of CO2 and NOx emissions and to reduce fuel consumption.

As the design of a new propeller involved many technical and economical difficulties, the University decided to use a turbojet which was already available on the market.

At the end of 2006, a Marboré VI-C turbojet, dismantled from a target plane which had crashed, was collected and



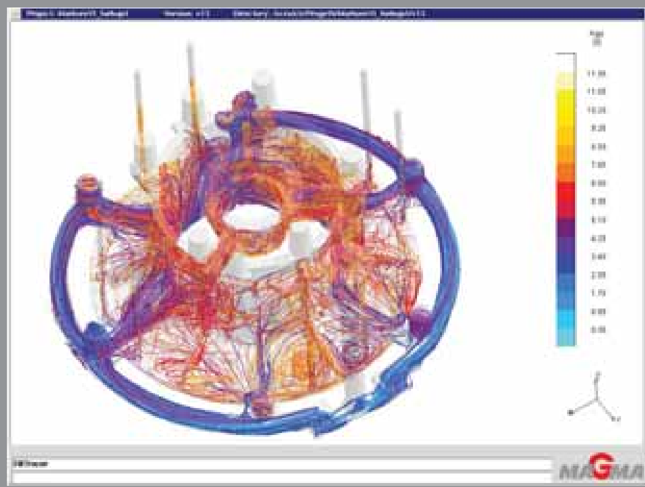
given to the University. The engine had been designed and produced by the French company Turbomeca in the 70's. After the impact, the propeller was heavily damaged, in particular the front section, seat of the centrifugal compressor. The project included the entire modelling of the turbojet with the help of a CAD software and the reconstruction of the damaged parts.

At the end of 2007, the rotor was completed, while the intake casing, originally created with magnesium alloy, was excluded from any analysis, as this study required particular knowledge about the casting process. For this reason, it was necessary to carry out a specific study for this part with the aim to find out all the technological details to plan and perform the casting process.

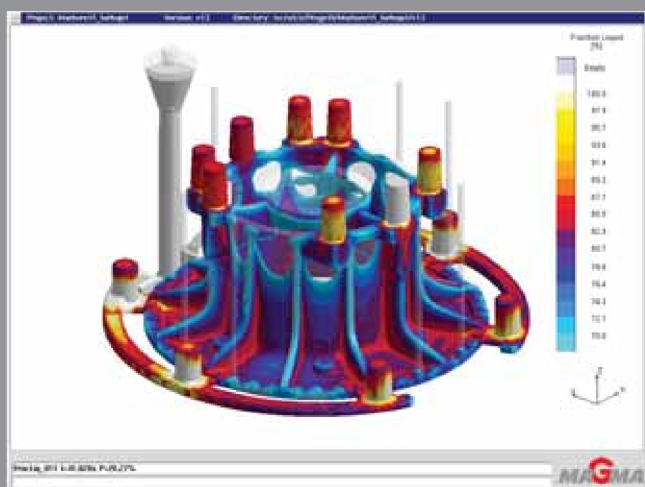
The first step was a careful CAD modelling which was slightly modified from the original according to the different use and then the project focused on the design of the casting system.

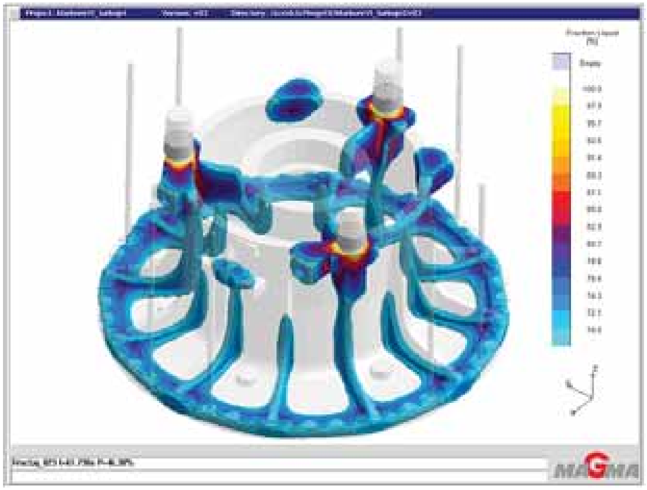
Motori Aeronautici: riduzione delle emissioni e dei consumi attraverso lo studio delle simulazioni di processo

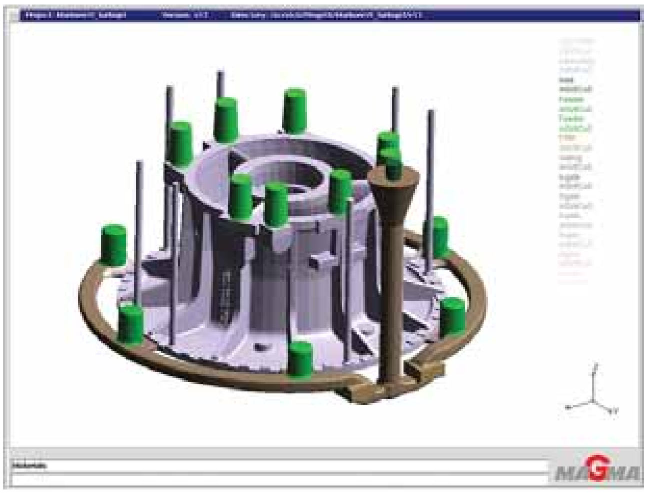
Il progetto Marborè, promosso dal Dipartimento di Ingegneria Meccanica dell'Università degli Studi di Padova, ha lo scopo di mettere a disposizione degli allievi aerospaziali un motore aereonautico funzionante a banco, su cui poter effettuare test e studi di ricerca volti a migliorare le prestazioni, come l'abbattimento delle emissioni inquinanti, quali NOx e COx, e la diminuzione dei consumi.



Visto il notevole sforzo, economico e tecnologico, che sarebbe stato necessario per la realizzazione ex-novo di un propulsore su cui lavorare, si decise di utilizzare un turbojet già presente sul mercato. Verso la fine del 2006 viene recuperato e messo a disposizione dell'Università un turbogetto di tipo Marborè VI-C, realizzato negli anni '70 dalla francese Turbomeca, smontato da un aereo bersaglio schiantatosi al suolo. A seguito dell'impatto, il propulsore è risultato essere fortemente danneggiato, soprattutto nel comparto anteriore, sede del compressore centrifugo. Il progetto prevede la completa modellazione del turbogetto, attraverso software CAD, e la ricostruzione degli organi danneggiati.



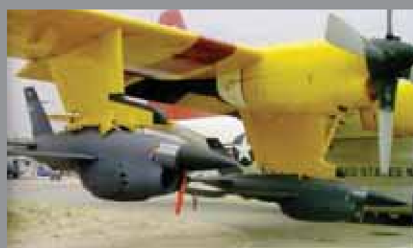


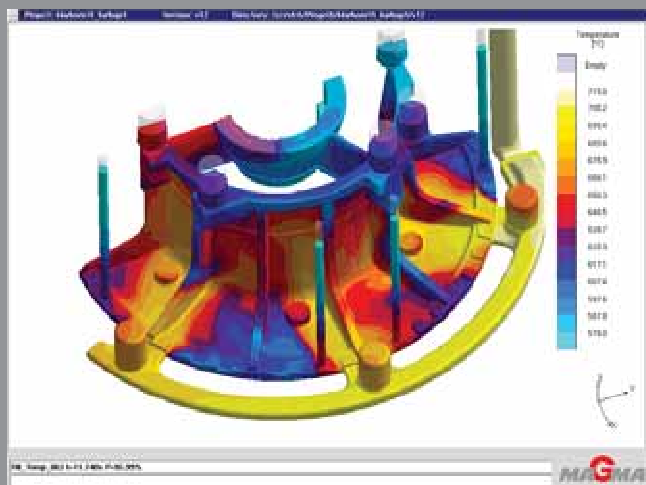


After a first sketch of the casting system using CAD, the software MAGMASOFT was used to verify and optimize the casting process. During this step an academic approach permitted to carry out a series of simulations which modified the model as to a careful analysis of the results. This enabled to obtain a single good quality prototype without limits on time and elaboration methods. First of all, the simulations of the initial versions, which were created in agreement with the partners involved in the project, were essential to choose among different possible configuration methods. These versions differed both in the cooling system and in the filters placement.

The first version had a central cast iron chill and three exothermic feeders on top of the component. Solidification results immediately showed that this type of placement was perfect for the bearing support: as a matter of fact, a very quick cooling improved the mechanical characteristics in the most “significant” area of the component. At the same time, isolated liquid bubbles on the external surface during the cooling caused feeding problems.

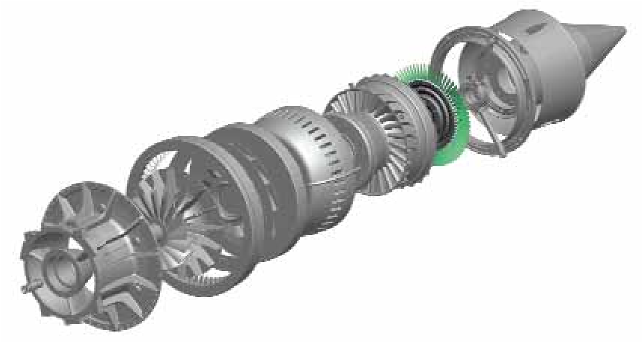
Alla fine del 2007 i componenti rotorici sono stati completati, mentre è rimasta esclusa da ogni tipo di analisi la bocca anteriore del motore, fusione monoblocco in lega di magnesio, studio che richiede particolari conoscenze del processo produttivo.
Si è quindi reso necessario realizzare un lavoro specifico per questa parte, che approfondisse tutti i dettagli tecnologici per la progettazione e la realizzazione per processo fusorio del componente.
Si è iniziata un’attenta modellazione CAD, con alcune lievi riprogettazioni dettate dalle diverse esigenze tra un componente progettato per il volo da uno statico da banco, soffermandosi poi sulla progettazione del sistema di colata. Dopo un primo abbozzo nell’ambiente CAD, si è passati a lavorare con il software MAGMASOFT, necessario per verificare e ottimizzare il processo di colata.
Durante questa fase si è mantenuto un approccio di tipo accademico: si è realizzata una serie di simulazioni applicando di volta in volta alcune modifiche dettate dall’attenta analisi dei risultati ottenuti, ponendosi come unico obiettivo la realizzazione di un singolo prototipo di buona qualità, senza porsi limiti nei tempi e nei modi di elaborazione.
Innanzitutto si sono implementate più versioni rappresentanti le varie configurazioni del sistema di colata inizialmente progettate in accordo con le parti partecipanti al progetto. Queste differivano nel sistema di raffreddamento e nella disposizione dei filtri di colata.
Nella prima versione era previsto un raffreddatore centrale di ghisa e tre maniche esotermiche, in corrispondenza delle zone massicce. I risultati di solidificazione hanno evidenziato subito che tale disposizione era ottima per il supporto del cuscinetto, in quanto il raffreddamento repentino garantisce caratteristiche meccaniche migliori, mentre per quanto riguarda la corona esterna erano presenti notevoli zone di liquido isolate durante la solidificazione e quindi conseguenti problemi di porosità.
La seconda versione prevedeva, invece, di utilizzare esclusivamente maniche esotermiche, disposte nella parte su-





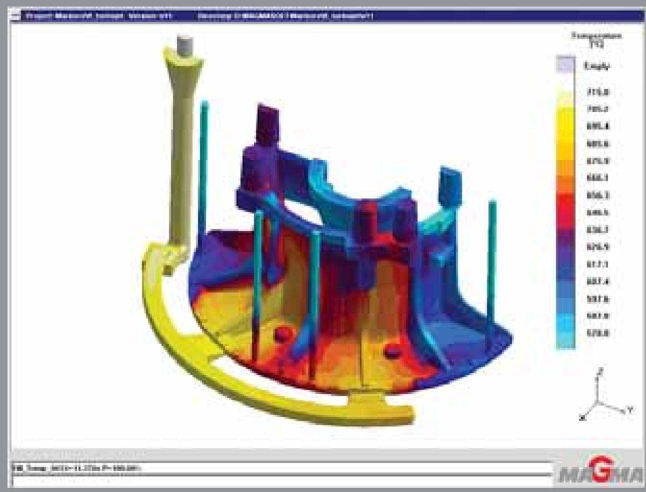
In the second version there were only exothermic feeders on the top. Just like the previous version, this new one presented both pros and cons during the analysis of the solidification results. The fluid temperature was more homogeneous in the cooling but the cooling front on the bearing support moving upward and the longer time of solidification led to worse mechanical characteristics, especially on the central part.

Both configurations, which were initially designed, enabled to obtain a “hybrid” system and simulations showed that this version was definitely better. It was constituted by a central cast iron chill and eight exo-feeders on the top of the component. In addition, the number of ingates increased up to six in order to improve the homogeneity of the input flow and to reduce the temperature gradients, which appeared at the end of the casting process in the previous versions with only four ingates.



Filling and solidification results pointed out that feeding defects decreased in comparison to the previous versions, hence the quality target was reached. Defects could be considered irrelevant due to the precautionary software applied and the particular refining of the casting process.

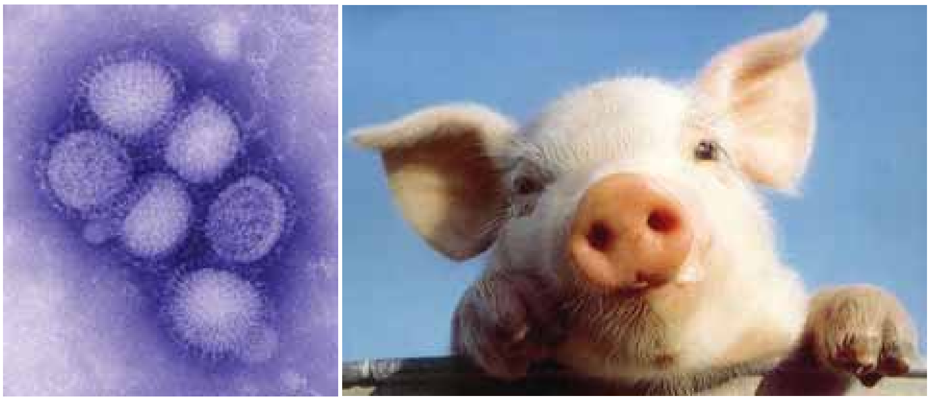
The sand mold was therefore realized using SLS (Selective Laser Sintering) rapid prototyping techniques. Afterwards, light alloy casting was carried out taking into particular consideration the preparation of the alloy. Finally, some X-ray analyses were performed to verify the integrity of the component and to compare the simulation results with real data. This study enabled to analyse each detail accurately and to follow the transformation from a CAD drawing to a real component. In addition, it pointed out the potentialities of this process, which is suitable both to optimize all the steps using specific software and at the same time, to minimize errors.



periore del getto. Anche in questo caso i risultati hanno messo in luce fattori positivi e negativi della configurazione. Si è ottenuta infatti una maggiore omogeneità del fluido in fase di solidificazione, peggiorando però le caratteristiche meccaniche, specialmente nel supporto centrale.
Si è cercato quindi di unire le caratteristiche migliori delle due versioni, ottenendo un sistema ibrido che dalle simulazioni è risultato decisamente superiore rispetto alle precedenti disposizioni.
Esso prevede l’utilizzo del raffreddatore in ghisa centrale e otto maniche esotermiche sulla corona esterna.
Inoltre per garantire una maggiore omogeneità del flusso in fase di riempimento, si è scelto di aumentare a sei il numero di attacchi, in maniera tale da limitare i gradienti di temperatura presenti a fine colata nelle versioni con solo quattro ingressi.
I risultati di riempimento e di solidificazione hanno sottolineato infatti che i difetti di microporosità sono diminuiti rispetto alle versioni precedenti, raggiungendo la soglia di qualità ricercata. I difetti ottenuti possono essere ritenuti trascurabili per la cautelatività del software e la particolare affinazione del processo produttivo.
Si è quindi realizzata la forma attraverso tecniche di prototipazione rapida, utilizzando tecnologie SLS (Sinterizzazione Laser Selettiva). Compiuta la fusione in lega leggera, con una particolare attenzione alla fase di preparazione del metallo da colare, si sono fatte alcune analisi radiografiche per verificare l’integrità del componente e confrontare quindi i dati delle simulazioni effettuate con i dati reali.
Diversamente da come avviene solitamente in contesto lavorativo, dove normalmente non si seguono tutte le fasi progettuali e realizzative, in questo studio è stato possibile analizzare accuratamente ogni dettaglio e vedere un disegno CAD trasformarsi in un componente reale.
Inoltre questo percorso ha evidenziato le potenzialità di questo processo che permette di ottimizzare tutti i passaggi attraverso software specifici, riducendo al minimo i margini di errore.

Healing the swine flu with modeFRONTIER

One of the hot topics of the winter 2009 that probably will be remembered is the outbreak of the so-called "swine flu". The new virus A-H1N1 captured the attention of the Italian media, which literally bombarded the population with daily reports on the number of deaths, the severity of this virus and other alarms based on the opinion of some "epidemiology experts", spreading in this way the fear within the population.



A photo of the A-H1N1 virus (left) and a swine (right). They do not look so dangerous...

During the first weeks of autumn some sentences such as "We will have an extraordinary peak of flu diffusion between Christmas and the new year" or "we will be the victim of a new pandemia with many deaths" were pronounced.

How is it possible to predict such an "apocalyptic" scenario so many weeks in advance? The truth is that it is extremely difficult, especially when no previous knowledge on the virus behavior is available. However, in epidemiology some simple mathematical models have been developed and used for many years; they are mainly based on ordinary differential equations (shortly ODEs).

Probably, the most known model is the so-called SIR model, where the population, which is supposed to be large and homogeneous enough, is divided into three groups (Susceptible, Infected and Recovered), according to their status (see [4]). Strong simplifications are present in this model which can be applied as scale level; in some cases it could lead to poor results. For this reason, there is a variety of SIR based models which remove some of these simplifications in an attempt to be closer to reality. In this work, we suggest to add a new category to the standard SIR model in order to consider the fact that unfortunately, some infected people may die. The resulting model can be expressed as:

$$\frac{dS}{dt} = -\beta IS$$

$$\frac{dI}{dt} = \beta IS - \nu I - \delta I$$

$$\frac{dR}{dt} = \nu I$$

$$\frac{dD}{dt} = \delta I$$

This is a non-linear system of first order ODEs; the four categories used to classify the population are S = Susceptible, I = Infected, R = Recovered, D = Dead and they are expressed in percentage terms. For this reason the sum of all the categories has to be always equal to one. The parameters β, ν and δ are constants which determine the evolution of the disease. The results strongly depend on the numerical values of these parameters. Specifically the peak value of the infected and the week of the year when it will appear, which are important information to have in advance, can be really difficult to capture if there is not a rigorous estimation of the above mentioned parameters.

Obviously, it is mandatory to know the initial conditions before solving the system: in other words we have to know the number of susceptible, infected, recovered and dead persons at time zero, when we want to begin our simulation.

The solution of such equations is always done, excluding trivial cases, through numerical techniques which have been expressively defined to tackle this kind of problem. To

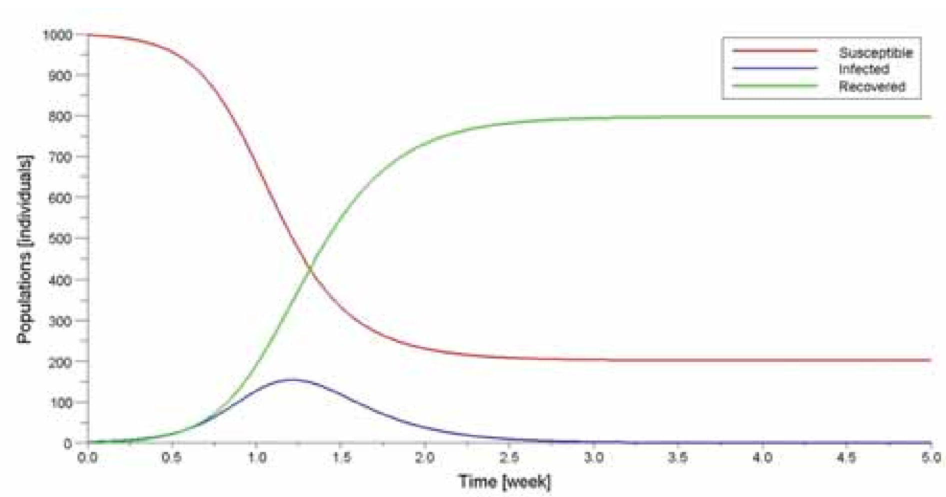


Figure 2: The solution of a classical SIR model: the three categories S, I and R are plotted versus time, expressed in weeks. It is clear that the disease has a peak between the first and the second week and that the maximum number of ill people is around 150 over 1000. In this case we adopted the following values for the parameters (β=10, ν=5 and the number of initial infected is 1.98 for 1000 persons).

Week of the year 2009	Number of Infected persons over 1000 $\hat{I}_{week}$	Number of total deaths in Italy (estimated population around 60.2 million) $\hat{D}_{week}$
43	4.28	n. a.
44	9.12	11
45	12.51	30
46	12.53	58

Table 1: The number of infected persons over 1000 (data source [2], November 15th) and the total deaths due to the swine flu (reported by the italian media) in Italy are reported in this table for some weeks of the year.

obtain reliable solutions, the numerical strategies have to consider the nature of the ODE to be solved; in general, ODEs can be really complicated and strongly nonlinear and the independent functions could have sharp variations within time.

For this reason, many techniques have been developed as it can be easily seen in literature (see [5] and [6] just to have an idea), to minimize the difference between the numerical and the theoretical solution.
The implementation of such techniques in general is not an easy task for many engineers and scientists who probably are more interested in obtaining a reliable solution for their problems rather than in spending time and money in compiling codes.

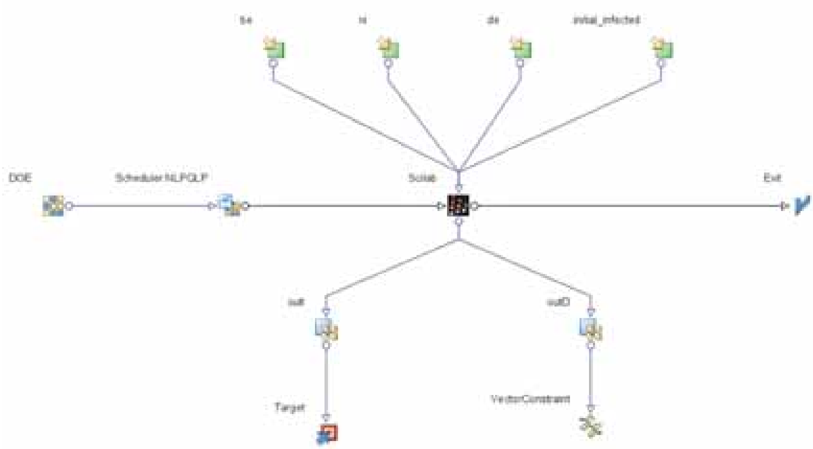


Figure 3: The modeFRONTIER workflow used for the model tuning problem.

To partially mitigate this situation, we use a general-purpose and open source platform, Scilab (see [2]) which provides the user with powerful numerical tools to manage different problems and to solve an ODEs system.
In Figure 2 the three categories S, I and R (these quantities are measured with reference to a population of 1000 persons) have been plotted versus time (expressed in weeks). In this case a classical SIR model has been solved: it can be easily seen that the number of infected persons amounts to a maximum of 150 out of 1000 and that it falls between the first and the second week. The model parameters (β=10, ν=5 and the number of initial infected is 1.98 for 1000 persons) have been chosen in this case without any reference to a real disease.
Unfortunately, the model parameters are not known in advance but, usually, they have to be estimated starting from some previously acquired knowledge on the evolution of the disease. Once these parameters have been estimated, it will be possible to predict the spread of the disease.
This is a typical model tuning problem which could be formulated, for example, as a least square problem. Actually, if we knew the number of infected persons and the deaths which can be ascribed to the flu during a given period, we could try to find out the values for the model parameters in order to best fit the known data. The result could give a better insight into the flu evolution, and the possible predicting of the peak of the infection and hence a better understanding of the general evolution of the disease.
To this aim we decided to use the data reported in Table 1, which are provided by the ISS (Istituto Superiore di Sanità) and collected by the author from different Italian media (see [2]). It is obvious that they are not numerous, but they are the only ones available at the end of the 46th week of the year (November 15th). However we would like to predict the swine flu evolution in Italy for the following weeks.

As mentioned above, our aim is now to find out the best values of β, ν and δ in such a way that our modified SIR model is able to best fit the data reported in Table 1. We are building the modeFRONTIER project drawn in Figure 3: the four input variables are represented by the four green nodes in the upper part while the output variables, the number of the infected and the deaths at different weeks, are extracted directly from Scilab through two output vectors (the blue nodes).
Among the many available strategies to adopt for the solution of this problem, we decided to use the following one, which has the desirable feature to lead to a mono-objective minimization problem.
We introduce a target node, involving the computed number of infected people, looking for the best fit:

$$target = min \sum_{week=42}^{46} \left(I_{week} - \hat{I}_{week}\right)^2$$

and a constraint node, involving the number of actual deaths:

$$C_{week} = \left(D_{week} - \hat{D}_{week}\right)^2 < 10^{-7} \quad \text{for} \quad week = 44, 45 \; and \; 46$$

For the solution of such a problem, usually, a Levenberg-Marquardt algorithm is recommended, in view of the nature

Algorithm	β	ν	δ (·10⁻⁵)	Initial infected over 1000	target	C_{44} (·10⁻⁸)	C_{45} (·10⁻⁸)	C_{46} (·10⁻⁸)
Levenberg-Marquardt	5.9999	5.0001	6.4441	0.00145	12.9094	$6.4493 \cdot 10^{-2}$	$1.5682 \cdot 10^{-1}$	9.9971
NLPQLP	5.9897	5.1027	4.9759	0.0020	0.2164	$7.7084 \cdot 10^{-2}$	$2.9615 \cdot 10^{-2}$	$4.0102 \cdot 10^{-1}$

Table 2: A comparison between the best solutions found with the two optimization algorithms adopted. It can be seen that the NLPQLP provides a better solution. C44, C45 and C46 represent the value of the constraint as defined in equation (2) expressed for the weeks 44, 45 and 46 respectively.

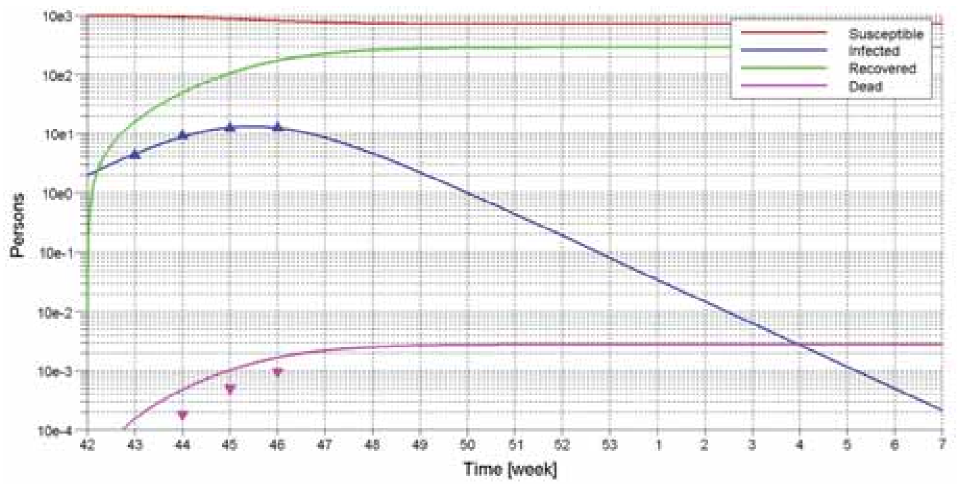


Figure 4: The evolution of the swine flu in Italy according to our modified SIR model. Note that the logarithmic scale has been adopted for the persons ages. It can be seen that the flu peak falls between the 45th and 46th week (blue curve)and that it concerns about 13.5 persons out of 1000. The flu should practically disappear before the new year. The triangles represent the fitted data, contained in Table 1: it immediately becomes clear that the death rate is slightly overestimated.

of the function to be minimized. It is well known, however, that this algorithm adopts a penalty oriented approach to manage constraints, which may not be the best in our case: we actually would like to have a very accurate fit also for the death rate, which is involved directly by the constraints.
The NLPQLP algorithm, which has a completely different approach in the constraint management, has also been tested: it can be seen (from Table 2) that it provides better results than the Levenberg-Marquardt algorithm.
The evolution of the flu is reported in Figure 4, as computed using the best fit parameters by NLPQLP. It is evident that the peak falls between the 45th and 46th week and it concerns about 13.5 persons out of 1000. Moreover, it points out that the flu should practically disappear before the new year. The mortality rate can be estimated by looking at the number of deaths after a long period (let us say after one year from the beginning): in our model this value amounts to 0.0028 out of 1000 persons, which means 0.03% (170 deaths in Italy approximately). This value appears to be very close to analogous quantities computed for other seasonal flues in the past, which usually range between 0.02% and 0.04%. Finally, it has to be mentioned that the deaths are slightly overestimated in our model.

However, if the reader visits the web site given in [2], he/she can read that the proposed data could be affected by slight variations, due to some delays in reporting by the surveillance network. Probably, the number of infected persons will not be exactly the same as those reported in Table 1, after November 15th. Hence knowing that the available data at the end of the 46th week may not be accurate, we would like to estimate how our previsions reported above, could change. In other words, we want to understand what is the error rate of our previsions, as the target data may be affected by slight variations.

Here, the first step certainly is to give a probabilistic characterization of the target values; we decided to use an exponential probability density function for each target value of the infected persons. This choice has been driven by the fact that the true values of the infected persons are certainly higher than those reported in Table 1; actually, they are expected to grow. In Table 3 the values of the location and the scale for the four exponential probability functions are collected.

These values have been arbitrary chosen (there is no information on the reliability of data we have) in such a way that values lesser than those reported in the last column of Table 3 have around 90% of probability to appear.

Five thousand simulations have been organized modifying the target values in accordance with the given probability density functions mentioned above and the corresponding peak position, peak intensity and mortality have been computed.

Week	Location	Scale	Around 90% of probability to have a target less than…
43	4.28	0.05	4.40
44	9.12	0.10	9.35
45	12.51	0.15	12.86
46	12.53	0.15	12.88

Table 3: The location and the scale parameters of the exponential probability functions used to characterize the target values of the infected people at different weeks.

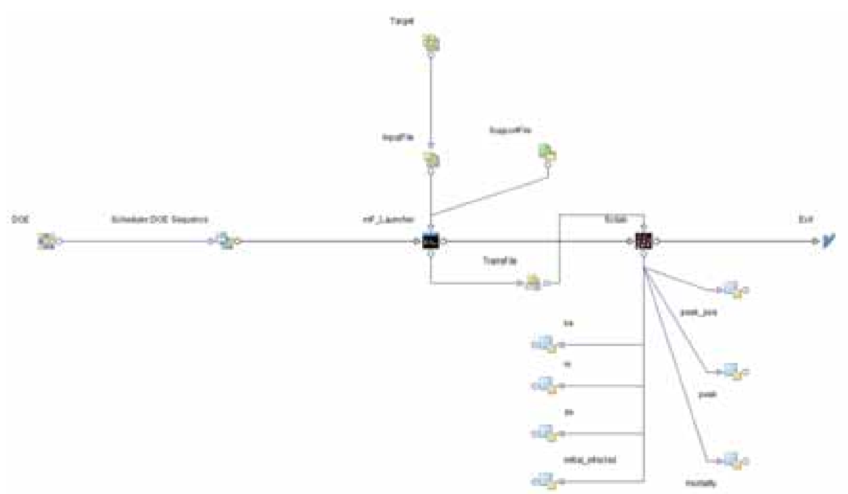


Figure 5: The modeFRONTIER workflow used for the solution of the sensitivity problem. A Latin-Hypercube technique has been used to generate a DOE in accordance with the probability density functions characterizing the targets. In the project shown in Figure 3, the model tuning problem is solved by modeFRONTIER with a batch call and a Scilab routine which are used to continuously extract the information about the disease.

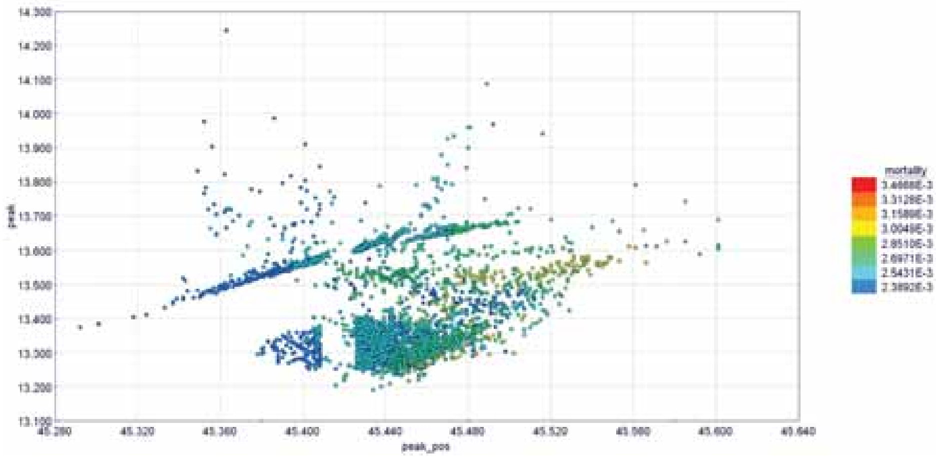


Figure 6: The peak is plotted versus the peak position. The bubble color is used to represent the mortality. The cloud of points summarizes the simulated scenarious. It can be easily seen that even the worst previsions in terms of peak and mortality rate have nothing in common with a pandemia or a catastrophic outbreak.

To launch these simulations a new modeFRONTIER project has been organized (see Figure 5): the Latin-Hypercube algorithm has been set up to plan an appropriate DOE and a batch call to the project described before has been applied in order to solve the model tuning problem. A Scilab routine finally extracts the results in correspondence with the best solution found.

In Figure 6 a bubble chart is shown: the peak value is plotted versus the peak position and the bubble color is used to represent the expected mortality. It can be easily seen that we obtain three ranges of existence; we can say that the peak position ranges between 45.29 and 45.60 weeks and that the peak ranges between 13.19 and 13.24 infected for one thousand inhabitants. The mortality rate never passes the 0.00347 over 1000 persons. It is interesting to observe that the resulting cloud of points is not uniformly nor homogeneously distributed, but it has important voids and regions with high densities.

To understand how the probability of the couple peak and peak position is distributed, we have built the diagram plotted in Figure 7. The cloud of points has been divided in a 20 x 20 cells regular array, and we have counted the number of designs inside each cell. These counts have been divided by the total number of computed designs obtaining the relative frequency, which can be reasonably associated with the probability. This plot allows to say that peaks of around 13.35 infected falling between the 45.43 and 45.44 week are the most probable ones. We can conclude that, even if considering uncertainties in the target values, it is possible to estimate the spread of the disease with a reasonable accuracy: it is certainly possible to exclude catastrophic scenarious even if few data are available. During the next weeks we will see if the model presented in this work has been able to correctly predict the spread of the swine flu or, on the contrary, if a terrible outbreak will happen. Let's hope for the best and be optimistic!

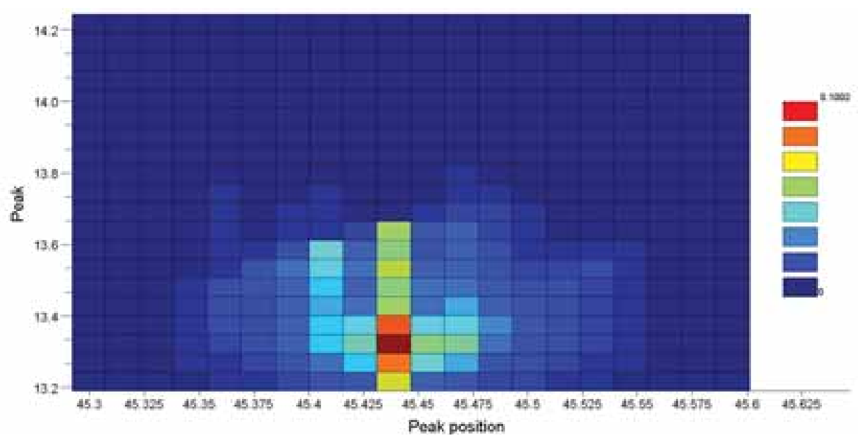


Figure 7: The frequency of the couples peak and peak position. The most probable scenarios are those characterized by a peak of around 13.35 infected falling around the 45.44 week of the year.

Conclusions

In this work we have shown how it is possible to model the natural spread of a disease, within a population, with relatively simple equations. If some observed or measured data are available it is possible to tune the model and predict the evolution of the disease with sufficient accuracy at macro scale.

The Scilab platform has been used to numerically solve the ODEs system and modeFRONTIER to tune the model and manage the uncertainties on available information. We would like to emphasize that the methodology adopted in this work can be used in the same way, also in other contexts, when a prevision is needed and experimental data are affected by errors.

References

[1] http://www.scilab.org/ to have more information on Scilab.
[2] http://www.iss.it/iflu/ to have more information on the italian sentinel surveillance. The data relative to the infected have been downloaded here.
[3] http://www.ministerosalute.it to have a complete description of the swine flu.
[4] http://www.wikipedia.com to have more information on the SIR model.
[5] P. Blanchard, R. L. Devaney, G. R. Hall, Differential Equations, (2006) Thomson Brooks/Cole, 3nd ed.
[6] K. S. Bhamra, O. R. Bala, Ordinary Differential Equations. An Introductory Treatment with Applications, (2003) Allied Publishers PVT. LTD.

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New trends in High Performance Computing

New hardware and software technologies can reduce costs and computational time very effectively. In order to have productive clusters, the right choice of operating system, computer hardware, interconnection and disk storage is crucial. Moreover, also deployment and support for computational software installation must be taken into account in order to have cost-effective solutions which will not become a nightmare for users and administrators.

Operationg system and queue system
Two worlds: Linux with Perceus project and Microsoft HPC Server 2008 are the leading edge technologies for developing a cluster solution.

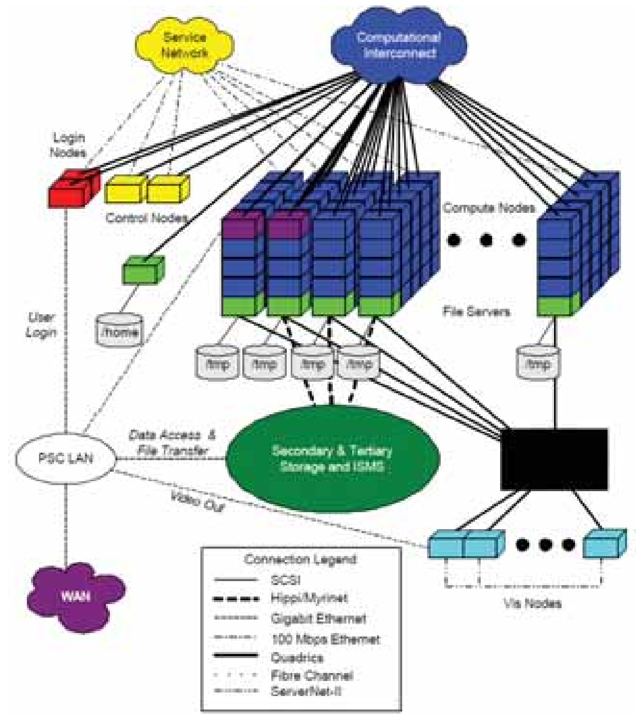
Perceus
Perceus is the next generation cluster and enterprise tool kit for the deployment, provisioning, and management of groups of servers. Employing the power of the Perceus OS and framework, the user can quickly suggest a machine out of the box. Perceus truly makes the computer a commodity, allowing an organization to manage large quantities of machines in a scalable fashion.
Perceus is developed and provided to the world under the GNU GPL by Infiscale.com.

HPC Server 2008
Windows HPC Server 2008 provides a productive, cost-effective, and high-performance computing (HPC) solution that runs on x64-bit hardware. Windows HPC Server 2008 can be deployed, managed, and extended using familiar tools and technologies. It enables broader adoption of HPC by providing a rich and integrated end-user experience, ranging from the desktop application to the clusters. A wide range of software vendors, in various verticals, have designed their applications to work seamlessly with Windows HPC Server 2008 so that users can submit and monitor jobs from within familiar applications avoiding to learn new or complex user interfaces.

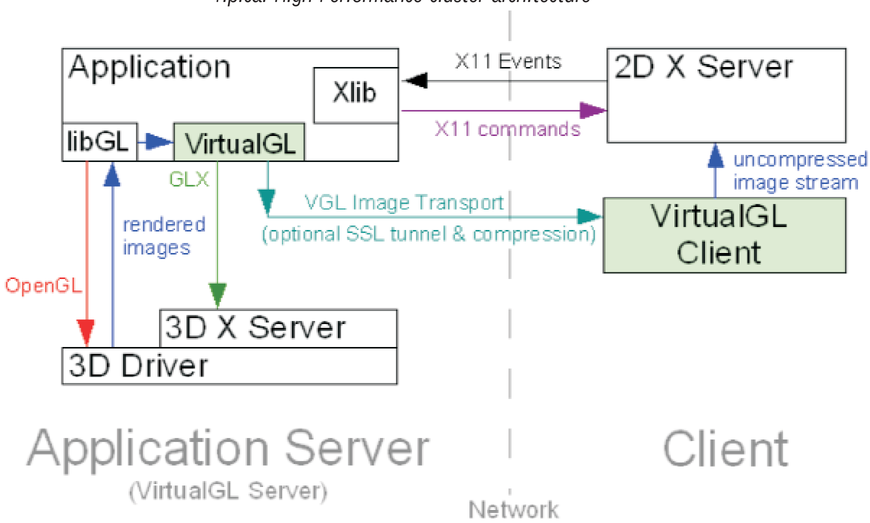
The queue system: the heart of a cluster
There are several points involved in a queue system:

HOSTS

- Master host – The master host is central to the overall cluster activity. The master host runs the master daemon sge_qmaster. This daemon controls all Grid Engine system scheduling and components, such as queues and jobs. The daemon maintains tables about the status of the components, user access permissions, etc. By default, the master host is also an administration host and a submit host.
- Execution hosts – Execution hosts are systems allowed to execute jobs. Therefore, queue instances are attached to the execution hosts. Execution hosts run the execution daemon.

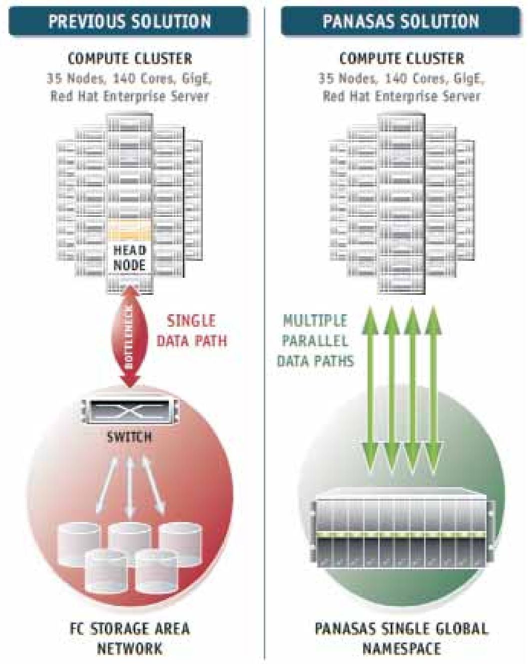


Tipical High Performance cluster architecture



When using the VGL Image Transport (formerly "Direct Mode"), the 3D rendering occurs on the application server, but the 2D rendering occurs on the client machine. VirtualGL compresses the rendered images from the 3D application and sends them as a video stream to the client, which decompresses and displays the video stream in real time.

- Administration hosts – Administration hosts are hosts allowed to carry out any kind of administrative activity for the Grid system.
- Submit hosts – Submit hosts enable users to submit and control batch jobs only. In particular, a user who is logged in to a submit host can submit jobs with the qsub command, can monitor the job status with the qstat command.



QUEUES

A queue is a container for a class of jobs allowed to run on one or more hosts concurrently. A queue determines certain job attributes, for example, whether the job can be migrated. Throughout its lifetime, a running job is associated with its queue. The association with a queue affects some of the things that can happen to a job. For example, if a queue is suspended, all jobs associated with that queue are also suspended. Jobs do not need to be submitted directly to a queue. If you submit a job to a specified queue, the job is bound to this queue. As a result, the Grid Engine system daemons are unable to select a better-suited device or a device that has a lighter load.

You only need to specify the requirement profile of the job. A profile might include requirements such as memory, operating system, available software, and so forth. The Grid Engine software automatically dispatches the job to a suitable queue and a suitable host with a light execution load.

A queue can reside on a single host or can extend among multiple hosts. For this reason, Grid Engine system queues are also referred to as cluster queues. Cluster queues enable users and administrators to work with a cluster of execution hosts by means of a single queue configuration. Each host that is attached to a cluster queue receives its own queue instance from the cluster queue.

License management

Most commercial software use FLEXLM (tm) license management system to distribute licenses. The combination of licensing system with queue system has become in the past months a serious matter for mass intensive optimization computation, as well for users and system administrators.

Available licenses are checked in only when the job has already entered the queue system, thus at that point is too late to deny a license because of no more licenses available.

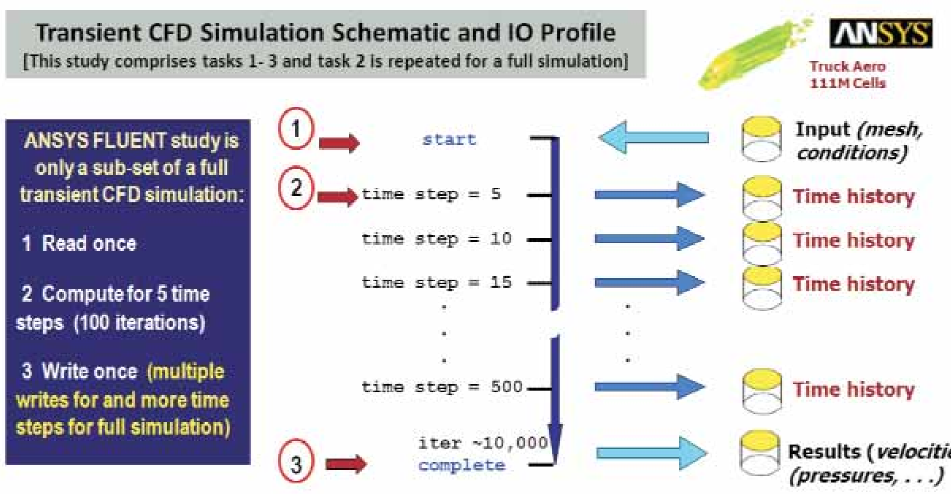
This is very disappointing for users coming back from weekend to find their optimization job basically not done over time, just because some other batch jobs where launced by other departments, or because network delays. The control of this situation needs a very deep understanding how queue systems work and interactions between all system components: customization must be well engineered to avoid interferences between the license manager and the cluster.

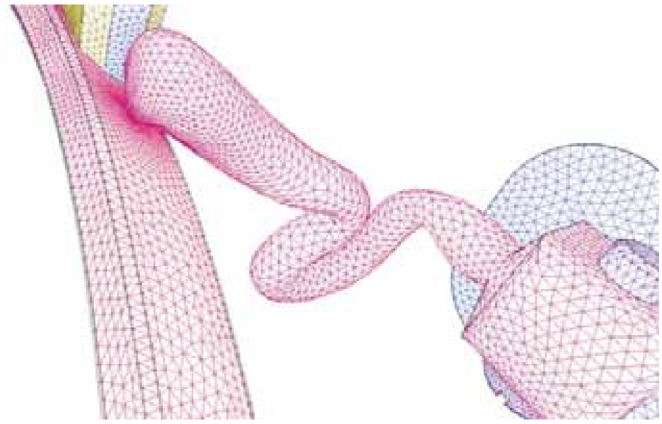
We develop lots of custom scripts for SunGridEngine (fully platform independent, portable to Microsoft cluster system) to solve this problem and to make queue jobs start at right time, allocating the right licenses and sub-licenses.

There will be a 0.1% of cases where this procedures will not work, spawning job at the wrong time, but this is a side effect of communication among daemons (queue, system,cluster etc..) that could not be taken away.

Parallel applications

The development of parallel programs requires integrated development environments along with the support for distributed computing standards. Visual Studio 2008 provides a comprehensive parallel programming environment for Windows HPC Server 2008. Besides supporting OpenMP, MPI, and Web Services, Windows HPC Server 2008 also supports third-party numerical library providers, performance optimizers, compilers, and a native parallel debugger for developing and troubleshooting parallel programs.





Large model with non-linear material and deformations example solved on a 64 nodes cluster system

Common bottleneck sources

As the CAE industry continues an aggressive platform migration from proprietary Unix servers to commodity HPC clusters, CAE models are becoming more realistic, too, requiring clusters to handle ever-increasing volumes of I/O and the movement of large files.

As organizations rapidly expand their cluster deployments, many encounter I/O bottlenecks when using legacy network attached storage (NAS) architectures.

Initially, these NAS systems offered advantages such as shared storage and simplified IT administration which reduced costs, but today a few of them provide the scalability required for effective I/O performance in parallel CAE simulations. Recently, a new class of shared parallel storage technology has developed to remove serial bottlenecks and to improve i/o performances, therefore extending the overall scalability of CAE simulations on clusters.

Parallel storage is the leading solution of parallel NAS and enables the most advanced and I/O demanding CAE challenges to become practical applications. Some examples include the high-fidelity transient CFD, large eddy simulation (LES), aerocoustics, large DOF structural dynamic response, parameterized non-deterministic CAE simulations for design optimization and the coupling of CAE disciplines such as fluid-structure interaction (FSI). CAE workflows are overburdened with lost productivity when engineers and scientists must wait for serial I/O operations and large file transfers to complete.

Furthermore, as simulation and workflow performance degrades, so does CAE analyst efficiency and effective workgroup collaboration. A parallel storage eliminates the I/O bottlenecks with a cost-saving solution that restores productivity and drives analyst creativity.

The benefits of parallel I/O for transient CFD were demonstrated with a production case of an ANSYS aerodynamics model of 111M cells, provided by an industrial truck vehicle manufacturer. Figure 2 below, illustrates the I/O schematic of the performance tests that were conducted, which comprised a case file read, a compute solve of 5 time steps with 100 iterations and a write of the data file. In a full transient simulation the solve and write tasks would be repeated to a much larger number of time steps and iterations, and with roughly the same amount of computational work for each of these repeatable tasks.

It is important to note that the performance of CFD solvers and the numerical operations are not affected by the choice of the file system, which only performs I/O operations. That is, a CFD solver will perform the same on a given cluster regardless of whether a parallel or serial NFS file system is used. The advantage of parallel I/O is best illustrated in a comparison of the computational profiles of each scheme. ANSYS CFD 12 on PanFS keeps the I/O percent of the total job time in the range of 3% at 64 cores to 8% at 256 cores, whereas 6.3 and NFS spend as much as 50% of the total job time in I/O.

Visualization and Postprocessing

Another relevant matter of large cluster is visualization and post-processing of results on relatively slow networks. An effective solution is performing 3D renders with openGL inside the cluster and giving the client the possibility of remote Display.

VirtualGL is an open source package which gives any Unix or Linux remote display software the ability to run OpenGL applications with full 3D hardware acceleration. Some remote display software, such as VNC, lacks the ability to run OpenGL applications at all.

Tipical cluster management system and visualization nodes

Other remote display software forces OpenGL applications to use a slow software-only OpenGL renderer, to the detriment of performance as well as compatibility. The traditional method of displaying OpenGL applications to a remote X server (indirect rendering) supports a 3D hardware acceleration, but this approach causes all of the OpenGL commands and 3D data to be sent over the network to be rendered on the client machine. This is not a tenable proposition unless the data is relatively small and static, unless the network is very fast and unless the OpenGL application is specifically tuned for a remote X-Windows environment.

With VirtualGL the OpenGL commands and 3D data are instead redirected to a 3D graphics accelerator on the application server and only the rendered 3D images are sent to the client machine. Thus VirtualGL "virtualizes" 3D graphics hardware allowing it to be placed in the "cold room" with compute and storage resources. VirtualGL also allows the 3D graphics hardware to be shared among multiple users and provides "workstation-like" levels of performance even on the most modest of networks. This makes it possible for large, noisy, hot 3D workstations to be replaced with laptops or even thinner clients. More importantly, however, it is the fact that VirtualGL eliminates the workstation and the network as barriers to the data size. Users can now visualize gigabytes and gigabytes of data in real time without needing to copy any of the data over the network or sitting in front of the machine that is rendering the data.
Usually, a Unix OpenGL application would send all of its drawing commands and data, both 2D and 3D, to an X-Windows server which may be located across the network from the application server. VirtualGL, however, employs a technique called "split rendering" to force the 3D commands from the application to go to a 3D graphics card in the application server. VGL performs this by pre-loading a dynamic shared object (DSO) into the application at run time. This DSO intercepts a handful of GLX, OpenGL, and X11 commands that are necessary to perform the split rendering. Whenever a window is created by the application, VirtualGL creates a corresponding 3D pixel buffer ("Pbuffer") on a 3D graphics card in the application server.
Whenever the application requests that an OpenGL rendering context have to be created for the window, VirtualGL intercepts the request and creates the context on the corresponding Pbuffer instead. Whenever the application swaps or flushes the drawing buffer to indicate that it has finished rendering a frame VirtualGL reads back the Pbuffer and sends the rendered 3D image to the client.

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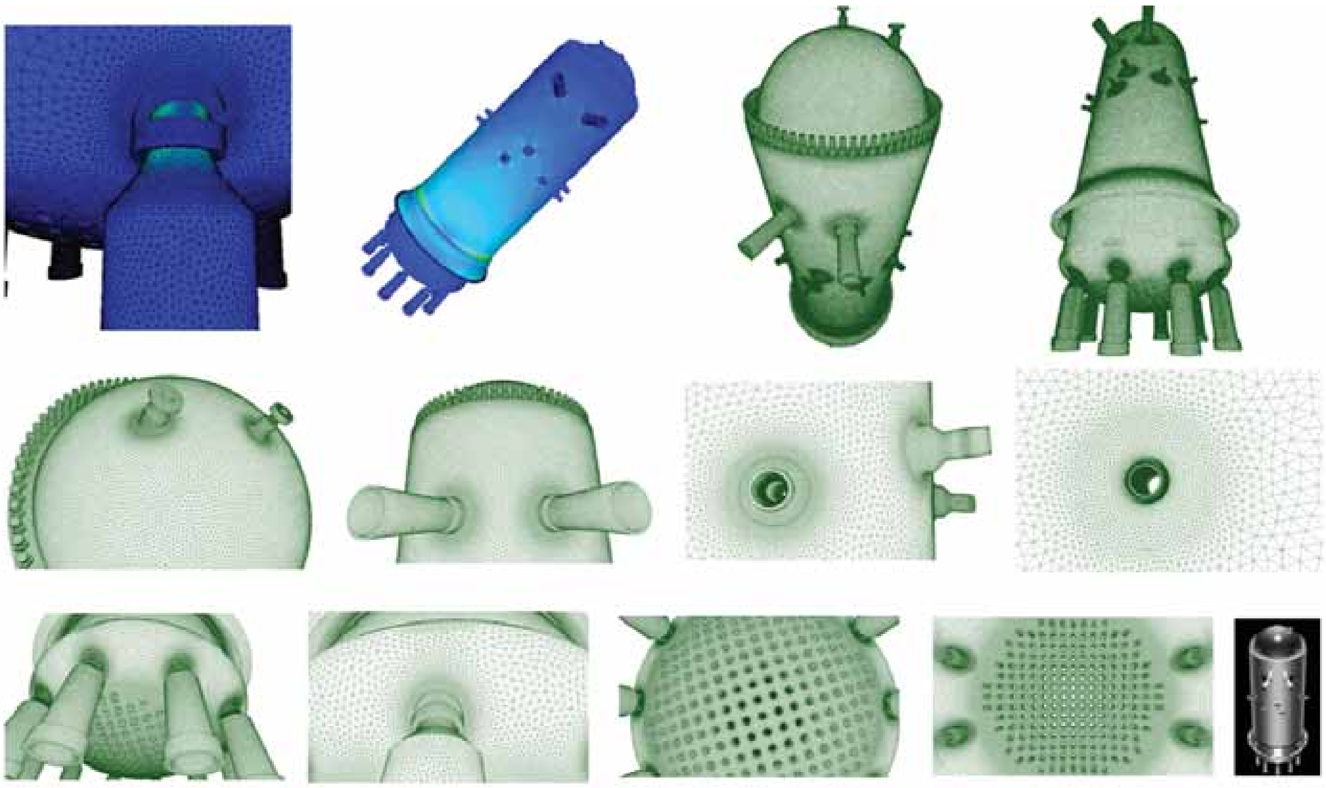
Enginsoft provides all ranges of HPC solutions: from ready to use systems to dedicated HPC setup for specific needs in the simulation market.
Enginsoft expertize ranges from system configuration, queue control, monitoring tools, licensing integration and etherogeneous systems building to maintain cluster efficiency along time.
Also integration with parallel file systems and remote graphic system is under continuous monitoring to provide our customers with the best of class solutions.



An example of a mesh generation for a reactor pressure vessel, 11 million nodes and 35 million DOFs.

Development of Digital Mechatronic Applications using Co-Simulation

The ever decreasing size and cost of embedded microcontrollers have brought digital electronic equipment to be used in almost every physical process or machine. In the real world, the software that runs on the microcontrollers actually implements the logic, the decision making and the control functionality of industrial processes, transportation systems, machine tools and electrical appliances in general. Moreover, the availability of low-cost sensors and actuators that provide a multitude of physical quantities in various fields to the electrical pins of a microcontroller, has made embedded electronics a crosswise pervasive ingredient to many engineering applications.

SimNumerica s.r.l. and his FE partner EnginSoft s.r.l. outline their approach to the virtual prototyping of systems where an embedded microcontroller controls a multiphysical process or a machine.

In this context, a computer program (usually written in C language) becomes effectively a component of the engineering application. Therefore, it must be designed, optimized and verified like any other physical component. Moreover, these engineering steps have to be performed taking into account also the fine scale interactions that this running software develops with the physical components. In fact, the validation of a system governed by microcontrollers cannot be approached without taking into consideration the embedded control firmware and, on the other hand, the validation of the firmware cannot be performed without considering its embedding physical system.

Therefore, the development of a digital mechatronics application is a tricky mixture of physical and abstract phenomena, since the physics of the software execution are mostly unobservable in a physical experiment. In a computer simulation, instead, the execution of the microcontroller software can be replicated exactly. Moreover, by adding a model for the simulation of the physical system (such as those commonly used in the FE-based design), a detailed evaluation of the interaction between the embedded software and the physical system becomes possible.

SimNumerica s.r.l. is targeted at the exploitation of muLab, the Microcontrolled Systems Simulation Laboratory, a prototype of which has been developed and widely tested at the University of Padua by a team of experts in numerical mathematics, electronics and software. muLab has been tested in a variety of pilot projects, which have already clearly demonstrated the advantages offered by muLab compared to general purpose platforms for the development of numerical algorithms and the hardware-in-the-loop approach.

muLab performs the co-simulation of the embedded software directly in the binary format which is executable by the microcontroller. In this way, the production software can be designed and tested well before the hardware prototype is available. Moreover, when the final product is available, a much larger set of functional tests can be performed in the co-simulation model, with respect to those feasible in a physical laboratory.

With muLab, firmware people and mechanical engineers become aware of their mutual responsibilities concerning the final performance of their design activity. This is important since, in principle, software components are not understandable to mechanical engineers and, vice versa, electronics engineers often are not adequately familiar with mechanical components.

FEA and muLab

Finite Element Analysis and the co-simulation implemented in muLab have the same DNA in common: they reveal the details of physical phenomena occurring at various space and time scales. In this way, they allow to observe the interactions between a software running on a microcontroller and its embedding physical system, with an approximation level decided by the user.

In the same digital mechatronics application, the time-scales involved may be quite distant from each other, e.g. firmware instructions are executed in microseconds or less, digital electronics signals present a milliseconds time base, kinematic/dynamic variables evolve in centesimal fractions of seconds and thermal variables evolve in several seconds.

For this reason, we use the term Computational Digital Mechatronics when we refer to this type of co-simulation. It inherits all the numerical engineering aspects of computational mechanics, plus:

- the co-simulation of a multiphysical engineering system and of the digital embedded hardware/software that interacts with this system;
- the numerical analysis of the algorithms implemented in the embedded microcontroller software (firmware), that runs within the numerical simulation model of the whole system.

muLab is a fundamental tool for a large variety of applications designed with FEA. Indeed, even in simple mechatronics applications, such as the temperature control of an air-conditioned railroad car (Figure 1), the algorithmic functionality implemented in a microcontroller may be quite complex. In general, it has to:

- read the temperature sensors and filter/compensate electrical disturbances and physical deficiencies of the sensor (nonlinearities, thermal inertia, condensed vapour, etc);
- infer the temperature at the user site; this is usually an indirect measurement, since the sensor can only be placed in hidden locations, which is performed by an algorithm that uses a numerical model of the process to predict the unknown quantity; the numerical model must typically have low computational cost and it is built by using emerging numerical methods in engineering, such as model order reduction, system identification, machine learning.
- implement the logical behaviour required by the machine design; this is usually a rather complex set of functions and procedures that covers machine initialization and configuration, manual or self-diagnosis, different operational modes, failure recognition and safe reaction, etc.

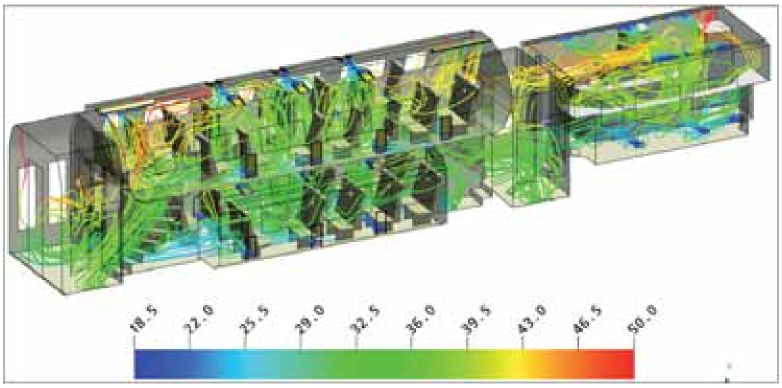


Figure 1

- control the actuators according to the specifications; this usually involves algorithms to safely operate, optimize and monitor the physical actions performed by actuators and related subsystems.

These algorithmic functionalities are easy to implement and verify in muLab, especially when they require the support of a numerical model. In particular, system identification and machine learning, which are based on the comparison between model predictions and experimental data, will be algorithmically supported explicitly in the near future.

MuLab: the software tool

The main feature of the software tool muLab is the simulation-based prototyping and validation of algorithms that should run on the microcontrollers embedded in a variety of digital mechatronics systems. The approach followed by muLab is hardware software co-design.
A main ingredient is the ability to monitor the functional

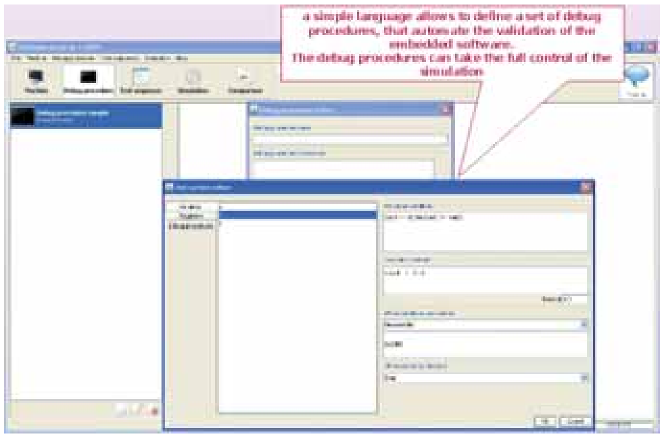


Figure 2

behaviour of the system up to the finest scale detail. To do this efficiently, muLab offers to the user the possibility to write a multi-level ensemble of debug procedures (Figure 2) that renders this monitor activity fully automatic during the simulation. This is very important because the user typically wants the computer to do hundreds of simulations during the night. The language used to write the debug procedures is a slight customization of the simplest programming languages actually used in computer programming.

Moreover, muLab is a collaborative design tool: the development of physical models becomes visible to the firmware designer and the firmware behaviour becomes visible to the mechanical engineer (Figure 3). As a consequence, the firmware development takes place in parallel with the hardware construction and fits to it.
At the same time, the physical system structure and organization can be cheaply modified until the expected performance appears to be adequate.

The environment includes also a source code debugger (Figure 4) that works both for the numerical models of the physical components and for the embedded software (firmware). The possibility to set a breakpoint during the simulation of a mechatronic system allows a deep understanding of the interactions between the firmware and its embedding physical system.

It allows the numerical analysis of algorithms that run on embedded microcontrollers, i.e. running in a non-sequential mode. This is usually much more difficult than it is for FE numerical methods. In fact, their execution is intrinsically non-sequential and may actually involve several subtasks executed by routines which are activated by interrupts caused by non-deterministic (and sometimes only loosely predictable) events.

Last but not least, muLab uses Standard and open languages and data formats:

- component model equations may be written in Python.
- model structures and user procedures are coded in XML.

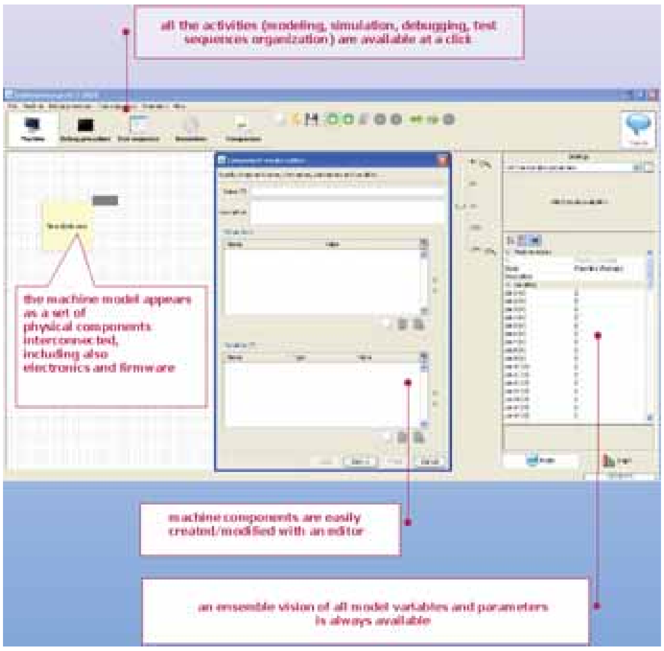


Figure 3

Advantages: reduced experimentation costs and development time
muLab enhances firmware debugging and simulation-based robust design. This is accomplished through the specification of detailed Test Sequences (Figure 5) by which the user can:

- specify complex test sequences;
- track and identify firmware fault conditions;
- Implement failure mode analysis (FMEA) of the hardware components.

The automation of test sequences allows the user to verify the application functionality in a large variety of situations, much larger than what is physically possible. Moreover,

- the experimental test phase can take place selectively and on a relatively mature firmware, where a large number of bugs has already been removed;
- the quality and value of the firmware verification procedure increases, while the debugging time decreases.

Thus, time, energy and money can be saved.
Practical issues concerning the multi-level debugging of the firmware:

- one advantage of the numerical simulation compared to a corresponding physical experiment is that the former is deterministic, and hence repeatable, while the latter is not;
- the methodology implemented in muLab supports a user-defined ensemble of debug procedures that monitor the numerical simulation: if something is suspect, a debug procedure can restart the simulation with increasing levels of diagnosis. In this way, following the diagnostic tree, the details of a wrong behaviour of the system can be traced at affordable time and computational cost.

Future Development
In a future release, additional parallel computing capabilities will be integrated in the software package. In particular, multi-core platforms and graphical processors (GPGPU) will be supported. The target is an efficient co-simulation of computational intensive models, such as large-scale dynamic FEM models, and of large firmware codes, in particular the ones involving the control of processes whose duration extends to relatively large time-scales. The combined use of multi-core CPUs and GPUs makes computational digital mechatronics affordable to small industrial engineering teams, even for quite complex applications.

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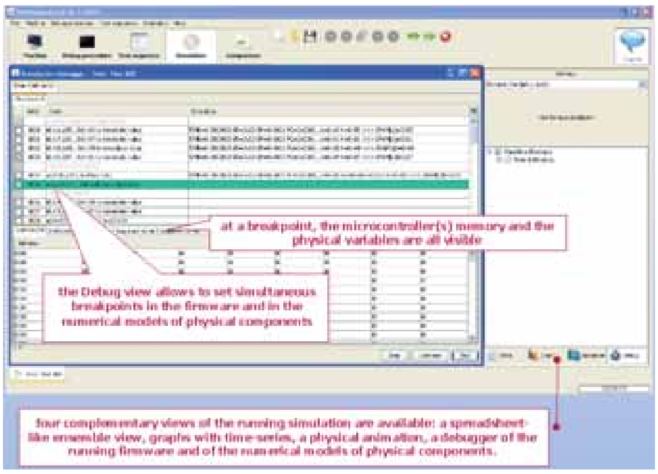


Figure 4

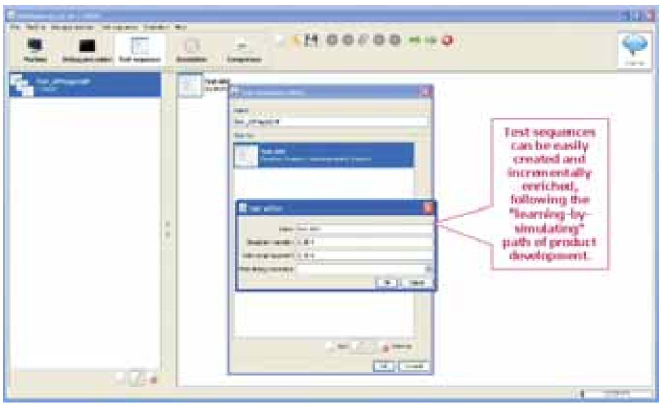


Figure 5

About SimNumerica and EnginSoft
SimNumerica was founded by a dedicated research team, all experts with broad experiences in numerical mathematics, electronics and software design, of University of Padua – Italy. SimNumerca's industrial partner and co-founder EnginSoft is an international CAE Computer-Aided Engineering Consulting company with unique multidisciplinary competencies in virtual prototyping.
SimNumerica's joint expertise is focused on environments for the virtual prototyping of mechatronics systems based on micro-controllers.

Innovation and EnginSoft in the USA

SUNNYVALE, California – December 10, 2009 - Stefano Odorizzi, CEO of EnginSoft, has recently returned from a trip to the USA and has reported that recruitment, sales, and expansion plans are moving forward rapidly.

EnginSoft CEO strengths connections with the US market

EnginSoft is continuously strengthening its connections and network in the US market. Stefano Odorizzi visited the United States in the last week of October to view and develop EnginSoft's local initiatives further. He met and interacted with several existing clients, and thus gained insights into how EnginSoft's services have benefited their business models.

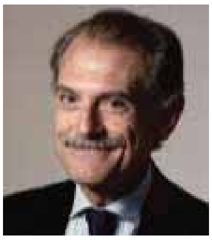
During his visit, Stefano wanted to discuss with US customers their visions for future product development, their concerns and existing alternatives to develop efficient working methodologies between clients and the EnginSoft teams. He managed to share EnginSoft's philosophy and business model with all the people he met during his short visit, and stated, "I am pleased to report that our initiatives in California are moving forward and that there has been an incredible amount of interest and enthusiasm shown by the local market. I had the pleasure of reviewing our operations and meeting with our management staff to discuss the next phases of our operations".

During this trip, Stefano met with some of the leading experts in the areas of Electronic Design Automation (EDA), Computational Fluid Dynamics (CFD), and Design Optimization. Stefano emphasized the positive results which could be achieved to date in the American market despite the tough economic situation. He visited some of the world's top academic institutions, namely University of California at Berkeley, University of Stanford, and the University of Santa Clara. These relations will support the company to further develop its future technologies and strategies. Stefano's visit was very successful and is a milestone inEnginSoft's road map. The outcomes will be incorporated in the company's partners' network and business sectors.

EnginSoft at UC Berkeley - Prof. Stefano Odorizzi meets with Prof. Alberto Sangiovanni Vincentelli

During his visit at the University of California at Berkeley, the EnginSoft CEO met with Professor Alberto Sangiovanni Vincentelli, a worldwide renowned expert and cofounder of Cadence and Synopsys.

The talk was a starting point for interaction and exchange of CAE, EDA, and VP knowledge, development and application results. The two experts shared their visions for the future of engineering simulation in industry with a very positive outlook for the upcoming years. With its highly innovative engineering and technology organization and network, EnginSoft wants to become an important player in the Global Computer Aided Engineering market fueling its growth also through close collaborations with top academic institutions.



Prof. Alberto Sangiovanni Vincentelli holds the Edgar L. and Harold H. Buttner Chair of Electrical Engineering and Computer Sciences at the University of California at Berkeley. Moreover, he is a co-founder of Cadence and Synopsys, the two leading companies in the area of Electronic Design Automation. He is the Chief Technology Adviser of Cadence, and a member of the Board of Directors of Cadence and the Chair of its Technology Committee, UPEK.

The University of California at Berkeley and its flagship campus were founded in 1868. Berkeley ranks first nationally in the number of graduate programs in their espective fields. Among its active faculty are 7 Nobel Laureates, 28 MacArthur Fellows, and 4 Pulitzer Prize winners. Today it is the world's premier public university and a wellspring of innovation.

EnginSoft special guest at the Business Association Italy America - BAIA

In this successful networking event organized by BAIA, Prof. Stefano Odorizzi presented and discussed the capabilities of leading edge technologies used to provide improved engineering designs across various innovative applications.

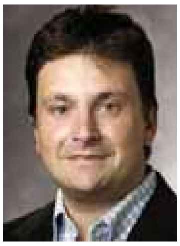
Stefano shared the key factors that have led to his success as an Italian entrepreneur building a US and Global business, as

well as the crucial role played by global partnerships with both companies and universities. This talk turned out to be a great opportunity to mix and mingle with young and seasoned professionals, entrepreneurs, students, and all the extended BAIA community, while enjoying Italian wine and delicious appetizers.
Stefano participated in an animated and dynamic roundtable discussion with students of the Fulbright BEST group pursuing the Certificate of the Technology Entrepreneurship program offered by the Center for Innovation & Entrepreneurship (CIE) of Santa Clara.

BAIA is an independent, nonprofit, open, apolitical business network that offers a place (physical and virtual) to facilitate the open exchange of knowledge and information, business opportunities, relationships and to promote a culture of innovation through entrepreneurial spirit and principles for Entrepreneurs, managers, professionals and interested individuals in the United States and in Italy. For more information, please visit http://www.baia-network.org/

EnginSoft at Stanford - Several Points in Common
Stefano also met with Prof. Gianluca Iaccarino of Stanford University. The meeting turned out to be a pleasant talk between two people who share an enthusiasm for innovation and excellence. EnginSoft and Stanford both act as laboratories for technology transfer to industry. They strongly invest in the next generation of engineering and technology experts, to foster their growth and dynamism, a perfect combination for a future collaboration. The obvious synergy between Stanford and EnginSoft will provide our customers with even more innovative solutions to meet industrial challenges, such as increasing quality and reducing project times.
EnginSoft provide access to a range of services related to the calculation and optimization of thermo-fluids, unmatched to date by any other European or American CAE company.
Prof. Iaccarino and Prof. Odorizzi discovered that they have a lot of interests and business objectives in common. A part from the high technological content of their meeting and talks, both are aware that great networking opportunities are indispensable to realize innovative visions.
Please stay tuned for upcoming news in the Newsletter Editions of 2010 and on www.enginsoft.com

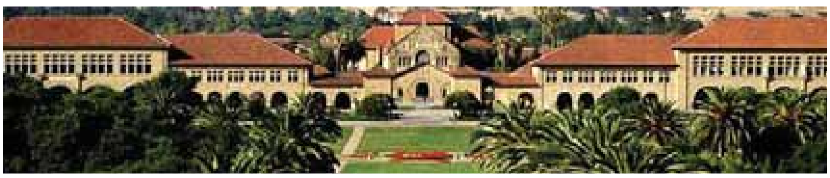
Stefano Odorizzi also met with Stanford Professor Bernard Widrow. In fact, the first statement of Professor Widrow was: "Optimization is everywhere," certainly a great start for a sparkling conversation! The two gurus exchanged ideas about the use of optimization techniques applied to human-like memory computers while enjoying tea. Prof. Widrow underlined its outstanding ability and talent for describing his most complex research at Stanford with simple words.
Silicon Valley represents a unique blend of knowledge, advanced research, remarkable
capital investments, and expertise. All this makes Silicon Valley an ideal and unique place to do business.



Prof. Gianluca Iaccarino is an Assistant Professor at the Mechanical Engineering Institute for Computational Mathematical Engineering at Stanford University with many years of experience in fluid dynamics, physical modeling and advanced computer simulations.

Prof. Bernard Widrow's research at Stanford focuses on adaptive signal processing, adaptive control systems, adaptive neural networks, human memory, and human-like memory for computers. He is the coinventor of the Widrow-Hoff Least mean squares filter (LMS) adaptive algorithm with the doctoral student Ted Hoff. The LMS algorithm led to the ADALINE and MADALINE artificial neural networks and to the back propagation technique. He has more than 21 patents under his name.

Stanford University is located between San Francisco and San Jose, in the heart of Silicon Valley, it is world-known for its multidisciplinary research within its schools and departments, as well as its independent laboratories, centers and institutes. There are currently more than 4,500 externally sponsored projects throughout the university, with a total budget for sponsored projects of $1.060 billion during 2008-09, including the SLAC National Linear Laboratory (SLAC).



BENIMPACT
Building's ENvironmental IMPACT evaluator & optimizer

BENIMPACT is a research project co-funded by the autonomous Province of Trento (Northern Italy) by means of the ERDF (European Regional Development Fund), whose priorities include research, innovation, environmental protection and risk prevention. The duration of the research activities is foreseen to be a couple of years.

BENIMPACT mainly aims at the development of methodologies (and of a related prototypical software platform) to support architects and engineers in the design of eco-sustainable buildings. The methodology shall be used to optimize the design of green buildings and will allow to identify the optimal trade-off between costs and environmental performances of the buildings.

The research activities will be carried out by EnginSoft and a bunch of authoritative partners: the Department of Civil and Environmental Engineering of the University of Trento, DTTNhabitech and the Trentino Institute for Social Housing.

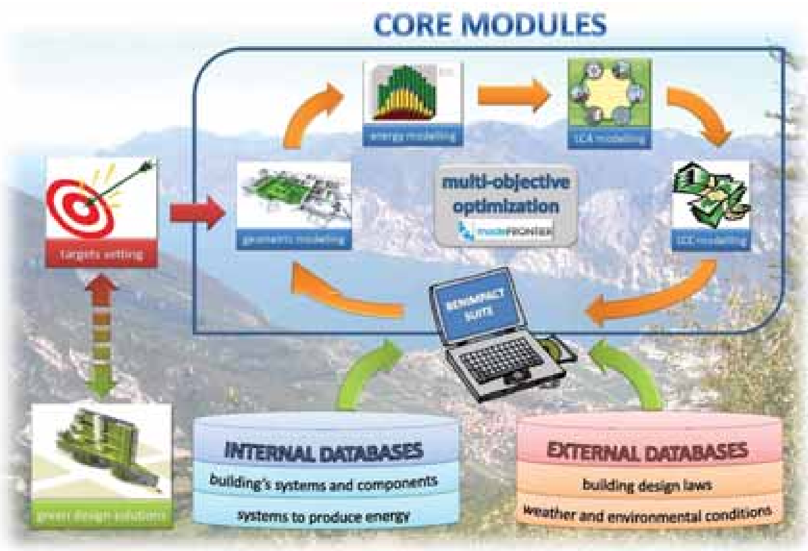
EnginSoft has carefully chosen the partners on the basis of their specific knowledge and their contribution to the research activities: the University of Trento will share its long-time experiences related to energy modeling tools and methodologies; DTTN-habitech, a consortium of more than 300 companies operating in the green-building trade, will supply the required linkage with the market and their deep knowledge in green building rating tools (such as LEED, Green Star, BREEAM, etc.). The Trentino Institute for Social Housing, the public organization of the Province of Trento that manages and develops public residential housing projects, will bring to the project group also the views of today's building designers.

The design methodology which will be defined during BENIMPACT, will allow to carry out an integrated building design process: all the steps required to achieve the design of a green building will be contemporary realized by means of a bunch of analysis tools reciprocally integrated into each other. This approach will significantly innovate traditional ones: in fact, nowadays, each different building design topic is completed independently by different professionals and in different design stages, thus leading to the definition of the building design parameters by means of subsequent steps and to buildings that are not optimal in relation to all the required objectives.

However, now with BENIMPACT, the use of the advanced modeFRONTIER technology will allow to build a suite of integrated applications (the BENIMPACT suite), that interact in a typical design chain process. Figure 1 shows the foreseen architecture of the design suite that will be implemented (in a prototypical release) in BENIMPACT. The shown architecture foresees the cooperation of core modules, databases and service modules (green design solutions and targets setting modules).

In particular, the core modules are the embedded applications of the suite in charge of carrying out the whole calculations and analyses. The multi-objective optimization module is actually the kernel of the whole suite: thanks to the modeFRONTIER functionalities, it will lead the search for the optimal design features of the building, supplying a design environment where all the other applications are integrated.

The geometric modeling module will translate the geometry of the building into a parametric model, able to store information related both to the building shape and materials, components and systems that will constitute the building construction. The energy modeling module will evaluate the energetic consumption of the designed building, taking into account the thermal loads required in order to guarantee predefined indoor comfort levels. The LCA (Life Cycle Assessment) modeling module will calculate the environmental



impact of the building during its entire life, and hence also consider the impacts that arise from resources extraction, manufacturing, on-site construction, occupancy/maintenance, demolition and recycling/reuse/disposal. The LCC (Life Cycle Costing) modeling module will evaluate the costs of the building, totaling up in a unique value the complete costs for the building construction, its maintenance, occupancy (i.e. the costs for energy consumption) and demolition.

It is important to note that all the core modules will be software applications (customized or implemented by means of ad-hoc written codes) that will work also in a stand-alone modality in order to allow the validation of each single application. Furthermore, it is possible that, for some particular applications, such as energy modeling, some existing codes will offer the required functionalities: In such cases, freeware tools and open-source codes will be preferred to commercial ones, in order to allow further implementations and improvements by the whole community of practice.

The databases included in the BENIMPACT suite will supply the required input data to all the applications involved. They will store data related to the systems and components of the building constructions and to the energy production systems normally used in buildings (such as boilers, solar and photovoltaic panels, geothermal heat exchangers, etc.). They will also supply technical constraints, derived by the current building laws, and the required meteorological data.

The service modules' green design solutions and target settings will supply border information to the analysis: the former, operating as an expert system, will suggest solutions for the green building design (such as green roofs, natural ventilation, externally ventilated façade, etc.), while the latter will translate, in an engineering format, the design objectives set by the user (for example, the design objective of low energy consumption should be translated, for the sake of the numerical analysis, into a defined value of Watts required per square meter of the building).

EnginSoft strongly believes that the activities which will be carried out in the framework of the BENIMPACT research project will bring benefits to the building trade, thanks to the tuning of brand-new CAE tools that will eventually improve the green building design. Moreover, BENIMPACT will help to protect the environment, it will allow and promote the diffusion of eco-sustainable buildings based on the definition, during the design phase, of the building features that guarantee low-environmental impacts and, at the same time, low life-cycle costs of the building. Last but not least, EnginSoft itself will take advantage of the BENIMPACT research activities: enhancing its knowledge related to green building techniques, the company will be able to expand its market to this emerging sector, offering its engineering consultancy services, specific software and educational program to new clients in in the eco-sustainable business, that seems to be thriving and not suffer from economic downturns.

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EnginSoft al METEF2010

Anche quest'anno EnginSoft prenderà parte alla Metef-Foundeq, l'ottava edizione dell'expo internazionale di riferimento dell'alluminio e dei metalli tecnologici in parallelo a Foundeq Europe expo internazionale degli impianti, attrezzature e prodotti della fonderia metalli. La manifestazione con cadenza biennale, a cui EnginSoft ha sempre partecipato, è in programma al Centro Fiera del Garda, a Montichiari, in provincia di Brescia, dal 14 al 17 aprile 2010.

EnginSoft presenzierà all'evento con uno proprio stand all'interno dell'area fieristica. In questa edizione verranno presentate le nuove releases di MAGMA, FORGE e ADVANTEDGE.

Nella scorsa edizione, nel 2008, la fiera ha registrato la presenza di 568 aziende espositrici (di cui 396 italiane e 172 estere), inoltre la cifra dei visitatori, provenienti sia dall'Italia che dall'estero, ha raggiunto quasi quota 19000.

Si preannuncia quindi un evento di grande successo, arricchito da interessanti appuntamenti quali:

- una tavola rotonda a cura del Comitato Laminazione nella prima giornata denominata: "Il futuro della laminazione dopo la crisi: l'innovazione come chiave per vincere le sfide del mercato",
- la presentazione del nuovo "Manuale di difettologia" intitolato "Difettologia dei presso colati" organizzato da AIM – Associazione Italiana di Metallurgia, Centro Studi Pressocolata
- la presentazione dei risultati del progetto europeo NADIA "New Automotive components Designed for a manufactured by Intelligent processing of light Alloys" coordinato da EnginSoft
- una conferenza internazionale organizzata da ITmetal.it e da CSMT Centro Servizi Multisettoriale e Tecnologico intitolata "ICT e settore dell'alluminio: quali formule per il successo".

Sito della manifestazione: www.metef.com

Continuing Higher Education on CAE: The TCN Consortium

Born in 2001, TCN Consortium is a private Italian company which organizes higher education activities in the engineering and CAE (Computer-Aided Engineering) fields.

The specific objective of TCN is to train the key resources, that ensure competitiveness to companies in each technological sectors fundamental to process and product innovation. The TCN motto – "training innovation leader" - embodies this objective.

The TCN Consortium has been working for many years in a professional and reliable way; moreover, it supports the entrepreneurship and the training managers in projecting and distributing customized training trails. The TCN efficient and agile approach is based on surveying enterprises' real educational needs to be converted into customized training trails: TCN Faculty, teamed by professors in Italian and foreign Universities together with experienced researchers and engineers, represents the key to achieve this goal.

TCN helps the enterprises to face the innovation challenges, enabling them to face an ever-changing industrial and technological landscape, transferring the necessary knowledge to create highly qualified human resources, that will immediately work in the industrial environment.

TCN Consortium offers courses from the catalogue and on-demand courses for entrepreneurship. In particular, TCN offers:

- Short Courses (1 to 5 days)
- MiniMaster (intensive training over two non-consecutive weeks)
- On-demand training via the Internet
- Publishing of manuals for the industry (TCN SBE&S Series)

TCN maintains a strong European and international identity: every two years it organizes "TCN CAE International Conference on Simulation Based Engineering and Sciences", an international conference based on the CAE technologies in the industry. Furthermore, TCN takes actively part in Europe to pilot projects aimed at designing innovative higher education contents and training trails for the industry.

On the website www.consorziotcn.it it is possible to consult the up-to-date TCN courses catalogue for the 2010, which is constantly enlarged and updated on the entrepreneurs demand. Nevertheless, this is just a general view of the TCN training offer.

For further information and requests, please contact:
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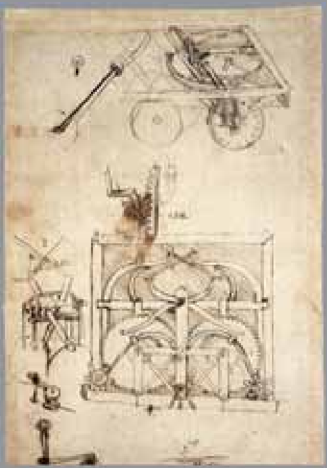
Analizzare cinematica e dinamica dei meccanismi con le tecniche multibody: terminologia, ambiti di applicazione ed opportunità



Automobile di Leonardo da Vinci (Codice Atlantico, f. 812r del 1478)

Le scuole di progettazione più tradizionali portano a considerare con maggior frequenza problematiche di tipo strutturale (incluse fatica ed acustica), fluidodinamico, o di processo. Gli strumenti di simulazione numerica offrono, in tutti questi ambiti, un aiuto formidabile ed efficace, ben noto alla grande maggioranza degli utenti che hanno una cultura ingegneristica moderna orientata all'efficienza.

La progettazione meccanica è tuttavia un contesto dove possono diventare decisivi i fattori non analizzabili dalle suddette branche della simulazione. Si pensi, per esempio, alle caratteristiche di **guidabilità** di un veicolo, alla **stabilità** di una lavatrice, alla **precisione** di un cambio da bicicletta, per restare su applicazioni che riguardano la quotidianità. Allo stesso modo potremmo citare la **velocità** delle macchine per la produzione e la lavorazione su larga scala di qualsiasi prodotto "consumer" (per esempio tessile, carta, alimentari, semilavorati), senza dimenticare i complessi **sincronismi** nascosti all'interno di qualsiasi mezzo di trasporto (per esempio auto, treni, aerei).
Tutte queste applicazioni sono accomunate da **requisiti e prestazioni che non sono esclusivamente di tipo strutturale.** La disciplina che fornisce questo tipo di risposte è la meccanica applicata, che studia la cinematica e la dinamica di sistemi di corpi variamente interconnessi. **Cinematica** e **Dinamica** sono termini di uso comune, ma sono spesso utilizzati in modo poco corretto. Senza addentrarci in eccessivi formalismi, precisiamo che l'analisi cinematica determina il modo in cui si muovono i corpi di un sistema (posizioni, velocità, accelerazioni) in relazione agli azionamenti (motori, camme) e ai vincoli. Viceversa, l'analisi dinamica determina le forze e le coppie che sono causa e/o effetto del movimento. In alcuni problemi è sufficiente limitare lo studio alla parte cinematica (ad esempio per la verifica di sincronismi e/o di possibili interferenze), mentre nei casi più generali è necessario completare le indagini con la determinazione delle forze in gioco (ad es. per trasmetterle allo strutturista o per scegliere componenti da catalogo).

Gli strumenti di simulazione adatti a condurre queste particolari analisi sono i cosiddetti **software multibody.** All'interno di un ambiente multibody l'utente assembla virtualmente il sistema meccanico e procede con l'analisi della risposta nel dominio del tempo e/o delle frequenze. I codici commerciali offrono la possibilità di interagire direttamente con le geometrie CAD, a vantaggio dei tempi di modellazione e della qualità di visualizzazione. Per applicazioni di nicchia e per scopi di ricerca si utilizzano, tuttavia, efficacemente anche approcci prettamente analitici, con i quali il modello viene definito attraverso scrittura diretta delle equazioni di moto.
Indipendentemente dallo strumento utilizzato, il passaggio fondamentale per giungere a risultati corretti ed affidabili nella simulazione multibody è rappresentato dalla fase di "virtualizzazione" del modello fisico. Con "virtualizzazione" si intende l'approssimazione di un sistema meccanico reale (infinitamente complesso), con una collezione di oggetti numerici pensati per riprodurne moto e proprietà.
La schematizzazione virtuale può avvenire in modo più o meno raffinato, con conseguenze dirette sull'efficacia della simulazione. È compito del modellista scegliere le dimensioni, il grado di complessità e i dettagli del modello che vuole creare, considerando simultaneamente gli obiettivi da raggiungere, onere computazionale e il tempo a disposizione. Il miglior modello non è quello più dettagliato, ma quello che risponde in modo più veloce ed esauriente alle esigenze. Questa regola, che vale in generale per tutte le dimensioni del CAE, assume un ruolo decisivo nella **simulazione multibody**. Per queste ragioni è indispensabile provvedere ad una formazione teorico-pratica specifica per l'analista meccanico.
EnginSoft propone un corso di **modellistica multibody** della durata di 2 giorni (2-3 Febbraio 2010, sede di Padova), rivolto a tutti i progettisti che affrontano problemi di cinematica e dinamica. Il corso è pensato e strutturato in modo da trasmettere in tempi brevi le nozioni per poter poi in seguito intraprendere le scelte per la modellazione multibody. Il corso sarà tenuto dal prof. Roberto Lot dell'Università di Padova in collaborazione con l'ing. Fabiano Maggio di EnginSoft.

Per informazioni sui contenuti consultare il sito del consorzio TCN www.consorziotcn.it
Per iscrizioni e informazioni generali consultare la sig.ra Mirella Prestini della segreteria del consorzio.
E-mail: info@consorziotcn.it - Tel: +39 035 368711

Interview with Mr Sakae Morita, General Manager, Marketing and Mr Kentaro Fukuta of ELYSIUM Co., Ltd. Japan

What are your impressions of the EnginSoft International Conference 2009?
Mr. Morita: Indeed, we brought back many new discoveries from our first participation in the EnginSoft Conference. It has been particularly interesting to see that there are many joint efforts and activities between industry and the academia and that lots of successes are actually linked to these collaborations. Although we can see similar efforts in Japan, there is still a huge gap between industry and the universities. The attitude and openness in Italy and in the surrounding countries in Europe seem to be very good.

Mr.Fukuta: Our time at the Conference in Bergamo was an extremely significant experience, more than I had anticipated before our trip to Europe. Much to our surprise, we met many participants from all over the world. This is one of the differences compared to CAE conferences in Japan. It's great to have the opportunity to actively exchange technical information between organizations from different countries.

Mr.Morita: From Professor Stefano Odorizzi's keynote speech and my personal conversation with him, I was particularly impressed by the fact that EnginSoft is expanding its business not only in Italy but also internationally and this in harsh economic times. At Elysium, we are keen to establish a longterm relationship with EnginSoft.

Elysium Booth in the exhibition area

Apart from the Conference, did you have time to explore Italy a bit?
Mr.Morita: Luckily, we had enough time to stroll around in the old city of Bergamo and in Milan after the conference. What really moved me is the deep history and the beautiful harmony between the past and modernity. These are memories I brought back from looking at the old architectures and from our visits to some museums.

Bergamo's medieval Città Alta - Impressions photographed by Mr. Morita / Mr Fukuta in October 2009

Mr.Fukuta: I will remember my first visit to Italy for a long time to come. I was fascinated by the beautiful landscape of Bergamo and the wonderful dinner we have enjoyed in a restaurant on one of the surrounding hills of the city.

Would you say that your presence, also as an exhibitor, at the Conference was effective?
Mr.Morita: Certainly yes. There were quite a few positive discussions about our products and we could generate some leads for our future business in Europe. I am really grateful to Ms. Barbara Leichtenstern for her deep considerations and to everybody at EnginSoft.

Mr.Fukuta: Thank you for all your support and for giving us such a good opportunity to meet the people of EnginSoft and the audience of the International Conference.

This interview was conducted by Ms Akiko Kondoh
Consultant for EnginSoft in Japan

New Year Greetings from Japan

with best wishes from Akiko Kondoh

It has been a great pleasure to launch the Japan Column in 2009. Sometimes inspiration is needed for product design and manufacturing. The same is true for CAE. I hope that the new encounter in the EnginSoft Newsletter, between Japanese and European (CAE) cultures, creates inspiration and motivation for 2010.

In the New Year, Shogatsu is generally celebrated on the first 3 days of January. In Japan, this is the most important period to spend with family. Osechi-ryori are special side dishes which we enjoy on the first 3 days of the year. Osechi-ryori consist of traditional ingredients in Japanese cuisine, all of them have special meanings. For example, sea bream (tai) should bring luck (medetai), herring roe (kazunoko) sends out "a wish for prosperity to our descendants", and sea tangle roll (kobumaki) means "happiness" (yorokobu).

This Osechi-ryori are arranged on the Urushi, a Japanese lacquer tiered box. Urushi is the coating material made from refined and processed lacquer tree sap. Urushi has been used for the last thousands of years. Indeed, Japanese lacquering techniques had improved rapidly at a time more than 1500 years ago. The black shining Urushi became a traditional craft and nowadays it is widely used for tableware, fine furniture and musical instruments. Urushi is resistant to humidity, heat, acid and alkali, but becomes depleted under extreme ultraviolet irradiation or desiccation. This is why Urushi was not much used for industrial products in the past. However, in recent years, Urushi has attracted people's attention not only in Japan but around the world because of its unique glazing style and excellent characteristics. Today, Urushi is applied to brand new areas of MONODUKURI*, for example for the interior of cars and airplanes and the exterior of various electrical products by combining Urushi material characteristics and specific lacquering techniques.

**MONODUKURI: Japanese for manufacturing and Japan's spirit for excellence in manufacturing*

modeFRONTIER at the 2009 MADYMO Users Meeting in Melbourne

EnginSoft's partner in Australia, ADVEA Engineering, hosted their semi-annual event "The 2009 MADYMO Users Meeting" in Melbourne, Australia on the 23rd & 24th of November.
The event attracted a wide-range of engineers from the Asia Pacific region with a focus on automotive active/passive safety, biomechanics, pedestrian safety and DOE/optimization.

Maciej Mazur, a University Student at the School of Aerospace, Mechanical and Manufacturing Engineering at RMIT, The Royal Melbourne Institute of Technology, one of Australia's original and leading educational institutions, presented a DOE and an optimization study of a cast-aluminium servo motor housing.
In his presentation, Maciej detailed how he coupled successfully modeFRONTIER with Catia and Abaqus for Catia to optimize the housing for weight and stiffness.

For more information about this presentation and about modeFRONTIER and CAE in Australia, feel free to contact Mr. Ryan Adams, email: radams@advea.com, Manager ADVEA Engineering. www.advea.com

Optimization Training Star-CCM+ AND modeFRONTIER in Göteborg, February 23

In cooperation with CD-adapco and FS Dynamics, EnginSoft Nordic will present a one-day hands-on training on optimization with modeFRONTIER and Star-CCM+. This training, to be held in Göteborg on February 23rd 2010, will teach how to automate and perform scripting of Star-CCM+ analyses, and how to setup an optimization together with modeFRONTIER. After an introduction and demonstration, training participants will be given a complete workshop to work through on their own. As such, they are expected to bring a laptop with Star-CCM+ for the exercises. After the workshop, the training will conclude with a discussion and a Q&A session.

For more information, please contact Adam Thorp
at info@enginsoft.se or visit http://nordic.enginsoft.com

Il mondo della forgiatura a stampi aperti, della laminazione piana e circolare, si è dato appuntamento a Padova per fare il punto sulle tecniche più avanzate di ottimizzazione di processo/prodotto.

Grande successo per il pomeriggio tecnologico - Forgiatura, Laminazione a Caldo di Prodotti Lunghi e Laminazione Circolare: Simulazione dei Processi: Nuovi Sviluppi, Vantaggi e Prospettive – organizzato il 24 giugno a Padova da EnginSoft, con la presenza di AFV Beltrame, Hydromec, FICEP e DIMEG – Università di Padova.

Dopo il successo dei primi due appuntamenti di Lecco, il 3 aprile, dedicato allo stampaggio a caldo di acciaio, e di Bergamo, il 7 maggio, dedicato allo stampaggio a caldo di non ferrosi (ottone ed alluminio), EnginSoft ha voluto dedicare un pomeriggio al mondo della forgiatura a stampi aperti, della laminazione di prodotti lunghi e della laminazione circolare.

L'invito è stato accolto da quasi una cinquantina di rappresentanti delle aziende più importanti in Italia che si occupano di trasformazione di acciaio a stampi aperti o per laminazione, desiderosi di conoscere le più avanzate tecniche di ottimizzazione di processo e prodotto.

A fare gli onori di casa è stato Piero Parona, Sales Manager di EnginSoft, con una descrizione delle molteplici attività di EnginSoft nel campo della prototipazione virtuale e della strategicità dell'uso di queste tecniche nell'ottica di riduzione dei costi.

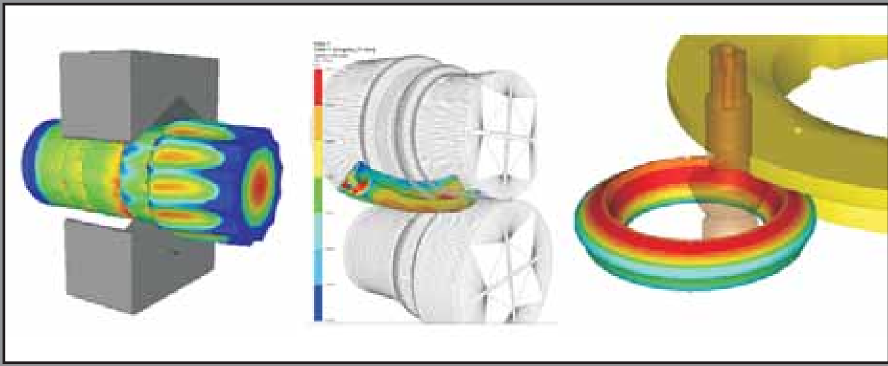
Si è entrati quindi nel vivo dell'argomento con gli interventi dell'ing. Marcello Gabrielli, sempre di EnginSoft, che hanno riguardato le tecniche di simulazione numerica dei processi di stampaggio a stampi aperti e laminazione con il software Forge di Transvalor. A partire da una analisi del modo attuale di progettare le sequenze di stampaggio, si è costruito un percorso innovativo dove, grazie alla simulazione applicata ad esempi reali su particolari noti ai presenti, si sono evidenziati tutti i vantaggi concreti ottenibili. Le recenti modifiche apportate al software grazie ad EnginSoft ed agli utilizzatori italiani, consentono ora di simulare per lo stampaggio a stampi aperti cicli anche molto complessi, con rotazioni relative di pezzo e\o mazze. Sono stati mostrati esempi concreti di forgiatura, ricalcatura in chiodaia e con mazze, blumatura, compattazione, sbozzatura, segnatura, bigornatura, evidenziando per ciascuno di essi i risultati più significativi forniti dall'approccio virtuale. Per un caso di riscaldo di un lingotto poligonale è stato mostrato un approccio di ottimizzazione, ottenuto mediante l'integrazione con modeFRONTIER, che ha consentito un risparmio di 4 ore di permanenza in forno, garantendo comunque il riscaldo a cuore del lingotto. Altrettanto significativi i risultati ottenuti grazie alla simulazione del processo di tempra, in termini di previsione delle fasi, durezza e distorsioni.

L'ing. Carlo Contri di Hydromec (www.hydromec.it) ha quindi mostrato le novità dei propri impianti per la forgiatura e la laminazione circolare, sottolineando come grazie a Forge, utilizzato attraverso la collaborazione con EnginSoft, per alcuni propri clienti, è stato fornito un servizio di co-design che ha consentito sia di valutare a priori se una macchina è in grado di produrre un certo particolare, sia di ridurre significativamente i sovrametalli, fornendo quindi un servizio "chiavi in mano" ai propri clienti.

L'ing. Stefano Fongaro di FICEP (www.ficep.it) ha quindi mostrato come ha affrontato e risolto il problema del taglio delle barre mediante nuove segatrici ad alta velocità per barre fino a 800mm di diametro.

Ritornando a tematiche relative alla simulazione di processo, la parte relativa alla simulazione della laminazione di prodotti lunghi è stata affidata alla testimonianza di un utilizzatore, la AFV Beltrame SpA (www.beltrame.it) di Vicenza. A partire dai risultati della simulazione della singola gabbia di laminazione, utili per una prima valutazione della deformazione del materiale, si è passati all'anali-

si di un treno completo di quattro gabbie di laminazione per l'ottenimento di un profilo IPE. I risultati ottenuti per questo particolare e per altri profili mostrati (bulbo, cingolo, T80) hanno dimostrato come la simulazione ha effettivamente consentito di valutare a priori le corrette calibrature delle gabbie.
Si è passati infine all'analisi del processi di laminazione circolare, per il quale sono state analizzate le fasi di forgiatura e tranciatura dell'anello, risolte in tempi molto rapidi grazie all'approccio 2D, e quindi la simulazione della laminazione vera e propria. Particolarità di questo processo è la moltitudine di cinematiche adottate per laminare (a rack assiale fermo o mobile, con coni fermi o mobili, con rullo ad asse verticale o inclinato, fermo o mobile) ed inoltre le cinematiche stesse sono funzione della crescita dell'anello. Nella pratica si definiscono delle curve di laminazione nel software del laminatoio ed i tool si muovono di conseguenza. Grazie alla flessibilità di Forge nella definizione delle cinematiche, si è mostrato come forge riesca a replicare in modo molto accurato quanto avviene nella realtà, aspetto questo dimostrato con esempi partici di laminazione di anelli di geometria dalla più semplice, rettangolare, alle più complesse, per anelli profilati, sagomati, flange e rulli. Non meno interessante è stato l'intervento del dott. Andrea Ghiotti del DIMEG – Università di Padova (www.dimeg.unipd.it) che ha mostrato le attività del DIMEG nella simulazione, tramite



Forge ed un approccio a reti neurali, della distorsione degli anelli nelle fasi di raffreddamento.
A completare la sezione tecnica, una dimostrazione dal vivo di utilizzo di Forge, curata dall'ing. Andrea Pallara di EnginSoft, che ha impostato il caso di una sequenza di fucinatura e stampo aperto ed una laminazione di un anello a sezione rettangolare. La demo live ha evidenziato come questi strumenti siano ormai molto facili da utilizzare, sia nella fase di preparazione delle simulazioni, che nella fase di interpretazione dei risultati.

Un appuntamento importante, dicevamo, dove alle presentazioni previste in agenda è seguito un partecipato dibattito tra i relatori ed il pubblico, dal quale è emerso come lo strumento sia già molto maturo per quanto riguarda le tematiche di forgiatura. Per quanto riguarda la laminazione circolare, l'aspetto critico sembra essere la precisione con la quale si riescono a modellare le curve di laminazione reali, in modo da prevedere comportamenti anomali del materiale durante il processo. Forge è stato migliorato in modo importante per questi aspetti specifici, grazie alla collaborazione con dei produttori di laminatoi.
Volendo sintetizzare, quanto mostrato nel workshop ha dimostrato come questi strumenti siano realmente in grado di dare una maggior coscienza del proprio modo di produrre e come le esperienze fatte con Forge siano utili sia a far crescere molto rapidamente chi si avvicina a questo mondo, e a far diventare "patrimonio aziendale" le procedure di stampaggio ottimizzate in tal modo. Ultimo aspetto non meno importante è il fatto che, grazie ai concreti vantaggi ottenibili, è possibile ammortizzare l'investimento in tempi molto rapidi.

In questo momento di difficoltà legata alla congiuntura economica, è necessario cogliere l'occasione per investire in metodologie innovative, in grado di dare maggiore competenza e conoscenza del proprio processo ai reparti di progettazione e produzione, di ridurre i costi, e di promuovere la propria immagine aziendale aumentando le possibilità di co-design nei confronti dei propri clienti.

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EnginSoft sponsorizza lo sport in trentino

Squadra di calcio femminile di serie A2 ACF TRENTO.
www.calciotrento.it

Il mondo dello stampaggio a freddo di viterie e minuterie metalliche, si è dato appuntamento a Bergamo per fare il punto sulle tecniche più avanzate di ottimizzazione di processo/prodotto.

Il 25/10 a Bergamo si è tenuto l'ultimo appuntamento del 2009 sulla simulazione dei processi di stampaggio dei metalli, dedicato questa volta al mondo dello stampaggio a freddo.

L'invito è stato accolto da una quarantina di rappresentanti delle aziende più importanti in Italia che si occupano di stampaggio a freddo di acciaio nei campi della viteria e bulloneria, della minuteria metallica e di altri particolati ottenuti per stampaggio, desiderosi di fare il punto sui vantaggi offerti dagli strumenti di simulazione nel miglioramento dei processi/prodotti.

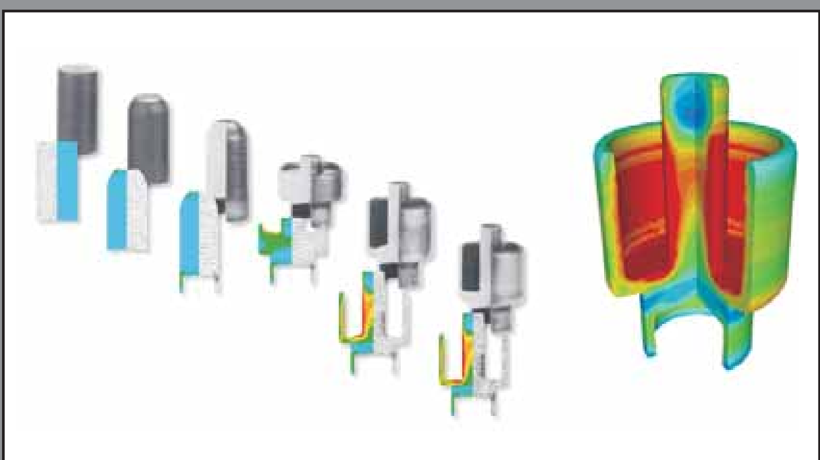
Grande successo per il pomeriggio tecnologico - Stampaggio a Freddo di Viterie e Minuterie Metalliche: Simulazione dei Processi: Nuovi Sviluppi, Vantaggi e Prospettive – organizzato il 25 ottobre a Bergamo da EnginSoft, con la presenza di SACMA Limbiate, Panzeri, Omega Ifs.

A rompere il ghiaccio, come di consueto, è stato Piero Parona, Sales Manager di EnginSoft, con una descrizione delle molteplici attività di EnginSoft nel campo della prototipazione virtuale e della strategicità dell'uso di queste tecniche nell'ottica di riduzione dei costi.

L'intervento successivo, a cura dell'ing. Marcello Gabrielli, sempre di EnginSoft, ha riguardato le tecniche di simulazione numerica dei processi di stampaggio a freddo con il software ColdForm di Transvalor. Attraverso esempi reali si è analizzato come il software sia un valido supporto alle decisioni che i tecnici devono prendere nella messa a punto del processo produttivo, per ogni operazione di stampaggio. Si è partiti dal processo di stampaggio da filo, trattando alcune sequenze di formatura per dei particolari di minuteria e viteria e mostrando come l'analisi dei contatti, del flusso di materiale e delle ripieghe possa aiutare ad individuare i problemi e mostrare la via per risolverli. Si è passati quindi all'analisi delle sollecitazioni sugli stampi, mostrando come intervenire per ridurne l'usura e migliorarne la vita utile, una volta individuate le zone di massima sollecitazione. Per alcune configurazioni si è affrontata una messa a punto delle condizioni di interferenza (blindaggio) per garantire il corretto precarico alle matrici. Si è quindi accennato ai risultati ottenibili nell'analisi della tranciatura e della rollatura dei filetti.

Sono stati quindi analizzati dei casi di stampaggio e tranciatura di lamiere, con cenni relativi all'influenza dell'anisotropia sul risultato dell'imbutitura ed è stato mostrato un approccio differente, con i software della FTI (www.forming.com) per i casi di stampaggio di lamiera sottile, per la quale vengono calcolati gli spessori, le zone di cedimento e di grinzatura.

In conclusione, sono stati mostrati esempi di messa in opera di rivetti e viti, dove il software ha consentito di valutare le resistenza degli accoppiamenti all'applicazione di condizioni di sollecitazione assiali e tangenziali.



Ha quindi preso la parola L'ing. Brigatti della SACMA Limbiate (http://www.sacmalimbiate.it), riferimento per le macchine automatiche per lo stampaggio a freddo, che ha mostrato quali sono le tecnologie che vengono adottate per migliorare precisione e prestazioni, quali ad esempio la slitta a guida conica, il sistema di cambio rapido degli stampi ed i sistemi di microregolazione degli aggiustamenti. Si è quindi soffermato sugli ultimi sviluppi nel campo dello stampaggio a tiepido, evidenziando i vantaggi di questa tecnologia.

Lo spazio dedicato alle testimonianze degli utilizzatori si è aperto con la presentazione dell'ing. Giussani della Panzeri (http://www.panzerionline.com), che ha mostrato come Coldform può essere utilizzato per la verifica e la messa a punto del processo di tranciatura di rondelle. Interessante lo studio effettuato con la collaborazione di EnginSoft e dell'Università di Trento, mediante il quale Panzeri è ora in grado di caratterizzare i materiali per la simulazione numerica, ma anche di certificarne la qualità per la produzione.

Si è passati infine alla presentazione dell'ing. Wegner di OMEGA IfS (http://www.omegaifs.it), che ha mostrato l'utilizzo del software in tre casi particolari: un perno, dove la formatura del profilo superiore dell'ingranaggio portatava alla formazione di bave, una doppia estrusione, dove è stato usato Coldform per valutare la forma della superficie libera ed una forcella, per la quale le analisi hanno consentito di rimediare ad una rottura delle matrici.

A completare la sezione tecnica, una dimostrazione dal vivo di utilizzo di ColdForm, curata dall'ing. Andrea Pallara di EnginSoft, che ha impostato il caso di una sequenza di formatura di una vita a partire dallo spezzone di filo, passando per l'estrusione del gambo, la formatura della testa e la creazione dell'impronta. La demo live ha evidenziato come questi strumenti siano ormai molto facili da utilizzare, sia nella fase di preparazione delle simulazioni, che nella fase di interpretazione dei risultati.

Al termine delle presentazioni i presenti hanno avuto lo spazio per porre delle domande ed ottenere degli approfondimenti da tutti i relatori presenti. Volendo sintetizzare, quanto mostrato nel workshop ha dimostrato come questi strumenti siano realmente in grado di dare una maggior coscienza del proprio modo di produrre e come le esperienze fatte con ColdForm siano utili sia a far crescere molto rapidamente chi si avvicina a questo mondo, e a far diventare "patrimonio aziendale" le procedure di stampaggio ottimizzate in tal modo. Ultimo aspetto non meno importante è il fatto che, grazie ai concreti vantaggi ottenibili, è possibile ammortizzare l'investimento in tempi molto rapidi.

In questo momento di difficoltà legata alla congiuntura economica, è necessario cogliere l'occasione per investire in metodologie innovative, in grado di dare maggiore competenza e conoscenza del proprio processo ai reparti di progettazione e produzione, di ridurre i costi, e di promuovere la propria immagine aziendale aumentando le possibilità di co-design nei confronti dei propri clienti.

Per maggiori informazioni:
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info@enginsoft.it

Bilancio del Ciclo di Workshop dedicati alla Simulazione dei Processi di Deformazione dei Metalli

Con l'appuntamento del 25/10 a Bergamo si è quindi chiuso il ciclo di workshop dedicati alla simulazione dei processi di deformazione dei metalli: il 03/04 a Lecco per lo stampaggio a caldo di acciaio, il 07/05 a Bergamo per lo stampaggio dei non ferrosi, il 24/06 a Padova per la forgiatura, la laminazione a caldo di prodotti lunghi e la laminazione circolare.Volendo fare un bilancio dell'intero ciclo, la partecipazione di oltre 180 persone di quasi 90 aziende ha decretato il pieno successo di questa iniziativa e con diverse delle aziende presenti si sta iniziando un percorso per l'introduzione di questi strumenti nella pratica progettuale quotidiana. Probabilmente le difficoltà economiche legate alla crisi hanno impedito ad altri di partecipare.

Questo ci ha spinto, per l'anno 2010, ad organizzare degli eventi simili, però avvalendoci di webinar che sfruttano la rete internet per proporre gli stessi contenuti, senza obbligare le persone ad effettuare delle trasferte. Rimanete sintonizzati sul nostro sito www.enginsoft.it per le date di questi eventi o contattateci per degli incontri specifici presso la vostra sede.
Le date sono:
11 Febbraio - 12 Marzo - 15 Aprile - 13 Maggio
www.enginsoft.it/webinar

EnginSoft Event Calendar

ITALY

14-17 April - METEF 2010 - International aluminium and foundry exhibition. Visit the EnginSoft Booth where we present news on process simulation technologies related to MAGMA, Forge, Coldform, AdvantEdge...
www.metef.com

14-15 April 2010 - Affidabilità e Tecnologie 2010
Meet EnginSoft in the exhibition and learn from our Seminar on Innovation in industry through Virtual Prototyping! www.affidabilita.eu

27-28 May - International modeFRONTIER Users' Meeting 2010. Starhotel Savoia Excelsior Palace, Trieste
Learn how modeFRONTIER, the leading multidisciplinary & multi-objective design optimization tool, is used globally in many industries to better understand product development processes, and achieve higher quality at reduced cost, allowing them to meet the challenge of producing better products faster!
www.esteco.com

Fall 2010 – EnginSoft International CAE Conference 2010
Exact dates and venue will be announced soon!
www.caeconference.com

FRANCE

17-18 Mars 2010 - Micado : Etats Généraux Micado : "La contribution de l'ingénierie numérique à l'ECO conception" Evry (91). Edition exceptionnelle en partenariat avec la Chambre de Commerce de l'Essonne sur le thème: "La contribution de l'Ingénierie Numérique à l'ECO Conception". www.af-micado.com

EnginSoft France 2010 Journées porte ouverte. Dans nos locaux à Paris et dans d'autres villes de France et de Belgique, en collaboration avec nos partenaires. Prochaine événement: Journées de présentation modeFRONTIER

2010 Séminaires Simulation de Process et Optimisation
EnginSoft France Boulogne Billancourt – Paris.S eminars hosted by EnginSoft France and EnginSoft Italy. Veuillez contacter Marjorie Sexto, info@enginsoft.com, pour plus d'information ou visitez : www.enginsoft-fr.com

21-23 June – ASMDO 2010 3rd International Conference on Multidisciplinary Design Optimization and Applications - Co-sponsored by ISSMO, ESTP, EnginSoft, and NAFEMS
Paris. ASMDO 2010 will bring together scientists and practitioners working in different areas of engineering optimization! www.asmdo.com

GERMANY

Please stay tuned to www.enginsoft-de.com and contact Stephanie Koch at: info@enginsoft.com for more information.

Seminars Process Product Integration. EnginSoft GmbH, Frankfurt Office. How to innovate and improve your production processes! Seminars hosted by EnginSoft Germany and EnginSoft Italy. Dates will be announced in early 2010.

modeFRONTIER Seminars 2010. EnginSoft GmbH, Frankfurt am Main: 26 January, 16 February, 9 March, 30 March, 20 April, 18 May, 15 June

UK

Please stay tuned to www.enginsoft-uk.com and contact Bipin Patel at: info@enginsoft.com for more information.

modeFRONTIER Workshops at Warwick Digital Lab
Please check www.enginsoft-uk.com for next dates!

25th February - Technical Seminar on Manufacturing Process Simulation Cranfield University

Attend EnginSoft UK's FREE Seminar and learn how state-of-the-art simulation tools can help reduce development time and drastically cut costs in manufacturing processes. The seminar will provide an interesting and effective overview of the most modern CAE technologies available today and how they can enhance your design production processes when combined with world-class expertise.
To register online, please visit: www.enginsoft-uk.com

SPAIN

24 - 27 February - 9th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering. Valencia. For more information and to arrange a meeting with Gino Duffett, APERIO Tecnología, please contact: g.duffett@aperiotec.es, www.aperiotec.es

SWEDEN

23 February - Optimization Training Star-CCM+ and modeFRONTIER. Goeteborg. In cooperation with CD-adapco and FS Dynamics, Esteco EnginSoft Nordic will present a one-day hands-on training on optimization with modeFRONTIER and Star-CCM+

modeFRONTIER Courses scheduled so far for 2010:
Esteco EnginSoft Nordic Office, Lund

- 21-22 January - Introduction to modeFRONTIER
- 9-10 February - Introduction to modeFRONTIER
- 11 February - Robust Design with modeFRONTIER

For further information, please contact Adam Thorp at: info@esteconordic.se

USA
Courses on: Design Optimization with modeFRONTIER
Ozen Engineering, Sunnyvale – Silicon Valley, CA
Learn about Optimization coupled with ANSYS. OZEN can easily help you out automating the search for the optimal design. The primary audience for this course includes ANSYS Classic and Workbench users as well as new modeFRONTIER users who want to have a complete overview to all software capabilities. Stay tuned to our US partner's website for the next events in the USA:
www.ozeninc.com - info@ozeninc.com

Europe, various locations
modeFRONTIER Academic Training
Please note: These Courses are for Academic users only. The Courses provide Academic Specialists with the fastest route to being fully proficient and productive in the use of modeFRONTIER for their research activities. The courses combine modeFRONTIER Fundamentals and Advanced Optimization Techniques. For more information, please contact Rita Podzuna, info@enginsoft.it

To meet with EnginSoft at any of the above events, please contact us: info@enginsoft.com

EnginSoft CAE Webinars in 2010

EnginSoft's engineering team will conduct a new series of CAE webinars in 2010. A variety of CAE topics will be covered by our experts based on EnginSoft multidisciplinary expertise and tradition.
The CAE webinars will demonstrate the best ways to innovate industrial processes using Virtual Prototyping.

Stay tuned on webinars calendar:
www.enginsoft.it/webinar

Optimization Crossword Puzzle

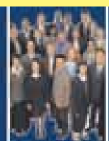
Search the words linked to modeFRONTIER® in the puzzle on the left, then put together the remaining letters starting from top: You will discover a nice message from EnginSoft!

O	B	R	E	T	U	P	M	O	C	E	S
B	P	S	T	A	T	I	S	T	I	C	S
J	T	T	W	I	M	C	D	M	T	S	I
E	S	C	I	N	H	C	E	T	A	H	M
C	I	L	E	M	T	O	O	L	M	O	U
T	M	U	G	N	I	L	E	D	O	M	L
I	P	S	S	F	R	Z	T	R	T	E	A
V	L	T	E	M	O	G	A	O	U	D	T
E	E	E	D	M	G	E	R	T	A	N	O
G	X	R	O	I	L	N	E	S	I	O	R
F	T	T	N	I	A	R	T	S	N	O	C
K	R	I	G	I	N	G	I	S	E	D	N

ALGORITHM	MODELING
AUTOMATIC	MOGA
CLUSTER	NODE
COMPUTER	OBJECTIVE
CONSTRAINT	OPTIMIZATION
DEMO	SIMPLEX
DESIGN	SIMULATOR
ITERATE	STATISTICS
KRIGING	TECHNICS
MCDM	TOOL

SOLUTION

_ _ _ _   _ _ _ _ _ _   _ _ _ _   _ _ _ _ _ _ _ _ _



ENGIN SOFT

Training Center EnginSoft

NUOVO LIBRETTO - NEW PUBBLICATION
CORSI DI ADDESTRAMENTO SOFTWARE 2010
SOFTWARE TRAINING COURSES 2010

EnginSoft è la società italiana di maggior consistenza e tradizione nel settore del CAE ove, grazie alla multidisciplinarietà delle competenze, è in grado di proporsi come partner unico per le aziende.
L'attività di formazione rappresenta da sempre uno dei tre maggiori obiettivi di EnginSoft accanto alla distribuzione ed assistenza del software ed ai servizi di consulenza e progettazione.
Per ciascuno dei possibili livelli cui la richiesta di formazione può porsi (quella del progettista, dello specialista o del responsabile di progettazione), EnginSoft mette a disposizione la propria esperienza per accelerare i tempi del completo apprendimento degli strumenti necessari con una gamma completa di corsi differenziati sia per livello (di base o specialistico), che per profilo professionale dei destinatari (progettisti, neofiti od analisti esperti).

La finalità è sempre di tipo pratico: condurre rapidamente all'utilizzo corretto del codice, sviluppando nell'utente la capacità di gestire analisi complesse attraverso l'uso consapevole del codice di calcolo. Per questo motivo ogni corso è diviso in sessioni dedicate alla presentazione degli argomenti teorici alternate a sessioni 'hands on', in cui i partecipanti sono invitati ad utilizzare attivamente il codice di calcolo eseguendo applicazioni guidate od abbozzando, con i suggerimenti del trainer, soluzioni per i problemi di proprio interesse, e discutendone impostazioni e risultati.

Anche nel 2010 EnginSoft propone una serie completa di corsi che coprono le necessità di formazione all'uso dei diversi software commercializzati.
Le novità proposte sono diverse, a conferma che l'idea che EnginSoft ha della formazione non è una realtà statica che si ripropone uguale a se stessa di anno in anno, ma è un divenire, guidato dall'esperienza accumulata negli anni, dall'evoluzione del software e dalle esigenze delle società che si affidano a noi per la formazione del proprio personale.

L'offerta dei corsi ANSYS è stata ridefinita per adeguarsi sia all'evoluzione del software ed alle caratteristiche della recentissima versione 12.1 che all' introduzione di nuovi moduli e solutori recentemente resi disponibili.

In tale senso si segnalano:

- il corso dedicato allo studio con ANSYS delle strutture in materiale composito, in particolare attraverso l'utilizzo del modulo dedicato ACP;
- il corso per il solutore esplicito ANSYS WORKBENCH EPLICIT/STR integrato nell' ambiente WorkBench e quello per il solutore esplicito generalizzato AUTODYN;
- i nuovi corsi, relativi alle applicazioni specializzate per la progettazione offshore, AQWA (codice per lo studio dell' idrodinamica di strutture galleggianti) ed ASAS (codice specializzato per la verifica di strutture OffShore);
- in campo elettromagnetico viene introdotto un corso per ANSOFT-MAXWELL, software che rappresenta il riferimento nel settore delle analisi elettromagnetiche in bassa frequenza;

- un modulo relativo al solutore ANSYS POLYFLOW dedicato allo studio di processi quali l' estrusione, la termoformatura, il soffiaggio di polimeri o del vetro;
- in campo fluidodinamico è da rimarcare l' introduzione, accanto ai corsi classici tradizionalmente erogati, di corsi specifici per il solutore ANSYS-FLUENT.

Sono stati inoltre rivisti ed aggiornati i corsi relativi a tutti gli altri software sostenuti da EnginSoft per adeguarli allo stato attuale delle relative distribuzioni.

Dal punto di vista organizzativo nel 2010 tutte le cinque sedi EnginSoft saranno impegnate nella formazione, dando la possibilità agli utenti di scegliere la location a loro più conveniente in termini di vicinanza geografica alla propria società.

Tutto questo a riprova dell'impegno nella formazione che, per EnginSoft, è e rimane un punto fondamentale della politica aziendale, un impegno costante verso l'eccellenza, un servizio per fare crescere i nostri clienti e, se lo desiderano, crescere con loro.

www.enginsoft.it/corsi

Key partner in Design Process Innovation