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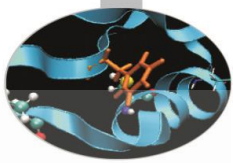
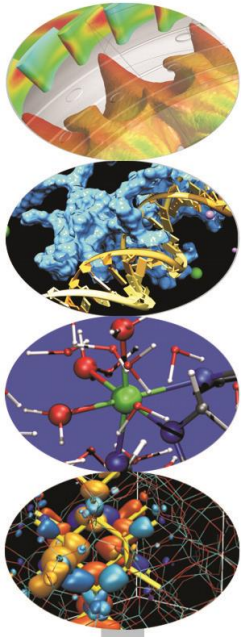
SuperComputing Applications and Innovation



PATC Workshop
HPC Methods for Engineering Applications
19-21 June 2017 Milan – Italy



Engineering Applications and HPC: a marriage of convenience

Claudio Arlandini, CINECA

06/07/2017

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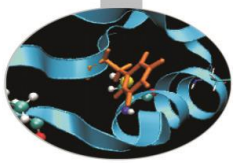

HPC in Europe: a perspective

06/07/2017

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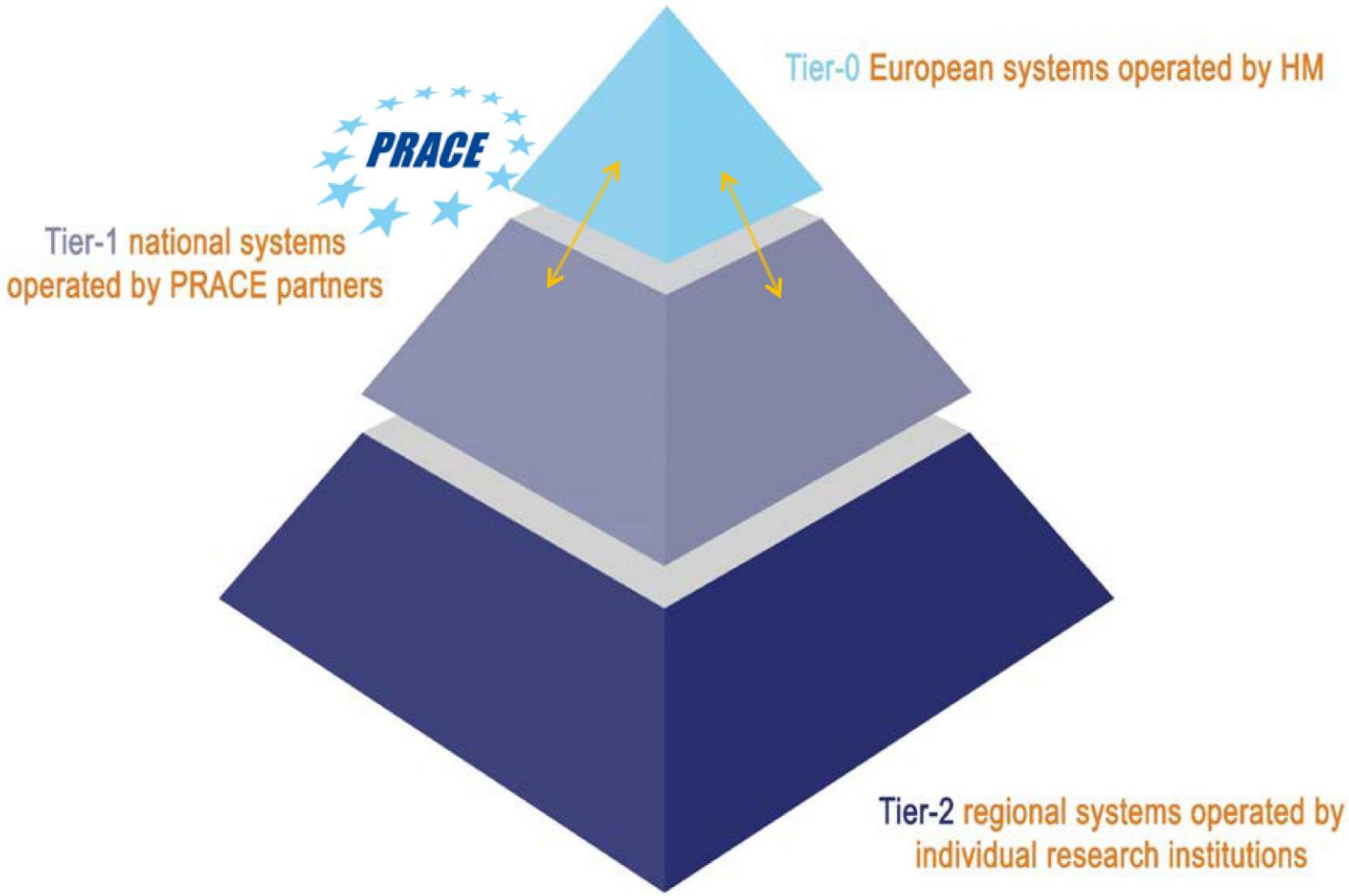
PRACE

www.prace-ri.eu

Partnership for Advanced Computing in Europe

- Open access to best-of-breed HPC-systems to EU Scientists
- Variety of architectures to support the different scientific communities
- High standards in computational science and engineering
- Peer review on European scale to foster scientific excellence
- Robust and persistent funding scheme for HPC supported by the national governments and the EC
- Support the development of IPR in Europe by working with industry and public services
- Collaborate with European HPC industrial users and suppliers

HPC Pyramid


Tier-0 European systems operated by HM
PRACE
Tier-1 national systems
operated by PRACE partners
Tier-2 regional systems operated by
individual research institutions

PRACE Tier 0 Systems

MareNostrum: IBM
BSC, Barcelona, Spain
#129 on Top500

NEW ENTRY 2016

Piz Daint: Cray XC 30
CSCS
Lugano, Switzerland

#8 on Top500 Nov16

#19 on Top500

JUQUEEN: IBM
BlueGene/Q
GAUSS/FZJ
Jülich, Germany

SuperMUC: IBM
GAUSS/LRZ
Garching, Germany
#36 on Top500

Hazel Hen: Cray
GAUSS/HLRS,
Stuttgart, Germany
#14 on Top500

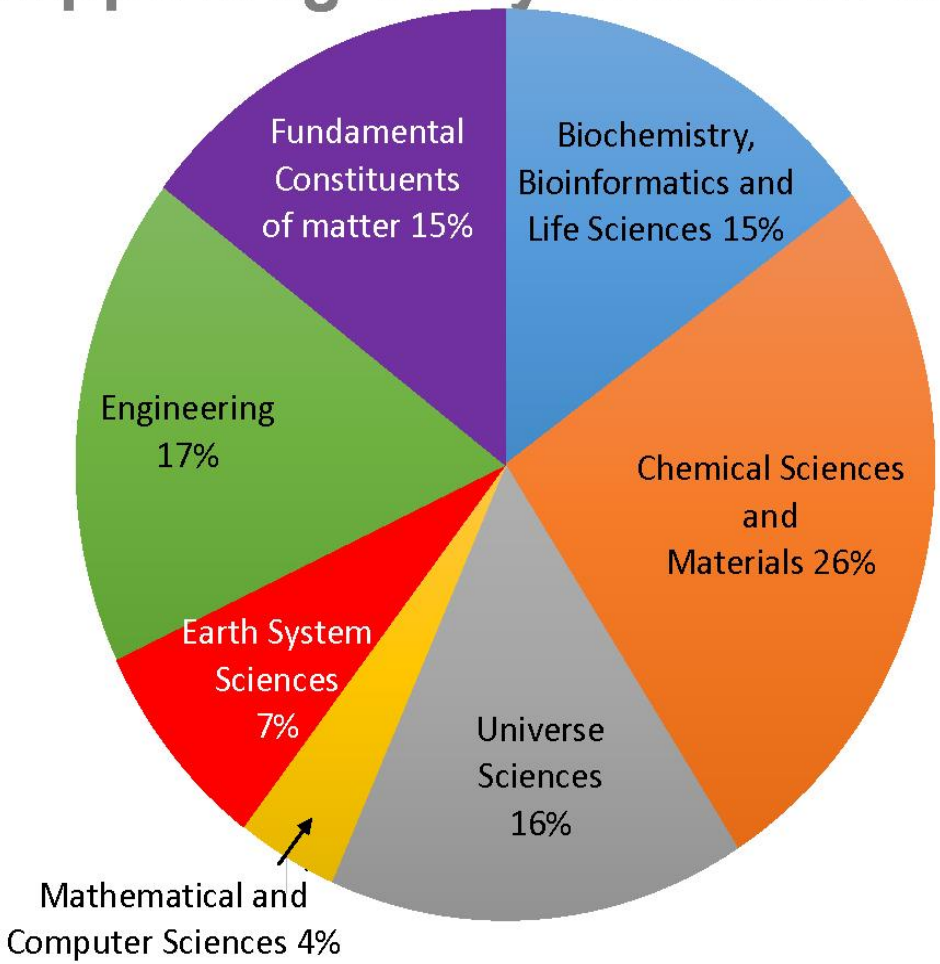
#74 on Top500

CURIE: Bull Bullx
GENCI/CEA
Bruyères-le-Châtel, France

#12 on Top500

MARCONI: Lenovo
CINECA
Bologna, Italy

Supporting many scientific domains

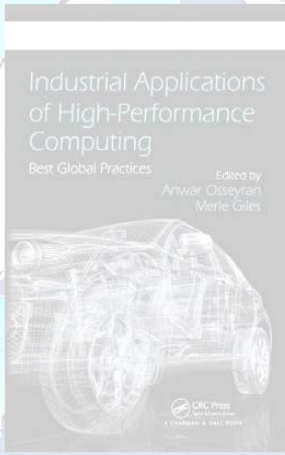


Research Domain Pie Chart up to and including Call 14, % of total core hours awarded

Criterion: Scientific Excellence

PRACE Achievements to-date

- ✓ 524 scientific projects enabled
- ✓ 14 000 000 000 (thousand million) core hours awarded since 2010
- ✓ Of which 63% led by another PI nationality than the HM
- ✓ R&D access to industrial users with >50 companies supported
- ✓ >10 000 people trained by 6 PRACE Advanced Training Centers and others events
- ✓ >60 Petaflops of peak performance on 7 world-class systems
- ✓ 24 PRACE members, including 5 Hosting Members (France, Germany, Italy, Spain and Switzerland)
- ✓ Best Seller book on Industrial Applications of HPC



PRACE Training and Outreach activities

provide a sustained, high-quality training and education service for the European HPC community

- 6 PRACE Advanced Training Centres
  4 PRACE Training Centres
- PRACE training events: Seasonal Schools, International HPC Summer School, On-demand training events
- Summer of HPC (programme for undergraduate and postgraduate students)
- PRACE Training and Events portal
- Code Vault, Massive Open Online Courses (MOOCs)

Training topics

Different levels of training

- Basic, intermediate, advanced

High performance computing

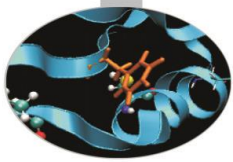
- Parallel programming
- Accelerators
- Performance optimization

Domain-specific topics

- Simulation software
- Visualization
- Data intensive computing

70 Universities
MIUR + 8 National Institutes (CNR, INFN, …)
800 employees

CINECA SCAI is the National Centre for HPC and Big Data



- Production management
- Application development

Asset liability and portfolio management

Computational fluid dynamic

Meteo climatology

Drug design

BOMBARDIER
ORACLE RACING
FERRETTIGROUP
PASSION. INNOVATION. EXCELLENCE.
ENGIN SOFT
LAPCOS Progettazione collaborativa e simulazione
LUNA ROSSA CHALLENGE
elica aria nuova
Electrolux
Dompé
PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile
arpa SIM Servizio Idro Meteo
PIEMONTE Arpa Agenzia Regionale per la Protezione Ambientale
JRC CCU
Unipol ASSICURAZIONI
CINECA

Wherever the computation offers a competitive advantage

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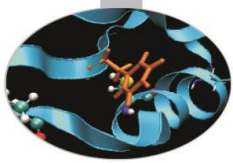
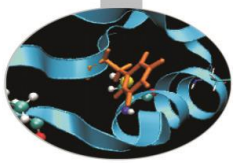


The evolving role of Computer Aided Engineering

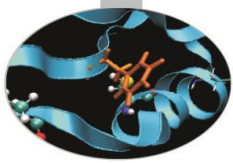
06/07/2017

CINECA



The Changing Role of Simulation

- The use of Simulation has seen continual double digit % growth annually for about 30 years until 2008
- This cumulative growth now means that Simulation is a significant portion of the Engineering Software Market and a driver for future growth
- This has resulted in increased focus and investment in simulation by major PLM software vendors

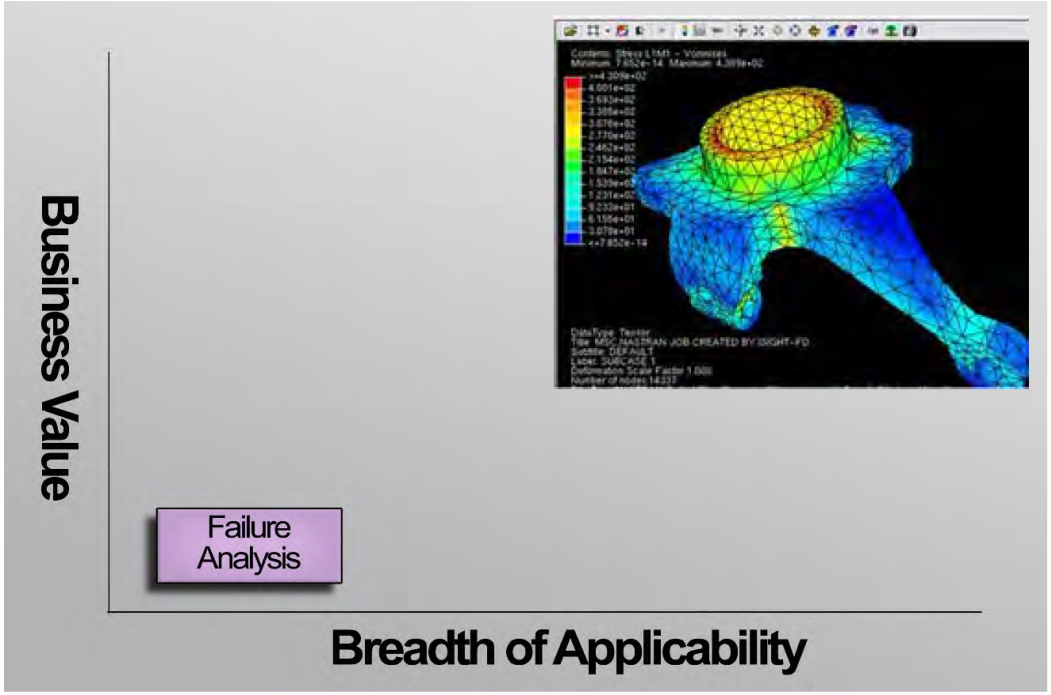


The Changing Role of Simulation

- This growth is coupled with increasing awareness that **Simulation is** the key enabler to **Increased Competitiveness**
- The changing role of simulation is more about it's role in business than the changes in technology
- Let's explore the Simulation as it relates to perceived Business Value and breadth of applicability

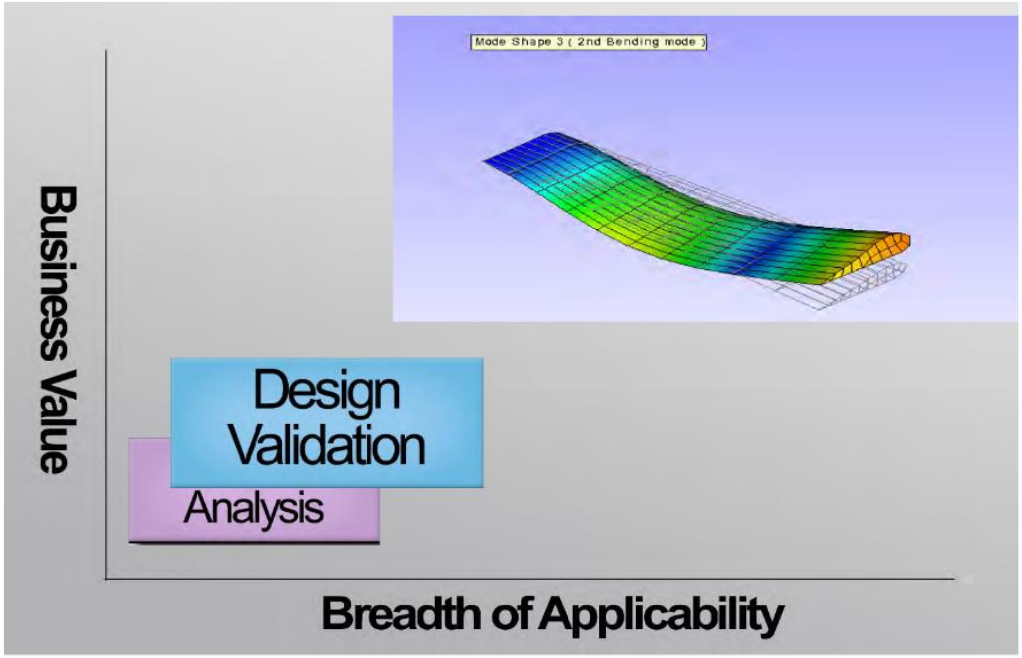
Failure Analysis

- This is where it begins
  - Understanding "why it failed"
- Run by a few "experts"
- Dominated by test vs analysis comparisons



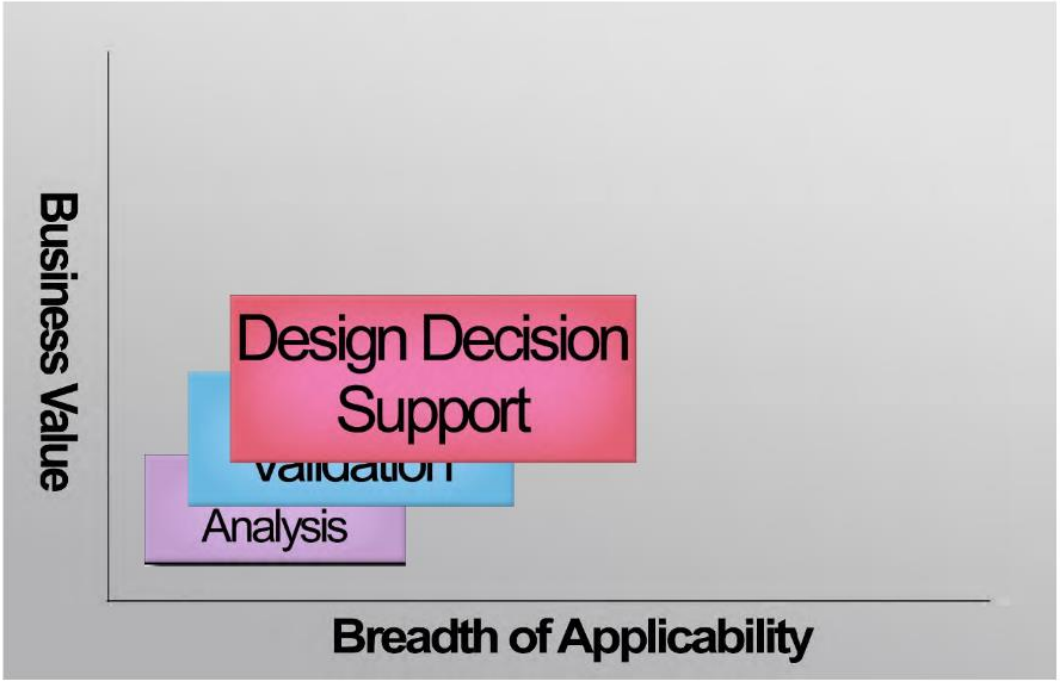
Design Validation

- Checking before it fails
- The dawn of Virtual Prototyping
- Broader use of simulation



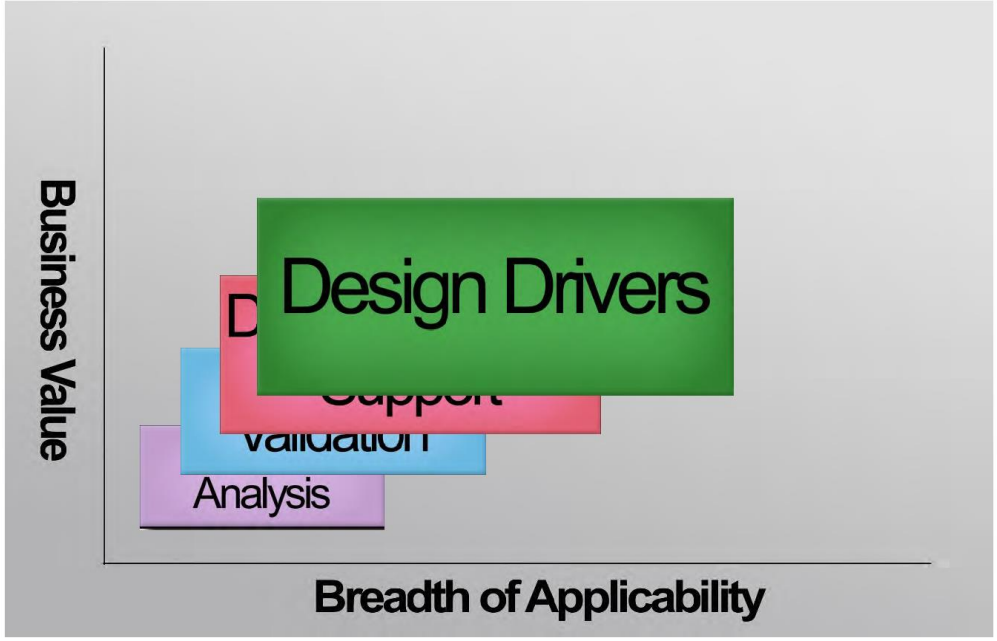
Design Decision Support

- Why not use simulation to make better design decisions
- Why not ask designers to run simulations



Design Drivers

- Simulation making design decisions

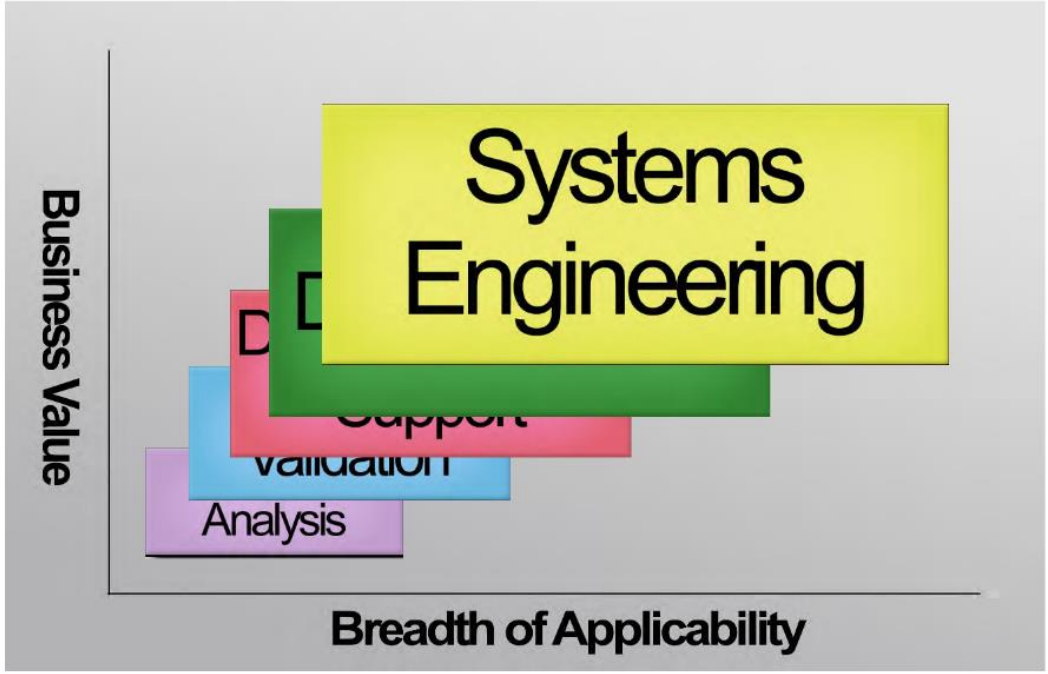


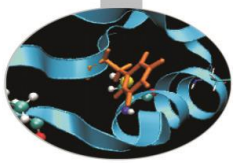
"We are only at the verge of the era where simulation generates, rather than evaluates, geometry."

Keith Meintjes, CIMdata

Systems Engineering

- Driven by growth of embedded software
- Heavily used in EDA world
- Design drivers extended to systems

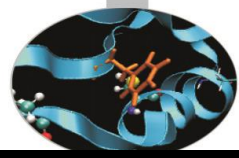




The workshop agenda

SuperComputing Applications and Innovation

Monday 19/06



Topics of the Day	Hours	Presenter	Title	Institution Name	TOPIC
PRE-PROCESSING: CAD import, CAD cleaning, meshing, CFD modelling	10.00	--	Registration	CINECA	--
	10.30	C. Arlandini	Engineering Applications and HPC: a marriage of convenience	CINECA	Workshop Introduction
	11.00	F. Russo	CAD cleaning morphing and meshing with Altair tools	Altair	CAD Management/ Meshing
	11.30	M. Di Nonno	The Influence Of Mesh Characteristics On Openfoam Simulations Of The Drivaer Model	BETA CAE Italy	CAD Management/ Meshing
	12.00	M. Fontana	Automate CAD management and meshing with Pointwise	Porto Ricerca	CAD Management/ Meshing
	14.00	A. Montorfano	Mesh generation for HPC problems: the potential of snappyHexMesh	Politecnico di Milano	Meshing
	14.30	F. Piscaglia	Development of algorithms in an open-source CFD platform: examples of validation and application to industrial problems	Politecnico di Milano	CFD
	15.00	M. Pischiutta	CFD simulations form motorcycle helmet design: the benefits of HPC	Nolan	Meshing, CFD
	15.30	R. Rossi	Surfboards design using Computational Fluid Dynamics	Università di Bologna	CFD

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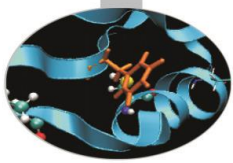
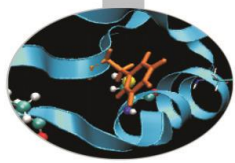
SuperComputing Applications and Innovation

Tuesday 20/06



Topics of the Day	Hours	Presenter	Title	Institution Name	TOPIC
COMPUTING: CFD modelling, MultiPhysics solvers, Optimization	10.30	A. Veneziani	Potential, perspectives and challenges of HPC for Clinical Trials and Surgical Planning: The Emory experience	Emory University/IUSS Pavia	CFD
	11.00	C. Chiastra	Computer simulations of bench testing for the investigation of coronary bifurcation stenting	Politecnico Di Milano	CFD
	11.30	V. Covello	Numerical simulation of human nasal cavity flow with particles	Politecnico di Milano	CFD
	12.00	J. Guerrero	Agile simulations in the era of cloud computing	Wolf Dynamics	CFD and Optimization
	14.00	M. Sperati	AcuSolve CFD for HPC applications	Altair	MultiPhysics
	14.30	D. Panfiglio	HPC resources in COMSOL® from Simulations to Apps	Comsol	MultiPhysics
	15.00	A. Palmas	Cloud-Based CFD simulations for Clean Rooms in the Pharma Industry	Conself	MultiPhysics
	15.30	I. Spisso	HPC Cineca Infrastructure: state of the art, towards the exascale and OpenFOAM perspective	CINECA	HPC and CFD

Wednesday 21/06



Topics of the Day	Hours	Presenter	Title	Institution Name	TOPIC
POST-RPOCESSING AND OPTIMIZATION: Optimization, Data Visualization, Data processing	10.30	H. Telib	Mimicking engineering "How-To" through HPC in the cloud: the SOUTH platform	Optimad	Optimization
	11.00	F. Salvadore	HPC and CAE: bridging the gap with CLOUD	CINECA	Cloud Computing, Data Processing
	11.30	M. E. Biancolini	Fast Radial Basis Functions for Engineering Applications	Università di Tor Vergata/RBF Morph	Morphing and Optimization
	12.00	A. Pavlovic	Parallel computing for crash simulations: the case of a minicar	Università di Bologna	Crash, FEM
	14.00	D. Feo	Automatic workflow for SCR-DeNOx optimization	Politecnico di Milano	CFD and Optimizazion
	14.30	R. Ponzini	Pre and Post-processing on HPC platforms: tools and way of doing	CINECA	Visualization, Data Porcessing
	15.00	C. Arlandini	CINECA ongoing projects for CAE applications	CINECA	Closing Remarks