INFORMATION SHEET

Scientific Computing

Understanding reality through physical modelling

The understanding of the functioning of systems through their physical modelling (mechanical, thermal, fluidic behaviour, etc.) requires a fine mathematical and analytical description for conducting realistic simulations over wide validity domains.

Model reduction and distributed computing methods help to achieve compromises between the level of representativeness of the models (margins, robustness) and the computing time. These approaches are very useful for the «extended enterprise», where co-simulation involves several partners.

CHALLENGES

Companies have to reduce calculation times and better prepare the physical tests necessary for the approval phases of their products, and for the monitoring phases once they are deployed. There are multiple objectives to be addressed, from the design phases of products to the description of their life cycle (ageing, damage, maintenance).

POSITIONING OF THE INSTITUTE

In recent years, IRT SystemX has invested heavily in the field of scientific computing and simulation, a priority area for the digital transformation of companies. The institute provides state-of-the-art solutions and develops more upstream research work in order to address challenges such as the hybridisation of scientific computing with data-based approaches, co-simulation approaches, the propagation of margins in design and the deployment of digital chains in additive manufacturing.

EXPERTISE

Topological optimisation, additive manufacturing, level set method, lattice structures, finite element method, model reduction, design margins, uncertainty management, digital twin, scientific machine learning.

Projects in this field

AMC project

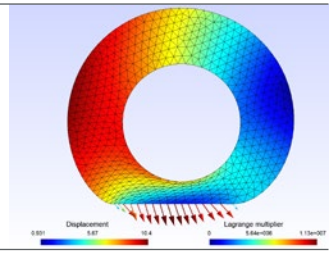
Agility and Design Margins: Facilitating the implementation of agile processes in the design of complex systems based on digital simulation

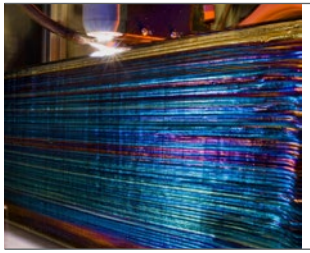
- New mathematical formalism for design margins
- Agile methods for organising design through simulation and co-simulation

HSA - IA2 project

Hybridizing Physical Simulations and Machine Learning Methods for the Aeronautics, Energy and Transportation Sectors

- Hybridizing of physical simulation
- Learning to reduce simulation cost and improve simulation quality





WAS project

Wire Additive manufacturing process Simulation: optimising strategies for driving robotic wire deposition manufacturing

- Digital twin of the additive manufacturing system
- Constrained manufacturing strategies
- Process optimisation to limit part deformation and improve mechanical properties

LCE project

Lyon Carpooling Experimentation: developing a carpooling solution based on a decentralised architecture

- Dynamic regulation of carpooling lanes integrating traffic flow models

Roadmap

SCIENTIFIC AND TECHNOLOGICAL CHALLENGES	RELATED RESEARCH FIELDS
Multi-scale, multi-physics	• Hybridization of simulation and data-based models • Topological optimisation • Modelling and simulation of the impact of the manufacturing process on part performance • Modelling and simulation of the topology induced by the manufacturing process • Reduction of models
Numerical simulation engineering	• Specification of simulation requirements in relation to system engineering • Assistance in the development of simulation and co-simulation • Visualisation for decision support • Quantum computing
Propagation of margins and uncertainties	• Explanation and calculation of margins in design • Correlation of manufacturing parameters with structural behaviour and defect occurrence

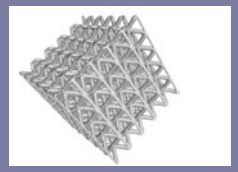
Platforms and demonstrators

DCIDE

Platform for the visualisation of simulations for decision support

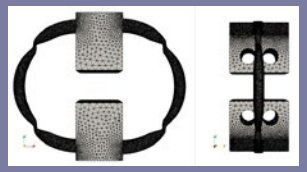
LATANA

Simulation brick for the geometry of a lattice structure



PISCO

Platform for topological optimisation by level lines



Target of IRT SystemX publications in this field (HAL collection)

● JOURNALS

Computer Methods in Applied Mechanics and Engineering, SEMA-SIMAI Springer Series, SIAM Journal on Scientific Computing, Journal of Sound and Vibration, Applied Mathematics and Computation

● CONFERENCES

CSMA (colloque national en calcul des structures), ADMOS (International Conference on Adaptive Modeling and Simulation), Sim-AM (International Conference on Simulation for Additive Manufacturing), EUROGEN (International Conference on Evolutionary and Deterministic Methods for Design, Optimization and Control), WCCM (World Congress in Computational Mechanics), Coupled (International Conference on Computational Methods for Coupled Problems in Science and Engineering), WCSMO (World Congress of Structural and Multidisciplinary Optimization)

Scientific Computing

ACADEMIC PARTNERS

RESEARCH GROUPS AND SCHOLARLY ORGANIZATIONS

INDUSTRIAL PARTNERS

ABOUT IRT SYSTEMX

SystemX is a technological research institute (IRT) with expertise in the fields of analysis, modelling, simulation and decision support for complex systems. As the only IRT dedicated to digital systems engineering, it coordinates partnership research projects, bringing together academics and industry in a multi-sector perspective. Together, they work to solve major scientific and technological problems in four priority application sectors: Mobility and Autonomous Transport, Industry of the Future, Defence and Security, Environment and Sustainable Development.

Through use-case oriented projects, SystemX's research engineers respond to the major societal and technological challenges of our time, and thus contribute to the acceleration of the digital transformation of industries, services and territories.

Located at the Paris-Saclay plateau and in Lyon, SystemX was created in 2012 as part of the future investment programme.

IN THE TEAMS

13 engineer-researchers

9 PhD projects
7 of which have been defended

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CONTACTS

Team leader
Rim Kaddah
rim.kaddah@irt-systemx.fr

Head of scientific research
Jakob Puchinger
jakob.puchinger@irt-systemxfr

www.irt-systemx.fr/en/

@IRTSystemX

IRT SystemX