

Activity Report 2016



CentraleSupélec

Laboratoire Génie Industriel - LGI

Industrial Engineering Research Department

Laboratoire Génie Industriel - LGI, EA 2606

Industrial Engineering Research Department



LGI research department's "raison d'être" is to diagnose, model, simulate, (re)design and deploy new human-techno systems. Functions, processes, architectures, resources, performances, values, costs, risks, business models, decisions, tradeoffs, lifecycle, competencies, projects, tasks, flows are our everyday life researcher's language/ontology. Human/user/consumer needs, preferences and habits become more and more our goal or grail. More and more, our models relate national and company economical and management decisions to community and individual preferences. Our fields of interest are as wide as healthcare systems, mobility solutions, smart manufacturing, connected systems, industrial ecology, supply chains, open innovation for disruptive user-centered innovations, energy production and distribution systems.

Year 2016

In addition to the **4 research groups**: Design Engineering (DE), Decision Aid (DA), Safety and Risks (SR), and Sustainable Economy (SE), LGI has also organized its activity through **5 sectorial axes**: (a) Health Systems (b) Mobility Systems (c) Energy Systems (d) Factory of the Future / Smart manufacturing and Connected Systems (e) Industrial Ecology.

These axes are multi-headed with respectively (a) Evren Sahin and Marija Jankovic, (b) Danièle Attias and Isabelle Nicolai, (c) Enrico Zio and Pascal da Costa, (d) Bernard Yannou, Julie Le Cardinal and Jean-Claude Bocquet, (e) Yann Leroy and François Cluzel. They are in charge to define once a year an activity report and to develop collaborative projects transversally to research groups.

In June, **Prof. Franck Marle** was selected as the head of Design Engineering Team.

We are also proud to welcome **Prof. Isabelle Nicolai** from Université Versailles Saint-Quentin en Yvelines, **Assoc. Prof. Yannick Perez** from Université Paris Sud, **Prof. Riane Fouad** from Ecole Centrale Casablanca as full members of LGI, under respective research agreements with their institutions.

In September, the Master of Science Industrial Engineering of CentraleSupélec was transformed into a **MSc of Complex Systems Engineering¹ of Université Paris-Saclay** co-designed by 9 partner institutions. Colleagues of LGI manage tracks: Master1 (research), Master 2 DE (Design Engineering) and Master 2 OILS (Optimization of Industrial and Logistics Systems).

The reader is invited to discover hereafter:

- The research activity of the 4 research groups: Design Engineering (DE), Decision Aid (DA), Safety and Risks (SR), and Sustainable Economy (SE),
- The research activity of the 10 industrial chairs and the two external partner research institutes,
- The aim and scope of our 5 sectorial axes,
- The who's who of LGI faculty members, technical and administrative staff.

Bernard Yannou, head of LGI

A handwritten signature in blue ink, appearing to be 'BY'.

¹ Master mention Ingénierie des Systèmes Complexes (ISC), cf. <https://www.universite-paris-saclay.fr/formation/master/ingenierie-des-systemes-complexes#mention>

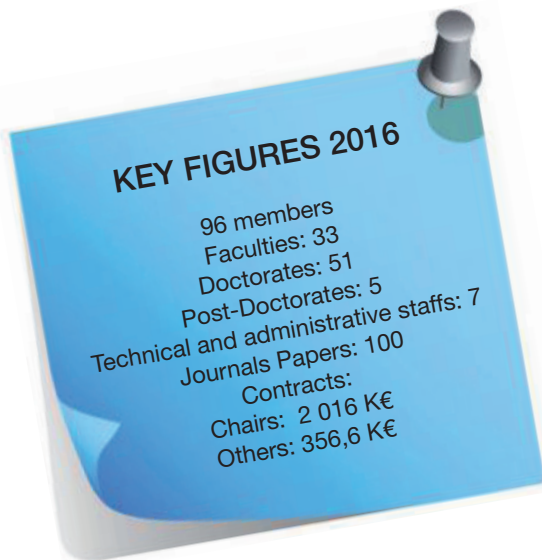
Laboratoire Génie Industriel - LGI

Industrial Engineering Research Department

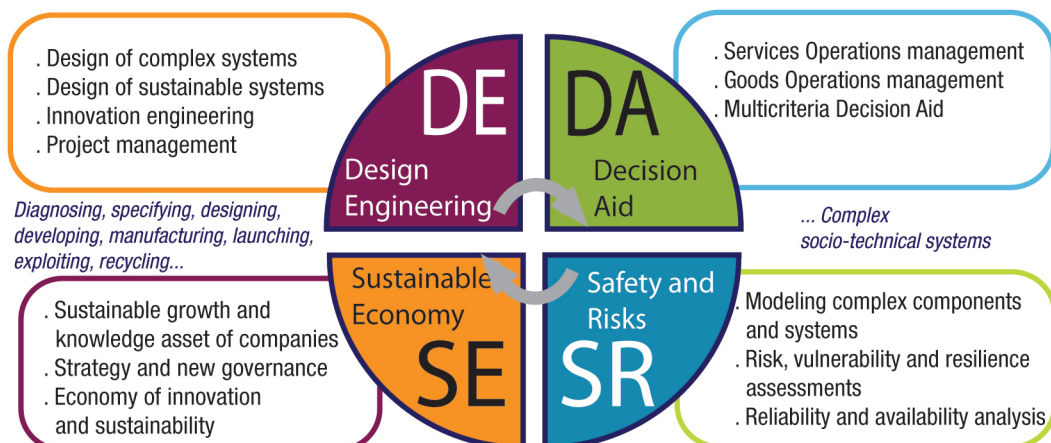
The goal of the Industrial Engineering (IE) Department (Laboratoire Génie Industriel, LGI) is to **develop models, methods and tools for diagnosing, specifying, designing, developing, manufacturing, launching, exploiting, recycling at best socio-technical systems**. These systems are industrial systems (production systems, value chains, eco-parks), complex products (airplanes, cars...), complex factories, transportation systems, health systems, energy networks, service systems and construction systems. Key principles of our research are: **multidisciplinarity, life-cycle thinking, societal issues, model-based engineering approaches**.

Studied systems are often characterized by the following:

- the presence of sophisticated technical components but also of human agents (organizations, policy makers, operators)
- a large number of individual components that interact,
- heterogeneity of these components, each with specific individual behavior,
- systems that must often be analyzed at different physical, spatial and temporal scales and from different points of view (technical performance, cost, environmental impacts, material flows, skills...)
- a system feedback on its components and the emergence of macroscopic properties.



The control of such systems presents many challenges and issues from both a technical and scientific point of view as well as practical and application perspectives like financial profitability, efficiency, continuity and reliability of service, security. The integration of technical systems is already challenging regarding, for example, aerospace, automotive or energy systems, but it is even more complex when it comes to inter-network systems («System of Systems» paradigm) such as health systems, human mobility infrastructure, distribution of products and services, transport and regulation of energy, gas, water, and other socio-technical systems including human or various agents such as organizations with different and even contradictory strategies, goals and preferences. **Our scientific approach consists in adequately modeling for analyzing and simulating in order to better understand the system behavior through virtual experiments on models and, ultimately, finding optimal solutions for the design, deployment and monitoring.** Often many life cycle phases of these systems must be modeled and analyzed: collection of needs and requirements specification, development (architectural design, design, validation, manufacture and market launch or startup), system management (its regulation, its maintenance, its failure modes, its upgrade, its dismantling and end of life).



The 4 research Groups of the IE department and corresponding research topics

Ten industrial chairs and two research institutes reinforce the 4 research groups.

Industrial Chairs



The 10 industrial Chairs associated with IE department, see <http://www.lgi.ecp/pmwiki.php/Chairs/HomePage>

The **two research institutes** for which the department is a founding member are: IRT System X (Digital Engineering of Complex Systems) and PS2E (Paris Saclay Energy Efficiency).



ACADEMIC PARTNERSHIPS

Europe: University of Stavanger-Norway, DTU-Denmark, University of Liverpool-England, Universidad Politecnica de Valencia-Spain, ETHZ-Switzerland, Politecnico di Milano, Aalto University-Finland, Magdeburg University-Germany, TU Munich, University of Bath-UK, Université de Louvain-Belgium, Université de Mons-Belgium, Poznan University of Technology-Poland, University of Catane-Italy, VU University Amsterdam-The Netherlands, University of Coimbra-Portugal, Université du Luxembourg, Koç University-Turkey

America: Northwestern University-Chicago, University of Illinois at Urbana-Champaign, MIT, Penn State University, Georgia University of Technology, University of Minnesota, UFRJ-Brazil, PUC-Brazil

Asia: Beihang University-China, Ecole Centrale Beijing, City University-Hong Kong, Wuhan University of Technology-China, Chiba University-Japan

Africa: ENIT-Tunis, ENIM-Monastir, Centrale Casablanca, American University of Beyruth

Oceania: University of Queensland (Australia)

INDUSTRIAL PARTNERSHIPS

Airbus, Air Liquide, Akka, Alstom, BNP Paribas, Bouygues Construction, CapitalDon, Carrefour, CEA, CERN, Dassault Aviation, DHL, EADS, EDF, Engie, Eurodécision, Faurecia, Groupe Renault, Hôpital Georges Pompidou, Hôpital Henri Mondor, IBM, Interact'IV, LVMH, Michelin, Place des Leads, PSA Peugeot Citroën, RATP, Safran, Sanofi, Schneider Electric, Siemens, SNCF, Thalès, Total, Vallourec, Valeo, Ville de Paris, Vinci construction.

Publications (selection out of 16 journal papers)

Innovation	Vallet Flore, Benjamin Tyl, François Cluzel, Yann Leroy, Research directions in eco-innovation: a French perspective. International Journal on Interactive Design and Manufacturing (IJDeM) Springer, 2016, 10 (3), pp.309-318.
	Bernard Yannou, François Cluzel, Romain Farel, Capturing the relevant problems leading to pain and usage driven innovations: the DSM Value Bucket algorithm. Concurrent Engineering: Research and Applications, SAGE Publications, 2016, pp.1 - 16.
Design	Jankovic Marija, Claudia Eckert, Architecture decisions in different product classes for complex products. Artificial Intelligence for Engineering Design, Analysis and Manufacturing, Cambridge Journals, 2016, 30, pp.217 - 234.
	Lamé Guillaume, Oualid Jouini, Julie Stal-Le Cardinal, Outpatient Chemotherapy Planning: a Literature Review with Insights from a Case Study. IIE Transactions on Healthcare Systems Engineering, 2016,
Sustainability	Cluzel François, Bernard Yannou, Dominique Millet, Yann Leroy, Eco-ideation and eco-selection of R&D projects portfolio in complex systems industries. Journal of Cleaner Production, Elsevier, 2016, 112 (5), pp.4329-4343.
	Bertoluci, G; Masset, G; Gomy, C; Mottet, J; Darmon, N, How to Build a Standardized Country-Specific Environmental Food Database for Nutritional Epidemiology Studies. PLOS ONE 11 (4).
Focus on a topic: healthcare	Camille Jean, Tu-Anh Duong, Julie Stal-Le Cardinal, Marija Jankovic, Jean-Claude Bocquet, Pierre Espinoza, Le partage de la valeur économique entre les acteurs d'un projet de télémédecine : enjeux méthodologiques ? European Research in Telemedicine / La Recherche Européenne en Télémédecine, Elsevier Masson SAS, 2016, 5 (2), pp.37-44.
Book	Franck Marle, Ludovic-Alexandre Vidal, Managing Complex, High Risk Projects. Springer, 2016, ISBN 978-1-4471-6787-7.
Proceedings	Cluzel F., Tyl B., Vallet F., The challenges of eco-innovation – From eco-ideation toward sustainable business models. Presses des Mines, Paris, France, 2016, ISBN : 978-2-35671-401-5.

Collaborations

Academic collaborations

France: Université Technologique de Compiègne, Université Technologique de Troyes, ESTIA, Ecole Centrale de Nantes, Université de Toulon, Supmeca, Mines ParisTech, Lorraine INP, AgroParisTech.

International: Erlangen-Nürnberg University (Germany), Technical University Munich (Germany), Norwegian University of Science and Technology, The Open University (UK), University of Illinois at Urbana-Champaign, Northwestern University, Penn State University, Georgia University of Technology, University of Texas at Austin, Massachusetts Institute of Technology, ENIM Monastir (Tunisia), University of Queensland (Australia), American University of Beyruth.

Invited Professors

Dr. Chao Fang, *Wuhan University, China*

Dr. Anthony Halog, *University of Queensland, Australia*

Associated industrial chairs

Sustainable Building and Innovation, Alstom, Engie, Groupe Renault, RATP, SNCF, SystemX



Managing Procurement Risks in Complex projects, Total



Associated research institutes

IRT-SystemX (automotive, aeronautical & urban complex systems), www.irt-systemx.fr



PS2E (Paris-Saclay Energy Efficacy), <http://institut-ps2e.com>



Organization of...

Summer school EcoSD
Eco-design of complex systems
30 may-3 June 2016



Industrial and institutional collaborations



Our research networks



Useful links

Design Engineering Team website:
www.lgi.ecp.fr/pmwiki.php/Recherche/DesignEngineering
Master in Complex Systems Engineering, specialization in Design Engineering
www.universite-paris-saclay.fr/fr/formation/master/ingenierie-des-systemes-complexes#mention



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Decision Aid Research Group in 2016

Research

The *Decision Aid for Goods and Services' Systems* Research Group (DA) is composed of 30 members among which 10 faculty members and 20 PhD students. The permanent members of the team come under the two "CNU sections": *Computer science (27)* and *Computer engineering, automation and signal processing (61)*.

Research conducted refers to the scientific fields of Operational Research and Decision Analysis. The focus is related to decision support in operations management, and concerns both systems of goods and systems of services. Scientific issues are positioned at two levels. (i) At an application domain level, research issues are related to performance evaluation and optimization of systems of production and distribution of goods and services. (ii) Conceptual, methodological, procedural and algorithmic issues are tackled to meet application challenges.

The development of methods to optimize various aspects of organizational systems, leading to mobilize, adapt, reformulate or even develop formal tools so to effectively answer to the questions to which decision makers are confronted. These works often lead to developing new concepts, tools and decision support methodologies decision whose validity extends way beyond the application for which they were initially designed.

Our research is structured into three main research projects:

1. Service Operations Management (Healthcare systems, Call centers, ...)
2. Supply Chain Management (supply chain design and planning, cooperation and competition, flow and inventory management, green supply chain)
3. Multiple Criteria Decision Aid (preference modeling and elicitation, multiobjective optimization)

The models and resolutions methods considered in our research refers to Decision Aid/Operational Research: discrete event simulation methods, combinatorial optimization and mathematical programming, game theory, value based and outranking based preference models, argumentation models, preference learning, stochastic models, dynamic programming,...



6 PhDs completed

Jinyan Liu «Preference elicitation for multi-criteria ranking with multiple reference points», [China Scholarship Council](#)

Karim Ghanes «Operations optimization in emergency departments», [ANR OSSU](#)

Shouyu Ma «Modeling and Analysis of New Extensions for the News-Vendor Problem», [China Scholarship Council](#)

Olivier Sobrie «Learning preferences with multiple-criteria models», [co-tutelle Umons, Belgium](#)

Siham Lakri «Performance Measurement and Management Systems of today's Supply chains: Design based on the systemic approach», [Chair Supply Chain](#)

Jing Peng «Queuing approaches for the analysis of collaboration strategies in service systems», [China Scholarship Council](#)

Key figures in 2016

- 30 members
- 4 research chairs
- 6 PhDs completed
- 20 journals papers published
- 15 journal papers accepted
- 11 conferences
- h-index : 42 (WoS)
- 787 citations (WoS)

10 faculties: Chengbin Chu, Yves Dallery, Asma Ghaffari, Zied Jémai, Oualid Jouini, Benjamin Legros, Vincent Mousseau, Wassila Ouerdane, Jakob Puchinger, Evren Sahin

20 PhD students: Khaled Belahcene, Hicham Benbitour, Selmen Boubaker, Amine Boudella, Maxime Claisse, Mathieu Darnis, Jianguang Feng, Karim Ghanes, Oumeima Khaled, Siham Lakri, Guillaume Lamé, Jinyan Liu, Shouyu Ma, Ouail Maghraoui, Abood Mourad, Jing Peng, Massinissa Mammeri, Haythem Selmi, Olivier Sobrie, Zhe Yuan



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delphine.martin@centralesupelec.fr (administration)



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Publications (selection out of 35 journal papers published or accepted)

O. Sobrie, M.E. Lazouni, S. Mahmoudi, V. Mousseau and M. Pirlot, A new decision support model for preanesthetic evaluation, Computer Methods and Programs in Biomedicine, vol. 133, pp 183-193, september 2016 (WoS Impact Factor 1,862)

B. Legros, O. Jouini, G. Koole. Optimal Scheduling in Call Centers with a Callback Option. Performance Evaluation, 95:1-40, 2016. (WoS Impact Factor 0,944).

Gerhard Hiermann, Jakob Puchinger, Stefan Ropke, and Richard F. Hartl. The Electric Fleet Size and Mix Vehicle Routing Problem with Time Windows and Recharging Stations. European Journal of Operational Research, 252(3):Pages 995–1018, August 2016 (WoS Impact Factor 2,679)

K. Belahcene, C. Labreuche, N. Maudet, V. Mousseau, W. Ouerdane, «Explaining robust additive utility models by sequences of preference swaps», Theory and Decision (WoS Impact Factor 0,750)

Zhaofu Hong, Chengbin Chu and Yugang Yu, «Dual-mode production planning for manufacturing with emission constraints», European Journal of Operational Research, 251(1), pp 96-106, 2016, (WoS Impact Factor 2,679)

A.Sena Eruguz, Evren Sahin, Zied Jemai and Yves Dallery, «A comprehensive survey of guaranteed-service models for multi-echelon inventory optimization», International Journal of Production Economics, Volume 172, Pages 110–125, 2016 (WoS Impact Factor 2,782)

Collaborations

Academic collaborations

France: Université Paris Dauphine, Université Pierre et Marie Curie, Université Paris-Sud, Telecom Bretagne.

International: University of Minnesota, Université de Mons (Belgique), Poznan University of Technology, (Pologne), Politecnico di Milano (Italy), University of Catane (Italy), VU University Amsterdam (The Netherlands), University of Coimbra (Portugal), Université du Luxembourg (Luxembourg), Koç University (Turkey), ENIT Tunis (Tunisia), SUTD (Singapore).

Invited Professors

Marc PIRLOT, *Université de Mons, Belgique*
Yanju ZHOU, *Centrale South University, China*

Associated industrial chairs

Supply Chain Carrefour, LVMH, Safran, Sanofi

Manufacturing and Logistic Chair, Faurécia

Anthropolis Alstom, engie, RATP, Renault, SNCF, SystemX

Call Centers, Interact'IV

Editor in Chief

Vincent Mousseau
EURO Journal of Decision Processes

Associate editors

IMA Journal of Management Mathematics;
Supply Chain Forum, an International Journal
Flexible Services and Manufacturing Journal

Editorial boards

4OR, International Journal of Information Systems in the Service Sector

Industrial and institutional collaborations



Our research networks



Best paper award ICORES 2016,
Rome:
O. Jouini
for the paper
«A Complementarity Problem Formulation for Chance-Constrained Games»



Safety and Risks Research Group in 2016

Research

Aim and Scope

Our team develops new methods, frameworks and modeling architectures, techniques and algorithms, for the safety and risk analysis of complex engineered systems, based on a holistic and systemic viewpoint. The modeling, simulation and optimization methods, frameworks, architectures, techniques and algorithms that we develop, integrate a number of competences for viewing and solving the problems from the different, multidisciplinary system perspectives (topological and functional, static and dynamic, etc.) that are needed, and giving due account to the existing uncertainties. In-house softwares implement the problem solutions developed and their applications on industrial systems like aircrafts, nuclear power plant components, renewable energy systems, electric power grids, smart grids, oil and gas systems, automotive and railway transportation systems.

Topics

Our research is organized around 3 main topics:

- 1. Energy network systems**, focusing on modeling, simulating and optimizing of electrical network systems, i.e., power grids, microgrids, smart grids. The analysis of these systems cannot be carried out only with classical methods of system decomposition and logic analysis; a framework is needed to integrate a number of methods capable of viewing the problem from different perspectives (topological and functional, static and dynamic, ...) and properly treating the related uncertainties by probabilistic and non-probabilistic methods.
- 2. Aging and failure processes in components of energy production plants**, aiming at modeling and assessing component degradation, analyzing and building maintenance solutions, and carrying out system simulation for reliability, availability, maintainability and safety (RAMS) analysis by multi-state, physic, Bayesian and Markov chains models, Monte Carlo simulation. A particular focus is on failure prediction and prognostics of critical components, by data-driven approaches, e.g. adaptive artificial neural networks, support vector machines and the like.
- 3. Dependable embedded systems**, consisting in developing concepts, methods and tools to design dependable embedded systems, with a special focus on avionic systems. The state-of-the-art Fault Tree assessment tools Aralia (now commercially distributed by Dassault Systemes) and now XFTA have been created and are continuously developed and updated.



Key figures in 2016

- 24 members
- 2 research chairs
- 2 PhDs completed
- 52 journals
- 24 conferences

2 PhDs completed

Siwar Kriaa «Joint safety and security modeling for risk assessment in cyber physical systems», **EDF**

Yanhui Lin «A holistic framework of degradation modeling for reliability analysis and maintenance optimization of nuclear safety systems», **China Scholarship Council**

5 faculties: Yanfu Li, Nicola Pedroni, Antoine Rauzy, Jean-Marc Roussel, Enrico Zio

14 PhD students: Islam Abdin, Benjamin Aupetit, Tasneem Bani-Mustafa, Fangyuan Han, Mélissa Issad, Benoît Lebeaupin, Anthony Legendre, Xing Liu, Chung-Kung Lo, Hoang-Phuong, Muxia Sun, Pietro Turati, Zhiyi Wang, Jinduo Xing

3 post-docs: Jie Liu, Rodrigo Mena, Zhiguo Zeng

1 engineer: Loic Peletan

2 visiting PhD students: Menfei Fan, Xiangyu LI



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Publications (selection of 7 out of the 52 journal papers published)

Energy network systems	Ferrario, E., Pedroni, N. and Zio, E., 2016. Evaluation of the robustness of critical infrastructures by Hierarchical Graph representation, clustering and Monte Carlo simulation. <i>Reliability Engineering & System Safety</i> , 155, pp.78-96.
	Zio, E., 2016. Some challenges and opportunities in reliability engineering. <i>IEEE Transactions on Reliability</i> , 65(4), pp.1769-1782.
	Turati, P., Pedroni, N. and Zio, E., 2016. An adaptive simulation framework for the exploration of extreme and unexpected events in dynamic engineered systems. <i>Risk analysis</i> .
Aging and failure processes in components of energy production plants	Liu, J. and Zio, E., 2016. A SVR-based ensemble approach for drifting data streams with recurring patterns. <i>Applied Soft Computing</i> , 47, pp.553-564.
	Liu, J. and Zio, E., 2016. Feature vector regression with efficient hyperparameters tuning and geometric interpretation. <i>Neurocomputing</i> , 218, pp.411-422.
Dependable embedded systems	Legendre, A., Lanusse, A. and Rauzy, A., 2016, October. Directions towards supporting synergies between Design and Probabilistic Safety Assessment Activities: illustration on a Fire detection system embedded in a helicopter. In <i>PSAM13 (Vol. 13)</i> .
	Meng, H., Aupetit, B., Kloul, L. and Rauzy, A., 2016. Production performance of an offshore system by applying AltaRica 3.0. <i>6E-Modèles formels/preuves formelles 1</i> .

Collaborations

Academic collaborations

Europe : ETH Zurich, Liverpool John Moores University, Manchester University, Norwegian University of Science and Technology, Politecnico di Milano, Technical University of Denmark, Universitat Politècnica de València and others.

Rest of the world : Alzahra University, Iran, Beihang University, City University of Hong Kong, Idaho National Laboratory, MIT, National University of Singapore, North China Electric Power University, Wuhan University of Technology and others.

Invited professors:

Yang Wang, China

Datian Zhou, China

Michael Gerard Pecht, University of Maryland, USA

Associated industrial chairs:

Chair on Systems Science and the Energy Challenge, Fondation Électricité de France (EDF), www.ssde.fr

Chair Blériot-Fabre, SAFRAN

Associated research institutes:

Critical infrastructure reliability and Safety Center, Beihang University, <http://cresci.cn>

European Commission Joint Research Center (JRC) Ispra, <https://ec.europa.eu/jrc/en/about/jrc-site/ispra>

Institute de la Science de Risque et Incertitude (ISRI),

CentraleSupélec

Laboratorio Analisi di Segnale e Analisi di Rischio (LASAR), Politecnico di Milano, www.lasar.polimi.it



Organization of...

International PhD School:

5th PhD School on Vulnerability, Risk and Resilience of Complex Systems and Critical Infrastructures, School 16-22 October 2016, Beihang University, Beijing, China

International conferences:

IEEE Prognostics and Health Management (PHM) Conference, Chengdu, China.

International Conference on Materials, Reliability and Safety (ICMRS 2016), Hangzhou, China.

IEEE-2016 International Conference on System Reliability and Science, November 15-18, 2016, Paris, France.

International mini-symposium: "Resilience of Complex Systems" at the 4th International Reliability Conference (IREC 2016), Tabriz, Iran, May 2, 2016.

International mini-symposium: "Risk Assessment of Complex Infrastructure Networks" at the 6th Asian-Pacific Symposium on Structural Reliability and its Applications (APSSRA 2016).

The international mini-symposium: "Advanced and efficient simulation methods for probabilistic analysis in engineering problems" at the ECCOMAS Congress 2016,5 - 10 JUNE 2016 Crete Island, Greece.

Industrial and institutional collaborations



Our research networks



Publications:

G. Moysan and M. Senouci, «A note on 2-input neoclassical production functions», Journal of Mathematical Economics, 67, 2016.

C. Cany, C. Mansilla, P. da Costa et ali, “Nuclear and intermittent renewables: two compatible supply options? The case of the French power mix”, Energy Policy 95, 2016.

P. Codani, Y. Perez, M. Petit, «Financial Shortfall for Electric Vehicles: economic impacts of Transmission System Operators market designs», Energy 113, 2016.

I. Nicolăi, S. Dantan, J. Bulteau, “Enhancing sustainable mobility through a multimodal platform: Would travelers pay for it?”, International Journal of Sustainable Development, 2016.

D. Attias, S. Mira-Bonnardel, C. Donada, “From the management of innovative projects to the innovative management of innovative projects: An analysis within the automotive industry”, Journal of Modern Project Management 4, 2016.

Collaborations

2 Departments Paris Saclay : MEP (Mécanique, Energétique, Procédé); SHS (Sciences de l’Homme et de la Société).

2 Doctoral schools Paris Saclay : Interfaces; SHS (Economie-Gestion)

2 Masters Paris Saclay : Economie de l’Environnement, Energie, Transports (EEET); Industries de Réseau et Economie Numérique (IREN).

Scientific Network:

France: Strate College, ESSEC, CEA Saclay, University Paris Dauphine, University of Montpellier, Club de l’Orme: the energy experts of Paris Saclay, Le Basis (Paris)...

International: UNIGE Université de Genève (Suisse), Research Institute of Innovative Technology for the Earth (RITE) Japan, EU-LAC Foundation Germany, Helmholtz-Zentrum für Umweltforschung

Member of:

- SFM, AIMS, EEM, FAEF, IAEE...
- Florence School of Regulation,
- Conference on the European Energy Market,
- CEESAR,
- Office Parlementaire de l’Evaluation des Choix Scientifiques et Technologiques.

2 Research Institutes

- VEDECOM, Institut de recherche partenariale publique-privée about decarbonized mobility.
- PS2E, Institut Paris-Saclay about energy efficiency.

Invited professor:

Bianka SHOAI TEHRANI, RITE, Japon: Electricity market liberalisation and decarbonisation

**Bourse KIC InnoEnergy PhD Grant 2016
for Yurong Chen.**

3 Chairs:

Chair Operational Efficiency by BNP Paribas.



Chair Armand Peugeot on Electromobility and Hybrid Technology by Peugeot-Citroën (with Essec and Supélec).



Patronage by endowment fund CapitalDon on Sustainable Growth.

CapitalDon

Organisation of

Colloque Simplexité et Modèles Opérationnels au Collège de France, june 2016, Paris, France

Conference «The Impact of Electric Vehicles on the Electricity System », jointly organized with the European Energy Markets Chair of University Paris-Dauphine, 17 October 2016.

International Conference: ‘V2X enabled Electric Vehicles’ Regulation issues and Business Models - Chair Armand Peugeot, 27-28 october, Paris, France.

Our 10 industrial chairs and 2 partner research institutes

TOTAL - Managing Procurement Risks in Complex Projects.



Prof. Franck MARLE

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pelec.fr

The Chair aims at identifying, analyzing then treating some risks related to the complex Exploration & Production projects, which are made of multiple interdependent contracts. The research topics are :

- Proposing In-Country Value actions that deliver sustainable value to the Host Country while maintaining the Project Risk Exposure acceptable
- Selecting a Project Contracting Strategy which minimizes risks while execution of the contracts (Engineering, Procurement & Supply, Construction & Installation)
- Proposing a way to coordinate actors during key decisions related to the Project Contract lifecycle



The Chair is connected to Exploration & Production branch of TOTAL. It is co-supervised by two divisions, respectively Projects & Construction and Contracts & Procurement.

The Chair is composed of a holder and 3 PhD students.

ANTHROPOLIS : Development of user centered eco-innovations in the context of urban mobility systems and their interactions with other urban systems.



Prof. Jakob Puchinger

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Infos :
<http://www.chaire-anthropolis.fr>

The « Anthropolis » chair places the human being at the center of new usages and new mobilities defining its research activities around three major topics:

- State of the art and usage scenarios: the chair will commence its investigations by identifying citizen's usage and behavior typologies and the elaboration of usage scenarios.
- Disruptive technologies and innovation: identifying developments of disruptive technologies at the service of urban systems (experiments, Living Lab...).
- Impact on urban systems: adapting existing simulation tools in order to evaluate the impact of various innovations and identifying the developments they induce on business models and new mobility solutions.

AnthroPOLIS
HUMAN CENTERED URBAN DESIGN



The chair is jointly operated with IRT-SystemX, unique IRT in Ile-de-France in the field of digital engineering of complex systems. The partners are: Alstom, ENGIE, RATP, Renault, SNCF.

The chair is composed of the chair holder, a researcher and two doctoral students.

The faurecia chair of manufacturing & logistics management



Prof. Evren SAHIN

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pelec.fr

The Chair of Manufacturing & Logistics Management aims at developing decision making tools that improve the performances of production and logistics processes of the automotive first tier supplier Faurecia. The objective is to better understand, model, improve and optimize operations, in terms of productivity, responsiveness and flexibility, while controlling costs (space, labor, investments, etc.), by developing innovative solutions (organizational, technological). Recent examples of studies developed in the Chair include:

- optimization of assembly line feeding policies by introducing «kitting» and «sequencing» as new part supply policies
- improvement of the performances of product picking processes by optimizing storage locations and picking routes
- design of a performing internal cross-docking processes within an assembly plant by assessing the performance of different modes of cross-docking
- assessment of the benefits that would stem from the RFID technology
- evaluation of the complete cost stemming from the diversity of finished products existing in a production site

CM&L

The Chair is co-managed with Prof. S Minner, Technical University of Munich, School of Management.



Supply Chain Chair



Prof. Yves Dallery
Supply Chain Chair
Director

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Chair team
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Head of Enterprise Par-
tnership
- Zied Jemaï Scientific
Head
- Bruno Croizat
Trainer and head of student
relationship

The Supply Chain chair includes in a unique partnership four major companies: Carrefour, LVMH, Safran and Sanofi.

The goal of this chair is threefold:

- Develop research and innovation in supply chain,
- Develop skills of managers and best practices in the four companies,
- Stimulate the interests of CentraleSupélec students for supply chain careers.

Following are the two core topics of the supply chain chair:

- Agility and resilience in supply chains: how to make supply chains more agile and resilient to cope with uncertain situations,
- Supply chain and enterprise performance: how to put forward the key role of supply chain in the financial and environmental performance of companies.

The supply chain chair was launched in 2008 with a first phase from 2008 to 2013 and renewed in 2014 for a second phase until 2018.

The strategic orientations of the Supply Chain chair are set by a steering committee consisting of:

- The supply chain directors of the four companies
- The supply chain team
- The head of the LGI (industrial engineering research lab)
- The head of the Centrale Alumni in purchasing and supply chain



Call Centers: Optimization of multichannel operations in modern call centers



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The chair « Call Centers » aims at proposing novel solutions for the operations management and optimization of multichannel call centers. It consists of adapting operations to the exponential growth of the technological progress while accounting for the human element, which is one of the most important features in call centers. In particular, the chair addresses the following research questions:

- Routing with high identification level for customers: In the new context of Web-RTC systems, the classical routing of customers to agents is no longer appropriate. Agents are becoming more and more active in selecting the jobs they handle. The objective is to study the effect of this change on performance and on agent behavior: are we converging toward a situation of hyper-specialization, or a situation with an increasing number of skills per agent?
- Advertizing during waiting: analysis of the impact of advertizing parameters on the customer behavior in commercial call centers. The objective is to understand how advertising may intensify or reduce the abandonment phenomena.



The chair is managed by LGI at CentraleSupélec, and is funded by the industrial partner INTERACT-IV.COM

The chair consists of the chair holder and one junior professor

Chair System Science and the Energy Challenge, 'Fondation Electricite' de France (EDF).



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The Chair "System Science and the Energy Challenge" develops new methods, frameworks and modeling architectures, techniques and algorithms, for the safety and risk analysis of complex engineered systems, based on a holistic and systemic viewpoint. More specifically, the research on energy systems and components involves methods for: simulation, prediction, optimization, degradation and failure modeling, RAM, risk, vulnerability, resilience analysis.

Two main research axes can be distinguished:

- Axis 1: Characterization of the aging and failure behavior of production plant components,
- Axis 2: Energy systems analysis.

These two axes develop into a number of individual researches carried out by: 2 assistant professors, 3 post-docs, 7 PhD students, 2 visiting PhD students, 1 master student and a large number of international collaborators from renowned universities and research institutes.



Chair Blériot-Fabre: Design of robust embedded avionic systems.



Prof. Antoine Rauzy

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The chair Blériot-Fabre is focusing on the science and the engineering of complex systems, with two specific thematic fields: system architecture and safety analyses, both essential for the design of avionic systems.

Models, modeling languages and assessment algorithms are at the core of the scientific and teaching activities developed in the framework of the chair.

The chair plays notably a central role in the design of the AltaRica language and in the development of associated assessment tools.



The chair is supporting one professor, an associated professor, a research engineer and several PhD students.

Armand Peugeot: A chair in partnership on hybrid technologies and the economy of electromobility.



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<https://sites.google.com/a/essec.edu/chaire-armand-peugeot/>

The Chair «Armand Peugeot» is a partnership with Essec Business School and covers the multidisciplinary fields necessary to address the complexity of the questions posed by the future of the automotive industry in the context of the development of electromobility.

The aim of the Chair is to create a space for exchanges, training and prospective research to develop technological, economic and strategy scenarios.



The Chair is a partnership between the University PSA CentraleSupélec, and ESSEC Business School.



Operational efficiency and management systems

Chair Holders :



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The aim of the OE&MS Corporate BNPParibas IFS Chair is to radically innovate the operations' management thinking by focusing on the whole operation's environment and system, beyond parcelled operation's optimization. Organization's operating models have a key influence on the organization's governance and strategy.

A main challenge is to produce new knowledge and tools to address specific intangible services' operating models at a time where service systems' operations cannot any more be understood and planned under a mechanistic view of pre-established continuous chains of standardized micro tasks. A major academic stake is to pass from a static and mechanistic middle and back office operation's system view to a dynamic, living system like operation's model.

The design process itself is designed as an iterative action-learning process among bank experts and researchers. Research is conducted under an integrated interdisciplinary approach including operations research, anthropology and organizational sciences.



The chair is jointly operated with BNP Paribas



BNP PARIBAS
La banque d'un monde qui change

Sustainable Growth: the impact of innovation and of market structures, in particular related to energy and the environment, on potential growth and sustainability of economic systems



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The Chair “Sustainable Growth” aims to propose models that are workable in a context where industrial, energetic, financial and economic crisis that mark the end of a quantitative growth model, and the rise of a new economy based on innovation and quality as key resources.

The convergence of economics and managerial approaches proves necessary to study these latter new economic and management models:

- Articulating economics and management issues by taking into account both macro and microeconomic levels;
- Challenges linked to energy and environmental sustainability, radical innovation and the size of firms.



Patronage by endowment fund CapitalDon on Sustainable Growth.

The Chair is composed by one leader and one young researcher, and aims at supporting the whole team of economics and management of LGI/Centralesupélec within its research program of sustainability.

Paris-Saclay Energy Efficiency institute PS2E

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PS2E is an Institute for energy transition devoted to the efficiency and flexibility of factories and urban areas. CentraleSupélec is one of the nine founding members. The LGI (DE, SR, SE teams) is actively involved in several of its programs: Eco-industrial parks, Energy flexibility, Heat networks, Audits and metrics.



Collaboration with PS2E involves 4 permanent researchers of LGI, supports 2 full-time postdocs and provides annually research internship subjects to Master students.



The Technological Research Institute SystemX (IRT SystemX)

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Based on the plateau of Paris-Saclay, IRT SystemX is positioned as an accelerator of digital transformation. Focused on digital engineering of future systems, research projects cover the scientific and technological challenges of industrial transport and mobility sectors, energy, security and digital communications. They meet the challenges that manufacturers face in the phases of design, modeling, simulation and testing of future products and services, integrating more and more digital technologies.

The evolution of technology and the need to involve their integration reflect the new paradigm «Digitizing» by a «systems» approach or «systems of systems». The IRT 2016-2020 roadmap focuses on four programs: systems engineering, intelligent territories, autonomous transport and digital infrastructures.

LGI (DE and DA research teams) is actively working on the first three programs with:

- a common Anthropolis Chair (2015-2019) on innovative urban systems and mobility centered on the needs of users,
- participation in several programs on autonomous vehicles and systems engineering,
- presence in the Programs Orientation Committee.



The collaboration with IRT System X involves 5 LGI academics, supports three PhD students and hosts two other PhD students in partnership with partner companies of IRT.

Sectorial Axes

Mobility Systems

Managers



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New mobilities: what ecosystem for tomorrow?

Eco-mobility involves all mobility solutions and encompasses every type of transport – individual and shared, public and private – that contributes to providing a positive response to sustainable development issues. This eco-mobility is also smart and connected.

These new mobilities need to be analyzed with a multi-disciplinary approach, fitting into a context of prospective and disruptive innovation. Research approaches include engineering, economics and social sciences, and employ tools to design and model socio-technical mobility systems.

The models developed attempt to understand and satisfy stakeholders' mobility requirements and identify the different action levers available to mobility suppliers while reducing the environmental and social impacts of the suggested solutions. In more detail, the themes tackled by our research are the following:

- **Sustainable urban mobility:** The changing behavior patterns of mobility users call for new services. By analyzing what determines their mobility requirements, we can model user behaviors and define the most suitable products.
- **Electro-mobility economy:** Prospective analysis highlights emerging business models, like electric vehicles integrated into the grid and autonomous, connected vehicles that, through their disruptive innovation model, create a new relationship between users and vehicles.
- **Disruptive innovation and the new "eco-mobility" system:** New mobilities are analogous to disruptive innovations that challenge the entire value chain of the "eco-mobility" ecosystem. Technico-economic analysis allows us to identify the different action levers available to new players in terms of innovation and value creation.

Smart Manufacturing and Connected Systems

Managers



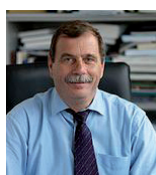
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Within this axis, we are interested in both new production methods of hyper-connected factories of the future and, more generally, the design of connected systems.

In terms of the industry of the future, the aim is to develop new approaches and to transform production methods in industry and in a broader scope to master «performance 4.0» in companies.

The objective is to support companies in their transition from a traditional industry to the industry of future. This industry must be more respectful of the environment, thanks to less resource-consuming, more intelligent and flexible modes of production generating less waste, while rethinking the man-machine interface.

This research concerns digital transformations of the industrial model such as:

- Transformation of business models by digital enterprises
- Modernization of the production tool
- More integrated design, marketing, supplier and sales functions
- Switching from mass production of standard products to mass production of more personalized products

Moreover, we also consider in this axis the design of any connected system in the broad sense: connected systems of product type (example: health monitoring systems) as well as production systems as already evoked by «industry of future».

Keywords: Factory of Future, Industry 4.0, smart manufacturing, connected factory, smart factory, machine learning, connected systems

Energy Systems

Managers



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Energy production and distribution systems, and loads

The “energy systems” or “energy” axis brings together all research dealing with the technical and economic management of energy systems, including:

- Economic viability, technical reliability, operational security, and the risks related to energy production, transmission, and distribution;
- Comparative analysis of low-carbon electricity production technologies, such as renewables and nuclear resources, and the investigation of electricity storage solutions;
- Integration of electrical mobility within the electricity supply and demand dynamics, investigation of new forms of low-carbon emission mobility solutions.
- Energy efficiency (eco-parks, co-generation, transmission, distribution, etc.), demand side management (smart grids, curtailments, etc.), and the effect of consumers’ behavior and usage on the energy consumption within the lifecycle of the product.
- Management of the different externalities produced by the energy system (beyond the CO2 emission), including nuclear wastes and the extraction of fossil and mineral resources.

Keys words

Renewable energy systems, Energy production plants, Energy networks, Energy market and regulation, Design of energy market, Energy transition, Energy performance contracts, Energy efficiency, Eco-designing energy stations, Simulation of energy consumption, Multi-criteria Analysis of Complex Energy System, Techno-Economic Analysis, Energy Economics and Management, Energy in Use Product, Uses and Behaviours in Energy Consumption, Decarbonised Mobility, Smart Grid, etc.

Health Systems

Managers



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The S2S (Axe Systèmes de Santé) Healthcare System Group of LGI is interested in developing new approaches, methods and tools related to Industrial Engineering, that are relevant for care production systems. For certain problems encountered in Healthcare, Industrial Engineering approaches that were initially developed for manufacturing systems can be applied, by integrating some specific assumptions and adapting the models. Other types of problems necessarily involve the development of new research methodologies for the realistic modeling of healthcare systems. Models we develop aim at achieving patient objective quality of service (by reducing waiting times, process times, etc.) and satisfying caregivers preferences (consultation hours, equitable load distribution, etc.) while avoiding the waste of resources (practitioners time, operational costs, investment costs, etc).

In more details, topics covered in our research team are:

- Modeling and simulation of hospital service operations
- Modeling and simulation of operations in EMS (Emergency Medical Service) systems
- Decision support for HomeCare
- Decision support for the design of m-health technologies
- Design of telemedicine systems

Industrial ecology

Managers



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Optimize material and energy flows in the design and manufacturing of goods and services

Circular Economy and Industrial Ecology are two complementary notions, where **Industrial ecology is seen as the scientific field allowing Circular Economy deployment** thanks to strategies like eco-design of products and services, product-service systems, industrial synergies... The objective is to **limit environmental impacts of human activities**, for example by pooling material, water and energy flows in an **integrated metabolism** approach.

The four LGI teams are all particularly implicated on Industrial Ecology issues. Current research themes deal with:

- **Eco-design and eco-innovation** methods and tools
- **Life Cycle Assessment (LCA)** of products and services, technologies families, value chains...
- **Industrial symbioses and eco-industrial parks**
- **Circularity indicators**
- **Sustainable supply chain** (reverse logistics, ecosystem services and sustainable supply chains...)
- **Energy efficiency**
- Technico-economic studies of **industrial value chains** including externalities
- **Decision making** in complex environmental with great uncertainties
- ...

These research projects are applied in numerous industrial sectors, however **sustainable buildings, cities and mobility** are particularly targeted.

WHO'S WHO



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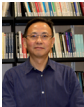
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