

2018

Annual Report

Laboratoire Génie Industriel
Industrial Engineering Research Department

LGI, EA 2606

“

In Industrial engineering, we observe, diagnose, model, design, exploit and optimize any and all kinds of human activities and their consequential performances/benefits for: end-users, value-chain stakeholders, nations.

Its transdisciplinary essence is what drives science in, for and with society; couched in the sustainability of life on Earth.



Bernard Yannou, head of LGI

This year...

We just moved on the brand new campus of Gif-sur-Yvette on the “plateau de Saclay” in September 2017 that we had to canvas, illustrate and narrate our activities for the 5-year ministerial scientific evaluation HCERES¹ of LGI.

It has been a challenging task, lasting a full year, of collecting information from our 5-year key research projects and accomplishments, our organization and our scientific and strategic vision. This team-building and reporting task culminated in the 2-day evaluation on November 27-28, 2018. The HCERES report synthesis is available (<https://www.hceres.fr/fr/rechercher-une-publication/lgi-laboratoire-genie-industriel-0>). The complete auto-evaluation report as well as the complete HCERES report are available on demand.

Excerpt of HCERES report synthesis on LGI – Feb 6th 2019 “(...) *the research unit has very good, if not excellent, indicators, both in terms of scientific production, partnership activity with the socio-economic world or doctoral training. The structure in four complementary teams is readable and coherent. The committee points out that these four teams all have a very good level of activity (...)*”

As far as our scientific project is concerned, we

plan to extend our axes in the next 5 years around **systems** and **digitalization**.

The world is becoming increasingly interconnected and systems are becoming more and more integrated in real time. The notion of systems of systems (SoS) becomes preponderant in understanding how the world works. Be it for the design of a product and/or service system (DE research group), its regulation (DA research group), its reliability (SR research group) and its economic viability (SE research group), the system must be designed in such a way that it is surrounded by other systems that are themselves constantly evolving. It will be necessary to develop models and theoretical approaches common to the teams and to develop more operational models within the research groups.

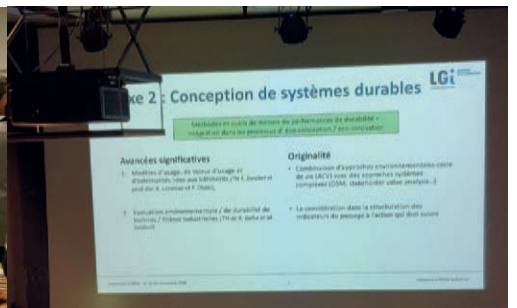
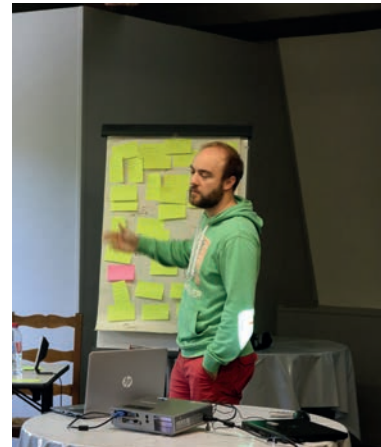
Digital technology is revolutionizing systems, both products and services in their use phase and throughout their life cycle, as well as the value and logistics chains of all types of activities.

LGI research department seeks to develop research projects and partnerships in compliance with this objective.

1. Haut Conseil de l’Evaluation de la Recherche et de l’Enseignement Supérieur



Preparation of HCERES



During the HCERES



Aim and scope

Industrial engineering is a well-established discipline worldwide. Despite the variety of names of research departments, curricula and doctoral schools in international universities, it often amounts to “Industrial, System Engineering and Management”. The objects of study of our scientific discipline are (1) Product-Service Systems and (b) as-is and to-be production or activity systems. These systems purposely exist to deliver adapted and optimal performances and create values to users through functions and services. These systems are designed, manufactured and delivered, exploited, maintained, updated and recycled. These systems are described by their architecture, are made of components, are configurable and demonstrate different properties like robustness, flexibility, agility, resilience, safety... Our scientific language is also made of processes, resources, performances, costs, risks, business models, decisions, needs, preferences,

competencies, projects, tasks, flows, stakeholders, value chains, supply chains, innovation, strategy, investments, economic and societal impacts...

The Industrial Engineering (IE) Research Department (Laboratoire Génie Industriel, LGI) studies production, activity or socio-technical systems along their life cycles. These systems are engineered by humans and must be observed, diagnosed, specified, designed, improved, manufactured, deployed, exploited, regulated, maintained and recycled. These systems (see Figure 1) 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.

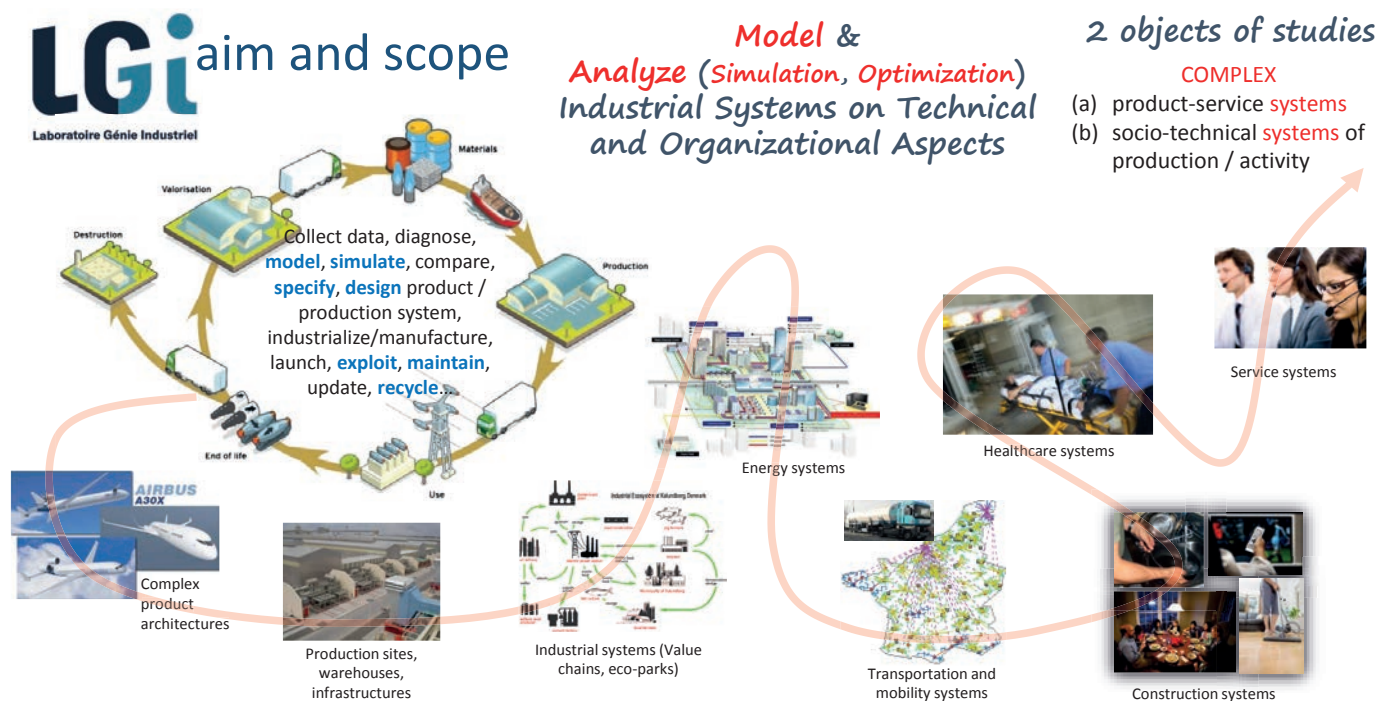


Figure 1: LGI studies production, activity or socio-technical systems along their life cycles

Key principles of our research are: multidisciplinary, life-cycle thinking (see Figure 2), societal and economical issues, model-based engineering approaches.

The systems we study 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...), see for instance Figure 3,
- a system feedback on its components and the emergence of macroscopic properties.

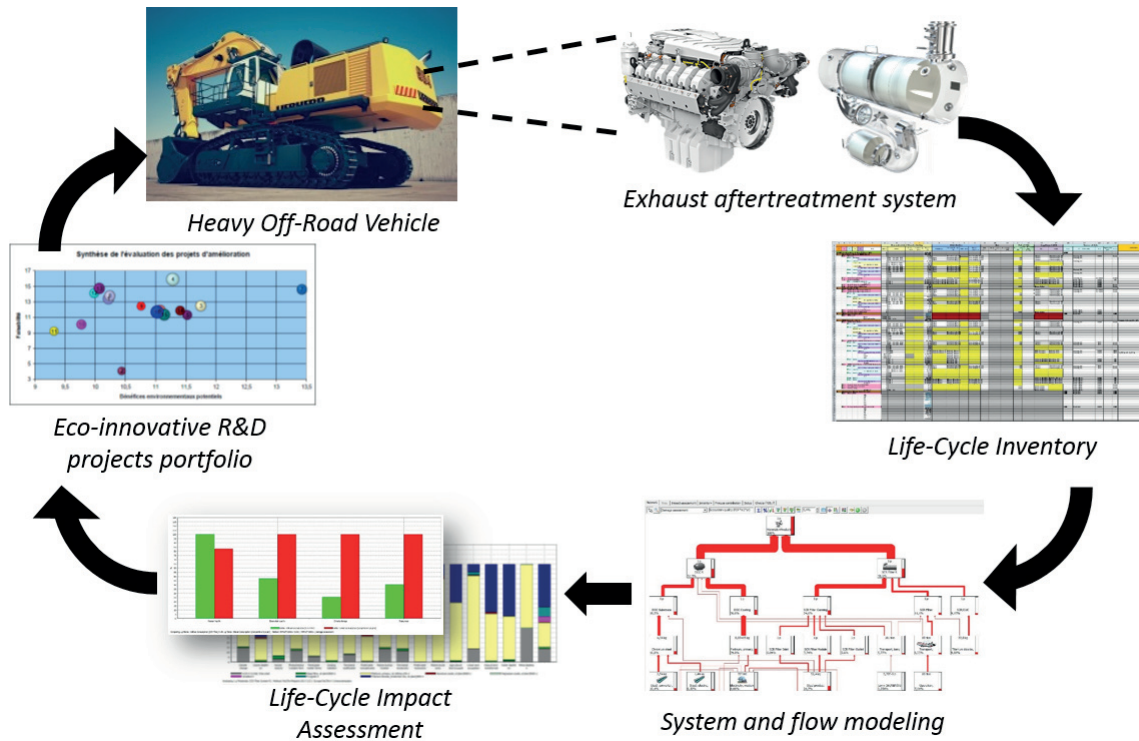


Figure 2: Life Cycle Assessment & Eco-Design of complex industrial systems



Figure 3: Simulation of a kitting automated cell (robot-operator collaboration upstream of an assembly line)

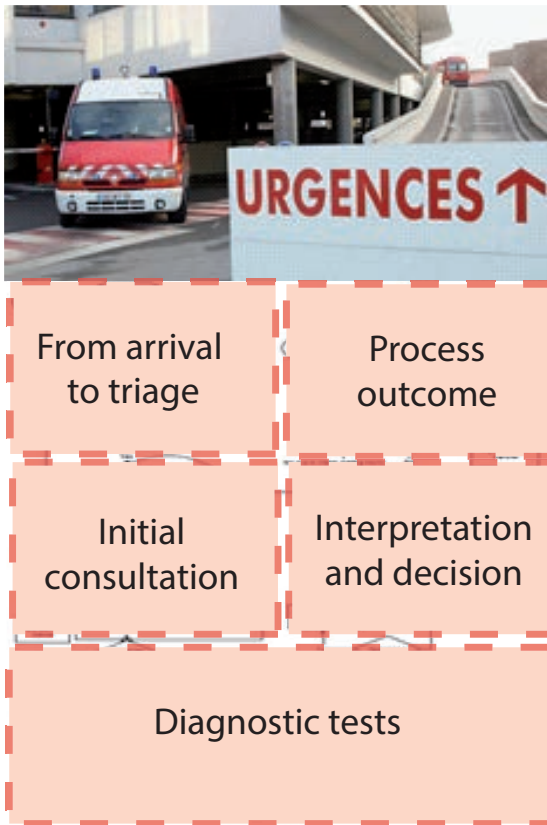


Figure 4: Optimization of patient flows in emergency services

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, resilience. 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 (see Figure 4) 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, dimensioning, validation, manufacture and market launch or startup), system management (its regulation, its maintenance, its failure modes, its upgrade, its dismantling and end of life).

Organization

LGI is organized in 4 research groups, 5 transversal themes and 8 industrial chairs. The 4 research groups have 3 research axis each (see Table 1). The 5 transversal themes are: Mobility systems, Energy systems, Healthcare systems, Industry of future, Circular economy. The 8 industrial chairs are presented in Table 2.

1. Design Engineering	Design of Complex Systems	Design of Sustainable Systems	Innovation Engineering
2. Decision Aid	Service Operations Management	Supply Chain Management/Transport	Multiple Criteria Decision Aid
3. Safety and Risks	Energy network systems	Aging and failure processes in components of energy production plants	Dependable embedded systems
4. Sustainable Economy	Economy and Management of Innovation	Economy and Management of Mobility	Economy and Management of Energy

Table 1: The research axes of the four research teams

Chair	Industrial partners / academic partners
Maîtrise des risques liés aux achats dans les projets complexes (2013+) Control of procurement risks in complex projects	Total
Anthropolis – Conception de systèmes urbains centrés usagers (2015+) - Human-centered urban systems design	RATP, SNCF, Renault, Alstom, Engie / IRT SystemX
Supply Chain (2010+)	LVMH, Sanofi, Carrefour, Safran
Call Centers (2016+)	Interact'iv
Science des Systèmes et Défis Energétiques Systems Science and Energy Challenges	EDF
Blériot-Fabre - Conception de systèmes aéronautiques embarqués robustes (2014+)	Safran
Armand Peugeot – Technologies hybrides et économie de l'électro-mobilité (2014+) Hybrid technologies and the economics of electro-mobility	PSA Peugeot Citroën / Geeps, ESSEC
Economie de la Croissance Durable (2011+) Sustainable Growth Economy	CapitalDon

Table 2: The 8 industrial chairs

Industrial Partners (currently)

- Automotive industry/transport: Renault, PSA, Valéo, Akka Technologies, RATP, SNCF, Alstom
- Aeronautics : Thalès, Safran, Airbus
- Energy : EDF, Total, Engie
- Information science: IBM, Place des leads, Interact-IV
- Control: Schneider Electric, Siemens
- Services: IWIPS, Leynaud & Associés, Etablissement Français du Sang, Mairie de Paris, Le Basic, CapitalDon
- Goods: LVMH, Sanofi, Carrefour
- Construction: Bouygues Construction
- Research institutes: CEA, IRT SystemX, VEDECOM, Agence Régionale de Santé

Academic Partners (currently)

More than 50 collaborations abroad: Allemagne (Université de Magdeburg, TU Munich, Université de Nuremberg Erlangen), Angleterre (University of Liverpool, University of Bath, The Open University), Australie (University of Queensland, Université de Melbourne), Autriche (University of Vienna), Belgique (Université de Louvain, Université de Mons), Brésil (UFRJ, PUC, Université de Lavras), Canada (Mc Gill University, ETS), Chine (Beihang University, Ecole Centrale Beijing, Wuhan University of Technology, University of Honk Kong), Danemark (DTU), Espagne (Université de Valence), Finlande (University of Helsinki, Aalto University), Italie (Université de Catane, Politecnico di Milano, Politecnico di Torino), Japon (Chiba University, RITE-Kyoto), Liban (Université de Beyrouth), Luxembourg (Université de Luxembourg), Maroc (Ecole Centrale de Casablanca), Norvège (University of Stavanger), Pays-Bas

(VU University Amsterdam), Pologne (Poznan University of Technology), Portugal (University of Coimbra), Singapour (SUTD), Suisse (HEC Lausanne, ETHZ), Tunisie (ENIT, ENIM), Turquie (Koç University), USA (Northwestern University Chicago, MIT, Penn State University, Georgia Institute of Technology, Iowa State University, University of Minnesota, University of Illinois at Urbana-Champaign, Illinois University).

KEY FIGURES

2018

85 members

Faculties: 30

PhD Candidates: 43

Postdoctoral Researchers: 5

Technical and administrative staffs: 7

Visiting scholars: 4

Journals Papers: 107

Contracts: 2,58 M€, including Chairs



DESIGN
ENGINEERING

Industrial Engineering Research Department

Design Engineering Research Group 2018

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8 Faculty Members: François Cluzel, Marija Jankovic, Julie Le Cardinal, Yann Leroy, Franck Marle, Flore Vallet, Ludovic-Alexandre Vidal, Bernard Yannou

2 Postdoctoral Researchers: Andreas Hein, Massinissa Mammeri

16 PhD Candidates: Ouail Al Maghraoui, Alexandre Bekhradi, Sylvain Bolifraud, Youssef Damak, Mathieu Dernis, Sarra Fakhfakh, Naouress Fatfouta, Tianjun Hou, Yiming Ma, Diya Moubdi, Lara Qasim, Michaël Saidani, Yasmine Salehy, Timothé Sissoko, Reza Vosooghi, Rongyan Zou.

Research

Research areas and results

Our research aims at scaffolding complex system design and engineering, combining the product/service, process and organizational dimensions. These complex systems are the focus of our work in diagnosis, modeling, analysis, simulation and optimization. Our expertise extends across three axes:

1. Design of complex systems: aims at developing methods and tools supporting decision-making with regard to design of products/services/systems, organizations, projects, and systems of systems. In 2018, several research projects were undertaken on using relational theory and complex systems modeling (matrix- and graph-based models) for modeling interdependencies between elements (like system architectures and business models, or project deliverables network and human organization) and organizing design options around these interdependencies.

2. Design of sustainable systems: systems aim at developing methods and tools to model, measure and optimize sustainable performances of complex systems. In 2018, main results deal with the development and implementation of eco-ideation mechanisms to systematically explore a sustainable design space. The development of circularity indicators applied to the heavy vehicles industry are also a major achievement in 2018. New research works have also been initiated on eco-design of digital services and the generation of sustainable architectures of complex industrial systems.

3. Innovation engineering consists in bridging the gap between business strategy, R&D planning, product road-

maps, conceptual design and innovation processes. In addition, we are developing and enhancing a structured need-seeker innovation methodology, named Radical Innovation Design®, for pulling disruptive innovations from the observation of painful usage situations. The results in 2018 are the creation of the HyB'RID startup to disseminate the method, associated with several research projects on modeling user-centered information.

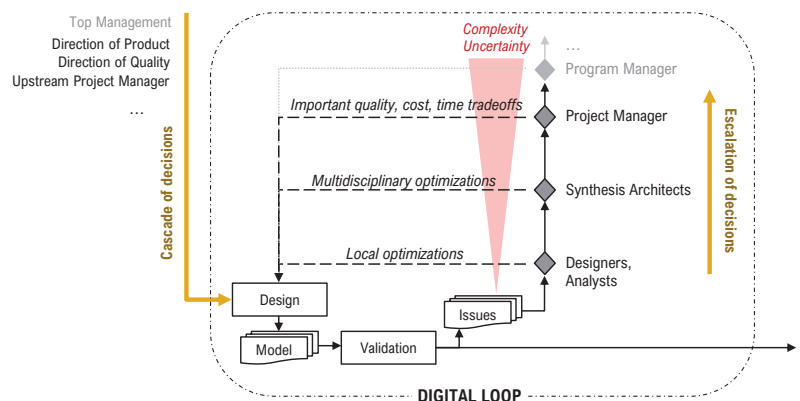


Fig. Escalation of decisions in a digital loop

Research Project

We aim at integrating our design science-based approaches at a higher system level, integrating also the digitalization of such systems and associated organizations. More precisely, for axis 1, the research project deals with systems of systems design, deeper modeling of interdependencies between system and project components, synchronization or sequencing of multiple interrelated decisions, and integration of innovative management modes (notably considering the co-existence with traditional management modes). Axis 2 aims at developing and promoting circular economy and evolving from an evaluation to a management mode, including selecting actions and prioritizing investments. This will be based on improvement of multi-criteria, multi-scale and multi-actor simulation and optimization models. About innovation engineering axis (axis 3), the project is twofold: characterizing the potential of a technology and digitalizing innovation. Characterizing the potential of a technology will enable push innovative technologies on markets, but also to propose maturity roadmaps, with potential markets associated to every level of technological maturity. Digitalizing innovation aims at making design and innovation activities more efficient, attractive and fluid.

In 2018

26 Members

1 research chair

3 PhDs completed

7 Journals

19 Conference papers

5 Book sections

Some Publications

Innovation

Guillaume Lamé, Bernard Yannou, François Cluzel. Usage-driven problem design for radical innovation in health-care. *BMJ Innovations*, 2018, 4 (1), pp.15-23.

Complex Systems Design

Guillaume Lamé, Julie Stal-Le Cardinal, Oualid Jouini. Methods and Contexts: Challenges of Planning with Scenarios in a Hospital's Division. *Futures*, Elsevier, In press.

Julien Ventroux, Franck Marle, Ludovic-Alexandre Vidal. Organizational reshuffling to facilitate coordinated decisions in complex projects. *Concurrent Engineering: Research and Applications*, SAGE Publications, 2018.

Sustainability

Yann Leroy, Bernard Yannou. An activity-based modelling framework for quantifying occupants' energy consumption in residential buildings. *Computers in Industry*, Elsevier, 2018, 103, pp.1-13.

Michael Saidani, Bernard Yannou, Yann Leroy, François Cluzel. Heavy vehicles on the road towards the circular

economy: Analysis and comparison with the automotive industry. *Resources, Conservation and Recycling*, Elsevier, 2018, 135, pp. 108-122.

Gaëlle Petit, Caroline Sablayrolles, Gwenola Yannou-Le Bris. Combining eco-social and environmental indicators to assess the sustainability performance of a food value chain: A case study. *Journal of Cleaner Production*, Elsevier, 2018, 191, pp.135 - 143.

Michael Saidani, Alissa Kendall, Bernard Yannou, Yann Leroy, François Cluzel. What about the circular economy of vehicles in the U.S.? An extension of the analysis done in the EU by Saidani et al. (2017). *Resources, Conservation and Recycling*, Elsevier, 2018, 136, pp.287-288.

Book / Chapter

Yann Leroy, François Cluzel. Comparing Sustainable Performance of Industrial System Alternatives in Operating Conditions. Pascal Da Costa; Danielle Attias. *Towards a Sustainable Economy - Paradoxes and Trends in Energy and Transportation*, Springer International Publishing, 2018, Sustainability and Innovation, pp.83-100.

Collaborations

Academic Collaborations (in 2018)

Gaëlle Petit (AgroParisTech)
Caroline Sablayrolles (ENSIACET)
Michael Kokkolaras (McGill University, Canada)
Harrison Kim, University of Illinois at Urbana-Champaign (USA)
Alissa Kendall, UC Davis (USA)
Guillaume Lamé, Cambridge University (UK)
IRSTEA

Industrial and institutional collaborations (in 2018)

TOTAL, CEA-DAM, Orange, DGA, Groupe PSA, Vinci Construction, RTE (projet PRC EcoSD AVEC), iWips, Manitou, Mairie de Paris, IRT SystemX.

Invited Professor

Michael Kokkolaras (McGill University, Canada)

3 Recent PhDs

Michael Saidani, *Monitoring and advancing the circular economy transition – Circularity indicators and tools applied to the heavy vehicle industry*

Tianjun Hou, *Online review analysis: how to get useful information for innovating and improving products?*

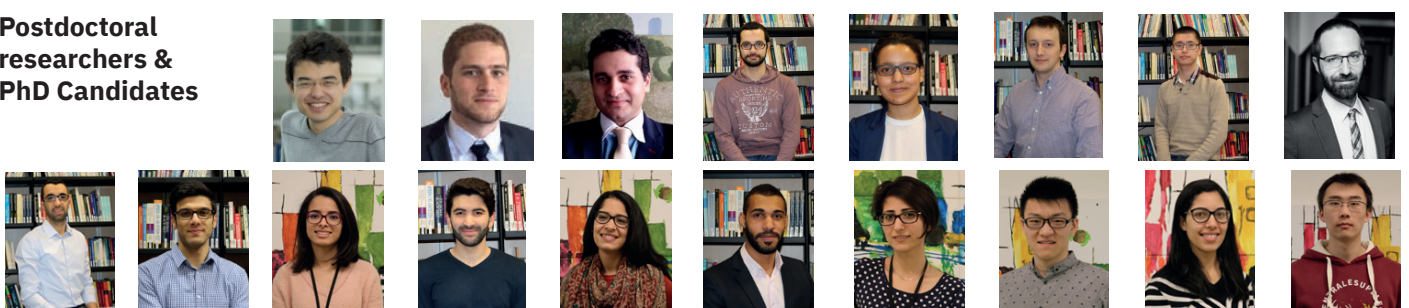
Alexandre Bekhradi, *Planning technology maturation by exploration of useful problems in markets: The case of innovative startups*

Members

Faculty Members

	<p>François CLUZEL Assistant professor francois.cluzel@centralesupelec.fr</p>	Eco-design, Innovation engineering, Eco-innovation, Industrial ecology , Life-Cycle Assessment (LCA), Artificial intelligence in design, Design automation
	<p>Marija JANKOVIC Associate professor marija.jankovic@centralesupelec.fr</p>	Complex system design, System architecture design, Innovation engineering, Collaborative engineering, Healthcare system engineering
	<p>Julie LE CARDINAL Professor julie.le-cardinal@centralesupelec.fr Head of “Enterprises Sciences” Education Department</p>	Facilitating decision-making, Systemic modeling, Knowledge management, Choice of actors, Complex system design, Healthcare system engineering
	<p>Yann LEROY Assistant professor yann.leroy@centralesupelec.fr</p>	Ecodesign, Life Cycle Assessment, Sustainable design, Eco-innovation, Industrial Engineering Life Cycle Engineering, Recycling
	<p>Franck MARLE Professor franck.marle@centralesupelec.fr</p>	Project management, Complex projects, Contracts & procurement, Project risks, Project vulnerability, Complexity modeling, Topological analysis, Propagation analysis, Clustering, Decision-making
	<p>Flore VALLET Assistant professor flore.vallet@centralesupelec.fr Working for Chair “Anthropolis” with IRT-SystemX</p>	Eco-design, Innovation engineering, Eco-innovation, Life Cycle Assessment, Urban mobility, Sustainable mobility, Industrial design
	<p>Ludovic-Alexandre VIDAL Assistant professor ludovic-alexandre.vidal@centralesupelec.fr</p>	Project management, Risk management, Complexity, System thinking
	<p>Bernard YANNOU Professor bernard.yannou@centralesupelec.fr Head of LGI</p>	Design automation, Design methodologies, Product development, Innovation engineering, Ecodesign, Artificial intelligence in design, Design processes and management

Postdoctoral researchers & PhD Candidates





Industrial Engineering Research Department

Decision Aid Research Group 2018

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11 Faculty Members: Walid Behiri, Yves Dallery, Asma Ghaffari, Zied Jemaï, Oualid Jouini, Benjamin Legros, Vincent Mousseau, Wassila Ouerdane, Jakob Puchinger, Fouad Riane, Evren Sahin

Postdoctorale researcher: Hicham Benbitour

15 PhD Candidates: Ouail Maghraoui, Khaled Belahcene, Selmen Boubaker, Amine Boudella, Junfei Chu, Mathieu Dernis, Sadèque Hamdan, Najoua Lakhmi, Abood Mourad, Gustavo Santamaria-Acevedo, Haythem Selmi, Reza Vosoghi, Shaohua Yu, Yizeng Zeng, Zhe Yuan

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 to effectively answer to the questions to which decision makers are confronted. These works often lead to new concepts, tools and decision support methodologies whose validity extends far beyond the application for which they were initially designed.

Our research is structured into three main research projects:

- Service Operations Management (Healthcare systems, Call centers, ...)
- Supply Chain Management (supply chain design and planning, cooperation and competition, flow and inventory management, green supply chain)
- 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 and dynamic programming.

5 Recent PhDs

Maxime Claisse, *Production Planning under Uncertainties and Forecasts Update*

Mohammed Hichame Benbitour, *Inventory Control and Internal Logistics Operations Management in the Automotive Industry: Application to Faurecia*

Mohamed el Amine Boudella, *Analysis of a hybrid robot-operator kitting system in the automotive industry: design and optimal assignment of parts to pickers*

Kahled Belahcene, *Frameworks for the multi-perspective analysis of critical infrastructures*

Junfei Chu, *Méthodes d'optimisation pour l'évaluation de l'efficacité croisée de l'analyse de l'enveloppement des données*

In 2018

26 Members

3 Research Chairs

5 PhDs completed

24 Journals

11 Conference papers

h-index (WoS) 33

430 Citations (WoS)

Some Publications

Mohammed Hichame Benbitour, Evren Sahin, Yves Dallery. The use of rush deliveries in periodic review assemble-to-order systems. *International Journal of Production Research*, Taylor & Francis, 2018, pp. 1-20.

Benjamin Legros, Oualid Jouini, Ger Koole. A Uniformization Approach for the Dynamic Control of Queueing Systems with Abandonments. *Operations Research, INFORMS*, 2018, 66 (1), pp. 200-209.

Oumaima Khaled, Vincent Mousseau, Michel Minoux, Xavier Ceugniet, Michel Stéphane. A compact optimization model for the tail assignment problem. *European Journal of Operational Research*, Elsevier, 2018, 264 (2), pp. 548-557.

Mohamed El Amine Boudella, Evren Sahin, Yves Dallery. Kitting optimisation in Just-in-Time mixed-model assembly lines: assigning parts to pickers in a hybrid robot-operator kitting system. *International Journal of Production Research*, Taylor & Francis, 2018, pp. 1-20.

Benjamin Legros, Oualid Jouini, Ger Koole. Blended call center with idling times during the call service. *IIE Transactions*, 2018, 50 (4), pp. 279-297.

Zied Jemai, Imen Safra, Aida Jebali, Hanen Bouchriha, Asma Ghaffari. Capacity planning in textile and apparel supply chains. *IMA Journal of Management Mathematics*, Oxford University Press (OUP), 2018, 00, pp. 1-25.

Khaled Belahcene, Christophe Labreuche, Nicolas Maudet, Vincent Mousseau, Wassila Ouerdane. An efficient SAT formulation for learning multiple criteria non-compensatory sorting rules from examples. *Computers and Operations Research*, Elsevier, 2018, 97, pp. 58-71.

Khaled Belahcene, Yann Chevalere, Nicolas Maudet, Christophe Labreuche, Vincent Mousseau, Wassila Ouerdane. Accountable Approval Sorting. *Proceedings of the 27th International Joint Conference on Artificial Intelligence and the 23rd European Conference on Artificial Intelligence (IJCAI-ECAI 2018)*.

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 Professor

Marc PIRLOT, Université de Mons, Belgique

Associated industrial chairs

Supply Chain: Carrefour, LVMH, Safran, Sanofi

Anthropolis: Alstom, Engie, RATP, Renault, SNCF, IRT-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 Queueing

Models and Service Management

Editorial boards


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

Industrial and institutional collaborations, Agence Régionale de Santé, Carrefour, EDF, Eurodecision, Hôpital Henri Mondor, IBM, Michelin, Place des Leads, Groupe Renault, Safran, Sanofi

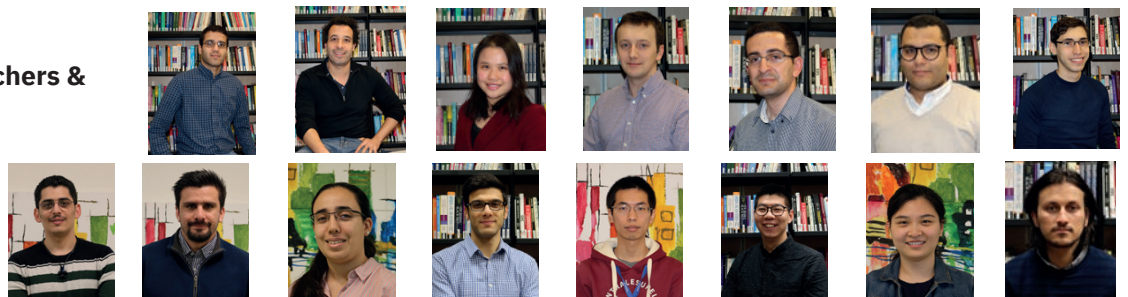
Our research networks : CNRS, GdR Macs, GdR RO, Roa-def

Members

Faculty Members

	Walid BEHIRI Assistant professor (ATER) walid.behiri@centralesupelec.fr	Supply chain, Operations research
	Yves DALLERY Professor yves.dallery@centralesupelec.fr Chair Holder "Supply Chain Management"	Supply chain management, Supply chain design, Service operations
	Asma GHAFARI Assistant professor asma.ghaffari@centralesupelec.fr	Decision aid, Supply chain, Operations research, Decision making modelling and analysis
	Zied JEMAÏ Associate professor zied.jemai@centralesupelec.fr Chair "Supply Chain Management"	Supply chain management, Competition and coordination in supply chain, Inventory management of perishable items
	Oualid JOUINI Professor oualid.jouini@centralesupelec.fr Chair Holder "Call Centers"	Stochastic modeling, Service operations management, Call centers, Healthcare systems
	Benjamin LEGROS Assistant professor benjamin.legros@centralesupelec.fr Chair "Call Centers"	Call centers, Stochastic modeling, Service operations management, Healthcare systems
	Vincent MOUSSEAU Professor vincent.mousseau@centralesupelec.fr	Multiple criteria decision aid, Preference modeling, Preference elicitation, Spatial decision, Behavioral decision analysis
	Wassila OUERDANE Assistant professor wassila.ouerdane@centralesupelec.fr	Multiple criteria decision aid, Preference modeling, Artificial intelligence, Argumentation theory, Explanation systems
	Jakob PUCHINGER Professor jakob.puchinger@centralesupelec.fr Chair Holder "Anthropolis" with IRT-SystemX	Urban mobility, Transport optimization, Combinatorial optimization, Exact and heuristic optimization methods, Operations research
	Evren SAHIN Professor evren.sahin@centralesupelec.fr	Supply chain management, Production, Internal logistics, Operations management, Service operations management, Healthcare engineering

Postdoctoral Researchers & PhD Candidates





Industrial Engineering Research Department

Safety & Risks Research Group 2018

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1 Postdoctoral researcher: William Fauriat

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1 Engineer: Loïc Peletan

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 different, multidisciplinary system perspectives (topological and functional, static and dynamic) 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.

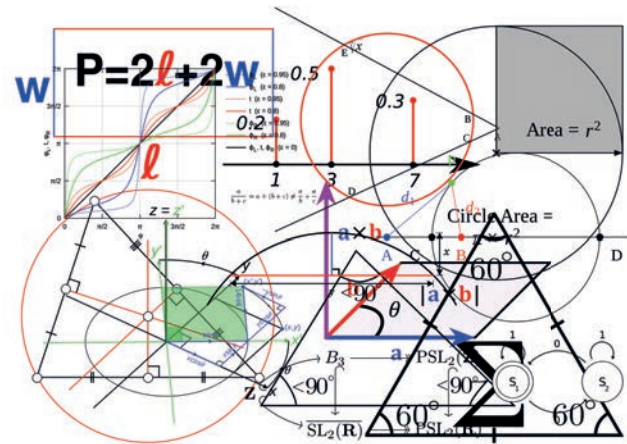
Research Area

Our research is organized around 3 main topics:

1. Energy network systems reliability, safety and resilience, focusing on modeling, simulating and optimizing electrical network systems, i.e., power grids, microgrids, smart grids, and other critical infrastructures interconnected with power systems (e.g. transport networks). 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, etc.) 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.



2 Recent PhDs

Fangyuan Han, *Frameworks for the multi-perspective analysis of critical infrastructures*

Zhiyi Wang, *A framework for seismic risk assessment based on artificial neural networks*

In 2018

16 Members

2 Research chairs

2 PhDs completed

64 Journals

14 Conference papers

Some Publications

Journal

Abdin, I. F., & Zio, E. An integrated framework for operational flexibility assessment in multi-period power system planning with renewable energy production. *Applied Energy*, 2018, 222, pp.898-914.

Fang, Y. P., & Zio, E. An adaptive robust framework for the optimization of the resilience of interdependent infrastructures under natural hazards. *European Journal of Operational Research*. (2019).

Zeng, Z., Kang, R., Wen, M., & Zio, E. Uncertainty theory as a basis for belief reliability. *Information Sciences*, 2018, 429, pp. 26-36.

Wang, Z., Zentner, I., & Zio, E. A Bayesian framework for estimating fragility curves based on seismic damage data and numerical simulations by adaptive neural networks. *Nuclear Engineering and Design*, 2018, 338, pp. 232-246.

Fan, M., Zeng, Z., Zio, E., Kang, R., & Chen, Y. A stochastic hybrid systems model of common-cause failures of degrading components. *Reliability Engineering & System Safety*, 2018, 172, pp. 159-170.

Li, X. Y., Huang, H. Z., Li, Y. F., & Zio, E. (2018). Reliability assessment of multi-state phased mission system with non-repairable multi-state components. *Applied Mathematical Modelling*, 2018, 61, pp. 181-199.

Book / Chapter

Mahboob, Q., & Zio, E. (Eds.). *Handbook of RAMS in Railway Systems: Theory and Practice*. CRC Press. 2018.

Fang, Y., & Zio, E. Game-Theoretic Decision Making for the Resilience of Interdependent Infrastructures Exposed to Disruptions. In *Critical Infrastructure Security and Resilience* (2019), pp. 97-114, Springer, Cham.

Collaborations

Academic collaborations

Europe: Technical University of Denmark, Politecnico di Milano (Italy), Universitat Politècnica de València (Italy), ETH Zurich (Germany), Norwegian University of Science and Technology, Liverpool John Moores University (United Kingdom), Manchester University (United Kingdom).
Rest of the World: Alzahra University (Iran), Beihang University (China), City University of Hong Kong (China), North China Electric Power University, Wuhan University of Technology (China), National University of Singapore, Idaho National Laboratory (USA), MIT (USA).

Invited professors

Juan Chen, Beihang University, China
Jose Ramirez-Marquez, Stevens Institute of Technology, USA
Roger Flage, University of Stavanger, Norway

Associated industrial chairs

Chair on Systems Science and the Energy Challenge, Fondation Electricité 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>
Institut de la Science des Risques et de l'Incertain (ISRI), CentraleSupélec
Laboratorio Analisi di Segnale e Analisi di Rischio (LA-

SAR), Politecnico di Milano, www.lasar.polimi.it

Industrial and institutional collaborations

Alstom transport, campus France, CEA, EDF, Safran, Siemens

Events

International conferences

IEEE-2018 International Conference on System Reliability and Safety, 24-26 November 2018, Barcelona, Spain.

Seminar

EDF-CentraleSupélec Chair Day, EDF R&D Paris-Saclay, France

Members

Faculty Members

	Yiping FANG Assistant Professor yiping.fang@centralesupelec.fr	Risk, Reliability and resilience assessment, Optimization, Complex engineering systems, Critical infrastructure, Uncertainty quantification, Stochastic and robust optimization
	Zhiguo ZENG Assistant Professor zhiguo.zeng@centralesupelec.fr	Reliability, Dynamic risk analysis, Prognostics and health management, Uncertainty quantification
	Enrico ZIO Professor enrico.zio@centralesupelec.fr	Risk, Reliability, Safety, Resilience analysis and maintenance and asset management of complex systems and critical infrastructures, Monte Carlo simulation methods, Soft computing techniques for meta-modeling, Evolutionary and heuristic techniques for optimization, Energy, Nuclear, Oil and gas systems

Postdoctoral Researchers & PhD Candidates





**SUSTAINABLE
ECONOMY**

Industrial Engineering Research Department

Sustainable Economy Research Group 2018

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Research

The Sustainable Economy Research Group, formed in 2011/2012, is the youngest team in the laboratory. We research economic and managerial analysis; assessment of innovations, including their economic impacts on organizations and the societies, with a special focus on eco-innovations and ecological transition, for the two key sectors of mobility and energy.

“Sustainable Economy” has three axes:

- **“Economics and Management of Innovation”.** This direction deals with the evolution of technical progress and the effectiveness of organizations. We seek a better understanding of the decisions of economic agents regarding investment and innovation, their microeconomic impacts on the growth of organizations, the organization of production and operational efficiency, as well as the effects on the distribution of income at the macroeconomic level (i.e. inequalities.). This research is conducted using optimization methods, econometric studies, as well as case and field studies.
- **“Economics and Management of Mobility”.** This second axis deals with decarbonated – electrical and autonomous – mobility, as well as with the links with the electricity market (i.e. hybrid energy market = electricity + transport) through the challenges of electrical storage (electricity storage/unloading solutions through electrical vehicles). This research is conducted using technico-economic studies, econometric methods and strategic analyses, notably on innovative business models on sustainable mobility.

In 2018

18 Members
3 Research chairs
3 PhDs completed
16 Journals
42 Conference papers
6 Book sections

Head | Pascal Da Costa

8 Faculty Members: Danielle Attias, Jean-Claude Bocquet, Pascal Da Costa, Angéla Minzoni, Eléonore Mounoud, Isabelle Nicolaï, Yannick Perez, Mehdi Senouci.

1 Postdoctoral researcher: Georges Vivien Houghbonon

9 PhD Candidates: Yurong Chen, Mathieu Dernis, Icaro Freitas Gomes, Rodrigo Gandia, Bassem Haidar, Martin Leurent, Robin Molinier, Judith Pigneur, Olfa Tlili.

- **“Economics and Management of Energy”.** This third axis deals with renewable, fossil and mineral energy resources (from the extraction industry to the final use within production of consumption systems), with the aim of reaching the decarbonization of the energy mix of the economy. In this perspective, energy efficiency (co-generation, industrial ecoparks) and the regulation of the markets tied to the energy transition are deeply studied. This direction develops research methods in technico-economics, and in forecasting, as well as analyses of global value chains.

3 Recent PhDs

Yurong Chen *How Carmakers Manage Innovation in the Electric Vehicle Ecosystem?*

Martin Leurent *Nuclear plants as an option to help decarbonising the European and French heat sectors? A technoeconomic prospective analysis*

Robin Molinier *Analyse économique des éco-parcs industriels : une approche par les transactions pour la valorisation des synergies et la gestion des risques*

Some Publications

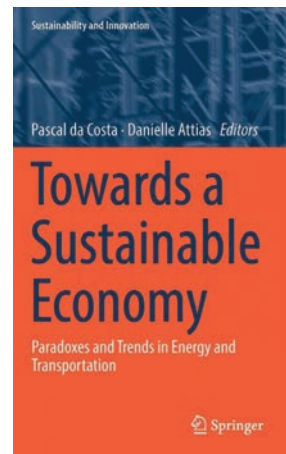
Dorothée Brécard, Rémy Le Boennec, Frédéric Salladaré. Accessibility, local pollution and housing prices. Evidence from Nantes Métropole, France. *Economie et Statistique*, INSEE, 2018.

Olivier Borne, Yannick Perez, Marc Petit. Market integration or bids granularity to enhance flexibility provision by batteries of electric vehicles. *Energy Policy*, Elsevier, 2018, pp. 140-148.

Camille Cany, C. Mansilla, G. Mathonniere, Pascal Da Costa. Nuclear contribution to the penetration of variable renewable energy sources in a French decarbonised power mix. *Energy*, Elsevier, 2018, pp. 544-555.

Martin Leurent, Pascal Da Costa, Miika Rämä, Urban Persson, Frédéric Jasserand. Cost and climate savings through nuclear district heating in a French urban area. *Energy Policy*, Elsevier, 2018, pp. 616-630.

Rodrigo Gandia, Fabio Antonialli, Bruna Cavazza, Arthur Neto, Danilo Lima, Isabelle Nicolaï et al.. Autonomous vehicles: scientometric and bibliometric review. *Transport Reviews*, Taylor & Francis (Routledge).



Pascal Da Costa, Danielle Attias. *Towards a Sustainable Economy: Paradoxes and Trends in Energy and Transportation*. France. Springer International Publishing, 2018.

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 Économie Numérique (IREN)

National and International Scientific Network:

France: Strate Ecole de Design, ESSEC, CEA Saclay, University Paris Dauphine, University of Montpellier, Club de l'Orme: the energy experts of Paris Saclay, Le Basic (Paris), VEDECOM: Public-private research institute about decarbonized mobility...

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

Member of:

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

Associated Research Chairs

- Chair Operational Efficiency by BNP Paribas
- Chair Armand Peugeot on Electromobility and hybrid Technology by Peugeot-Citroën (with Essec)
- Patronage by endowment fund Capitaldon on Sustainable Growth




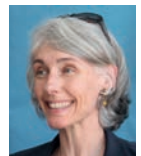

European Project: H2020 - AVENUE Autonomous Vehicles to Evolve to a New Urban Experience

Events

- Seminars by Paris-Saclay doctoral students in Economics and Energy Transition with the support of FAEE (French Association for Energy Economics) and CEC (Chaire d'Economie du Climat): bi-monthly seminar.
- 6-7 December 2018 : 6th International Conference of the Chair Armand Peugeot : Electromobility Challenging Issues. CentraleSupélec, Gif-sur-Yvette.

Members

Faculty Members

	Danielle ATTIAS Adjunct Professor danielle.attias@centralesupelec.fr Chair Holder “Electro-mobility” (PSA Peugeot Citroën)	Electromobility, New business models for Automotiv Industry, Innovavite mobility and Public Policies
	Jean-Claude BOCQUET Professor jean-claude.bocquet@centralesupelec.fr	Complex system design, Design process and management, Value chain management, Technico economics of complex systems
	Pascal DA COSTA Professor pascal.da-costa@centralesupelec.fr Head of SE Team, Head of “Enterprises Sciences” Education Department	Sustainable development, Climat, Environment and energy, Ecosystem services, Optimal resources exploitation, Optimal pollution, Innovation, Endogenous growth theories, Semi-endogenous growth, Imperfect competition
	Angela MINZONI Adjunct Professor angela.minzoni@centralesupelec.fr Chair Holder “operational excellence” (BNP Paribas)	Business and industrial anthropology, Design, Gender issues, Simplicity
	Eleonore MOUNOUD Associate Professor eleonore.mounoud@centralesupelec.fr	Sustainable development, Innovation, Management
	Isabelle NICOLAÏ Professor isabelle.nicolai@centralesupelec.fr	Eco-innovation, Disruptive technology, Multi agents and criteria decision-making, User-centred design, Multimodal mobility, Business model
	Yannick PEREZ Associate Professor yannick.perez@centralesupelec.fr Chair “Electro-mobility” (PSA Peugeot Citroën)	Market design, Energy economics, Electromobility
	Mehdi SENOUCI Associate Professor mehdi.senouci@centralesupelec.fr	Economic growth and fluctuations, Economic theory, International financial macroeconomics

Postdoctoral Researchers & PhD Candidates





Themes

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Ambassadors



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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 may also be 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 stakeholder's mobility requirements in a transition context. The themes tackled by our research are the following:

- Sustainable urban mobility: we rethink the mobility concept (new usages, new services, multi-modal transport system) for the ecological, digital and social transition of the urban spaces or territories with the integration of the autonomous vehicle.



















- Electro mobility economy: we study the link between the business models of electric vehicles and smart grids, and also the performance of new mobility services (MaaS).

Our purpose is to offer a global and pertinent analysis and design approach of mobility systems while strengthening collaborations between LGI teams.

Keywords:

Sustainable urban mobility, electro-mobility, Business model innovation, autonomous car, MaaS, user centered eco-innovations, disruptive technology and mobility eco-system.

We work in partnership on action research projects and thesis supervision on the following topics.

	Engineering Design	Safety and Risks	Sustainable Economy	Scientific locks
1. Analysis and modeling of multi-modal uses				Overall performance indicators Estimation of direct, indirect and induced effects
2. Design of innovative mobility solutions				Multi-criteria decision, multi-agent simulation
3. New business models and value chain				Overall performance indicators Modeling interdependencies between actors and value creation
4. Multi-modality prospective scenarios				Complex system modeling Modeling interdependencies between actors and value creation
5. Mobility and smart city				Modélisation interdépendances entre acteurs et création valeur Politique coordination
6. Externalities and performance evaluation				Modeling interdependencies between actors and value creation Policy coordination
7. User/demonstrator experiences				Complexité des systèmes Politique coordination

The main results in 2018 which are significant for partnerships between LGI teams are the following :

Launching of project	H2020 AVENUE Autonomous Vehicles to Evolve to a New Urban Experience, programme «Full-scale demonstration of urban road transport automation» (2018-2022)
Renewal of partnership	Armand Peugeot Chair on eco-mobility (ESSEC, Peugeot)
PhD in co-tutelle	With U. Lavras (Brazil), thesis of Rodrigo Gandia “Innovation in Business Models: A Study from the View of Mobility as a Service (MaaS) in Autonomous Vehicles in Brazil and France
Publishing of a book	Pascal DA COSTA and Danielle ATTIAS (Eds), Towards a Sustainable Economy: Paradoxes and Trends in Energy and Transportation, Springer International Publishing, 2018
Journal articles published in 2018	Renewable and Sustainable Energy Reviews, International Journal of Automotive Technology and Management, Sustainability, Energy Policy...
Conferences and workshops attended in 2018	ROUTE 2018, EURO 2018, EWGT 2018, Rencontres Francophones Transport-Mobilité 2018 ...



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The “Healthcare System Engineering” (S2S) Research Group aims at developing new approaches, methods and tools for managing and organizing healthcare systems, by adapting approaches traditionally used in Industrial Engineering in order to integrate the specificities of healthcare systems. Healthcare systems considered by the group are diverse: hospitals, day hospitals, emergency departments, home healthcare, telehealth, m-health, etc.

Research objectives can be seen as twofold:

- Adaptation and transfer of concepts, methods and tools traditionally developed in Industrial Engineering for the case of healthcare
- Development of specific methods and tools needed for designing and good functioning of healthcare

Scientific challenges are numerous: healthcare system performance is multidimensional (societal, medical, economic); it is a complex system (human is a key element of this system, diversity and number of stakeholders, interdependence between decisions and system actors, need for a specific collaboration/coordination approaches and models); uncertainties pertaining to design, analysis, simulation and future behavior prediction are challenging. The research in this domain is multi-disciplinary with a clear systems orientation, combining domains such as systems engineering, operations management, simulation and optimization. The overall objective of developed approaches and methods is to create value for all stakeholders of the healthcare system (e.g. satisfy service quality for the patient, take into account healthcare professional preferences, optimize resource utilization, and manage costs related to organization processes).

“Healthcare System Engineering” Research group is constituted of researchers in majority coming from IC and AD research teams. It is coordinated by Evren Sahin (professor LGI, AD) and Marija Jankovic (Professor LGI, IC). The research group is dynamic: numerous collaborations with healthcare practitioners have been developed in past years, and in particular with the AP-HP. Dynamic and strong international research network is developed in order to support and collaborate to address healthcare system challenges.

Relevant events and results in 2018 :

- Collaboration in the research chair “Avenir Santé Numérique” with Dr. Tu Ah Duong, University “Paris-Est Créteil”, in particular in the domain of technology integration and e-health system design processes. The objective of this research chair is to foster research related to development of Digital healthcare.



- Presentation “What challenges, projects and collaborations for healthcare system engineering?”, 5th AP-HP day of nursing research
- Research scholarship award, OpenHealth Institute, for the project entitled “Data analytics for the patient flow improvement in emergency surgery rooms” in collaboration with hospital “La Pitié Salpêtrière”
- Coordination of a workshop on Patent pathway modelling, Research workshop AP-HP-CentraleSupélec-INRIA
- Initiation of a collaborative research project concerning 4 establishments of AP-HP and INRIA related to the subject of “Patient pathway modelling in treatment of lung cancer”
- Collaborative research project with Hôpital Raymond-Poincaré on the “Development of a mobile system dedicated to geriatric patients suffering from functional handicaps”
- Presentation of healthcare system engineering, “Rencontres Postes d’accueil” organized by AP-HP

Keywords:

Complex system design, operations management, performance management, optimization, healthcare logistics, service systems, technology development and integration

Ambassadors



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

Circular Economy aims at **minimizing the impacts of human activities on the Environment**, for example by pooling material, water and energy flows with a life cycle perspective and in an integrated metabolism approach. Circular Economy is deployed thanks to strategies like **industrial ecology, eco-design of products and services, product-service systems, functional economy...**

The four LGI teams are all implicated on Circular Economy issues. Current research themes deal with:

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

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

2018 main facts

Signing of two framework agreement between Centrale-Supélec and the **French National Institute for Circular Economy (INEC)**, and between CentraleSupélec and the research institute **IRSTEA**, and launching of **Yasmine Salehy's PhD thesis**, co-supervised by IRSTEA on the modelling and simulation of sustainable systems architectures

- Launching of **Marcel Villanueva's PhD thesis** with **Orange** in the Eco-Design of digital services
- Launching of an EcoSD collaborative research project on **Value Analysis for Eco-Design** and recruitment of **Olivier Pialot** for a post-doc on this project
- Publication of the book **"Towards a Sustainable Economy"** coordinated by **Pascal Da Costa** and **Danielle Attias**, edited by Springer
- Three PhDs completed: **Martin Leurent** ("Nuclear plants as an option to help decarbonising the European and French heat sectors?", CEA), **Robin Molinier** ("Economic Analysis of industrial symbioses: a transactional approach", CEA), **Michael Saidani** ("Monitoring and advancing the circular economy transition – Circularity

indicators and tools applied to the heavy vehicle industry", Bourse CSDN)

- Two industrial chairs discussed, to be launched in 2019:



- "Controlled Industrialization in dense urban area", **Gouvernement princier de Monaco**
- "Circular Economy Monitoring", several partners including **RTE, Communauté d'agglomération Paris-Saclay, SIOM**.

5-years ambition

- **Innovative technology potential characterization:** The topic focus on how to embed innovative and sustainable technology into complex system. This topic aims at tackling issues related to modeling, simulating and optimizing multi-scale, multi-physics and multi-criteria to generate sustainable complex systems architectures.
- **Development of circularity indicators:** The issue is to define circularity indicators for products, services and value chains in order to highlights their circularity performance and moreover to drive industrial activities towards much more sustainability.
- **Performance assessment of projects in circular economy:** The main issue is to enrich the assessment process of such project integrating environmental impacts and social impacts. The objective is to propose new method to assess the impact investing (including, environmental, social, economic and governing aspects).

Keywords:

Circular economy, Industrial ecology, Eco-design, Eco-innovation, Circularity, Material, Energy, Environmental impact, life cycle, Life Cycle Assessment (LCA), Material Flow Analysis (MFA), Industrial symbiosis, Eco-industrial park

Ambassadors



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The research objectives are the modelling, simulation, analysis and optimisation of energy and electricity production and distribution systems and the study of their interactions with the technical and economic environment. The theme therefore brings together all the cross-cutting research of the four LGI groups, on the design and technical and economic management of energy systems.

Several research themes and scientific obstacles are the subject of research:

- Economic viability, technical reliability, operational safety and risks related to energy production, transmission and distribution;
- Comparative analysis of low-carbon electricity generation technologies, such as nuclear renewable energies, as well as the study of electricity storage solutions (hydrogen, etc.);
- The integration of electric mobility into the dynamics of electricity supply and demand, the examination of new forms of low-carbon mobility solutions;
- Energy efficiency (eco-parks, cogeneration, transport, distribution, etc.), demand management (smart grids, erasure, etc.), and the effects of consumer behaviour and use on energy consumption over the product life cycle (rebound effects, etc.);
- The management of the various externalities produced by the energy system (beyond CO₂ emissions), including the impacts of nuclear waste and the extraction of fossil and mineral resources.

The researchers involved in the theme are at the forefront of the scientific community:

- Member of the Scientific Committee of the International Conference on the European Energy Market (P. Da Costa)
- Organization of the International Association of Energy Economists World Conference to be held in June 2020 (Y. Perez)
- Member of the European Safety and Reliability Association ESRA (E. Zio)
- Member of the European Reference Network for Critical Infrastructure Protection, ERNCIP (E. Zio)
- Paul Caseau Prize awarded by EDF and the Académie des Technologies to Camille Cany (LGI and CEA), Theme: Renewable energies, nuclear, hydrogen.

A selection of articles published in reference journals:

O. Borne, Y. Perez, M. Petit, Market integration or bids granularity to enhance flexibility provision by batteries of electric vehicles, *Energy Policy*, Elsevier, 2018

M. Leurent, P. Da Costa, S. Sylvestre, M. Berthélemy, Feasibility assessment of the use of steam sourced from



nuclear plants for French factories considering spatial configuration, *Journal of Cleaner Production*, Elsevier, 2018

M. Leurent, P. Da Costa, M. Rämä, U. Persson, F. Jasserand, Cost and climate savings through nuclear district heating in a French urban area, *Energy Policy*, Elsevier, 2018

C. Cany, C. Mansilla, P. Da Costa, G. Mathonnière, T. Duquesnoy, A. Baschwitz, Nuclear and non-dispatchable renewables: two compatible supply options? The case of the French power mix. *Energy Policy*, Elsevier, 2016.

I. Prodan, E. Zio, A model predictive control framework for reliable microgrid energy management, *International Journal of Electrical Power & Energy Systems*, 2014

Publication of books:

P. Baraldi, R. Flage, T. Aven, E. Zio, *Uncertainty in Risk Assessment*, Wiley, 2014

E. Zio. *The Monte Carlo Simulation Method for System Reliability and Risk Analysis*. Springer, 2013

P. Da Costa, D. Attias. *Towards a Sustainable Economy: Paradoxes and Trends in Energy and Transportation*. Springer International Publishing, 2018

Keywords:

Energy systems, Reliability, Economic viability, Resilience, Renewable energies, Smart grids, Complex systems, Energy supply, Externalities, Energy mix...

Ambassadors



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The research objectives

In this theme, we are interested in both new production methods of hyper-connected factories of the future and, the design of connected systems.

In terms of factories 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 traditional industry production to industry of the future technologies and methods. While adopting 4.0 technologies, this industry must be more respectful of 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”.

A selection of articles published

M. E. A. Boudella, E. Sahin, and Y. Dallery. Kitting optimisation in Just-in-Time mixed-model assembly lines: assigning parts to pickers in a hybrid robot-operator kitting system, *Int. J. Prod. Res.*, 2018, vol. 56, no. 16, pp. 5475–5494

Benjamin Legros, Oualid Jouini, Yves Dallery. A flexible architecture for call centers with skill-based routing. *International Journal of Production Economics (IJPE)*, 2015, 159, pp. 192-207

Rowan Wang, Oualid Jouini, Saif Benjaafar. Service Systems with Finite and Heterogeneous Customer Arrivals. *Manufacturing and Service Operations Management, INFORMS*, 2014, 16, pp. 365-380



On going PhD Thesis

Rongyan ZHOU, Master data management for industry 4.0

Shaohua YU, Optimization models and methods for tour planning in smart urban logistics.

Main partners

The Boston Consulting Group, Sculpteo, Opeo, Pôle de Compétitivité Systematic (participation to “Digitalisation de l’Industrie et des Services” think tank), Dassault Aviation, Trendeo, Groupe Renault, La French Tech, Alliance Industrie du Futur (AIF), Thales, Naval Group.

Keywords:

Industry 4.0, Smart manufacturing, Industrial Internet of Things (IoT), Cyber-Physical System (CPS), Cloud computing, Robotization, Simulation, Information systems, Cybersecurity, Additive manufacturing, Augmented reality, Machine learning, Connected systems



Industrial Chairs

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Partners:

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Puchinger
Professor



Flore
Vallet
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Ouail
Al Maghraoui
PhD Candidate



Abood
Mourad
PhD Candidate



Reza
Vosooghi
PhD Candidate



Shaohua
Yu
PhD Candidate

Research

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.

2018 was an important year for the Anthropolis Chair, as its first PhD thesis (Ouail Al Maghraoui) has been finalized and submitted to the reviewers by the end of the year. Our research activities allowed us to actively participate at 7 conferences and workshops, to publish 2 articles in international journals with impact factor and 6 articles have been submitted. We have been hosting several researchers for short research stays in 2018 (Tom Van Woensel, TU Eindhoven; Penny Kong, TUMCREATE Singapore; Mahdi Moeini and Hagen Salewski, University of Kaiserslautern; Olivier Gallay and Marc-Antoine Coindreau, University of Lausanne).

Publications

Abood Mourad, Jakob Puchinger, Chengbin Chu. A survey of models and algorithms for optimizing shared mobility. *Transportation Research Part B: Methodological*, Elsevier, In press.

Ouail Al Maghraoui, Flore Vallet, Jakob Puchinger, Bernard Yannou. Modeling traveler experience for designing urban mobility systems. *Design Science* In press.

Reza Vosooghi, Joseph Kamel, Jakob Puchinger, Vincent Leblond, Marija Jankovic. Robo-Taxi Service Fleet Sizing: Assessing the Impact of User Trust and Willingness to Use. *98th Annual Meeting of the Transportation Research Board*, Jan 2019, Washington, D.C., United States

Production

and scientific animation

7 M.Sc. and internship students

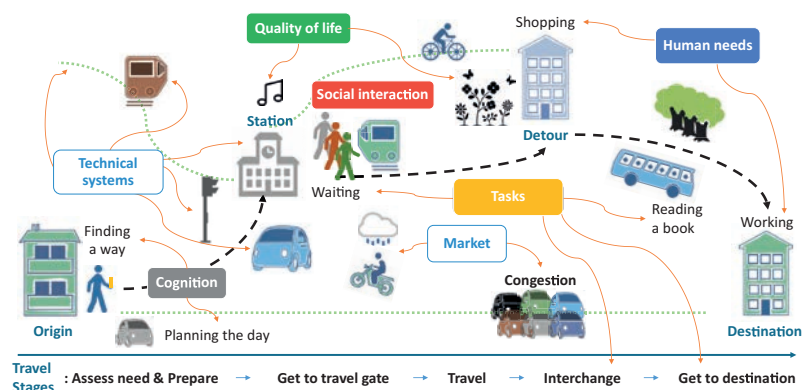
3 student projects

20 Scientific Publications

3 workshops organized

10 keynote speaker presentations

8 Technical Deliverables



A model of the traveler experience

Thesis of Ouail Al Maghraoui

Call Centers

Optimization of multichannel operations in modern call centers

Contact: Oualid.jouini@centralesupelec.fr

Partner:
INTERACTIV GROUP
interactiv
-group 



Oualid Jouini
Professor



Benjamin Legros
Researcher



Ger Koole
Professor



Research

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?

- Advertising during waiting: analysis of the impact of advertising parameters on the customer behavior in commercial call centers. The objective is to understand how advertising may intensify or reduce the abandonment phenomena.

Methodology

- Quantitative approach for the operations management
- Stochastic models
- Queueing systems
- Markov chains
- Markov decision processes
- Empirique analysis

Contributions

- Recommendations and insights for call center managers
- Contributions to the litterature of service operations management
- Contributions to the littérature of stochastic processes
- Scientifique approach for the developpement of Interactiv Group products in order to make them more flexible and performant

Publications

B. Legros, O. Jouini and G. Koole. Blended Call Center with Idling Times during the Call Service. *IIE Transactions*, 50(4), 2018, pp. 279-297.

B. Legros, O. Jouini and G. Koole. A Uniformization Approach for the Dynamic Control of Queueing Systems with Abandonments. *Operations Research*, 2018, 66(1), pp. 200-209.

B. Legros and O. Jouini. On the Scheduling of Operations in a Chat Contact Center. *European Journal of Operational Research*. In press, 2018.

Supply Chain Chair

Contact: yves.dallery@centralesupelec.fr

Partners:

Carrefour, LVMH, Safran and Sanofi.



Yves Dallery
Professor
Supply Chain
Chair Director



Zied Jemaï
Scientific Lead



Laurent Grégoire
Head of Enterprise
Partnership



Bruno Croizat
Trainer and
head of student
relationships



Selmen
Boubaker
PhD Candidate



Haythem Selmi
PhD Candidate

Research

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

Publications

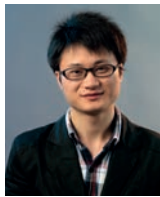
S. Boubaker, Z. Jemaï, E. Sahin, Y. Dallery. A new metric to evaluate the supply chain agility. *International Conference on Industrial Engineering and Systems Management, IESM 2017, Saarbrücken, Germany.*

S. Boubaker, Z. Jemaï, E. Sahin, Y. Dallery. 2018. Supply chain agility : review of situations, *8th International Conference on Operations Research and Enterprise Systems (ICORES 2019), Prague.*

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



Enrico Zio
Professor



Yiping Fang
Assistant
Professor



Zhiguo Zeng
Assistant
Professor



William Fauriat
Postdoctoral
Researcher



Islam Abdin
PhD Candidate



Tasneem
Bani-Mustapha
PhD Candidate

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.

Our research is organized around 2 main topics:

1. Energy network systems reliability, safety and resilience, focusing on modeling, simulating and optimizing electrical network systems, i.e., power grids, microgrids, smart grids, and other critical infrastructures interconnected with power systems (e.g. transport networks). 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, etc.) 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.

Publications

Selection of the journal papers published in 2018

Abdin, I. F., & Zio, E. An integrated framework for operational flexibility assessment in multi-period power system planning with renewable energy production. *Applied Energy*, 2018 222, pp. 898-914.

Fang, Y. P., & Zio, E. (2019). An adaptive robust framework for the optimization of the resilience of interdependent infrastructures under natural hazards. *European Journal of Operational Research*.

Zeng, Z., Kang, R., Wen, M., & Zio, E. Uncertainty theory as a basis for belief reliability. *Information Sciences*, 2018, 429, pp. 26-36.

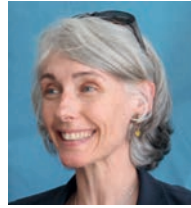
Wang, Z., Zentner, I., & Zio, E. A Bayesian framework for estimating fragility curves based on seismic damage data and numerical simulations by adaptive neural networks. *Nuclear Engineering and Design*, 2018, 338, pp. 232-246.

Fan, M., Zeng, Z., Zio, E., Kang, R., & Chen, Y. A stochastic hybrid systems model of common-cause failures of degrading components. *Reliability Engineering & System Safety*, 2018, 172, pp. 159-170.

Li, X. Y., Huang, H. Z., Li, Y. F., & Zio, E. Reliability assessment of multi-state phased mission system with non-repairable multi-state components. *Applied Mathematical Modelling*, 2018, 61, pp. 181-199.



Angéla Minzoni
Adjunct Professor



Eléonore Mounoud
Associate Professor
2012- 2017

The aim of the OEMS Corporate BNPParibas IFS Chair is to innovate radically in operations management thinking, beyond parcelled operations optimization, by encompassing the whole operations system and its environment. Organizations operating models have indeed a key influence on their governance and strategy.

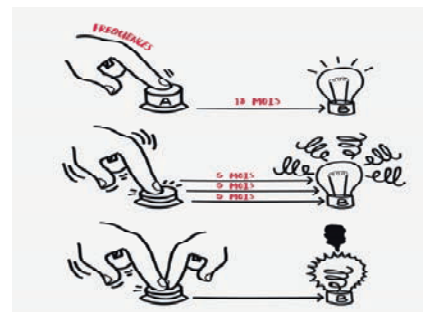
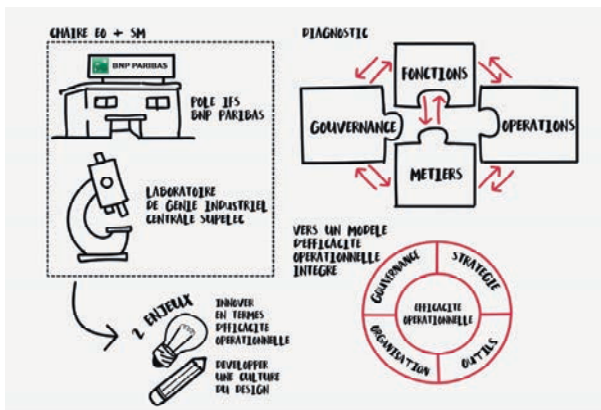
Our main challenge is to produce new knowledge and tools to address the specificities of intangible services operating models. Service systems' operations cannot any more be understood and planned under a mechanistic view, as preset continuous chains of standardized micro-tasks. The research focuses on middle and back office operations. A major academic stake is to move from a static mechanistic view to a dynamic organic model, inspired by living systems.

The design process itself is designed as an iterative process, it is action-based and involves jointly bank experts and researchers. This is an integrated interdisciplinary research including operations research, anthropology and organizational sciences.

2018 was mainly dedicated to the organization of conferences on artificial intelligence from an anthropological perspective, synthesizing philosophical, systemic, operational and ethical approaches.

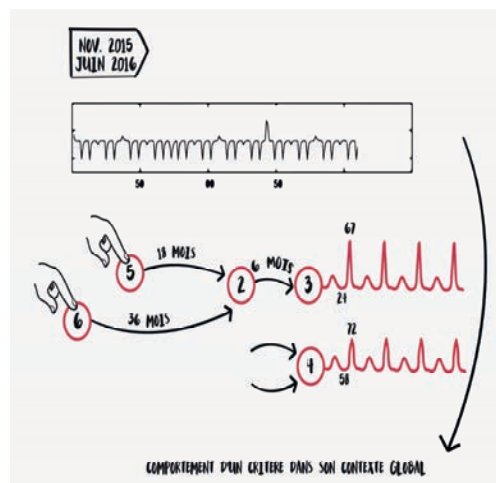
These conferences were attended by BNP Paribas executives and managers, between 80 and 100 at each conference.

This work continues between January and April 2019 through an exploration of the uses of these tools in context at BNPP.



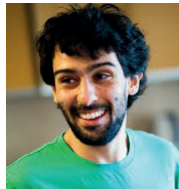
Understanding and regulating frequencies of objectives and operations to avoid "system overheating" and "organizational tachycardia".

Illustrations: B. Pacaud





Pascal Da Costa
Professor
Chair holder



Mehdi Senouci
Assistant Professor



Georges Vivien
Hounbonon
Postdoctoral
Researcher
2017-2018



Emilien Ravigne
PhD Candidate
2019-2021

Research

The Sustainable Growth Chair is a private sponsorship by the Capitaldon endowment fund. His research topic is the impact of innovation and market structures, related to energy and the environment, in particular, on potential growth, dynamics economic systems, including redistributive effects (inequalities).

Keywords:

Innovation-based growth;
Economics of Climate and
energy, Jobs, Inequalities
and innovations,
Redistributive effects.

Publications

For example, a selection of publications associated with researchers who are or have been involved in the Chair:

P. Da Costa and D. Attias (eds.), *Towards a Sustainable Economy: Paradoxes and Trends in Energy and Transportation*, Springer Nature, 2018.

G.-V. Hounbonon and M. Senouci, The impact of innovation on wage inequality in France, WP LGI/ED, 2018.

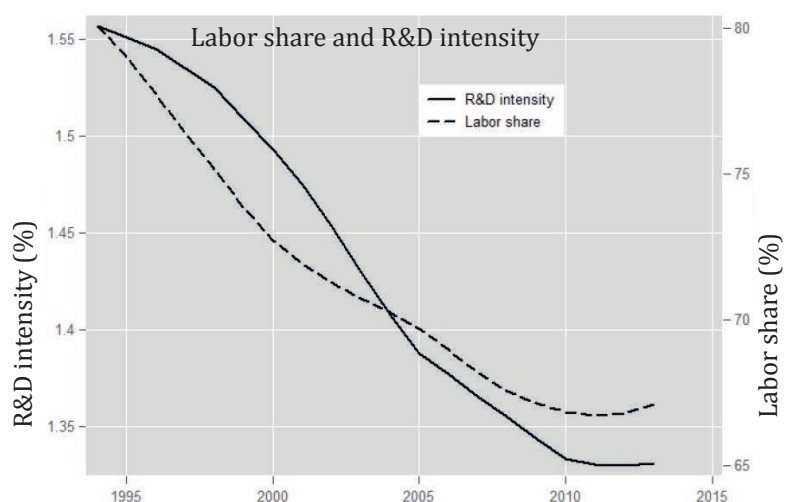
G. V. Hounbonon and P. da Costa, Declining Labor Share and Innovation, WP LGI/ED, 2017.

P. da Costa, L. Rougé, F. Henriët, Climate and economic policies in endogenous growth models with innovation, WP LGI/ED, 2015.

R. Coulomb and M. Magnier, The Impact of Political Majorities on Firm Value: Do Electoral Promises or Friendship Connections Matter? *Journal of Public Economics*, 2014.

F. Henriët, N. Maggiar, K. Schubert, Can France achieve the Factor 4 objective? An evaluation using a stylized energy-economy model", *Economy and Forecast*, 2014.

W. Tian and P. Da Costa, Inequalities in per capita CO2 emissions in European Union, 1990-2020, *11th International Conference on the European Energy Market (EEM)*, Krakow, IEEE, May 2014.



Note: Local polynomial smoothing of the trends in R&D intensity and labor share. We use the epanechnikov kernel with a polynomial of degree zero (constant) and the bandwidth of 2.36 for labor share and 3.56 for R&D intensity

Declining Labor Share and Innovation
Georges V. Hounbonon & Pascal Da Costa



Contact: danielle.attias@centralesupelec.fr



Danielle Attias
Chairholder



Yannick Perez
Associate Professor



Yurong Chen
PhD Candidate



Bassem Haidar
PhD Candidate

Partners:

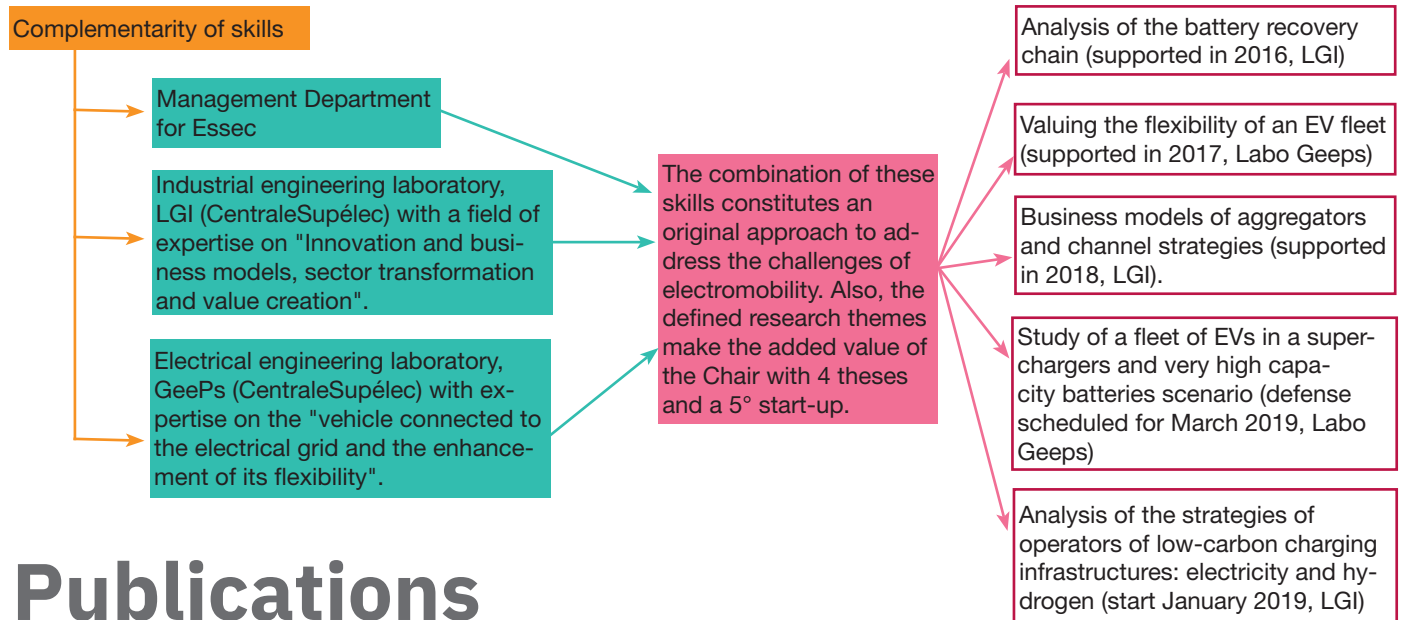
PSA Groupe, ESSEC, PSA University
Electrical engineering laboratory,
GeePs (Centralesupélec)

Research

The objectives of the Chair

The Armand Peugeot Chair, created in 2011 and renewed in 2016, aims to provide research skills to contribute to the development of innovation in the electric and/or hybrid vehicle sector.

The challenges of electromobility are complex and raise technical-economic, political, sociological and strategic issues for all manufacturers, including the PSA Group.



Publications

Sélection de Publications

Hoarau Quentin and Perez Yannick, 2018, Interactions Between Electric Mobility And Photovoltaic Generation: A Review, *Renewable and Sustainable Energy Reviews*, 2018, 94, pp. 510–522.

Borne Olivier, Yannick Perez and Marc Petit 2018, Market integration or bids granularity to enhance flexibility provision by batteries of Electric Vehicles, *Energy Policy*, 2018, Volume 119, pp. 140–148.

Attias Danielle , Editor, *The Automobile Revolution: towards a new Electro Mobility Paradigm*, Springer International Publishing, 2017.

Ramírez Díaz Alfredo, Marrero Gustavo, Ramos-Real Francisco, Perez Yannick, 2018 Willingness to pay for the electric vehicle and their attributes in Canary Islands, *Renewable and Sustainable Energy Reviews*, 2018, Volume 98, pp. 140–149.

Attias Danielle , The autonomous vehicle: disrupting business models for urban transport embedded in the smart city's revolution, *26th Gerpisa International Colloquium*, 11-14 juin 2018 Sao Paulo University