

LGI, EA 2606

LABORATOIRE GÉNIE INDUSTRIEL



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 (2) as-is and to-be production or activity systems.

These systems' purpose is to deliver adapted and optimal performances and create value 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) Department (Laboratoire Genie 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, ecoparks), complex products (airplanes, cars...), complex factories, transportation systems, health systems, energy networks, service systems and construction systems.

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

The systems studied 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.

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 preference.

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).

TEAMS

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LGI is organized in 4 research groups, 5 transversal themes and 7 enterprise chairs. The 4 research groups have 3 research axis each. The 5 transversal themes are: Mobility systems, Energy systems, Healthcare systems, Industry of future, Circular economy.

THE RESEARCH AXES OF THE 4 RESEARCH TEAMS

1. Design Engineering

Design complex products, services and systems, Define design processes and methods, User-centered design, Eco-design, Systematize innovation, Manage knowledge and skills, Circular Economy

2. Operations Management

Design and manage the supply chain, Manage production, Predict demand, Manage supply, Manage logistics and transportation, Size the industrial system, Manage health system operations

3. Risks, Reliability and Resilience (R3)

Analyze and lower industrial risks, Increase system reliability and service continuity, Move from corrective to preventive maintenance, Enable flexibility and resilience

4. Sustainable Economy

Modeling and simulating the technico-economy... Of the development of electric vehicles and recharging stations, Of the French energy mix, Of global carbon capture, Of the use of hydrogen, Circular Economy

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LGI affiliates its PhD Doctorates at Doctoral School *Interfaces*, and the diploma are delivered under the following disciplines: *Industrial Engineering, Complex Systems Engineering, Computer Science, Engineering Economy.*

LGI belongs to the *Engineering and Systems Science* Graduate School of Paris-Saclay University, through its *Industrial and Manufacturing Engineering* discipline topic.

THE 7 ENTERPRISE CHAIRS

Supply Chain - AIR LIQUIDE, L'OREAL, SAFRAN - Since 2010

Chair holder: **Evren Sahin**

Risk and Resilience of Complex Systems - EDF, ORANGE, SNCF - Since 2010

Chair holder: **Anne Barros**

Anthropolis – Human-centered urban systems design - EDF, ENGIE, NOKIA Bell Labs, RENAULT / IRT SystemX - Since 2014

Chair holder: **Flore Vallet**

Armand Peugeot – Technologies hybrides et économie de l'électro-mobilité - STELLANTIS / GeePs, ESSEC - Since 2014

Chair holder: **Yannick Pérez**

FlexTech – Human Centered Design - Armée de l'Air, CS GROUP, THALES / ESTIA - Since 2019

Chair holder: **Guy André Boy**

OPP-BTP Prevention & Performance in the construction industry - Organisme Professionnel de Prévention du Bâtiment et des Travaux Publics (OPP-BTP), Eiffage Infrastructures, Vinci Construction Terrassement (VCT) - Since 2020

Chair holder: **Christian Michelot** assisted by **Isabelle Nicolai**

Alliance Circular-IT - Digital solutions for circular industrial and territorial ecosystems

MANITOU Group, General Electric Healthcare, MEWS Partners, Communauté d'agglomération Paris-Saclay (CPS), SIOM (Syndicat Inter-communal des Ordures Ménagères), in collaboration with: ADEME, CSTB - Since 2022

Chair holder: **Bernard Yannou** assisted by **Ghada Bouillass**

HIGHLIGHTS 2022

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Launch of **Alliance CircularIT**



Guy Boy has been appointed Full Member of the International Academy of Astronautics (IAA)



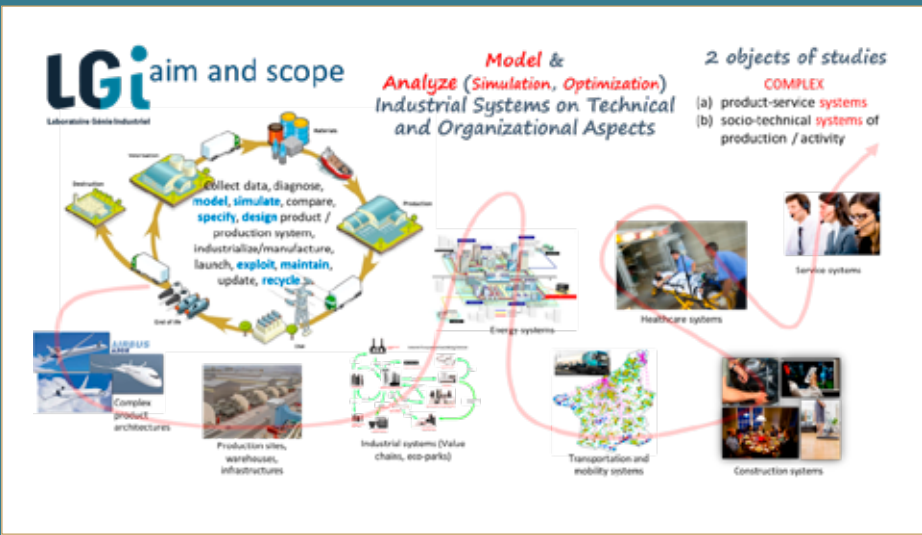


Figure 1
 LGi studies production, activity or socio-technical systems along their life cycles

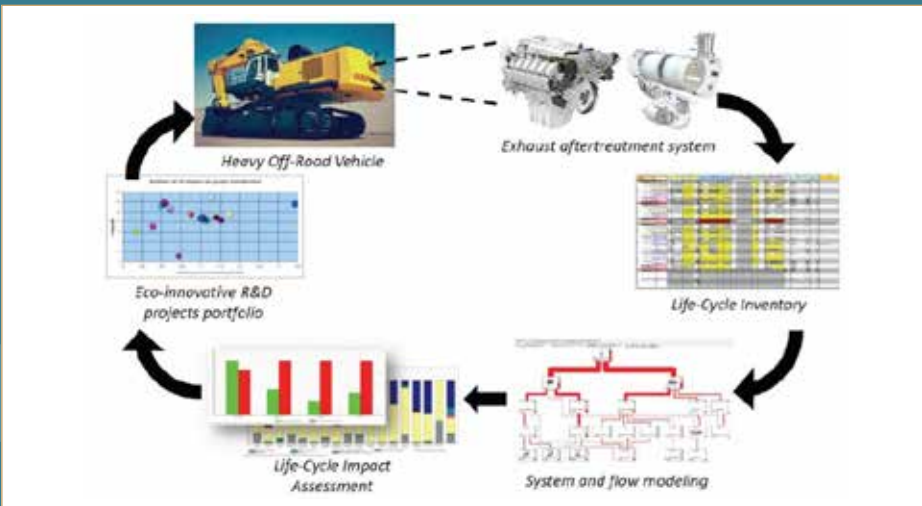


Figure 2
 Life Cycle Assessment & Eco-Design of complex industrial systems



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

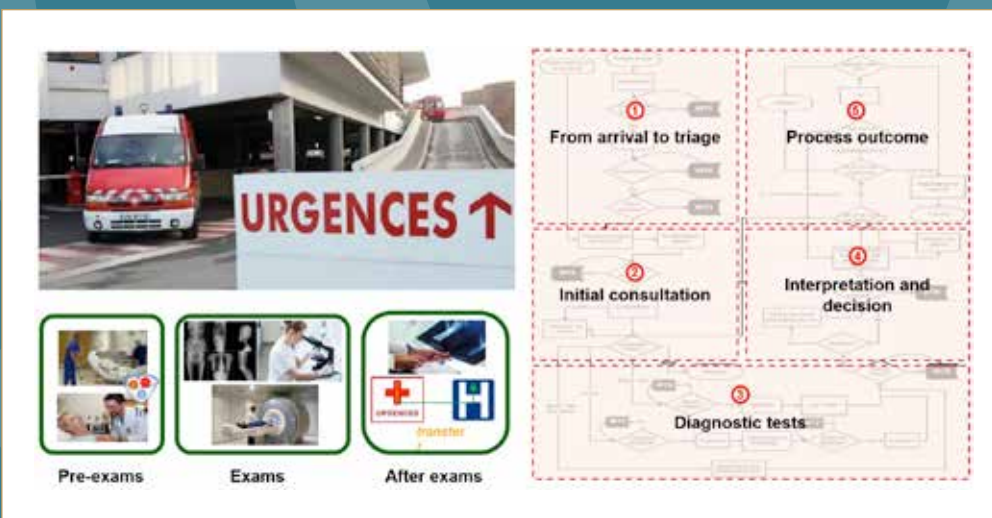


Figure 4
 Optimization of patient flows in emergency services

Industrial Partners

- Automotive industry/transport: RENAULT, STELLANTIS, RATP, SNCF, Style & Design
- Aeronautics: THALES, SAFRAN, CS Group, Armée de l'air
- Energy: EDF, RTE, ENGIE, CEA, AIR LIQUIDE, ENGIE, IFPEN
- Control: SCHNEIDER Electric, SIEMENS
- Services: BI Consulting, Mews Partners, ALTEN
- Goods: LVMH, L'OREAL
- Construction: EIFFAGE, VINCI CONSTRUCTION
- Research institutes: CEA, IRT SYSTEMX, VEDECOM, ARS (Agence Régionale de Santé), INRAE, CSTB
- It & networks: ORANGE, NOKIA Bell Labs
- Health: AP-HP (Assistance publique – Hôpitaux de Paris), General Electric Healthcare
- Local authorities: CPS (Communauté d'Agglomération Paris-Saclay), SIOM (Syndicat Intercommunal d'Ordures Ménagères)

Academic Partners

More than 50 collaborations abroad: **Australia** (University of Queensland, Université de Melbourne), **Austria** (University of Vienna), **Belgium** (Université de Louvain, Université de Mons), **Brazil** (UFRJ, PUC, Université de Lavras), **Canada** (Mc Gill University, ETS), **China** (Beihang University, Ecole Centrale Beijing, Wuhan University of Technology, University of Honk Kong), **Denmark** (DTU), **England** (University of Liverpool, University of Bath, The Open University), **Finland** (University of Helsinki, Aalto University), **Germany** (Université de Magdeburg, TU Munich, Université de Nuremberg Erlangen), **Italy** (Université de Catane, Politecnico di Milano, Politecnico di Torino), **Japan** (Chiba University, RITE-Kyoto), **Lebanon** (Université de Beyrouth), **Luxembourg** (Université de Luxembourg), **Marocco** (Ecole Centrale de Casablanca), **Netherlands** (VU University Amsterdam), **Norway** (University of Stavanger), **Poland** (Poznan University of Technology), **Portugal** (University of Coimbra), Singapour (SUTD), **Spain** (Université de Valence), **Switzerland** (HEC Lausanne, ETHZ), **Tunisia** (ENIT, ENIM), **Turkey** (Koç University), **USA** (Northwestern University Chicago, MIT, Penn State University, Georgia University of Technology, Iowa State University, University of Minnesota, University of Illinois at Urbana-Champaign, Illinois University).

Key figures

- Professors, Associate Professors & Researchers 27
- Engineers & Administrative staff 5
- PhD Students 55
- PostDocs 5
- Visiting professors 5
- Publications of the year (WoS) 44

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