Thematic
Smart Systems & Smart Environments
« Smart : Everything & Everywhere »

February, the 14th, 2020

centralelille
ÉCOLE CENTRALE DE LILLE

1

Outline

- Summary of the new curriculum of the Ecole Centrale de Lille
- Smart system curriculum in 2nd year (G2)
- Smart system curriculum in 3rd year (G3)

centralelille
ÉCOLE CENTRALE DE LILLE

2

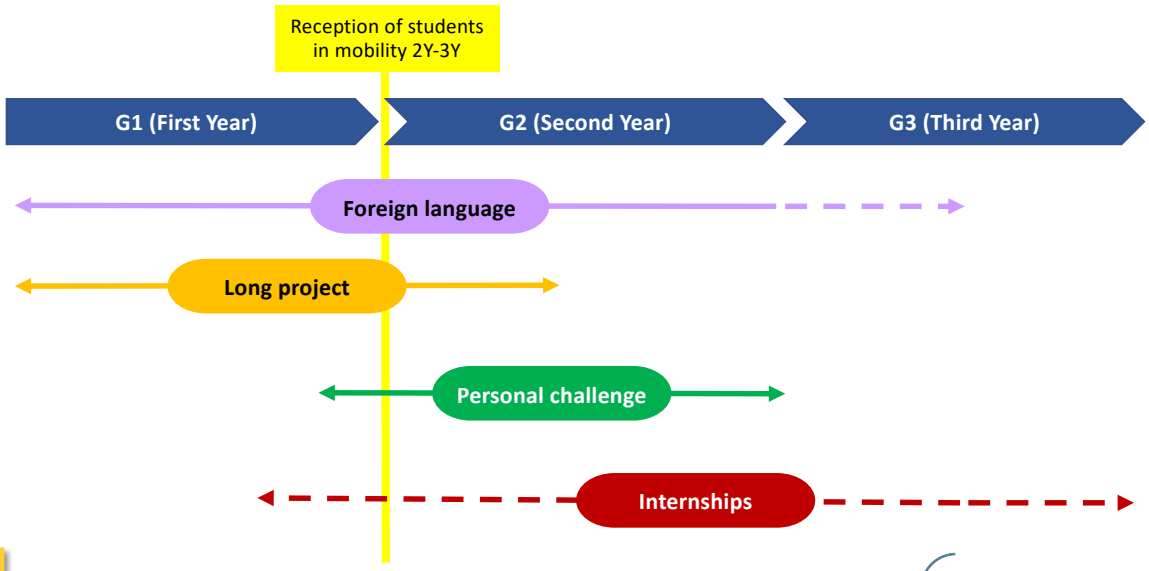
Introduction

- Problematic: which generalist engineer for 2030?
- How can future engineers be made responsible?
- How to give our engineers a taste for excellence
- How to teach them to be autonomous and to learn throughout life

centralelille
ÉCOLE CENTRALE DE LILLE

3

The main lines of Lille curriculum



centralelille
ÉCOLE CENTRALE DE LILLE

4

G2 semester 7 : Alternating long time / short time

Integration Elective (IE) : based on several disciplines from different departments (**192h/student**)

Rules:

- Each student chooses two elective courses: IE1 (Integration Elective n°1) and IE2 (Integration Elective n°2)
- Each integration elective is multidisciplinary but must be built according to a guideline

Teaching rhythm: One week break for a challenge (C1, C2, C3 and Project defense)

- **Imagine & Make**
- **Business game**
- **Leadership in extreme situations**

IE1 (4 weeks)	C1	IE1 (4 weeks)	C2	IE2(4 weeks)	C3	IE2(4 weeks)	Prj

English class + 2nd foreign language class

Long Term Project (by team)

Personal challenge

centralelille ÉCOLE CENTRALE DE LILLE

5

G2 semester 7 : Integration Elective courses

IE1	IE2
Sport and Science	Apprenticeship by Shipwreck
Biomedical engineering	Biomimetic flow control
Imaging and Instrumentation Sciences and Technologies	DEcLICK: Two liters per Hundred Km
Autonomous transport system*	Eco-design for positive energy housing
The sound of science	Retro-engineering and re-design
Modeling for organizational management	Architectural design and sustainable development
Energy approach and power transmission	Construction 4.0
Creation of high-tech StartUp	**Energy transition and power grid***
	Preliminary design of a railway line*

* Selected courses for the mobility

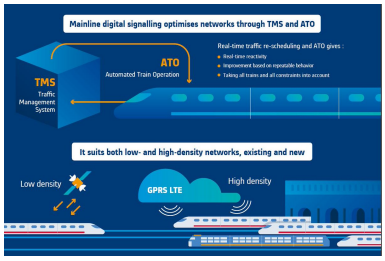
centralelille ÉCOLE CENTRALE DE LILLE

6

IE1 - Autonomous transport system (1)

First half of semester 7 (S7)

- An autonomous transport system is an **automated system** with some form of **intelligence** to adapt to unforeseen situations. It is instrumented with numerous **connected objects** that allow it to **perceive its environment and even to communicate with this environment**. This allows it to adapt its behavior or even optimize it according to its environment.



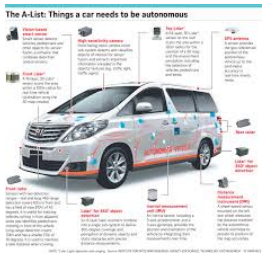
centralelille
ÉCOLE CENTRALE DE LILLE

7

IE1 -Autonomous transport system (2)

- Autonomous systems have common characteristics:
  - **automatic piloting,**
  - **control of energy consumption,**
  - **operating safety to guarantee great robustness,**
  - **increased security to avoid cyber-attacks**
  - **intelligence to give them flexibility to adapt to a changing context**
  - **study their acceptability by society.**

Pedagogy based on a mini-project on a type of autonomous system per group of 8 students



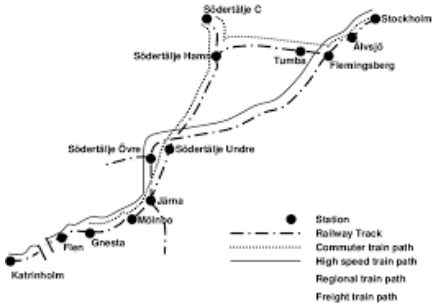
centralelille
ÉCOLE CENTRALE DE LILLE

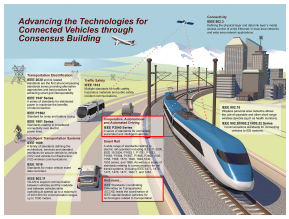
8

IE2 - Preliminary design of a railway line (1) : First possibility

9

- This course deals with the mobility of people by rail in a context of sustainable development. It is a **complex problem** whose solution is the result of choices and **compromises on tracks, stops, number and duration of trips, passenger flow and energy consumption**. In addition to safety, environmental and public health issues are addressed from the point of view of noise and particulate emissions and carbon footprint.





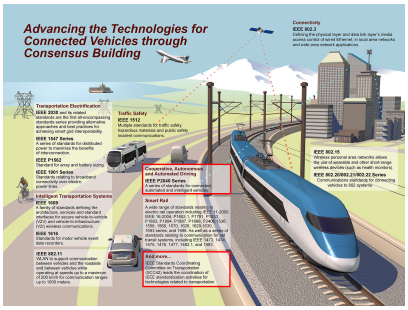
centralelille
ÉCOLE CENTRALE DE LILLE

9

Preliminary design of a railway line (2) : First possibility

10

- The knowledge developed in **mechanics** (braking, wheel-rail contact, tribology, noise and particle emissions), in **electrical engineering** (traction, braking, energy, electromagnetic noise) and in **automation** (regulation by fixed or mobile block by discrete and continuous approach, search for optimal solutions) enables the students to develop a scientific approach to analyze performance and propose solutions, based on interdisciplinary modelling.



Interventions by professionals in the field (industry and research) and visits to laboratories and industrial sites will immerse the students in the reality of the complexity of the design, construction and operation of a railway line and rolling stock.

centralelille
ÉCOLE CENTRALE DE LILLE

10

Energy transition and smart grid (1) : Second possibiity

11

- Faced with the problems of global warming, the energy transition has become an imperative for many countries. One aspect of this transition is the **increasing use of renewable energies**, which implies a profound change in the entire sector of electricity production, transport, distribution and even consumption patterns.

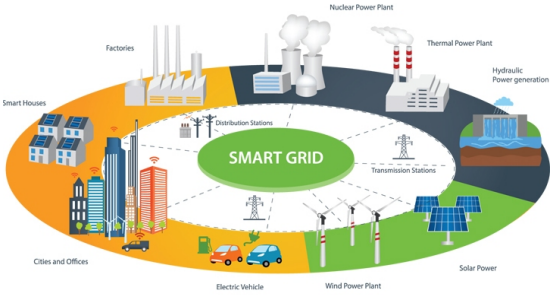
centralelille
ÉCOLE CENTRALE DE LILLE

11

Energy transition and smart grid (2) : Second possibility

12

- This integration elective presents the main forms of **electricity production, the most traditional and the most recent based on the use of renewable sources**. The impact of these new forms of electricity production on the grid will be studied. It will also highlight the fundamental changes that are taking place in terms of **consumption and storage** and the consequences for the management of these networks, which guarantee the interconnection between sources and consumers.



Analyze the entire energy conversion that takes place thanks to a unified modeling tool (bond graph)

centralelille
ÉCOLE CENTRALE DE LILLE

12

G2: Disciplinary electives (semester 8)

- Follow 3 disciplinary electives during half a semester two times
  - At least one disciplinary elective (with regard the 6 electives) in Company & Society
  - The others without departmental constraints
- English and a second foreign language

centralelille
ÉCOLE CENTRALE DE LILLE

13

G2 semester 8: Disciplinary Electives

- Hourly volume per DE : 96H
- Two half semesters: S8a and S8b

MATHEMATICS and COMPUTER SCIENCE

- Random modeling and scientific calculation (S8a)
- Optimization and Prescriptive Analysis (S8a)
- Information systems (S8a)
- System and network (S8a)
- Collaborative Intelligence (S8a)
- Signal representation and inverse problems (S8a)
- Web 2.0 technologies (S8b)
- Mobile programming and augmented reality (S8b)
- Object oriented programming (S8b)

ELECTRICAL ENGINEERING, ELECTRONICS, AUTOMATICS

- Design and control of a robotized production line (S8a – Automatic Control)
- System modeling and control: application to robotics (S8a – Automatic Control)
- Smart Systems (S8a)
- Smart Decision (S8a)
- Electronic systems for sensors (S8a - Electronic)
- Electronic systems for telecoms (S8a - Electronic)
- Real time estimation for engineers (S8b-Automatic Control)
- Embedded systems architecture for control and supervision (S8b)
- Design of Automated Systems (S8b)
- Electronic systems for sensors (S8b)

centralelille
ÉCOLE CENTRALE DE LILLE

14

G3 Thematic:
Smart Systems & Smart Environments
Track1: Interactive Systems and Advanced communications
Track2: Embedded Systems and Cyber-physics

February, the 15th 2020

Philippe PERNOD (Thematic)
Yannick DUSCH (Track 1)
Alexandre KRUSZEWSKI (Track 2)

centralelille
ÉCOLE CENTRALE DE LILLE

15

Context

- An ever-growing need to question and **act on the environment**
- An **increasingly interactive and connected** world
- More **mobile** and more **autonomous**
- **Intelligence** that is both **centralized** (supervision) and **distributed** (local intelligence)
- **New uses**, and an ever-increasing demand for **personalization**
- **Environmentally friendly**

Computer Science + Internet + Communication → Rapid distribution to any type of "Object". or "Systems" → New generations of **intelligent** and **communicating systems**

2025 Horizon: More than 21.5 Billion "objects" connected
Market: 1.567 Billion Dollars




16

Smart Systems & Smart Environments

17

Intelligent and Communicative DeepTech Systems to address major societal issues

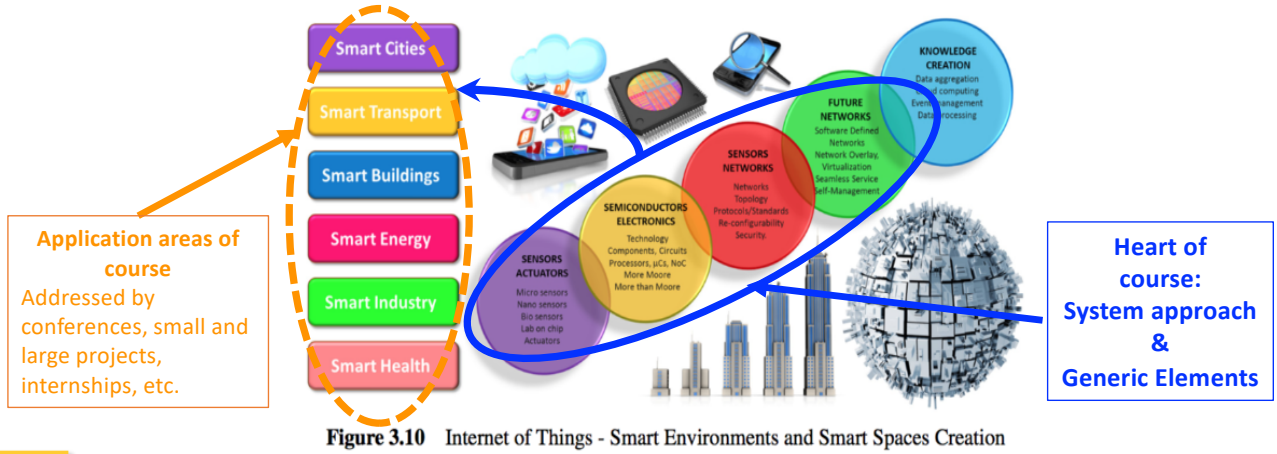
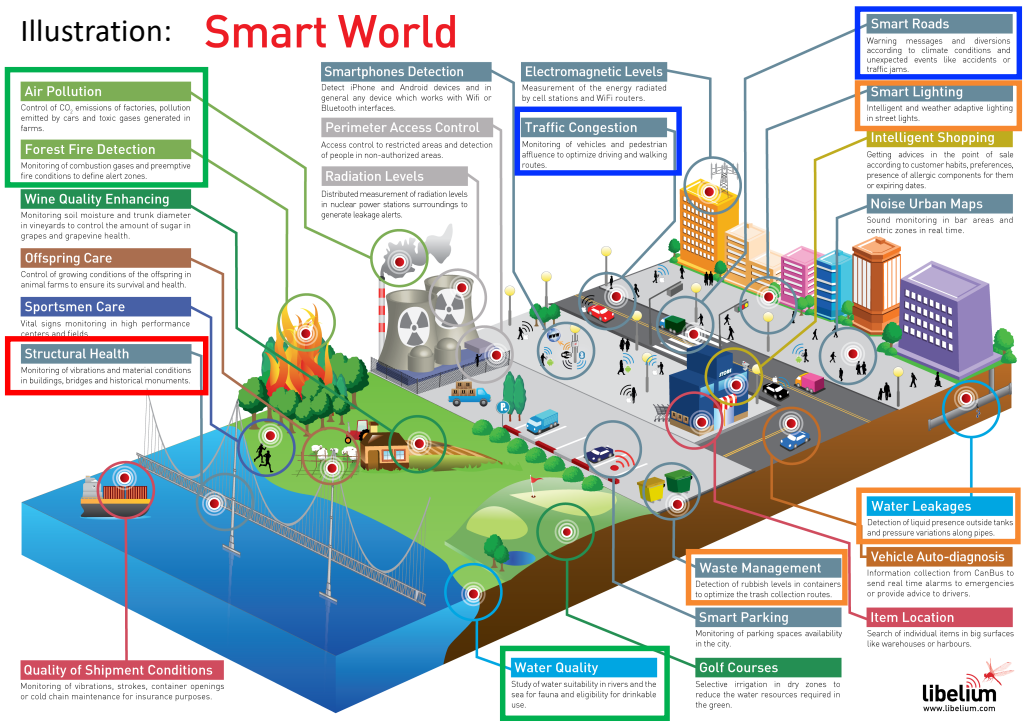


Figure 3.10 Internet of Things - Smart Environments and Smart Spaces Creation

Intelligent Systems & Environments → **Address all Economic and Social fields**

17

Illustration: Smart World



18

Organization of the theme:

- Issues, Challenges, SSSE Markets: Block "Conferences / Round Tables / Brainstorming"
- Generic tools for SSSE: Comsol, Matlab, Simulink, Labview, C Language and Arduino

Track1
"Interactive Systems and Advanced communications"

Teachings Common at 2 Tracks
90H

Track2
"Embedded Systems and Cyber-physics"

- Application Conferences
- Joint projects (hard / soft & Uses) (2+2)
- Inter-training between students of the 2 tracks

19

Smart Environment: Distributed and Connected Air Quality Monitoring

Track1: "Interactive Systems and Advanced communications"

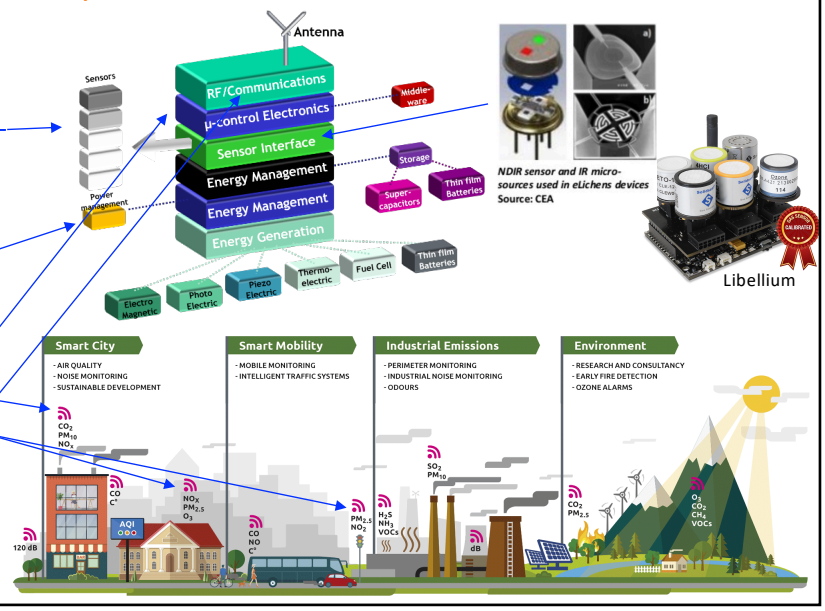
Multifunctional Sensors and Effectors :
Sensory Interfaces, Active and Intelligent Materials, Biomimicry

Micro-Nano-Technologies and Systems :
Micro-Nano-Technologies, Integration/Packaging, Cybersecurity (Physical)

Green electronics and new paradigms :
Materials and life cycle, New approaches to information processing, Ultra-low consumption, Recovery and storage of ambient energy

Radio-frequency and optical engineering:
Communication and instrumentation

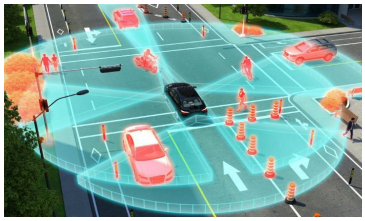
Advanced communications networks :
Mobile Networks (4G, 5G), IoT Networks, Digital Communications



20

Connected vehicles and driving assistance

21



Track2:
"Embedded Systems and Cyber-physics"

Sensor networks :
Data fusion and analysis

Cyberphysical systems :
Real-time estimation,
Distributed and energy-efficient control law,

Decision:
Supervision, Human-Machine Interfaces

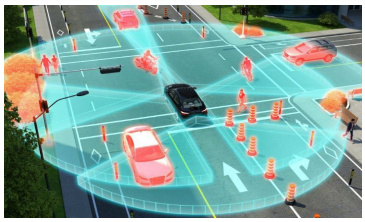
Software architectures and connectivity:
Operating systems, Distributed (microcontroller networks) and parallel (FPGA) architectures, Cybersecurity (software)

centralelille
ÉCOLE CENTRALE DE LILLE

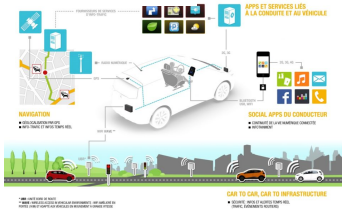
21

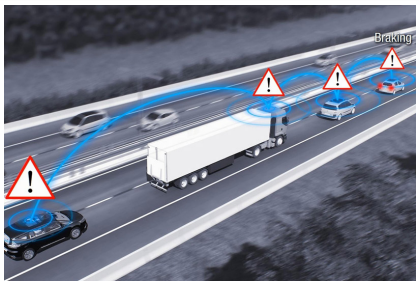
Connected vehicles and driving assistance

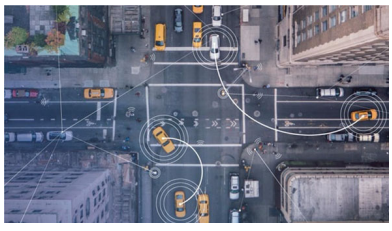
22



Connected Vehicle







Track2:
"Embedded Systems and Cyber-physics"

Sensor networks :
Data fusion and analysis, Internet of Things

Cyberphysical systems :
Real-time estimation,
Distributed and energy-efficient control law, multi-scale systems

Decision:
Supervision, Human-Machine Interfaces,
Operational research and optimization,
Collective Intelligence (AI)

Software architectures and connectivity:
Operating systems, Distributed (microcontroller networks) and parallel (FPGA) architectures, Cybersecurity (software)

centralelille
ÉCOLE CENTRALE DE LILLE

22

Course based on a rich and powerful local ecosystem

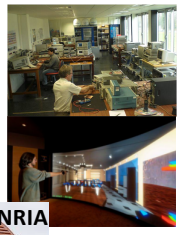
23

Collaboration with a fast-growing regional ecosystem in the:

- Euratechnologies
- Plaine Images
- Eurasanté
- Nombreuses Startups
- CEA-Tech
- INRIA Tech
- CITC
- Competitiveness clusters: PICOM, UP-TEX, I-TRANS, etc.

Course that can be supported by Site Excellence Resources:

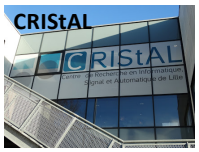
- **Technology platforms**
  - CNFM / Micro-Nano-Manufacturing Plan
  - RF characterization platform
  - Telecom platform
  - Virtual Reality Platform
  - FIT Technology Platform (IoT-Lab)



- **Research Centers**

IEMN

CRIStAL



IRCICA

INRIA

of Excellence

23

Course that offers very broad opportunities

24

- **In all sectors:**
  - Health, Smart City, Housing, Energy, Transport, Industry of the future
- **Open to many engineering professions:**
  - R&D, Systems Engineers, Design Offices, Project Managers, Integrators, Business Engineers, Researchers
- **In all types of companies:**
  - Large groups, ETIs, SMEs, Startups
  - Public establishments and Communities
- **And also the academic structures:**
  - Research centres, Universities, Schools, etc.
- **At national and international level**
- **But also a very rich local ecosystem** I

Thales, ST Microelectronics, Nokia, Freescale, Tronics, APIX, Opérateurs télécoms,Facebook, Amazon, Google, Equipementiers télécoms (Bouygues Telecom, Orange, SFR, etc.), Eveon, Oxylane, Renault, PSA, Valeo, SAFRAN, Fextronics, Stanley Robotics, Inductosense, TDK, SAGEM, PYTHEAS Technology, Airbus Defence and Space, Eurocoptère, DCNS, L-Acoustics, NoiseFloor, Oticon, Thurmelec, A-Volute, MC2 Technologies, Wavely, …

CEA Tech (LETI, LIST, LITEN), INRIA, CNRS, Universités, Ecoles, Institut de la vision, IEMN, CRIStAL, IRCICA,

USA : MIT, GeogiaTech, Univ. Texas / Austin, Univ. Illinois
Japon : Univ. Doshisha, Univ. Tokyo
Singapour : CINTRA (Thales-NTU-CNRS)
UK : London King's College

24

The possibility to follow a Master 2 in parallel (fully compatible)

Co-accredited Masters
Centrale Lille & University of Lille
compatible

centralelille

Université de Lille

- **Master "Networks and Telecommunications"** (eligible for students of Track 1):
  - Course: Communicating Systems
  - Course: Telecommunications

- **Master "Systems, Autonomous Machines and Field Networks"** (eligible for students of Track 2)

centralelille
ÉCOLE CENTRALE DE LILLE

25

centralelille

AUDACE • EXIGENCE • RESPECT

26