

# LOCIE

## Design Optimization and Environmental Engineering Laboratory

The vocation of the LOCIE (Design Optimization and Environmental Engineering Laboratory) is to federate multi-disciplinary approaches to sustainable management. These concern the technical aspects of sustainable development and, given the skills of the members of the LOCIE, the fields of Biotechnologies for the Environment, Process Engineering, Civil Engineering and Habitat, Materials and Composites Mechanics, and finally, Product Life Cycles are studied.

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Staff: 25 researcher-lecturers (of which 12 professors or HDR) and 30 doctoral students

Three general objectives summarize LOCIE activities:

- To design materials, processes and structures to improve environmental protection and to create a pleasant, functional and safe living environment for people;
- To optimize their design with respect to one or several of the following fields: mechanics, energetics, environmental engineering and economic profitability;
- To develop experimental, numerical and methodological tools to carry out studies specific to sustainable management.

To reach these objectives and to bring together skills in the most effective way, the LOCIE is structured into four teams:

BGEPE (Biotechnology and Process Engineering for the Environment) is focused on improving the quality of the environment, as concerns liquid effluents (domestic, agricultural, industrial, rain water) through biofiltration processes (planted or not) and ultrasound processes, as well as gaseous effluents through filtration: electronic air cleaner, drainage filters, self-cleaning filters (for liquid aerosols, ambiences, diesel engine particles, etc.).

MMSC (Material Mechanics and Composites) studies the behavior of conventional and piezoelectric composites, as well as of multimaterials. Furthermore, the theory of plasticity and limit loads is used to forecast ductile fracture criteria for metallic materials and porous polymers, as well as those of mechanical assemblies. It is also applied to the study of the stability of civil engineering structures.

GCH (Civil Engineering and Habitat) develops three avenues of research. The first is the analysis of structures in the mountains: extreme stresses, dimensioning methods, diagnostic approaches, experimentation for behavior monitoring and characterization, repair methods. The two others concern the performance of buildings with regard to their environment: sustainable design and production engineering of on one hand, and energy management (energy efficiency and saving) and enhancement of renewable energies in buildings on the other hand.

MAPIE (Modeling, Analysis and Prevention of Environmental Impacts) mainly made up of members of ENSAM's "Mechanical Design and Environment" Institute in Chambéry, develops sustainable design and environmental impact assessment methods for products. They also study product dismantling processes and materials sorting to facilitate their recycling.

All of LOCIE's research activities are organized around three structuring transversal activities :

- The improvement of the quality of the environment (meaning all of the characteristics that allow an entity to fulfill environmental requirements);
- The optimization of the management of energy and material flows in the processes linked to the environment;
- The study of structural and process behavior and analysis of structural stability.

Details :

### **Biotechnologies and process engineering for the Environment**

From life sciences to engineering sciences

From the study of fundamental mechanisms to the design and development of innovative eco-properties

#### **Theme: The improvement of environmental quality**

Through the anticipation of the regulatory constraints, by proposing high-performance bioprocesses and processes that integrate into a sustainable development approach.

Through the integration of environmental and health risk-reduction criteria

#### **Research themes :**

##### **Biofilters (planted) on**

- domestic, agricultural and industrial effluents
- rain waters
- leachate from dumps

##### **Treatment of gaseous effluents**

- Control of dust accumulation in subway stations using electrofilters
- Studies for a self-cleaning filter
- Design of filter for diesel vehicles
- Treatment of kitchen effluents
- Modeling of drainage filters

##### **Reduction in the volume of sludge using ultrasonic process**

#### **Competences and resources:**

##### **Gas filtration:**

- Electrofilters
- HEPA filters (high efficiency particulate air filters)
- Modeling and optimization of filtering processes
- Efficiency measurements up to 0.3 $\mu$ m for 900 m<sup>3</sup>/h maximum
- Various particle counters
- Micronic and submicronic particle generators

##### **Treatment of volatile organic compounds:**

- Design, modeling and optimization of biofilters
- Efficiency measurements

##### **Treatment of liquid-phase chemical pollutants:**

- High-frequency ultrasound reactors
- Respirometer
- HPLC

##### **Sludge reduction in purification plants:**

- Low-frequency ultrasound reactors
- Biological pilot
- Planted biofilters

##### **Keywords:**

Aerosol, air, biofilm  
biomass, bioprocess, bioreactor, VOC, waste, RTD,  
water, environment, filtration, HEPA filtration, fluidization, gas,  
hygiene, porous medium, modeling, unit operations, optimization,  
treatment of pollutants, ultrasound.

#### **International relations:**

Lodz Polytechnical University – Poland, Laval University – Quebec, Ecole Polytechnique de Montréal – Quebec, University of Western Ontario - London – Canada, ROSLO - Slovakia.

#### **Industrial partners:**

CEA Saclay / Marcoule, CCLA, CNR, CTIFT, GDF, ITV, LAURETTE Industries, RATP, RECYCL' AIR, RENAULT, SADE, Saunier – environnement, SINT

## Civil engineering and Habitat

Analysis and behavior of structures in the mountains (ACOM)      Performances of buildings and environment (PBE)

Experimental validation  
Energetics  
Management of solar plants  
Structure monitoring  
Repair and reinforcement  
Environmental quality

### The team's experience and skills

- Managing energy in the construction industry
- Energetics and physics of building environments
- Quality of interior environments
- Environmental quality applied to the construction industry
- Computer-integrated construction site management
- Information systems
- Assistance for selection of construction solutions
- Experimental methods
- Development of simplified calculation methods
- Supervision and experimentation in situ
- Administration of assets
- Structural dynamics: shock, natural risks

### **Performances of buildings and environment (PBE)**

*Head Gilbert Achard*

- "Integrated" management of energy in the construction industry:
  - ✓ Energy optimization: savings, efficiency, renewable energies
  - ✓ Analysis of the thermo-aeraulic behavior of buildings and associated energy systems
  - ✓ Optimized management of active solar plants (PSD, PAC, PV/T)
- Sustainable design and production engineering:
  - ✓ Improvement of the environmental quality of buildings
  - ✓ Computer-integrated construction site management (study of production methods used in the construction phase to control costs, deadlines and quality of the objects built).
  - ✓ Administration of assets.

### **Analysis and behavior of structures in the mountains (ACOM)**

*Head - Michel Mommessin*

- Experimentation and development of methods to design and dimension structures through:
- Better knowledge of potential risks in order to best define the stresses applied to the structure and the nature of the stakes to be protected.
- Analysis of the environmental quality and the life cycle of the structure
- Dimensioning of the structures subject to non-conventional stresses (shock-type loading for example)
- Diagnostic approach
- Methodology for the repair and reinforcement of structures
- Experimental validation

### **Programs**

DEA (post-graduate degree) in Design of buildings and urban techniques- co-accreditation with the EC, ENTPE, INSA of Lyon, and the UCB.

University of Savoie Doctorate specialty civil engineering and habitat

### **Equipment**

- experimental tertiary building (thermics and energetics)
- meteorological station
- dynamic acquisition units, accelerometers, displacement sensors, force sensors
- ultra-rapid camera
- ultrasound device to characterize concrete

- linear loading frames (6 m) and gantry crane (4 x 4 m)

**Partner organizations**

CSTB, CTBA, CTICM, PUCA, RGPU, ADEME, Région Rhône-Alpes, CNRS, Institut de la Montagne, Institut National de l’Energie Solaire.

**International relations**

UTCB Bucharest, Concordia University in Montreal, Loughborough University, USTO Oran

**Partner companies**

Léon Grosse, Spie, Tonello IC, EDF, ASTATO.

**MMSC Team**  
**Material Mechanics and Composites**  
**Main research themes:**

Multi-scale approach to  
composites  
behavior

Homogenization in  
plasticity and calculation  
of structures

**Simulation/Modeling Experimentation / Control**

**A multi-scale approach to composites behavior**

- Conventional and visco-piezoelectric methods.
- Standard and piezoelectric fiber composites.
- Linear and non-linear structural calculation.
- Optimization of the use of piezoelectric composites.
- Design and realization of test benches for efficiency measurements of piezoelectric inserts (damping, micro-generators, etc.)

**Homogenization in plasticity and calculation of structures**

- Limit analysis, convex optimization, MEF, parallel calculation, plasticity homogenization.
- Forecasting ductile fracture for Gurson-type methods and periodic models. Comparison with experience.
- Structural stability in civil engineering: Structures in reinforced ground, supports, static and dynamic ground-structure interaction.
- Micro-mechanics of screwed assemblies and calculation of structures.

**Means**

- SUN, Apple and PC workstations
- DYNAMAT 50 kN and SCHENCK 100 kN tensile testing machines
- TORSIOMAT 15 Nm torquemeter and METRAVIB Viscometer
- Equipment to elaborate conventional and piezoelectric composites
- Physico-chemical characterization (DSC, DETA, Rheometer, infrared spectrophotometer)

**Partnerships**

- LGEF Lyon
- CORE Louvain la Neuve
- Politecnico di Milano

**Projects underway in the Rhône-Alpes region**

- Programme Avenir
- Programme Emergence

**Industrial relations**

- EDF
- Renault
- Vetrotex International

LOCIE is hosted by the ESIGEC, School of engineering part of the University of Savoie.

**ESIGEC is a school of engineering, recognized by the French chartering engineering council.**

3 branches are taught as fully chartered engineers :

**ENVIRONMENTAL ENGINEERING  
BUILDING CONSTRUCTION ENGINEERING  
COMPOSITE MATERIALS**

The school of engineering also host a Master programme :

**Master in Ecotechnique**

With the different cursus and specialities :

**Structures and system optimisation**

*Composites material and structures optimisation  
Behaviour and optimisation of built structures*

**Environmental engineering and sustainable buildings**

*Biotechnology processes for the environment  
Eco-design, production and environmental quality products  
Energy saving inside buildings*

**Solid waste and renewable energies management (VERDEC)**

In the near future a fourth engineering branch will open in the field of RENEWABLE ENERGIES

Full engineering cursus covered 3 years, and admission are made on both a contest and an interview for pre-selected students following the contest. All the admitted students have a 2 years university level background.

All of the 3 departments welcome almost 36 students per year, so that, including Master's degree students the school hosted almost 350 students.

**Engineering cursus details :**

**Environmental engineering**

- Multidisciplinary training in fields linked to pollution control (water, air and soil)
- Scientific and technological training of engineers qualified to:
  - ✓ design processes for liquid and gaseous effluent treatment and water purification
  - ✓ initiate and take charge of the environmental management in a company
  - ✓ soil contamination processes
  - ✓ analyze and manage natural and industrial environments
  - ✓ manage industrial and household waste recycling
- Training of students to be independent thinkers and to take initiative through technical visits, practical work in pilot units, industrial final year projects and internships.

**Training and program**

- Possibility of studying certain semesters abroad in the framework of the Socrates/Erasmus program: Great Britain (Salford, Lancaster, Loughborough), Germany (Heilbronn, Offenburg, Freiburg), Spain (Madrid), Portugal (Lisbon), Lithuania (Klaipeda) Sweden (Göteborg, Borås, Luleå) ...
- Possibility of obtaining an engineering degree from ESIGEC combined with a Master of Sciences "Environmental Sustainable Process Technology" by studying in the 3<sup>rd</sup> year at the Chalmers University of Technology ( Göteborg, Sweden)
- Double Master programme in "Energy Resource Recovery" with the university of Borås (Sweden)
- Possibility of studying in 3<sup>rd</sup> year at the Ecole Nationale Supérieure de Chimie de Paris "Chemistry and radiochemistry downstream of the nuclear cycle".
- Possibility of a co-degree course in 3<sup>rd</sup> year (Masters in Sustainability)
- Initiation internships (6 weeks at the end of 1st year), internship at the end of 2<sup>nd</sup> year, engineering internship (4 to 6 months at the end of 3<sup>rd</sup> year). Possibility of obtaining a BFE grant from the Rhone Alpes Region to study abroad

(China, Vietnam, Canada, United Kingdom, Poland, Colombia, Germany, Chili, Mexico, New Zealand, Australia...).

- Privileged relationships with the professional community: 30% of the specialized courses are taught by outside lecturers.

<b>Common-core syllabus</b> Engineering Mathematics, Probability and statistics, Applied Mechanics, Fluid Mechanics, Thermodynamics, Heat Transfers, EEA and physical measurements, Computer studies, Operational research, Economics, English	786 h
<b>Chemistry</b> Water chemistry, Primary water treatments, Analytical chemistry, Solution chemistry, Atmospheric chemistry, Chemical water treatments, Chemical kinetics	376h
<b>Environmental physics</b> Hydrogeology, Atmospheric physics, Meteorology, Fluid Mechanics, Acoustics, CAD	214h
<b>Applied biology</b> Ecology, Applied biology, Technologies for sustainability, Agriculture and the environment	202h
<b>Process engineering</b> Process engineering, Effluent treatment, Soil treatment	435h
<b>Personal self-improvement work and Contract Modules</b> Case studies, personal investment projects	308h
<b>Steering of projects</b> Technology, Economics, Environmental law, Commercial law, Final year project	379h

### Specific equipment

- Pilot water treatment units:  
Anaerobic digester, activated sludge reactor (variable load), oxidation reactor (ozone/UV), micro and ultrafiltration, reverse osmosis, sand filtration, electrolyzer, lamellar settling tank, press filter, etc.
- Pilot units for the treatment of gaseous effluents:  
Scrubber, fluidized beds (Gas-Liquid, Gas-Solid, Gas-Liquid-Solid), absorbing column, gas permeation unit, electrostatic precipitator, gas filter, cyclone...
- Equipment to analyze water, air, soils:  
UV-vis and Infrared spectrophotometers, spectrofluorimeter, atomic absorption spectrophotometer (flame and furnace), electro-chemical technology (polarograph, coulometer), liquid and gas chromatographs, ionic chromatograph, submicronic particle counter, Nox analyzer.
- Field and sample taking equipment (liquid, solid and gaseous):  
Pygmy current meter for flow measurement, high-capacity gas pump, conductimeter, oxygen analyzer, pH and ionometer, automatic sampling device, etc.

### **Companies that employ ESIGEC engineers:**

Engineering firms (waste management, water treatment, environment): cabinet Gaudriot, Cabinet Merlin, Saunier Environnement)

Control and certification offices: Apave, SOCOTEC, Véritas

Companies specialized in the environment: ERIC, France Déchets, Iris Instruments, Sage, SNF Floerger, Swan, USF Filtration

Operating and treatment companies (water, air, waste): Aquaprox, Degrémont, Lyonnaise des Eaux-Dumez, ONYX CGEA, OTV, Saur, Vivendi water.

Production industry (environmental engineer): Air-Liquide, Alstom, Bollhof Otal, Danone, Davigel, Evian, Rhodia, Solvay, Tefal, Nestlé Waters

Public service for the state or local governments: ADEME, Water Agencies, BRGM, Chambers of Commerce and Industry, Associations of Municipalities, General Councils, DRIRE, Air quality monitoring networks, Inter-municipal syndicates

Public or private research centers: CNRS, CEA, CreeD, EDF-GDF, Universities

### Construction engineering

Construction Engineering trains general engineers capable of assuming responsibilities during all the different phases of a construction project : drafting the administrative, legal and financial dossiers, technical studies of the construction, work supervision and construction site management.

Training characterized by:

- A multi-disciplinary technical approach to building: structure, foundations, thermal, acoustics, etc.
- The complementarity of the skills developed: technical, administrative, legal and financial
- Over 30% of the specializations are taught by professionals who come to lecture.
- Practical training that comprises technical visits, tutorials, various study and development projects on industrial subjects, as well as internships.

Training and program

- The program is built around common courses for the three departments (30%) and specialization courses (70%)
- Initiation internships (6 weeks at the end of 1st year), internship during 2nd year and a final year internship (three to six months at the end of 3rd year).
- Possibilities
  - of obtaining a grant from the region (BRFE) in order to study abroad for one semester or for an internship abroad.
  - of following a DEA (Master's in research) as a double degree during the third year.
  - of a subsequent specialization: renewable energies, structural design and calculation, management

<b>Common-core syllabus</b> English, chemistry, sustainable development, law, economics, EEA, project management, computer studies, engineering mathematics, solid and fluid mechanics, operational research, techniques of expression, thermodynamics, heat transfers	786 h
<b>Structure and geotechnics</b> Solid mechanics, reinforced and prestressed concrete, metal constructions, wood constructions, aseismic constructions, soil mechanics	440 h
<b>Technical equipment</b> Environmental Sciences for construction, construction thermics, climatic engineering, electrical equipment, architectural acoustics, road and diverse systems	232 h
<b>Design and realization</b> Technology, construction materials, mathematical and computer techniques for construction, pathology and security, design and computer-integrated construction site management, quality management, architecture and graphic shop	335 h
<b>Operational techniques</b> Construction contracts, construction economics, financing, construction law, elaboration of programs	136 h
<b>Projects</b> Technical projects, construction operation project, final year project	440 h
<b>Personal self-improvement work</b> Optional classes in the common core syllabus and in specific courses	320 h

Specific equipment

- ALLPLAN CAD architecture and construction software
- Computerized acoustic measurement systems (01dB and Brüel & Kjær)
- Technical calculation software in construction geotechnics, structure and thermics
- Soil tests in laboratory: odometer, shear device, permeameter
- Continuous beam and trellis testing bench
- Characterization of construction materials
- Air treatment unit, regulation bench; experimental hot water heating circuit
- System to analyze hygrothermal comfort

Companies that employ ESIGEC engineers in Construction Engineering:

- Companies : BOUYGUES, EIFFAGE Construction, SPIE Batignolles, VINCI, ENTREPRISE INDUSTRIELLE, QUILLERY, GFC, GTM, KESSER, QUILLE, DV CONSTRUCTION, EUROLAMELLE, INTHERSANIT, Rhône-Alpes fluides
- Engineering firms, project management, general contractor: BETREM, CETEC, ETB, GSE, INGEROP, SGI-SECTRA, TONELLO IC,...
- Control offices: ALPES CONTRÔLES, APAVE, SOCOTEC, QUALICONSULT, VERITAS, ...
- Paragovernmental: Aéroport de Paris, AREA, EDFD, OPAC, SNCF,...
- State and local government services: Associations of Municipalities, General Councils, Fire and rescue departments, etc.
- Research and higher education: CSTB - Scientific and Technical Construction Center, CTBA - Technical Center for Wood and Home furnishings, IUT de Toulouse, University of Marne la Vallée,...

## Composite Materials

- An original three-year course integrating two complementary aspects: Materials Science and Composites Engineering.
- Multi-disciplinary training that aims at the mastery of all aspects of Design, Elaboration, Calculation and Control of Composite Structures
- Training of students to be independent thinkers and to take initiative through the realization of industrial projects and dossiers directly linked to the composites sector.
- Practical training integrating technical visits, practical work in processing, material sciences and simulation, industrial projects and internships.
- The Rhône-Alpes region is the French leader in the field of composites, with almost 30% of all French activity in this field. In Savoie, the composites sector is also well established:  
3G Composites, Apira, Arcar Composites, Bird, Bollhoff Otal, Compositec, Rhonalp System, Roctool, Saint-Gobain Vetrotex France, Saint-Gobain Vetrotex International, Serac Composites, Sotira 73, Strativerre,...

### Training and program

- The program is built around common courses for the three departments (30%) and specialization courses (70%)
- Possibility of studying a semester in a university abroad:  
International Masters in Advanced Materials or Automotive Engineering (Chalmers University of Technology, Sweden), Master of Engineering in Aeronautical or Automotive or Material Engineering (Loughborough University, UK),...
- In third year, it is possible to follow different DEAs or Research Master in Mechanics or Polymers and Composites.
- Initiation internships (6 weeks at the end of 1st year), internship during 2nd year and a final year internship (three to six months at the end of 3rd year). It is possible to obtain a grant (BRFE) from the Rhône-Alpes region to favor exchanges abroad, including: Germany, Canada, Chile, Luxembourg, Switzerland, the UK, Vietnam,...
- Privileged relationships with the professional community; 30% of the specialized courses are taught by outside lecturers from different industries including:

Common-core syllabus English, chemistry, sustainable development, law, economics, EEA, project management, computer studies, engineering mathematics, solid and fluid mechanics, operational research, techniques of expression, thermodynamics, heat transfers	786 h
Chemistry & Physical chemistry General chemistry, macromolecular chemistry, instrumental methods, Physical chemistry of surfaces	240 h
Composite materials and structures Calculation of composite structures, Behavior of heterogeneous materials, Corrosion, Composites, Mechanics of composite structures, Metals and alloys, Materials physics and mechanics, Industrial processes for composites, properties of polymers, rheology, glass and ceramics.	684 h
Engineering mechanics CAD, Mechanics of homogeneous anisotropic environments, mechanics of failure and damage, finite element methods (static, dynamic and composites), plasticity of heterogeneous materials, strength of homogeneous and composite beam materials, technology	380 h
Projects Strategy elements, Case studies, Study projects, Final year project, Seminars	610 h

### Specific equipment

The Composites department is equipped with:

- Platform for physico-chemical and mechanical characterization comprising: dielectric analyzer, modulated differential calorimeter, gas and liquid chromatographs, tensile testing machine 50 kN, Rheometer, IT-TF Spectrophotometer, Torquemeter, viscometer, etc.
- The department has its own composites processing platform comprising:  
Contact, dry and wet molding  
Partnership with Compositec for training in *Industrial Processes for the processing of composites*, including:  
Spray up, RTM, filament winding, Prepreg, SMC presses, Thermoforming, etc.
- Workstations equipped with programming, injection simulation (Moldflow), structural calculation (Ansys, Samcef) and CAD (Solidworks) tools.

Companies that employ ESIGEC Composite Engineers:

- Industries that use composites: AIRBUS, ALCATEL SPACE, ARES, EADS COMPOSITE AQUITAINE, DAHER LHOTELIER, EUROCOPTER, GOODYEAR, HUREL HISPANO, LATECOERE, PSA, RATIER FIGEAC, RENAULT, SALOMON, SNCF, VALEO, VOLVO
- Engineering firms and R&D centers: ABMI, ALTRAN, ASTRIUM, BIRD, BLUE ENGINEERING, CALCUL INGENIERIE, COMPOSITEC, CTA, DYNE DESIGN ENGINEERING, GIST, MECALOG OMEGA PHI, RETEC ...
- Industries manufacturing raw materials, elaboration and transformation of composites: BIRD, CROWN CORK & SEAL, FAURECIA, HUTCHINSON, MARMILLON, MECELEC, MULTIBASE, NOVOPLAST, PECHNINEY PLASTIC PACKAGING, PLASTIC OMNIUM, SIGMA TECH, SOTIRA,...

ESIGEC

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### **Master Programme VERDEC**

Renewable energies and waste recycling in the construction Industry

Program transformed in September 2004 into a Master in Sustainability, VERDEC specialization

Sustainable habitat design, Climatic engineering, Energy management, Thermal solar energy, Photovoltaic solar energy, Wood energy , Wind power, Waste management

The aim of the DESS VERDEC (a 1-year post-graduate degree) is to train and specialize technical managers in the field of renewable energies and waste recycling in the construction industry. Each graduating class is made up of some twenty students with different backgrounds and of different ages (in initial or continuing education), which creates good group dynamics and fosters the exchange of knowledge.

Energy at the service of sustainable development

- for sustainable learning
- to communicate one's motivations and skills to the technical and economic stakeholders in the construction and energy sector
- to participate professionally in the sustainable development of society

Organization of teaching modules (450 hours):

- applied physics
- energy and environment
- construction engineering
- energy management in the construction sector
- waste management
- thermal solar energy
- photovoltaic solar energy
- wind power, wood energy
- geothermal cogeneration, micro-hydropower
- technico-economic analysis of new and renewable energy projects

Final year project (100 hours)

Vocational development internship (4 to 6 months)