Cyber-Physical Systems Engineering (CPSE)

CAMPUS

Arts et Métiers campus of Aix-en-Provence

OBJECTIVE

This Master of Science program aims at exploring the concepts, methods, models and tools used to design, simulate, manufacture and control Cyber-Physical Systems (CPS) in the scope of the Industry 4.0. It is a multi-disciplinary program addressing a wide range of up-to-date Industry 4.0 challenges, which companies have to face today to ensure their competitiveness on the worldwide market.

The objective is to train future engineers and researchers to evolve in complex multi-disciplinary industrial environments embedding Cyber-Physical Systems as well as other mainstream Industry 4.0 concepts, technologies and processes.

This is reached through a well-balanced training program that combines theoretical and practical learning sequences, during which students are placed in both academic and real-life industrial configurations, in order to develop multiple transversal skills.

LEARNING OUTCOMES

Through this program, the future engineers and researchers acquire the following knowledge and skills:

- Deep theoretical knowledge on the mainstream concepts, methods, models and tools involved in CPS engineering and Industry 4.0 technologies and processes. It includes the positioning with respect to the state-of-the-art, as well as the identification of open issues and future trends in the Industry 4.0 areas;
- Extended practical skills for the definition of multi-disciplinary technical solutions for CPS engineering. It includes the training on commercial software and tools through several projects efficiently distributed all along the training program;
- Deep understanding of the overall value chain, the strategic and supply chain management and the associated concepts with a particular focus on Industry 4.0 issues;
- Structured research methodology to be used as a template to address a wide range of research challenges related to Industry 4.0;
- Transversal adaptation, integration, analysis, critical thinking, self-learning, communication, valorization and organizational skills gained when confronting to both academic and industrial multi-disciplinary projects;
- International exposure through the courses taught in English and exchanges with other foreign students.

TRAINING PROGRAM

The Cyber-Physical Systems Engineering program is fully accessible in English. It is composed of two main sessions:

- From October to January: professionalizing and scientific modules, English/French module, long multi-disciplinary project;
- From February to September: master thesis either in a laboratory or in a company, in France or abroad.

The 4 professionalizing modules are as follows:

- Research methodology (12h)
- Artificial Intelligence and data analytics (12h)
- Industry 4.0: concepts, survey and future trends (12h)
- Value chain, strategic and supply chain management (12h)

The 6 scientific modules are as follows:

- Digital Mock-Up for CPS modeling and advanced engineering (24h)
- Reverse Engineering and rapid prototyping of CPS (24h)
- Digital chain for CPS engineering in a heterogeneous context (24h)
- Supervision of CPS during the engineering and exploitation phases (24h)
- Smart sensors, actuators and manufacturing technologies (24h)
- Advanced control, identification and fault-detection for CPS (24h)

Each module is decomposed in both theoretical and practical learning sequences. An additional multi-disciplinary project (120h) is planned during the first session to further investigate the notions introduced in the various modules, and to further interact with state-of-the-art methods, models and tools through real-life industrial projects.

The English module (24h) aims at reinforcing the knowledge and skills of the future engineers and researchers to analyze scientific papers, to communicate through different medias, to write good-quality papers. English native speakers follow a French module (24h).

The master thesis takes place during the second session, from February to September. It can be performed in a laboratory or in a company, in France or abroad. During this period, the students are under the scientific responsibility of one or several professors involved in the Master of Science. Professors usually propose several projects on which the students can candidate. Students are also encouraged to look for prospective subjects by themselves. In this case, the subjects have to be validated by an ad-hoc committee, prior to the signature of any tripartite agreement.

EXAMPLES OF CAREERS

Laureates of the Master of Science in Cyber-Physical Systems Engineering have access to a wide variety of possibilities to pursue their career in all the areas where the Industry 4.0 concepts spread, and more precisely (but not limited to):

- in the industry: in various departments (R&D, design, quality, method, control, supply chain, etc.), in numerous sectors (manufacturing, construction, services, consultancy, agriculture, etc.) and in different fields (automotive, aerospace, health, IoT, etc.);
- in the academia, while becoming researcher or professor in France or abroad.

Laureates can also be enrolled in a PhD thesis to further investigate and work on up-to-date scientific challenges and thus become a recognized expert in an area of the Industry 4.0. This is a preliminary step to reach a position of researcher or professor in the academia.

EXAMPLES OF MASTER THESIS PROJECTS

The master thesis is an important part of this training program which takes place during the second session, from February to September. It can be performed in a laboratory or in a company, in France or abroad. Here is a non-exhaustive list of master thesis projects that were proposed during the last years:

With industrial partners:

- Application of big data to the treatment of multiple configurations in PLM (SOGETI HIGH TECH)
- Machine Learning for the classification of parts to be supported prior to their additive manufacturing (POLYSHAPE)
- Deep learning for multimodal segmentation of point clouds for reverse engineering of mechanical products in augmented reality (PERSPECTIVES)
- Multi-sensor monitoring and big data for smart manufacturing in aerospace (AIRBUS)
- Passive and active vibration control systems for manufacturing processes (CETIM & SECO)
- Modeling of dynamic systems of the power chain in automotive (PSA)
- Performances and study of the sensitivity of non-linear dynamic filtering absorbers on helicopters (AIRBUS HELICOPTER)
- …

With academic partners:

- Advanced segmentation of hybrid Digital Mock-Up (Laboratory MAP, Marseille)
- Segmentation of digitized parts assemblies using curvature estimators (IMATI-CNR of Genova, Italy)
- Understanding how much iterative the CAD modeling process is (ÉTS Montréal, Québec, Canada)
- Use of a priori knowledge to fill in holes in reverse engineered point clouds (Laboratory LURPA, ENS Cachan, Cachan)
- …

This is clearly not an exhaustive list and prospective candidates are encouraged to contact us to discuss their professional project and get further information on the various possibilities.

HOW TO APPLY

- For Arts et Métiers students: through the 2A and 2B selection processes.
- Foreign students must have a degree equal to M1 (first year of Master of Science degree) and should contact Prof. Jean-Philippe PERNOT (jean-philippe.pernot@ensam.eu) to start the application process.
- Applications end mid-July.

PRATICAL INFORMATION

- Teaching language: English

- Periods: October to January (courses), February to September (master thesis)
- Teaching hours during the first session (October to January): 48h of professionalizing courses + 144h of scientific courses + 24h of English/French course = 216h of face to face training + 120h of multi-disciplinary projects as well as additional personal works.
- ECTS credits: 30 credits/session (60 ECTS for the M2)

CONTACT

Prof. Jean-Philippe PERNOT (jean-philippe.pernot@ensam.eu)

KEYWORDS

Cyber-Physical Systems, Industry 4.0, Factory of the Future, Digital Twins, Digital Thread, Digital Mock-Up, Reverse Engineering, Rapid Prototyping, Artificial Intelligence, Data analytics, Smart Product, Smart Manufacturing, Decision Making, CPS supervision and control, fault-detection.