



## Introduction

The fourth industrial revolution, branded as “Industry 4.0” by the Germans in 2011, is characterized by the digital shift, the integration of business processes and information systems, the real-time management of operations, the automation and robotization of operations, optimization and management of assets, sharing and security of big data, tracking parts from cradle to grave (the “Digital Thread”), data analytics, Internet of Things (IoT) and Artificial Intelligence (AI). Compared to the three previous revolutions, it is characterized by real-time connectivity, speed of implementation of the various technologies, a cultural change and development of new skills.

This fourth industrial revolution is propelled by the advent of new technologies and the generalization and standardization of well-known technologies. Its purpose is to increase the operational efficiency of organizations and improve their products and services. Digital technologies can be used to customize products and services, and to adapt and coordinate operations in real time to the needs of customers and organizations.

As highlighted by the Boston Consulting Group’s 2015 report, Industry 4.0 will transform the workforce of tomorrow. We will need “Industrial Data Scientists” with knowledge of information and communication technology (ICT) and Artificial Intelligence (AI) skills, user interface design, advanced analytics, cause fundamental analysis and statistical programming.

## Innovation 4.0 Network

The main goal of the Innovation 4.0 Network is to establish collaboration between Québec universities in Research and Development and training of Quebec's highly skilled workforce for various fields of application of the technologies of Industry 4.0. Quebec universities participation are: Concordia University, École de technologie supérieure (ÉTS), Laval University, Polytechnique Montréal, McGill University, Sherbrooke University, Université du Québec à Montréal (UQAM) and Université du Québec à Trois Rivières (UQTR).

Innovation 4.0 Network is a promising initiative for which the Quebec and Canada governments have expressed an interest. Faced with a growing need for organizations in terms of technological development and support in this digital shift, members of Innovation 4.0 Network consider that there is a need to support the university mission in this area, in collaboration with initiatives already in place such as ADRIQ, CRIQ, IVADO, ENCQOR. Innovation 4.0 Network will therefore bring together researchers and practitioners from various organizations, whose multiple and complementary expertise will reach various business sectors. This Innovation 4.0 Network will be a showcase of Quebec’s achievements and expertise in Industry 4.0. It is therefore not only a mean to satisfy a growing demand from companies for research and technological development, but also for training. Thus, there is a strong need to train the skilled 4.0 workforce to integrate into centers of excellence and SMEs. Innovation 4.0 Network will ultimately be an important platform for collaboration among universities in research, knowledge sharing, fundraising and access to infrastructure and ressource sharing.

## Technology 4.0 and Industrial Sectors

The Innovation 4.0 Network includes different technologies of Industry 4.0: Internet of Things (IoT), big data analytics (including artificial intelligence), smart and additive manufacturing, augmented and virtual reality, autonomous systems, organizational transformation and human factors. The business sectors addressed are: manufacturing, aerospace, energy health & safety, construction, transportation and logistics, mining, pharmaceuticals, forestry and telecommunications.

### Objectives

The objectives of Innovation 4.0 Network fall into two groups, respectively applied research and its governance, as well as knowledge transfer and training

#### Applied research

- Transfer and application of technology to the Industry 4.0;
- Collaborative research projects in Industry 4.0 technologies;
- Seek joint funding;
- Establishment of national and international partnerships;
- Hire professors in the field of 4.0;
- Sharing and invest in laboratories and equipment of research.

#### In knowledge transfer and training

- Support and promote students activities (internships, scientific clubs, forums, industry visits, conferences, workshops, competitions, etc.);
- Academic programs through continuous improvement of existing programs to better meet the changing needs of industry and students, sharing resources and expertise, creating new collaborative programs, etc.;
- Professional development courses and workshops for students, engineers and professionals;
- Develop a Master and Summer School program in Innovation 4.0;
- Sharing best practices.

### Research Areas

The research areas of the Network focus primarily on five fundamental aspects:

#### The development of leveraged technology 4.0 applied:

- Development of connected, remotely configurable and autonomous industrial objects for real-time monitoring and control of operations;
- Development of cloud computing systems for the sharing of industrial information (ex., product design and industrialization) and the coordination of value creation networks;
- Development of applied and dedicated data analysis technologies predictive maintenance;
- Develop standardization and system integration tools for multidisciplinary optimization of product design and production system design;
- Develop machine learning and machine vision technologies for quality inspection in complex product environments;
- Develop augmented reality technologies applied to support complex operations;
- Develop hybrid systems applied to the planning and control of operations (ex., simulation, optimization, machine learning);
- Develop IT security technologies for distributed industrial operations management systems;
- Develop technologies to monitor the physical efforts of human work in real time.

### The development of technology 4.0 applications in partners:

- Development of an Internet-based business control system for industrial objects in a company;
- Development of a system to assist the design of manufactured parts in a partner using machine learning to predict the service life of parts;
- Development of an agile control system for handling in a partner's mines;
- Development of an intelligent product distribution system in a future hospital.

### The deployment of technology 4.0 in organizations and society:

- Studies of the deployment of an Internet based operation control system of industrial objects to a partner;
- Studies of strategies and approaches for the digital shift of manufacturing SMEs (ex., diagnostics, digital business models, transformation approaches, manufacturing strategies and distribution);
- Reengineering method development 4.0 of the organizations;
- Study of humans place in transformation 4.0;
- Studies of innovation processes 4.0 in organizations and ecosystems of technological innovation.

### The design of connected and intelligent systems:

- Development of methods for designing and evaluating the performance of agile reconfigurable manufacturing systems;
- Principles and design methods for intelligent autonomous industrial and logistics systems;
- Development of an agent-based methodological framework for the design and coordination of agile production and logistics networks;
- Development of a modeling framework for the design and evaluation of value creation networks.

### Analysis of the impacts of these technologies:

- Studies of the impact of 4.0 technologies on employee work and communication structures in organizations;
- Studies of the economic impact of innovation 4.0;
- Studies of the impact of 4.0 technologies on the ergonomics of human work.

### Leading Professors of Innovation 4.0

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