Cyber Physical Systems Analysis: what can be the contributions from the "MIMAR community" ? - Prof. Anne Barros (CentraleSupélec, France)

The chair "Risk and Resilience of Complex Systems" at CentraleSupélec (Paris), starts in 2020 a research activity dedicated to the modelling and the resilience analysis of cyber physical systems. The partners involved in the project are EDF (French national power supplier), Orange (French Telecom operator), SNCF (French national railways operator) and Paris Airports. The objective is to define use cases encompassing three networks, one for the physical transportation system, one for its power supplying and one for its telecom services providing. The following questions will be addressed: which kind of decisions can be optimized in relation with safety and business continuity, what are the relevant performance indicators for such decisions and what are the suitable modelling techniques?

A review of similar problem statements with related modelling techniques will be provided, including among others, physical models, stochastic hybrid models and networks of networks. Contributions of the proposed approaches will be discussed within their validity domain and the needs for new contributions from the "MIMAR community" will be highlighted.

An overview of optimisation models for offshore windfarm maintenance - Prof. Rommert Dekker (Erasmus School of Economics, Netherlands)

In this talk we give an overview of optimisation approaches for reducing maintenance costs of offshore windfarms comprising of many identical windmills. Many coastal countries are building very large offshore windfarms and the success of the energy transition depends on the profitability of these windfarms where maintenance cost play a dominant role.

We will first consider the maintenance of one windmill, in terms of components and failure modes as well as the choice for time-based and/or condition-based maintenance. Next we will consider the logistic challenges around the maintenance of these offshore windfarms and how these have been addressed by operations research methods.

New Maintenance Orientation in The Frame of Industry of The Future: Challenges and Opportunities Brought by Data Analysis - Prof. Benoît Iung (Université de Lorraine, France)

Next generation of industry such as those promoted by “Industry of the Future”, “Industry 4.0.” paradigm, holds the promise of increased flexibility/adaptability in production (e.g. manufacturing) to cope with the challenges of producing individualised products as expected by customers with a short lead-time to market and at the cost of mass production. These challenges can only be met by further developing the digitalisation of production systems (towards Cyber Physical Production System - CPPS) in which data science, smart manufacturing objects (SMO) and services are predominant. This vision should increase global competitiveness by promoting innovative business models mainly driven by servitization (anything-as-a-service) and stakeholders’ collaboration in the way to keep industrial employment in Europe. More precisely, CPPS is a new way to organise the system (heterarchical vs holistic approach) to enable fast integration feedback and control loops throughout distributed manufacturing infrastructures all along its life cycle. So, the resulting organisation is assimilated to a complex manufacturing ecosystem based on interaction of humans, objects (e.g. products, components), customers, society partners … having to offer a dynamic, real-time optimized and self-organizing value chain from relevant data. These advanced characteristics imply that the system in support of the value chain need to become more adaptable, agile, robust, resilient … to face fault, unforeseen events while guaranteeing system performance. However, the process of predicting reliability and performance in such context is far from trivial. The main barriers include, at least, the inability to anticipate unknown faults particularly for complex systems, and the inability to sustain system functionality and performance in the presence of system anomalies and severe disturbances. To face these barriers, the conventional challenges on diagnostics, prognostics, maintenance decision-making… should be extending, mainly by using Data Science tools to construct concepts such self-healing, self-assessment, self-maintenance, self-repair … as promoted by the Prognostics and Health Management (PHM) community. Thus, data processing is a very important tool for (predictive) advanced maintenance leading to consider the technologies and methodologies referred to advanced data analytics (e.g. internet of things, big data, artificial intelligence) as a main pillar to offer predictive capabilities and deploy a new way of organizing and implementing proactive maintenance on an industrial scale.

In that way, the aim of this keynote speech is to survey, with illustrations, the key developments in data analytics-based (predictive) advanced maintenance, and its emerging challenges. In the frame of “industry of the future/industry 4.0”.