



## **Advanced methods for the risk assessment of industrial facilities and plants in the oil&gas and energy sectors**

- **Context of the research**

As the digital, physical and human worlds continue to integrate, we experience a deep transformation in industry, which far-reaches into our lives. The 4th industrial revolution, the internet of things and big data, the industrial internet, are changing the way we design, manufacture, provide products and services. This is creating a complex network of things and people that are seamlessly connected and communicating. It is providing opportunities to make productions systems more efficient and faster, and more flexible and resilient the complex supply chains and distribution networks that tie the global economy.

In this fast-pace changing environment, the attributes related to the reliability of components and systems continue to play a fundamental role for industry, and those related to safety and security continue to be increasingly of concern. The innovations that are being developed have high potential of increased wellbeing and benefits, but also generate new and unknown failure mechanisms, hazards and risks, partly due also to new and unknown functional and structural dependencies. On the other hand, the advancements in knowledge, methods and techniques, the increase in information sharing, data availability and computational capabilities, and the advancements in knowledge that these can bring, offer new opportunities of development for the analysis and assessment of risks.

Risk assessment must evolve for addressing the above challenges and grasp the above opportunities. Development directions include:

- the use of advanced dynamic modelling techniques, like dynamic bayesian networks, multi-agent dynamic modeling (dynamic risk assessment)
- the use of simulation for accident scenario identification and exploration (computational risk assessment)
- the extension of risk assessment into the framework of resilience and business continuity (resilience assessment and business continuity analysis)
- the reliance on data (condition-based risk assessment)

The objective of the research is to study, develop and advance methods of risk assessment to provide the most informed and knowledgeable evaluation of industrial assets with regards to hazards, threats and potential accidents. The methodological research is complemented by the development of computer codes

for the quantification of the methods, and their use in case studies from the oil&gas and energy sectors.

- **Objective of the research**

Methodology study, development and advancement; software tool development; industrial case study.

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## The future of risk assessment

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## ABSTRACT

Risk assessment must evolve for addressing the existing and future challenges, and considering the new systems and innovations that have already arrived in our lives and that are coming ahead. In this paper, I swing on the rapid changes and innovations that the World that we live in is experiencing, and analyze them with respect to the challenges that these pose to the field of risk assessment. Digitalization brings opportunities but with it comes also the complexity of cyber-physical systems. Climate change and extreme natural events are increasingly threatening our infrastructures; terrorist and malevolent threats are posing severe concerns for the security of our systems and lives. These sources of hazard are extremely uncertain and, thus, difficult to describe and model quantitatively.

Some research and development directions that are emerging are presented and discussed, also considering the ever increasing computational capabilities and data availability. These include the use of simulation for accident scenario identification and exploration, the extension of risk assessment into the framework of resilience and business continuity, the reliance on data for dynamic and condition monitoring-based risk assessment, the safety and security assessment of cyber-physical systems.

The paper is not a research work and not exactly a review or a state of the art work, but rather it offers a lookout on risk assessment, open to consideration and discussion, as it cannot pretend to give an absolute point of view nor to be complete in the issues addressed (and the related literature referenced to).

### 1. Introduction

Safety is freedom, freedom from unaffordable harm, and, thus, a human right. Risk assessment has been the dominant paradigm for ensuring this right in the design and operation of industrial systems. Examples of areas of applications include the chemical process industry, the nuclear industry, the transportation sectors, the aerospace industry etc.

Risk assessment is a mature discipline. The structured performance of a risk assessment guides analysts to identify possible hazards/threats, analyze their causes and consequences, and describe risk, typically quantitatively and with a proper representation of uncertainties. In the assessment, the analysts make assumptions and simplifications, collect and analyze data, and develop and use models to represent the phenomena studied. For example, the failure modes of components due to a given earthquake, the heat fluxes on a structure due to a fire, the response of operators to an accident are all the results of conceptual models that attempt to mimic how a real accident would proceed, based on the knowledge available. The risk assessment of a system requires the consideration of a possibly very large number of scenarios with multiple failures of its components and, by so doing, provides an in-depth understanding and knowledge of the system failure modes with

consequent increase of the awareness on risk and the attention to safety, which typically leads to an overall improvement of the safety of the system.

The World we live in is rapidly changing in many ways. Digitalization is bringing new opportunities of connectivity, monitoring and awareness, and is changing the way we communicate and socially behave. Mobility and social pressure are changing the landscape in which we live and operate. Continuous advancements in technical knowledge and technology are improving our production processes, products and services, as well as our environments, while changing the business and work/job scenarios. As the digital, physical and human worlds continue to integrate, we experience a deep transformation in industry, which far-reaches into our lives. The 4th industrial revolution, the internet of things and big data, the industrial internet, are changing the way we design, manufacture, supply products and services, the way we move and live in our environment. This is creating a complex network of things and people that are seamlessly connected and communicating. It is providing opportunities to make production systems and services more efficient and faster, and more flexible and resilient the complex supply chains and distribution networks that tie the global economy.

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