



## Numerical Transition on the Move

### Digitalization supporting accidents prevention: current challenges and emerging risks. The contribution of the project HUMAN4DIG 5.0: Human-Centric Digital Technologies for Safer Workplaces

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Digital transformation and Industry 5.0 place increasing emphasis on human-centricity, resilience, and sustainability. However, many digital solutions currently implemented in workplaces do not adequately consider workers' needs, capabilities, and well-being. Recent applications of digital technologies aimed at reducing workplace accidents focus on monitoring workers' conditions (e.g., health parameters, location, and environmental exposure). These systems aim at preventing specific risks and assist workers and safety managers during hazardous tasks through dynamic remote support or digital assistance systems. Such technologies can provide real-time alerts, warnings, insights, and forecasts, helping workers and safety managers make informed decisions at the right time. Despite their potential benefits, the design and management of these digital systems often focus primarily on technological aspects, while occupational safety and health (OSH) impacts, user acceptance, usability, and privacy issues are rarely fully evaluated during the development phases. As a result, rapid technological change may introduce new safety, cognitive, and psychosocial risks if human factors are not adequately considered when implementing digital technologies for risk prevention in the workplace. Factors such as perceived usefulness, privacy concerns, and emerging risks (including psychosocial challenges and work-related diseases) can limit the adoption of these systems in workplaces, even though their potential benefits—especially in terms of accident prevention—are significant. In particular, when focusing on two key smart applications used to prevent workplace risks—digital surveillance systems and automatic assistance systems—several issues must be addressed according to both “safe-by-design” principles and sustainable approaches. A major challenge is the lack of specific guidelines for designing these technologies using a truly human-centric approach. These challenges are addressed by the research project HUMAN4DIG 5.0, funded under the SAFERA 2024 program. The project aims at developing multi-level guidelines that support the implementation of more human-centric digital technologies for automatic surveillance and digital assistance systems in hazardous workplaces. The project involves European Universities—University of Salento and Campus Biomedico (Italy), and University of Belgrade (Serbia)—, a non-profit association (PESI, the Spanish Technology Platform on Industrial Safety and Security) and a private company (Ipartic Consulting in Spain). This partnership creates an interdisciplinary research team combining expertise in occupational safety, engineering, digital technologies, and industrial practices. The project has started on April 2025 and will end in April 2027.

The main objective of HUMAN4DIG 5.0 is to develop guidelines that support human-centric Cyber-Physical Systems (CPS) used for digitalized surveillance and assistance systems in hazardous workplaces. These guidelines aim to provide a reference framework for both Occupational Safety and Health (OSH) and digitalization strategies. To achieve this goal, the project adopts multi-model and multi-level approaches, including multi-criteria decision tools, to evaluate both the actual benefits of digital surveillance and assistance technologies and the potential risks and impacts associated with their use. A key innovation of the project is the integration of workers' and safety managers' perspectives, which are often neglected in current technology-driven development processes. This approach follows the “safety-by-design” principle, ensuring that human factors are considered from the earliest stages of system design. The guidelines are being developed across different levels of application: A reference framework

for integrating OSH principles and digitalization strategies will support strategic decision-making within organizations. At the operational level, multi-criteria decision models are being developed to support the design, implementation, and management of digital surveillance and assistance systems. These tools will provide practical methods for OSH practitioners and digital experts to collaborate effectively in designing and deploying human-centric and safe-by-design digital processes, aligned with the Industry 5.0 vision.

The results of the HUMAN4DIG 5.0 project aim at supporting companies undergoing digital transformation, Industry digitalization experts, as well as OSH professionals by providing tools and guidelines for developing and managing digital surveillance and assistance systems that are safer, more human-centric, and sustainable.

The guidelines and frameworks developed will also contribute to improving usability and user acceptance, helping end users to better understand both the benefits (e.g., accident reduction) and limitations (technical and social) of these technologies.

In the next phase of the project, an international survey will be conducted to evaluate critical issues related to the use of digital surveillance and assistance technologies for occupational safety and health in workplaces. Researchers, practitioners, industry experts, and professionals working in OSH, digital technologies, and industrial safety are invited to participate and share their knowledge and experience.

If you are interested in contributing to this research, please feel free to contact me ([mariagrazia.gnoni@unisalento.it](mailto:mariagrazia.gnoni@unisalento.it)).

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## AI Systems & Risk

### Global Risk Analysis for AI systems

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From peer-reviewed scientific journals to the general press and social media, the news has for many months been largely dominated by the subject of AI, and the question is equally pressing within companies, local authorities and public bodies, at every level of decision-making: governance, management, operations. The associated risks are themselves widely debated, from technical, economic and societal angles, with a range of discourse running from catastrophism to fanaticism, not to mention those who cultivate doubt about the possibility of a "sentient" AI, which bears no relation to the reality of the models. All of this reflects both a strong appetite and a degree of anxiety in the face of technologies that remain broadly ill-defined outside scientific and technical circles. These analyses and debates, however, remain largely decontextualised and are of little help to the decision-maker or project manager confronted with the development or implementation of these systems, which requires a genuine risk analysis, detailed and grounded in its own specific context.

Such an approach is built first on the basis of a normative and regulatory ecosystem that is both specific to AI and more generic. ISO 22989 lays the foundations by establishing a common language without which no collaboration or regulation is possible. ISO 23053 builds on this vocabulary to describe concretely how to construct AI systems based on machine learning. ISO 23894 enriches this approach by integrating a risk dimension, indispensable for anticipating the undesirable effects specific to AI. Finally, ISO 42001 oversees the whole: it is the governance and management standard that enables organisations to steer their AI responsibly, drawing on concepts (22989), architectures (23053) and risk analysis (23894) as implementation building blocks. Together, they trace a path from definition to design, from risk management to the organisational governance of AI.

This normative AI core is informed by ISO 25010 (software quality) and IEC 61508 (functional safety, not without tensions around the notion of determinism, which the probabilistic nature of AI models fundamentally calls into question). It is today structured and overarched by the AI Act (EU Regulation 2024/1689), the world's first binding legal framework dedicated to AI, whose risk-based approach redistributes the role of each of these standards. The AI Act does not replace any of them: it federates them, confers upon them a new legal standing, and transforms what

until now fell within the realm of good practice into genuine compliance obligations. Adhering to ISO 42001 or ISO 23894 is therefore no longer a matter of mere industrial voluntarism — once these standards are harmonised under the AI Act, their documented implementation will give rise to a presumption of regulatory compliance, in the same way as the well-established CE marking mechanism.

This unified normative block then becomes the indispensable technical passport for satisfying three distinct but converging regulatory regimes that the AI Act oversees and articulates: product liability (the revised , under which non-compliance with the AI Act now creates an automatic presumption of defectiveness), the safety of autonomous machinery (Machinery Regulation 2023/1230, whose conformity assessment must simultaneously integrate machinery requirements and AI requirements), and the placing on the market of intelligent medical devices (MDR, for which the AI Act imposes an integrated compliance pathway alongside ISO 14971 and IEC 62304). It is further complemented by the standards and regulations specific to cybersecurity and data protection — ISO 27001, ISO 27005, NIS2, the Cyber Resilience Act and the GDPR — which the AI Act explicitly invokes for its robustness and security requirements applicable to high-risk systems. It must also, in certain cases, be situated within specific frameworks such as Safety Management Systems (SMS) in aviation. To which must be added the social and environmental responsibility issues addressed by ISO 26000, whose principles of equity, transparency and respect for fundamental rights directly echo the ethical requirements of the AI Act. The challenge for industry is therefore to build, from now on, a unified documentary architecture, conceived through the lens of the AI Act, that simultaneously addresses all of these requirements — failing which they risk facing an accumulation of redundant dossiers, cross-audits and cascading non-compliance risks.

It is precisely to meet this requirement for coherence and comprehensiveness that a Global Risk Analysis approach (GRA, Desroches et al. 2016) appears particularly justified and well-suited. Starting from a rigorous definition of the system in question — its complete lifecycle, including the phases of governance, strategy definition and needs assessment, its operating environments and contexts of use, as well as its precisely defined objectives — the mapping of hazards and threats can be conducted on the basis of the following categories: Environments, Regulation, Safety and cybersecurity, Governance, Socio-economic, Management, Operational performance, Human and cognitive factors. Within the framework of the HUDERIA analysis, which is centred on respect for human rights, the categories of Human Rights and Influence are added. In this way, we have identified more than 500 hazardous elements or events across these categories.

The identification of hazardous situations then leads to the construction of system-specific scenarios in context, drawing on two evaluation frameworks: a severity scale based on the system's objectives (technical and economic performance, safety of persons, property and data) as well as on the notions of reversibility and scope of consequences; and a likelihood scale based on the classes of uncertainty associated with the risks, which can be linked to probabilistic thresholds. These two scales make it possible to define the decision-making and governance framework specific to the organisation, grounded in its risk acceptability criteria. Their application leads to the definition and implementation of control measures — reduction of initial risks and management of residual risks — and results in a complete risk map together with a structured and prioritised operational control plan.

This global analysis must be supplemented by a cyber risk analysis conducted according to the EBIOS RM method, and where necessary by the SEP (Stakeholder Engagement) component of the HUDERIA analysis, whose components 1 (hazard identification) and 3 (risk assessment) are already covered by the GRA described above.

Thus, the implementation of a global risk analysis method (through the consideration of the diversity of hazard and threat types, as well as of final consequences) structured and supported in terms of clear and accessible presentation of results (risk maps, risk prioritisation, risk financing diagrams) simultaneously addresses: the requirement for normative and regulatory coherence, without multiplying analytical frameworks that are sometimes mutually incompatible; the questions and uncertainties of decision-makers, which generalised, vague and decontextualised discourse tends to sustain; and finally the requirements of operational risk management, covering the technical performance and safety of the system, but also the legal, financial, economic and reputational dimensions inherent in any AI system implementation project.

## AISS: Artificial Intelligence in Safety and Security

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In July 2025, at a stage in human history when AI is increasingly present in our lives without us realising whether this is a helpful wave or a devastating tsunami, a group of safety experts within ESReDA formed a new PG—AISS: Artificial Intelligence in Safety and Security. It aims to address a major challenge: How can AI and other emerging technologies strengthen safety and security? (<https://zenodo.org/records/15736652>).

Two months after the group began its work, its members gave three presentations at the 67th ESReDA seminar: Trustworthy Complex and Intelligent Systems - Høvik (Norway):

- Towards a Taxonomy of AI Tools Applied in the Process Industry (Peter KOUWENHOVEN, MSc Chemical Engineering);
- Safety Assurance for AI-Based Components: Possible Coping Strategies (Eric MARSDEN, Programme Manager, FonCSI and Meine VAN DER MULEN - DNV);
- The Development, Use, and Management of AI to Ensure Safety and Security in Socio-Technical Systems (Tuuli TULONEN, - Finnish Safety and Chemicals Agency, John KINGSTON, Chair NRI Foundation, Sever PAUL - Romanian Railway Investigation Agency).

The PG is currently preparing the *call for papers* for the 71st ESReDA seminar, which will be held in the autumn of 2027 in collaboration with the National Centre for Scientific Research “DEMOKRITOS” in Athens, Greece. The title and purpose of the seminar will be announced shortly.

The members of the PG plan to publish the results of their work by the end of 2028. Among the themes emerging are: the competencies needed to exploit AI in safety and security work; the value of AI use in regulatory and independent accident investigations, and; the sociotechnical implications of AI use in this field.

### ➤ **What competencies are critical when using AI for safety & security management?**

Practitioners already use AI in their safety and security work. AI extends what was possible. AI could affect existing practice, both for better and for worse. To provide guidance to AI developers and users, we aim to predict the effects of AI incautiously implemented in safety and security work.

Our concern is that speed will win out over quality unless organisations implement AI with care. Practitioners will need to better recognise the sensemaking dimension of what they do. Something they may have felt able to take for granted, but in future will need to safeguard. Of designers we ask that they equip AI with ways to augment sensemaking. Well-designed AI could prompt alternative framings, reveal assumptions, and alert users to the need to look deeper into issues.

We will reflect on what AI implies for the skill set of people working in safety and security. Existing skills might also need an upgrade. For example, practitioners may need deeper awareness of measurement assumptions to evaluate AI outputs, and greater self-awareness of how they formulate problems and structure their dialogue with LLMs.

### ➤ **How might regulatory and independent investigators of accidents use AI, and to what issues must they be alert?**

We see potential benefits and likely issues. AI can support accident investigations through technical analyses such as video and image analysis, modelling and simulation, processing of vehicle data, detection of human behaviour patterns, and so on. However, it cannot conduct them autonomously; investigations also involve human, legal, and ethical judgments. The analytical path of the investigation depends upon the aim of the investigation. Investigations by prosecutors are not the same as those by insurance companies, and both differ from investigations aimed at improving safety.



*Dr. John Kingston*

Investigators are keen to use the capability of AI to analyse big data sets and recognise patterns. However, we are mindful of the current risks: put simply, the information may be wrong. Data may be incomplete, poor quality, or biased. Concerning the latter, it appears that hallucinations can come from the materials used to train the AI model.

Investigation could also benefit from AI algorithms that recreate the conditions of accidents, such as speeds, angle of impact, distances, and 3D reconstructions. However, these tools carry risks in their current stage of development. Using these tools can send the investigators in the wrong direction if they do not understand the statistical background. Ultimately, they may take AI findings as true, when they are false.

*The goal of AI is "to make us happy" and not "to be accurate". (Mollick, 2024)*

We are also mindful that the safe use of AI systems is more than a technical and technological question concerning properties of large neural networks. This is because safety risks are dependent on the context of use, and therefore on the interaction between technology and the human and organisational dimensions, rather than being intrinsic to the AI model. Risks appear from the interactions between humans and intelligent machines (which can be extremely persuasive, can degrade human moral judgement, lead to automation bias, over-reliance and deskilling, and which degrade our metacognitive abilities), and evolve over time as the different actors learn and adapt to each other.

- **Investigating these issues requires a sociotechnical systems approach to human-AI collaboration**

### **Reference**

67th ESReDA seminar, "Trustworthy Complex and Intelligent Systems". September 25th – 26th, 2025, DNV Headquarters, Oslo, Norway. Doi.org/10.5281/zenodo.17913220  
<https://zenodo.org/records/17913220>.

(Mollick, 2024) Co-Intelligence: Living and Working with AI, Portfolio, 2 Avril 2024, ISBN-13 978-0593716717

## **Socio-Technical Systems Engineering**

### **Towards a Handbook on socio-technical systems design: (re)engineering the future**

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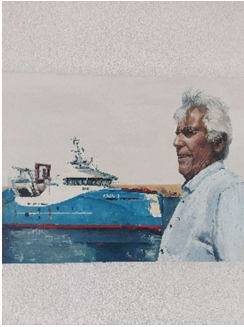
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Historically, ESReDA has contributed to the progress made in the safe and reliable design and operations of closed, complex systems in nuclear, process and transport industries. Nowadays, ESReDA encounters a challenge in assessing the impact of open, dynamic and future proof system developments. Such a challenge also incorporates societal demands in order to enable foresight on future performance, first time right and zero effects: no accidents, no waste and no failures. Our nascent system methodology designer handbook is the result of a joint effort by scientific experts working in the fields of risk management and safety & integral sustainability (re)designing of Transport Infrastructure & Logistic (food) systems, on land, at sea and in the air. The experts belong to the Dutch post-PhD group of emeritus professor John Stoop, since 2006 ESReDA member. Our project aims to provide useful information to engineering design students, from both theoretical and practical viewpoints, based on current case practices and the state of scientific knowledge. Safety and sustainability area is concerned by ongoing debate with evolving UN-EU CSR/CSRD frameworks (2000-present). This raises questions of how to mobilize artefact innovations in open, complex systems, make them largely safe and sustainable, climate adaptive and operational futureproof. Design and operational developments have a finite lifespan. Transition occur mostly incrementally but often by leaps and bounds with ad-hoc legislation in cases of unexpected incidents with disastrous, irreversible consequences. The focus was firstly on the quality of safe labour, secondly on environmental issues and nowadays on safety & sustainability (re)design aspects.

Sustainable and renewable energy supply of Transport, Infrastructure and Logistic (food)systems (TIL) is central to business models under the UN post Paris Climate Agreements and EU Regulations on nature, environment and sustainability with focus on recovery and resilience. Nowadays, increasingly as a consequence of climate change, extreme weather events pose critical challenges on TIL sectors, on land, at sea and in the air, including multifunctional spatial planning. The increased occurrence of phenomena such as wildfires, floods, droughts and heat waves poses significant threats to public health, infrastructure and economic resilience to nowadays, futureproof business models.



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The principle contribution of these Til (re)design studies lies in bridging the gap between theoretical knowledge and practical interventions developing robust and adaptable (sub)systems, capable of responding to increasingly unpredictable safety & sustainability challenges with social-societal embedding. The goal of this study is a design guidance towards safe working platforms complying with the ongoing energy transition and climate adaptive four-fold dilemma: integral sustainable, safety reliable, operational affordable and societal acceptable.

Moreover, an imbalance has arisen between short- and long-term perspectives on growth and (inter) national economic progress within conflicting and multifunctional usage spaces. This requires ambitious, futureproof (re)design requirements from closed, static-reactive artefact systems to open, dynamic-anticipatory value chain systems without accidents, waste and failures (Triple ZERO: Zero accidents, Zero waste, Zero failures). Such redesign requires discriminating derivative solutions -complying with conventional configurations and functionalities- from disruptive solutions – challenging new system concepts and architecture- to comply with new usage and spatial operating conditions.

Besides, this redesign requires far-reaching and new interdisciplinary forms of collaboration, decision making and value chain innovations in a multi-actor environment and operational control. The consequences are a change in perspectives. Rather than the specifics of aerial, maritime or land based TIL system characteristics, the dimensions of time and space are identified as primary design pillars.

The dynamics of open dynamic-anticipatory TIL systems are embedded in both the short-term stability and control over the system performance as well as the long term adaptations due to its never ending life cycle. The open nature of these TIL systems requires a more encompassing scope, serving the multi-functional and multi-actor operating environment with specific operating assumptions, conditions and constraints. Redefining TIL systems in terms of open dynamic-anticipatory value-driven systems questions traditional concepts of the role of delegated management responsibilities, feedback from optimized operatorship and multifunctional use of space during its life cycle. Such a redefinition is also impacted by the large-scale deployment of Artificial Intelligence and Machine Learning in safety critical decision making in a Joint Cognitive System environment with natural language processing aspects. Such a redefinition requires a distinction between the notion of 'value' versus the notion of 'performance'.

Such distinction requires a discrimination and synchronization between an 'operating envelop' representing inherent properties derived from design, versus a 'performance window', representing emergent properties due to operating conditions in a multifunctional space. A knowledge-based roadmap is necessary creating value chain (re)design processes with fundamentally improved coordination between relevant stakeholders, citizens, administrators/politicians as well as scientists, system design architects and subsystem artefact engineers. This place ongoing demands for system methodology designing, pairing scientific knowledge with practical operational knowledge and expertise. Since 2000, innovation technology is not any longer subordinate to decision-making preventing unacceptable social-societal consequences and unrealistic TIL business models.

This publication gives insight in design and engineering theories, design- and operators roles, failures and faults and presents cases on onshore and offshore wind energy developments, the food case for North Sea fisheries value chain and the aviation case with respect to innovative operator simulator training perspectives.

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*This report/ handbook is to be edited by the second half of 2026 by John Stoop and Frans Veenstra, developed in interaction with the Dutch TU Delft PhD working group & ESReDA project group Foresight in Safety. The authors of each case study are listed in each chapter. Contact email: [stoop@kindunos.nl](mailto:stoop@kindunos.nl)*

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### Mutual bridging of reliability gaps between nuclear fission and fusion facilities

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Nuclear energy systems – fission and fusion – are complex technological infrastructures that must operate under extreme physical conditions while maintaining a high level of reliability. While nuclear fission has been used for commercial power generation for decades, fusion remains largely in the experimental and demonstration phase. Despite significant differences in physics and design, fission and fusion facilities face similar reliability challenges. However, methodological approaches to reliability assessment differ between these two nuclear fields, reflecting the technological maturity, operational environments, and safety philosophies. But can each field learn from the other to improve reliability by sharing methods, data, and experience to address their respective gaps?

The primary difference of reliability assessment frameworks between fission and fusion lies in their level of standardization. Fission power plants rely on established reliability engineering frameworks developed over decades of commercial operation. These include probabilistic safety assessment, standardized codes, regulatory compliance procedures, and well-defined operational protocols. The emphasis is on preventing low-probability but high-consequence accidents through redundancy, defence-in-depth strategies, and extensive regulatory oversight. The analyses are developed by certified teams and verified by regulatory bodies supported by national and international guides, including those of the International Atomic Energy Agency and the U.S. Nuclear Regulatory Commission. Fusion research, by contrast, often relies on evolving methods that follow the technology development.

The overall methodological approach is therefore closer to the large-scale scientific experimentation than to industrial engineering, and so the analyses are being developed by distributed teams of experts focused on specific research projects like ITER, EU-DEMO, or HL-2M. In addition, safety philosophy differs. Fission reactors must actively prevent uncontrolled chain reactions and radioactive releases. Fusion systems, however, are intrinsically limited by plasma stability. As a result, fusion reliability research focuses mostly on maintaining stable plasma confinement and protecting reactor components. The operational experience and standardization also refer to the equipment reliability statistics. While the information on failures in commercial fission plants is strictly noted and reported, the research-oriented fusion facilities are less restrictive in organizing the system of failure monitoring and statistical data treatment. This causes greater diversity and heterogeneity in the structure of the input data, and so the parameter uncertainty.

The differences in the reliability assessment frameworks are also caused by the specific needs of the fission and fusion fields at the current state of development. One of the main reliability challenges in fission facilities is aging infrastructure, as many reactors currently in operation were designed in the 1970s and 1980s, and their components experience gradual degradation, so that the reliability assessment frameworks require information from inspection programs, predictive maintenance, and life-extension strategies. Another challenge is the complexity of the safety-related infrastructure. Fission plants employ multiple redundant safety barriers to prevent the release of radioactive materials, which, in turn, can introduce additional failure modes leading to unplanned reactor shutdowns. A further issue is human and organizational reliability. Consequently, fission plants invest in operator trainings, human-machine interface design, and safety culture development.

In fusion reactors, many components are custom-designed and not yet optimized for long-term industrial operation. Systems such as cryogenic cooling, plasma control instrumentation, and tritium handling infrastructure must operate reliably despite being relatively new technologies. While operating under the extreme heat loads, neutron bombardment, and electromagnetic stresses, fusion-specific components are subject to rapid degradation, which must be reflected in reliability models. Future fusion power plants will also require advanced remote-handling systems and modular component designs to allow efficient replacement of damaged components under the radiation field.

The key question is how these two distinct nuclear fields can support one another in addressing gaps in their reliability assessment frameworks. Can fusion-specific reliability databases be organized with the same level of structure as those used in commercial fission facilities? Can the probabilistic risk assessment standards developed for fission reactors be extended to the lifetime simulation methods emerging in fusion? Is it possible to transfer recent advances in human reliability assessment from fission to the fusion domain? And could the remote handling systems being developed for fusion facilities contribute to improving the reliability of fission plants? These and many other questions arise when comparing progress in reliability studies across fission and fusion. Exploring them could open an exciting area of research for both communities, or at least initiate a few lively debates. Nevertheless, it seems that fission can adopt innovations in materials science and modular design from fusion-oriented research facilities, while fusion can leverage the decades of operational experience and safety methodologies developed in the fission industry. Through such cross-disciplinary learning, the reliability and safety of future nuclear energy systems can be significantly improved.

## About Time and Space

### An Essay on Generative Designing in Transport Infrastructure & Logistic (TIL) Systems

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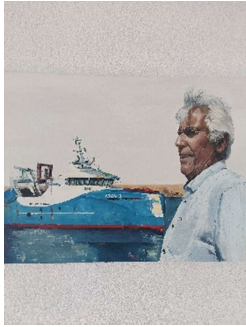
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Summary: this Essay can be read as a triptych. Based on 40 years of experience in design, safety, and scientific research, we have developed a plan for an innovative design approach for TIL (food)systems: transport, infrastructure, and logistics. Firstly, the principle of precaution: learning from proven shortcomings and disastrous developments is no longer permissible in cases of unexpected incidents with disastrous, irreversible consequences. This raises the question of how to mobilize innovation in open, complex systems and make them largely sustainable, climate neutral and operational futureproof. Design and operational developments have a finite life span: transitions occur by leaps and bounds, not incrementally. Firstly, the initial focus and material aspects of physical designing in transport, infrastructure, and logistics were central, primarily based on developments in transport technology with high readiness levels. Secondly, through digitization, information provision in data systems emerged and process control was developed through automation, digitization and robotization. Initially, the focus was on the quality of labor, then environmental issues and nowadays integral sustainability aspects as well. The sustainable energy supply of TIL systems is now central to business models, the UN (post) Paris Climate Agreements and European regulations on the environment, sustainability and resilience. Thirdly, societal dialogues are underway regarding renewable energy transitions and climate neutral innovations in open, complex transport systems within conflicting, multifunctional usage spaces. An imbalance has arisen between the perspectives on growth, economic progress, land use, and societal values: safety-wellbeing, nature-ecosystems and integral sustainability. This requires formulating ambitious futureproof requirements for systems and their socially undesirable consequences for a transition from closed, static systems to open, dynamic systems without accidents, waste or failures. This requires far-reaching and new interdisciplinary forms of collaboration, decision-making and value chain innovations in a multi-actor environment and operational control.. Not only innovation in the creative design process itself, but also focused on innovation, transition, valorization and forward-looking designing in the context of First Time Right and Zero Defects. Above all, it requires thorough, fundamentally improved coordination between TIL relevant stakeholders, such as citizens, scientists, financiers, engineers, administrators and politicians. Besides, the issues of innovations, disruptive developments and futureproof technological challenges place ongoing, new demands on system methodological system designing. Technology is not subordinate to decision-making—as if "proven technology" were simply available "off the shelf"—but at least secondary and in the context of futureproof innovation in advance "superior." To meet new, future-proof challenges, both design perspectives must be synthesized in a dialectic process, including societal implications. This Essay specifically focusses on a method that can lead to a new design

perspective: the "generative design" of open systems without unacceptable social, construction and process-technical consequences and unrealistic revenue models.

Design and engineering: alongside European thinking in terms of "design," an American school of thought has emerged in design that focuses not so much on HOW to design, but on WHAT is being designed in "systems and value change engineering." Applied designing focuses more narrowly on the artifacts themselves, not on the system design environment, let alone open TIL systems. This design environment is limited to narrowly defined Programme of Requirement-constraints, where the actual design process is strictly protocolized, monetized and quantified. This is then precisely defined in design protocols and guidelines. The crucial transition from the Program of Requirements and Wishes as an expression of values and needs to the physical design is thus stripped of creativity, innovative capacity, conceptual thinking and context-specific embedding. As technical scientists and futureproof designers further exploring concepts of system methodical designing and value range engineering perspectives is needed. Wherefore, reductionist protocols, mathematical parameterization and linear modeling blur the distinction between derivative, disruptive and prospective designing. It was common practice, the designers have been forced to limit themselves to technical components, partial aspects and often ad-hoc change agents occurring at specific points in time. However, integrated and future-proof design in open user environments benefits from system architecture that do justice to the complexity, dynamics and layered nature of open TIL systems, including the associated decision-making processes and sustainable integration into the user environment and therefore, society. "Architecture" and "Design" must be further distinguished from "subsystem engineering" in the design and development of the system artifact. In maritime design, the distinction between a Naval Architect with a system overview and a Maritime Engineer as a domain specialist specializing in subsystems has been preserved. In coping with the perceived unbalance between safety and growth, the span of control in managing systems performance is enlarged from optimizing design and operations towards the value chain that is inherent to every optimization process within TIL systems. Such values represent both corporate internal as well as external societal assets and considerations.



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The difference between 'architect' and 'engineer' can be characterized between three dimensions of the system design environment, respectively the 'value domain', 'operating envelope' and the 'performance window'. The 'value domain' represents the primary internal corporate values: economy, safety and customers satisfaction as well as external societal values such as environment, sustainability or climate. The 'operating envelope' defines the boundaries of the operating environment and conditions for normal and abnormal system states. The 'performance window' indicates the characteristic performance levels and limitations of the design itself in terms of state-of-the-art technology, design concepts and (sub)system configurations with predetermined design goals. This design methodology follows the classic iterative design logic of reasoning from goal, via function towards form. Such an engineering design logic is to be synchronized with the multi-actor decision making processes considering further selection and development of the design alternatives as presented by this methodology. While the call for disruptive designing is strong in these discussions about value chain innovations and future-proof transitions, little to no distinction is made between derivative and disruptive designing when addressing and assessing these changes. Disruptive designing, however, is fundamentally different from derivative designing; it requires a certification review upon acceptance of a novel design into practice, is procedurally complex, costly, and time-consuming and can lead to high costs in case of substantial redesigning. Today's technical standards and regulatory frameworks are based on historical technology and the highest Technology Readiness Levels.

Failures and Faults: safety-critical behaviour in terms of the failures and malfunctions of TIL systems can become manifest, based on numerous examples as multiple, small-scale undesirable events up to and including a single catastrophic failure. The consequences of each of these events have their own characteristic indicators of safety and associated risks. Over time, successive schools of thought in safety designing have been developed. However, initially focused on preventing physical damage from accidents and incidents, over decades this focus has been expanded to the probability of events, waste, failures and ultimately, potentially irreparable consequences for the environment and operational sustainability. Restoring viability after an event came into focus with the introduction of concepts such as resilience and serendipity; in other words, operational response to unforeseeable and unpredictable events and phenomena. After a systems integrity has been compromised "regeneration" should restore its original potential. So far classical safety design thinking, safety design principles have been developed over time, based on extensive accident investigations and learning from identified shortcomings. These principles range from 'failsafe/safe life' for technical artifacts to 'self-reliance' and 'situation awareness' of occupants and drivers.

These safety design principles have primarily been focused on preventing similar incidents during operational management by drawing lessons from accident investigations. Adjustments are therefore event-driven and retrospective in nature. However, if it turns out that the incident did not arise solely from failures during the operational phase, but also from flaws in design and technology, regulations, supervision and/or certification. Therefore, these shortcomings within the system itself must be addressed. Changing operating conditions, applications and nowadays integral sustainability requirements can also create new safety issues that were not anticipated in the original design and regular use. Due to societal changes, the acceptance of "minor" accidents and practices that were once considered "normal" now lead to users disapproval and private-public protests. Mainly resulting to major adjustments at the level of establishing traffic control, rescue and victim assistance, installing navigation and communication systems and mandating supporting data recording and on-board systems for control and traffic process management. Such adjustments may result in entirely new (sub)system configurations that must lead to a renewed stable system state. This often occurs in combination with novel technology, market conditions and societal perception and assessment of risk. This can even lead to entirely new systems that are better equipped to handle changing circumstances than the originally designed systems. At system level, this involves disruptive versus derivative changes. Which can nevertheless introduce new, unforeseen safety problems.

Making safety shortcomings visible has not been limited to eliminating causal factors in the accident process. Intrinsic system properties must be addressed with the question: "how does the system-level design address safety?" This successively led to the development of design principles for system properties themselves: robust, redundant, reliable, rescue and emergency, recovery, resilience and regeneration. This shift from focusing from the accident factors to the system vectors highlights the importance of tipping points. A need arises for guidance and manageable change in the transition from derivative, disruptive and prospective design and for the ability to navigate through solution spaces within the system design landscape. In the design of open TIL systems, this places a central role on the question of how transition and innovation at system levels, with predictable functional consequences, can be organized from system design methodology perspectives. Especially, for open TIL systems Time and Space have become decisive design pillars. After all, TIL systems focus on fulfilling societal needs for mobility of matter, information and energy that has arisen through the spatial and temporal separation of societal activities.

Based on multiple safety investigations in TIL systems, the role of operators and their feedback loops becomes under scrutiny. A primary role of the operator is to manage the energy balance between potential and kinetic energy during a safe and economic performance of the operations. Such a performance is based on a responsible conduct of the duties, represented by the notion of 'good seamanship' and 'good airmanship' principles. A feedback from this operational level is required to manage the triplet of producing the core corporate values: safety, economy and customers satisfaction. By sharing 'flight stories' through narratives of how crews coped with operational situations a learning process within organizations can be achieved, considering proactive design, training, inspection, maintenance and certification. Such sharing information connects operational reality with strategic goals and values. It facilitates a shift from reactive learning towards a proactive, generative systems design. Such a perspective focuses not only on causes of single or multiple events, but also on systemic properties as designed into TIL systems with their inherent values, production assets and considerations. Considering all aspects, actors and factors involved reliefs safety investigations from partial interests and judicial considerations. Such investigations are conducted according to the Van Vollenhoven Doctrine: Independent Investigations are a Citizens Right and Society's Duty. In this doctrine, safety investigations are the problem providers for knowledge development.

concepts of Space and Time: in the design of open systems such as transport, infrastructure, logistics and food production, Time and Space are becoming key design aspects. Transport, after all, involves movement while retaining the form and properties of what is being moved. This is in contrast to the transformation and conversion of matter, energy and information. TIL systems are collectively continuous, but individually discontinuous. After all, one cannot be everywhere at all times, but a need for movement as a social value must be guaranteed, everywhere at all times. Also, access to the global network must be guaranteed locally for all actors in an open network. Open systems must take into account the operational environment in which they function, with fellow and competitive users, bystanders as well changing circumstances during use, such as competing revenue streams, climate- and weather. Open systems are constantly subject to change and adaptation due to the multitude of specific desires and needs of multi-actors. Critical aspects must be optimized according to their individual needs, capabilities and resources. This allows us to define two operating spaces: an "operating envelope" in which the system is limited by its nature and physical operating space, and a "performance window" in which operational

performance and boundaries are central. For open TIL systems in particular, Time and Space are key design pillars characterized as integral and non-dual.

Infrastructure and Logistics: transport is, by definition, the movement of matter, information and energy resulting from the spatial and temporal separation of social activities. Given the long-term social and technological dynamics of every society, transport is constantly adapting to changes in values, needs and the execution of these movements. Long-term socio-economic transitions are underway in the development of urban and industrial agglomerations, often unfolding over decades. Rise and fall, economies of scale, spatial footprints and changes in network configurations drive spatial planning and development. There are leaps and bounds in energy supply, propulsion technologies and the extent of logistical connections and networks. Spatial separations and rearrangements exist between the extraction of raw materials, storage and transshipment, processing and manufacturing, the consumption of finished products and waste management. Management and decision-making at the political-strategic level take place in administrative centres of power, separate from extraction, production and business operations. Disruptive developments are driven by changing societal and socio-economic perspectives on transport infrastructure (TIL) systems, characterized by terms such as European Guidelines for Sustainability and Resilience, Trans-European Networks, the Netherlands as a Distribution Country or Natura 2000 areas. In short: transport systems are characterized by a never-ending life cycle. Moreover, due to their 24/7 availability, transport systems are in a permanent state of wear and tear, maintenance and adaptation. The construction and design of roads, ports, urban and spatial planning are subject to changes at the level of architecture, social appreciation, urban development, scale, self-reliance, disaster management and emergency assistance as well considerations regarding multiple functional land use. This creates a new aspect of preserving and reusing industrial heritage in agglomerations undergoing transition, in accordance with European Guidelines on heritage and participation. Infrastructure and logistics are preeminently multi-actor and multi-aspect design dimensions in a social context. TIL systems, on land, at sea and in the air impose distinctive requirements on managing change.

Conclusion: how the renewable energy transition will develop over time must not depend solely on learning from identified shortcomings and emerging insights. The concepts of precaution and climate neutrality are now leading. Irreversible processes do not require regenerative designing, but generative design approaches without accidents, waste, or failures for people, resources and products (triple ZERO impact). And that is precisely where the world of architects, engineers, and designers have acquired their skills and insights par excellence and can commit themselves to safe, sustainable and integrally deployable TIL (food)systems.

## Call for Expressions of Interest:

### I-Risk Initiative: To Build a European network in the field of natural mass-driven hazards

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I-RISK is a national network in the field of natural, mass-driven hazards. It gathers companies, research laboratories and universities working in the field of landslides, rockfalls, mudslides, torrential floods, and avalanches. I-RISK is placed under the auspices of the National Pole Infr@2050. I-RISK organises strategical workshops on various topics to increase the resilience against mass-driven hazards:

- management and resilience against exceptional natural hazards
- dynamic behaviour of structures subjected to natural hazards
- snow cover in the climate change context
- the role of water in landslides
- impacts of permafrost melting on mountain infrastructure.

I-RISK also helps to adapt training offers responding to the needs expressed by the concerned Industrial sectors and end-users. It supports the development of specific and oriented training sessions for natural mass-driven risk practitioners and other stakeholders. The last two new professional educational offers and a summer school series were for Swiss I-Risk partners.

Besides, I-RISK conducts a series of webinars to shed light on, and share within the community, the tools and knowledge developed by the companies and the laboratories who are members in its national network.

Still, I-Risk is launching its new initiative to “Build a European network in the field of Natural Mass-Driven Hazards”.

### Why this initiative

The initiative aims at:

- Promoting and stimulating interactions between research and private stakeholders.
- Extending the existing I-Risk Network to the European sphere to foster multi-collaborative EU actions between different EU partners.
- Contributing into the development and the design of technical standards and recommendations.

We recognize the necessity to build a European partnership to answer EU Research & Innovation calls for projects, regularly emitted by the EC. We are convinced that we should improve our collective practices by exchanging on the different above-mentioned goals, and especially by changing the scale at which we organize these exchanges.

### Next steps and proposed organisation

Setting up a European network will start with a first exchange with all potential partners through brain-storming meetings and discussions to build up a common shared ambition.

The next steps, including the creation of specific working groups, will be structured according to the outputs of the preceding phase of exchanges and consultations with other EU entities who will express their interest. Basically, the timeline could be as follows:

- Regular meetings (video and face-to-face if necessary) between all the partners engaged in the network - about 3 per year to share information on specific actions of interest, opportunities to build projects, etc. One of these meetings will be devoted to the strategy purposes for the coming year, including specific events to be conducted and related funding matters.
- Workshops to work on a specific topic.
- Organization of specific events to disseminate and share widely the problems encountered and the innovations obtained or participation of the collective in partner events.

### Expression of interest

To all ESReDA members and EU experts in the field, if you are interested to get more information or want to contribute to the birth of the EU I-Risk Collaborative Network in the field of natural mass-driven hazards, please, contact [julien.baroth@univ-grenoble-alpes.fr](mailto:julien.baroth@univ-grenoble-alpes.fr), with [i-risk@i-risk.fr](mailto:i-risk@i-risk.fr) in Cc.

## Call for Expressions of Interest: ESReDA's Open Data Initiative

### Dr. Manuel Chiachío



*Dr. Manuel Chiachío*  
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Developed countries are facing a nascent digital revolution fueled by human-like artificial intelligence, bioinspired engineering, and deeply intelligent robots, where humans and digital assets will work together within a large smart ecosystem.

The built environment, particularly industrial and civil infrastructure, will certainly be part of this revolution since infrastructures (roads, railways, cities, energy facilities, etc.) are the foundation upon which this future smart ecosystem will be based.

Deep integration of smart technologies into infrastructure has the potential to reduce European spending on infrastructure asset management while significantly increasing reliability and resilience.

However, achieving this advanced level of digitalization requires learning from and responding to high-quality data. The creation, updating, and refinement of predictive models for smart digital twins demands substantial amounts of high-value data.

Those who are working with digital twin technologies already recognize the limitations due to data insufficiency to train and test these systems effectively. When available, data are often siloed within specific applications or components, making it difficult to use for training decision-making models across pervasive systems commonly found in industry and infrastructure.

In light of this, this is an opportunity for ESReDA to become a key player in providing open, high-value datasets related to asset management, reliability, and maintenance of physical and digital assets across various industries.

#### **Call for Expressions of Interest:**

To all ESReDA members and EU experts in the field, if you are willing to collaborate actively in the **Open Data Initiative**, please, send your expression of interest to Dr. Manuel Chiachio ([mchiachio@ugr.es](mailto:mchiachio@ugr.es)) and Dr. Antonio J. Guillén ([ajguillen@ucm.es](mailto:ajguillen@ucm.es)).

## ESReDA Running Project Group

### **DMAD ESReDA Project Group: Building the Future of Digital Asset Management – Report from our recent meeting in Madrid**

*Antonio Sánchez, Aitor Goti*



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The DMAD (Digitalization of Maintenance and Asset Data) Project Group continues to demonstrate remarkable momentum. On October 21, 2025, the group held its second regular meeting at the ICEI (Instituto Complutense de Estudios Internacionales) of Complutense University Madrid (Spain), bringing together 25 participants from universities, research institutions, and leading companies across Europe.

#### **A Day of Collaboration and Innovation**

The event, framed within the "Road to WCEAM/Congrega 2026" initiative, featured rich discussions on asset management challenges in strategic sectors. Experts from ISDEFE and ENAGAS shared insights on cybersecurity, energy transition, and the complexities of hydrogen infrastructure—highlighting that major transformations require not just technology, but decades of strategic planning.

#### **Key Initiatives Moving Forward**

The afternoon session showcased the group's ambitious agenda with, among others:

- Open Source Community Pilot – Under the scientific leadership of Joaquín Ordieres (UPM) and Manuel Chiachio (UGR), DMAD is developing a collaborative platform for sharing datasets, failure mode libraries, and predictive models using GitHub and HuggingFace.
- Agentic AI for Maintenance – The group explored cutting-edge applications of Large Language Models integrated with specialized agents for intelligent maintenance planning—a promising frontier for predictive maintenance.
- Digital Twins – Presentations from Quantia and SGS opened new collaboration pathways for applying digital twin technology to real-world asset management challenges.
- International Maintenance Association (IMA) Document Review – The critical review of IMA's Digitalization of Assets, Facilities and Maintenance Management framework continues, aiming to create a practical roadmap that prevents "digital islands."



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#### **Looking Ahead**

DMAD members are actively preparing proposals for national and European funding calls, organizing specialized seminars, and planning the IMS+AMEST 2027 event in Seville. A new DMAD meeting is scheduled for early 2026 in the Basque Country.

#### **Join Us!**

The DMAD Project Group welcomes researchers, practitioners, and organizations passionate about digital transformation in asset management. Whether your expertise lies in AI, digital twins, maintenance optimization, or industrial data management, there is a place for you in this vibrant community.



**Interested?**

Contact the DMAD coordinators Antonio Sanchez Herguedas ([antoniosh@us.es](mailto:antoniosh@us.es)) and Aitor Goti ([aitor.goti@deusto.es](mailto:aitor.goti@deusto.es)).

## Forthcoming ESReDA Seminars

**68th ESReDA Seminar**  
**Multidisciplinary Approaches to Resilience Assessment in Critical Infrastructures and Digital Systems**  
**May 14th - 15th, 2026,**  
**ISMA University of Applied Sciences, Riga, Latvia**

<https://esreda.org/seminars/68th-esreda-seminar-multidisciplinary-approaches-to-resilience-assessment-in-critical-infrastructures-and-digital-systems/>



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### Brief description

The evolving complexity and interdependence of critical infrastructures- alongside their growing reliance on digital technologies- pose unprecedented challenges for resilience assessment and management. As infrastructures become increasingly interconnected, the potential for cascading failures, systemic disruptions, and hybrid threats (both physical and cyber) demands a comprehensive, multidisciplinary approach.

The 68th ESReDA Seminar on “Multidisciplinary Approaches to Resilience Assessment in Critical Infrastructures and Digital Systems” aims to provide a platform for the exchange of scientific knowledge, practical insights, and methodological advancements related to the resilience of complex socio-technical systems. This seminar will explore the integration of engineering principles, information and communication technologies (ICT), risk and systems sciences, human and organizational factors, and public policy to advance a holistic understanding of resilience.

Building upon the outcomes of previous ESReDA seminars, this event will foster collaborative dialogue among academic researchers, industry practitioners, regulators, and other stakeholders. The seminar seeks to promote the development of rigorous, evidence-based frameworks and tools for resilience assessment and enhancement, in the context of increasing uncertainty, technological transformation, and societal expectations

### Registration is now open:

<https://esreda.org/seminars/68th-esreda-seminar-multidisciplinary-approaches-to-resilience-assessment-in-critical-infrastructures-and-digital-systems/>

For follow up and more details you may contact Prof. ([Laila.Zemite@rtu.lv](mailto:Laila.Zemite@rtu.lv)) with Antonio Guillén ([ajguillen@us.es](mailto:ajguillen@us.es)) in Cc.

You may equally visit our site: <https://www.esreda.org/>

## In memoriam of Guy Planchette.(1938-2025)

### **A discreet, hearty and efficient person in the risk management French community – a fellow, friend and leader**

Jean-François Raffoux – ESReDA Honorary President

Born in « La Martinique » Guy Planchette came to mainland France to prepare for and then attend the “Ecole Nationale des Arts et Metiers”. His entire professional career was spent within the RATP (Parisian Transport Authority) in the fields of maintenance, human resources and then Risk management. In 1998 he was entrusted with the creation of the general delegation for Risk management, marking a significant step in implementing safety and reliability techniques into public transport.

Upon retirement in 2002 and thanks to the support of the 14 major industrial French companies he created the scientific association IMdR (Institute for risk management) which he chaired until 2009.

Concurrently he was elected president of IEC (Institut Européen des Cindyniques) where he has developed an innovative scientific approach to assess hazards in complex systems under the leadership of G.Y Kervern. In 2006 he proposed the integration of IEC into IMdR, thereby multiplying the skills of this institute and broadening its scope of action.

With some colleagues he developed, diffused and taught, along 20 years, Cindynics and issued in 2023 a book “Cindyniques:la science du danger” (ISTE Editions) edited in French and English.

Guy Planchette has been a visionary and passionate leader and teacher attesting through his relations with his colleagues, intense human qualities.

He will remain a source of inspiration for long in the risk community.

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All ESReDA Members, are kindly invited to contribute to the ESReDA newsletter sharing news, announcement of events, your experiences, ideas, etc. You are supposed to elaborate proposals to create new Project Groups, host ESReDA Seminars or initiate collaborative activities

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#### **ESReDA: European Safety, Reliability & Data Association**

Association internationale sans but lucratif, régis par la loi Belge du 27 Juin 1921-Titre III (Registration N°: 0452522618 - Siret:E00005802)

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