

NDE 4.0: Redefining Traditional Inspector Roles

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Abstract

The successful shift to NDE 4.0 will not only require developing and embracing new technologies associated with the fourth industrial revolution or becoming an integral part of the overall Industry 4.0, but also developing and adopting new ways of working. It is undoubtful that people will remain in charge of the inspections. However, it is arguable if the current “procedure-following” “level I-III” paradigm can withstand the changes that come along NDE 4.0. With the increased autonomy and interconnectedness expected with NDT 4.0, the majority of traditional NDE tasks will no longer be needed. Instead, different skills, such as that of programming and adapting systems, as well as problem solving, will become vital for the inspections. Therefore, we suggest that a new paradigm is needed—one in which inspector roles and, thus, also the requirements will have to be reinvented. We expect the inspectors to be relieved from the tedious and error prone aspects of the current system and to take responsibility for increasingly complex automated systems and work in closer collaboration with other experts. Thus, we propose that the traditional inspector roles will be transformed into that of the system developer, caretaker and problem solver, each role requiring a specific set of skills and assuming different responsibilities. In this talk, we will present the new roles and discuss the challenges that arise for people with NDE 4.0.





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NDE 4.0: Redefining traditional inspector roles

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Materials Research and Testing, Germany**

Iikka Virkkunen
Aalto University & Trueflaw, Finland



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About me: Marija Bertovic, PhD

Education

- Graduate study of **Psychology** (Dipl. Psych.) at the University of Rijeka (Croatia)
- Doctoral Study in **Work and Organisational Psychology** (PhD) at the Technical University Berlin (Germany)
- Thesis: Human Factors in Non-Destructive Testing (NDT): Risks and Challenges of Mechanised NDT**

Current occupation

- Research scientist** at BAM - Federal Institute for Materials Research and Testing in Berlin, Germany.
- Department for **Non-destructive Testing**
- Work area: Probabilistic Safety and Reliability Analyses/**Human Factors Analyses**

Experiences

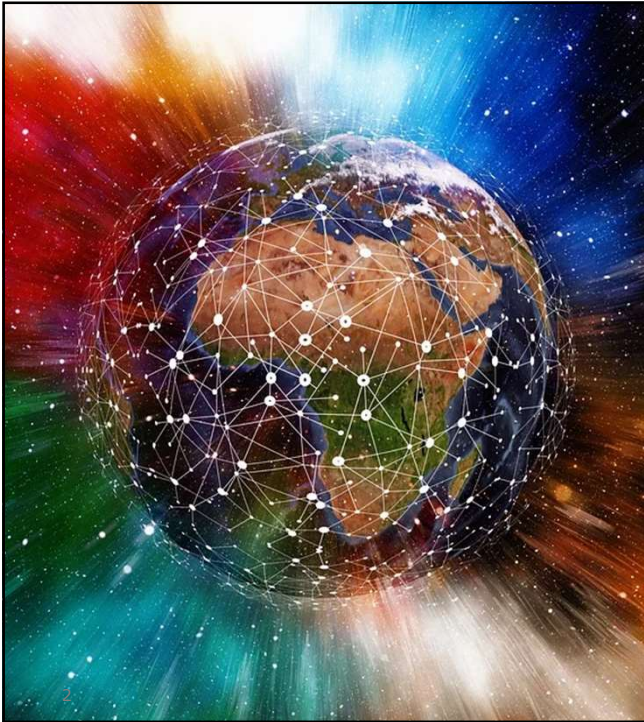
- 15 years of experience** in the study of human factors and the reliability of NDE
- Chairwoman of the DGZfP subcommittee "**Human-machine interaction**" in the committee "NDE 4.0"
- Co-chair of the ICNDT specialist international group "**NDT reliability**"
- Recipient of the DGZfP **Science Award** in 2018



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Digital Transformation: A Game Changer

“Technologies, markets and social structures are changing. Faster, more far-reaching and more intertwined than ever.”

– Kai Gehrmann, Attoma, 2019

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Information and communication



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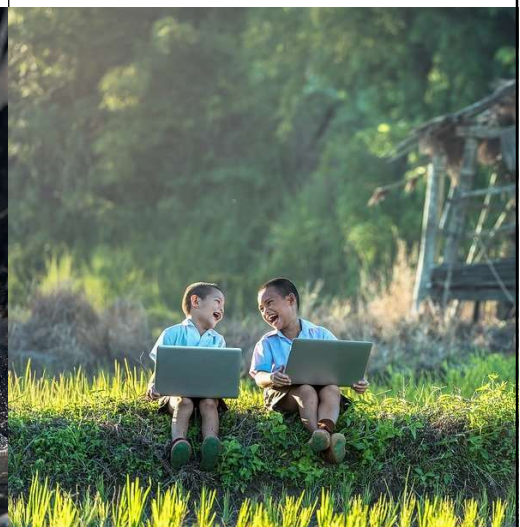
Learning and free time



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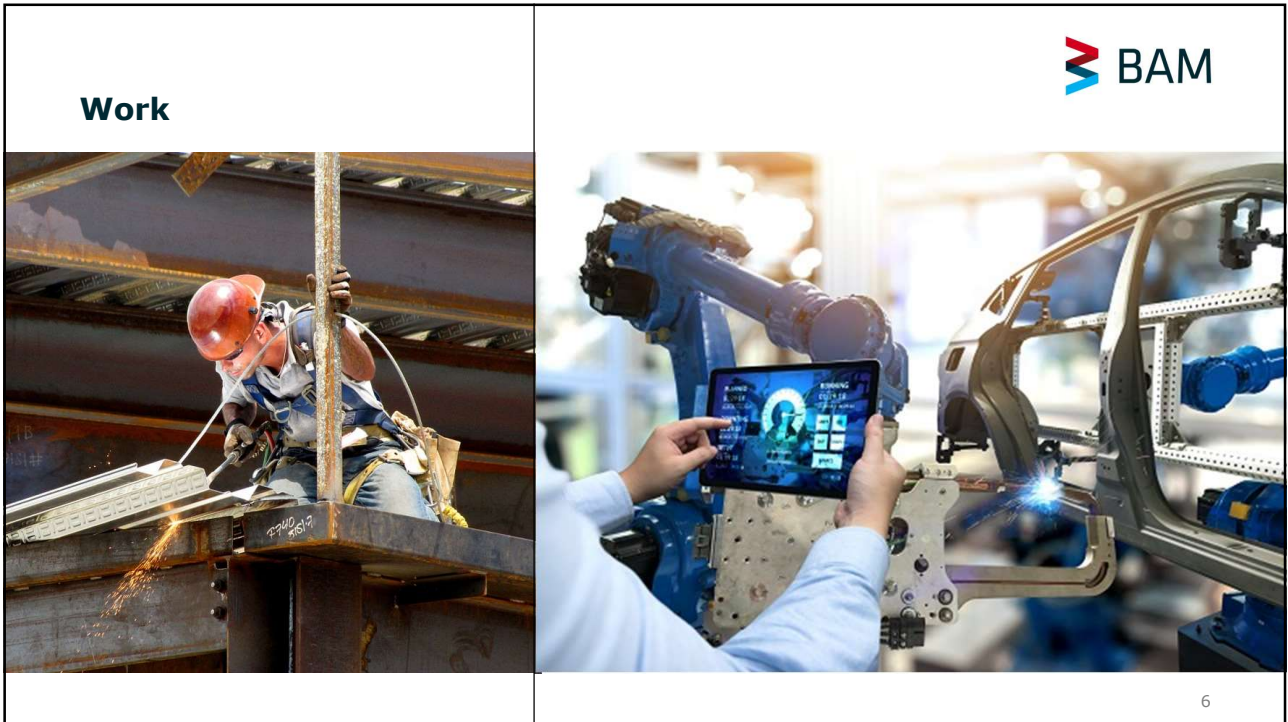
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Social interaction



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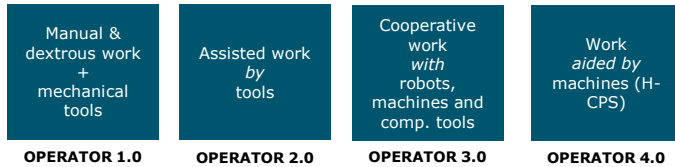


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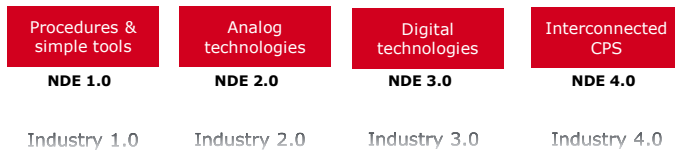
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NDE revolution from the operator's perspective



Operator Generations (R)Evolution

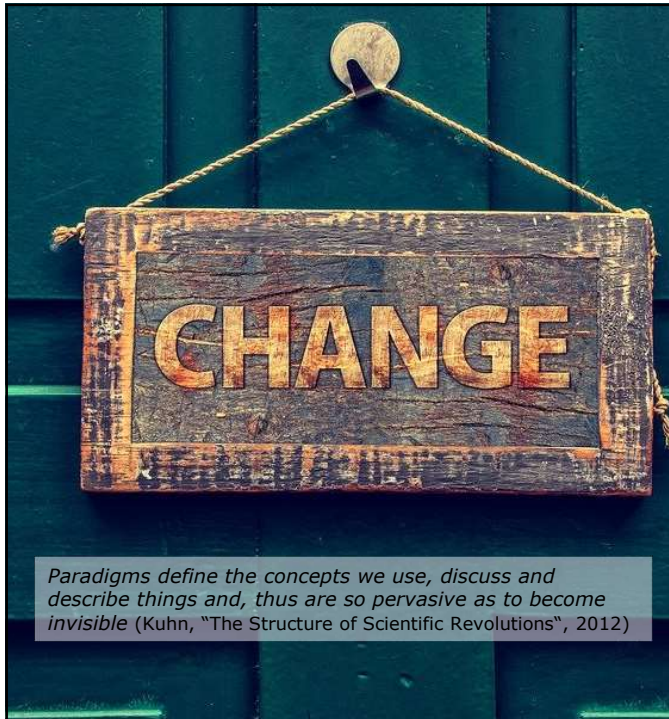
Romero, et al. (2016). The Operator 4.0: Human Cyber-Physical Systems & Adaptive Automation Towards Human-Automation Symbiosis Work Systems.



NDE revolutions

Vrana, J., & Singh, R. (2021). NDE 4.0—A Design Thinking Perspective. Journal of Nondestructive Evaluation, 40(8), 1–24.

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Paradigms define the concepts we use, discuss and describe things and, thus are so pervasive as to become invisible (Kuhn, "The Structure of Scientific Revolutions", 2012)

Outline

- Paradigm change (from traditional NDT to the NDE 4.0 system)
- New inspector roles in NDE 4.0
- Addressing the challenges

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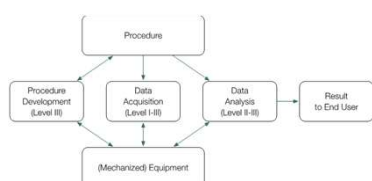
Transitional systems pave the way to industry 4.0



NDE 3.0

Traditional system

Human interacting with a conventional manual, semi- of fully-automated device



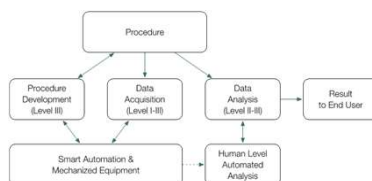
*Bertovic M., Virkkunen I. (2021) NDE 4.0: New Paradigm for the NDE Inspection Personnel. In: Meyendorf N., Ida N., Singh R., Vrana J. (eds) *Handbook of Nondestructive Evaluation 4.0*. Springer, Cham. https://doi.org/10.1007/978-3-030-48200-8_9-1.



"NDE 3.5"

Transitional system

Human interacting with cyber-physical systems in a conventional way



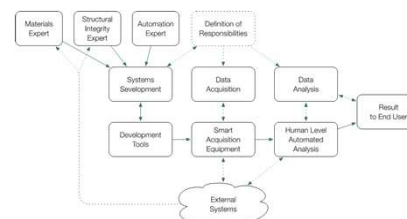
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NDE 4.0

NDE 4.0 system

Human interacting with cyber-physical systems in a revolutionised way



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"We define a Full NDE 4.0 System to be..."

an NDE system, that through smart automation and information interchange makes integrated use of information from different sources and disciplines and provides a non-destructive evaluation result in high level of interpretation that is directly related to the purpose of the inspection.

In addition, we define **an NDE 4.0 subsystem** to be an NDE system, which provides results to be used as part of similar integrated (**industry 4.0**) system to be used in forming system state information at high level of interpretation directly related to the purpose or serviceability of the system."

Bertovic M., Virkkunen I. (2021) NDE 4.0: New Paradigm for the NDE Inspection Personnel. In: Meyendorf N., Ida N., Singh R., Vrana J. (eds) *Handbook of Nondestructive Evaluation 4.0*. Springer, Cham. https://doi.org/10.1007/978-3-030-48200-8_9-1.(p. 12)

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Different demands for the workers



NDE 3.0

Traditional system

- working according to well-defined procedures
- high physical and cognitive demands
- high influence of the environment and the organisation
- responsibility at the hands of the operator at the sharp end



Different demands for the workers



NDE 3.0

Traditional system

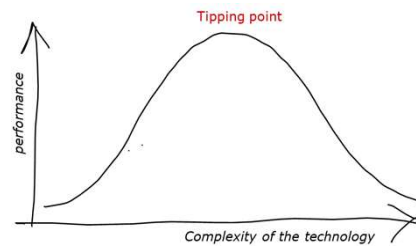
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- responsibility at the hands of the operator at the sharp end




"NDE 3.5"

Transitional system

- traditional training, qualification, procedures and design approaches meet new technologies
- the task becomes more diverse and demanding – monitoring automation
- implementing one technology can lead to improvement, implementing several requires a full redesign of current practices




Different demands for the workers



NDE 3.0

Traditional system


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"NDE 3.5"

Transitional system


traditional training, qualification, procedures and design approaches meet new technologies
the task becomes more diverse and demanding – monitoring automation
implementing one technology can lead to improvement, implementing several requires a full redesign of current practices



NDE 4.0

NDE 4.0 system


significant changes in the nature of the task (operator → decision maker and problem solver)
function allocation according to strengths and abilities
by putting the user in the centre of the design, the task becomes less demanding and the acceptance increases




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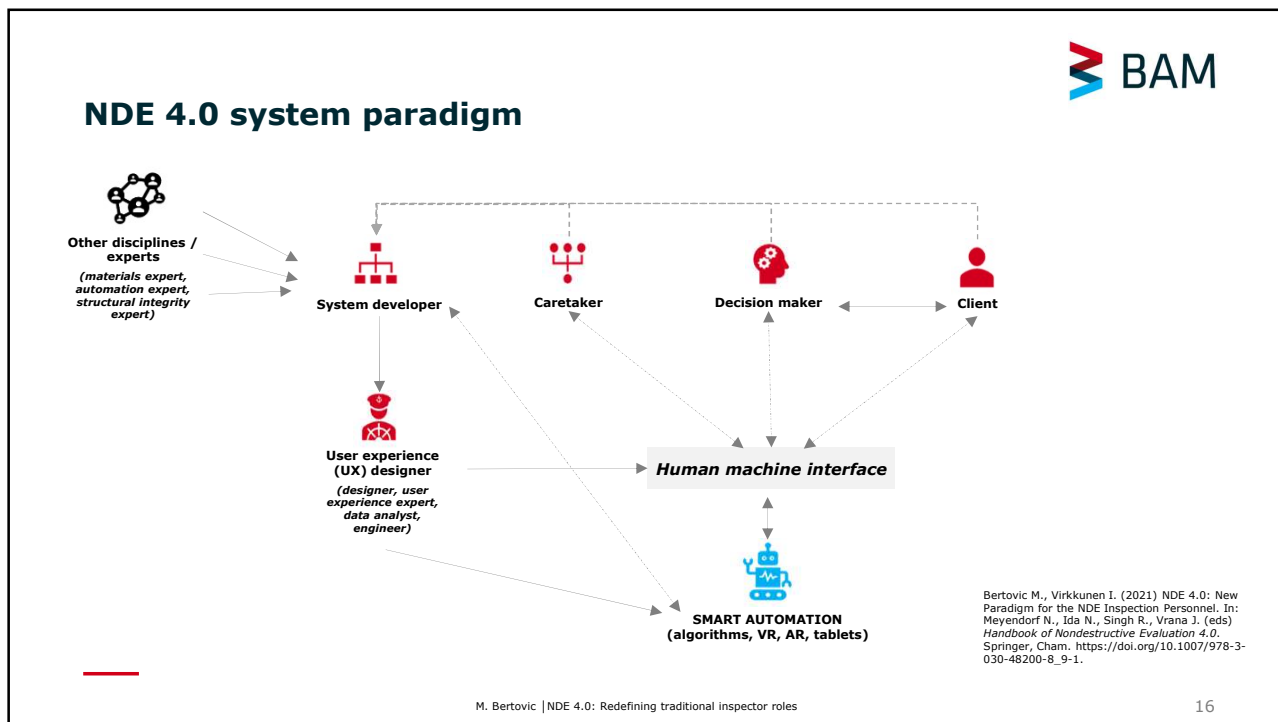


New inspector roles

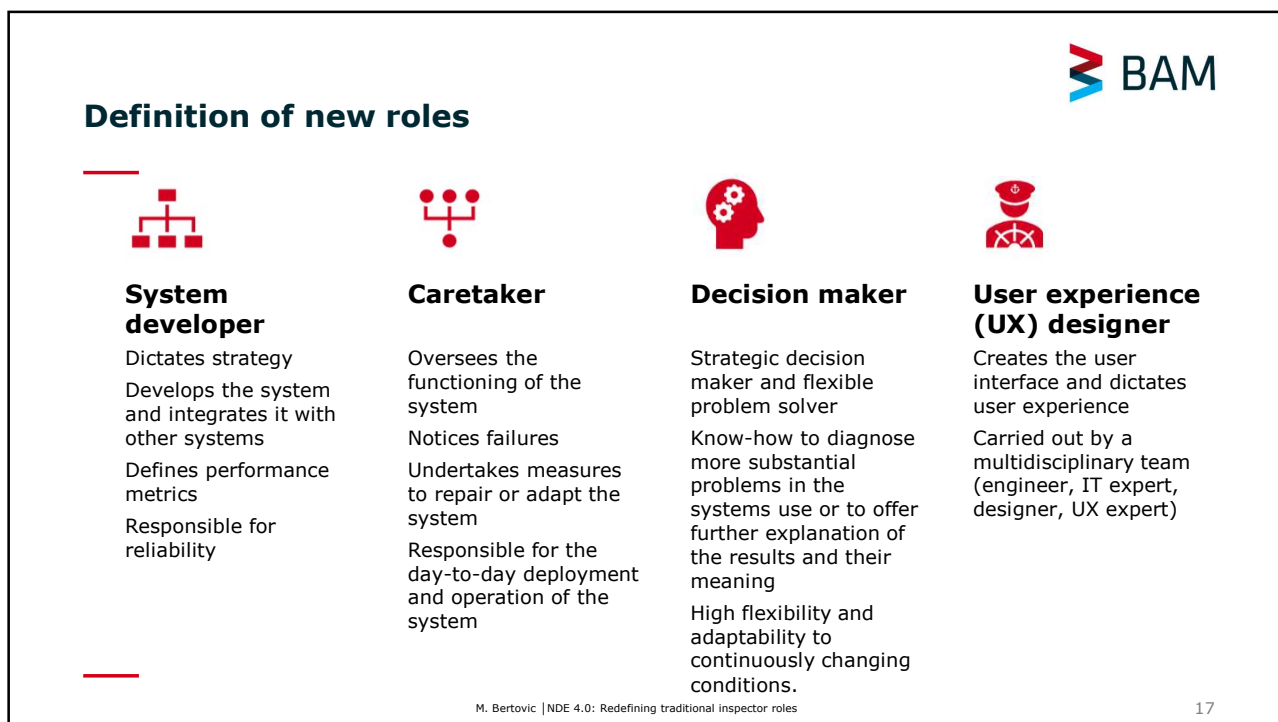
“The highest form of technology is not full automation or full autonomy, but it is automation and autonomy that are very beautifully, gracefully, linked to the human operator.”

- David Mindell, MIT Professor and pioneer of autonomous robotics

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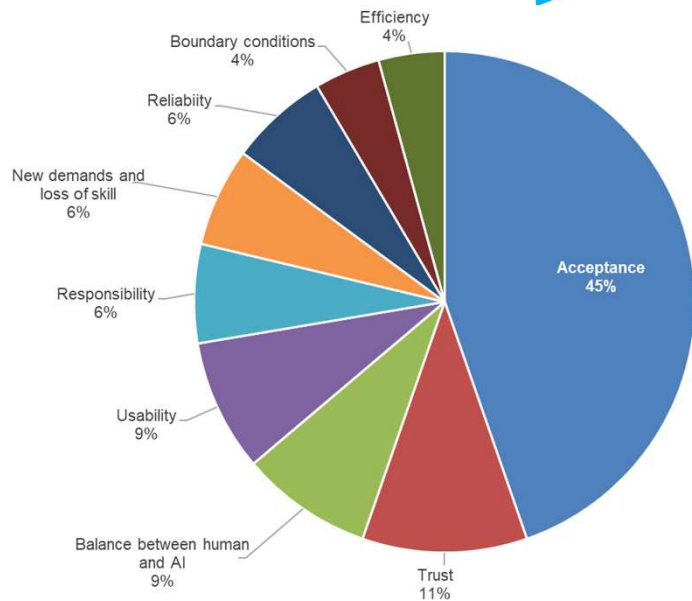
Challenges

“The key is to understand that this technology is not about replacing people. It’s about harnessing the strengths of humans and robots to achieve new levels of efficiency and productivity that neither can achieve alone”

- Prof. Julie Shah, Interactive Robotics Group, MIT

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Major challenges concerning human machine interaction




The survey conducted by the DGZfP committee NDE 4.0 and subcommittee Human Machine Interaction (N=81)


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Addressing the challenges




New demands
Appropriate function allocation
Human-centred design
Usability
Decision aids



Loss of skill
Adaptive automation
Decision aids
Specific training




Acceptance
Shift from a technology-centred to a human-centred approach
User-centred design
Appropriate function allocation
Reliability as a precursor for trust



Performance
Reliability of the entire human-AI system

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