NDE 4.0 – Giving Inspector the 6th Sense!

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Abstract

For centuries humans have taken care of their safety using the five basic senses – touch, sight, hearing, smell, and taste. The revolutions in manufacturing, infrastructure, and transportation systems came with unfortunate incidents and fatal accidents. The engineering community rose to the challenge of quality, safety, and reliability through non-destructive inspections.

The **first inspection revolution** was around highlighting the surface for human organic sensory perceptions. The **second revolution in NDE** used physical understanding of material response to electromagnetic or acoustic waves, which lie outside the range of human perception, into signals that can be interpreted by humans. This resulted in a "look inside" into the components or a better visualization of material inhomogeneities behind or close to the surface. The **third revolution in NDE** came along with computers and digitalization that simplified imaging and analysis of signals, such as X-ray detectors, digital ultrasonic and eddy current equipment, and digital cameras. Robotics automated the processes, making them convenient, fast, and repeatable. The **fourth revolution in NDE** (now) integrates the digital techniques (from the third) and physical methods of interrogating materials (from the second) in a closed loop manner transforming human intervention and enhancing inspection performance. The application of Digital Twins and Digital Threads provides the ability to capture and leverage data right from materials and manufacturing processes to usage and in-service maintenance. The data captured across multiple assets, can be used to optimize predictive and prescriptive maintenance, repairs, and overhauls over the lifetime of an asset.

The Industry 4.0 can bring the ability to synthesis all the data right from manufacturing, usage, environment, (digital history acting like a lifelong blackbox), combine it with data from detected damage in other older assets (experience), such that the **intelligent inspection system** can predict with a certain probability that there is a hidden anomaly even when it is smaller than equipment's ability to detect. IN other words, the POD of the cyber-physical inspection system using digitalized history can get better than intrinsic capability of the physical equipment, in a sense proving a 6th sense to the inspector.

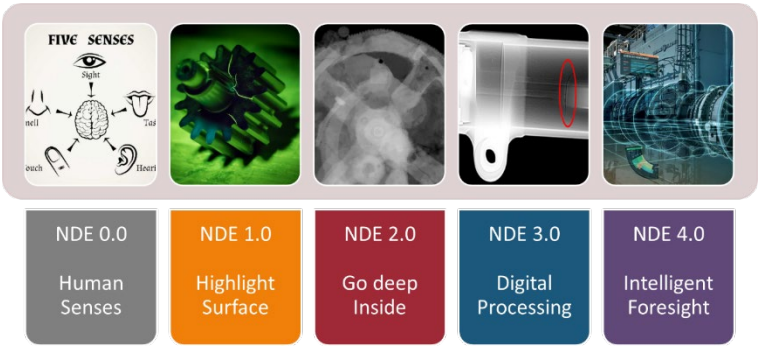

Figure - The NDE 2.0 changed the game by providing inspectors with **equipment** to see hidden damage using physical waves.
The NDE 4.0 could change the game again by augmenting an inspector with an **intelligent system** to foresee a damage on the digital twin before the inspection equipment can pick it up on physical structure.

About the Author – Ripi Singh

Dr. Ripi Singh is now a purposeful innovation coach with a lifetime of learning in technology, people, and process development. It all started with aging airplane program in 1992 as a post doc fellow at Georgia Tech. Decades of his research work on fatigue and fracture, damage tolerance, human factors in NDE is well published and frequently referred to. Ripi is now working hard to bring industry 4.0 perspective and innovation processes to the NDE community and CT Eco-system: with his virtual coaching lectures and articles. Ripi serves as Chair of ASNT Committee on NDE 4.0 and Vice Chair of ICNDT SIG on NDE 4.0. He is also on various university advisory boards, US delegation to ISO 56000 on Innovation Management, International Association of International Professionals, and CT Academy of Science and Engineering. Ripi is an author of 4 books, over 100 peer-reviewed publications, and dozens of keynote lectures.