

NRC Perspective on Implementing Artificial Intelligence and Machine Learning in Nondestructive Examinations

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Drivers for Automated Data Analysis (ADA)



The variety of open-source ML tools has enabled the use of ML algorithms to be developed for many uses

Work is ongoing by several groups to use these tools to develop automated data analysis algorithms to analyze NDE data

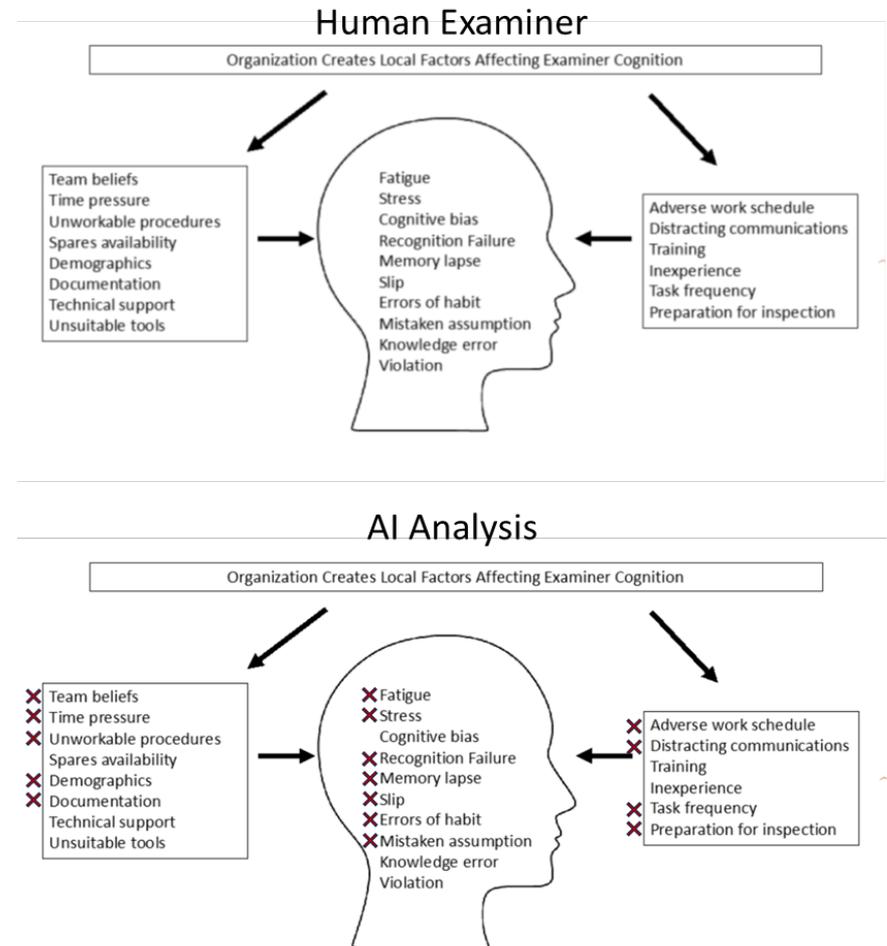
These ML algorithms can potentially greatly increase the reliability and consistency of NDE in the field

If used incorrectly, these tools could degrade inspections

Automated Data Analysis – Possible Benefits

ADA has the potential to improve detection of flaws and improve the human factors of an examination.

- In-service flaws are rare in the nuclear industry. Computers can maintain vigilance in cases where humans can be challenged.
- Humans and computers make different types of mistakes, and a qualified analyst paired with an analysis run by ML gives the best of both worlds.
- Reduced dose to inspectors if ML used to support manual UT examinations.



Graphic adapted from NUREG/CR-7295

Automated Data Analysis – Possible Hazards

- Licensees may not understand the capabilities and limitations of ADA, which could lead to improper use of ADA
- ADA assistance may allow people to pass Appendix VIII qualification testing without the skills to recognize unknown degradation in the field
- ML algorithms can be challenging to train and retrain, possibly making the ML algorithms unreliable
- ML algorithms require a new class of experts to support UT examinations

Practical Issues

- A weakness being found in an AI/ML procedure that calls many past examinations into question
- Wide use of incompatible hardware or software for a given procedure calling several examinations into question
- Confusion over the correct implementation of an AI/ML procedure resulting in difficult to answer questions between licensees, vendors, and/or regional NRC staff

Where is AI/ML Going to be Used?

- Near Term
 - Upper Head Examinations
 - Other encoded examinations
- A Few Years
 - Manual examinations?
 - Radiography?
 - Visual testing?
- Several years
 - ??

Barriers to AI/ML Implementation

- Some high-value examinations (many dissimilar metal welds) may not have a sufficient set of service-induced or realistic flaws to train models
- The complexity of using the AI/ML systems requires a new set of experts

How to Get Enough Flaws for Training?

- Sources of Flaws and Flaw Signals
 - Use service-induced flaws
 - Build mockups with implanted flaws
 - Virtual and/or Synthetic modified or simulated flaws
 - AI-generated flaws
- Each of these methods have advantages and disadvantages

What are the Tolerances?

- What are the essential variables for the virtual and simulated flaws?
- What are the essential variables for the AI/ML training?
- Does the transducers need to exactly match?
- Can the V/S flaws or ML training for one transducer be used effectively for a slightly different transducer?

Implementing Performance Demonstration

- PD is currently capable of handling individual and very specific procedures
- Careful consideration of tolerances will be needed when AI becomes more common and expands to manual examinations
- ASME Code meetings will provide a good forum for moving forward as the technology develops

Added Complexity

- Complicated and sensitive systems are a bad pairing with the hectic outage schedules at plants
- Small changes to AI/ML systems and how the data is handled can have significant effects
- Licensees would benefit from training on the strengths and weaknesses of AI/ML systems
- Regional NRC inspector would need training to evaluate AI/ML examinations

How to Reduce Complexity?

- AI/ML systems will be easier to implement if they are as simple as possible and require as few inputs as possible in the field
- Using AI/ML would be facilitated if it was relatively simple to verify that the AI/ML system is being used correctly

Path Forward

- The NRC will continue to work with EPRI to monitor developments in the use of AI/ML for NDE data analysis
- We will pay extra attention to the training methods and deployment of AI/ML systems

