The future of Non-Destructive Testing (NDT) with wireless sensors, A.I. and IoT

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# Overview

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In recent years, much is being written about “Industry 4.0”

**Drivers**

- Affordable miniaturized, wireless sensors
- Ubiquitous Internet connectivity
- Costs of cloud-based data storage/analysis
- Analysis / recommendation capabilities with A.I.

**Impact**

Industrial systems increasingly:

- Sophisticated
- Interconnected
- Data-exchanging

Growing degree of industrial automation
Far less attention has been paid to NDT’s role in supporting the goals of Industry 4.0

Contributing factors:
• Typical product life-cycle of 7-10 years
• Business models relying on one-time purchases
• Standardization hurdles
• High degree of expertise required from inspectors
We have been observing and shaping an overlap between the goals of Industry 4.0 and NDT

NDT stands for increased...

- Quality
- Productivity
- Safety
- Sustainability

...along the entire life-cycle of products and productive assets.

The future of NDT: processes with...

- Higher accuracy, fewer errors
- Higher detection probability
- Granular data and insights anywhere, anytime
- Testing by groups of people, higher skill variance
- Focus on productivity, speed by reducing / avoiding rework

NDT might just be a poster child for Industry 4.0, enabling cost savings while improving outcomes.
Contemporary NDT is already gradually enabling two of Industry 4.0’s four design principles:

- **Interoperability**
  - Data collection by wireless sensors
  - Data exchange over the Internet of Things (IoT)
  - Data analyzed by AI to generate insights

- **Technical assistance**
  - A.I. for insights from fused heterogeneous data
  - Self-monitoring of objects
  - Predictive self-management of objects

- **Information transparency**

- **Decentralized decisions**
A high-level, generalized NDT inspection process consists of three phases

**Preparation**
Ensure accurate and reliable measurement acc. to standard

**Measurement**
Execute inspection and measurement procedure acc. to standard

**Reporting**
Generate high-quality report of data and insights acc. to standard
After customer observation, we have identified and addressed 5 major pain points:

1. Complex user interfaces
2. Inefficient workflows
3. Complicated data interpretation
4. Incomplete traceability
5. Obstructed data sharing

Applications: concrete rebar and flaw detection, metal hardness testing

Source: Wikipedia Commons
User-friendly and intuitive interfaces increase ease-of-use, reduce skill requirements

- Tomographic structural investigations
- Analogy to a smartphone camera

iOS UI of Proceq GPR Live, “as easy as taking a selfie”
Precise positioning of probe increases accuracy, reduces errors and rework for higher productivity

- Probe can be placed *randomly* on ruler tape
- Laser indicates position
- Imaging software stitches single measurements to panoramic view

*Pundit Live Array with A.I. positioning system*
Mobile computing enables on-site data processing and visualization

- High-resolution touch displays
- High computational performance
- 3D visualization
- Signal processing

Algorithms increasingly support interpretation

Proceq GPR Live views from reflection data to 3D topographic image
Artificial Intelligence augments the user’s skills with insights and recommendations

- Automated pattern recognition
- Augmentation of user skills instead of “override”

Target tagging on the Proceq GPR Live with optional A.I.-automated recommendations
Wireless connectivity to a cloud platform reduces transcription errors and time-to-reporting

Mobile device (iOS) app
- Verification wizard
- Logbook feature
- Voice output
- Generation and sharing of reports with one tap
- WiFi / cellular
Artificial Intelligence reduces measurement error of rebar locators and cover meters

A.I. correction model

- Trained on more than 1'600 configurations
- Compensation for influence of extra rebars

**Error reduction feature of the Proceq Profometer 6 AI through A.I. correction model**
Traceability of procedures enables check of data consistency, prevents data manipulation

Logbook feature

- Logging of all procedure activities/changes/settings, probe ID and user name
- Ability to add:
  - Geolocation
  - Photos
  - Text and audio comments

Logbook feature of Equotip Live metal hardness testers
Unobstructed wireless and cloud data sharing and storage enable collaboration

- Wireless probes
- Diminished manual data entry and reporting
- Real-time data sharing and collaboration
- Instantaneous data export and reporting
The NDT industry is ready and well-suited for the adoption of wireless sensors, A.I. and the IoT

Future-proof NDT

- Higher ease-of-use
- Improved workflows
- Augmented data interpretation
- Higher efficiency, accuracy, traceability
- Unobstructed data sharing and collaboration

We call for a task group of experts to create and propagate opportunities of such technological advances.