Exploring the Role of User Experience in Enhancing IoT Applications for Smart Manufacturing: A Review

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Professional Experience

- *Currently:* Research Associate in Data Science for Smart Manufacturing Data Hub (SMDH) at Ulster University
- Research Associate in Piloting Technologies at Ulster University
- User Experience Designer at Hewlett Packard Enterprise

Publications & Activities

- A User Experience Methodological Framework and Dashboard for the Measurement and Scoring of Dynamic, Adaptive and Intelligent Aspects of a Software Solution (iHCI), 2023
- Can Sentiment Mining of Novice and Expert User Survey Feedback Enhance the Digital User Experience? (IEEE), 2023
- A Holistic UX Methodological Framework for Measuring the Aspects of How Dynamic, Adaptive and Intelligent a Software Solution is and Make Recommendations for Improvement (CERC), 2020
- A Framework for the Development of a Dynamic Adaptive Intelligent User Interface to Enhance the User Experience (ACM), 2019

Smart Manufacturing Data Hub

- Led by Ulster University
- £50m of government funds (Innovate UK)
- In partnership with: University of Cambridge, University of Edinburgh, University of Dundee, Hartree Centre, Energy Systems Catapult, Manufacturing NI, MEGA, D2N2, Scottish Engineering, Industry Wales, Byzgen.
- Supports small and medium-sized manufacturers to become more competitive by harnessing the power of data, by installing IoT sensors to monitor air quality, energy, etc.

MADE SMARTER INNOVATION | SMART MANUFACTURING DATA HUB

Presentation Overview

- Aim, Research Questions & Contributions
- Method
- Overview of User Experience (UX) in general and in Smart Manufacturing
- Background to Internet of Things (IoT) Devices
- Problem
- Frameworks & Methodologies used to Measure the UX in Smart Manufacturing
- Challenges
- Suggestions for Improvement
- Conclusion & Future Work

Aim, Research Questions & Contributions

- **Aim:**
  - Explore how the UX of IoT applications for Smart Manufacturing could be enhanced.

- **Research Questions:**
  1. What frameworks and/or methodologies are currently being used to measure the UX of IoT technologies in Smart Manufacturing?
  2. What challenges do the frameworks and methodologies present?
  3. How can the UX of IoT technologies in Smart Manufacturing be enhanced?

- **Contribution:**
  - Recommendation: One interface that adapts to IoT devices or machinery in line of sight.

Method

Hybrid Approach

Systematic (structure)

Scoping (gaps)

Inclusion

Date Range: 2019 – 2025
Scope: UX, industry & augmented systems
Search Terms: Augmented manufacturing, UX & Industry 5.0
Language: English

Exclusion

Outside of date range
Not including defined data or search terms
Not in English language

Overview of UX

What is User Experience (UX) Design?

"*User experience (UX) design is the process design teams use to create products that provide meaningful and relevant experiences to users. UX design involves the design of the entire process of acquiring and integrating the product, including aspects of branding, design, usability and function.*" [1]

Overview of UX in Smart Manufacturing

Mid 1700s

Industry 1.0
Machinery
Steam Power

1870

Industry 2.0
Mass Production
Electricity

1970

Industry 3.0
Automation
Computers

2011

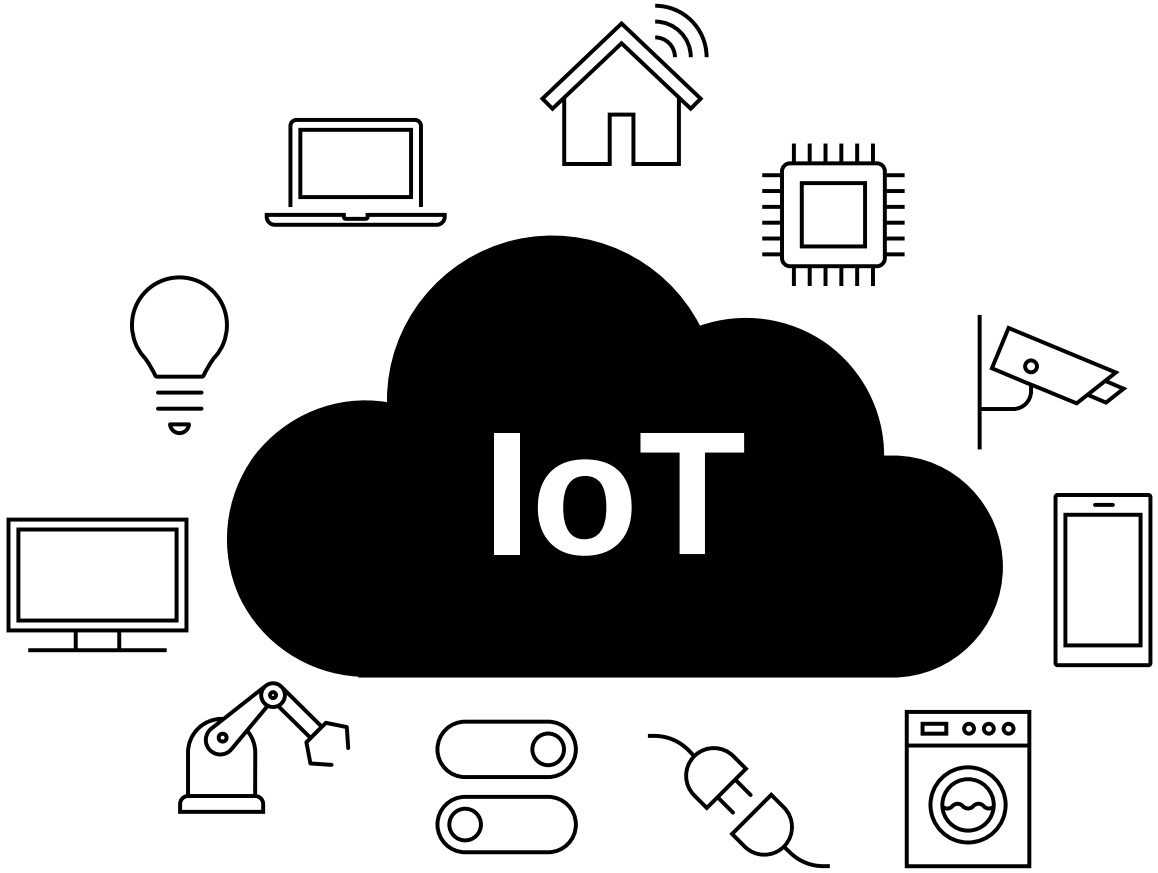
Industry 4.0
IoT
Smart Factories

2020

Industry 5.0
Personalisation & Humanisation
Sustainability

Background to IoT Devices

- Launched in Industry 4.0 – 2011
- Assist legacy machinery
- Cost effective alternative to new machinery
- Provide data on: products, people, processes, and infrastructure.
- Talk with each other over a network – unified experience for the user.
- Device to device – Thing-to-Thing
- Human to device – Human-Thing
- Data displayed via visual dashboard to assist user with decision-making.



Problem

The interoperability of IoT devices and UX of their applications, such as Home Assistant, to work as one cohesive system and aggregate data to portray results in a meaningful way to support decision-making between human and machine with daily tasks, whilst adapting and supporting its user, their intelligence and needs.

How are these applications currently being assessed within the realm of Smart Manufacturing?

Frameworks & Methodologies used to Measure the UX in Smart Manufacturing

	IoT Devices	Application UX	User Needs	User Intelligence	Machine	Industry
Almeida et al. [2] IoT Checklist	Y					
Aranburu et al. [3] eXperience Capturer			Y			Y
Villani et al. [4] INCLUSIVE Framework			Y		Y	Y
Johnston et al. [5] DAI Framework	Y	Y	Y	Y		Y
Stoll et al. [6] AVISAR	Y		Y			Y

Challenges

1. Lack of a cohesive framework or methodology.
   - None focus on the needs of industry, machine, individuals, and IoT devices.

2. Lack of a manufacturing focus when understanding the experience of IoT devices.
   - Delays implementing technologies due to cost, lack of education, and not seeing its potential.

3. Lack of a manufacturing interface for IoT devices.

Suggestions for Improvement

- With ~18 billion connected IoT devices, most are ‘locked’, whereas others are open-sourced [7]. At minimum, there should be an open-sourced interface for manufacturing realm that focuses on the user and their operational environment.
  - This would:
    - Cater to the needs of Industry 5.0
    - Allow most companies to transition to the next Industrial Revolution with ease, less friction on training and financial costs; and
    - Bring long term success and value to each company over time and the longevity of the products being made.

Conclusion & Future Work

- Critically examined current frameworks and methodologies that have been created to enhance the human-machine experience of Smart Manufacturing systems.
- No framework or methodology that caters to Smart Manufacturing, IoT device(s), machine and the system user.
- Most companies are only now implementing IoT devices to their manufacturing production due to prices coming down.
- The UX of IoT devices and their applications should focus on enhancing usability to better engage and support the user operating them.
  - User needs to adapt the interface irrespective of their educational background and disabilities.
  - This would improve the human-machine relationship and the well-being of our workers.

- Future Work: Augmented or Virtual Reality to improve worker safety via training sessions by highlighting areas of concern and offer recommendations.

Thank You

Any questions?

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