Analysing Sociotechnical System Interactions for Supporting Technology Integration in Manufacturing Environments (ASSIST-ME)

Elizabeth M. Argyle, PhD
University of Nottingham

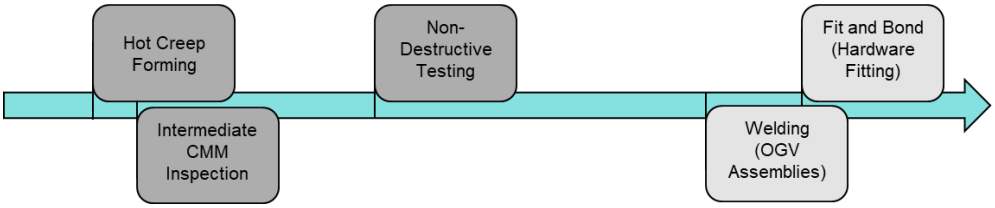
John White, CEng and Chris Nex, CEng
Rolls-Royce Plc

1 | Motivation

Within the Rolls-Royce Fan Case and Outlet Guide Vane (OGV) Assembly value chain, digital technology has the potential to support aspects of work that are currently largely manual. While such technology offers potential benefits (e.g. improving system productivity and worker wellness), in order to make the most of the these opportunities, it is necessary understand the boundaries of existing operations in order to minimise unintended consequences from technology introduction.

In a series of case studies across the OGV manufacturing value chain, this work addressed several objectives:

- Exploring Cognitive Work Analysis (CWA) as a method for modelling existing sociotechnical system interactions and constraints
- Identifying leverage points where digital solutions could support future industrial workers
- Identifying information requirements for supporting cognitive work in manufacturing systems



Domain selection for Cognitive Work Analyses across the OGV and fan case value stream

2 | Method

Work System Selection

The analysis focused on several primarily manual processes across the OGV manufacturing value chain.

Data Collection Methods

Data collection occurred across three Rolls-Royce manufacturing sites in the UK. Participants represented production workers, product inspectors, manufacturing engineering, and management. All interactions occurred during daytime hours, and as such, models represent the data shared by workers involved in daytime shifts.

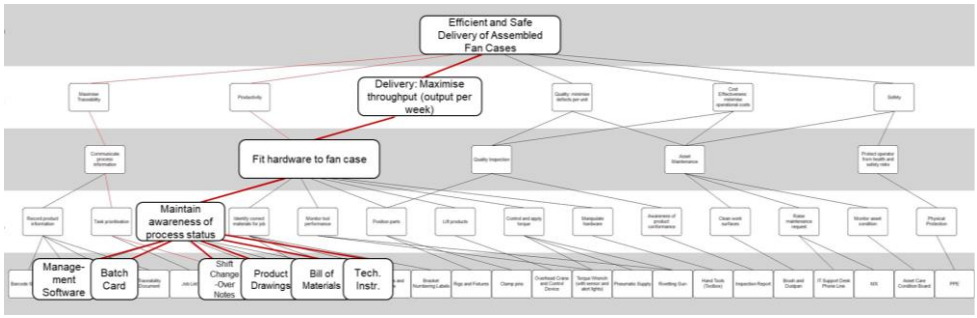
Data collection techniques included:

- Workplace observation
- Process walk-throughs and talk-throughs
- Semi-structured interviews
- Engineering document review

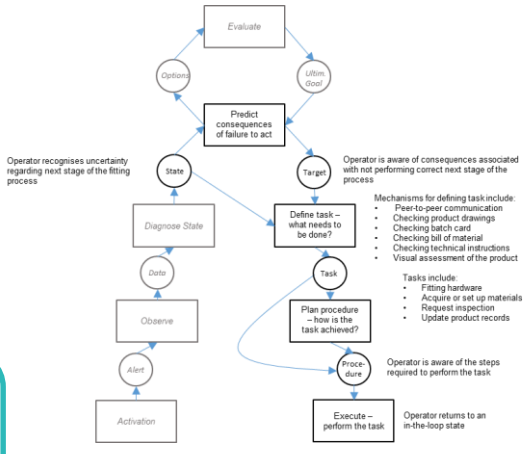
Cognitive Work Analysis (CWA)

CWA is a technique for modelling constraints within complex sociotechnical systems and has been used extensively in fields such as air traffic control, and the nuclear industry (Vicente, 1999).

Component	Description
Work Domain Analysis	What constraints does the workplace structure impose upon the system?
Control Task Analysis	What tasks and functions are performed within the work system?
Strategies Analysis	Through what means are these tasks achieved?
Social Organisation and Cooperation Analysis	How are aspects of work distributed among system actors?
Worker Competencies Analysis	What is needed to do this work? (skills-rules-knowledge)



Abstraction Hierarchy of the Fit and Bond (Hardware Fitting) work domain



Decision Ladder for the Fit and Bond scenario associated with maintaining situation awareness following disruption

3 | Expected Outcomes

Case study findings will be used to identify the boundaries of effective system operation. Current findings have indicated several leverage points for digital interventions to support future workers.

System Constraints Modelling

For each work system, findings from the associated case studies will be communicated via CWA diagramming methods (Abstraction Hierarchy Diagrams, Decision Ladders, Strategies Diagrams, and Information Requirements Frameworks).

Opportunities for Supporting Future Industrial Workers

The application of CWA has shown to be particularly effective in terms of:

- Modelling the impact of automation on operator performance in inspection scenarios
- Identifying aspects of manual work where technology intervention could support operators in maintaining situation awareness
- Identifying information requirements for supporting workers in identifying and resolving non-conformance issues

Acknowledgments

This work was funded by the EPSRC Connected Everything Network Plus [EP/P001246/1] as part of the Early Career Researcher Placement Scheme.

References

Vicente, K. J. (1999). *Cognitive work analysis: Toward safe, productive, and healthy computer-based work*. CRC Press.