THE ROLE OF HUMAN FACTORS AND ERGONOMICS

in the uptake and diffusion of advanced manufacturing technologies

Summary Report

imcrc | we champion manufacturing innovation

BAE SYSTEMS Maritime Australia

Flinders UNIVERSITY

SUMMARY

The adoption of Industry 4.0 technology will transform work, shifting toward technology-mediated interactions that are less physically demanding, more abstract, loosely coupled and cognitively challenging.

Human Factors and Ergonomics (HFE) provides tools and techniques for analysing and predicting impacts of the transition to Industry 4.0 and designing and integrating solutions to address these impacts.

1 Manufacturing is experiencing a fourth industrial revolution


BIG DATA


COBOTICS


ARTIFICIAL INTELLIGENCE


ADDITIVE MANUFACTURING


AUGMENTED & VIRTUAL REALITY


INTERNET OF THINGS


POWERED EXOSKELETONS


DIGITAL TWINS


WEARABLE TRACKERS

2 The transition to Industry 4.0 needs to be guided by consideration of HFE

HFE's importance is pronounced as manufacturing shifts to more technology-mediated interactions. Considering HFE in manufacturing delivers a range of benefits:


INCREASED PRODUCTIVITY
– technology workflows that are efficient and streamlined


INCREASED SAFETY, WELLBEING AND WORKER HEALTH
– ensuring systems and tools minimise repetitive movements that result in injury or discomfort


INCREASED JOB SATISFACTION
– making tools more seamless and engaging


INCREASED QUALITY
– positively influencing the quality of tasks employees perform


LOWER COST
– reducing health and safety costs, decreasing errors and making workflows more efficient and streamlined

3 Australian industry should begin facilitating the shift to Industry 4.0

1. Collaboratively identify opportunities to use Industry 4.0 technology
2. Identify new Industry 4.0 job profiles and work roles
3. Adopt a whole of organisation / systems view to Industry 4.0 technology
4. Prepare the workforce for change.

MANUFACTURING IS BEING TRANSFORMED THROUGH DIGITISATION, PAVING THE WAY FOR INDUSTRY 4.0

The convergence of next-generation digital technologies is creating a fourth industrial revolution in manufacturing. Industry 4.0 will bring decentralisation of information and decision-making, more flexible and productive manufacturing facilities, and new generations of interconnected and autonomous equipment.

Industry 4.0 is characterised by a range of key enabling technologies including:

These technologies have the potential to disrupt existing business models, processes and patterns of work, ushering in significant improvement in quality, reliability, productivity and efficiency in manufacturing. A gulf will increasingly emerge between manufacturers that do and don't adopt Industry 4.0 technologies, with those that do being better positioned to compete in an increasingly global and competitive manufacturing market.

HUMAN FACTORS AND ERGONOMICS IS CRUCIAL IN THE TRANSITION TO INDUSTRY 4.0

The adoption of Industry 4.0 technologies is expected to transform work by shifting toward technology-mediated interactions that are less physically demanding, more abstract, loosely coupled and cognitively challenging[1]. Greater task complexity may increase the potential for human error as system operations becomes less transparent, requiring new understanding of system performance.

Human Factors and Ergonomics provides tools and techniques for analysing and predicting impacts of the transition to Industry 4.0 and designing and integrating solutions to address these impacts. HFE is a combination of many disciplines such as social sciences (psychology, sociology), health sciences (medicine, physiology, biomechanics) and design sciences (engineering, industrial design, architecture, user interface design). More specifically, HFE is the science of designing a job to fit the worker, rather than expecting the worker to fit the job.

HFE is more than implementing the latest stretching program (although that may play a role in decreasing injuries) or supplying ergonomic chairs; it takes a holistic look at the tasks that are being performed and matches them with the capabilities of the worker to minimise injury risk and stress, and maximise quality and efficiency.

Key elements considered as part of HFE include:

BENEFITS OF CONSIDERING HUMAN FACTORS AND ERGONOMICS

HFE has long been recognised as beneficial for worker health, safety and wellbeing. It not only improves worker job satisfaction but has demonstrated reduced frequency, severity and costs of injuries and absenteeism. Less well understood is the value of HFE for improving productivity, product and service quality, performance reliability and sustainability of production.

Specific benefits of applying HFE to advanced manufacturing technology include:

INCREASING PRODUCTIVITY 	HFE can improve productivity. For example, HFE can help to ensure that the workflow used in a system or technology is efficient and streamlined. This helps to minimise the number of steps required and reduce the time workers spend on low value / repetitive tasks, releasing them for higher value tasks.
INCREASING SAFETY, WELLBEING AND WORKER HEALTH 	HFE can reduce exposure to health and safety risks. For example, HFE can help to ensure that systems and tools are designed to minimise repetitive movements that result in long-term injury and discomfort. One study found that HFE interventions produced a median reduction of 50% in numbers of work-related musculoskeletal disorders, with lost workdays and cost per claim reducing by 65% and 56% respectively.[2]
INCREASING JOB SATISFACTION 	Given the share of time workers spend interacting with different systems and technologies used in the workplace, the design of these systems and tools can influence their experience of work. HFE principles can be applied to make tools more seamless and engaging to work with. This can result in higher levels of engagement, lower levels of frustration and – ultimately – more job satisfaction and less absenteeism.
INCREASING QUALITY 	The effective application of HFE not only improves the way workers interact with systems and tools, but also influences the quality of the tasks they perform. For example, application of HFE principles to digital workflow management tools in the healthcare sector have led to reduced manual transcription errors. This helps to maintain established quality standards.
LOWERING COST 	The full potential cost savings of applying HFE is difficult to calculate, particularly when taking into account the breadth of technologies and systems where HFE can be applied. However, savings associated with reduced health and safety costs, error reduction and more efficient / streamlined workflow compound to create significant cost reductions at an organisational level.

FLINDERS RESEARCHERS INVESTIGATED HUMAN FACTORS RELEVANT TO SHIPBUILDING 4.0

In line with all other forms of manufacturing, Industry 4.0 offers a vision for transformation of the shipbuilding industry through the establishment of 'Digital Shipyards'. Ships constructed using smart shipbuilding processes can drive production efficiency, ship safety, cost efficiency, energy conservation and environmental protection.

Major changes to the world of human work are required to adapt to the shift to 'Digital Shipyards'. Shipyard workers need to upskill their digital capabilities, particularly in areas such as big data and analytics.

There are a range of HFE considerations critical to the uptake of 'Digital Shipyard' technology

1 Structural and organisational factors:

- Does the organisation have the skills and competencies needed to adopt and use the technology?
- Is the organisation structured in a way that will drive adoption and use of the technology?
- Will the organisation's feedback processes inform improvements to the technology or rollout?

2 Individual factors:

- How are individual users supported to accept and utilise technologies?
- How are technologies matched to individual capabilities?

1 Technology factors:

- What are users' previous experience with the technology?
- What policies will guide the introduction of the technology (e.g. mandatory, optional)?
- How is the technology perceived in terms of usability?

ADOPTION PRINCIPLES FOR INDUSTRY

Australia's aspirations to create a strong and productive sovereign manufacturing sector requires Australian manufacturers to embrace Industry 4.0 technologies and ways of working.

There are a range of strategies manufacturers and industry more broadly can pursue to support their transition to Industry 4.0 manufacturing:

1 Collaboratively identify opportunities for Industry 4.0 technology

A hallmark of HFE is that it is participative in nature and draws on evidence and the 'expert' knowledge of people involved in the work to identify problems and opportunities facing them. To promote usability, safety and wellbeing, work processes and technology must be designed through participation, a backwards and forwards process between end-users and designers to ensure that technologies and processes are fit for purpose.

2 Identify new Industry 4.0 job profiles and work roles

Analyse different processes that could be impacted by Industry 4.0 technology, identify requirement competencies and develop new work roles and job profiles. There will be increasing demand for higher standards of IT competency, knowledge about digital devices, virtual / augmented / mixed reality, and 3D printing and smart production.

3 Adopt a whole of organisation / systems views

Consider how adoption of Industry 4.0 technology will impact on systems and processes across the entire organisation. This includes strategic and production planning, procurement, human resources, health and safety, and quality and management policies and processes.

4 Prepare the workforce for change

Minimise the risk of resistance to new technology by actively managing employee perceptions and intervening to ensure expectation of technology (and its consequences on their work design and performance outcomes) are accurate. Assessing workforce readiness and expectations ahead of implementing a new technology will identify potential barriers and allow pre-implementation strategies to be tailored to the nature of, and timelines, for planned adoption.

[1] Andriaensen, Decre, & Pintelon, 2019

[2] Goggins et al., 2008

TAKING THE WORK FORWARD

and how Flinders University can help

Contact us to discuss how
we can help your organisation.

Australian Industrial Transformation Institute

Flinders University Tonsley
GPO Box 2100
Adelaide SA 5001
(08) 8201 5083
aiti@flinders.edu.au
www.flinders.edu.au/australian-industrial-transformation-institute

View Australian Industrial Transformation Institute publications at:
www.flinders.edu.au/australian-industrial-transformation-institute/publications

imcrc | we champion manufacturing innovation

BAE SYSTEMS Maritime Australia

Flinders UNIVERSITY

This report is based on work funded by the Department of Industry, Science Energy and Resources (Innovative Manufacturing CRC) in collaboration with BAE Systems Maritime Australia.