SDPS 2023

Towards a supra-disciplinary design and process science

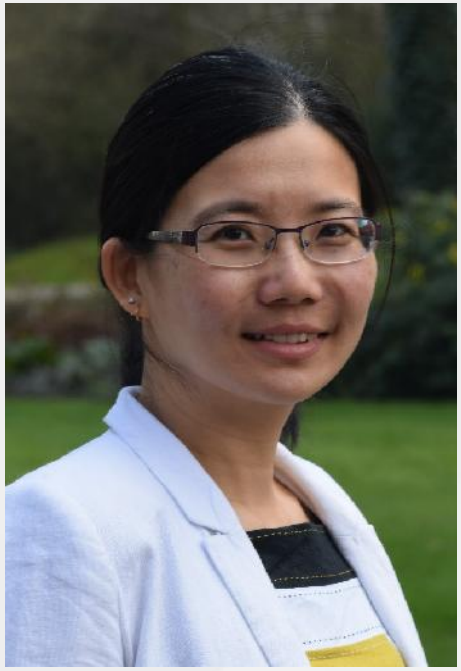
Workshop Session: Intellectualized Cyber-physical Systems

HUMAN - THE MISSING LINK IN CPS?

Position statement by:

Dr. Mey Goh

Biograph



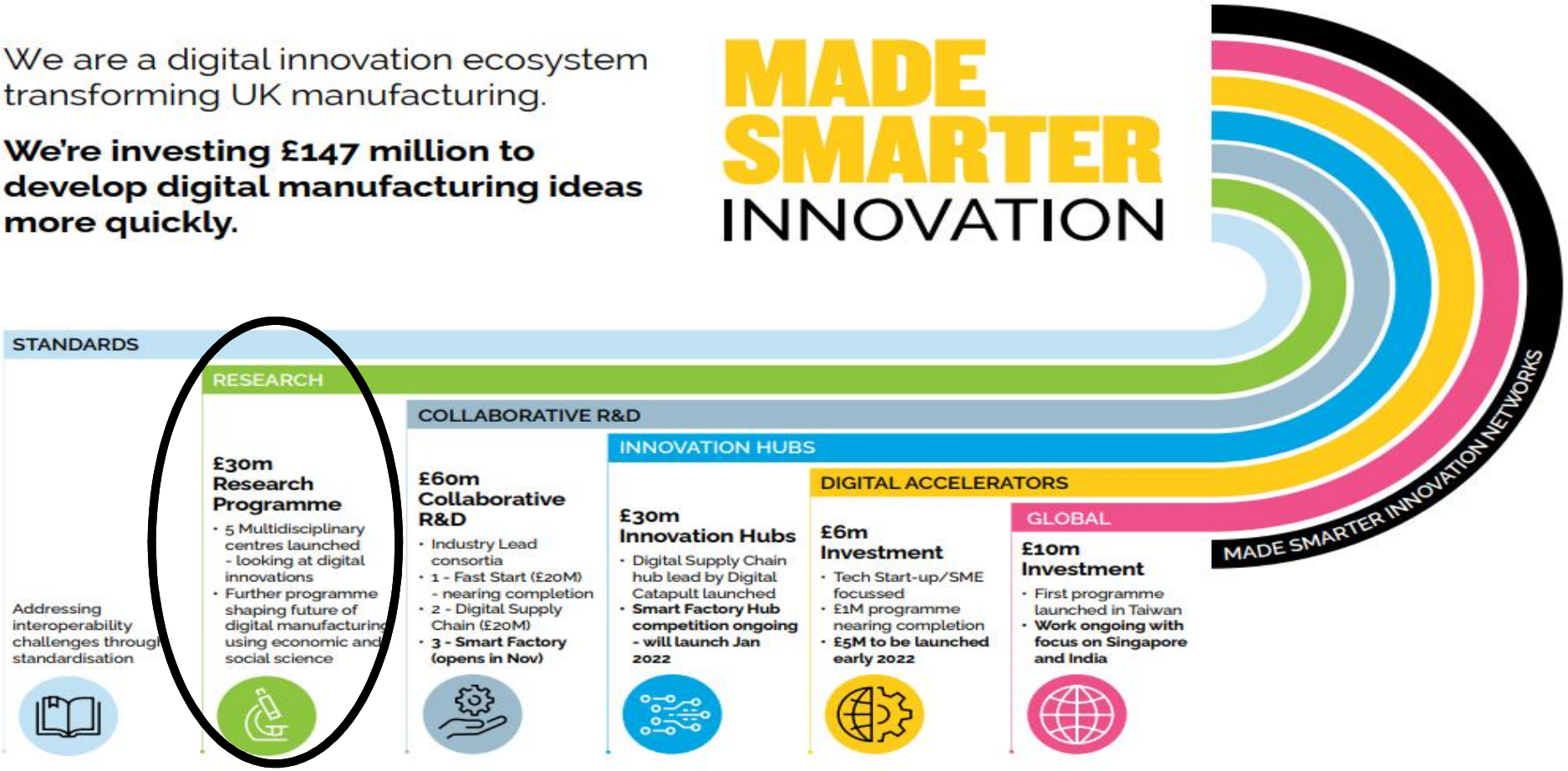
- Reader in Transdisciplinary Digital Manufacturing at Loughborough University
- BEng (Hons) in Mechanical Engineering from University Tenaga Nasional, Malaysia
- PhD in Mechanical Engineering from University of Bristol, UK
- Digital manufacturing, knowledge management, human factors and intelligent automation
- Made Smarter Innovation: Centre on People-Led Digitalisation (2021-2025), Universities of Bath, Loughborough and Nottingham

Centre for
People-Led Digitalisation

We are a digital innovation ecosystem transforming UK manufacturing.

We're investing £147 million to develop digital manufacturing ideas more quickly.

MADE SMARTER INNOVATION



UK Research and Innovation

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Why People-Led Digitalisation?

- People and culture have been identified as a major barrier to digitalisation
  - Resistance on the one hand, unsympathetic "technology first" implementation on the other
  - Digitalisation seen as a solution to productivity challenges
  - Appropriate implementation may also address quality of work and skills challenges

Aim: To create processes to support industry realise a people-led approach to digitalisation

Aida Garcia Lazaro
Economist

Impact of digitalisation on the labour market

Boroto Hwabmungu
Information Systems

Stakeholders and power. Construction sectors

Beate Ehrhardt
Data Scientist

Expertise to support projects as required

Begüm Kilic Ararat
Management

Challenges of digital technology adoption in manufacturing.

Fortune Nwaiwu
Economics & Management

Success metrics and measurements.

Thomas Stead
Qualitative Design Research

Participatory action research approach

Industry identified challenges

Our Aim: To create "*needs driven*" processes to support industry in realising the potential of a people-led approach to digitalisation

Other MSI research

Existing academic / industry knowledge

Elizabeth Argyle
Human factors

Sociotechnical system design and analysis

Claire Palmer
Manufacturing

Digital interfaces

Laura Smyth
Policy

Research Area (TBC)

Zihan Wang
Management

New working spaces (e.g. fab labs & makerspaces) impact on digital skills

3 PDRA Vacancies

Loughborough University

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Being smart is only means to an end

- It may be tempting (even exciting) to create an intelligent and fully autonomous CPS
- Humans are integral part of CPS
- Humans can act as sophisticated sensors in detecting unusual or unexpected events, decision makers, provide new knowledge and offer adaptations
- Being smart is only a means to an end, need to produce positive economic, social and environmental outcomes for all

Cyber-Physical Social Systems (CPSS)

"a complex socio-technical system in which human and technical aspects (CPS) are massively intertwined."

Dystopia

Operating the equipment

Workers staff digitalised systems

Autonomy reduced by constant surveillance and interaction demands of machines themselves

Left-over automation (tech first deployment)

Complex overbearing organisation, simple jobs

Utopia

Equipping the operator

Digitalisation supports workers in achieving what they want to achieve

Permits greater autonomy by offering a safety net based only on hard constraints

Human-centric deployment

Complex organisation, complex jobs

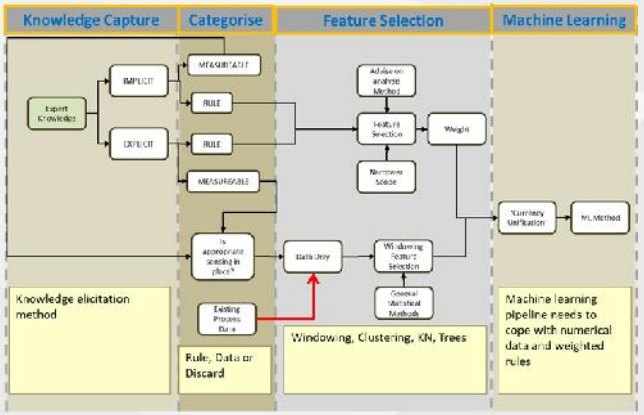
ContraVision of Future Digital Manufacturing technologies, https://digitop.ac.uk/?page_id=6501

Intellectualization of CPS

- Human skills are still important in manufacturing
  - Dexterity, decision making
  - Easily miss the variability dealt by humans (not always understood)
- Collecting and processing data could be expensive
  - Low volume, high value manufacturing
  - Including expert knowledge improves accuracy and speed of ML
- Need to involve users in design
  - Trust and communication
  - Design for acceptance (not as afterthought)

Example projects

- Human skills capture for automation
- Ontology for decision support
- Experts-in-the-loop machine learning



Personalization and Socialization

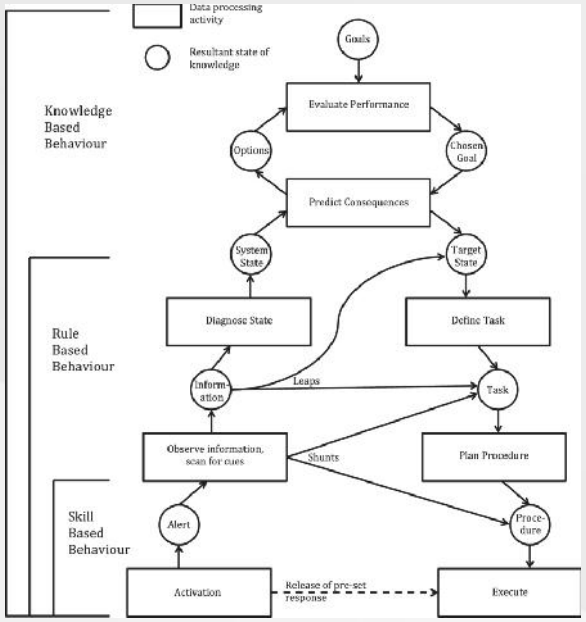
- Digital technologies pose new questions but also provide new solutions
- Mixed methods to better model the human factors

Example projects

- Trust and fluency in HRC using wearable sensing and VR
- Cognitive workload and human factors
- Mental health and trust on automation

Whole Systems Thinking

- Variability is inherent nature of complex systems
  - Safety II
  - Humans provide adaptation and resilience
- Build in resilience requires understanding of variability
  - Complexity and emerging behaviour
- It is important to ask which function (sensory, physical or cognitive) should be allocated to the different elements of the CPS
  - Joint cognitive systems, co-agency
  - Adaptive, personalization, etc.

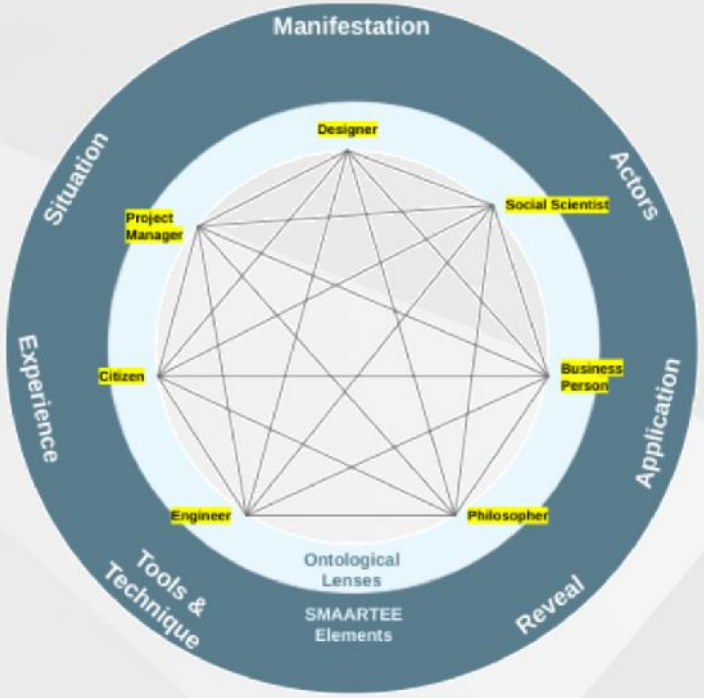


Symbiotic digital twin interface

Transdisciplinary Engineering

- Transdisciplinary challenges
  - Language, ontological lens, perspectives
  - Methodological issues, e.g. how to merge human factors and engineering knowledge
  - Interoperability and interfaces are important

- Design principles and methodology for complex systems



Will Brown, PhD candidate, Loughborough University

Value by Design

- Design for acceptance and societal value
  - Need trust for sustained acceptance leading to adoption
  - Ethics and environment (sensors, energy)
- Desirable future of work
  - Skills needed within future digital working
  - Not necessary meaning technical digital skills
  - Able to work in a digitalised environment
- Guiding principles for value-driven CPSS

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Thank you

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Loughborough University

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