



# New technology and healthcare: is it safe? Can a human factors approach help to make it safer?

Associate Professor Robyn Clay-Williams

# Acknowledgement of Country

THE ARTWORK CIRCLES OF THE NIGHT SKY IS CREATED BY PROFESSOR LIZ CAMERON,  
DHARUG WOMAN AND MACQUARIE UNIVERSITY ALUMNUS

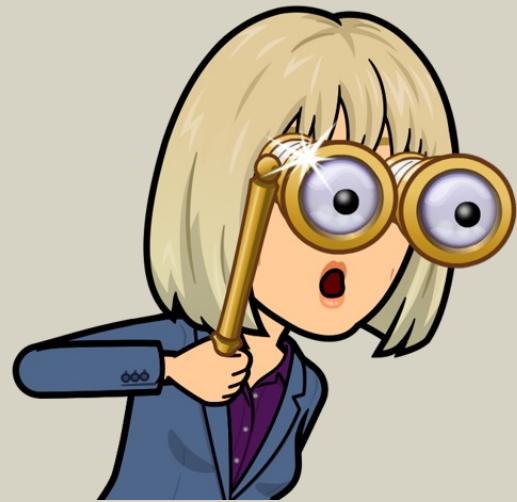


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I acknowledge the traditional custodians of the land on which Macquarie University is situated, the Wallumattagal people of the Dharug nation, and the Kaurna people of the Adelaide Plains on whose land we meet today. Their cultures and customs have nurtured, and continue to nurture, this land, since the Dreamtime.

I pay my respects to Elders past, present and emerging.



# What do we mean by “human factors”?



- Human factors applies evidence-based methods and knowledge about people to design and improve the interaction between people, systems, and organisations
  - Achieved by ensuring there is a **good fit** between people and their environment
  - Don't change behaviour, **re-design** the system

## Behaviour change directly contradicts a HF philosophy

*“We cannot change the human condition, but we can change the conditions under which humans work”*

– James Reason, 1997



# Good vs. Bad Design

Fit for purpose?



# Good vs. Bad Design

Fit for purpose?





## Automated pill dispensing machines:

- compact storage
- automatic tracking of patient medications
- pharmacy notified when restock needed
- expired and recalled items are flagged
- enhanced security access



## Automated pill dispensing machines:

- compact storage
- automatic tracking of patient medications
- pharmacy notified when restock needed
- expired and recalled items are flagged
- enhanced security access

## Use in hospital Emergency Departments:

- is it fit for purpose?
- is it intuitive to use?



# GOOD DESIGN

EVIDENCE-BASED  
**User-focused**



# Human Factors – a user focus



For any task/context:

- Physical needs
- Cognitive needs
- Organisational context

# Human Factors

For any task/context:

❶ *Physical needs*

❷ Cognitive needs

❸ Organisational context



Physical ergonomics is concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity. (Relevant topics include working postures, materials handling, repetitive movements, work related musculoskeletal disorders, workplace layout, safety and health)<sup>1</sup>

1. International Ergonomics Association

# Human Factors

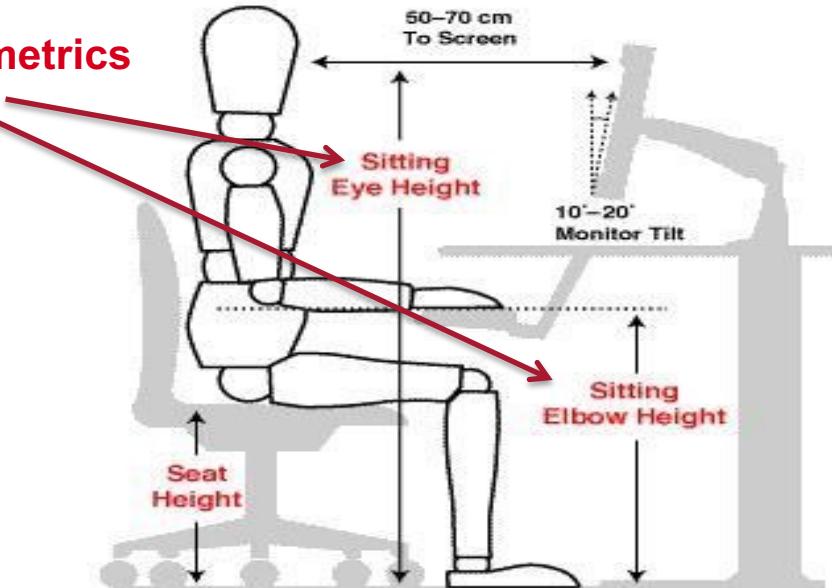
# Ergonomics

For any task/context:

-  *Physical needs*
  -  *Cognitive needs*
  -  *Organisational context*



# Anthropometrics



# Variation takes many forms ...



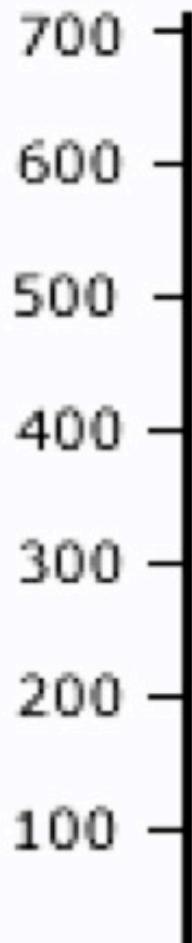
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Frequency



Women  
1968 WAF  
N = 1905

5%



152

165

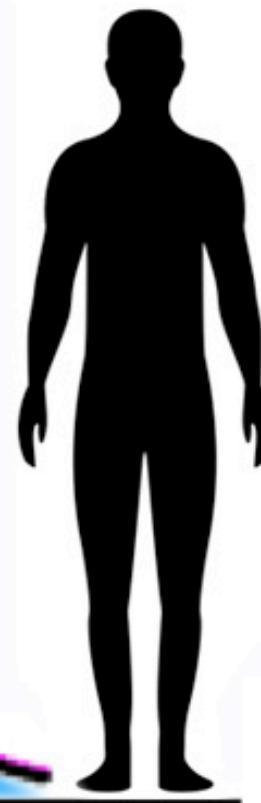
178

188

Height in cm

Men  
1967 USAF  
N = 2420

95%





5<sup>th</sup> percentile female



Shutterstock

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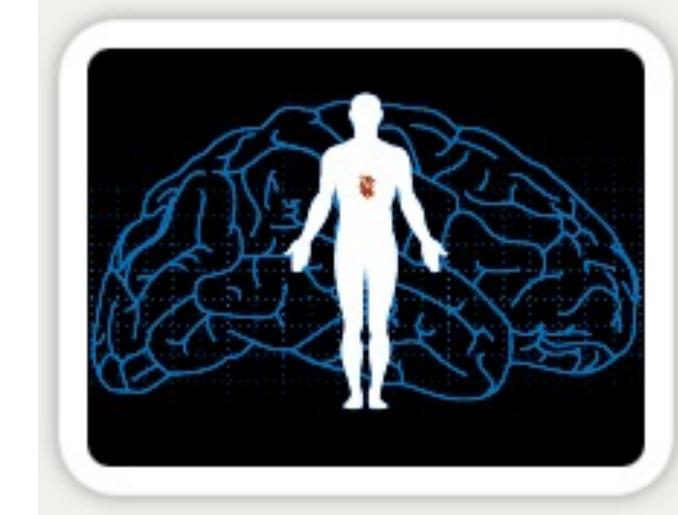
# Robotic Surgery

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For any task/context:

- ➊ Physical needs
- ➋ *Cognitive needs*
- ➌ Organisational context



Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. (Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system design)<sup>1</sup>

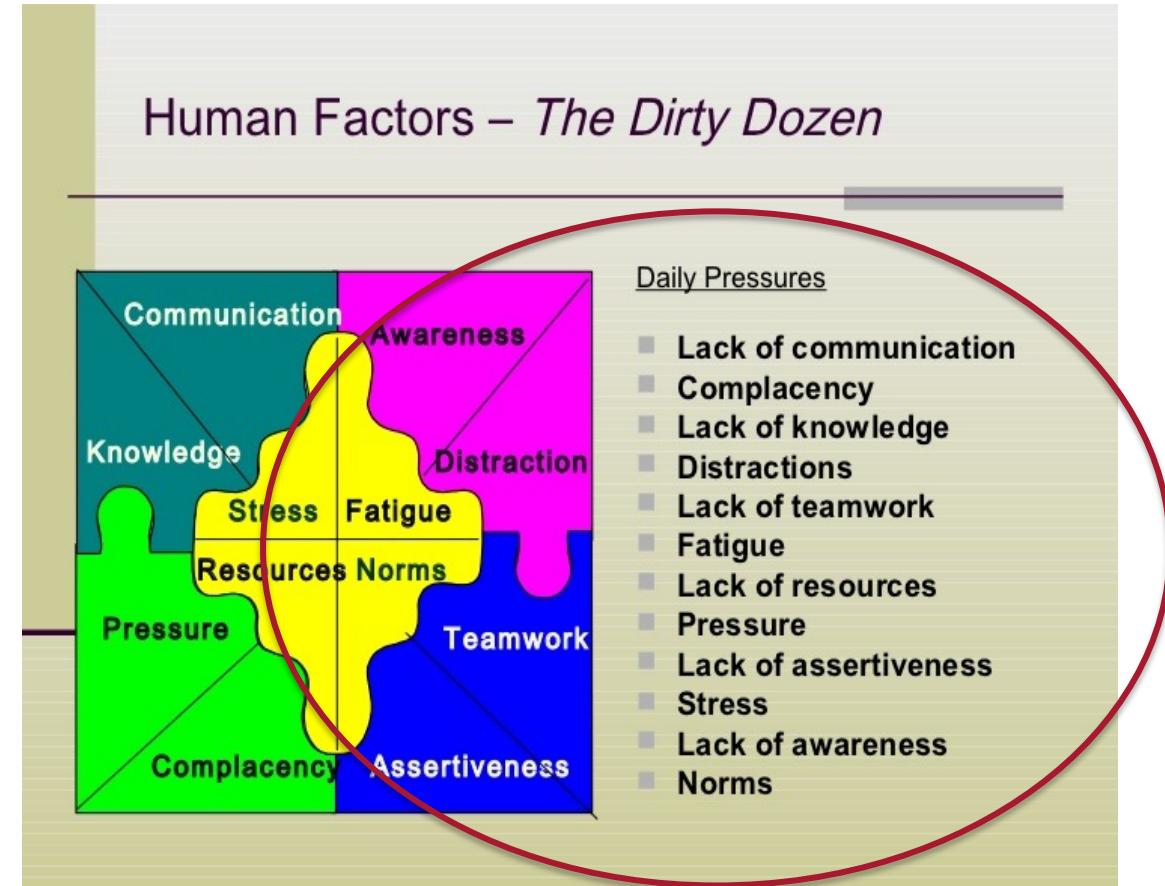
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# Human Factors



For any task/context:

- Physical needs
- Cognitive needs
- Organisational context



The “Human” Factor

# Interruptions

An interruption is a prompt that breaks one's attention from the primary task at hand





# How big of a problem are interruptions?

Nurses experience **57** interruptions per **100** medication administrations

Surgical teams experience interruptions on average **10 times per hour**

Clinicians in EDs experience interruptions between **3 and 43 times per hour**

Increased workload, fatigue, stress and frustration

Associated with a **12% increase** in medication administration errors

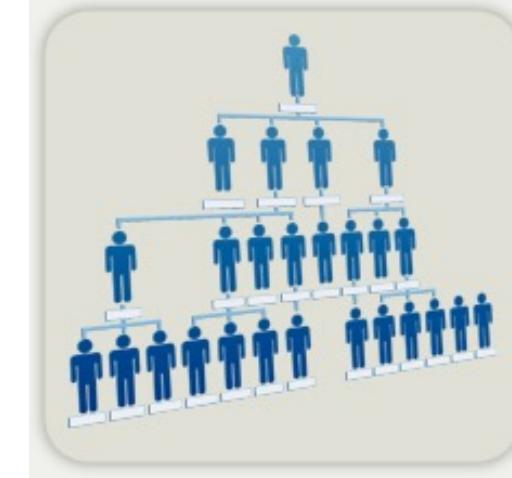


# How do we reduce unnecessary interruptions?

Context	Strategies
Medication administration	<ul style="list-style-type: none"><li>• 'No interruption' zones for some tasks</li><li>• 'Protected hour' where no interruptions permitted</li><li>• Wear a 'do not interrupt' vest or sash</li><li>• Dedicated rooms for medication tasks</li><li>• Barriers to make staff less visible</li><li>• Education strategies for staff, patients, visitors</li></ul>
Surgical areas	<ul style="list-style-type: none"><li>• Provide interruption free periods for designated activities/procedures</li></ul>
Communication (e.g. pagers, cell phones)	<ul style="list-style-type: none"><li>• Alternative communication methods for non urgent tasks</li><li>• Implement policies for pager/cell phone use to limit interruptions</li></ul>

For any task/context:

- ➊ Physical needs
- ➋ Cognitive needs
- ➌ *Organisational context*



Organizational ergonomics is concerned with the optimization of sociotechnical systems, including their organizational structures, policies, and processes. (Relevant topics include communication, work design, design of working times, teamwork, participatory design, community ergonomics, cooperative work, new work paradigms, virtual organizations, telework, and quality management)<sup>1</sup>

1. International Ergonomics Association



# A healthcare informatics example

## Evaluation of a virtual care system:

- telephone/online advice and counselling about pregnancy, childbirth, and first year of parenting
- two levels of support: counsellors, customer service officers
- transitioning to 24 hour video consulting service

## Evaluation:

- observation in training
- semi-structured interviews
- 16 participants



# A healthcare informatics example

Screens shared among users  
(needed to be able to quickly swap place)

- Camera positioning
- Screen customisation
- Difficulty locating decision support tools - individuals had different workarounds
- Solution was 'training', but should it have been **design**?



# Emergency Department

## Check In

### Registration

Register at reception



RECEPTION

## Waiting Time

### Assessment

A **nurse** will talk to you about your reasons for the hospital visit



More **serious** injuries or illnesses are treated **first**

You may have to wait if your injuries are less urgent



## Treatment

**Resuscitation** for life-threatening conditions



Treatment for very **urgent** conditions



Treatment for **less urgent** conditions



We may need to wait for **test results**

## What's next?

### Leave the ED

If fully treated, you can now go home



### Hospital

Admitted to hospital ward for more treatment



### Transfer

Transfer to another hospital for better care

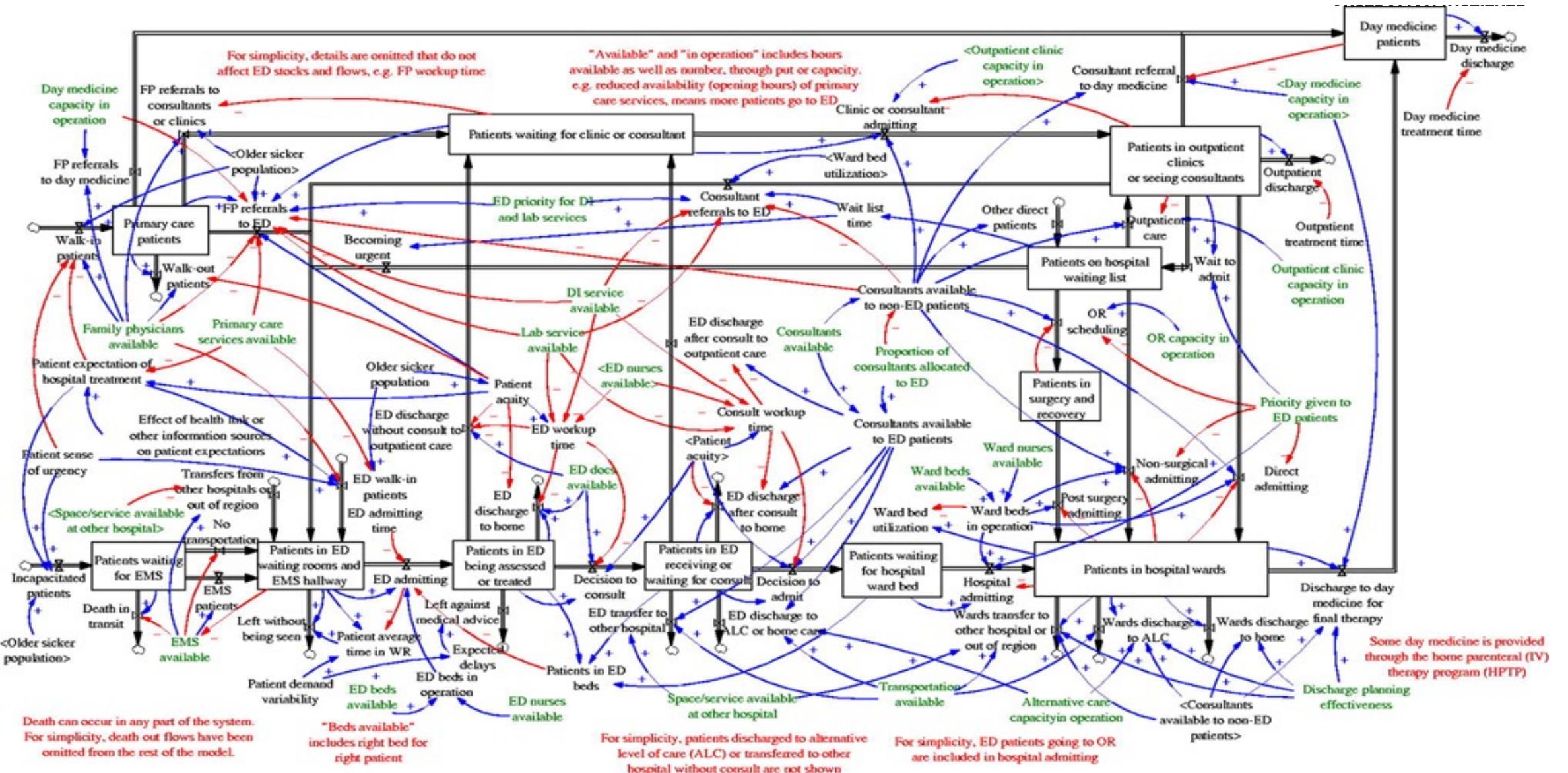


### Special Unit

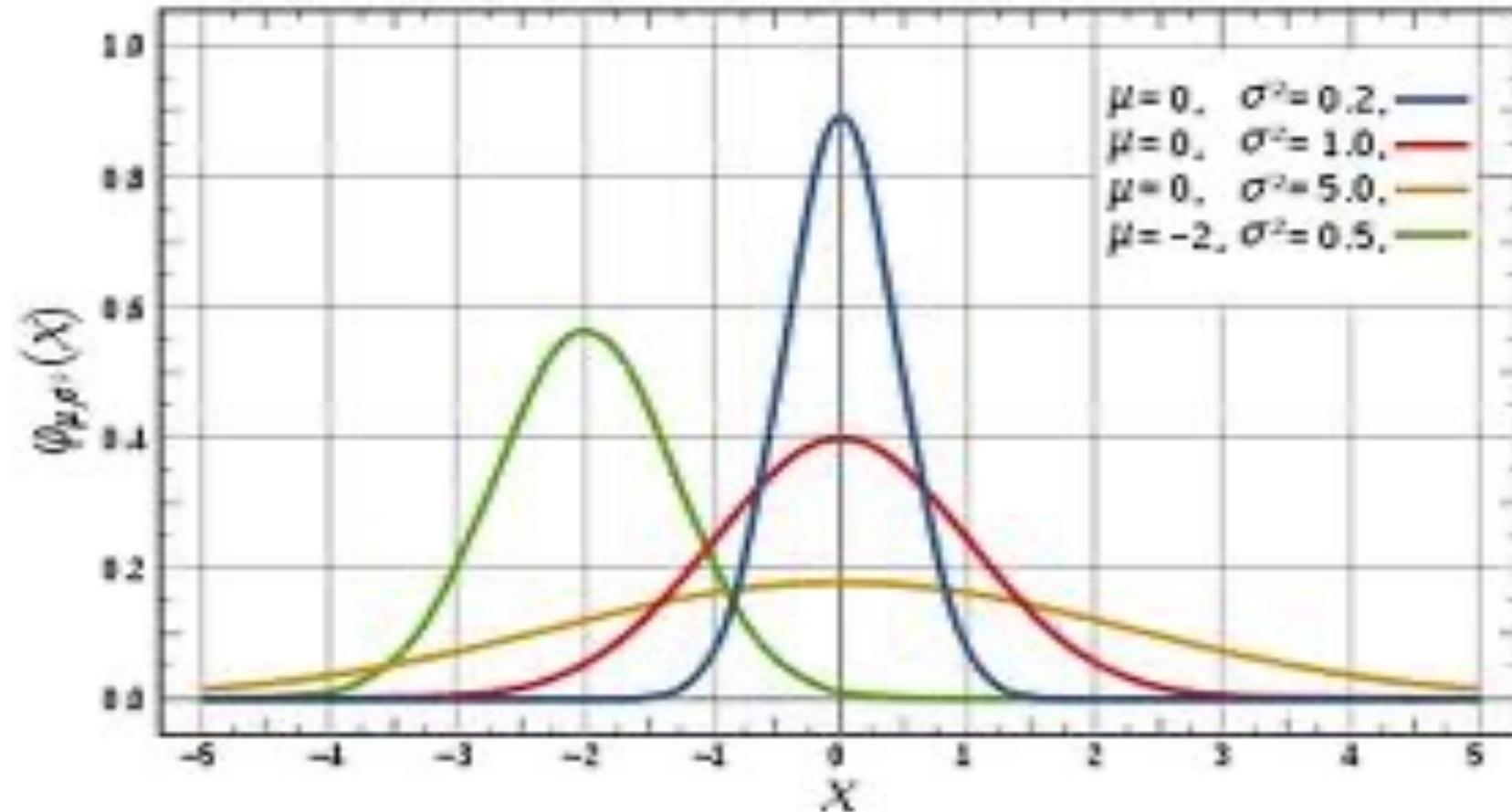
You may be assessed by a specialised unit



# Emergency Departments are complex



# Human performance is variable

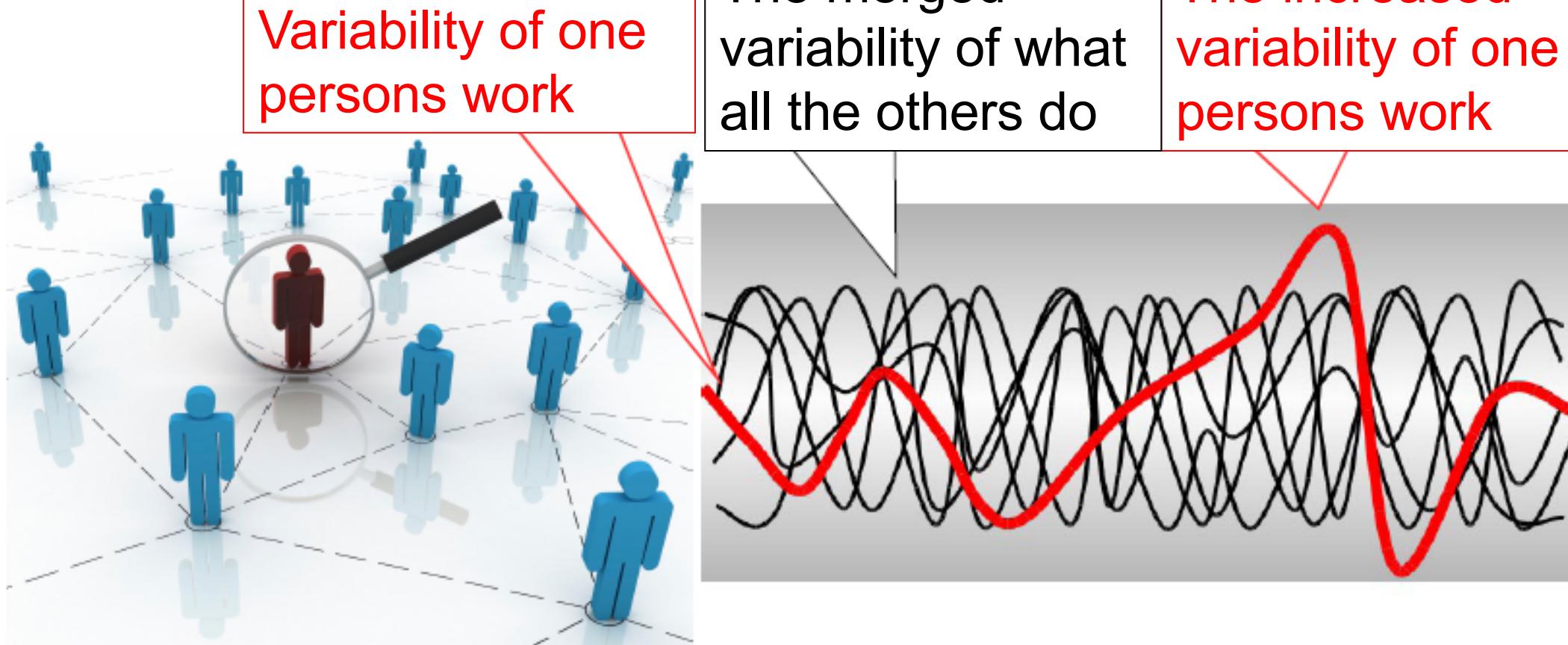


# FUNCTIONAL RESONANCE

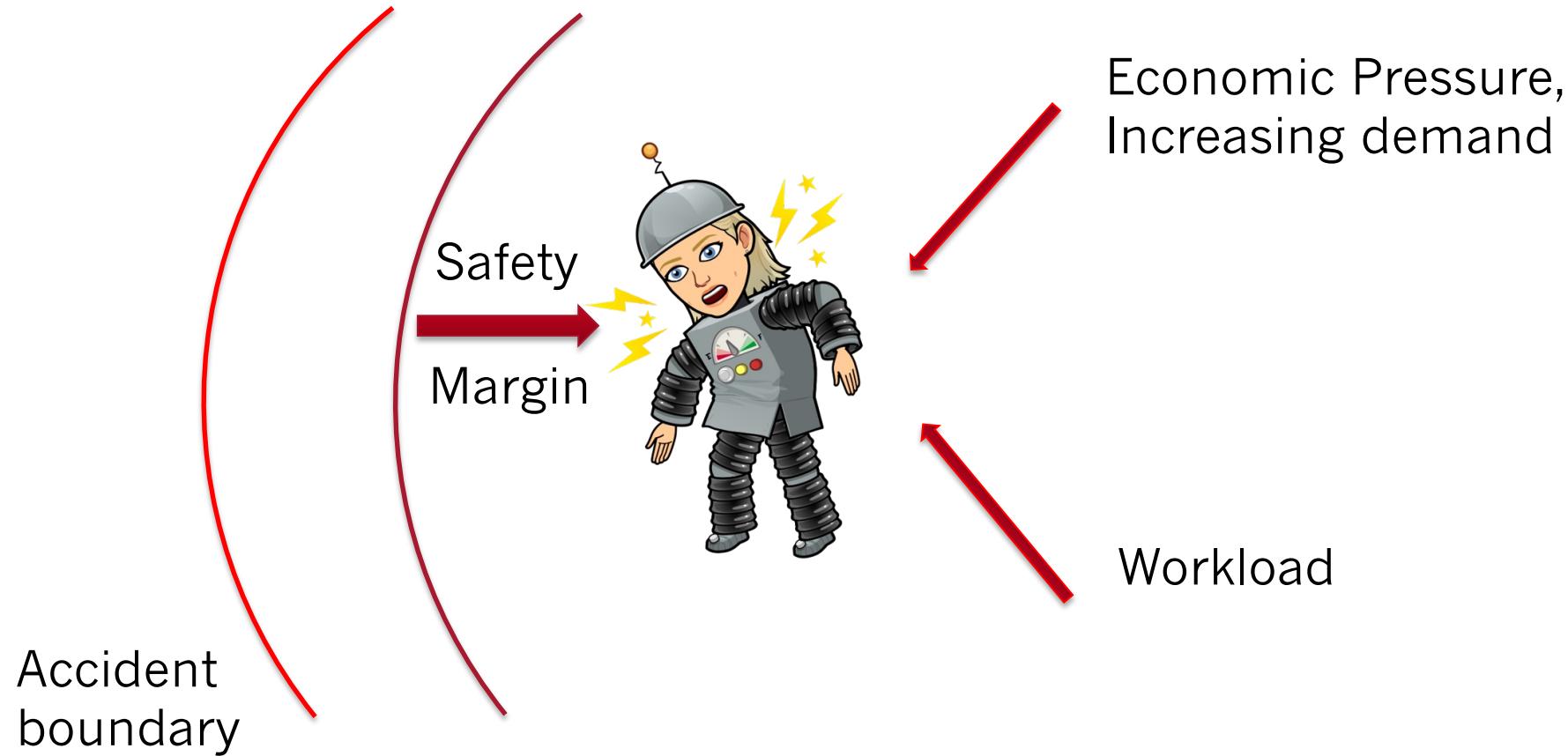
The alternative to a single 'cause'



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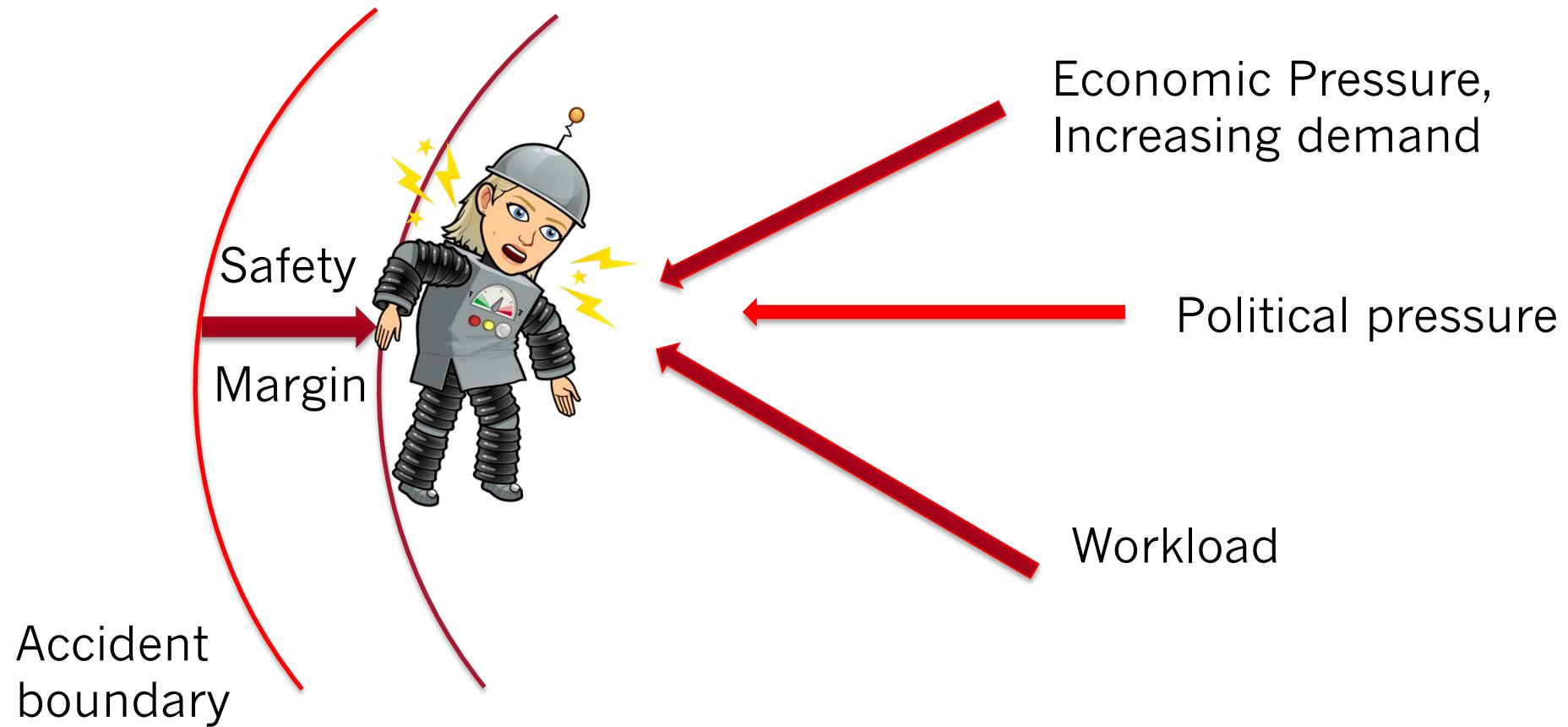


# System boundaries



[Cook & Rasmussen, 2005]

# System boundaries

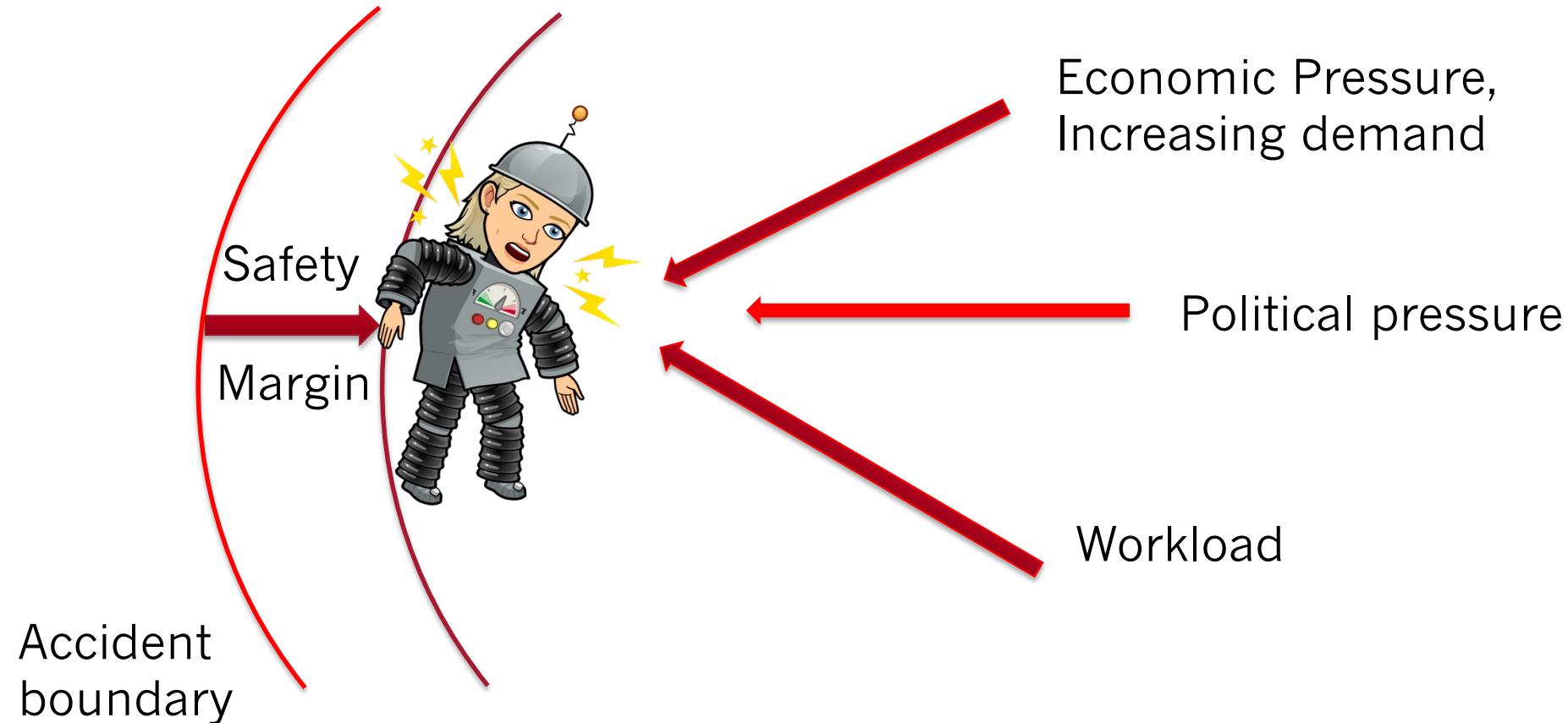


[Cook & Rasmussen, 2005]

# How do we keep work safe?



Weak signals: variation/time, near misses, staffing issues (burnout, retention), ??



[Cook & Rasmussen, 2005]

# Success/Failure Equivalence

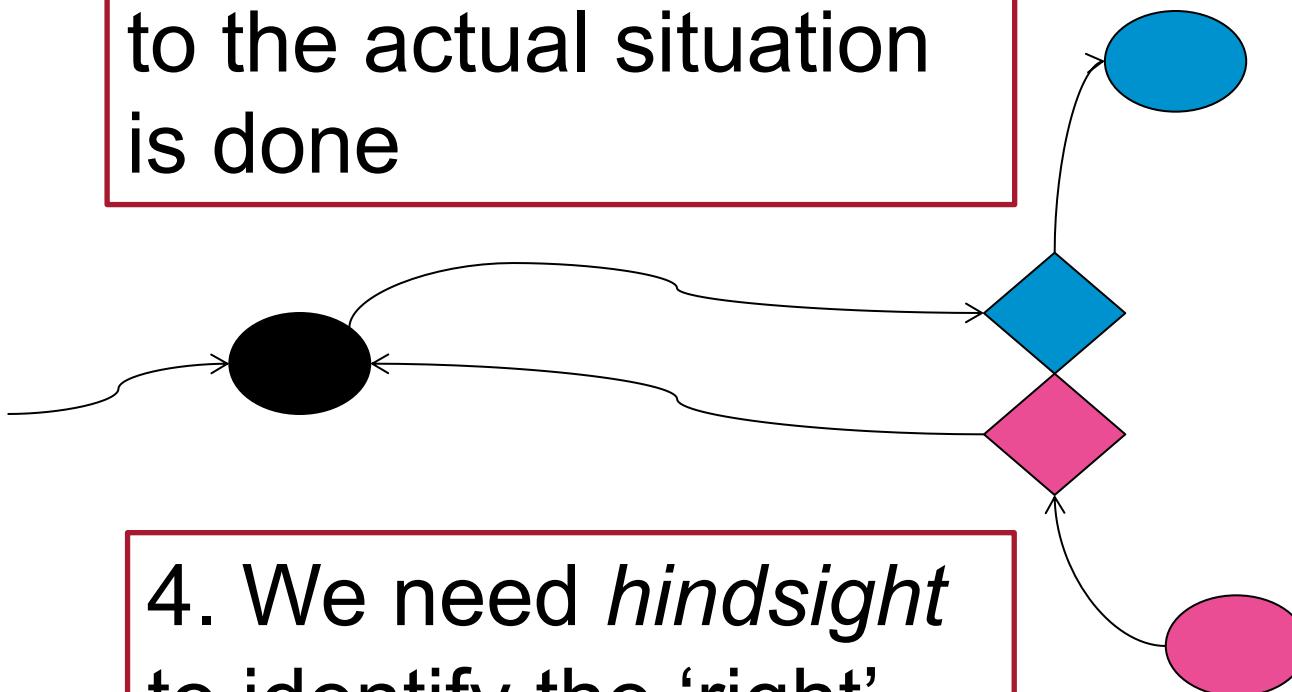


1. An action adjusted to the actual situation is done

2. If the result is as expected, we consider the action as 'right'

4. We need *hindsight* to identify the 'right' action

3. If the result is not as expected, we consider the action as 'wrong'



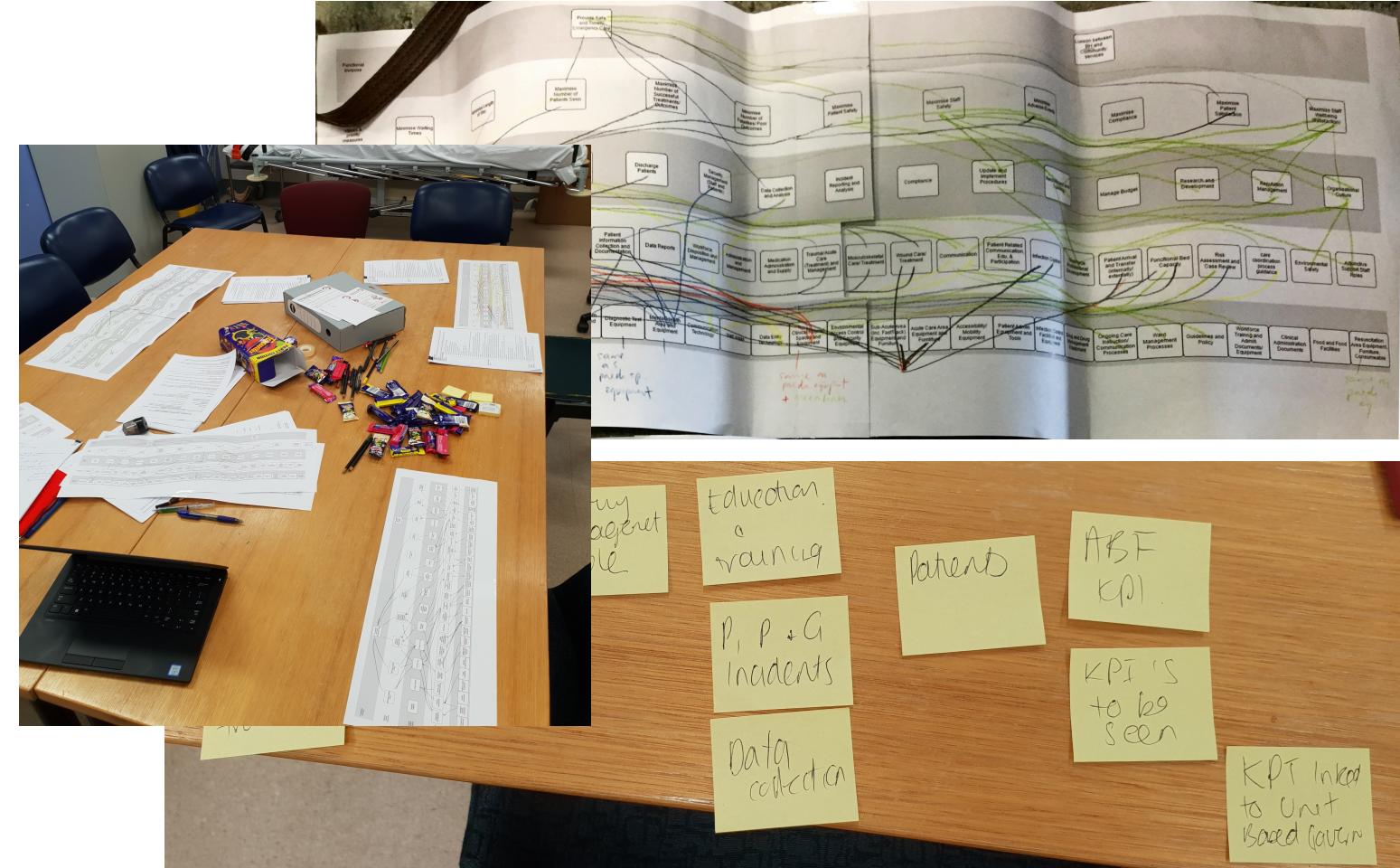
# HF & technology in hospital Emergency Departments

## Study Aim:

- To improve ED performance

## Method:

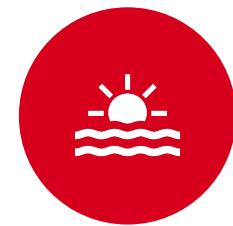
- Cognitive Work Analysis  
(human factors tool to identify work-as-done and reveal constraints around improvement)
- Thematic analysis of observation notes  
(observations undertaken to support the Cognitive Work Analysis)



# Potential for improvements: **information technology**



ADMINISTRATION



THE PHYSICAL  
SPACE



EQUIPMENT



SHARING  
WORK-AS-DONE



INFORMATION  
TECHNOLOGY



COMMUNICATION



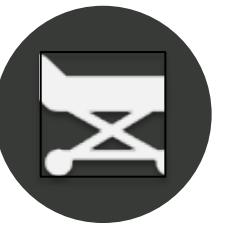
TRAINING AND  
WELLBEING



HOSPITAL  
ENGAGEMENT



CLINICAL  
PRACTICES &  
PROCESSES



PATIENT ROLE &  
EXPERIENCE

# Technology interoperability

## EMERGENCY DEPARTMENT

- Multiple ICT vendors: large multinational, state health department, local
- ICT poorly integrated: within ED, between ED and other hospital systems, between ED and external stakeholders
- Current approach to solving problems: training, workarounds e.g multiple screens, separate windows, post-it notes, using phone for screenshots, etc

Example: booking patient transport



# Use of automation

## EMERGENCY DEPARTMENT

- Very little is automated; decision support available in some areas but not always used: 'the way we've always done it' thinking, impenetrability of vendor proprietary software, decision support not always to hand
- Automation does not always align with user needs: can require more effort than doing it manually, need for adaptable systems
- Current approach to solving problems: automation not well-leveraged, piecemeal implementation rather than systems approach

Example: reporting ED status



# Fit-for-purpose?

## EMERGENCY DEPARTMENT



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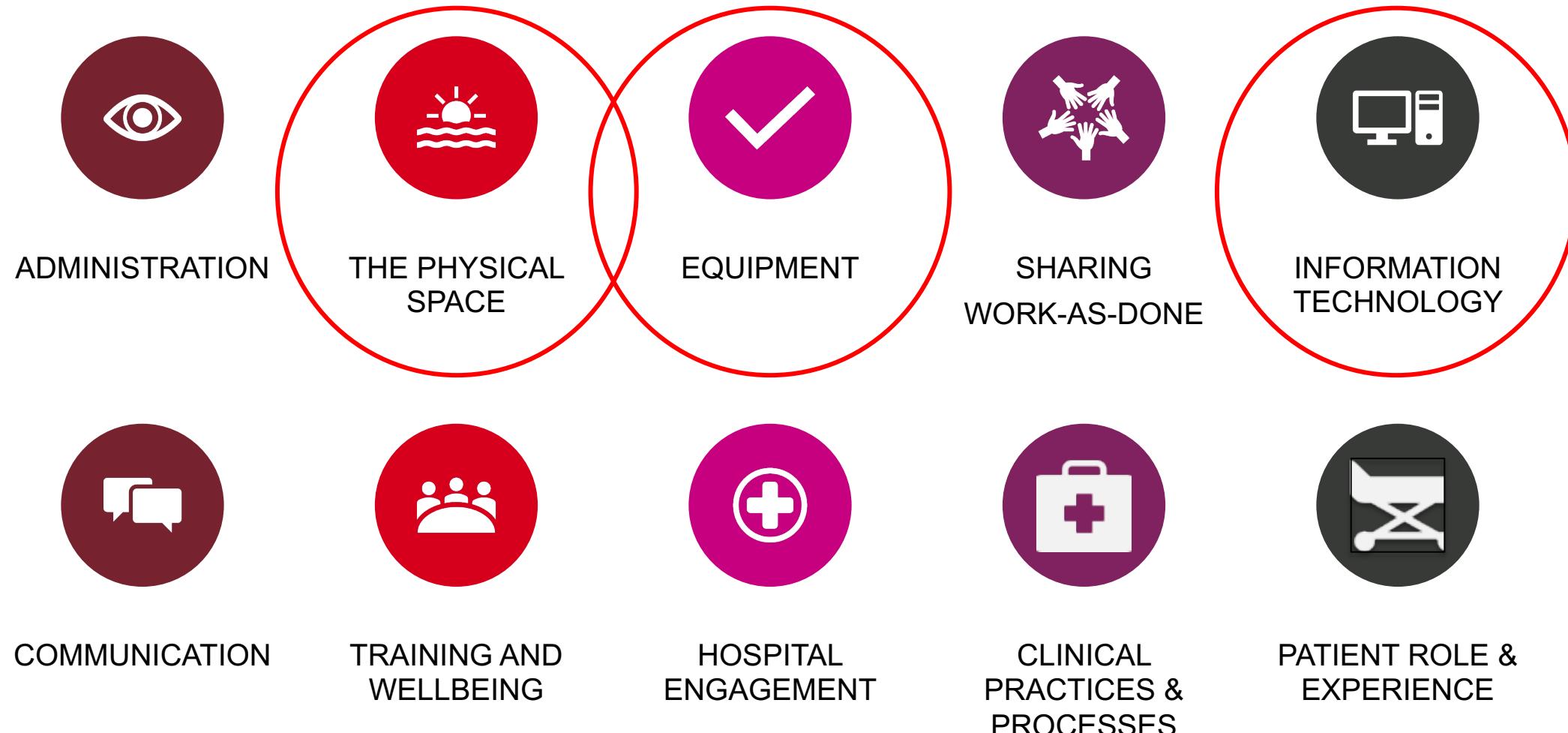
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- Vendors attempt to deliver ICT systems customized for workflow: **e.g. nurse unit manager displays vs. medical displays**
- The one-size-fits-all within the doctor/nurse role is not fit-for-purpose: **does not accommodate individual workflow**
- Current approach to solving problems: **training, reactive approaches**

Example: Admitting a patient **(an ED works in teams!)**



## Potential for improvements: technology, equipment & space



# Fit-for-purpose?

## EMERGENCY DEPARTMENT



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- Technology and equipment is expensive, so resources can be limited: e.g. **ECG/EKG machines, ultrasound machines, wheelchairs**
- Equipment must be mobile so it can be shared, moved to individual patients when needed: **this means equipment might not be easy to locate when needed**
- Current approach to solving problems: **designated parking positions for various equipment, ask staff to return after use**

Example: Accessing the ECG (EKG) machine (ED equipment has multiple users!)



# Usability specification and testing

EMERGENCY DEPARTMENT



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- IT and equipment has pre-defined technical specifications, but not user-defined (functional) specifications. **This means usability typically tested in the workplace during/after implementation**, problems discovered too late.
- Some/increasing use of simulation for testing **but could be better utilised, especially in situ testing pre/post implementation**.
- Current approach is to **train/adjust workflow to meet IT needs rather than vice versa**, low expectations/understanding of what is possible leads to resignation/coping rather than demanding change.



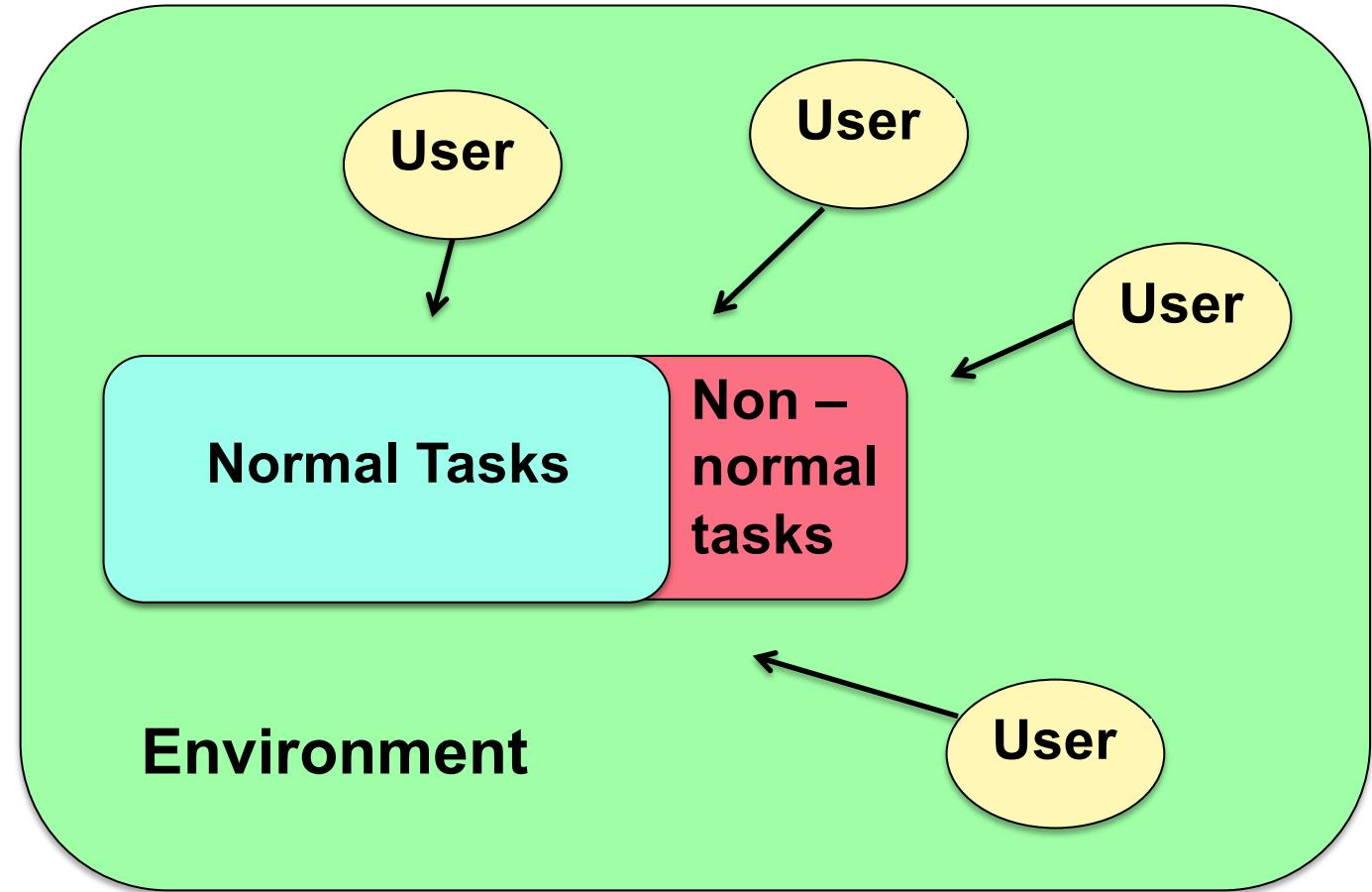
# Specifying user needs

- Currently, the primary focus of usability testing is on **safety**
- We need to move beyond current thinking about usability:
  - Not just **usable**, but **easy to use**
  - We want the user to have **excess cognitive capacity** to perform their work while using the IT
- One way forward is to develop a **functional specification** for new ICT systems to complement the technical specification



# Specifying user needs

- What is the task?
- Who will perform it?
- In what context?
- How do we define success?
  - *Desired* criteria
  - *Adequate* criteria



# Specifying user needs



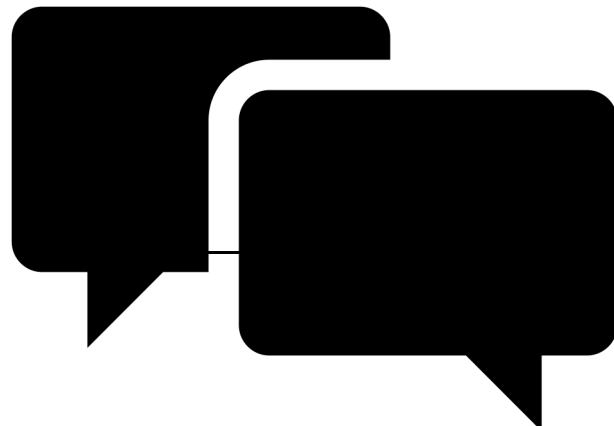
- Three criteria for goals:
  - **clear, quantify performance, testable**
- Badly specified requirements:
  - '[product] must be intuitive to use'
  - '[product] must minimise frequency of user error'
- Good specified requirements (fetal heart monitor example):
  - **'On average, users must be able to resolve the fetal heart rate with +/-1 beat/minute precision'**
  - **'At least 80% users must agree that the monitor cart is easy to manoeuvre'**



# But who is the healthcare provider 'user'?

- A clinician?
- A category of clinician e.g. doctor, nurse or allied health professional?
- A sub-category of clinician e.g. Specialisation?
- Do we consider level of experience?
- Do we consider other demographics factors?
- An individual person? **Expectation from other fields such as genomics and personalised medicine is that we will customise to the individual user**





# Artificial Intelligence (AI) in healthcare

## Increasingly used in healthcare

1. Diagnosis & prediction e.g. image processing for radiology, dermatology
2. Decision support e.g. treatment recommendations, medication management
3. Remote monitoring e.g. wearables
4. Healthcare administration e.g. scheduling, records, data management
5. Robotics e.g. surgery, home support
6. Consumer Apps



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[Health Services Daily](#) NEWS THE SOURCE

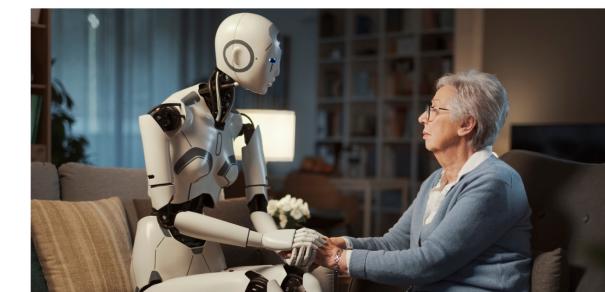
Healthscope leverages AI to improve patient experience

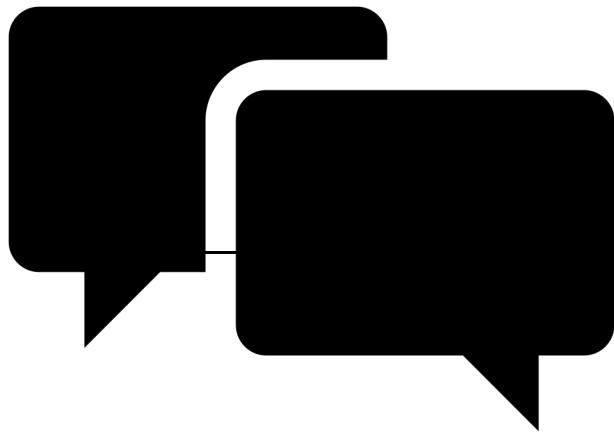
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By  
CHARLOTTE THOU





# Artificial Intelligence (AI) in healthcare



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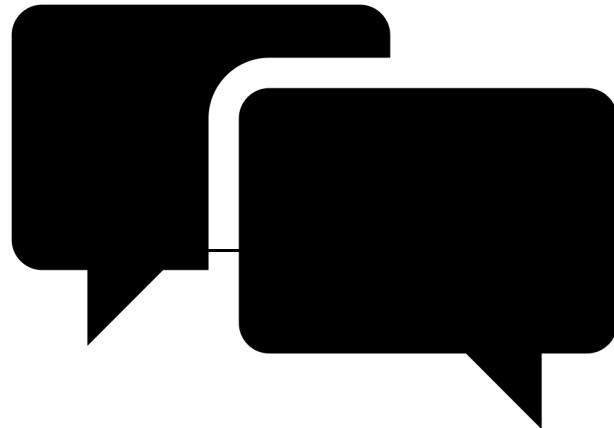
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**Me: What are 5 key concerns with AI in healthcare?**



ChatGPT



# Artificial Intelligence (AI) in healthcare



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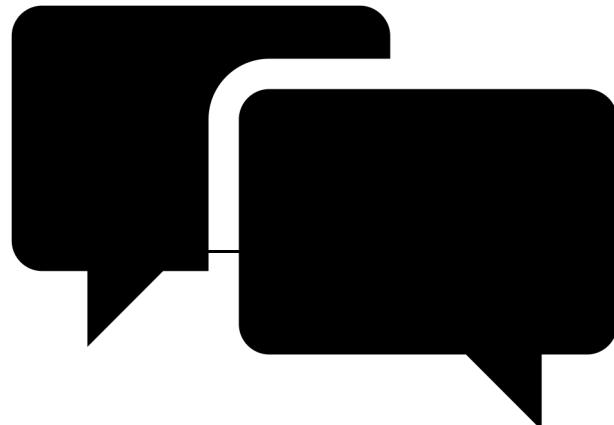
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**Me: What are 5 key concerns with AI in healthcare?**

**ChatGPT:**



- 1. Data privacy & security**
- 2. Bias and fairness**
- 3. Lack of transparency**
- 4. Regulatory and ethical concerns**
- 5. Integration issues**



# Artificial Intelligence (AI) in healthcare



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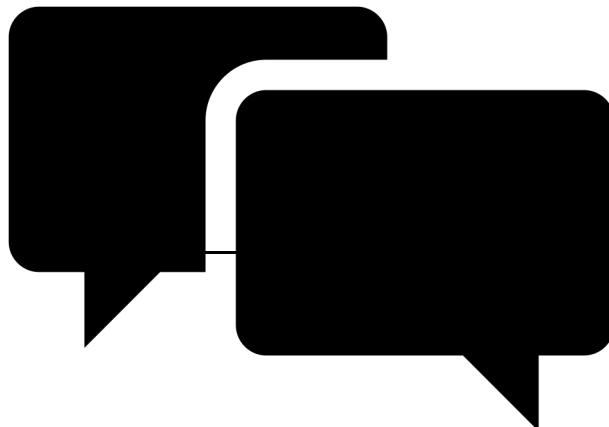
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**Me: What are 5 key issues with AI in healthcare?**

**ChatGPT:**

- 
1. Data privacy & security (**consent, storage**)
  2. Bias and fairness (**representation of demographic groups in models**)
  3. Lack of transparency (**algorithms are a 'black box'**)
  4. Regulatory and ethical concerns (**accuracy: sensitivity & specificity**)
  5. Integration issues (**see point 3.**)



# Artificial Intelligence (AI) in healthcare



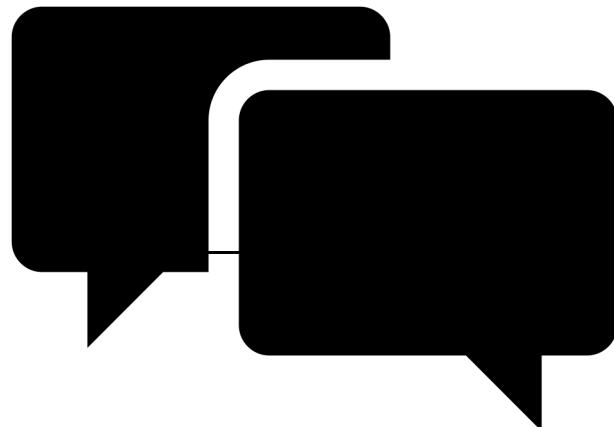
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**Me: Produce a picture of a hospital Emergency Department**





# Artificial Intelligence (AI) in healthcare



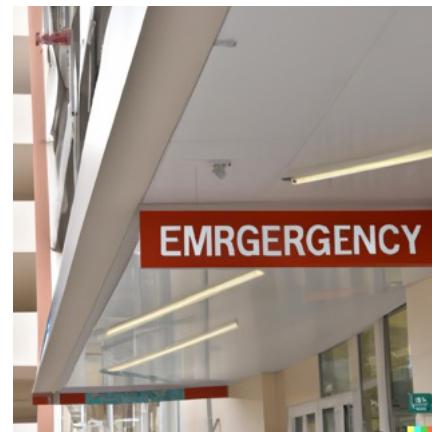
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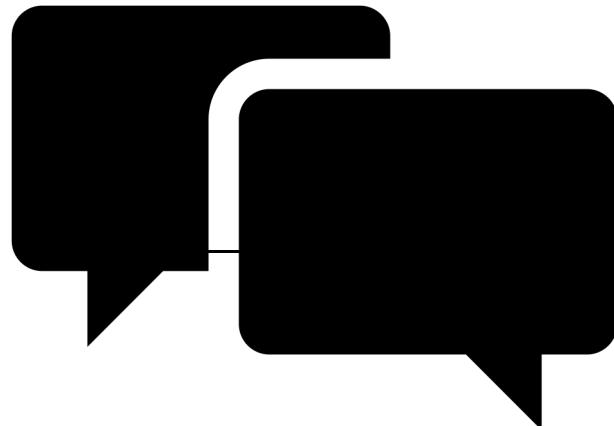
**Me: Produce a picture of a hospital Emergency Department**



**Dall-E:**



“LLM’s generate responses that can appear authoritative and plausible to an end user; however, these responses may be completely incorrect or contain serious errors” – *World Health Organization*



# Artificial Intelligence (AI) in healthcare



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## How can human factors help?

AI needs to be:

- \* Fit for purpose
- \* Intuitive to use

We need to use the same human factors approach to design and evaluation that we use for other technology

“caution that would normally be exercised for any new technology is not being exercised consistently with LLMs” – *World Health Organization*



# Thank you

Via AIHI: [biy.ly/3h5zjLu](https://biy.ly/3h5zjLu)

Contact:

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**A HUMAN FACTORS RESOURCE**  
for Health Professionals and Health Services Staff



# Thank you

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