Complex socio-technical systems and ergonomics

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and
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Sociotechnical systems and ergonomics

- Human factors and Ergonomics
- What do we mean by socio-technical systems
- Some current thinking
- What we learn from other sectors
- Some tools and approaches
- What should we be thinking about

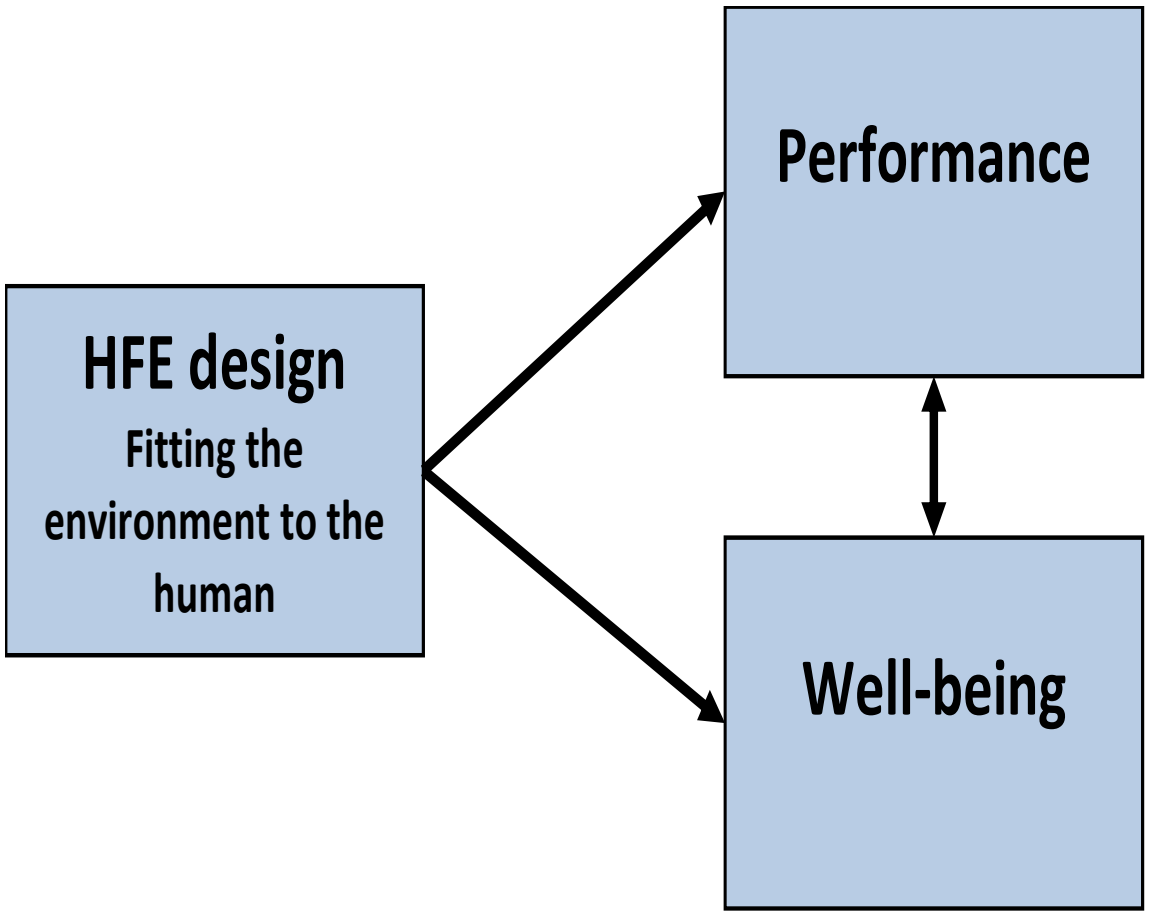
Ergonomics = Human Factors

Dul, J., Bruder, R., Buckle, P., Carayon, P., Falzon, P., Marras, W.S., Wilson, J.R. & Doelen, B. van der (2012). A strategy for Human Factors/Ergonomics: Developing the discipline and profession. Ergonomics, 55(4), 377-395.

Defined by the International Ergonomics Association (2000):

"Ergonomics (or human factors) is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to optimize human well-being and overall system performance."

Human factors/ergonomics (HFE) is the only discipline that seeks to optimise ***both*** performance and well-being



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Features of systems ergonomics (1)

- *Focus on the human-machine, human-human-machine or socio-technical system*
- *Awareness of context and its influence – decisions on boundaries of system of interest, and parent-child systems or systems of systems*
- *Focus on the interactions, and on the integration of the interacting elements*

Adapted from: Wilson, J Fundamentals of systems ergonomics IEA 2012, Recife, February 2012

Features of systems ergonomics (2)

- *Holism – see the inputs as physical, mental/cognitive, social and emotional, and the outputs as well-being and performance*

- *Emergence – recognition of emergent properties and that complex systems in real use change in ways not expected or planned for (for good or ill)*

Adapted from: Wilson, J Fundamentals of systems ergonomics IEA 2012, Recife, February 2012

Sociotechnical systems and ergonomics

Sociotechnical systems as a focus for safety

- Design
- Risk assessing
- Solutions

Sociotechnical factors are at the foundation of nearly all forms of contemporary human activity

- Education
- Healthcare
- Entertainment
- Social media

Sociotechnical system – history

- The concept of the sociotechnical system originated with the insights of Tavistock Institute early 1950s e.g. coal mines
- Re-emerged in the 1980s
- Cognitive systems engineering (Hollnagel & Woods, 1983; Rasmussen, Pejtersen & Goodstein, 1994)
- Macroergonomics (Hendrick, 1984)
- Human-systems integration
- Resilience engineering (Hollnagel, Woods & Leveson, 2006)
- System theoretic accident model and processes (STAMP) approach (Leveson, 2012)

Complexity

- Sociotechnical systems are formally *complex* in that their associated phenomena can have multiple causes and consequences that are highly context dependent, difficult to predict and which frequently emerge from dynamic, non-linear relationships among system components.

Interactions

- The idea of a sociotechnical system is that the conditions for successful organizational performance – and conversely also for unsuccessful performance – are created by the interaction between social and technical factors" (Hollnagel, 2009, p.19)

Traditional Reductionist Approaches

- Common to sociotechnical perspectives is the view that traditional, reductionist approaches to the investigation of work systems will generally only account for a small amount of the “variance” in factors impacting safe and effective performance.

Root causes and human error

- Historical tendency of researchers and accident investigators to search for and identify “root causes” of workplace incidents and disasters, i.e., one or more discrete casual factors to which the occurrence of an accident can be attributed. Leveson (2012)

- While this bias commonly results in the flawed attribution of cause to “human error”

- And precludes examination of the less immediately apparent, more diffuse influences of systemic, sociotechnical factors.

Historical tendency of human factors and ergonomics (HFE) researchers to limit the scope of their work to phenomena that can be carefully controlled in the classical experimental sense.

This generally precludes the ability to examine phenomena within the context of larger sociotechnical settings within which the influences of critical social and technical factors exert their influence

Joint optimisation

- Optimal system performance can only be achieved through sustained attention to the design and operation of relevant social and technical sub-systems and processes

- The performance of “local” systems or processes is seen as being continuously impacted by and, in turn, continuously impacting the activities of progressively larger and more diffuse systems.

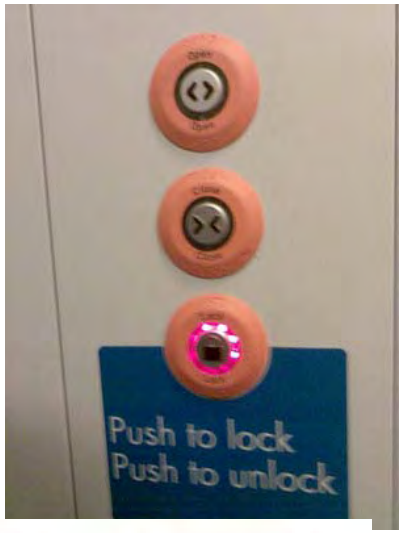
Emergent properties

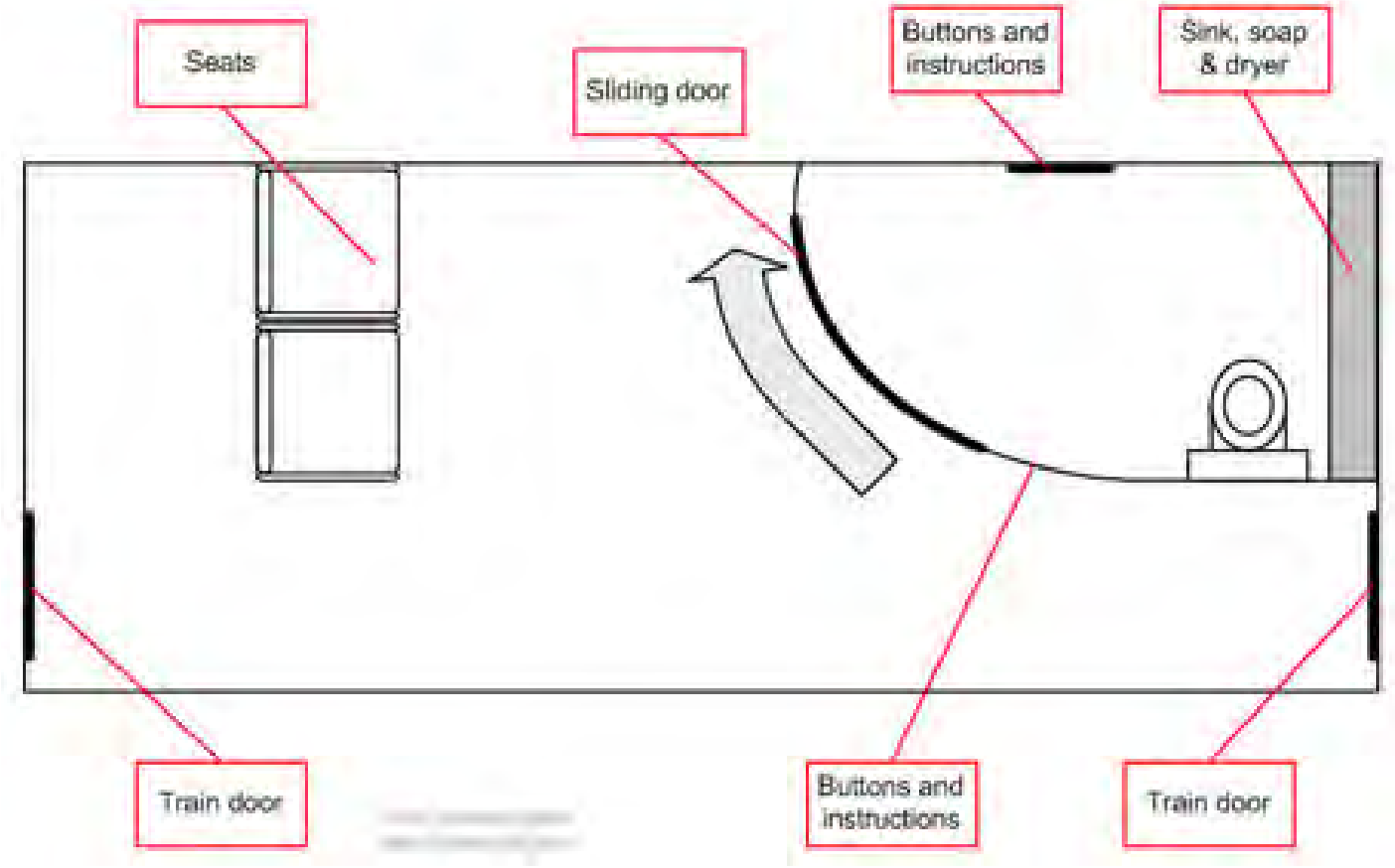
"the arising of novel and coherent structures, patterns and properties during the process of self-organization in complex systems"

Goldstein (1999)

So what does all this mean for safety and ergonomics?

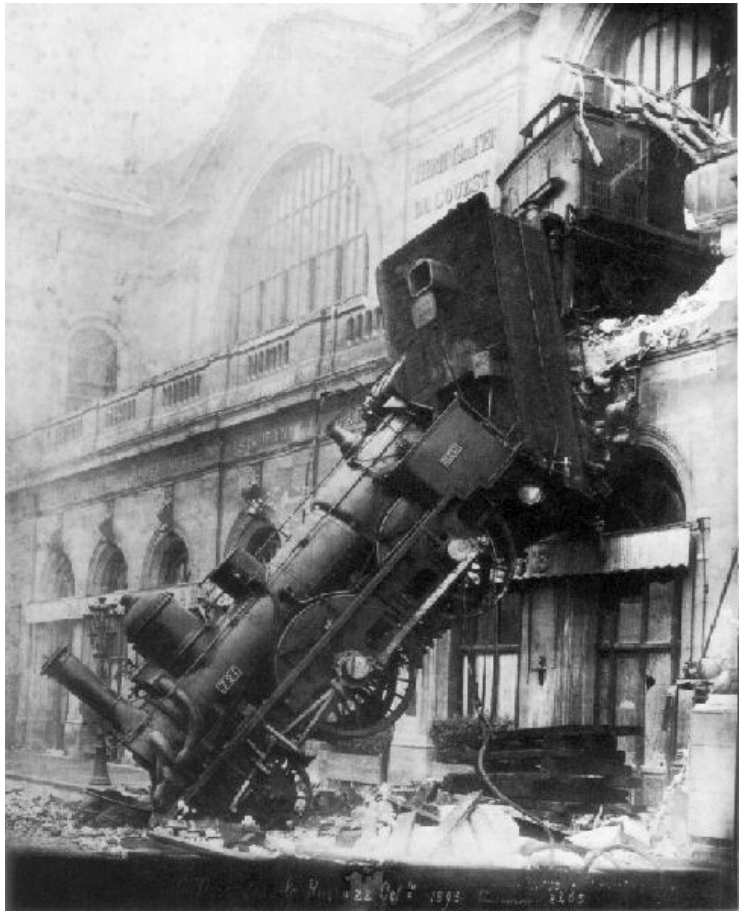
Controls and Displays





Complex systems and ergonomics

Gare Montparnasse, Paris
October 22, 1895



Train departed on time

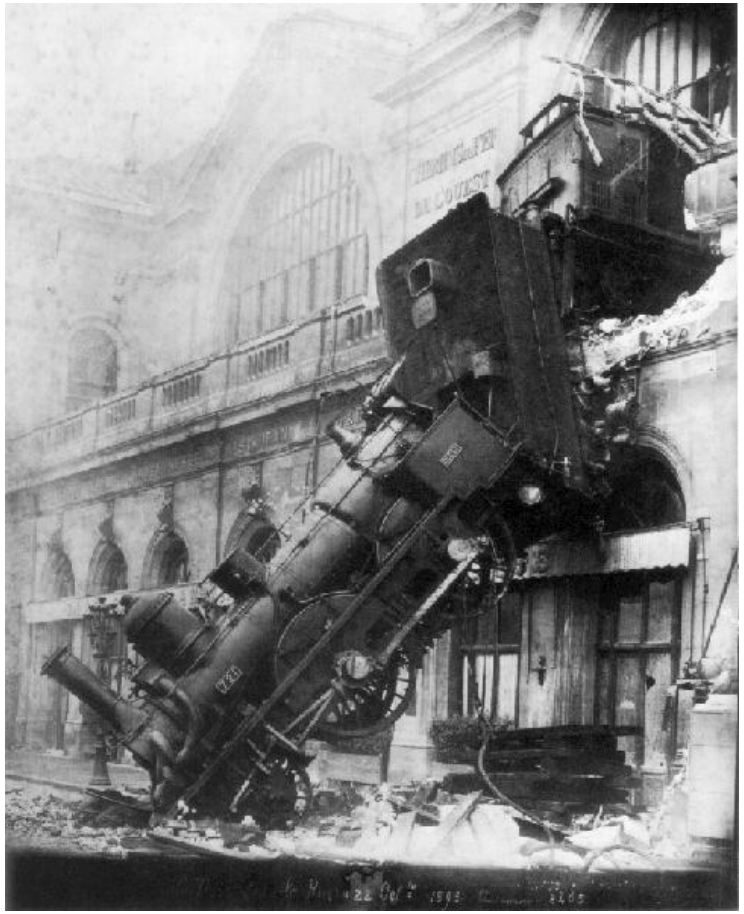
Driven by Guillaume-Marie Pellerin, a 19-year railroad man.

Pellerin found the train running several minutes late.

In an attempt to make up time, Pellerin approached Gare Montparnasse in Paris at cruising speed

Required him to utilize the Westinghouse (air) brake to safely bring the train to a stop.

Gare Montparnasse
Paris
October 22, 1895

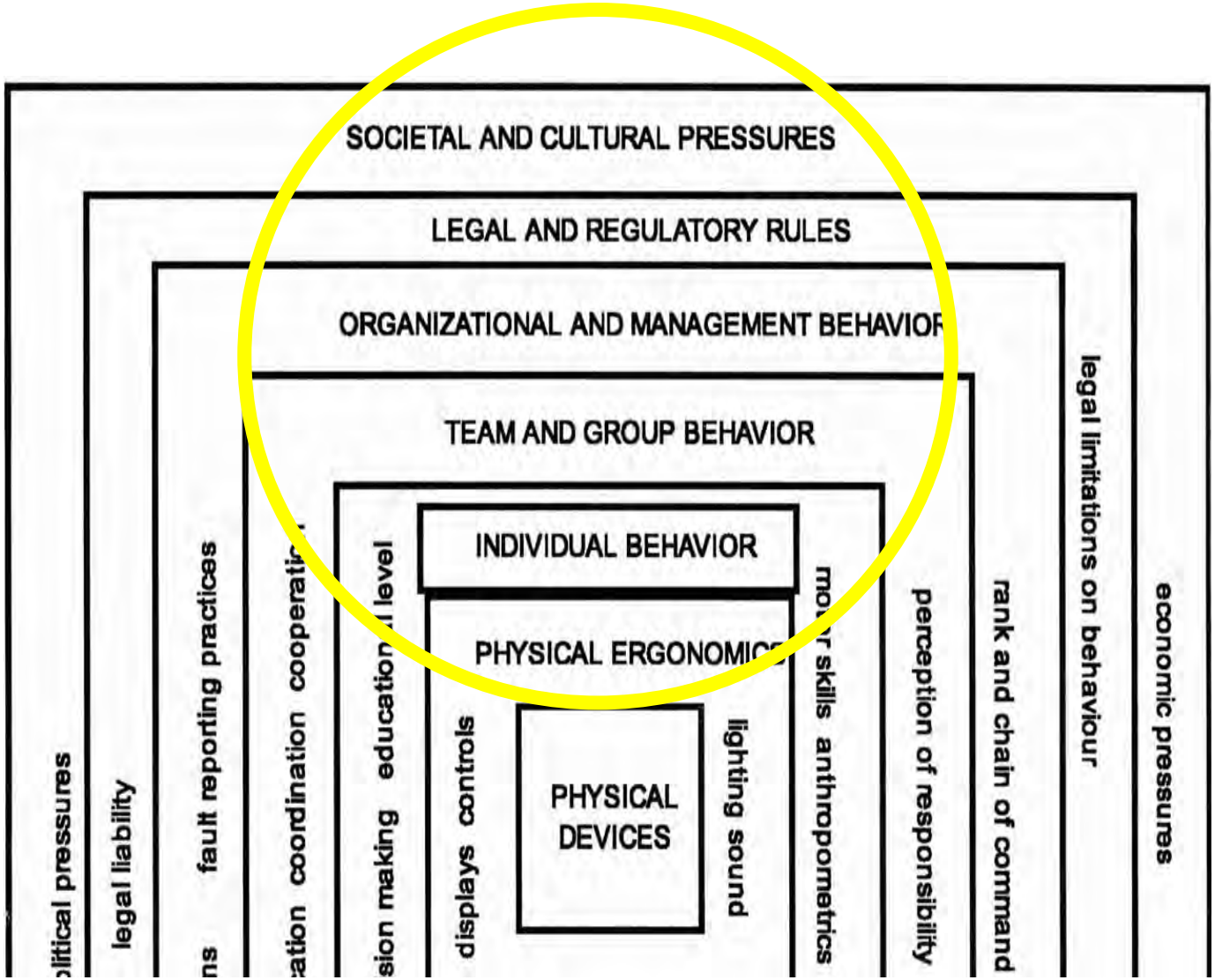


When the Westinghouse brake failed, the locomotive brakes were insufficient

Conductor Albert Mariette was pre-occupied by paperwork during the train's approach to the station

He made no attempt to apply the hand brake until just before the Express crashed through the buffer stop.

Understanding the system

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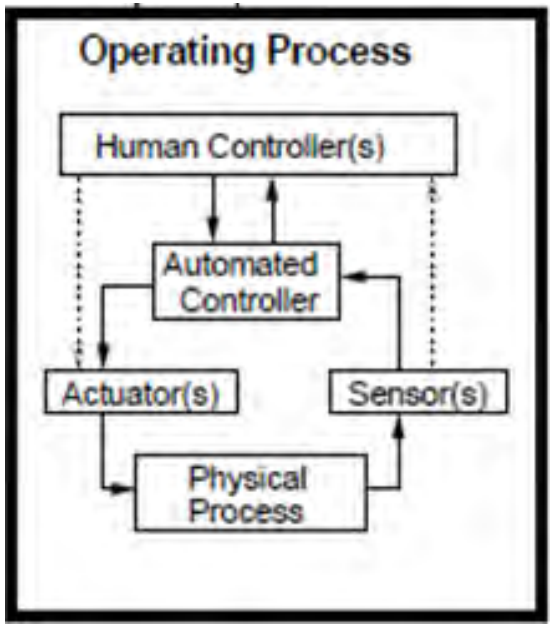
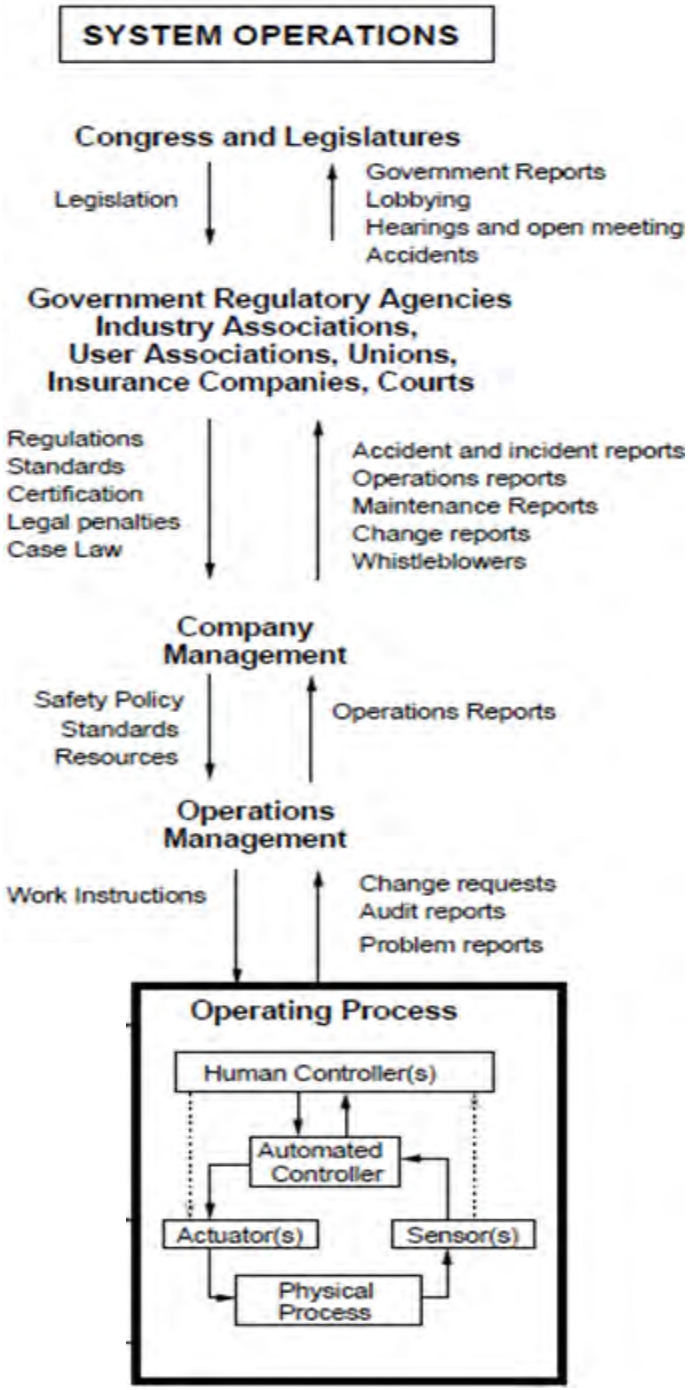
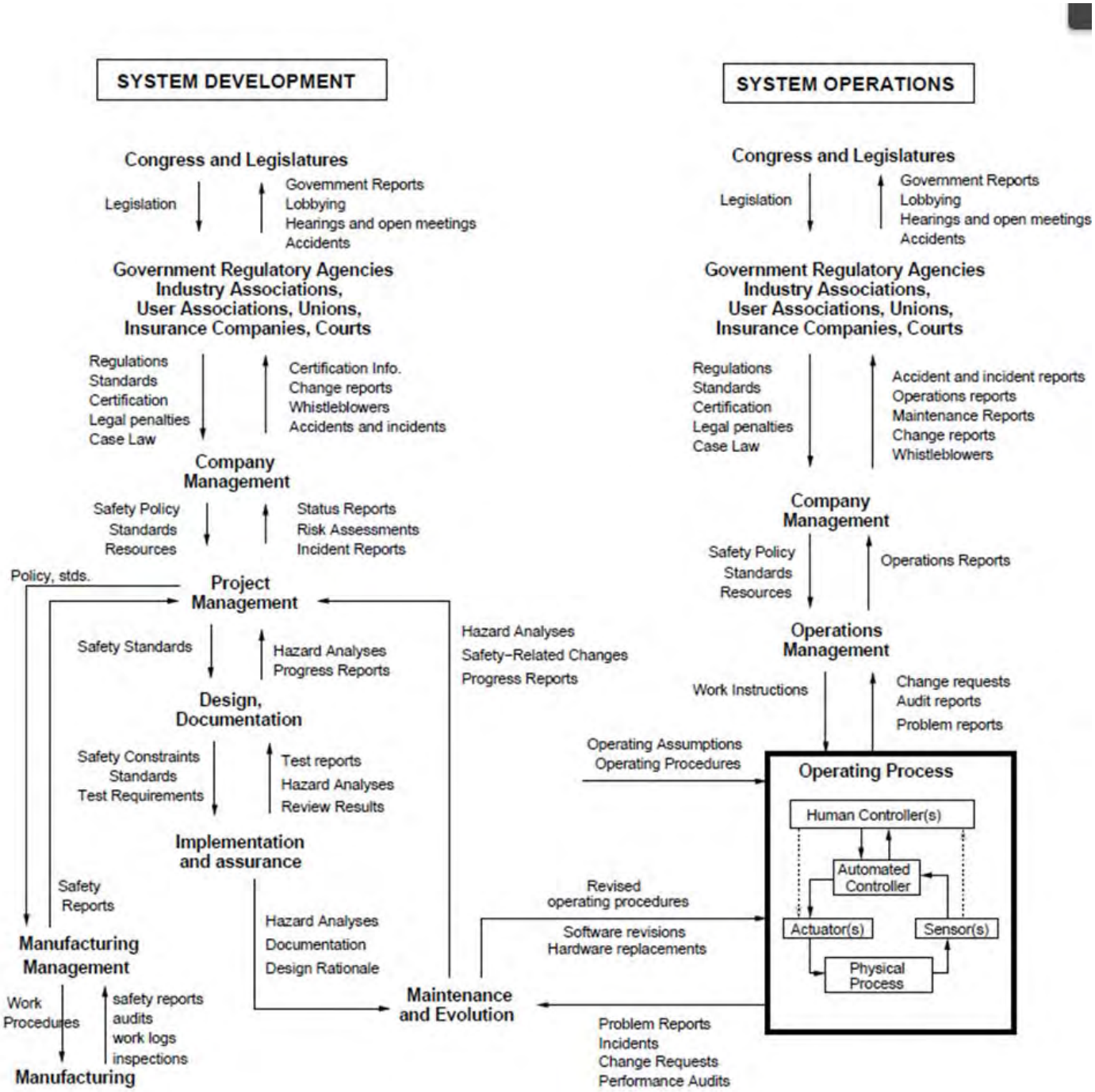

Operating Process
Human Controller(s)
Automated Controller
Actuator(s)
Sensor(s)
Physical Process


SYSTEM OPERATIONS
Congress and Legislatures
Legislation
Government Reports
Lobbying
Hearings and open meeting
Accidents
Government Regulatory Agencies
Industry Associations,
User Associations, Unions,
Insurance Companies, Courts
Regulations
Standards
Certification
Legal penalties
Case Law
Accident and incident reports
Operations reports
Maintenance Reports
Change reports
Whistleblowers
Company
Management
Safety Policy
Standards
Resources
Operations Reports
Operations
Management
Work Instructions
Change requests
Audit reports
Problem reports
Operating Process
Human Controller(s)
Automated
Controller
Actuator(s)
Sensor(s)
Physical
Process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Project
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Hazard Analyses
Progress Reports
Design,
Documentation
Safety Constraints
Standards
Test Requirements
Test reports
Hazard Analyses
Review Results
Implementation
and assurance
Safety
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Physical
Process
Revised
operating procedures
Software revisions
Hardware replacements
Problem Reports
Incidents
Change Requests
Performance Audits

Human error caused Sedgwick County election results confusion

- August 07, 2012|by Kim Hynes | KWCH 12 Eyewitness News

- (SEDGWICK COUNTY, Kan.) — All of the votes in Sedgwick County have been counted. Election Commissioner Tabitha Lehman says they took their time She says there was a lot of confusion because initially someone checked the wrong box on the computer. By doing that, the election website showed that a majority of precincts reported when in fact only advanced votes had been tallied.
- The computer program would not let Lehman correct the mistake, so all night it showed the wrong precincts reporting. She says after that happened, they took their time and double checked everything before posting new results. All votes had been tallied by 11:15 Tuesday night.

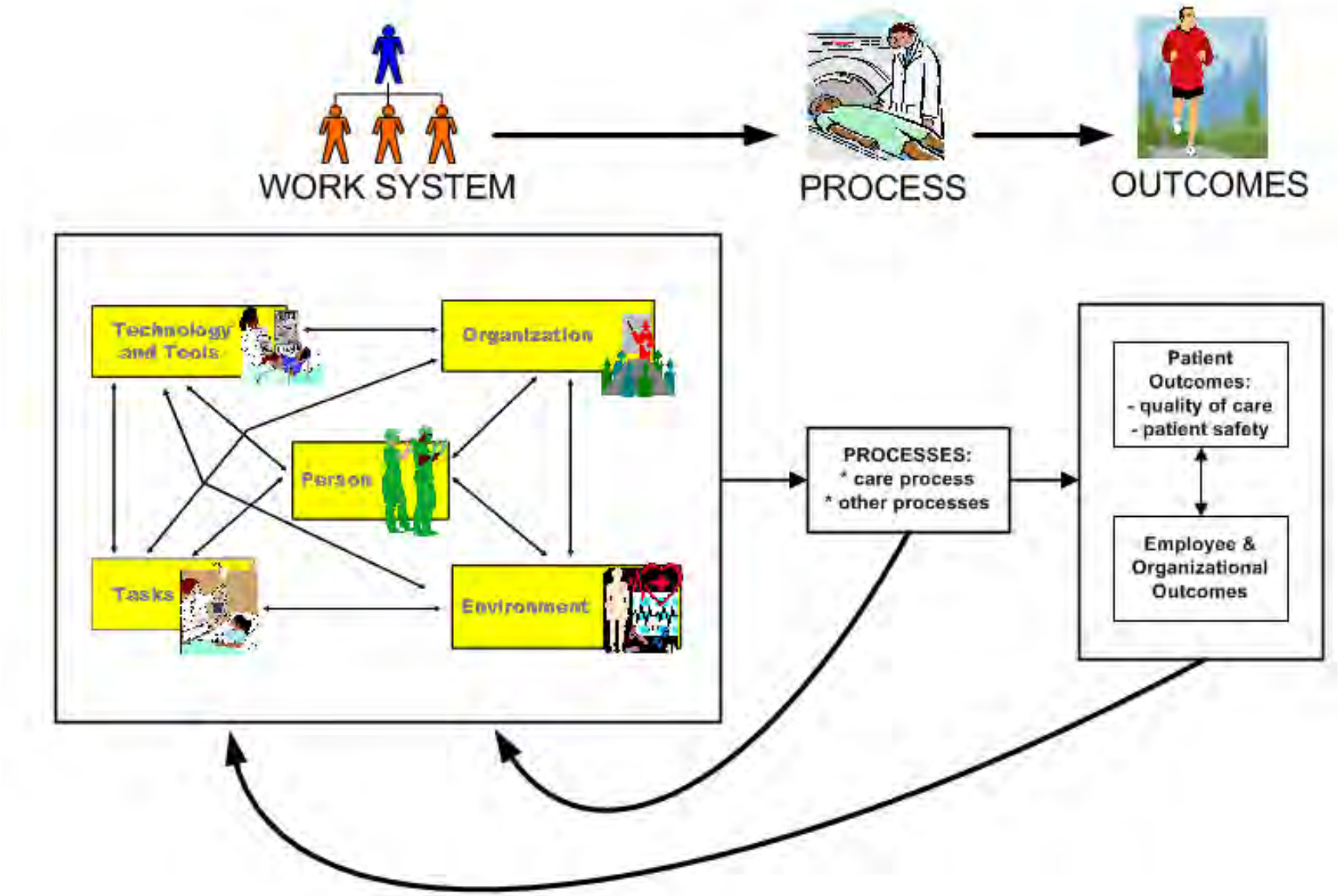
- Lehman says this is her first complicated election and she's had a steep learning curve. She says they will review what happened, but that it had nothing to do with the computer system it was simply human error.

Fukushima Daiichi

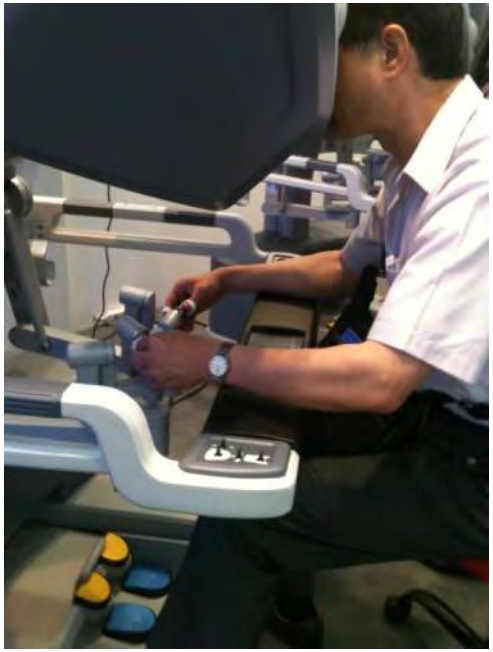
- The accident at the Fukushima Daiichi nuclear power plant was a man-made disaster caused by poor regulation and collusion between the government, the operator and the industry's watchdog, a report has said.

- The commission's chairman, Kiyoshi Kurokawa, a professor emeritus at Tokyo University: What must be admitted – very painfully – is that this was a disaster 'Made in Japan.' Its fundamental causes are to be found in the ingrained conventions of Japanese culture: our reflexive obedience; our reluctance to question authority; our devotion to 'sticking with the programme'; our groupism; and our insularity.

Conceptual model for Socio-technical models in ergonomics: applied to Health (Carayon et al, 2006)



Physical



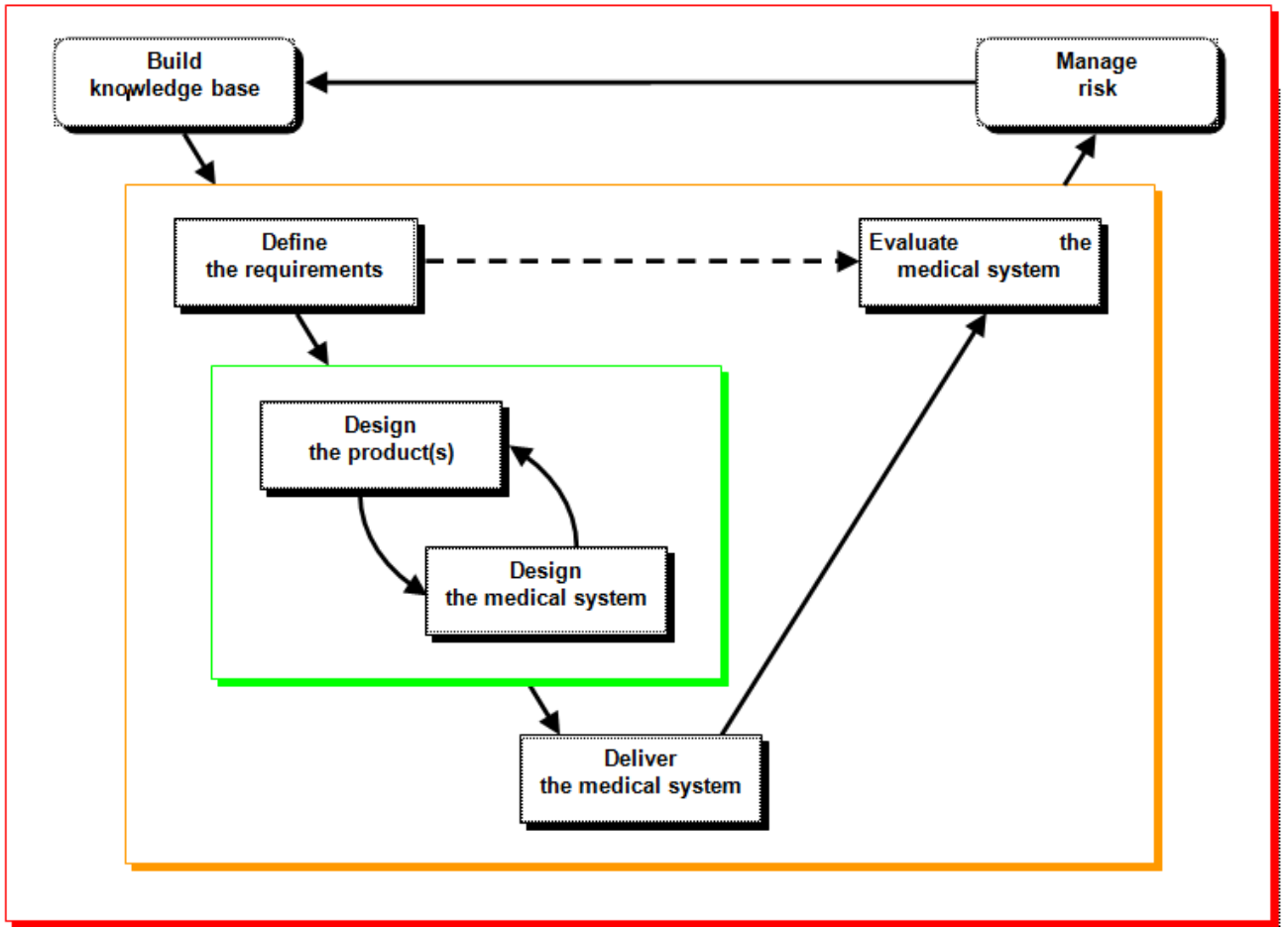
Physical and Cognitive

Physical, cognitive and organisational

Physical, cognitive and organisational

Organisational

Systems approaches to Design




Prospective Hazard Analysis Toolkit
Edited by:
John Clarkson
James Ward
Peter Buckle
Jon Berman
Draft v0.9

•System mapping approaches

•Some of the common system mapping approaches include:

•Task diagrams describe a hierarchy of operations (tasks) and plans (necessary conditions to undertake these operations);

•Information diagrams describe a hierarchy of information and/or material (things) used or needed in physical or electronic form;

•Organisational diagrams describe a hierarchy of people and/or roles within single or multiple organisations;

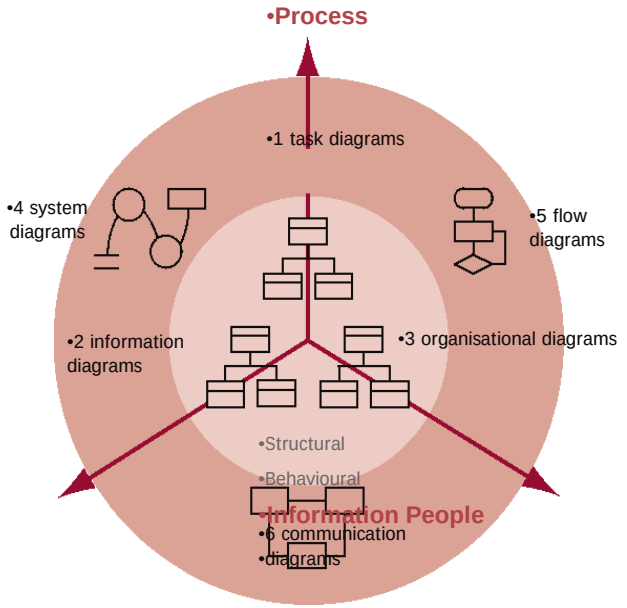
•System diagrams represent how data (or objects) are transformed through activities, where such data are stored, and how such activities are sequenced;

•Flow diagrams, which include traditional flow charts, and swim-lane diagrams, represent activities occurring in sequence or in parallel;

•Communication diagrams represent information and material flows between people (stakeholders) linked by some common process.

•This is by no means an exhaustive list. There are other mapping approaches that also are capable of providing insight into the operation of a system.

•Identify the broad type of mapping required, noting the methods most closely associated with this objective. Use of more than one method may be necessary to complete the system description.

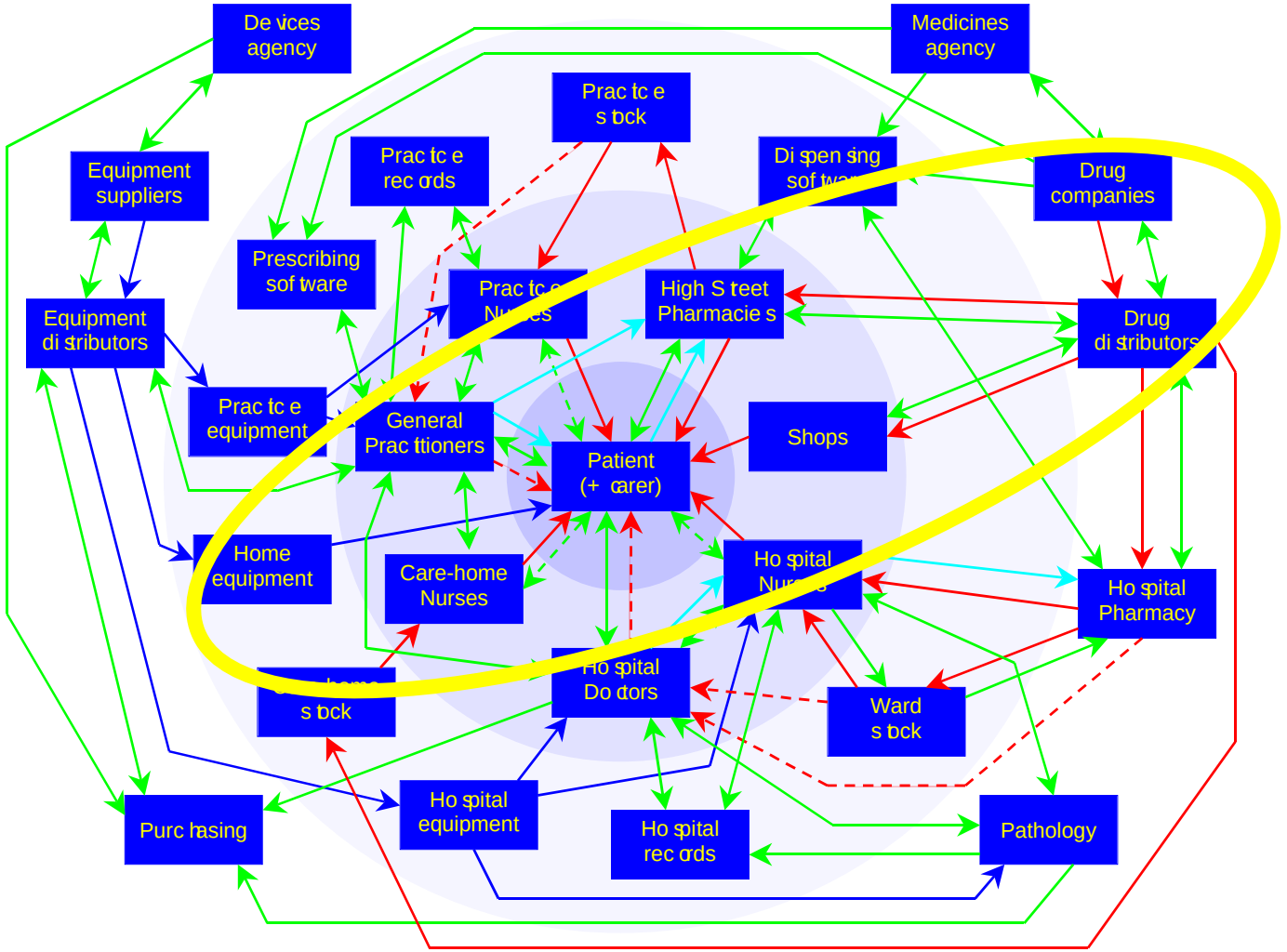


•System mapping approaches focus on one or more of the people, process or information perspectives

•System Mapping Approaches

Mapping Systems:

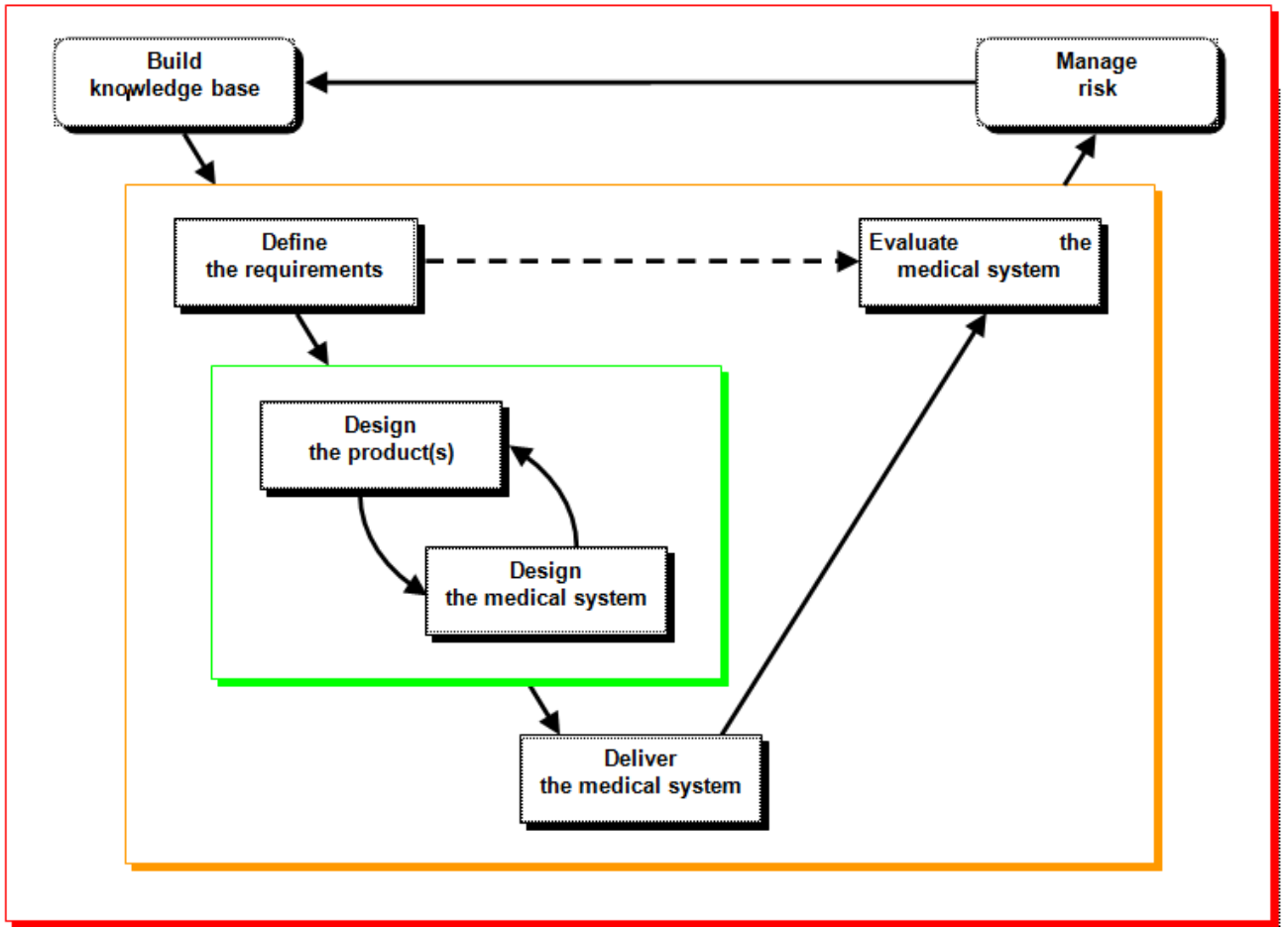
What are you looking at? And what are you not looking at?



Assessing risk

Characteristics of interest \ Risk assessment approach	1.SWIFT	2.HAZOP	1.Influence diagram	1.Barrier analysis	1.FMEA	1.HEART	1.APJ	1.Event tree	1.Fault tree	1. Risk matrix
Hazard identification	✓	✓	✓		✓					
Risk identification		✓	✓	✓	✓	✓	✓			
Existing barrier identification		✓	✓	✓	✓	✓		✓	✓	
Required barrier identification			✓	✓	✓	✓		✓	✓	
Risk prioritisation					✓	✓	✓	✓	✓	
Risk communication					✓	✓	✓	✓	✓	✓

Systems approaches to Design



Systems approaches to Solution finding

Build a knowledge base

- *Problem analysis and systems definition*
- *Participatory approach with relevant stakeholders*
- *Informed by risk assessments*

Develop design requirements

Systems approaches to Solution finding

Design the Product

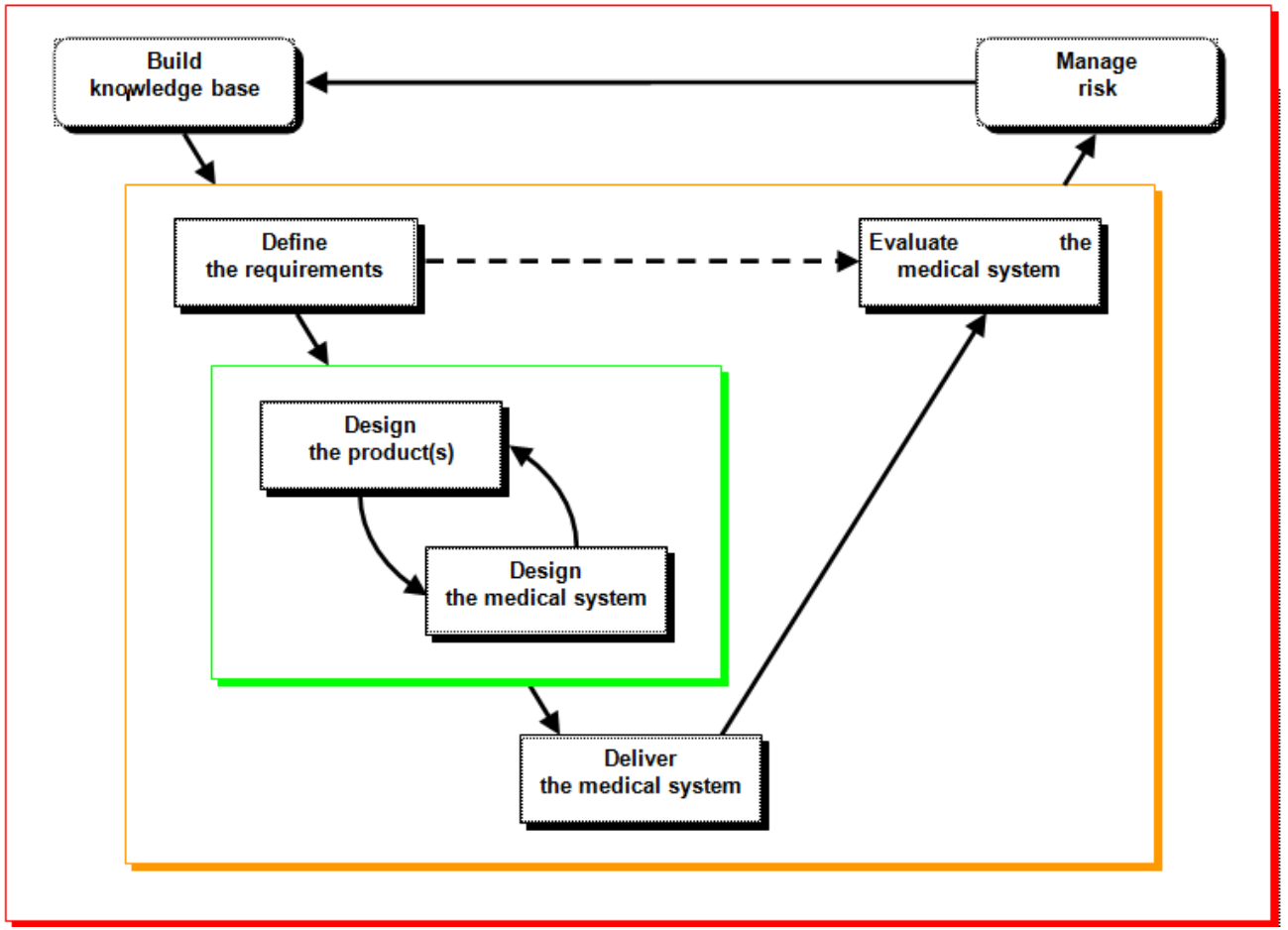
- *Creativity stimulation and idea generation*
- *Idea generation and concept development*

Evaluate

- *Concept evaluation*
- *Ongoing systematic evaluation (mindful of the fact that complex systems in real use change in ways not expected or planned for)*
- *Dissemination*

Ongoing surveillance and risk assessment

Systems approaches to Design



Sociotechnical systems and ergonomics

- Human factors and Ergonomics
- What do we mean by socio-technical systems
- Some current thinking
- What we learn from other sectors
- Some tools and approaches
- What should we be thinking about

What should we be thinking about

- What are we assuming about the state of our current systems?
- What does emergence look like? And how would we recognise it?
- How can we check where we are at?
- And finally, how can we avoid……..

“Errors have been made. Others will be blamed.”

Thank you

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