Modeling the human role in operational systems

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2 European projects

- TATEM - the design of new aircraft 'health monitoring' technologies
  - TCD role - developing human requirements for future technologies
- HILAS - learning from operational performance in flight operations & maintenance to improve aviation systems and technologies
  - TCD is co-ordinating HILAS - 4 years, 40 partners, 15 countries
- TATEM & HILAS are supported by the European Commission 6th framework programme

Humans in systems integration

System stage	Human role	Development focus
No automation	Humans manage technology and system interfaces	Core technologies

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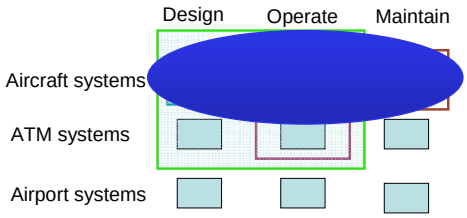
Integrated system design - 'system of systems'	Information systems link people and technologies in seamless processes crossing boundaries	Complex systems deliver operability for customer and society

System integration in aviation



Models of 'humans in the system'

Level of model	What does the model produce?	Operational functions enabled	Design functions enabled
Descriptive classification of human factors	Factors which potentially affect performance	Taxonomies for incident analysis, performance reports	Checklist for design support

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Analytic model of human operator	How 'human factors' affect performance	Analyse & diagnose problems and events	Evaluate HMI from user perspective

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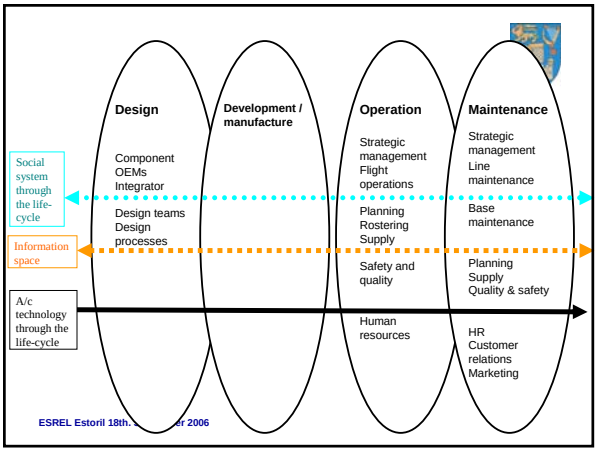
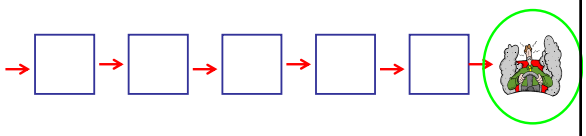
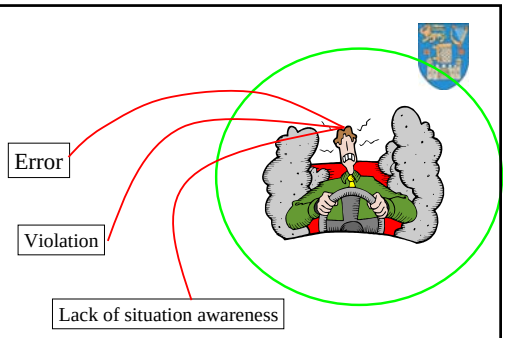
Analytic model of human			Evaluate HMI
of system			concepts



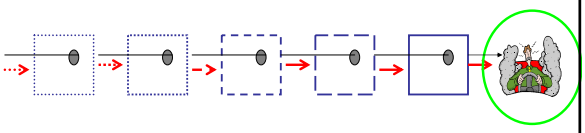
Process and performance





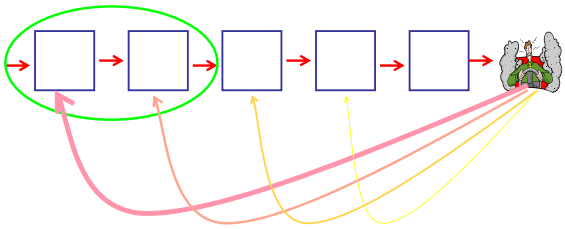
Problems of intentionality

'Swiss cheese' - post-hoc reconstruction



More leverage upstream

Re-design requires understanding system-performance links at each stage



Beyond human error

- 'Traditional' error theory (eg Reason) has an internally consistent error typology, but..
- How to access intentions?
- What is the situation (of which people are aware) in which intentions are formed?
- How do errors relate to 'the system'? Can one identify a 'latent failure' before it occurs?

The inherent ambiguity of error

- Two common definitions of error:
  - Failure of intention
  - System malfunction
- This ambiguity reflects a confusion between the ***results*** and the ***consequences*** of action (conflation fallacy)
- The consequences of an action (for a system) are the product of its ***results*** and the ***context*** in which it occurred.

What is a social (/technical) system?

- Normative regularities of social action
- Ambiguity of *norms*
  - What should be done
  - What normally is done
- In social systems with important consequences (eg aviation)
  - Relations of power determine what ought to be done - the *official* system
  - The contingencies of situated action determine what *is* done
  - The regularities of situated action create the *real* system

The 'new view' of error

- The radical discovery of LOSA* et al.
  - *LOSA - Line Operations Safety Audit
  - Errors and violations are 'normal'
    - Normal violation? --- contradiction?
  - The envelope of acceptable action varies according to threat and demand (situation/context)
- There is a dynamic interaction between action, system and context
  - To understand this interaction each term needs first to be understood independently.
- Let us consider the operational system….

Operational systems - the principle of relevance

- Reality of social systems - compelling force
  - Although imperfectly known
- Prioritising operational processes
  - Functional sequence linking input to outcome
- Other social processes may facilitate or inhibit operational processes
- Principle of relevance
  - Purpose of enquiry
  - Stakeholder interests

'Causal structure' of operational processes

Technology driven	•Process transformation is done by technology •People monitor and control the process	Process industries

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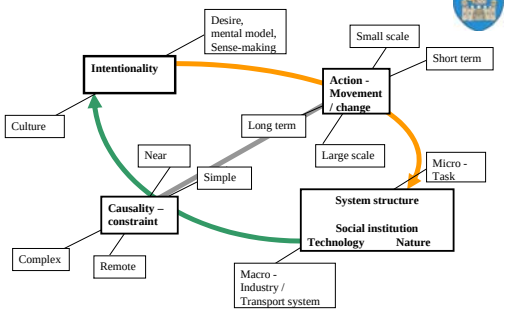
Technology driven	•Process transformation is done by technology •People monitor and control the process	Process industries
People & technology	•People directly control technologies in process of transformation •Varying degrees of automation	Flight operations
People driven	•People operate on technology in discrete tasks co-ordinated by people •Information technology can support this co-ordination	Aircraft maintenance

Critical sources of 'process strain'

	Base maintenance	Line maintenance & dispatch	Approach and landing
Preconditions for initiating process	**1**	**2**	**3**
Parallel dependencies between tasks	**2**	**1**	**2**
Internal task dynamics	**3**	**3**	**1**

Social & technical systems

- The social system, organised as a set of operational processes, is what links people to technology in a functional way
- The operational system is not equivalent to a set of procedures
- The social system operates in between the set of HMIs which interface people & technology
- How to model this complex socio-technical system?



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QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.

Basic organising principles

- Operational processes
  - Functional/causal structure that sustains outputs
  - Integration of actions of humans & technology
  - Structure of local & remote dependencies defines critical path
- Social processes complement operational processes
  - Co-ordination mechanisms
  - Task and team structure
  - Quality of relationships - e.g. trust
- Information space
  - Co-ordination of action
  - Leverage of resources
  - Integrates social and technology systems
  - Can transform critical dependencies

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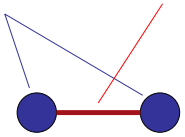
Identifying leverage - the critical path

- Elements
  - Actions of people, tools and technologies in the process
- Relations
  - Causal structure of operational process



Leverage suggests where and how to intervene to redesign, change or improve the system

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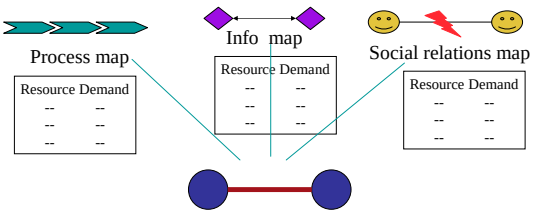

The probability of successful transformation along a process is a function of the critical path and the resource demand balance (material, information and human) at each step

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Challenges

- For systems engineering
  - How to develop Human Factors / Organisation Theory as an integrated core discipline for design & management of complex systems
- For human & organisational factors
  - How to better address the material and social reality of operational systems