Human Factors: Methods of an Applied Science

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Presentation Overview

This presentation will:

- Review the shared origins of Murphy's Law and Human Factors;
- Discuss the implications of Human Factors as an Applied Science;
- Introduce Human Factors Methods; and
- Reflect on the wisdom of canned tuna

"It is found that **anything that can go wrong at sea generally does go wrong sooner or later**, so it is not to be wondered that owners prefer the safe to the scientific. It is also found that it is as bad to have too many parts as too few… Sufficient stress can hardly be laid on the advantages of simplicity. The **human factor** cannot be safely neglected in planning machinery. If attention is to be obtained, the engine must be such that the engineer will be disposed to attend to it."

Alfred Holt, 1877

Holt's Safety Insights:

1. We require defences against all possible risks;

   "…anything that can go wrong at sea generally does go wrong…"

2. Innovation must consider safety;

   "… owners prefer the safe to the scientific…"

3. Safety requires reducing system complexity;

   "… Sufficient stress can hardly be laid on the advantages of simplicity…"

4. Safety requires accommodating the human factor.

   "The **human factor** cannot be safely neglected in planning machinery."

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Holt's Safety Insights:

1. We require defences against all possible risks;

   How do we identify possible risks?

2. Innovation must consider safety;

   How can we demonstrate an innovation is safe?

3. Safety requires reducing system complexity;

   How do we reduce complexity whilst complying with the first insight?

4. Safety requires accommodating the human factor.

   What known human factors constraints are relevant?

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Human Factors

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

International Ergonomics Association, 2000

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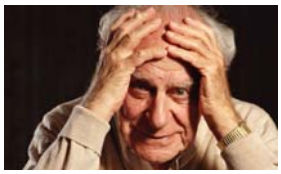
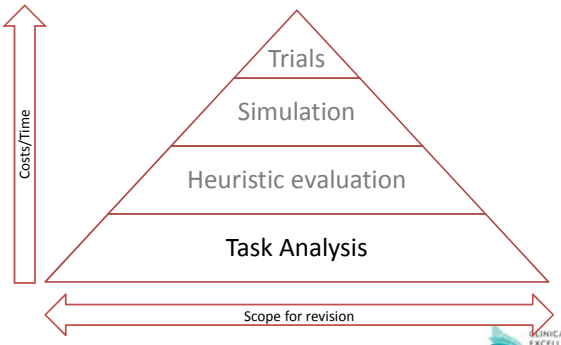
An applied science approach

- Based on real-world **observations**
- Aims to **explain** the world as-it-is
- Uses testable ideas (**falsifiable**)
- Must be **tested**



Karl Popper: "In so far as a scientific statement speaks about reality, it must be falsifiable: and in so far as it is not falsifiable, it does not speak about reality".

Human Factors Methods



Task Analysis

- Information gathering to understand how staff **actually perform work** tasks to achieve **their intended goals**.
- Work-as-imagined vs work-as-done
- Budget Task Analysis vs Cognitive Task Analysis

Task Analysis

- Often used for:
  - Identifying training requirements (KSA's)
  - Identifying design constraints
  - Redesigning processes
  - Estimating workload
  - Evaluating staffing requirements

10

Information Gathering Techniques

- **Observations (with think-aloud protocol)**
- **Critical Decision Method**
- **Time and Motion Studies**
- **Surveys and Questionnaires**

11

Observations with Think-Aloud

12

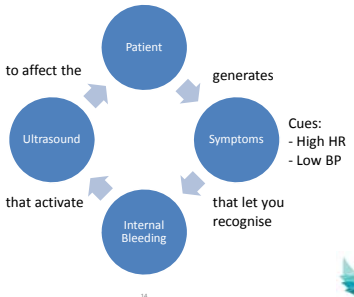
Critical Decision Method

- Semi-structured interviewing approach:
  1. SME asked to describe a *critical incident;*
  2. Develop a timeline;
  3. Identify critical decisions; and
  4. Decision-point probing – identifying key cues, goals, *sensemaking* process

13

Critical Decision Method Output

- Anaesthetist decision-making



14

Time and Motion Studies

1. Break tasks into small, simple steps;
2. Observe completion of steps to identify redundancy or wasteful effort;
3. Measure time taken for each step.

- Predates *Cognitive* Task Analysis - does not capture the workers *experience* or *decision-making processes*.
- Can provide an objective baseline of performance for empirical before/after studies.

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15

Surveys and Questionnaires

- Confirm the accuracy of the findings/ interpretations of the task analysis.
- Determine *generalizability* of the findings to other facilities.
- Determine user preferences/biases.

16

Explaining "work-as-done"

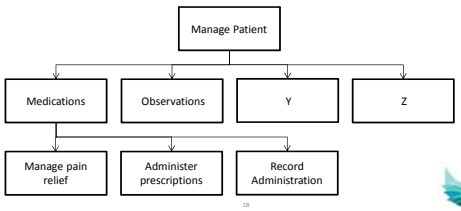
Task Analysis Outputs:

- Task Hierarchies
- Workflow diagrams
- Timelines and maps

17

Task Hierarchies

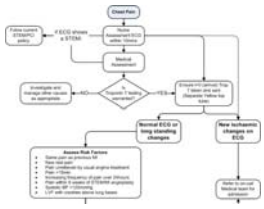
- Break higher-level goals into their component lower level tasks
- Usually a starting point for further analyses (i.e. what tasks do I need to map out)



18

Workflow diagrams

- Captures sequence of tasks and critical decision points
  - **Can directly inform layout/sequence of forms, pathways, checklists and interfaces**
  - **Identify dependencies**



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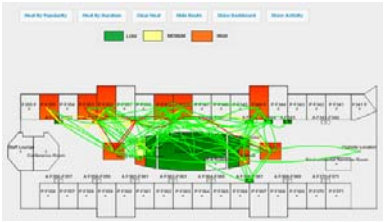
19

Timelines and maps

- Tell us where and when tasks occur. This is useful for:
  - Process redesign
  - Designing the layout of physical environments

Where should we place sinks if we want doctors to wash hands between patients?



Task Analysis Summary

- Effective Task analysis:
  - Should provide a clearer sense of the root cause of a problem;
  - Reveal opportunities for simplification; and/or
  - **Make it easier to predict the flow-on effect of a proposed change.**

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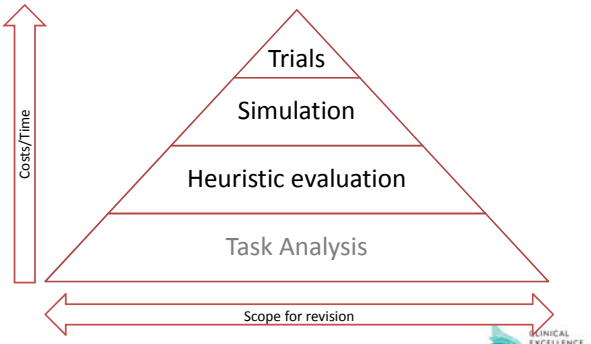
Human Factors Methods



Human Factors Evaluation

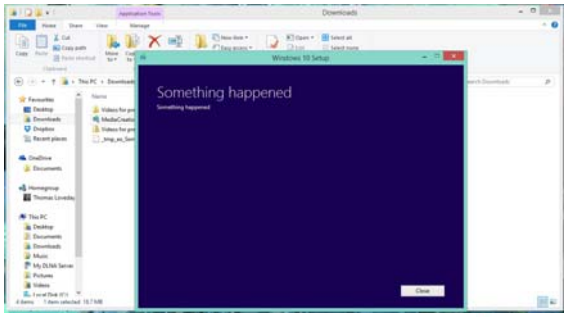
Heuristic Evaluation:

- Evaluators examine an interface for consistency with usability principles.
- Should involve 3+ evaluators
- Several heuristic rulesets for different purposes:
  - **Interfaces** (Nielsen, 1995) – 10 criteria
  - **Devices** (Zhang et al, 2004) – 14 criteria
  - **Observation Charts** (Preece et al, 2013) – 7 criteria, 50+ sub-criteria

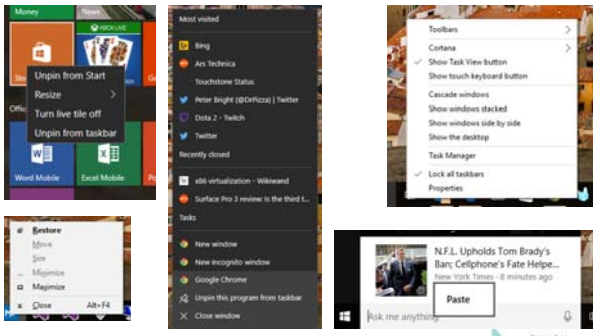
Nielsen's Heuristics

- Visibility of system status
- Match between system and the real world
- User control and freedom
- Consistency and standards
- Error prevention
- Recognition rather than recall
- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Help users recognize, diagnose, and recover from errors
- Help and documentation

Diagnose and recover from errors



Consistency and Standards



Heuristic Evaluation

Advantages:

- Cheap
- Fast
- Requires minimal training

Disadvantages:

- Requires extensive experience to do well
- Not specific
- **Subjective – not truly empirical**
- **No user input/involvement**

Maintaining Empiricism

Empirical evaluation requires:

- **Hypothesis:** Must identify key performance measures and expected trends in advance;
- **Control:** Must be able to control for extraneous variables;
- **Significance:** statistical vs practical.

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Empirical Point of Care Trials

Best practice:

- Between-within design
  - Requires multiple matched sites for each condition; AND
  - Pre-post comparisons.
- Quantitative metrics (i.e. time to complete, error count)

Reality:

- Meaningful quantitative measures may not exist.
- May not encounter full spectrum of relevant cases.
- Failing a POC trial is an expensive lesson.

∴ Best used as a final validation.

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Simulation-based evaluation

Benefits:

- Avoids exposing patients to risk.
- Can observe rare events.
- Experimental control.
- Scales well – low fidelity simulation often viable.

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Case Study: Risk Assessment

- **Goal:** Develop decision-matrix to improve clinician judgments about **X.**
- **Hypothesis:** Clinicians judgments about cases would be better with tool than without.
- **Between-subject design:** Present clinicians with 6 matched patient histories.
  - Grp 1: No Matrix
  - Grp 2: Matrix.

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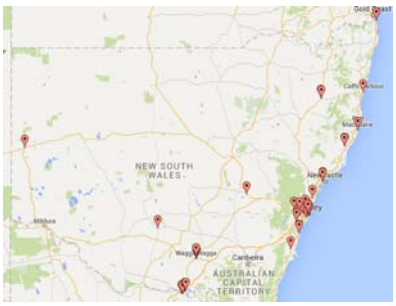
Simulation in NSW Health



NSW Health Simulation Facilities

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Usability testing

- A form of simulation-based evaluation - it is a **systematic evaluation** under **controlled conditions.**
- Focused on identifying impediments to *"ease of use*" and goal completion by testing it on real users.
- Can incorporate both qualitative and quantitative techniques

What happens in a usability test?

- Usually involves asking participants to think-aloud while completing '**scenarios**' which encompass key interactions with:
  - Software
  - Hardware
  - Processes
  - Environment
  - Other people

Who gets tested?

- As few as five 'users' can reveal most issues (>90%), as long as they are representative of the types of people who will use your solution
- Should be **real**, **current** users

Why usability test?

- It is exceedingly difficult to predict what a first-time user of a design/intervention/ solution will experience
- Provides more detailed information regarding impediments to ease of use than other evaluation methods

Case Study: SurgiNet

- **Aim:** Get Surgical Residents to document level of supervision during procedures.
- **Intervention:** Addition of questions regarding supervision in SurgiNet.
- **Expectation:** Increased reporting of supervision practices during surgery.
- **Evaluation Method:** Usability Testing

Case Study: SurgiNet

- **Example Scenario:**

  "You performed a laparoscopy for penetrating trauma under the supervision of Dr X who is in the operating suite writing up notes. You completed the surgery with no complications. Complete the operation report in SurgiNet."

- **Findings:**

  100% of users tested did not complete the supervision questions because they did not discover the fields.

Canned Tuna

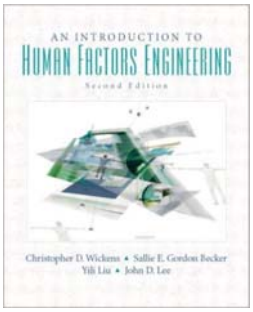
The Wisdom of John West

- Alfred Holt:
  > "It is also found that it is as bad to have too many parts as too few… Sufficient stress can hardly be laid on the advantages of simplicity."
- Healthcare workers are overloaded.
- 'Effective' safety interventions may not do enough to justify the additional workload.
- Fewer, more effective interventions are required.

Summary

- Human Factors is a Science.
- Task Analysis can be used to determine work-as-done.
- An empirical approach to evaluation is critical.
- Simulation can be done on the cheap.
- We must only retain the best 'tuna'.

If you'd like to learn more…



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"A general "law of least effort" applies to cognitive as well as physical exertion. The law asserts that if there are several ways of achieving the same goal, people will eventually gravitate to the least demanding course of action. In the economy of action, effort is a cost, and the acquisition of skill is driven by the balance of benefits and costs. Laziness is built deep into our nature."

Daniel Kahneman, Thinking, Fast and Slow

For further information:

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