Functional Allocation to Balance the Requirements of Humans and Automation

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❑ **Introduction to Allocation of Function**

❑ **Evidence of impact of automation on behaviour**

❑ **Description of an AoF tool that considers the degree of automation.**

Allocation of Function

- ❑ **Fitts List (1951)**
  - 6 things humans could do best and 5 that machines could do best
  - Updated as MABA - MABA Lists
  - Although these were guidance not methods, they became a *de facto* method in the UK

- ❑ **Price (1985)**
  - Interesting theoretical treatment, but provided limited practical guidance

- ❑ **Proprietary Methods**.

Human-centred Automation

❑ Human-centred automation facilitates a cooperative relationship
  NOT: Operator or automation?
  BUT: How much automated support does operator need?

❑ Degree of Automation can be divided into:
- Information acquisition
- Information analysis
- Decision-making
- Action

❑ Concerns if Decision-making and Action are both fully automated, because this provides no opportunity for error trapping.

Why does Some Automation Fail?

❑ Too much attention to building and demonstrating, rather than obtaining valid scientific conclusions

❑ Automation is seldom supported by an adequate Task Analysis to identify issues and potential error modes.

Direct Impact of Automation

❑ **Brittle Automation**

- Automation only operates safely within boundary conditions
- *Automation Paradox*: Automation is often least reliable when it is most needed

❑ **Automation Surprises**

- First public demonstration of fly by wire plane, it flew low over runway, when pilot tried to ascend, software prevented increase in engines

❑ **Automation-induced Decision Bias**

- Partially reliable diagnostic aids accepted even when conflicting with directly visible evidence

❑ **Motherhood and Apple Pie**

- Automated reminders of the obvious can be irritating and distracting.

Indirect Impact of Automation

❑ **Trust**
- When system identified potential threats operators found more of these, but missed more important threats

❑ **Vigilance**
- Overall vigilance can be reduced by automating one monitoring/vigilance task

❑ **Situational Awareness**
- Operators scan displays much less with automation
- When alarms automatically returned to normal, operators unaware that they had occurred
- Reduced monitoring of automated systems can leave operators unaware of the state of plant after an automation failure
- Actively selecting actions supports situational awareness.

Golden Rules for Automating Safety Critical Functions

❑   Whenever there is the potential for an automated system to implement an action which could have immediate life threatening consequences, this action **MUST** require confirmation by a human operator

❑   Where a rapid response is needed which will **reliably** place the system in a safer condition, an automated response is acceptable, provided that there are clear cues to the operators that this has occurred

❑   Avoid systems that will prevent human interaction in the event of an automation failure

Allow these to be broken at your peril.

Degree of Automation

1. Human acts without any computer assistance
2. Computer offers complete set of decisions and/or actions
3. Computer executes its suggestion, but only if human approves
4. Computer allows human limited time to veto before automatic execution
5. Computer executes automatically then informs human
6. Computer only informs human if asked
7. Computer executes autonomously and ignores human

Tool to Balance Interaction Between Operators and Automation: Principles

1. Automation should only be used in ways that support operators to undertake their tasks safely and effectively. Therefore, the tool must focus on:
   - Safety-critical tasks, particularly emergency procedures
   - Common operational tasks that are stressful or time consuming
2. For these tasks the constituent subtasks will be identified and examined separately
3. The tool will propose the maximum and minimum levels of operator involvement for each sub task using the *Degree of Automation* rating scale, where 1 is complete operator involvement and 7 is maximum automation
4. The proposed default situation will be to adopt the degree of automation associated with maximum operator involvement.

How the Tool Will be Used

❑ **Initial Task Analysis**
- Undertake a high-level task analysis to identify safety-critical tasks and common stressful operational tasks
- Where possible, collect further information about these tasks from operator experience feedback and discussions with operators

❑ **Detailed Task Analyses**
- Undertake task analyses of the identified tasks, at a level sufficient to identify the significant subtasks

❑ **Complete Degree of Automation Questionnaire**
- Obtain ratings of the degree of automation for each subtask from comparison with a set of statements in a questionnaire.

Sample Rating Scale Question

Degree of Automation
Min   Max

Could the required action have immediate
   life threatening consequences?   **1   3**

- If the statement is true, record the minimum and maximum values for the degree of automation
- If for another true statement the minimum degree of automation is higher, then this replaces the previous value
- Similarly, the maximum value is replaced if this is lower than that previously recorded.

Implementation

- The tool will identify the range of operator-automation options that would avoid the most serious impacts of inappropriate automation, whilst balancing requirements such as workload, situational awareness and vigilance

Dynamic AoF
- Varies the amount of automated support dependent upon workload or other factors
- Default condition is to adopt the degree of automation that involves the most operator involvement
- If necessary, give more automated support, which can be implemented either automatically or if selected by an operator.

Further Development of the Tool

- The statements proposed for the degree of automation questionnaire will be given to human factors specialists with process control experience
- They will be asked to rate the minimum and maximum levels of automated support for each statement, first for solely monitoring tasks
- This will be repeated for control tasks, cognitive tasks and combinations
- The ratings and descriptions will then be revised as necessary.

Thanks

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risk analysis

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