SHELL Model

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HP Activity Categories:
Design of working environment and human-machine interfaces [1]

Model

Abstract:

The ICAO SHELL Model is a conceptual framework proposed in ICAO Circular 216-AN31. One practical diagram to illustrate this conceptual model uses blocks to represent the different components of human factors. This building block diagram does not cover the interfaces which are outside human factors (hardware-hardware; hardware-environment; software-hardware) and is only intended as a basic aid to understanding human factors.

References

Developer and source:

The concept (the name being derived from the initial letters of its components, Software, Hardware, Environment, Liveware) was first developed by Edwards in 1972, with a modified diagram to illustrate the model developed by Hawkins in 1975.

Hawkins (1993) modified Edwards' model to include the interactive nature of the person to person relationship (Liveware-Liveware) and called it SHELL.


Year of development / publication, updates etc:

1972, 1975, 1993

General Description

Purpose:

The SHELL model is a conceptual model of human factors that clarifies the scope of aviation human factors and assists in understanding the human factor relationships between aviation system resources/environment (the flying subsystem) and the human component in the aviation system (the human subsystem). The SHELL model adopts a systems perspective that suggests the human is rarely, if ever, the sole cause of an accident. The systems perspective considers a variety of contextual and task-related factors that interact with the human operator within the aviation system to affect operator performance.
As a result, the SHELL model considers both active and latent failures in the aviation system. Each component of the SHELL model (software, hardware, environment, liveware) represents a building block of human factors studies within aviation (International Civil Aviation Organization, 1993). The human element or worker of interest is at the centre or hub of the SHELL model that represents the modern air transportation system.

**Technical description of method or tool etc**

**Description of the content/study:**

The SHELL Model is a practical diagram using blocks, to represent the different components of human factors. The building block diagram does not cover the interfaces which are outside human factors (hardware-hardware; hardware-environment; software-hardware) and is only intended as a basic aid to understanding human factors:

**Software** - (The interface between people and software) The rules, procedures, written documents etc., which are part of the standard operating procedures.

**Hardware** - (The interface between people and hardware) The Air Traffic Control suites, their configuration, controls and surfaces, displays and functional systems.

**Environment** - (The interface between people and the environment) The situation in which the L-H-S system must function, the social and economic climate as well as the natural environment.

**Liveware** - (the interface between people and other people) The human beings - the controller with other controllers, flight crews, engineers and maintenance personnel, management and administration people - within in the system.

The model has the form of a plus-sign (+), consisting of 5 blocks, each with one letter of SHELL in it, with one of the ?L?-s in the middle. A connection between blocks indicates an interconnection between the two elements. The match or mismatch of the blocks (interconnection) is just as important as the characteristics described by the blocks themselves.

It is recommended to:

- Disseminate the findings of the present study to airlines, air service providers, regulators, pilot and controller organizations (unions).
- Conduct a comprehensive literature study on air-ground communication errors.
- Study communications occurrences related to data link problems.
- Analyze the use of similar call signs based e.g. timetable data, in order to identify those specific call signs used by airlines that cause confusion.
- Prepare information packages on risks and (new) mitigating measures for pilots and controllers regarding air-ground communication.
- Relate ICAO DOC 4444 r/t SARPS to occurrences, to check whether the currently prescribed mitigating measures in the r/t system are still adequately covering all hazards.
- Investigate radio communication between ground controllers and taxiing aircraft in greater detail (e.g. use of non-standard r/t because controller often has to explain in plain language what a/c should do, aircraft not all painted in company colours anymore, new means of pointing out a/c to other pilots necessary, tower designators are sometimes difficult to follow, many conditional instructions, etc.).
Technical requirements for using the method, tool, etc:

n/a

Measure/Response Type:

n/a

Results obtained and interpretation:

In this model the match or mismatch of the blocks (interface) is just as important as the characteristics of the blocks themselves. A mismatch can be a source of human error.

**Evaluation**

Advantages:

Useful in giving a visual sense of how elements of these systems interact and affect one another and in creating an awareness of how these factors influence one's decision making process. It is useful to reduce errors and prevent accidents and incidents.

Disadvantages:

This building block diagram does not cover the interfaces which are outside human factors (hardware-hardware; hardware-environment; software-hardware) and is only intended as a basic aid to understanding human factors.

Alternative Methods:

Pear Model (a mnemonic model used to recall the four considerations for assessing and mitigating human factors in aviation maintenance)

ADREP 2000, (based on the SHELL model).

Human Factors Case (Eurocontrol)

**Usability (ease of use, efficiency, effectiveness)**

Ease of use:

high

Efficiency:

high

Effectiveness:

high

Constraints concerning conditions of use:

The tool can be used if a reference scenario exists to compare it to the solution scenario.

Reliability:

n/a

Validity:
Required effort (to conduct & to analyse):

n/a

Level of HF expertise needed (required user qualification)

High: high level of expertise required, only for experts, lots of training required
Other expertise needed (required user qualification):

Human factors specialist

Cost Information

Very low: (<100 €) low costs to purchase or free license, no special devices necessary
Experiences of use by SESAR partners (including references):

n/a

Reported and/or published experiences of use (including references):

n/a

Applicability to lifecycle phase (E-OCVM):

It is applicable for lifecycle phase V3 as ?pre-operational validation?.

Application Area:

Aviation and general transport

Keywords:

Human factors interaction

Short Description:

The ICAO SHELL model is a conceptual framework of human factors that clarifies the scope of aviation human factors and assists in understanding the human factor relationships between aviation system resources/environment and the human component (Software, Hardware, Environment, Liveware).