Human Error Assessment and Reduction Technique (HEART)

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HP Activity Categories:
Identification of potential human error and assessment of human error [1]

Resource Type:
Technique

Abstract:
A technique to arrive at the human error probabilities by matching the task being assessed to one of the nine generic task descriptions from a given database and then to modify the human error probabilities (HEPs) according to the presence and strength of the identified error producing conditions (EPCs).

References

Developer and source:


P. Humphreys, Human reliability assessors guide, Safety and Reliability

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Year of development / publication, updates etc:
1988

General Description

Purpose:
HEART is designed to be a quick and simple technique for quantifying the risk of human error. It is a general method that is applicable to any situation or industry where human reliability is important.

HEART is a quantitative human error probability assessment technique only. It can be used in combination with qualitative Human task analysis techniques that identify operator tasks to be assessed. HEART is relatively simple to use when compared with other human reliability quantification methods and also it is
easily understood by practitioners from both engineering and social science backgrounds.

There are 9 Generic Task Types (GTTs) described in HEART, each with an associated nominal human error potential (HEP), and 38 Error Producing Conditions (EPCs) that may affect task reliability, each with a maximum amount by which the nominal HEP can be multiplied.

The nine generic task types used in HEART:

1) Totally familiar, performed at speed with no idea of likely consequences
2) Shift or restore system to new or original state on a single attempt without supervision or procedures.
3) Complex task requiring high levels of comprehension and skill.
4) Fairly routine task performed rapidly or given scant attention.
5) Routine highly-practiced, rapid task involving relatively low level of skill.
6) Restore or shift a system to original or new state following procedures with some checking.
7) Completely familiar, well designed, highly practiced routine task occurring several times per hour
8) Respond correctly to system command even when there is an augmented or automated supervisory system
9) None of the above.

The key elements of HEART are: Classify the task for analysis into one of the 9 Generic Task Types and assign the nominal HEP to the task. Decide which EPCs may affect task reliability and then consider the assessed proportion of affect (APOA) for each EPC. Then calculate the task HEP.

HEART is recognized as a successful and cost-effective tool for predicting human reliability and identifying ways of reducing human error, it can be also applied to any industrial operation due to its methodology being centred upon the human operator rather than the technical process.

Type (e.g. observation, questionnaire, interview, checklist, measurement instrument, etc.):

Observation by expert

**Technical description of method or tool etc**

Description of the content/study:

HEART is based on the following premises:

1. Basic human reliability is dependent upon the generic nature of the task to be performed.
2. Given perfect conditions, this level of reliability will tend to be achieved consistently with a given nominal likelihood within probabilistic limits.
3. Given these perfect conditions do not exist in all circumstances, the human reliability predicted may be expected to degrade as a function of the extent to which identified Error Producing Conditions (EPCs) might apply.

Heart is a six step process:
Step 1. Classify generic task type

Step 2. Assign Nominal Human Error Probability.

Step 3. Identify the error producing conditions (EPCs).

EPCs are

- Unfamiliarity
- Shortage of Time
- Low signal to noise ratio
- Ease of information suppression
- Ease of information assimilation
- Model mismatch (operator / designer)
- Reversing unintended actions
- Channel capacity overload
- Technique unlearning
- Transfer of knowledge
- Performance standard ambiguity
- Mismatch between perceived / real risk.

Step 4. Determine the Assessed Proportion of Affect (APOA).

For each EPC identified in Step 3, the analyst makes a judgement on how much it influences the overall unreliability of the task. This is known as the Assessed Proportion of Affect (APOA) for the EPC.

Step 5. Calculate Final Human Error Probability (HEP).

Step 6. Consider Error Reduction Measures (ERM)

For each EPC identified in Step 3, the analyst may attempt to apply the associated HEART ERMs. Here, a tactical or a strategic approach could be adopted. Note that the derivation of appropriate ERMs is a specialist task that involves more than just choosing items from a table.

Technical requirements for using the method, tool, etc:

Human factors expertise and error modelling

Measure/Response Type:

Expert judgement

Results obtained and interpretation:

Overall metric of error probability

**Evaluation**

Advantages:

Since probabilities of human operator tasks have a big influence in ATM safety assessments, a technique like HEART is very relevant for Safety Assessment Methodology. General strengths of HEART are:

- HEART has a very low demand on assessor resources and allows flexible assessments.
- It identifies the major influences on human performance in a systematic, repeatable fashion.
- It has been developed primarily for use in design assessments and appears to be most powerful and useful in this context.
- It can be incorporated by an FTA (Functional Task Analysis).
- Limited training is required.
- It is conservative (tending towards pessimism rather than optimism).
- It is capable of sensitivity analysis.
- A range of EPCs is used.
- It identifies areas for error reduction, albeit simplistic ones.
- It is versatile?HEART has a track record in various industries.

Alternative Methods:

NE-HEART (Nuclear Electric HEART)

CORE-DATA

Use of Expert Judgement

Hierarchical Task Analysis

TRACER-Lite

various Human Reliability Assessment; Methods

THERP

JHEDI

Usability (ease of use, efficiency, effectiveness)

Ease of use:
  high
Efficiency:
  high
Effectiveness:
  medium

Constraints concerning conditions of use:

Experienced professional expertise required.

Reliability:

In P. Humphreys, Human reliability assessor?s guide, Safety and Reliability Directorate UKAEA (SRD) Report No TRS 88/95Q, October 1988, several human reliability assessment techniques, among which HEART, are compared on various criteria, which are: Accuracy, Validity, Usefulness Effective use of resources, Acceptability and Maturity. All techniques are evaluated on these criteria by a panel of experts, in the form of marks from 1 to 5, where 5 means evaluated high (positive) and 1 means evaluated low (negative). These criteria evaluations are next weighted and added for each technique. The results are presented in the table below. According to this table, HEART receives the highest Preference Index of the techniques evaluated.

Validity:
See reliability.

Required effort (to conduct & to analyse):

The effort to conduct a thorough error analysis is considered as very high to produce valid and reliable results.

**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):

n/a

**Cost Information**

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

None

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

HEART has been used by NATS for human failures quantification of events in fault trees modelling the occurrence of top events in ATC operations for two airspace sectors in the UK.

Applicability to lifecycle phase (E-OCVM):

It has been developed primarily for use in design assessments and appears to be most powerful and useful in this context.

It can be incorporated by an FTA (Functional Task Analysis).

This refers to V1 and V2 phases.

Application Area:

It has been used as a human error quantification technique in the UK, especially for nuclear power and reprocessing, and chemical industry, and is used in various European and Scandinavian industry sectors (petrochemical and chemical), as well as for railway and defence industries.

Keywords:

Human error, human reliability assessment, error probability assessment technique.

Short Description:

HEART is a quantitative human error probability assessment technique. It matches the task being assessed to one of the nine generic task descriptions from a given database and then to modify the human error probabilities (HEPs) according to the presence and strength of the identified error producing conditions (EPCs).