Nové metody a postupy v oblasti přístrojové techniky, automatického řízení a informatiky
Ústav přístrojové a řídicí techniky ČVUT v Praze
odborný seminář Jindřichův Hradec, 28. až 29. května 2009

VLIV SPOLEHLIVOSTI LIDÍ NA AKTIVITY V PROJEKTOVĚ ŘÍZENÝCH ORGANIZACÍCH

Human Dependability Effects on Activities in Project Controlled Companies

Ing. Bc. Petr Kolář

Abstract: Possibilities of dependability increase in project controlled companies with application results of human reliability analysis (HRA). Methods and possibilities of the qualitative and quantitative evaluation of HRA, sketchy increase possibilities, e.g. motivation, training, human/machine interface etc. The possibility to embodiment of the appraisal human reliability analysis into the complex reliability analysis. SW support of HRA in the environment of the project controlled work.

Key word: human factor, human reliability analysis, human/machine interface, motivation, stress, project control, MS Project, SW support

1. Introduction

The emphasis was placed on the complex understanding of the reliability system with embodiment influence on the human reliability analysis, and also the characterization of the analogy between reliability objects and human factors including the explanation of the applicability consistent terminology. Article describes and illustrates HRA implication into the project controlled companies.

In the text it was introduced difficulty during the qualification activities with influence human factor and its possible failure including suggestion for the recruitment information about processes with attendance the human factor. Significant section was dedicated to the methods of the human failure qualification. In the text were introduced partly methods applicable for frequently recurrent processes with application operation statistical data, partly methods for rarely se recurrent or unique activities, or activities with unattainable data records out of praxis. Important part of the article shows, how to include HRA directly to methodology of the project control. There was described recommendation for using SW equipment, which become possible the process of the qualitative and quantitative analysis of the human factor. As a component was the recommend of the orientation follow-up applied research.

2. Human factor influence on the system reliability

The term "system reliability" is chiefly understand as studying, doing analyses and rating reliability attributes of the system with dependency on reliability attributes of the elements, which are building system so, that fill it the desiderative functions and for determined using conditions. This general formulation is fully application-able to the reliability system of the human factor (HF) influence. Also by human factor is necessary to put stress on the indispensability of the systematical approach to supplying reliability system during all live cycle periods in manager, technical and economical view.

By using HRA in praxis is needful awake several fundamental facts:

- Human is inseparable component of the modern technology
- Human is connected in maintenance process and in control of the technology
- Human is often the key factor of the aggregative operation reliability
- In procedures are requirements on the quantitative HRA
- HRA is chiefly the quantitative method for the officiating influence typical incorrect activities any workers (operator, maintenance man etc.) on the system reliability (mostly safety or failure)

3. Qualification of the human factor failure

Human failures are possible to divide in errors produced by failure or momentary blackout of the vigilance, by insufficient training and instruction, by lack of bodily or intellectual competence, by lack of motivation or careful decision, which does not conform to instruction and also manager errors.

In process life cycle is possible to divide these types of HF failure:

- Before-accident mistaken of the maintenance with latent effects
- Weighty break the operation rules leading to emergency state
- In-command response on the issue of the emergency state

It is possible apply the methods used by general procedures of the reliability system analysis to the finding and qualification HF failure, e.g. FMEA or FTA. Benefit of using this method in practice by HF analysis is, that these methods are usually put to use by workers at quality departments and therefore do well apply their advantage. Afterwards they are competent connect result following analysis immediately to the basic reliability system, even not only at qualification phase of the individual failure HF, but also at quantification phase. Overall result of the complete probabilistic system analysis (PSA) is possible present and document using existing quality workers experiences with understandable form. Using HRA method in combination with methods FMEA and FTA is then appropriate for practice.

For increase of the maintenance dependability is optimal to use project control of all activities – project manager is then able to plan time slack, deadlines, using of personnel and material, financial budget etc.

Similarly as in another branches, where appearance evaluation HRA, also is in airplane traffic, that „have no incidents is worse than have some incidence" – this state aptly stress the difficult accessibility to input data for HRA. Also in airplane industry is by specific sense normal to have some accidents.

However already was recognized, that a lot of active human failures elude from report. Instant recognizing and err correction can't anyway retrieve for produce damage or injury, and also for identify necessity and report incident, let alone full accident. So we have here an example of important (instant) instruction for individual, without whichever instruction benefit for organization. Instruction is not hereafter dispense and potential for identification of the hide failure foundation (human factor) in controlling, organization point of view or working condition is exhaustively lose.

Notable method in scope HRA is e.g. the "error control" – this term is meant as using every accessible data to understanding all the errors causation and intake of the responsible steps, including changeover firm politics, procedures expert preparations to theirs reduction and to minimization the occurred consequences.

4. Quantification of the human factor failure

Quantitative HRA differ from analysis products or machines chiefly in way of the understanding rate, significance and probability of the human failure. Difficulty occurs in first of all by cognitive human activities. Evaluation of these activities become involved also into field of psychology, psychiatry, general medicine, manager controlling and human resources management.

Already at phase of the qualitative analysis have to be evident at least in basic features correlation between individual process and influencing requirement. As general used methods I can give the name of methods ETA or RBD, at deep HRA is possible to use e.g. methods TESEO, THERP or SLIM.

The most elementary is method TESEO. It estimates reliability HF using five key factors, with were value as the most important among all the factors rule probability human errors. Its model defines probability of the personnel error as multiple following factors:

- Type realized activity (K_1) = factor of the activity type
- Disposable time to implementation activity (K_2) = stress factor by usual activities, exceptional activities
- Personnel characteristic (K_3) = factor of the operator quality
- Psychological state of the personnel (K_4) = factor of the trepidation and stress
- Local working condition (K_5) = ergonomic factor

Probability of human failures during realization any fixed activity is then calculate as $P_{HEP} = K_1 \times K_2 \times K_3 \times K_4 \times K_5$.

Concrete numerical values for individual factors K_i it is possible obtain out of given tables. Where reach the product all the five factors of numerical value bigger than 1, presuppose that probability human error is equal 1.

5. SW support of the human reliability analysis

HRA is at least so exacting (because data storage and calculations), as reliability analysis of whatever else reliability system. In foregoing text was explained, that aim one's effort to human activities is different chiefly in the qualitative phase – methods of documentation of component states and errors are similar, in some aspect even coincident with approach to documentation in field of any appraisal products or processes.

To processing HRA it is ergo possible employ whatever SW, which can use any of methods FMEA, FTA, ETA or RBD. The most important factor then is probably, what SW support is available in concrete operation, or in organization outsourcing the processing of the reliability system (e.g. Relex or Isograph).

6. Project control with MS Project support

Managers coordinates planning, course of activities an evaluation of projects must work with huge quantum of information. They can't work efficient without SW support and one of the most used tools is MS Project.

MS Project application serves planning, tracking and control of projects and rationalist communication links around the project team. Project is standard understand as work plan, which has and its end some outcome. It can be marketing campaign, emission new product, house building or carry out maintenance. It's possible to divide project to small parts – tasks. To tasks can be assigned resources – work type (most often peoples, which do their work and put forward the project), material type (use up during the project) and cost type (fixed or variable costs, which can be connected to work/material type).

With the baseline can be calculated difference between plan and reality including critical path and do any optimalizations. It's possible to define resources reservoir, draw on them and improve coordination. Workers with participation on more projects can model several changes of projects priority, resources, terms of beginning and finalization of projects and can monitor correlations with reality.

In enterprise project management used in large organizations is profitable MS Project Server implementation, which defines especially roles of single workers in relations to projects, its competence to use project information. Project server becomes robust data store, which use usually MS SQL Server. Project data can be therefore easily used for other applications.

7. Human reliability analysis implemented to project control

Theory of the project control use many of variables and calculations to clarify most important aspects of time schedule, cache flow, work plan and chronogram of using materials. Project control improve quality of operation calculating time total and free slack of tasks and resources on them and is directly applicable to risk management.

MS Project can be defined and use many data fields several data types. It's possible to define evaluations and verifications. Data fields are in database relations to tasks and

resources. Any fields can be shown in custom defined tables, charts and print layouts. All the data are easily exportable to extern databases and applications.

MS Project facilitates definition of the branch solution, concretely including quality and dependability scope. For users is very friendly to have all work data together in only one application to backup and analyses. Very easy is using table methods as REASON, TESEO, FMEA or FMECA.

Assessment of tasks difficulty and criticality rating can be used worksheets structured as follows:

1. Background information
    a. Reason for carrying out task
    b. Method of control
    c. Relationship to other tasks (in terms of plan behavior)
    d. Personnel required to perform task
2. Task difficulty
    a. Task critical cues
    b. Time constraints
    c. Required accuracy
    d. Task complexity
    e. Skills and knowledge required
    f. Difficulty rating (high=3 / medium=2 / low=1)
3. Task criticality
    a. Likely errors
    b. Potential conflicts
    c. Task failure consequences
    d. Criticality rating of safety (high=3 / medium=2 / low=1)
    e. Criticality rating of availability (high=3 / medium=2 / low=1)
4. Overall rating (= 2.6 + greater of 3.4 or 3.5)

Tasks with scoring over specified limit must be redefined or at least properly monitored, to scoring can use more fragmented levels. Tasks with scoring over specified limit must be redefined or at least properly monitored, to scoring can use more fragmented levels or multi levels.

8. Conclusion

In scope of the research was recommended methods of qualitative and quantitative evaluation of the human reliability analysis, including succession to serviceability SW to execution analysis and documentation.

During follow-up research in this theme will be suitable do the complete concrete and complex methodology of human reliability analyses especially in project controlled companies. Consecution will be demonstrated for example on processes of maintenance, which are at the time well described and perform qualitative and quantitative human factor analysis of these activities as a part of project control.

It will be asset to concentrate one's effort on methodology of the inquiry data in concrete workplace conditions, further to analyze responsibility structure the component workers and work technique with high level of secret information.

References

Norms:
[1] ČSN EN ISO 9001:2001 Systémy managementu jakosti – Požadavky
[2] ČSN IEC 60300-3-1:2003 Management spolehlivosti – Část 3-1: Pokyn k použití – Techniky analýzy spolehlivosti – Metodický pokyn
[3] FAA AC 43-6B: Altitude reporting equipment and transponder system maintenance and inspection practices
Books:
[4] LIBBERTON, G.P.: 10th Advances in Reliability Technology Symposium. Bradford UK: University of Bradford 1988. ISBN 1-85166-202-2. 386 p.
[5] MYKISKA, A.: Bezpečnost a spolehlivost technických systémů. Prague: Publisher CTU in Prague 2004. ISBN 80-01-02868-2. 206 p.
[6] MYKISKA, A. et al.: Elektronický katalog intenzit poruch, analýza vlivu spolehlivosti lidského činitele na složky ukazatelů provozní technologičnosti a koncepce její SW podpory. Report to project FT-TA/026, Theme T3. ČVUT Prague 2005. 62 p.
[7] NOVÁ, M.: Zahrnutí selhání lidského činitele do analýzy spolehlivosti/bezpečnosti letecké techniky. Prague: CLKV 2002. DT 629.7.004.6. T-VZLÚ P 3-8. Č. z. R-3439/02. 50 p.

Contact

Czech Technical University, Faculty of Mechanical Engineering, Department of Instrumentation and Control Engineering, Technická 4, Prague 166 07, Czech republic, +420 224352530, pkolar@fs.cvut.cz