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A mathematical background for information technology of project's processes integration taking into account risk factors

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Abstract

The necessity of researches in given sphere was shown by analysis of existent approaches to integration of main project processes and mechanisms of rectifying the after-effect of risk factor. Main goals and problems of integration method were formulated. Preconditions for transformation of work package into language of regular scheme of process network were defined. And also methods of solving such problem as reduction of work package to agreeable view were developed. The experiment based on the actual data was conducted. As well practical aspects of methods were formulated.

Keywords: PROJECT, INTEGRATION, PROCESSES, NETWORKS, WORK PACKAGE

Introduction

While analyzing technical-economic values of the project, one should consider all the processes as the whole entity in accordance with the system concept. This is needed in order to get jail time, costs and resource loading of the project. Varied character of the processes prevents their integration. Some processes are constantly present in the structure of project works and most often are yielded to some formation rules, such processes are called the main ones. The other processes may appear occasionally or with some probability.

Special model of project plan is necessary for combination of various processes. Plenty of processes of various characters leads to that fact, that combination of processes manually is almost impossible, information technology is necessary to be used.

Objectives

The aim of research is to analyze approaches to integration of main project processes and mechanisms of rectifying the after-effect of risk factor. To develop integration method on the base of researches and to undertake an experiment based on actual data with the usage of information technology on the base of developed method.

Analysis of existing methods

Monte Carlo [1] and PERT [2] techniques are widely used analysis methods of influence of risk factors on the project. They use statistical approach for determination of continuance or working costs of the project. Advantages of these methods are their simplicity and small labor efforts for modeling, but they do not give detailed project time schedule and due to this their accuracy falls. Also some technical-economic values (for example resource loading in the point of time) are impossible to determine with the help of static modeling.

Matrix approach is often used while presentation of project plan [3]. It is very accessible while formation of main project processes, as it allows to combine project stages in accordance with different logical conditions, quickly and effectively, using matrix transformation device. However insertion of unrestricted work areas or repeats during the approach is bulky and non- direct operation. That is why for various processes integration this approach is non-effective.

Stochastic modeling methods [4] or modeling with the help of Petri nets [5] may be also used for fulfillment of a task of integration. These methods have not become a frequent practice in the field of project control because of complexities of the implementation or absence of tools. Language of regular schemes of process network (RSPN) is suggested in this research to be used for solution of the integration task.

Modification of project structure with the usage of RSPN language

Within a matter of this article, research of influence of risk factors on the project structure of creation of complex technique includes investigation of project inner risks. Among these are resources fault, defects, and risks of not achieving of program quality. In response to their appearance, in project there set mechanisms of rectifying the after-effect of risk factor. Integration of these mechanisms with the main project processes leads to certain changes in the work structure (fig.1).

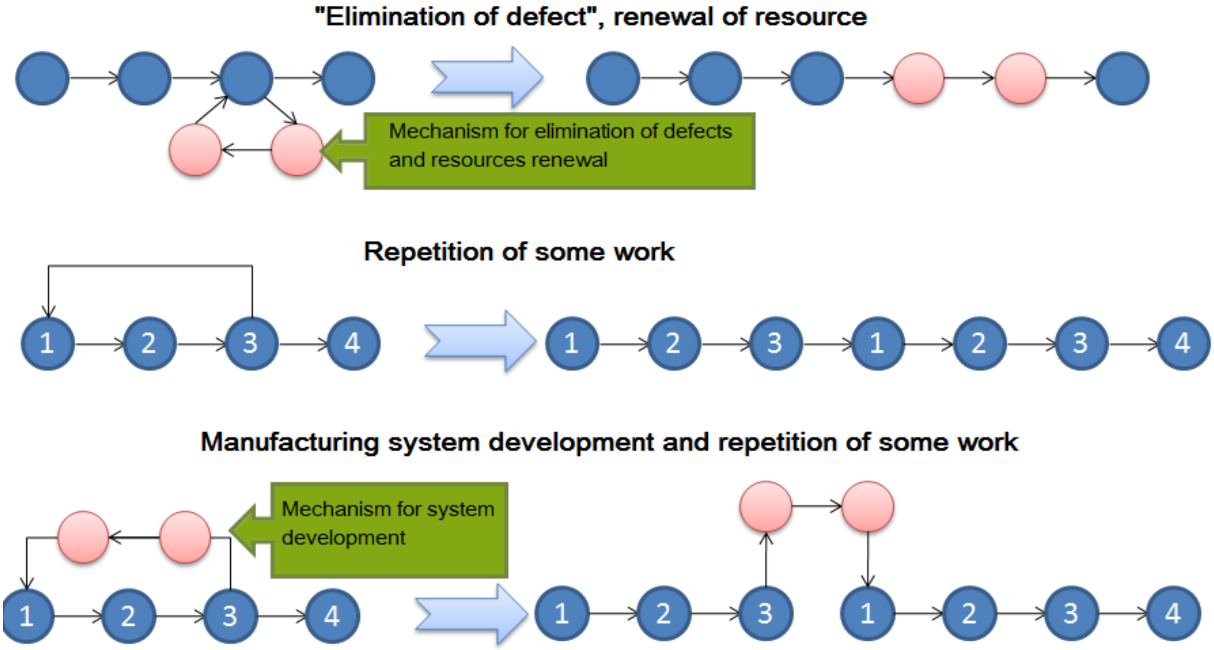

Figure 1 Changes in work breakdown structure

The main project processes and changes in the structure of works may be interpreted into the RSPN language in accordance with the table 1.

Table 1 Main processes and changes in the work breakdown structure

Name	RSPN
Sequenced area of work	*Y(1)vY(2)vY(3)vY(4)*
Parallel area of work	*[Y(1)^Y(2)^Y(3)^Y(4)]*
"Defect elimination"	*Y(1)vY(2)vY(3){DR:0,6:R(1)vR(2)}vY(4)*
Repetition of some work	*{ER}Y(1)vY(2)vY(3){SR:0,6} vY(4)*
Manufacturing system development and repetition of some work	*{ER}Y(1)vY(2)vY(3){SR:0,6:R(1)vR(2)}vY(4)*

Limitations and initial conditions

Accomplishment of a set of conditions and limitations is necessary for simplification of project range recording of works of complex technique creation on the RSPN language. They are connected both with RSPN language limitations and with logic of project process. Let us assume the range of works as the canonic network model, consisting of tops and connecting arcs.

The network should have the only starting and ending tops. If this condition is not observed, fictitious starting and ending tops should be added (fig.2).

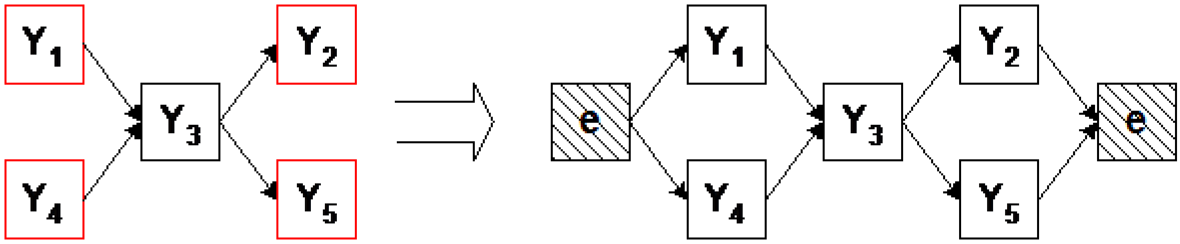

Figure 2 Fictitious starting and ending tops

Then it should be checked that the network does not contain tops, not having followers or predecessors (except starting and ending top). If there are these tops, one should insert fictitious starting or ending top, acting as predecessor or follower respectively.

Network should be transformed to the combination of sequenced and parallel work areas. If this is not the case, the network should be led to aggregate type by means of doubling of some tops (fig.3).

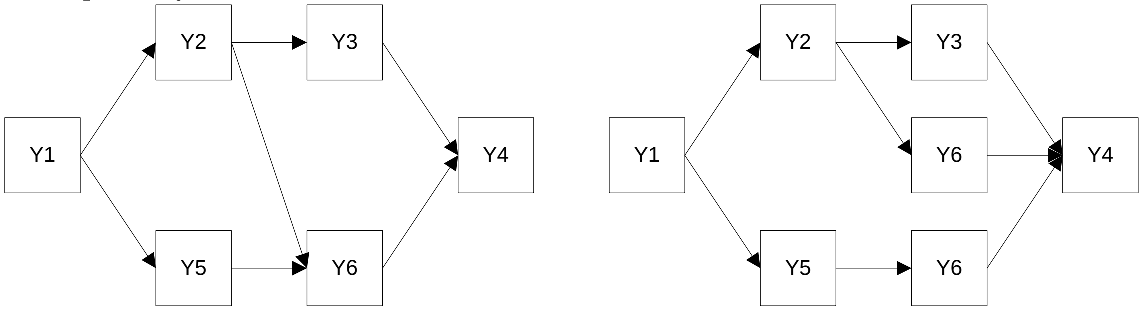

Figure 3 Putting the network into aggregate type

Return and repeat of some range of work cannot be fulfilled if rerun point is not direct or indirect predecessor of the work, where risk factor appeared.

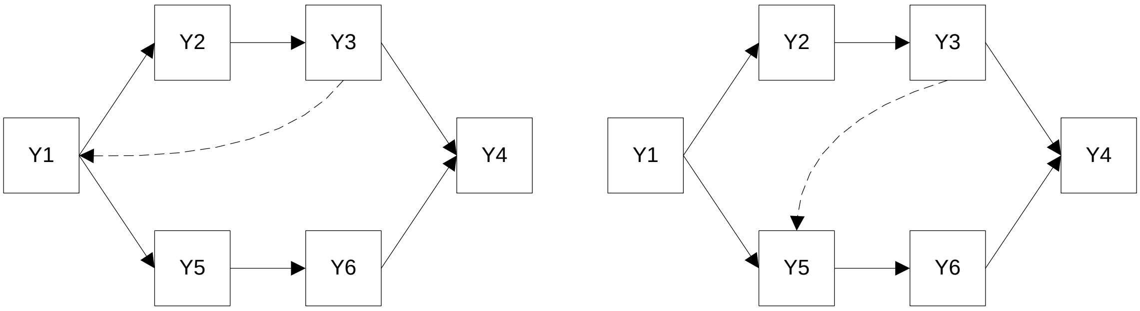

Figure 4 Returns in the project structure

At the left of the fig. 4 allowable return is depicted as Y1 top is indirect predecessor of Y3 top, at the right – there is inadmissible return.

Application of the method on the actual data

Project of creation of pilotless aircraft (PA) was analyzed on the base of this approach. Initial data were provided by NII PFM KHAI (Kharkov institute for scientific research). Seven risks of non-achieving of program quality with different grade of influence on the project structure were marked. Integration of main processes (modeling and design-engineering segmentation, detailed design, work preparation, production and assemblage) with mechanisms of rectifying the after-effect of risk factor was fulfilled.

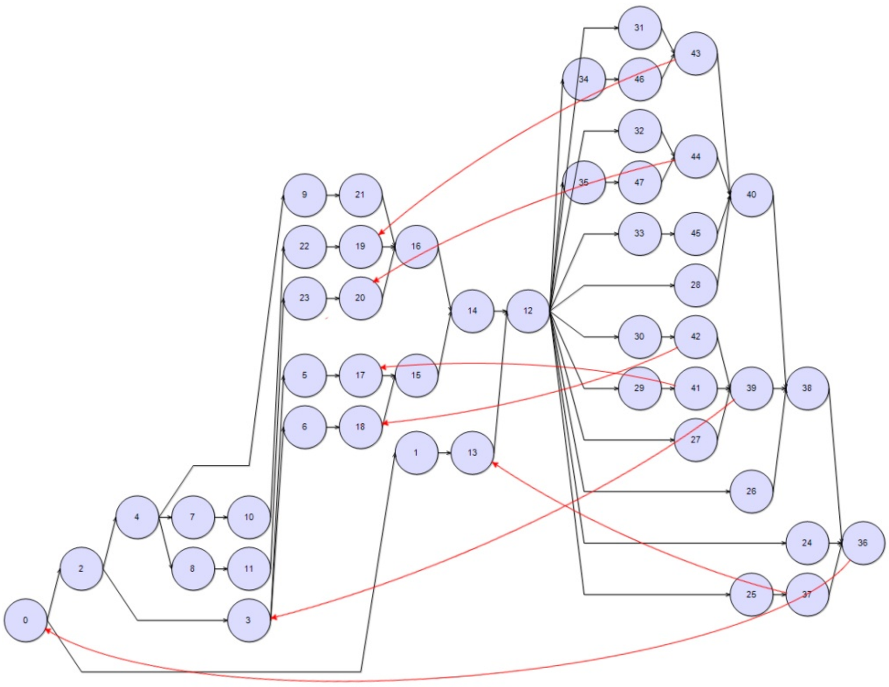

Figure 5 Project of PA creation

In result of project translation (fig.5) into the RSPN language, the following expression was obtained:

$R_{projectPA}$*=Y(0){ER(5)}v[Y(1)vY(13){ER(3)}^Y(2)v[Y(3){ER(6)}v[Y(5)vY(17){ER(1)}^Y(6)vY(18){ER(2)}]vY(15)^Y(4)v[Y(9)vY(21)^Y(7)vY(10)vY(22)vY(19){ER(4)}^Y(8)vY(11)vY(23)vY(20){ER(0)}]vY(16)]vY(14)]vY(12)v[[Y(24)^Y(25)vY(37){SR(3):0,5}]^[[Y(26)^[Y(27)^Y(29)vY(41){SR(1):0,65}^Y(30)vY(42){SR(2):0,55}]vY(39){SR(6):0,2}]^[[Y(28)^Y(33)vY(45)]^[Y(31)^Y(34)vY(46)]vY(43){SR(4):0,5}^[Y(32)^Y(35)vY(47)]vY(44){SR(0):0,6}]vY(40)]vY(38)]vY(36){SR(5):0,1}*

Conclusion

The article is devoted to approaches of integration of main project processes and mechanisms of rectifying the after-effect of risk factor. Advantages and disadvantages of existing methods were found out. On this base it was concluded concerning the necessity of integration method development. The RSPN language was chosen for that aim.

The usage of developed method allows to submit project plan as the whole entity in the compact symbol form, including the processes of various characters. This method may be successfully used during development of information technology for analysis and synthesis of project structural models under the conditions of uncertainty, for automatization of planning of production and administrative management, for simulation modeling of technical-economic values of the project and also while development decision support system under the conditions of uncertainty.

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