The need for New Methodological Approaches for filling gaps in Quantitative Project Management

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Abstract

This paper is section 5.1 from the unpublished book "*Mathematical methods in human labor research and new directions in quantitative project management (Missing nonlinearities in quantitative project management)*".

The high percentage of project failures continues to be a central topic of discussion in the field of project management. Improving the quality of planning and execution of projects is one of the main ways to repair the situation with the massive failure of projects.

In this regard, this paper discusses the problems of overcoming the difficulties in the quantitative management of projects related to the need to improve the accuracy of project estimates.

The problem here is that in the framework of existing quantitative project management methodologies project estimation problems have no satisfactory solutions.

The solution of these problems requires more decisive steps, up to a paradigm shift in the quantitative project management.

Keywords: Quantitative project management, failure of projects, project estimation errors, system dynamics, mental models, statistical methods, paradigm shift

1.5.1. On overcoming the difficulties in the quantitative project management

In each discipline there are periods when protracted failure with serious negative consequences forces a return to the basics and a review of the whole system of views and approaches, because the fragmented nature of the local improvement is no longer able to ensure steady progress.

This state of affairs at present is typical for project management, despite the fact that the last two decades have seen rapid development of theoretical and practical methods, such as system dynamics [1] and earned value management [2], positive influence of which on the development of the whole area of project management is obvious.

This circumstance forces making use of the positive experience of other areas of knowledge for the development of quantitative methods in the management of human labor in general, and in project management in particular. In this regard the first thing to do is to use the experience of physics, as the leader of the quantitative sciences, in order to create new fundamental methods of project management. It is particularly necessary to pay attention to the possible applications of classical thermodynamics [3] and statistical mechanics [4] to solve pressing problems in the field of human labor research. Also it is preferable to use methods of classical thermodynamics for creating top-down methodologies of quantitative analysis of human labor [5], and methods of statistical mechanics - to create bottom-up methods in the same field [6].

To avoid confusions related to the possible criticism of the so-called static approach to the problems of quantitative analysis of human labor, [5] it is appropriate to draw parallels with the static equilibrium thermodynamics, the results of which have been successfully used for solving various practical dynamic problems, including the design of internal combustion engines, rocket engines, and more.

General analysis of the validity of modern methods of quantitative project management and their comparison with the huge financial losses associated with the massive failures of projects leads to the conclusion that further progress in this area will be largely due to the level of the fundamental soundness of new quantitative methods for project management.

In this connection it is useful to briefly consider the experience of the fundamental approach of system dynamics in quantitative project management.

1.5.2. System dynamics in quantitative project management

Successes of system dynamics in the field of project management indicate that this is one of the most promising directions for development of quantitative project management. The main pledge of the success is the fact, that this direction of development of quantitative project management is based on the fundamental results obtained by Jay Forrester [7] and others [8] in the general theory of system dynamics.

By its nature, the differential equations of system dynamics are versatile and suitable for the adequate representation of accumulation processes in a wide variety of systems. However, the fundamental character of the equations of system dynamics is not sufficient to achieve full success in the specific fields of their applications.

The point here is that each particular area of application of the system dynamics has its own internal fundamental laws, without knowledge of which it is impossible to objectively describe the behavior of the system as a whole and therefore achieve the desired results.

In this sense, the area of project management is not an exception. After the formal obtaining of the equations of system dynamics in each specific situation, it is required to disclose the content of intensities that make-up the right-hand sides of differential equations in an informal way. This disclosure is impossible without the knowledge of the fundamental laws underlying the behavior of the projects and the development teams.

The point here is that the outward simplicity of the equations of system dynamics is misleading, since the intensities of transitions between different states of the system are interrelated with different functional dependencies. The adequate representation of these functional dependencies is far more important than formal obtaining of the equations of system dynamics. And yet they are either not known, or poorly investigated.

Disclosure of the right-hand sides of differential equations of system dynamics for project management is as fundamental of a problem as the derivation of the equations themselves. Moreover, the complexity of disclosure of the right-hand sides of equations is much higher than the complexity of compilation of the equations in their generalized form, which has repeatedly been used in various areas of quantitative science even before Forrester. This is a common form of presentation of the growth or accumulation of something, if it is assumed that the quantities under study can be assumed to be continuous in the strict mathematical sense.

Attempts of application of the methods of system dynamics to the organization of projects without the knowledge of the fundamental laws in this area offer ample opportunities for arbitrariness and subjectivity in the disclosure of the right-hand sides of the differential equations of task dynamics.

At the same time mental models that have qualitative nature and which approximately reflect the true state of affairs for disclosure of the right-hand sides of equations are commonly used for disclosure of the right-hand sides of equations [9]. This situation contains serious risks of obtaining inconsistent and sometimes contradictory results.

This casts doubt on objectivity of this methodology in project management, as there are no clear borders between the scientific forecasting and simple drawing of something that someone wants to see himself and to show others.

In order to somehow compensate for this arbitrariness and subjectivity in the organization of project works, lower and upper limits are imposed on the parameters of the project. On the one hand this allows retaining control over the process of evaluation and prediction of parameters of the project, but on the other hand this kind of artificial means significantly reducing the objectivity of forecasts.

In this methodology, the presence of the lower and upper time limits on the duration of the work indicates a lack of power of the methodology. Complete and powerful methodologies usually do not need such artificial limitations. If a mathematical model of the process is fully justified and has no internal contradictions, the positive results of the prediction will be obtained automatically, without introducing any additional artificial constraints.

The overall impression of the methodology of using system dynamics in project management is that the goal is simply to achieve some acceptable solution without worrying too much about the objectivity of approach. This approach can be justified only in short-term business considerations and objectives. Such an approach cannot be justified in long-term business goals, particularly not from a scientific point of view.

If we approach this problem only in terms of scientific objectivity, then high scientific standards in the methodology of system dynamics can only be met by using differential equations with respect to the numbers of tasks. Besides, the methodology will be applicable for a sufficiently large number of tasks only.

It seems that the choice of the appropriate mathematical model could have a significant impact on the quality of project estimations and predictions. The problems with the applications of system dynamics in project management arise because of the discrete, random and nonlinear character of the process of task solution. Considering task solution as a human action it is possible to apply nonlinear and random models of human actions to the problems of system dynamics [10].

Regardless of the power of technologies for forecasting and assessment built on the simulations, they will not help if an adequate model of the investigated processes is not laid in the basis.

Putting some plausible model of the process in the basis for a simulation will make the forecasted output closer to the objective reality, even with some distortions caused by nonlinearities and noise of the system.

We always have to remember that simulation is a means and has no connection with the mechanisms and models of the investigated processes themselves. Simulation is not a panacea and with erroneous bases may give erroneous result. The provision of simulation systems with adequate and generalized models for the processes under study is the most important thing.

Another indicator of the imperfections of system dynamics in project management is that the application of this new methodology does not reduce the percentage or the number of failed projects and the number of projects with significant delays and over cost conditions.

This state of affairs requires a careful analysis of the possible causes of shortcomings of the system dynamics in project management.

1.5.3. The decisive role of expert assessments in the old and new project management technologies

If we compare the old and new technologies and methodologies in project management, it becomes apparent that in all technologies, qualitative and expert approaches have remained almost unchanged and have a dominant position with regard to quantitative methods, which are in the initial phases of the development. This is particularly true for estimates of time intervals in the implementation of projects and their individual parts.

The main sources of errors in both old and new techniques were and still are expert assessments at specified time intervals. That is the basic contradiction, was and still is the difference between reality and expert estimates of the duration of the separate portions of projects. In this sense, there is almost no difference between the old and new technologies. That's why we do not see major changes or improvements in the statistics of failed projects, where the percentage of such projects remains almost unchanged.

On such a claim a possible objection may be that, in those areas and critical projects where the latest technologies in project management are applied in a systematic and consistent way, they have great success. Such objections can be answered with the following counter objection: the modest contribution of new methods to improving the quality of project management is not due to scientific and methodological innovations in this area. Instead, it is the result of more focus on the process of project implementation.

This positive effect of concentration on quality and performance can be found in almost any business, and is known to many.

1.5.4. Contemporary quantitative PM cannot be considered as a self-sufficient field of knowledge

Traditionally the role of qualitative methods in project management was higher than the role of quantitative methods. Despite that fact, the accumulation of detailed evidence over the last decades and attempts of their analysis allow us to have new approaches to the problems of the quantitative description of the projects.

At the same time it must be emphasized that the rapidly developing modern techniques like system dynamics and EVM do not change the situation in the quantitative project management much. This is because these modern techniques themselves need to expand their capabilities through the use of functional relationships of the fundamental nature between the parameters of projects. In particular, the further progress of system dynamics in project management will be closely linked with the ability to replace the mental models with corresponding models of a fundamental nature.

So the question very often comes down not to how to manage complex projects in extraordinary circumstances, but how to accurately manage simple projects in the most ordinary conditions. The point is that at present time, projects carried out even in the most predictable environments and under conditions of moderate risk are not provided with accurate quantitative methods of planning and execution.

Specifying the problem further, we can say that at present there is no scientifically valid method that would allow obtaining the functional relationships between the parameters of the project from a single point of view, a circumstance which is extremely important in the planning and change management of projects. Existing methods for this purpose are inaccurate and at best can have a minor supporting role for the dominant qualitative and intuition based methods in PM.

The first thing to understand is the strange state in which quantitative project management currently is, and to take this into account when establishing adequate methods for a quantitative description of the process of human labor and project management.

The point is that the need for quantitative methods and appropriate tools is not absolute in project management, as, for example for the synthesis tools in the electronic design automation. On the other hand, the presence of good project management tools, built on the basis of adequate quantitative methods, would be of great benefit to the industry.

It is clear that quantitative project management techniques must be based on the universal functional dependences between the parameters of the project. There is not any doubt about the existence of such universal laws because those dependencies are the basis for traditional qualitative project management, but only on an intuitive level.

Naturally, the use of these relationships on an intuitive level is approximate in nature, and in parallel with the growing complexity of projects it is gradually beginning to fail to satisfy the requirements of the industry. This in its turn creates a real basis and good preconditions for the development of quantitative methods in the field of project management. In this sense the main goal for the development of quantitative models in PM is to transform the qualitatively adequate intuitive models that are based on the human experience into mathematical formulas and theories.

1.5.5. Collected project data cannot be used directly for project management purposes

It is also natural that the first attempts to establish quantitative methods in the field of project management were based on measurements associated with the project work and the processing of data obtained.

Since experimentation with projects in the classic sense of the theory of experimentation in order to obtain reliable data is impossible for many reasons, people have chosen the path of least resistance, and instead began simply to collect data about completed projects.

There is no doubt that project data collected in this way contain valuable information about functional relationships between the parameters of the projects. But since these data did not results from a classical experiment, they are not a suitable source for obtaining the functional relationships mentioned above. In other words, unlike the classical experiments that are conducted under the same conditions, the project data are collected from projects that have been run under different conditions. Therefore these data are simply not comparable with each other, and for that reason cannot be processed together.

Ignoring this fact and manipulating the collected project data as if those are the results of a classic experiment by the PM community over the past 30-40 years have caused serious errors and huge financial losses for the entire field of project management.

In particular, for a specified period of time about one dozen formulas for the functional relationship between the complexity and the total effort of the project are obtained. Also, several formulas are obtained for the relationship between the total effort of the project and its duration, and many other formulas, which are based on the processing of data from some specific project database.

1.5.6. There is a need to change the paradigm in quantitative PM

It is time for us to understand that the empirical relationships based only on specific project data may have very limited applications, and that the current situation in quantitative PM cannot be considered normal. We must take this field of knowledge from the existing primitive empirical phase of its development, and follow the path of the conceptual and mathematical generalizations [11].

There is no doubt that the collected databases do contain valuable information about the functional relationships between project parameters. In principle, these relationships can be obtained from project data, but this requires new approaches and methods. In this regard, for the further development of quantitative project management theory we can make great use of other, more developed areas of expertise such as physics, mathematical biology, mathematical economics, and others.

The solution of this problem requires: (a) creation of a large-scale quantitative united ideology for more accurate presentation and description of human labor and (b) development of a quantitative theory of project management based on that united ideology.

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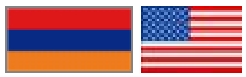

Dr. Pavel Barseghyan is a consultant in the field of quantitative project management, project data mining and organizational science. Has over 40 years experience in academia, the electronics industry, the EDA industry and Project Management Research and tools development. During the period of 1999-2010 he was the Vice President of Research for Numetrics Management Systems. Prior to joining Numetrics, Dr. Barseghyan worked as an R&D manager at Infinite Technology Corp. in Texas. He was also a founder and the president of an EDA start-up company, DAN Technologies, Ltd. that focused on high-level chip design planning and RTL structural floor planning technologies. Before joining ITC, Dr. Barseghyan was head of the Electronic Design and CAD department at the State Engineering University of Armenia, focusing on development of the Theory of Massively Interconnected Systems and its applications to electronic design. During the period of 1975-1990, he was also a member of the University Educational Policy Commission for Electronic Design and CAD Direction in the Higher Education Ministry of the former USSR. Earlier in his career he was a senior researcher in Yerevan Research and Development Institute of Mathematical Machines (Armenia). He is an author of nine monographs and textbooks and more than 100 scientific articles in the area of quantitative project management, mathematical theory of human work, electronic design and EDA methodologies, and tools development. More than 10 Ph.D. degrees have been awarded under his supervision. Dr. Barseghyan holds an MS in Electrical Engineering (1967) and Ph.D. (1972) and Doctor of Technical Sciences (1990) in Computer Engineering from Yerevan Polytechnic Institute (Armenia). Pavel's publications can be found here: http://www.scribd.com/pbarseghyan and here: http://pavelbarseghyan.wordpress.com/. Pavel can be contacted at pavelbarseghyan@yahoo.com