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Parkinson's Law, Overtime Work and Human Productivity

(Impact of the Planned Time of Work on Human Productivity)

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Abstract

Contemporary approach to the modeling of human work process considers people's productivity as something constant, inherent to the individuals and human groups. This leads to the inadequate project cycle time models and scheduling risk models.

Especially there are serious unresolved problems with the work completion time variations. Existing risk models produce unrealistic high values for the standard deviation of the project completion time.

In reality the human work productivity is not a constant. It is highly variable and, which is more important, it is highly controllable.

Indeed people differ by potential maximum productivities which can be considered as nearly constant values. But those constant maximum productivity values have nothing to do with the everyday working productivities of individuals.

Developer's hourly productivity can be much lower than his maximum possible productivity number. At the same time his or her daily productivity can be higher than his or her daily maximum productivity number because of the extra working hours or overtime work.

Analysis of the people's work process shows that the planned time of work has a significant impact on their productivity. This happens because people in the process of work are dynamically controlling their own capacities and abilities, always taking into account for the remaining time to completion and the remaining volume of work.

In this sense, the people's process of work is always located in between the following two extreme regimes. If the allotted time is longer than it needed for the normal completion of

work, the whole process takes place in accordance with the Parkinson's Law. If that time is unreasonably short, it leads to the need for overtime work.

Optimum mode of people's work is somewhere between these two extremes and is directly dependent on the choice of a planned duration of work.

This kind of analysis of human work shows that the productivities of the successive steps of this process are not independent values.

This fact fundamentally changes our understanding of the schedule risk analysis, because the existing methodologies of this analysis are based on the notion of independence of the productivities of the successive steps of work.

All this leads to the statement that the controllability of the people's productivity automatically means controllability of the variance of the risk function, which is crucial for the methodology of risk analysis.

These circumstances lead us to a new methodology of the definition of the optimal duration of human work and schedule risk analysis.

This paper presents a new productivity model of human work that incorporates the planned duration of work, student syndrome and Parkinson's Law for the early work simulations and schedule risk analysis.

Keywords: Human productivity, Parkinson's Law, overtime work, optimal mode of human work, controllability of human productivity, schedule risk function, controllable variance of the schedule risk function.

Introduction

Usually, for the planning and monitoring of people's work are used simplified ways of representing their productivity, according to which each person is attributed to a number that reflects his or her relative productivity. Usually it is some average value, which in the specific field of human activity reflects the produced valuable work of people within the unit of time.

This averaged approach to the quantitative representation of the productivity of people has a

history of centuries and is fully justified for the description of ordinary and simple human activities. These are the areas of human activities, where the results of people's work are easy to measure and evaluate.

But, as we know, not all works produced by people can be easily evaluated, and, moreover, measured. As the complexity of work performed by people gradually increases, the evaluation and measurement of the results of their useful work becomes more and more difficult. This is due to the fact that complex work requires non-standard solutions and creative approaches to the non-standard problems and challenges that arise in the course of such a work. Further growth of the complexity of people's work leads to the gradual increase of the proportion of the creative work in it, bringing with it randomness and unpredictability in the assessment and measurement of the useful results of work.

But such unpredictability can be inherent, not just for complex work of people only. In some adverse circumstances, it could become a serious problem for relatively simple works, too. In analyzing these and other similar problems it becomes apparent that the static representation of the productivity of human labor in the form of constant values is not suitable for solving problems arising in connection with the assessment and planning of complex human activities. In such cases, the solution of the problem is to develop dynamical mathematical models of human productivity. In these dynamical models, the productivity of the people is the function of different parameters and time, which is much closer to reality than the existing models with constant values of human productivities.

Indeed, the static models of people's work are not able to explain many phenomena associated with fluctuations and oscillations of the human productivity, although these phenomena are well known and have a particular qualitative interpretation [1, 2]. For example, as a rule the conflicts between workers are accompanied by a decrease in their productivity, a phenomenon which is impossible to explain and describe in the framework of static models of people's productivity.

Similarly, within the same models cannot be explained so-called Parkinson's Law, which essentially reflects the impact of the planned time of work on the productivity of people.

The everyday activities of people also includes many other phenomena and processes, explanation of which generally incompatible with the idea of the constancy of the productivity of human labor.

From such phenomena in the first place one can mention the so-called creative resonance, in the course of which the work of like-minded people can be in an order of magnitude more productive than the separate work of the same people. In this sense, the working groups of people can be divided into two groups. The first group – are the amplifier teams, in which people are working with the productivity that exceeds their own productivity. The second group - those are the attenuator teams, which suppress the productivity of people.

Qualitative and quantitative studies of the above mentioned phenomena and related processes are important for progress in the science of project management, since they potentially can greatly affect the quality of the organization of human labor.

Another example of non-applicability of the concept of the constancy of human productivity is the enthusiastic work of people when they depriving of sleep and rest can work with high productivity.

Confining with these examples, one can note that depending on the circumstances, the productivity of people, which do a difficult and complex job, can vary widely. This shows the controllability of such work, and especially the controllability of the productivity of people are very high, which is very important from the perspective of the organizational science.

Using the classical approaches based on the traditional constant values of human productivity, one can explain the phenomena associated with the implementation of the simple work only. But even in this case, due to the constant desire of workers to shirk and evade, human productivity is not a constant value. It approximately can be so only under the strict supervision of the management personnel. As for the difficult and complex human work, problems here are much sharper and can be investigated with sophisticated and comprehensive modeling approaches only.

It is important to note, that if in the area of physical work the productivities of individuals can differ maximum several times, in the realm of the intellectual work the differences between people are huge and therefore the hidden resources there are far greater.

In other words, the model of human work with constant values of productivity for simple work can be generally considered as adequate, but it is not so for complex work. Moreover, there are

many situations and phenomena in the process of organization of human complex work that can be explained only by the models of variable human productivity [1, 2].

The dynamic and controllable nature of human productivity

Analysis of the human work process shows that the labor productivity is sufficiently flexible and can vary within a wide range. In this connection it should be noted that people often confuse the productivity of labor productivity in particular working and psychological environment, with its maximum possible productivity. Very often, this becomes the cause of confusion during the planning and implementation of project works. The reason for such confusion is that even if a person could potentially have a high productivity, in particular working situation his or her performance may be very low.

This can happen for various reasons, including the motivation of people, their health, conflicts at work, and, finally, it may be due to errors of management. In particular, the reason for the low productivity of people can be the wrong task assignment, which can be beyond the capacity of the executer. In addition, each work contains pieces of varying complexity. For that reason the productivity of people can vary within a wide range [1].

Since the above mentioned factors may vary within wide limits, consequently the productivity of human labor can vary too. It is for this reason, that the productivity of human work is a dynamic value and this should be the deciding factor in the course of development of quantitative methods for describing the process of human work.

In addition, as the noted factors that are affecting the productivity of people are controllable in a wide range, so the productivity itself is manageable in a wide range too. Naturally, the above generally refers to non-physical labor, meaning all sorts of design and engineering work, various kinds of research, and so on.

Because in parallel with productivity of people also one can control the duration of work by means of overtime hours, this fact makes people's daily productivity even more manageable.

For improving the controllability of human labor in the project environment there is an important factor too, which is the planned duration of work. In this sense, the organization of design work has two extreme regimes - overtime regime and Parkinson's regime. Let's consider these regimes in more detail.

Joint mathematical model for Parkinson's Law, human overtime work and student syndrome

From the experience of the daily work of people is known, that the planned time for a specific piece of work can significantly affect the human productivity. It is also known that at different stages of work, people's attitude to their duties is different. Thus, in the early stages of work human productivity is affected by so-called student syndrome. According to [3] "student syndrome refers to the phenomenon that many people will start to fully apply themselves to a task just at the last possible moment before a deadline". This syndrome is expressed by the delaying the beginning of work, motivating and justifying that by the fact that there is still enough time for the successful completion of work. The reason for this is not the desire to deviate from the fulfillment of the responsibilities, but the lack of mobilization of internal forces and capacities of people and determination to overcome the current difficulties with the proper organization of work. It is also important to note that, even if a person devotes a lot of time to some work, but if this effort does not focused on achieving certain goals, the result of work will be unsatisfactory.

In parallel with the advancement of work and the reduction of the uncertainties characteristic of the initial stages of work, are created objective conditions for the mobilization of the individual's internal reserves, which can significantly improve the human productivity. Also this is facilitated by the fact that over time the work objectives are becoming clearer.

For the quantitative analysis of this problem, let's introduce the concept of maximum individual productivity P_m of a human, when his or her internal forces and capacities have been mobilized in the best way. Let's assume that this value represents the amount of labor performed by a person for one day. Here, for measuring the productivity of human labor as a unit of time has been selected one day, because this way allows easily include the effect of overtime hours of work on the growth of productivity.

Suppose we consider the case where one man must perform volume of work W within the specified planned time T. Working with the productivity P_m during the time of T person can do the work W_1.

$$W_1 = P_m T \qquad (1)$$

Comparing the value W_1 with the whole volume of work W one can see that there are two possible cases:

1. $W_1 \geq W$,
2. $W_1 < W$.

These two cases from the point of view of work fulfillment have different meanings.

Parkinson's regime of work

If $W_1 \geq W$, then the work of volume W cannot be done during the planned time T and to complete it on time it is necessary to do some additional work $W_1 - W$ consuming effort E_0 equal to

$$E_0 = \frac{W_1 - W}{P_m} \qquad (2)$$

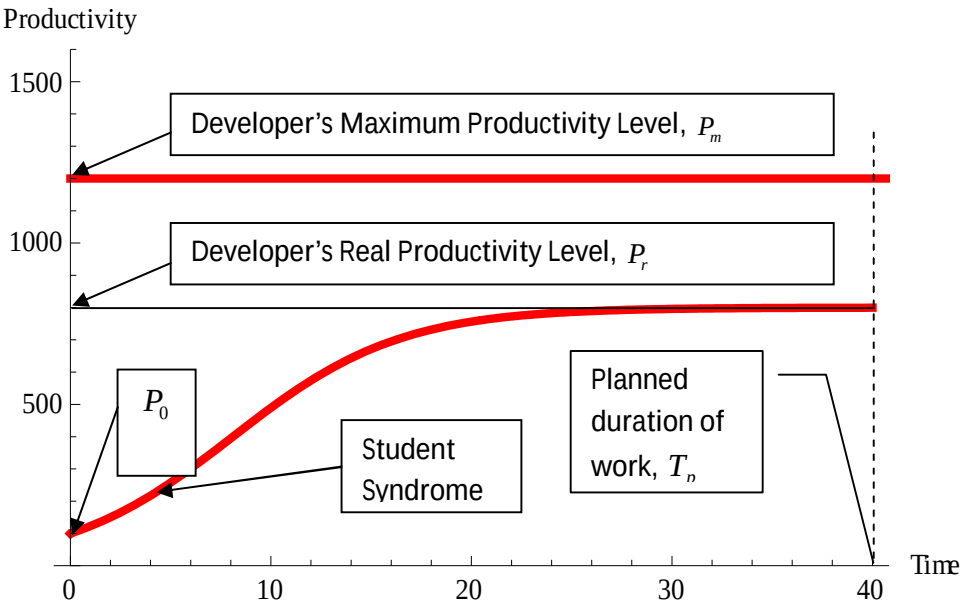

Fig.1 Graphical presentation of Parkinson's Law together with student syndrome

In this case when for the work is allotted more time than would be needed if the person would work with the productivity P_m. But this does not happen, because under the Parkinson's Law

the work will fill all the time allotted under the plan for it completion. In turn, this means that the work will be done with productivity lower than P_m. In Fig.1 is presented a typical situation where the reserved time for work T greater than would be needed if the person would work with maximum productivity P_m.

Fig.1 also shows the student syndrome in the form of a gradual increase of productivity.

The growth of labor productivity in the initial part of Fig.1 presented by the initial value of productivity P_0, by the growth rate $\frac{dP}{dt}$ and by the difference $P_m - P_r$.

In turn, all these quantities depend on the planned time T_p. These dependences are explained by the fact that during the work the human beings are always mentally assess what has been done and what have to be done to complete the work on time.

According to the developer, he or she knows how to begin the work (P_0), how to intensify it ($\frac{dP}{dt}$), and with what productivity P_r continue to work in order to successfully complete it within the planned time T_p. If the goal is to complete the W work within the planned time T_p, then the mathematical expression of this requirement is as follows.

$$W = \int_0^{T_p} P(t)dt \qquad (3)$$

It is quite another issue that the developer may have nonrealistic conception or understanding about the difficulty of work, and thus improperly assess the opportunities of completing the work within the planned time T_p. Also the developer can misestimate his or her own capacity to overcome the known difficulty of work.

Taking as a basis the expression (3) one can see that different planning times will correspond to different productivity curves over time. For three planned durations of work, these curves are presented in Fig.2.

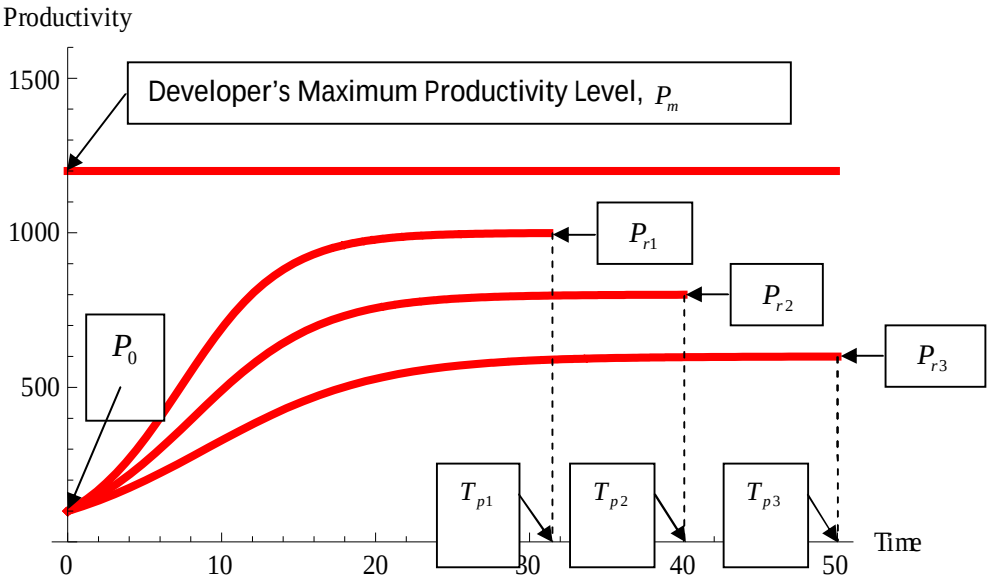

Fig.2 Three different Parkinson's modes of the same work: P_{r1}, P_{r2} and P_{r3} are the real productivity levels of the same developer, depending on the different planned durations of work, correspondingly T_{p1}, T_{p2} and T_{p3}. P_0 - is the productivity level at the beginning of work

All of these curves represent the Parkinson's Law for the different planning times T_p. As seen from the Fig.2, the reduction of the planned duration of work leads to the increased human productivity. This process can be continued until the actual human productivity P_r becomes equal to P_m.

The overtime regime of work

Further reduction of the planned duration of work leads to the situation when it becomes impossible to complete the labor on time working with maximal productivity P_m.

In this case, to complete the work on time there is a need for some overtime effort. Fig.3 shows a typical case of overtime work, when worker at the moment of time T_1, estimating the remaining work, realizes that during the remaining time $T_p - T_1$ it is impossible to finish the work successfully.

This forces the developer artificially to raise the daily productivity $P_2(t)$ to a new level P_{mm} in expense of the overtime working hours. This new parameter P_{mm} depends on the remaining time $T_p - T_1$ and the remaining volume of work W_r.

$$W_r = W - \int_0^{T_1} P(t)dt \qquad (4)$$

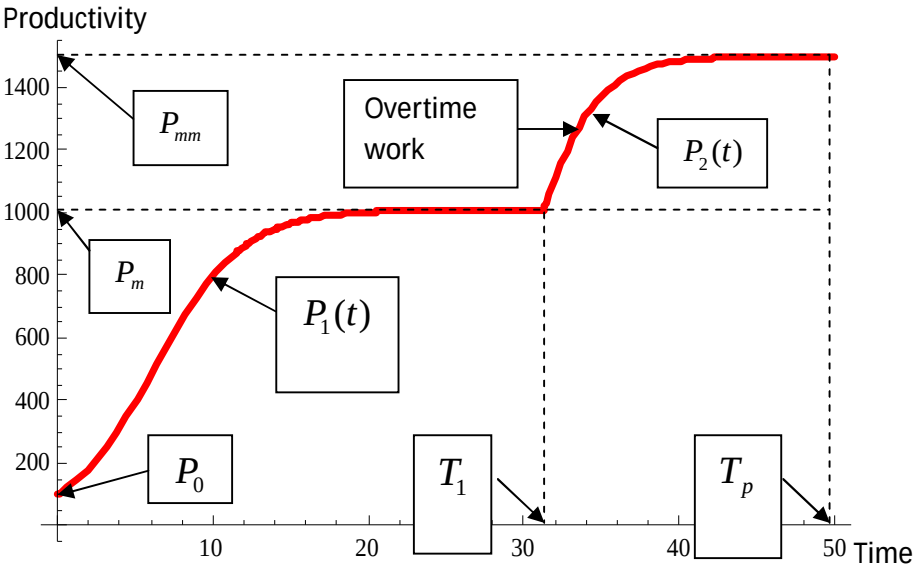

Fig.3 Fulfillment of work with tight planned time T_p

In this case the human productivity curve $P(t)$ consists of two functions $P_1(t)$ and $P_2(t)$. The volume of work W can be expressed with the these as is follows

$$W = \int_0^{T_1} P_1(t)dt + \int_{T_1}^{T_p} P_2(t)dt \qquad (5)$$

Depending on the value of the planned time of work, the overtime mode, as shown in Fig.4, can be light or overloaded, correspondingly with P_{mm1} and P_{mm2} maximum values of daily productivities. Also Fig.4 shows two planned durations of work T_{p1} and T_{p2} and two moments of productivity change T_{11} and T_{12}.

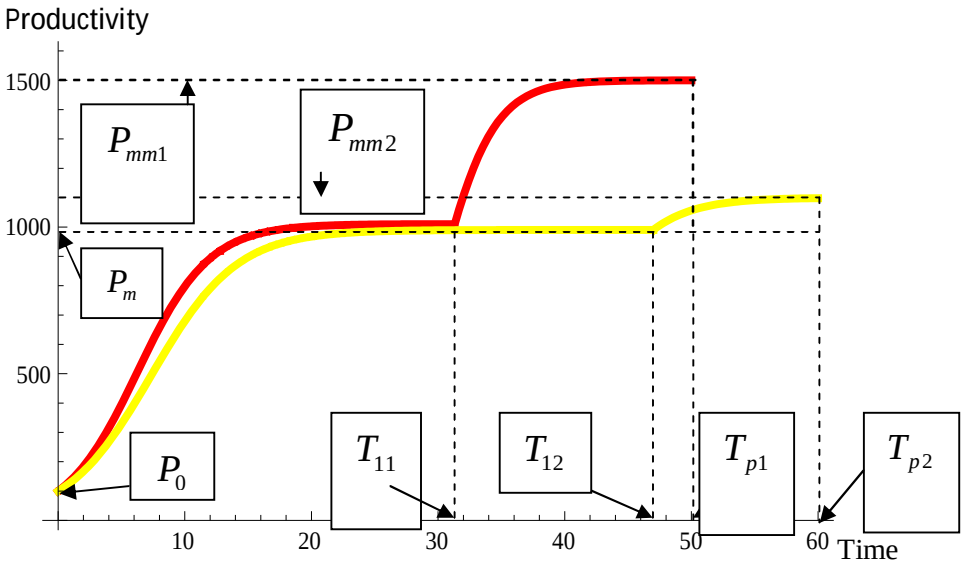

Fig.4 Completion of work with hard and light overtime regimes

Besides, depending on the severity of the overtime regime there might be additional risk, related to the problems, associated with the employee dissatisfaction. This in turn can decrease the productivity of labor.

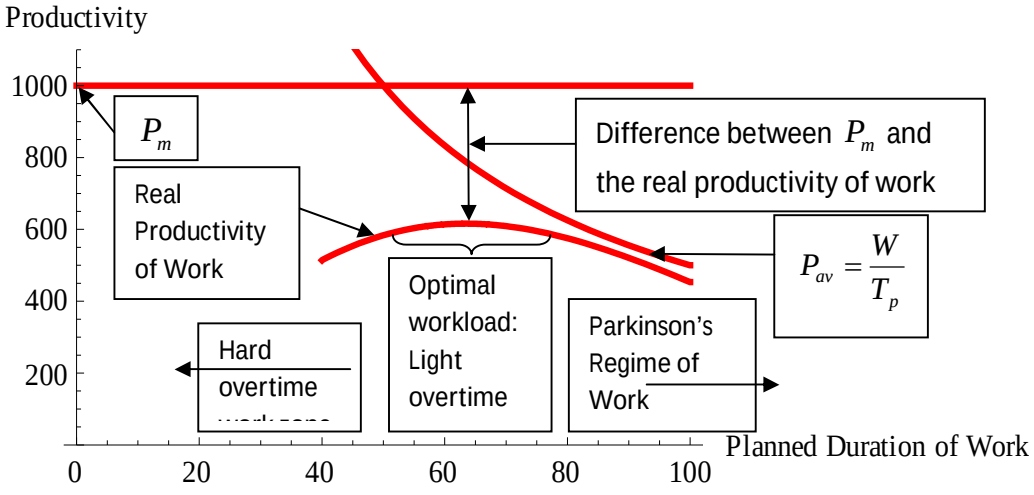

Fig.5 Between hard overtime regime of work and Parkinson's regime there is an optimal overtime regime of work with maximum productivity

In this sense there is an optimal level of severity of the overtime regime of work shown in Fig.5.

Also in Fig.5 is shown the relationship between average productivity of a person P_{av} and planned duration of time.

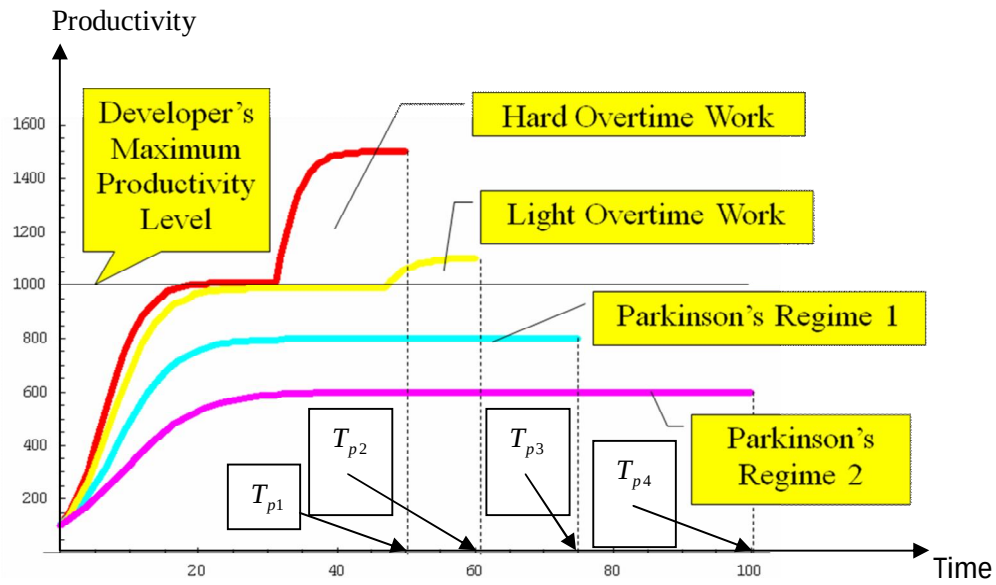

Fig.6 Joint presentation of Parkinson's regimes and overtime regimes of human work

Also in Fig.5 is shown the relationship between average productivity of a person P_{av} and planned duration of time.
Fig.6 combines four different overtime modes and Parkinson's regimes for the some work.

Considerations related to risk analysis

Controllability of human productivity completely changes the whole situation with schedule risk analysis. It shows that for the risk analysis we need to consider that the serial actions of human work are not independent events, and they are highly dependent from each other.

This simply means that if the first half of work $W_1 = \frac{W}{2}$ was done with low productivity P_1, then in order to complete the work on time, the second half of work must be performed with higher productivity P_2. In the case of one working person the duration of the first part of work can be calculated as

$$T_1 = \frac{W_1}{P_1} = \frac{W}{2P_1} \qquad (6)$$

If the planned duration of work is T_p, then the duration of the second part of work must be $T_2 = T_p - T_1$. This means that for the completion of the remaining work $W_2 = \frac{W}{2}$ on time the second part of it must be done with productivity

$$P_2 = \frac{W_2}{T_2} = \frac{W}{2T_2} \qquad (7)$$

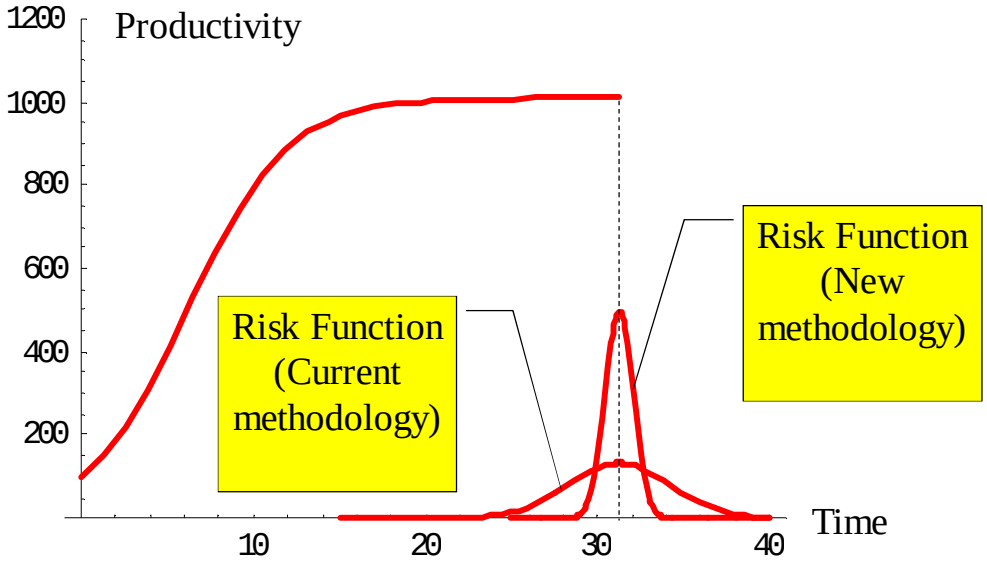

Fig.7 Controllable variance of the risk function

From (5) and (6) we can have

$$\frac{W}{2P_2} = T_p - \frac{W}{2P_1} \qquad (8)$$

From here can be obtained the needed functional relationship between P_1 and P_2 with constant completion time of work T_p.

$$P_2 = \frac{WP_1}{2T_p P_1 - W} \qquad (9)$$

In this sense there exist functional relationships between the productivities of people at different stages of project works.

Especially, there are important functional relationships between productivities of the last stages of project works and the productivities of the initial stages of the same work. Of course, in the case of complex project works, these functional relationships will be more complicated than the expression (9).

This kind of controllability of human productivities on the different stages of project works allows correcting the things on the fly and which helps to complete the work on time.

Therefore the resulting schedule variance also can be much smaller for the new methodology than for the current one. In Fig.7 are presented two schedule risk functions for the series of simple human actions with resulting Gaussian distribution functions [1]. The distribution function with bigger variance presents the existing methodologies of schedule risk analysis with constant productivities. The narrow curve is the result of the risk estimations based on the corrections of productivities on the fly.

Conclusions

- Human work performance is highly variable and, which is more important, it is also highly controllable,
- Planned time of work has a significant impact on the human productivity,
- There are two extreme modes of human work schedule: Parkinson's mode and overtime mode,
- Optimum mode of people's work is located somewhere between these two extremes and is directly dependent on the choice of a planned duration of work,
- Slightly tight schedule is an optimum one for human work productivity,

- Too tight schedule cannot be considered as an optimal one because potentially it contains additional elements of risk,
- Work completion time distribution for existing cycle time models has unrealistically high variance,
- Accordingly schedule risk analysis currently is too pessimistic and uncertain,
- Existing schedule risk models doesn't account for variability and controllability of human work productivity,
- Because of the variable and controllable characters of human productivity, the variance of the schedule risk function is controllable too.

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