THE MATHEMATICAL MODELING OF THE PROGRAMMING OF THE ASSIMILATION OF NEW PRODUCTS IN THE CONSTRUCTION MATERIALS INDUSTRY

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Abstract: It is presented the research methodology using the existing informational system in enterprises for the mathematical modeling of programming the assimilation activity of the new products as well as ways and solutions of projecting and upgrading this, in a modern and unitary conception. Thus, it is presented the place and role of the informational system, the projecting stages of information flow, analysis and projecting methods, flows and informational circuits' studies from the enterprises. It addresses to the managers of enterprises from the building materials industry, to engineers and economists. It is emphasized the role of the research and development function in the evolution of the enterprise and the superior quality of the operations made using the calculation technique.

Key words: mathematical modeling, programming, construction materials

1. THE ROLE OF THE RESEARCH AND DEVELOPMENT FUNCTION IN THE EVOLUTION OF THE ENTERPRISE

The process of economic growth of an enterprise is a complex phenomenon and for knowing and conducting it, a series of factors that interact should be taken into consideration. From all the functions whose interconnection directly influences the evolution of an enterprise through all the aspects, the research-development function plays an important role for assuring the dynamism of an enterprise. In figure 1 are presented and detailed for research-development the enterprise's functions, the corresponding tasks and operations. This detailing is imposed by knowing the effects of the research-development function for conducting the economic growth process.

Each product manufactured in an enterprise passes through a characteristic

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evolution and has certain duration represented in figure 2.

The functions of the enterprise are presented in figure 1 along with the detailing for the research and development together with the corresponding operations and tasks. This detailing is imposed by knowing the effects of the research-development function for conducting the economical growth process.

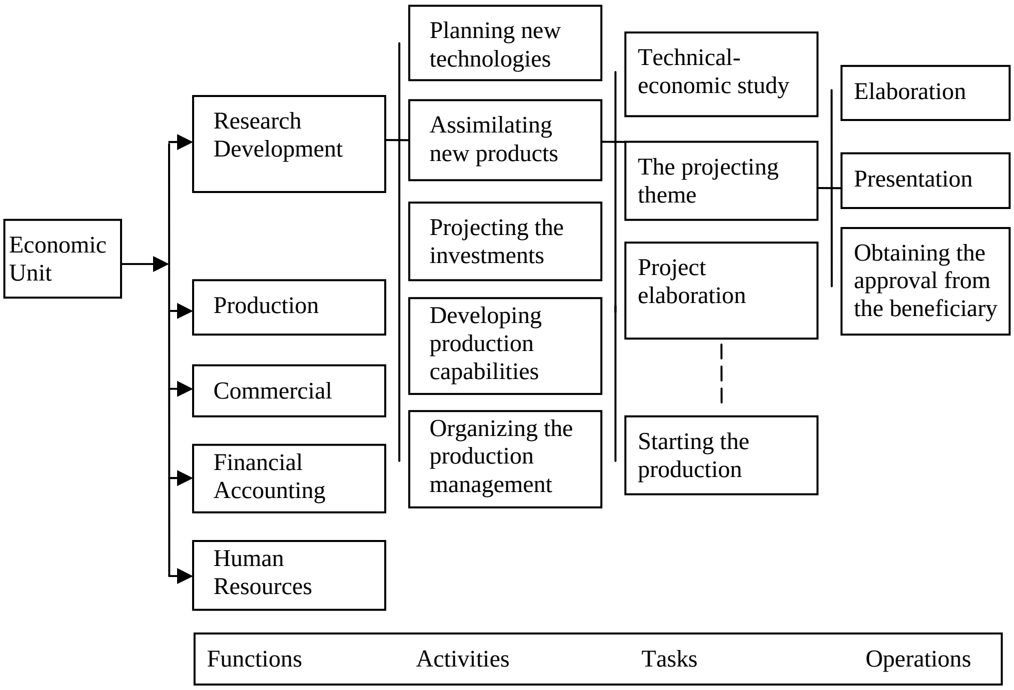

Fig. 1. The functions of the enterprise for research and development

Each product manufactured in an enterprise passes through a characteristic evolution and has certain duration represented in figure 2.

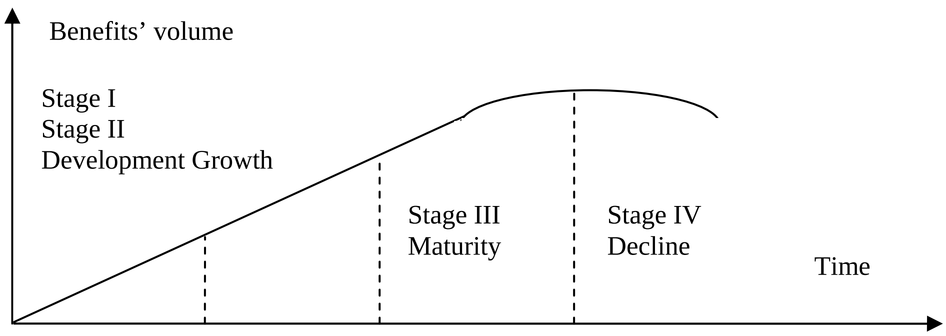

Fig. 2. The evolution duration of each product

A modern management, through objectives, for assuring a high and relatively constant level of benefits, requires a perspective vision, which allows adopting an optimal developing strategy. For this reason, it is extremely important to create products long before these impose themselves as a necessity.

The time variation of the enterprise's benefits for more products regarding the life cycle is indicated in figure 3. It can be observed that assuring a high volume of benefits requires in time continuous assimilation of new products.

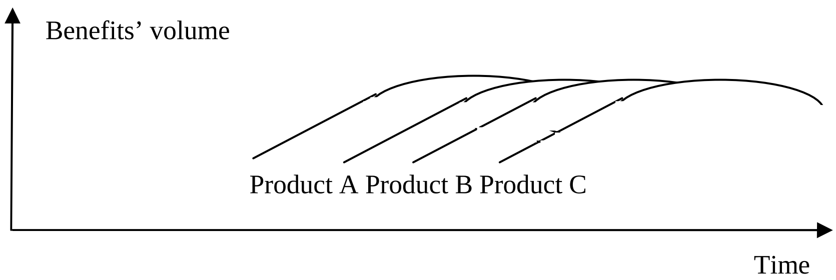

Fig. 3. The time variation of the enterprise's benefits

Between the duration of the assimilation cycle Ta and the duration of the life cycle Tv exists a proportionality relationship as the simpler products whose assimilation subsists less are renewing more often and the more complex products, with a longer assimilation have a longer life cycle too. The *k*=Ta/Tv ratio is inferior limited by the complexity of the research-projecting activity, which imposes to this process a limited duration, below which under optimal economic conditions it cannot be passed. (figure 4).

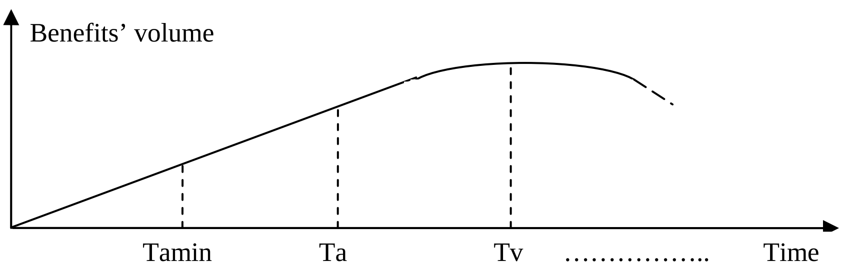

Fig. 4. The duration of assimilation and life cycle of products

The superior limit of k can fall to the *k*=1 value, a limit hypothetical situation because designing some products which in the moment of their launch would be overdone has no sense (Ta=Tv). In the research-development activity programming, the reduction of the coefficient *k* at a limit value $k \rightarrow k$min must be tracked on a permanent basis. This can be accomplished through the permanent reduction of the assimilation cycle's duration.

2. THE NECESSITY FOR MATHEMATICAL MODELING OF PROGRAMMING THE ASSIMILATION ACTIVITY OF NEW PRODUCTS

The always highly imposed requirements to the new products (functional performances, design, reliability), in parallel with high productive requirements (reduced gauge and minimal consumption of materials), but also the necessity of assuring all the guarantees that the products put into fabrication correspond to the norms and standards in force create optimal conditions for completion and control of the manufacturing, leading to a very complex system of new products' assimilation. In this system are involved a series of compartments with a large volume of documents and with a large assimilation duration. Thus, a complex assimilation procedure of new products must be established which will include coordinating the actions, tracking all the stages and framing in the project timeline requirements.

Thus, it will be made a mathematical model following figure 5.

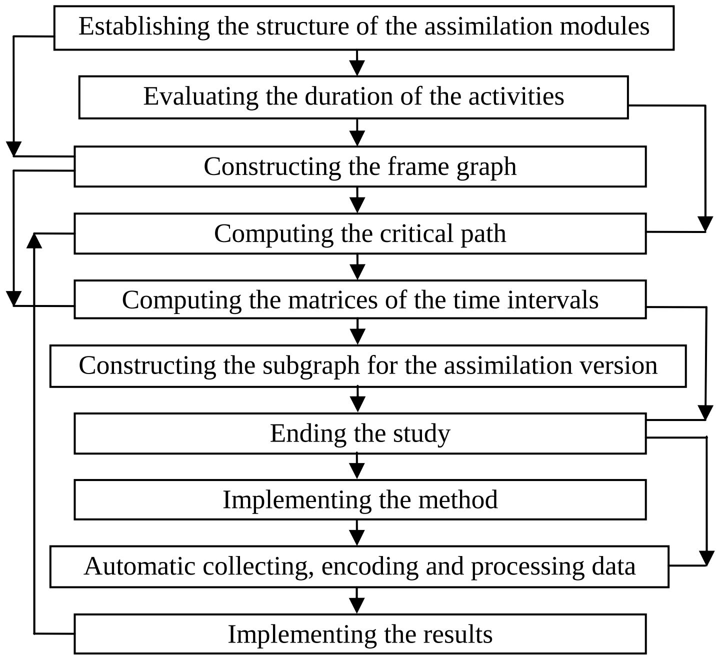

Fig. 5. Mathematical model for assimilation of new products

Complete and detailed determination of the structure of the assimilation cycle requires a decomposition of the entire process in its containing elements until detailed definition of all the elementary operations, evaluation of the work volume necessary for each operation, estimation of its durations and operation grouping in tasks with finality, which can be identified in a responsible compartment. In what follows, it is presented the assimilation cycle's structure in the case of cornerstones for pavement.

In the decomposition of the tasks into operations, it was taken into consideration an optimal grade of detail. Tasks division in a too large number of operations means useless complication with negative consequences on operative application possibilities, and on the other hand undifferentiating some independent stages does not emphasize the real possibilities and those of some reduction reserves of the assimilation duration by the superposition of tasks and operations. Between the multitude of component operations and tasks S={S1,S2,S3…Sn} and the multitude of offices and compartments B={B1,B2,B3…Bn} exists a complex relationship like in figure 6. The line which connects a task with an office is marked with a letter that indicates the number of operations from the task. The complexity of the relationship between the two sets {S} and {B} is in figure 6 and it is observed the difficulty of tracing the relationships. Thus, it is imposed using a procedure that will offer a clear and suggestive structure of the process.

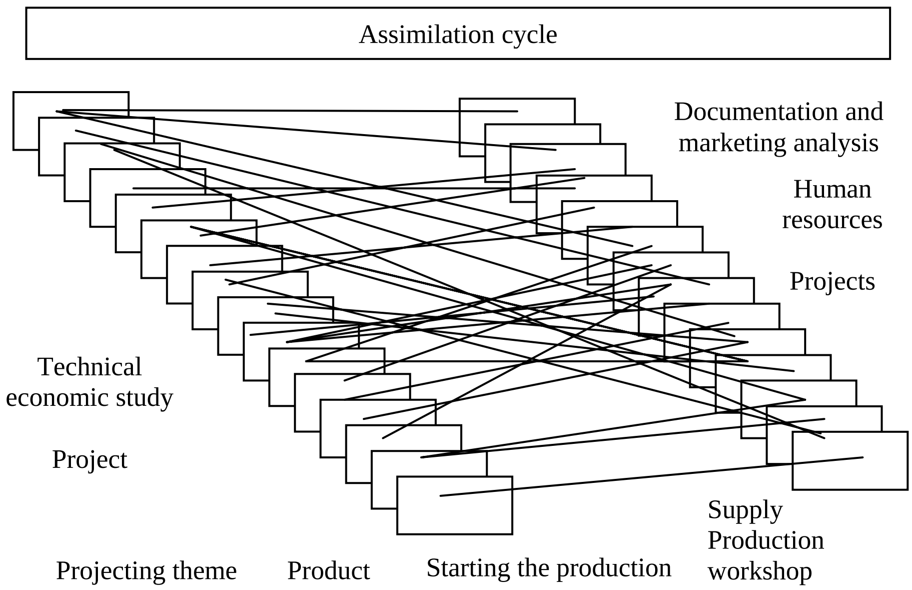

Fig. 6. The relationship between the multitudes of components

When implementing the model of assimilation of new products is necessary to specify all the component operations. For this, two influence factors are taken into consideration: the complexity of the product $p1$, the number of markers $r1$.

The complexity of the product takes into consideration the different difficulty grade in projecting, depending on the product time and the grade of innovation. The number of markers takes into consideration the work's volume through considering a proportionality element, for example the number of specific markers $r1$. Based on these influence factors, the duration of each operation is calculated using the relation:

$$t = a + b \times r1$$

The values of *a* and *b* can be taken from specialty tables.

Example:

Stage:	Technical-economic study		
Name:	Documentation and marketing analysis	*a*=10	*b*=20
	Elaboration	*a*=15	b=22
	Deliberation session with interested factors	*a*=3	*b*=33

There are some activities, especially those with testing orientation, whose duration is independent from the number of markers, which leads us to the conclusion that the duration is approximated. For this reason and considering that the influence factors' weight may vary as a result of changing some given conditions, it is required to establish a system that will allow permanent updating the values.

When analyzing figure 5, it results that the structure of the assimilation cycle and the duration of the component operations can be passed in a higher projecting stage of the situation suggested through the model planning.

Due to the complex structure of the assimilation cycle, the relatively high number of component operations which have a series of delays because of simplistic programming and in absence of a global vision of the entire process it is imposed to use a scientific programming and tracking method, which will provide a complete and suggestive perspective on the time evolution of the process and which will allow a permanent and operative adjustment of the appeared error events. The mathematical model adequate to this process is a graph.

The stages of graph construction are:

- establishing the set of activities;
- determining the succession of the activities according to the graph topology.

An arch represents each activity of the project and a node represents an event. Example: "Projecting the angles of the front-right side of the paving stone" is presented in figure 7. The node ri represents the event at the beginning of the activity and the node xy the event at the end of the activity.

Fig. 7. Example for projecting the angles of the front right side of the paving stone

In case a certain activity cannot start before some activities end, the graphic representation is that from figure 8.

With this the paving stone's support model process is marked by the condition of the execution of the paving stones' support model and by the documentation preparation of the paving stones' support model. The initial moment of the whole project is represented by the event of commencing the activity of "documentation and marketing analysis" from the "technical economic study" stage from figure 6, followed by the designed stages to be completed.

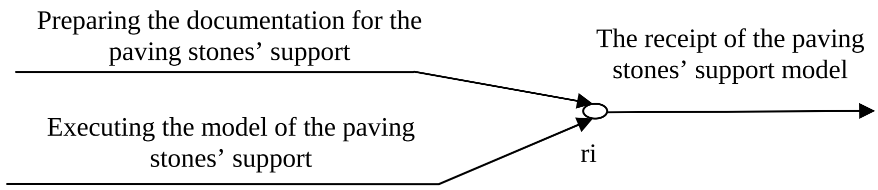

Fig. 8. The start of a certain activity after the ending of other activities

A procedure to shorten the project duration is by fragmenting an activity in order to allow the initiation of another one that is conditioned only by a part of the previous work. Ex: "dyeing the mobile trolley" can be done on the completed modules without the need to finish the wheels. Just like in figure 9.

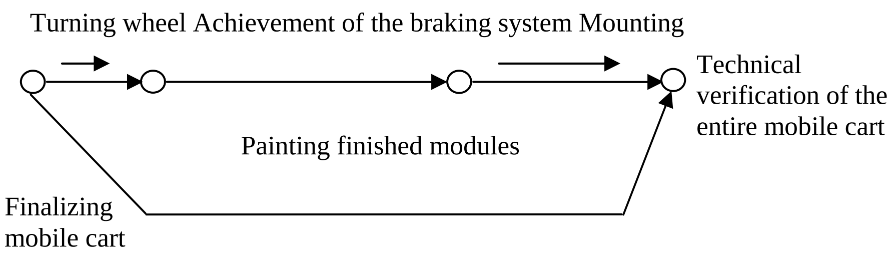

Fig. 9. The procedure to shorten of project duration

The presented case is a general one, but in some particular cases not all the activities must be represented because not always a prototype is manufactured, usually moving directly to the execution of the zero series.

For the critical path algorithm calculus, for each of the nodes two strokes have been taken: nearest time for achieving that event and the farthest time for achieving the event, ti. For some node the two strokes are from the above table, Table 1: ta = max (th + thi); ti = min (tj- tji).

With the help of these formulas we can calculate the times of different operations and the total time of the project. From user's point of view, the planning and tracking procedure of the assimilation stages of new products realization is not always enough. Many times it is necessary to know the timeline between a certain activity and another one, especially the main activities that are followed with the internal plans given in the calculus stage of the time matrix.

By noting the events that represent the finalization of the activities with "o" and i = 1,2 … the last activity, we have: tij = | oi – oj | with i, j = 1,2, 3 … the last activity. If these calculations are made at every graph for all the important activities, the timeline matrices are obtained.

The mathematical models of programming the assimilation activity of new products allow using the means of processing the data in the technical production domain. So, at the elaboration of the plan view in the assimilation of new products domain, the mathematical model allows establishing all the characteristics and terms for the designed products. All these variables are configured in a database and can be consulted with a series of specially designed applications, like in figure 10.

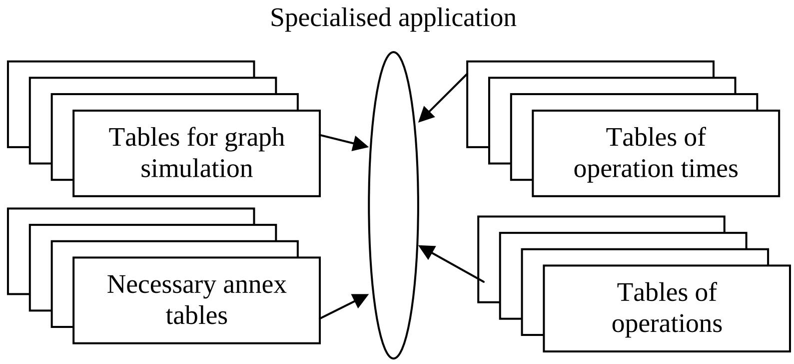

Fig. 10. The configuration of variables in a database

3. CONCLUSIONS

The computer conducting systems of the technological processes are conducting systems of some physical processes and are treated through the methods and means of informatics and are subject of industrial informatics. The computer conducting systems of the technological processes can function in a tight relationship with a system of economic management. These two systems form the global computer system of an enterprise. The current tendency of the computer conducting systems of the technological processes is to decentralize the equipment systems, to use the computing, acquisition, control, signaling etc equipment, flexible modeling and with a low price of the whole system. The scientific substantiation of the computer conducting systems of the technological processes and its elaboration represent important objectives for the research system from the informatics, automatics field and other domains which pull together its projecting and exploitation.

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