Project Management Information Systems: an Experience of Developing and Implementation on a Production Enterprise. Case Study

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Abstract

There is considered in this paper an experience of development and implementation of a project management system, that includes such components like information technology of project management and a new organizational unit "Project Management Center" of a production aircraft enterprise “Skyeton”. The authors highlighted the main problem of project management in the production enterprise – the intersection of production and project activities in resource management of the enterprise. So, in the paper, there is presented how this problem was solved via the development and implementation of a PRP system that is destined for the collection, storage, processing, and use of project information for budgeting and management of logistical and labor resources purposes, and the scheduling of project realization on different levels of the production and project activities of the Skyeton. The theoretical and practical substantiation of the use of such a system is presented, as well as its advantages compared to similar systems.

Keywords

Resources management, project and program portfolio, project management, plan, production enterprise, information technology.

1. Introduction

Production (or manufacturing) enterprise is a business entity established to produce goods for sale to wholesalers, retailers, or end consumers [1].

Such kind of enterprise decides how much of each commodity that it sells (its “outputs” or “products”) it will produce, and how much of each kind of labor, raw material, fixed capital good, etc., that it employs (its “inputs” or “factors of production”) it will use. The various decisions a business enterprise makes about its productive activities can be classified into three layers of increasing complexity. The first layer includes decisions about methods of producing a given quantity of output in a plant of a given size and equipment. It involves the problem of what is called short-run cost minimization. The second layer, including the determination of the most profitable quantities of products to produce in any given plant, deals with what is called short-run profit maximization. The third layer, concerning the determination of the most profitable size and equipment of the plant, relates to what is called long-run profit maximization [2-5].

If a large enterprise is project-oriented and its project and production activities are closely united then there is a place to talk about megaprojects, because project management in production processes is needed large investment commitment, organizational complexity, and long-lasting impact on the economy, the environment, and society.

Proceedings of the 2nd International Workshop IT Project Management (ITPM 2021), February 16-18, 2021, Slavsko, Lviv region, Ukraine
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In the paper authors consider an Aviation Production Company “Skyeton”. The enterprise was founded by a group of engineers and pilots in 2006. The company develops and supplies small unmanned aerial systems and light sport aircraft for numerous aerial solutions.

One of the enterprise products is Skyeton K-10 Swift - a two-seat, single-engine light sports or ultralight aircraft designed in Ukraine. The Skyeton Swift is a conventionally laid out single-engine, high-wing light aircraft with side-by-side seating for two. The wings have a constant chord, each braced with a single lift strut to the lower fuselage longeron. They use a single metal spar and have stressed skin metal upper surfaces and leading edges, combined with fabric-covered lower surfaces aft of the spar. Fabric covered ailerons and inboard slotted flaps together occupy the whole of the wing trailing edges. The wings carry 2.17° dihedral [6-8].

The main feature of the Skyeton enterprise is using project approaches for production activity. This means that process of creating every aircraft was considered as a separate project, and the production of all aircraft was defined as a project portfolio. So, there was a situation of intersection of the processes of production of airplanes and project management processes. To combine these processes, it was necessary to overcome the next gaps: lack of the information technology that allowed manage both projects and products at the same time with constant information synchronization and lack of organizational unit that will be responsible for project management, like Project Management Office.

These gaps were a bridge by the project management system implementation. The project management system included implementation of information technology, changing organization structure, and developing project management methodology.

Today exist a lot of scientific researches is dedicated to overcoming these gaps. Some of them are works of Teslia I.M., Morozov V.V., Livesey V.P., Ahrari A.M, Hassan A., and so on [9-13]. Nonetheless throughout proposed in the research approaches there was no one suitable for Skyeton enterprise.

The objective of the paper is a description of the experience of project management system implementation on the production enterprise Skyeton.

2. The Main Focus of the Paper

The main challenge of project management system development and implementation was resources management of production and project activities of the Skyeton. This problem was based on the relationship between the use of project resources and produced resources of the enterprise. On the (fig.1) this relation is presented.

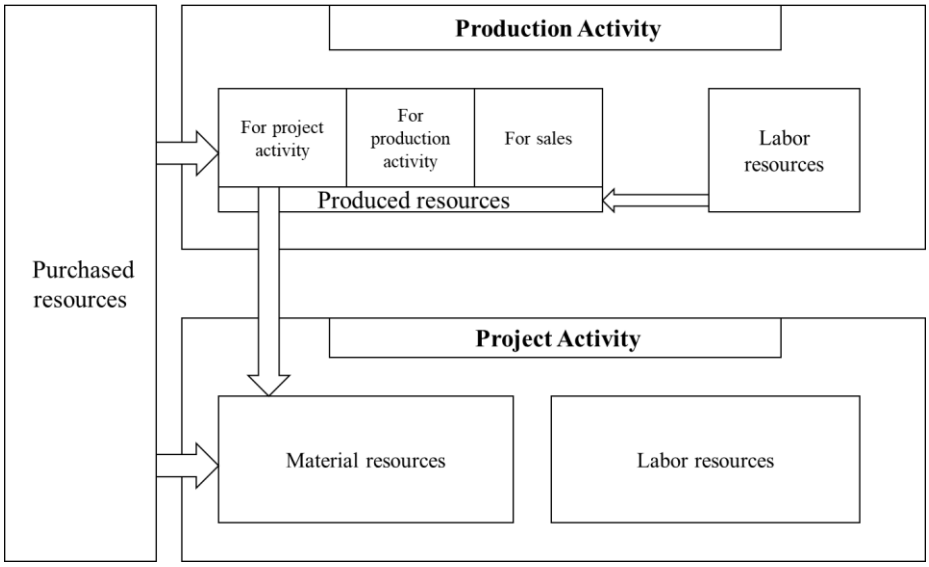

Figure 1: Relation between resources for project and production activities

Let’s make a short describing the figure.

For project activity the next types of resources are highlighted:

Labor resources – a staff of an enterprise that is involved in the creation of a product of production activity.

1. **Produced resources** – resources that are the results of the production activity of an enterprise. Authors highlight the next types of produced resources:
   - *Resources for production activity.* Examples of such resources: raw materials, material, and semi-finished products. These resources are parts of other produced resources.
   - *Resources for project activity.* These resources are used for the creation of products resulting from the project activity of an enterprise.
   - *Resources for sales.* These resources are used for external sales.
2. **Purchased resources** – resources resulting from procurement processes of the enterprise. Purchased resources are involved in the production of produced resources.

Table 1 shows an example of Skyeton resource and its constituents.

Table 1

Example of Skyeton resource and its constituents

L-0 Longeron.								
Code of LR	*Labor resources (LR)*	*Labor costs, person * h*	*Code of PR*	*Purchased resources (PR)*	*Plan amount of PR*	*Code of PrR*	*Produced resources (PrR)*	*Amount of PrR*
LR.1	Avangard LLC (laser cutting)	6	P.1	Bolt M6x24 OST1 31138-80	8	PR.1	Upper belt	1
LR.2	Technical control	0.7	P.2	Nut M6 OST1 33059	8	PR.1-1	Upper belt (produced)	1
LR.3	Coating anodizing wh./ col.	3	P.3	Ducson DX61 primer with DX32 thinner	0.1	PR.1-2	Upper belt (painted)	1
LR.4	Riveting plot	4	P.4	Rivet 3,5x12 OST1 34078-85	36	PR.2	Lower belt	1
LR.5	Layout precinct	3	P.5	Rivet 3,5x8 OST1 34078	21	PR.2-1	Lower belt (produced)	1
LR.6	Painting precinct	2	P.6	Rivet 3,5x9 OST1 34078	200	PR.2-2	Lower belt (painted)	1
LR.7	Locksmith precinct	4.7	P.7	Rivet 4.0x10 OST1 34078	2	PR.3	Spacer	2

On the (fig.2) presented the hierarchical structure of “Longeron” resource components and also labor resources for its production.

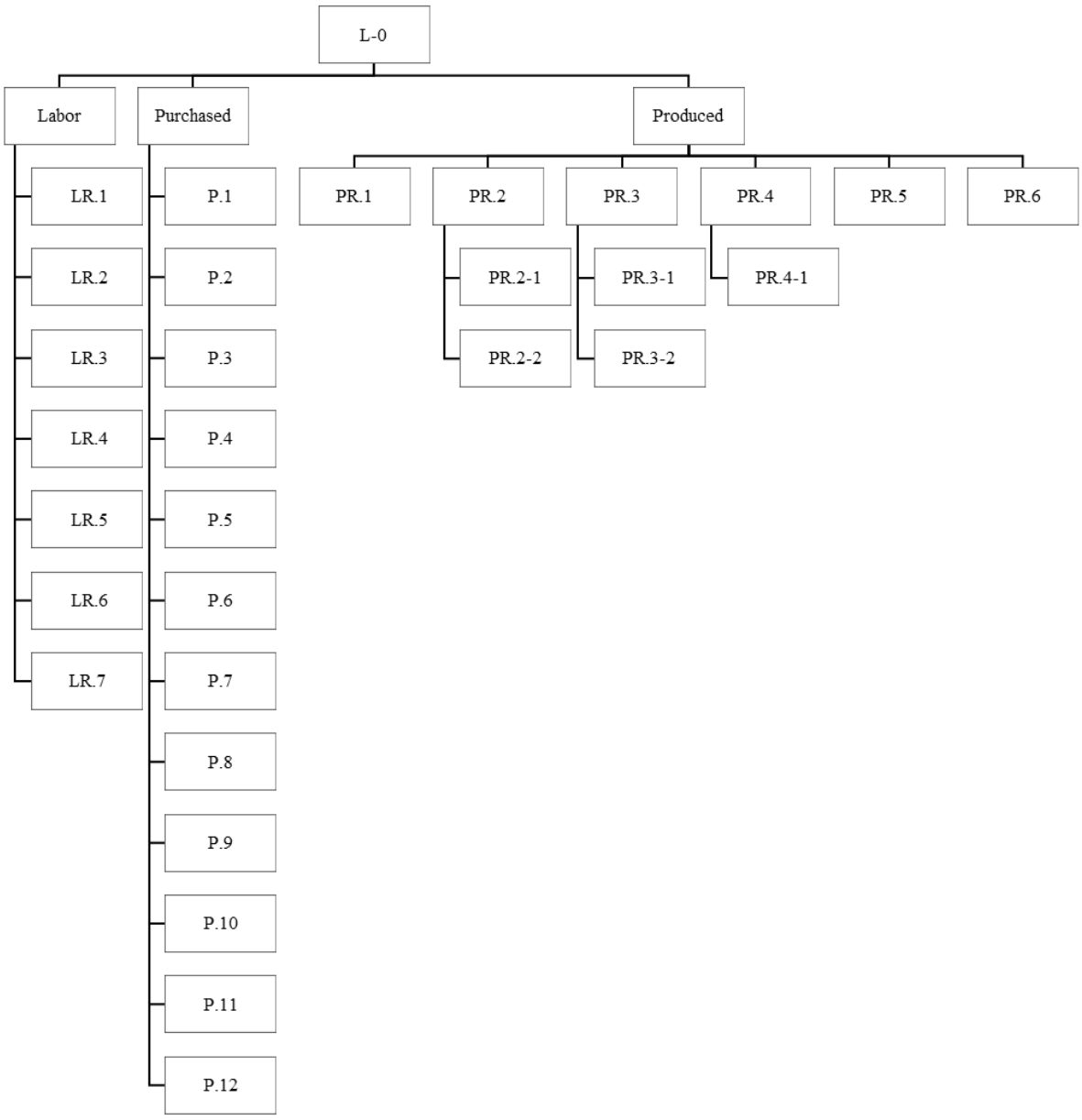

Figure 2: Hierarchical structure of "Longeron" resource

The longeron is one produced resource of an aircraft, but for the creation of Swift K-10, it is needed about 900 produced and 600 purchased resources. The project portfolio consists of 4-5 aircraft that are created at the same time on different stages of production. Looking at the figure it could be imaged that it is a pretty hard task to manage all resources of the project portfolio given the fact that during the management of these resources in project activity of an enterprise here is a plurality of processes of planning, procurement, storage, logistics, etc.

So, there should have been implemented pretty powerful information technology that would allow to make a portfolio schedule and would have tools for all processes of resource management.

There was decided to implement software "Primavera P3" for project portfolio planning. But this solution was turned out to be unsustainable in the context of project and production activities of the enterprise because there were issues the solution of which is not provided for in a functional environment of Primavera P3. These issues are defined below.

During implementation of the Primavera information system, the next issues were raised:

1. It was necessary to do about 2700 operations for the creation of every aircraft. As far as there was a necessity to manage the projects and the production it was necessary to put all these operations into the Primavera database. Also, links between operations should be set, and

resources assigned to tasks. Wherein it was produced in parallel a few aircraft that shared the same labor resources. As the result, it was obtained a complex manageable project portfolio schedule plan.

2. There was a big variance in order of resources production and so it was able to use different optimizations models for schedule plan, but it was impossible when the project plan was created by hands.
3. Constant changes in project portfolio lead to changes in portfolio schedule plan which was pretty hard to make by hands. For example, the CEO decided to change priorities, and there became a situation when it was needed to push one aircraft forward and the schedule plan was changed pretty much and these changes demanded hard work.
4. Often details were produced not one by one but by packages. This helped to reduce time wasted on equipment setup. As a result, part of the produced resources were sent to the warehouse. These resources were used in the next aircraft and did not have to be produced again. Information about warehouse contained in accounting system. And for quality planning, there was a necessity to exchange information between Primavera and the accounting system.
5. It was unclear in the Primavera project model how to manage resources that change their state.
6. It was necessary to manage procurements in the project portfolio and often it is convenient to group purchases from different projects. Also, there was needed to purchase resources in advance. The time for purchase depended on resources. It was tricky to manage such things in Primavera.

So, such software as Primavera did not cope with the task of project and production management of the enterprise. There was presumed that with MS Project and the other similar products there will be similar problems. Considering this there was a variant to implement Enterprise Resource Planning (ERP) system, but after marketing analysis, it was defined that ERP system has a weak project management module and these class of system also can solve all planning issues and as result can't be used for management of project and production activities of the Skyeton.

And as a solution, it was decided to develop add-ons for Primavera. And in the process of development, it becomes clear that it easier would be to develop an independent information system that add-ons for Primavera. Such information system should allow to management resources like an ERP system and manage projects like Primavera and will connect information systems are involved in project and production activities. But creation of the such system was needed some theoretical base – the development of a matrix management approach [14].

3. The matrix management approach

The matrix management approach is the project management approach, the implementation of which is carried out in functionally oriented management structures and ensures the achievement of project and enterprise goals.

The implementation of methods and tools of projects and organizations management reflects the technology for solving functional problems and does not allow creating a system of actions (works) in matrix management technology.

Management technology matrices are formed at the intersection of project and organization management processes with business management procedures.

The realization of the matrix management approach indicates the nature of project implementation, the movement of materials, resources, and information along the technological chain determines the organizational and technological features of the structure of the project-oriented enterprise as an object of management.

The matrix management approach is used in project and program portfolio management and allows to manage project resources (in contrast to resource management in projects - which is typical for the critical chain method).

The matrix models for resource management of the project and program portfolio are an integration of the critical chain method and the matrix management method and allow to manage both the resources in the projects (when the resources allocated to the project are distributed among the

works overtime) and project resources (which is typical for the allocation of resources for portfolio/programs projects).

And, it is very important, they allow to manage the production of these resources (during the construction of aircraft, create a plan for the production of details that takes into account the simultaneous implementation of several projects). This helps to solve the problem of resource management of project and program portfolios, which will increase the efficiency of the enterprise.

As is known, the use of the critical chain method provides effective resource management in the project, while the matrix management approach is used to interconnect project management processes and production activities aimed at generating resources.

Therefore, the authors proposed the development of a matrix model of resource management of the project and program portfolio.

The matrix model of resource management of the project and program portfolio is an improved approach to project and program portfolios management and provides management processes and procedures that are not only in the vast majority of cases capable of ensuring the systematic completion of projects on time, within budget and by the originally agreed specifications, but also can significantly reduce the time of project execution without increasing resources.

The matrix model of resource management of the project and program portfolio considers each portfolio/program as a set of projects ordered or related to each other, implemented through the production activities of the enterprise, which focuses on the production of resources for the project and program portfolio and products for customers [15].

Based on matrix model was developed and implemented PRP that allowed to solve problems with resource management of the portfolio of projects and programs of the company "Skyeton".

4. PRP system development and implementation

The PRP system is destined for the collection, storage, processing, and use of project information for budgeting and management of logistical and labor resources purposes, and the scheduling of project realization on different levels of the functional and project-oriented activities of production and construction enterprises. This system is used in particular to the challenges of associated production (operative) and project activities of the enterprise.

PRP system covered the next processes of the Skyeton activities:

- project planning;
- project administration;
- project financing; and project information support. The PRP system aims to enhance the management efficiency of the project-oriented organization by optimal (rational) resource utilization and production project activities [16-22].

For these reasons, the PRP system solves problems listed below:

- collection and storage of the information of available and required labor resources;
- conducting of the regulatory information on the complexity and duration of the operations implemented by the company;
- classical calculations of network, bipartite, and line charts;
- modeling of the production (operating) planned activities of the enterprise;
- preliminary analysis of the production (operating) planned activities of the enterprise;
- report processing of the resource loading and production (operating) planned activities;
- resource loading optimization;
- calculation of the optimal number of resources.

The PRP system has the following structure on the (fig.3).

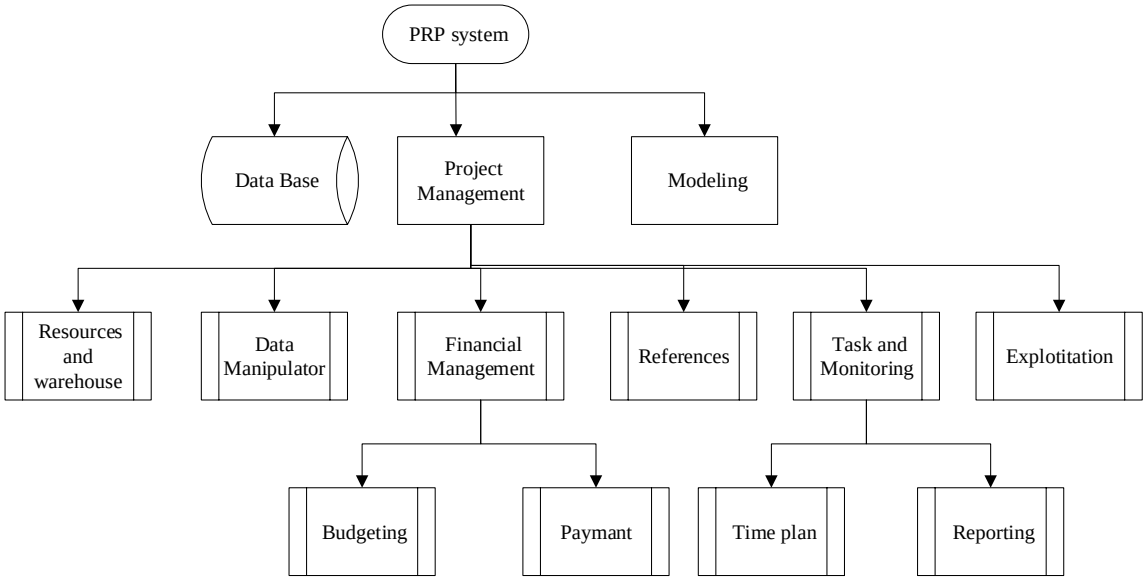

Figure 3: The PRP system structure

There are two unique advantages from the traditional project management information systems that the PRP system has: *possibility of the simulation modeling* and *the ability to plan the project from a «product -resource- product» position* [23].

Simulation module allows to create the optimal management plan for material and technical and labor resources of Skyeton production based on the established limits, the process sequence, and the requirements to the timing and cost for creating the aircraft.

Schematically, the operation of the simulation module is shown in fig.4.

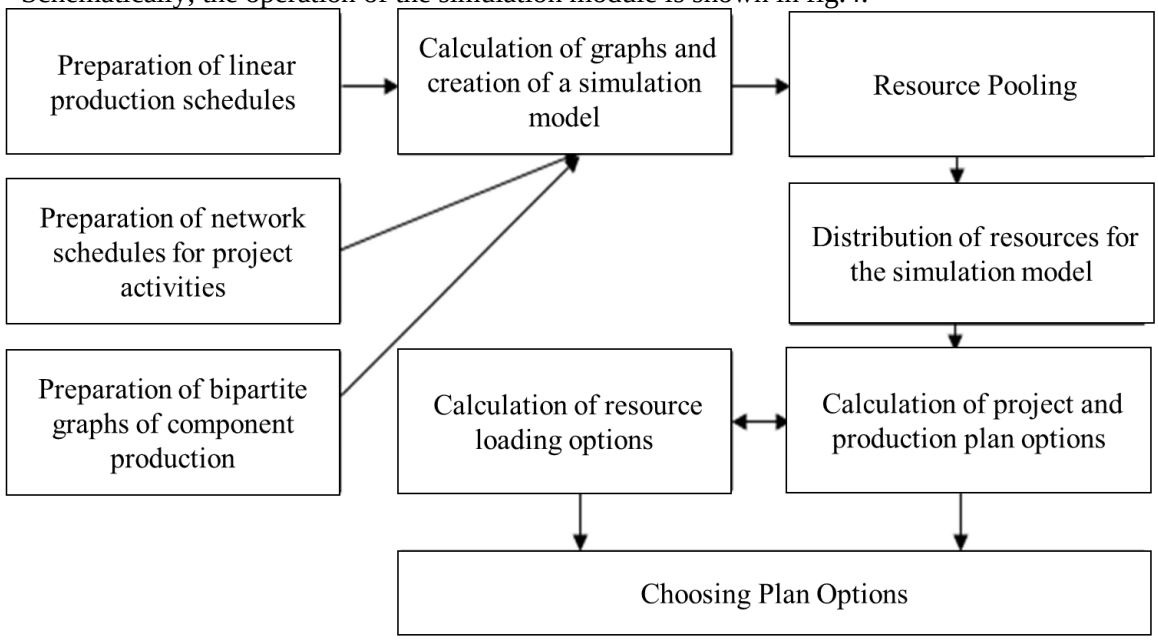

Figure 4: The operation of the simulation module

When using the simulation module, the best solutions are searched for taking into account the functioning of the entire enterprise, which is achieved by raising the awareness of all management services.

The logic of the ability to plan a portfolio of projects from a «product -resource- product» position is as follows (fig.5, fig.6):

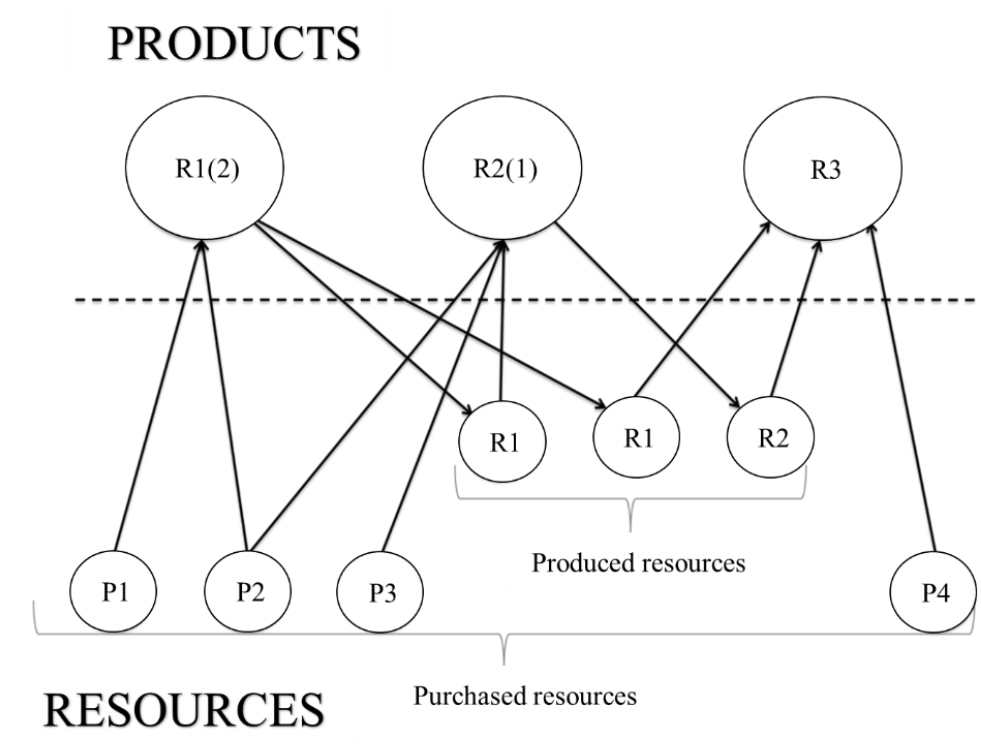

Figure 5: Portfolio Planning Bipartite Graph

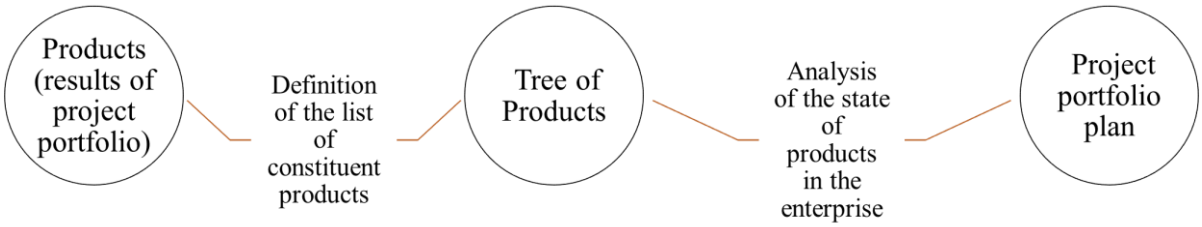

Figure 6: The logic of using the bipartite graph

1. When initiating projects, the portfolio defines the product (result) of the project and the requirements for it.
2. A tree of products is being built, the result of which is a list of products necessary for creating the result of the project and the sequence of their necessity in the project.
3. The action on a product at a project-oriented enterprise is determined:

- purchase a product;
- produce;
- take in the warehouse;
- available.

4. A correlation of product requirements is carried out for all portfolio projects and a plan is drawn up.

When using matrix models, the work will be characterized by two parameters: the product, which is the result of the work, and links with other works. Duration of work is determined automatically by labor efforts for product production.

In Figure 7 it is shown a new work flow chart.

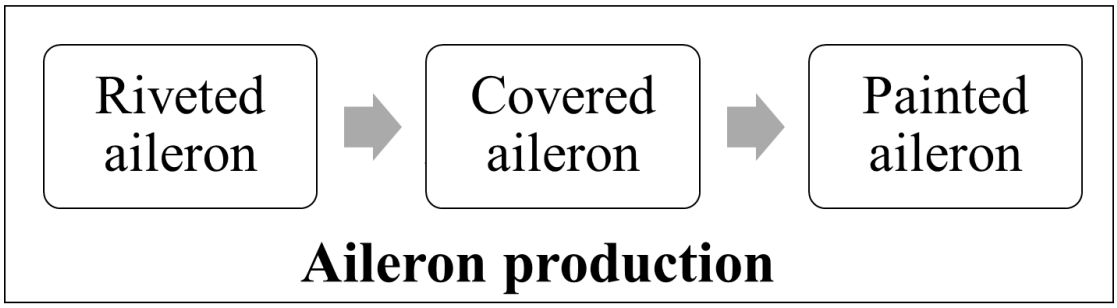

Figure 7: Diagram of the production process of aileron [19]

Such presentation of the resource's movement process has several advantages:

- the number of operations reduces;
- duplication of resources disappears;
- mess with how to calculate the cost of resources disappears (if resources are entered in the project management information system in the different states, how to determine on which of the states to assign the value?);
- the process of determining the status (stage) of the task simplifies. For now, this value is the result of readiness or unavailability of many products.

In addition to the planning and monitoring of the tasks fulfillment, materials and technical management, labor resources management, the system allows more accurate than traditional project management information systems to present the technical process, avoid duplication of resources, which is important for the management of projects [24-31].

5. Creation and implementation of project management center

For support of project management in the Skyeton enterprise and PRP-system, in particular, was created a department "Project Management Center".

Project Management Center (PMC) is a structured department of the Skyeton that standardizes project management practices within the enterprise.

For this purpose, a single terminology, a single scheme of interaction is implemented, so that managers responsible for the project can understand each other freely.

In addition to individual projects, PMC manages the main portfolio of Skyeton projects and structural departments, defines the methodology of repetitive processes, identifies the most effective methods for their future implementation in practice.

Assignment of the center:

1. Providing transparent access to the project and program portfolio.
2. Facilitate project and program portfolio management.
3. Developing the methodology of megaproject management.
4. Regular analysis of projects and portfolios.
5. Project Change Management.

The main functions of the PMC:

1. Project support: providing managers in the departments with project management guidance.
2. Project management process/methodology: development and implementation of an adequate and standardized process; interest in the experience of domestic and foreign enterprises; analysis and control of project implementation; change management in projects.
3. Training: guiding training programs; consultation on emerging issues; training in project management techniques.
4. Software tools for project management: monitoring the work of responsible employees of the branches when working with automated systems; providing consulting support to users of project management software.

5. Asset control and regulation: identifying staff of project managers who can coherently manage related projects and allocate resources qualitatively; forming a responsibility matrix that determines the place of each manager in the project.

The PMC is responsible for allocating resources to improve production. Controlling the projects and responsible persons, the PMC appoints the persons who are most suited to the priority projects and continues to monitor the project until its completion. It also eliminates duplicate tasks, raises productivity, and gives the highest priority to critical projects.

The Skyeton Project Management Center consists of the following organizational units:

1. Strategic Committee for the Development and Modernization of the Skyeton.
2. The Working Group for Information and Organizational Support of the Strategic Committee, which in turn includes:

- Project and Program Implementation Committee;
- Back office.

6. Conclusion

The result of the implementation of the project management system was a PRP system that calculates the rational terms of task execution and project budgets in operational activities of the production aircraft enterprise "Skyeton". Experience has shown that the implementation of such technologies increases the production performance of the enterprise by 15-50%. Using the PRP system, it managed to increase the productivity of production by 1,5 times from 8 to 12 airplanes per year without increasing the number of work resources. For today, this system implements in other productions, for example, the Tutkovsky company.

The main conclusions of the paper:

1. Production enterprises have specific features in business processes, organizational structure, etc. which should be included when the project management system is implemented.
2. Traditional information technologies of project management not suitable for the management of project and production activities of the enterprise, because these systems could not support all processes of project resource management and a lot of information is lost in project management processes.
3. Using the information system algorithms which are based on the bipartite graph is more convenient for such enterprises like the Skyeton because allows to manage the production of resources for projects of the enterprise.

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