

MODELING OF PRODUCTION PROCESSES – REVIEW ARTICLE

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Abstract: The purpose of this paper is to present an available methodologies that may be the basis for modeling production processes. In literature there are many affordable methods and notations for modeling processes, but they are still not widely used in companies. Choosing the right methodology and tool for modeling processes is not as easy as it appears. It requires, first and foremost, a thorough analysis of the production process, an understanding of the purpose for which the process is modeled and the appropriate selection of that method, which will allow for a simple and transparent presentation of even a complex production process. Although the methodologies available on the market are not the most difficult and actually allow for a clear presentation of the production process, the companies do not always decide to use them. The high cost of buying the right modeling software and the time it takes to devote to the specific activities to create the model of the production process are quite significant. Few companies see the real benefits that a given methodology can bring, and most of them present the production process in the simplest form – using only a flowchart.

Keywords: process modeling, production processes, methods and notations of process modeling, modeling tools.

1 Introduction

According to M. Hammer, the process is “... a related task group which common result is value for the customer” [6]. In the *Reengineering the Corporation – A Manifesto for Business Revolution*, M. Hammer and J. Champy give a slightly more detailed definition of the process by formulating it as inter-related activities that have their own inputs and outputs, and create value for customers [5] or organization [3]. The graphic representation of the production processes (mapping of their position by means of graphic symbols) allows for the rapid identification of critical areas, and make the necessary changes that are closely linked to improving their position. Companies in which production processes are carried out should first of all focus on their continuous improvement, in that it enables them to achieve additional benefits for customers and the company itself. Therefore, the selection of appropriate methods and tools for modeling production processes seems to be crucial for the undertakings engaged in improvement activities.

To choose the right modeling methods, you must first understand what self-modeling is. Incorrectly in the literature, the model is often brought into the normal flowchart or process map. While mapping only serves as a mapping of the process itself (subsequent actions/steps) and identifying owners of each stage, modeling will also allow to identify some process-specific parameters (indicators). These parameters allow to control the production process (its automation) as well as in the future for the implementation of supporting tools, including appropriate tools and IT systems, as well as for optimization of production processes with respect to the selected criteria, in this case predefined parameters (indicators) [8].

Modeling allows not only to map the actual course of the production process (successive operations) and the relationships that take place between the processes identified in the process but also to give the process concerned the proper characteristics (parameters/indicators) relevant to the production process and its users. However, it is still only a mapping – i.e. the transfer of the actual production process to the most accurate graphic model. In this context, the model will only reflect the most important features of the analyzed production process from the point of view of the task (goal) that it pursues [4]. With this dependency, one production process can be described by different models, and each one can be equally useful in a particular enterprise or an individual. It is worth pointing out here that it is also common in the literature that the model should be a compromise between the best and the simplest mapping of a given phenomenon or a process [7].

The first step in modeling a production process is to gather as much data and information about the modeled process. Correct identification and detailed analysis of elements - material and information flows (including its inputs and outputs), its objectives and participants will allow the most accurate representation of the process using the chosen model. The knowledge of these elements and the purpose of modeling itself determines the choice of the appropriate method or approach to be applied. A well-structured production process will allow for better understanding of the process and will significantly improve later on. The benefits of modeling production processes will be reflected in the added value that the firm will achieve – the speed at which decisions are made and related actions, minimizing manufacturing costs and increasing the quality of products and services [1, 2, 9]. By applying appropriate methods of process modeling in an enterprise, it should not be limited to the purpose of changes in production processes but also, and perhaps above all, to the potential for the creation and subsequent implementation of IT systems that allow for the monitoring and Controlling production processes and controlling them [8, 9, 11].

Turning to issues related to modeling of production processes, it seems important to define also the basic terminology here. As in the literature, the notion of the method is often interwoven with notation, and the term is also misleading, it is worth pointing out at the outset how these concepts will be distinguished. The notation is therefore a set of graphical elements available for the diagrams to be created, together with a description of the relationships between them. The method determines the approach to modeling; It outlines the principles that should be followed when modeling - describe what elements (e.g. diagrams) and in what order they should be used so that the model created is as precise and consistent as possible. Often, along with the notation, there is also a suitable method or methodology, but remember that these are two different concepts. Also, the term tool is associated with some of the methods and notations – software vendors often dedicate their programs to selected methods and associated notations. The tool will thus be understood as a computer program, by which it is possible to present a model of a selected manufacturing process [9].

For ease and due to the existing literature divisions, and actually lack a certain uniqueness, the method and notation will be in this article described in one category, the tool, however, will be in a synthetic way presented as a tool to create a model in the context of specific methods and notation (corresponding software).

2 Types and levels of modeling

There are many different models in the literature, due to the variety of problems that these models try to solve. An interesting classification for modeling systems and also identified within these systems processes is presented in a publication of A. Burduk, distinguishing the three most commonly used classifications – with respect to their form (appearance), the time and type of variables. The criterion of form (appearance) divides models into three groups [4]:

- physical models (physical) – they are a physical representation of the characteristics of the studied phenomenon, of appropriate scale and degree of accuracy (e.g. product model)
- schematic (graphical) models – take the form of diagrams, block diagrams, maps (e.g. model of flow of information in the system)
- symbolic models – in the form of mathematical and algorithmic writing, define relations between selected variables taking the form of mathematical formulas (e.g. simulation model of production process).

As it is emphasized by A. Burduk, the most universal models used at many levels of the company are schematic models that allow analysis of the problems that arise and provide the basis for further action. Equally often used in companies there are simulation models that belong to a group of symbolic models. With them, it is possible to perform simulations and to verify planned changes and decisions. Simulation models allow control of the process, assuming that the appropriate outputs of the process can be optimally adjusted for its inputs [4].

Among the schematic models we can distinguish three levels [4]:

- block diagrams – which represent the graphical course of activities identified in the selected process, enable identification of elements in the process and the relationship between them;
- process maps – which present the graphical activities identified in the process and their owners and contractors, improve the process and compare it with its previous versions;
- process models – which represent the graphical process of activities identified in the process and their contractors in a highly advanced form, consisting of not many different types of schemes, allowing for taking into account relations with external entities – depending on the chosen method or notation and allow to give the processes certain characteristics (parameters/indicators), enable building of information systems, reorganization of processes, optimization and control of processes.

3 Commercially available methods and tools for process modeling

As it was mentioned earlier, the creators of the given method/notation dedicate it to the appropriate IT tools, so this is also worth mentioning in this statement. The following table (Tab. 1) shows the methods/notations of process modeling and the corresponding IT tools that are most commonly used and widely described in the literature.

The variety of literature-based methods and notations of process modeling introduces some chaos and makes it difficult to choose the best solution. In scientific publications, however, the benefits of BPMN notation are very often emphasized – this approach is very comprehensive compared to other available methods. Its great detail, standardization and extensive usage make it a very popular method for business process modeling. In its favor, it also speaks of the fact that it is a constantly evolving notation that has a large base of elements and objects, which allows to reproduce even very complex production processes. The simple record of the process makes it easy to understand the model, also by people who have never before been modeled. BPMN is a very precise standard, and there are many tools on the market that support it. However, this method is

quite time consuming and the software for commercial use is relatively expensive. By the way, most companies do not decide to use it [11].

Also, some of the presented above methods/notations require some degree of know-how from their users, understanding the rules and rules used. All this involves additional costs and is time consuming, which many entrepreneurs cannot afford. These methods are very helpful when you are going to make far-reaching changes in the production process or deploy software that will support this process. Therefore, in most enterprises, no process modeling is used, and only a simple flowchart is generated that shows the process flow or is created in a slightly more advanced process map.

Table 1. Selected methods/notations of process modeling and corresponding tools

Method/notation	Characteristics	Selected tools
Business Process Modeling Notation	- allows to create many different patterns / models - a rich set of objects and elements - allows you to automatically generate program code used for application development - allows to assign selected parameters / indicators to a modeled process - allows to describe even very complicated processes - allows the contractor to identify the individual activities identified in the process - very detailed and quite popular method	- Microsoft Visio - Bizagi Modeler - iGrafx Process - Oracle Designer - ARIS Platform
Data Flow Diagrams	- allows for graphical presentation of data flow and information in the process - a small number of available objects and elements - allows you to create diagrams on three levels of detail - does not represent the relationship between the individual activities identified in the process	- Power Designer - Microsoft Visio - SmartDraw - Visual Paradigm
The Integrated Definition for Function Modeling	- a collection of several methods (most commonly used IDEF0 and IDEF3) - is used to graphically display functions, activities and activities in the process/system - allows the process control and necessary resources to be included in the diagram - allows for multi-level modeling of processes	- AIØ WIN - Edraw Max - Microsoft Visio
The Architecture of Integrated Information Systems	- a collection of several solutions for process modeling - is a graphical representation of processes in the form of events - a small number of available objects and elements - enables modeling on different levels (data, functions, organization, products / services, processes) - allows for a simulation modeling	- Platforma ARIS - ARIS Express - Microsoft Visio

Source: Own elaboration based on [1, 2, 3, 4, 8, 10, 11].

Conclusion

The appropriate selection of methods and tools for modeling production processes guarantees their correct reproduction and gives rise to a further improvement activities. Before selecting the appropriate method, it is necessary to analyze in a detail the particular production process, the elements of which are to be modeled. Equally important is the knowledge of the modeling goal itself, since each of the modeling methods allows for different results. The next step will be selecting the right modeling method, if there are no major problems with IT tools, which are in fact many (both free and paid version) on the market, the choice of the right notation or method is already a bit more complicated.

This choice should be therefore determined not only by the company's financial capabilities or the time, which can be devoted to modeling itself, but also the complexity of the modeled production process, the reason for deciding on modeling – the goal to be met by the model and its future customers. However, it is important to address the key question – Is modeling of the production process necessary? If the process is smooth and the benefits are satisfactory, it is not enough to prepare a map of the production process.

Process maps and common diagrams are a commonly used method for presenting production processes, mainly because they are not complicated enough to use time-consuming and cost-effective modeling methods in most of small and medium enterprises. Everything really depends on the ability of the company and often emphasized in the design of the purpose of modeling. Larger companies whose production processes are complex can, and should, allow themselves to be modeled accordingly – in line with the idea of continuous improvement and added value that process modeling undoubtedly brings.



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MODELOWANIE PROCESÓW PRODUKCYJNYCH – ARTYKUŁ PRZEGLĄDOWY

Streszczenie: Celem niniejszego artykułu jest przedstawienie dostępnych na rynku metodologii mogących być podstawą przy modelowaniu procesów produkcyjnych. W branżowej literaturze znajduje się wiele przystępnych metod i notacji pozwalających na modelowanie procesów, jednak w dalszym ciągu w przedsiębiorstwach nie znajdują one szerszego zastosowania. Wybór odpowiedniej metodologii i narzędzia do modelowania procesów nie jest jak się okazuje wcale łatwy. Wymaga on przede wszystkim dokładnej analiza procesu produkcyjnego, zrozumienie celu dla którego proces ten jest modelowany i odpowiedniego dobranie do tego metody, która pozwoli na proste i przejrzyste przedstawienie nawet skomplikowanego procesu produkcyjnego. Choć dostępne na rynku metodologie nie należą do najtrudniejszych i faktycznie pozwalają na przejrzyste przedstawienie procesu produkcyjnego, to przedsiębiorstwa nie zawsze decydują się na ich wykorzystanie. Dość znaczną przeszkodą są tutaj wysokie koszty związane z zakupem odpowiedniego oprogramowania do modelowania i czas, jaki należy poświęcić na poszczególne działania zmierzające do stworzenia modelu danego procesu produkcyjnego. Niewiele przedsiębiorstw widzi realne korzyści, jakie może przynieść użycie danej metodologii, a większość przedstawia procesy produkcyjne w najprostszej postaci – jedynie za pomocą schematu blokowego.

Słowa kluczowe: modelowanie procesów, procesy produkcyjne, metody i notacje modelowania procesów, narzędzia modelowania.