Features in management and monitoring of production process in manufacturing industry using integrated information technologies solutions

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Abstract. This paper gives a brief overview of the conditions, approaches and prospects of production control and monitoring of manufacturing industry through implementing information systems for optimizing the manufacturing process and to provide an answer to the question of the specificities for successful management of machine manufacturing enterprise through integrated software solutions. New integrated IT solutions based on the newest business management trends and information technologies that includes tools for management of the production and materials, as well as inventory planning, allocation of production resources, process analysis and production organization leads to improvement of the efficiency of business management and production management processes in manufacturing.

1. Introduction

Every business, notwithstanding its scale and phase of development, needs information. The process of management decision making is not always supported by the required information. This requires that more attention is paid on the activities of collection; processing, storing and using information adequate to the management needs (11).

For the purpose of helping the managers use their best abilities for high quality decision making, the required information should be provided promptly, at the adequate place and in the appropriate form. The fast development of business management software in the recent years contributed to the increase of the efficiency of many enterprises. The use of specialized software intended for the process control in production companies with different organizational and territorial structures contributes to the flexible management of the technical preparation of manufacture, the manufacture itself and the processes of material supplies and product sales (17).

These complex integrated systems have many advantages. First, they provide to the management complete overview on the corporate resources and processes running in the company, at any time, via a single interface. Second, they contribute to the optimization of resources and allow minimizing stock and more efficient personnel management (20).

Integrated information systems attracted considerable attention in the business world at the burn of the millennium. Despite the sizable investments involved, these software packages were a breakthrough, where they were installed by a vast majority manufacturing firms (18). After the initial excitement, however, an increasing number of managers have started to complain about the shortcomings of these systems. The main critique is that integrated information systems impede making changes to new product development and introduction process of an organization in dynamic
business environment. Over the past couple of decades, much focus has been placed on creating models for how products are “defined and documented” in information systems.

The purpose of this paper is to make a short analysis of the terms and conditions, approaches and prospects related to the successful management of machine manufacturing by implementation of complex integrated information systems for process control.

2. Literature review

Integrated information systems are modular software packages that integrate a firm’s business functions around a common database and standardized processes that are configured to fit the needs of the user organizations (22,25). Substantial research efforts have been directed to this special category of enterprise software. The notorious failures of some of the early implementations (see examples in, 23) gave rise to much research on the typical pitfalls and success factors of implementing information systems (for reviews and recent examples, see, e.g., 2,25,26,29,31). The variability in the outcomes of the implementations also motivated broad research on integrated information systems overall performance effects (12,14) and end users’ assimilation of the implemented systems (1,3,24,27,30).

Over time, the studies on integrated information systems have also started to cover more specialized tools, such as customer relationship management, manufacturing planning, advanced production scheduling, supply chain management, and sourcing software (1,21). This trend has been motivated by practical considerations, as firms have increasingly implemented standalone software (4,6,9). Although most firms do not have plans to completely abandon their integrated information systems, many have implemented standalone tools to replace some functionality of their information systems (7,10).

Because integrated information systems’ inflexibility is the most often cited reason why managers consider replacing them with other solutions (10), this study analyses the terms and conditions, approaches and prospects related to the successful management of machine manufacturing by implementation of such systems.

The connection between Product Development and Manufacturing logically falls within the New Product Development and Introduction (NPDI) process of an organization. A common language connecting the functions within the NPDI processes is needed and, once established, it can be used within and across the integrated information systems (13, 15). These systems will eliminate the need to manually transform product information, starting with the development processes, into manufacturing processes that are consistent across regions or manufacturing facilities. They will enable increased efficiency, productivity and quality of products as well as agility across the enterprise. The following benefits are a few examples that illustrate the magnitude of the opportunity:

- Reduction in search time for data – Estimates of time spent looking for data in the NPDI process range from 20 percent to 50 percent because data is not centralized, is not in a standard format and often is not electronically available to all parties.
- Reduced time to create master recipes
- Shorten manufacturing planning and site sourcing processes – Planning processes typically require site level knowledge of what materials can be used and what equipment constraints can be met.

3. Specificities of production preparation management

Management of machine manufacturing is the most complex case of production management. As a rule, machine manufacturing industry produces items with complex hierarchic structure. These items are usually multi-variant on all levels of production. In difference to the chemical industry where the product has its process route from the raw material to the end product, in machine manufacturing every assembly, part and semi-finished product have individual process routes. In other words, machine manufacturing industry produces complex multi-variant products based on complex multi-variant process routes.
The issue becomes more complicated due to the fact that each complex structure changes in the course of time, the design specifications and the process routes change too. Some changes are related only to the documentation and the future manufacture, other refer only to the manufacture at the given moment. Some changes affect the whole item, other - only certain components. Some changes enter into force immediately, other - from a specified moment on.

Therefore manufacture should be managed under conditions of constantly changing normative base.

The practical implementation requires real-time updating of the normative base. At any time it must be guaranteed that the participants in the production involved in the technological process have up-to-date information and that the up-to-date information about such technological process is kept only in the process control system (8).

The experience of the leading companies developing business management software in the recent years shows that the production management by means of information system is only possible when the normative base for the process engineers is created and maintained in the system itself (fig.1). Only if the process engineers create and update the specifications, technologies, the consumption rates of materials with the resources of the system, it may be expected that the production will be managed by means of up-to-date normative base.

The efficient management of machine manufacturing requires huge and various information about items, semi-finished products, auxiliary materials, tools, equipment, operations, workplaces, consumption rates, notices of amendments. Usually this whole information is scattered in numerous flow charts, operational charts and other process documents (19).

Data must be attached to the relevant product structure. Information about the auxiliary materials, instruments and equipment, kept in the process documents, shall be automatically attached to the product structure (fig. 2). Any real-time amendment of that information must update the relevant product structure. At any time the production worker, by opening the content of the product structure must see in the system guaranteed up-to-date information. He/ she should be sure that the up-to-date information about such product structure is kept in the process control system of the industrial enterprise and only in it.

![Figure 1. Model of information system implementing the interaction between the product preparation and the production management (28)](image-url)

The key for the successful implementation of production management system is to ensure the work of the process engineers within the system as an integral part thereof. The system must contain the whole panoply of resources required for the work of the process engineers:
To maintain the following processes:
- Design development - development of basic non-graphic design information: product structure, design specifications, group specifications;
- Forwarding of the tree structure to the production;
- Change of the product structure in result of production practices and at the clients' request;
- Function available in the product structure enabling the description of the sequence of assembly, processing, disassembly.

To generate documents:
- Flow chart;
- Operational card;
- Technical control card;
- Equipment card;
- Order card;
- Instruments card;
- Registration of amendments card.

To maintain functions increasing the efficiency of work of the process engineers:
- Standard flow technological processes;
- Group flow technological processes;
- Library of standard operations;
- Real-time order for equipment design;
- Calculator of consumption rates for materials and labour expenses;
- Control on specific operations.

To be integrated with CAD/CAM systems – integration means capability for importing the results from the work of the CAD/CAM systems in the control system.

**Figure 2.** Model of information system unifying the information split into many schedule and operation maps and other processing documents (28)
The production control via automated systems requires that the process tree of the product represents a design tree with added elements of the technological processes - work in progress, auxiliary materials, instruments, equipment. Such additional information changes the design tree of the product to such extent that the changes become ambiguous. Generally machine manufacturing may not create unambiguous link between the design and the process tree of the product. Therefore within the production control system independent process tree for the product should be maintained independently.

4. Manufacturing supervision in machine manufacturing enterprise

The management with plan orders underlies the manufacturing supervision. Depending on the operative information (terms of the orders, provision of materials for the orders, the situation in the workshops), the production supervisor makes decisions for the issuing of plan orders (5). For each order he/ she is able to see the current deficit of materials and semi-finished products, the estimated provision as at the time of work commencement, the possible redirections of deficit materials, the loading and the resource equipment as a function of time.

The supervisor shall issue the order, which actual execution shall start within the next 3-5 days. Upon confirmation, plan orders will become workshop orders and shall become compulsory for execution in the workshop.

The plan orders and workshop orders for a particular workshop represent the plan of the enterprise (fig.3). The workshop actually may execute only workshop orders. Thus the management strategy specifying what should be produced and when should be produced with accuracy of 3-5 days is determined on corporate level by taking into account the interests and the policies of the enterprise in general.

The practice shows (16) that the implementation of information systems for production management in machine manufacturing enterprises results in reduction of the work in progress by about 25% and in increase of the productivity by up to 10%.

![Figure 3. Workshop plan and its updating (TECHNOCLASS, 2018)](image_url)

Until the implementation of such system, the production was always "overloaded", there was no objective idea in what phase of implementation was the order, the work-in-progress was uncontrollable because it was driven by the interests of the workshop and not by the interests of the enterprise.
Conclusion

Increasing complexity continues to be one of the biggest challenges facing manufacturing today that operates in an environment of change and uncertainty. In practice, the reconfiguration work is generally considered onerous, as one must pay attention to the numerous interactions between the integrated features that are used across the organisation, a fact that has led many firms to avoid changes as much as possible. Moreover, all changes must fit the data structures and logic of the software, limiting the options for how processes can be redesigned.

This study has provided an answer to the question of the specificities for successful management of machine manufacturing enterprise through integrated software solutions, which are the following:

- the management of machine manufacturing starts by technological preparation of production, and reasonably it is within the management system of the machine manufacturing and it is impossible to separate it as a process and to expect success of management;
- the machine manufacturing schedule is made every day on the basis of the MRP standard and depending on the type of production it is rescheduled on a daily basis (or at least once a week) and for that reason the workshop orders are issued for those parts, which production should start within the next three to five days.
- as the operative planning resolves tasks connected with workshop resources management, the APS standard may be used for its implementation;
- supervision by integrated software systems has the following advantages:
  - real-time maintenance of exhaustive information for the production resources;
  - functionality for selection of appropriate resources for implementation of the process operations on the basis of data about the process capabilities, ensured technical documentation, installed special equipment, available instruments;
  - functionality for assessment of the production tasks with a view to the availability of staff with the required qualification and authorities;
  - functionality for assessment of the production tasks with a view to the availability of the required semi-finished products, basic and auxiliary materials.

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