COMPUTER-AIDED SOLUTIONS TO SUPPORT THE OPERATION OF A MANUFACTURING COMPANY, WITH THE USE OF PERSONALISED IT SOLUTIONS

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Abstract: Computer-aided information flow affects the operating efficiency of manufacturing companies. Personalised IT solutions (PITS) may appear to be helpful. The article discusses the rationale and requirement for the use of computer-aided solutions at manufacturing companies and the practical applications of such solutions in selected areas. Computer-aided management of technical documentation (CAMTD), computer aided items design (CAID) and total productive maintenance (CATPM) and options of further work have been proposed. These solutions were prepared in the form of DBMS systems. The final solution will be to integrate PITS into the IT system supporting the information flow in the production company.

Keywords: COMPUTER-AIDED, PRODUCTION, COMPANY, DBMS, PERSONALIZED IT SOLUTIONS (PITS)

1. Introduction

The use of computer-aided solutions at a production company, including the use of CaX [8] techniques, may cover all of the company’s basic processes or selected areas or tasks. The flow of information may be supported by integrated management systems (IMS), production management systems (PMS) or personalised IT solutions (PITS) [2]. MES’s (Manufacturing Execution Systems) in production management can be used to integrate several functional areas [13]. The choice of the solution to be implemented will depend on a number of factors, particularly the capacity of the production company, which is linked with the size of the company.

Industry 3.0 focused on the computerisation of certain functions or areas of significance for the delivery of basic processes [3], while industry 4.0 places emphasis on the integration of computerised processes [14]. An important aspect is the automation of design, production and distribution processes, which requires the use of computer-aided solutions [16].

To be able to improve communication between its units (such as production sites or departments) as well the management of information flow [10] and, as a result, the management of its resources [7], the production company under analysis should employ adequate functional solutions. Such solutions may include computer-aided solutions [9], which can take the form of personalised IT solutions (PITS). A company without such solutions in place will find it difficult to deliver its processes efficiently, control them precisely and respond to events quickly.

If the resources necessary to deliver processes are limited, solutions designed to support the processes are needed. However, before any such solution is implemented at a particular company, it is necessary to identify the company’s needs.

Even a company with an integrated management system in place will have some room for PITS’s, as the company’s IMS will normally cover between 70% and 80% of the company’s processes. For the remaining processes, the company will need solutions that reflect its specific requirements as well as future changes. One area where this may be the case is production maintenance, including product, system and process improvement, and this will require the integration of data from various sources [1]. Therefore, it is advisable for manufacturing companies to monitor, on an ongoing basis, their requirements for computer-aided solutions.

The purpose of the work was to find solutions to improve the operation of a production company. The work was based on the assumption that computer-aided solution would improve the operating efficiency of the company under analysis and that employing a dedicated procedure to identify the company’s needs would help design and develop dedicated IT solutions for certain areas or functions. Different options and methods were employed to find the final solution.

The analyses in the area of computer-aided solutions were conducted in 2017-2013 at a medium-sized company manufacturing industrial fittings. The products offered by the company are catalogued, [12].

All production is preceded by its preparation [3]. The analyses were focused on finding solutions to support the company in the production preparation process and to ensure the efficiency of production. One example of the work as part of the analyses is computer-aided preparation of production documentation, which is discussed in [11].

2. Prerequisites and means for solving the problem

The full information flow covers production preparation and preparation with accompanying activities. In the area of technical production preparation (TPP), the important aspects include not only the discipline of technology, design and engineering computations, protection of machinery and equipment, but also the procedures and regulations that apply to the company’s products and the company itself, which should be taken into account.

The company under analysis had an IMS in place. Therefore, the analyses included three development options: (1) keeping the company’s IMS in place, (2) replacing the IMS in place with a production management system (PMS) or (3) supplementing the IMS with other solutions (PITS) based on the company’s needs and, as far as practicable, compatible with the IMS [15]. The second option would be the best one for the company under analysis, as it means moving away from a large IT system that is not working at its full capacity and implementing a solution that will support the company’s basic process, i.e. production, and integrating it with the other processes. This means that the company’s resources and processes would be interconnected by an IT solution to control and manage the company’s production. However, following consultations with the company and based on an cost/benefit analysis, the third options was chosen, i.e. to implement dedicated solutions to support certain areas or tasks.

For the flow of technical product documentation, it is necessary to ensure that the flow of such documentation is controlled, that such documentation is archived and that hard copies of it can be digitalised into a database. It was, therefore, necessary to prepare a dedicated solution that reflected the needs of the technical department in this respect. A DBMS was proposed as a way to support the flow of documentation. [6]

The first stage in the technical production preparation process is product design. In this process, the customer’s requirements (such as standards) must be taken into account. The solution was to support the design of the face and flange of a valve (these two parts are components of the body of the valve). It was also important for the designers to visualise the results of the design work in a CAD environment and to ensure efficient archiving of the 3D models of
the designed products. The solution to this problem was a DBMS [4].

The efficiency of the company’s production process is also linked with its machine park. The maintenance of machinery and equipment is normally the responsibility of the company’s production maintenance team, although it may be the case that this responsibility is assigned to a particular person or a company’s technical team. This area generally includes day-to-day and scheduled maintenance of machinery and/or the keeping of operation/maintenance records. Once again, a dedicated DBMS can be the solution. [5]

In all the above cases, it is necessary for the company to be able to gather the required information systematically, with access, archiving and processing being not less important. It was decided that DBMS’s were an effective response to the user’s needs and, therefore, the solution proposed to the company was based on a DBMS.

3. Solution of the examined problem

3.1. Managing technical documentation

In the case of PITS’s, the challenge was to organise the system for managing the company’s technical documentation to ensure that the documentation is archived systematically and that searching for the necessary documentation was a smooth process. Based on the analysis of the company’s needs, it was necessary to design a solution that would incorporate a standardised, continuous document numbering system and provide the company with full information on the flow and status of its documents. Therefore, the proposed solution (Figure 1) should allow the company to (a) register new documents, (b) search for existing documents and (c) register the flow of documents. In other words, the company can use the solution to register new documents and, subsequently, to archive them and find them quickly in the database.

![Figure 1: Elements PITS-CAMTD](image1)

It was also necessary for the company to be able to use its (a) product catalogue, (b) operations and maintenance (O&M) manuals and (c) list of materials. (Figure 1)

The documentation was divided into three types: design documentation, process documentation and assembly documentation (Figure 2), divided by content.

![Figure 2: Documentation catalog](image2)

The solution also allows the user to access the company’s product catalogue (Figure 3) to search for a product in the catalogue or to register a new one, to view all the products or only new ones.

![Product catalogue](image3)

One aspect of efficient management of documents is the ability to control the flow of document, is a challenge. The proposed dedicated solution allows the company to control the release and return of documents. The information provided by the system includes who a document was released to or returned by, the release and return dates, the type of document and the number of copies.

As regards O&M documentation, it is necessary for the company to be able to archive such documents, to register new ones and to find existing ones. The solution offered the option to keep English-language documents and templates of O&M documents that could be downloaded and edited.

The search criteria are the same, regardless of the required resources, e.g. O&M documents or the product catalogue.

3.2. Design work support

As regards the product design process, it was necessary to design a 3D model generator for flanges. Such a generator (Figure 4), which is part of the dedicated solution, allows for defining the parameters of the flange and face of the valve and for viewing standardised values.

![Generator of flanges](image4)

When the selected parameters of the flange are approved, the modelled part can be visualised in 3D using the selected graphic design software (Figure 4) and 2D documentation can be produced.

In the process of designing the solution, the challenge was to think of a way to archive 3D models efficiently and to work in groups, i.e. to make such models available to other users, and allow for such models to be exchanged between work group members. Therefore, it was necessary to ensure that the solution allowed the user (a) to create a model of a flange, (b) to search for an existing model and (c) to change the settings. The response was a PITS-CAID solution, which is shown in Figure 5.

![The main panel IRI. Elements PITS-CAID](image5)
The company also required a solution that would provide it with (a) access to a group of standards in respect of certain parameters and (b) access to the application (i.e. the solution) anywhere within an LAN.

The last step in the process was to prepare a standard file to allow the user to install the application on the user’s workstation.

3.3. Production maintenance

In the case of total productive maintenance (TPM), the fundamental purpose was to ensure efficient and effective management of the company’s technical resources (machinery and equipment).

The response was a solution based on the processing of information in this area. Therefore, the proposed dedicated solution should allow the user (a) to gather information on the company’s machines, (b) to keep machine operation records, (c) to issue machine maintenance requests and (d) to generate reports, which was provided (as shown in Figure 6) by means of a computer aided total productive maintenance (PITS-CATPM) solution.

![Fig. 6 Elements PITS-CATPM.](image)

The PITS-CATPM solution (Figure 6) was divided into five ‘thematic groups’ (modules), i.e. machines, maintenance requests, personnel, orders and reports.

The Machines module is used to enter and store information on the company’s machines and to keep machine operation/maintenance records. The Maintenance Requests, module allows the user to issue day-to-day maintenance requests or scheduled maintenance requests and to monitor the maintenance work. The module can include information identifying the request, the machine(s) covered by the request and the personnel responsible for performing the requested maintenance work.

The Reports module is a report generator (Figure 7). The user can both view and print reports. The Reports module can also be used to generate various useful reports/summaries.

![Fig. 7 Module Reports.](image)

The Orders module allows the user to generate orders for spare parts necessary for the requested maintenance work. The user can keep a record of the necessary spare parts and use the module to easier calculations of spare part purchases. The Personnel module contains information on the company’s personnel.

4. Results and discussion

Computer-aided management of production at the operating level requires, *inter alia*, the use of solutions for automated exchange of data between IT systems in a way that reflects the user’s specific needs and requirements. The response could be a production management system (PMS) or the integration of a number of standalone IT systems (e.g. PITS’s), in which case it is necessary to address the question of compatibility [3].

The analysis included the option to implement a PMS. A PMS reflecting the company’s needs and requirements would improve the quality of the computer-aided management solutions in place at the company. The process of designing such a system would be a complex and multi-stage process. The preparations for the process would take a long time and require remodelling the flow of information within the company. Issues might occur both before and during the implementation of the system, as well as during the initial period of its operation.

Another possibility is the design of a PITS based on an analysis of the company’s needs, with the option to allow for the exchange of data between the PITS and the IMS in place at the company. In the case of catalogue-based production, a PITS allows the user to coordinate its production work based on the process-oriented approach. As long as the company’s hierarchical organisation is maintained to ensure the stability of its operation, this allows the company to adopt, for certain processes, solutions based on modules, i.e. particular operational units.

One example of this approach is an enquiry from the company’s customers about a non-standard product for which online reporting by a few departments is required. The computer-aided solution would cover the company’s sales, technical, purchasing and production departments. The response to the company’s requirements in this example would be a system for identifying non-standard solutions and allowing for a flow of documents in line with decision-making procedures.

The 2007-2013 analysis of the company’s operation included the flow of information, with special emphasis on decision-making processes and the resulting flow of documents. It was, therefore, necessary to ensure control of the flow of information and of decision-making for different areas or tasks. For example, the suggestion was that standard orders should be separated from non-standard ones in customer service. In particular, the latter may be very difficult to deal with. Handling such orders requires the use of a dedicated solution to control the flow of documents. Also, the time needed to design the requested product should be reduced and the production process made more efficient. These activities are the responsibility of the company’s technical department and can be supported by a computer-aided solution. Therefore, the proposed solution designed to support the work of the technical department (covering document management, design work and production maintenance) needs to be supplemented with a PITS for non-standard orders.

Based on the analyses of the company, the response could be a PITS for “the identification of non-standard order processing” that would allow for data to be exchanged electronically between the company’s units involved in the production of such orders. The solution should allow the company (a) to archive input data and the documents produced in the course of work, (b) to access such resources from multiple workstations operated by such units of the company and (c) to control the production of the order. Databases with product indexes and (spare) part indexes.

Implementing such a solution would help improve the flow of information in the processing of non-standard orders, resulting in improved customer service. This, however, would require further work on a computer-aided solution, i.e. a PITS.
5. Conclusion

The exchange of information within a manufacturing company requires the use of an information system supported by IT solutions. Such solutions may include integrated management systems, production management systems or personalised IT systems. They can be used to support the flow of information within the organisation or in respect of a specific process, area or task. In addition, the designers should take into account the scalability of the IT system or the addition of applications for new tasks in response to the company’s needs identified through analyses.

The company under analysis had an IMS in place and used a PITS based on previous analyses. However, five years later, new analyses revealed that both the IMS and the PITS needed some upgrading. This shows that the analysis of a company’s needs to decide what IT support the company requires should be a continuous process, based on the PDCA (Plan-Do-Check-Act) cycle.

The technical department of virtually any company needs solutions designed to improve the flow of information. The problems such departments usually encounter are related to product design, production planning or production maintenance. The response to such problems should include efficient preparation of technical documentation for the product to be made, efficient flow of such documentation and the provision of technical resources to ensure uninterrupted production. These issues were addressed by the proposed PITS solution for the company’s technical department, as it covered technical document management, design work and production maintenance.

PITS’s cover certain operating areas and provide support for defined processes. They help to improve the flow of information to the extent of the support provided by them. PITS’s are dedicated solutions designed to offer specific functionalities and to be used in a specific operating environment. PITS’s can be operated from multiple workstations. Although the input data in such systems is stored in one place, the data can be accessed by multiple users. In such a case, it is necessary to define access priorities. As a result, a member of the company’s personnel will have access, to the extent of their authorisations, to the PITS from their workstation.

In the case of the company under analysis, the PITS’s in place allow the company to gather and systematically store and process information according to the company’s needs. They could also be used at other companies, provided the required software and hardware are available.

The analysis of the three options shows the directions and possible actions as regards industry 3.0 computer-aided solutions for companies, as well as within the context of industry 4.0. Regardless of the option, there is room for PITS’s.

The proposed approach to supporting the operation of a manufacturing company with IT solutions is in line with the efficient business management philosophy. Efficient use of the proposed solutions will depend on many factors, including the human factor, i.e. the users of the solutions. However, the directions for development within the context of industry 4.0 leave no doubt as to whether the use of computer-aided solutions is justified or even.

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6. Reference

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