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Integrated Computer System of Management in Logistics

Krzysztof Chwesiuk*

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Abstract

This paper aims at presenting a concept of an integrated computer system of management in logistics, particularly in supply and distribution chains. Consequently, the paper includes the basic idea of the concept of computer-based management in logistics and components of the system, such as CAM and CIM systems in production processes, and management systems for storage, materials flow, and for managing transport, forwarding and logistics companies. The platform which integrates computer-aided management systems is that of electronic data interchange.

Keywords: management, logistics, integrated system, components, integrated platform, computer-aided system

1. Introduction

Taking into account the development of computer technologies, we can classify today's production processes as follows:

1. independent, computer controlled machining and assembly stations (CM – Computer Module),
2. FMS – Flexible Manufacturing Systems,
3. CAM – Computer Aided Manufacturing Systems,
4. CIM – Computer Integrated Manufacturing Systems.

Typical operations in today's production systems include technological (machining and assembly), control, transport, storage operations and their combinations. Besides, there are processes of component and raw material supply, co-operation, distribution of finished products and after sale services.

* Maritime University of Szczecin, Szczecin, Poland

Logistics come to assistance in managing the production system understood in such broad terms. There are clearly distinguished areas of logistics:

– material supply,
– co-operation,
– production,
– distribution.

Processes taking place in these four areas of logistics require efficient management. To improve the system of logistic management of production we have to design and implement a computer system.

This paper presents the idea of a wide range computer system which aids the management of production system logistics.

2. The Concept of Comprehensive Computer System of Management in Logistics

The production system consists of four subsystems:

1. materials supply, handled by materials supply logistics,
2. co-operation, handled by co-operation logistics,
3. manufacturing, handled by manufacturing logistics,
4. finished goods distribution, handled by distribution logistics.

Figure 1 graphically illustrates a logistic chain of materials supply for the manufacturing process in a production company. Participants of this chain are as follows:

– original suppliers,
– suppliers of components and subassemblies,
– supply centres (see Fig. 1).

Figure 2 shows a logistic chain of co-operation in the manufacturing process in a production company. There are two types of business entities in this chain:

– suppliers to co-operators,
– co-operators (see Fig. 2).

Figure 3, in turn, presents graphically a logistic chain of distribution of finished goods from one particular manufacturer. This chain comprises such business entities as:

– distribution centres,
– wholesale and retail stores,
– end recipients (see Fig. 3).

Figure 4 illustrates graphically the concept of a full-range computer-based management system in the production process logistics. Its component systems are as follows:

– computer-aided manufacturing – CAM,
– computer integrated manufacturing – CIM,

– material requirement planning (MRPI) and manufacturing resource planning (MRPII),

– management of finished goods distribution – SD (see Fig. 4).

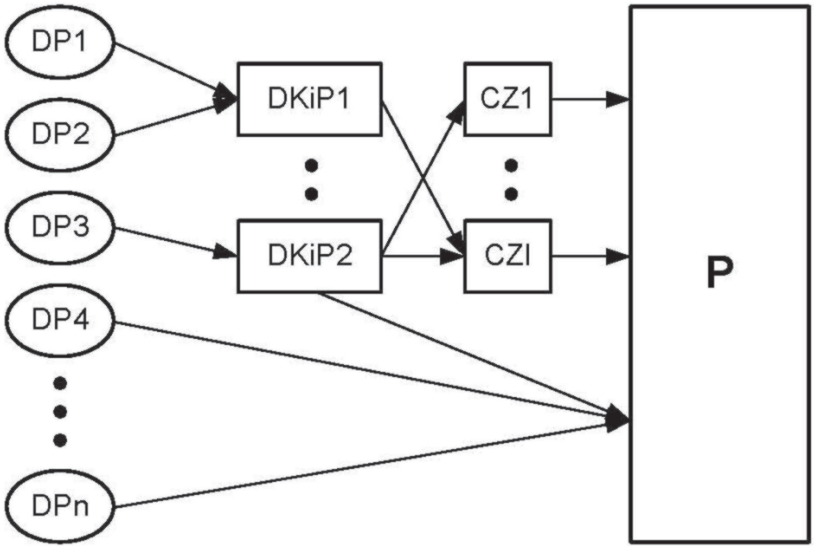

Fig. 1. Logistic chain of materials supply. DP – original supplier, DKiP – supplier of components and subassemblies, CZ – distribution centre, P – producer. Source: author's study based on [1]

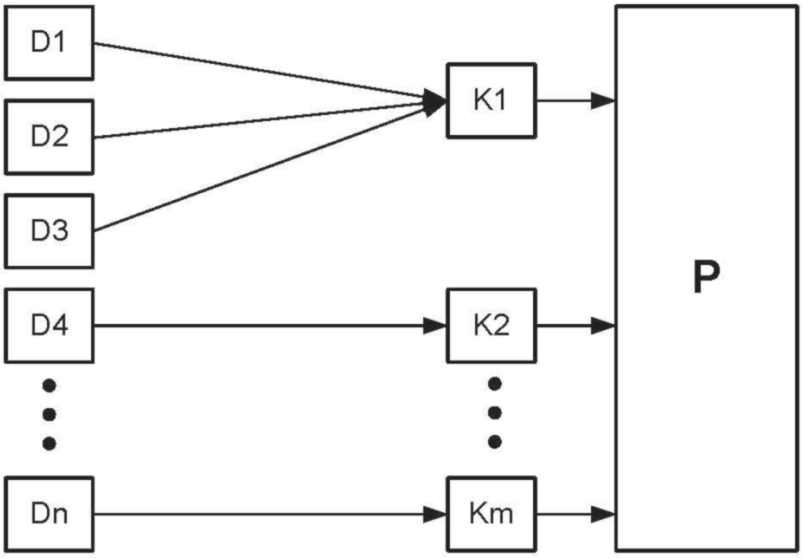

Fig. 2. Logistic chain of manufacturing process co-operation. D – supplier to a co-operator, K – co-operator in manufacturing process, P – producer. Source: author's study based on [1]

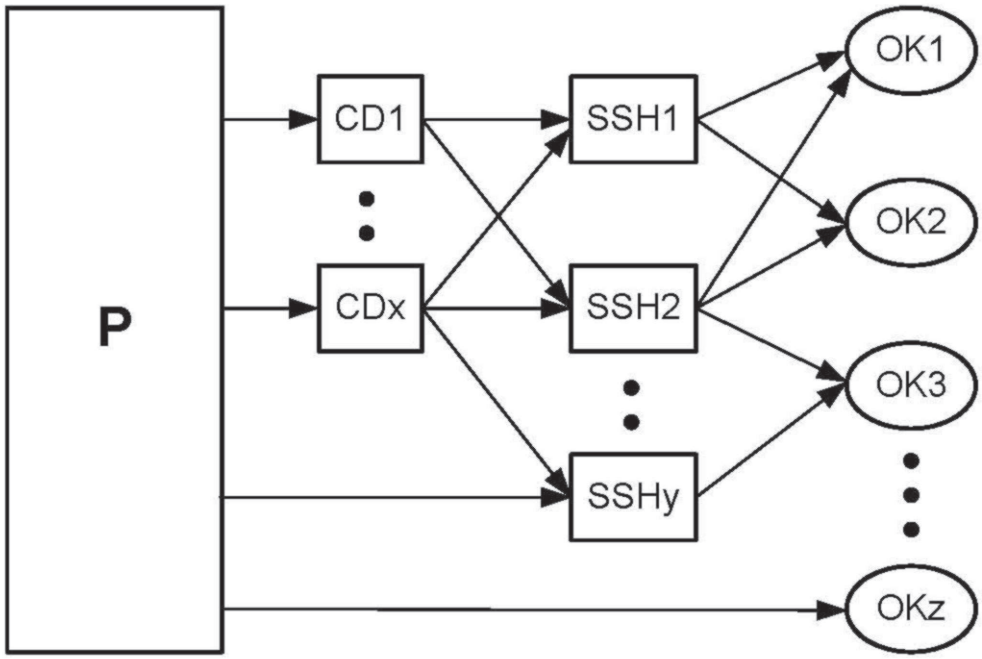

Fig. 3. Logistic chain of finished goods distribution. CD – distribution centre, SSH – wholesale and retail network, OK – end recipient, P – producer. Source: author's study based on [1]

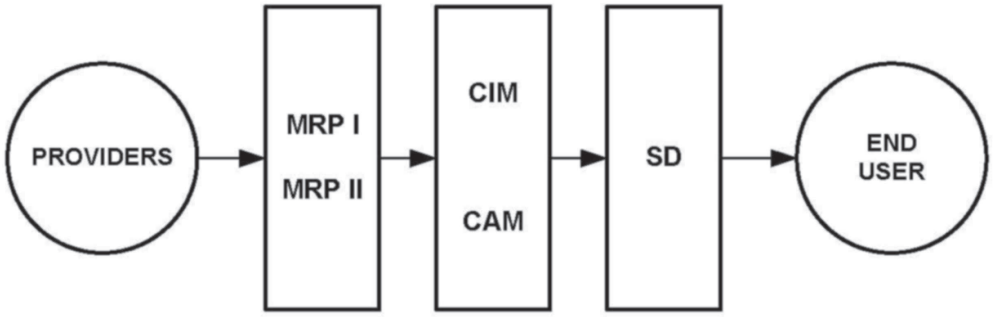

Fig. 4. Concept of computer integrated management system in production logistics. MRPI – computer system for material requirement planning, MRPII – manufacturing resource planning system, CAM – computer-aided manufacturing system, CIM – computer integrated manufacturing system, SD – computer-aided goods distribution management system. Source: author's study

The chart of a computer integrated management system in production logistics shown in Figure 4 indicates with arrows the direction of material flow, or to be exact, the flow of all production factors involved in the process of manufacturing a finished product and its distribution to end users. However, electronic flows of data between the main components of the comprehensive computer system run in the opposite direction. It is in the first step of the logistic distribution chain that information on the demand for given maker's products is recognized and processed. This is done in the computer system of distribution by collecting and aggregating orders from end recipients for given product models and types of a given manufacturer. Besides, in projecting the product demand the amounts in stock of each member of the logistic distribution chain are taken into account. Data from the computer-based distribution system are transferred to production management systems, i.e. CAM and/or CIM, which are operated in the production company.

After information is processed in CAM and/or CIM systems, the latter in particular, the resultant information is obtained in the form of, e.g. a plan and schedule of manufacturing. This information and the data from current monitoring of the materials in stock and the state of materials flows in production lines are directed to MRPI and/or MRPII systems.

Based on the computer-aided systems of production resources control the material flow is managed in the logistic chain of materials supply and the logistic chain of production co-operation, from original suppliers and co-operators to producers.

The computer integrated management in production logistics comprises several computer systems, used in such areas as:

– forwarding,
– transport services,
– transport terminal services,
– customs offices,
– banks,
– insurance companies,
– standardization offices,
– others.

The key condition for successful design and operation of a computer integrated management in production logistics is that the co-operating computer systems share the relevant information. This objective is obtained by access to a common integrated data base (data warehouse) and by the use of common standards of electronic data interchange – EDI.

3. Brief Characteristics of Basic Components of the Computer Integrated System of Management in Logistics

3.1. Computer Integrated Manufacturing – CIM

The basic aim of CIM is a comprehensive computer-aided system for integrated implementation of production orders. One can say it is an integrated system of production order execution.

All data that appear in manufacturing processes from material supply, through work engineering to manufacturing and assembly, should always be utilized in planning tasks. While planning production operations the planner should send all data to the production area through strictly defined information channels. All data connected with manufacturing and executed orders are stored in the central data base. Production data are created mainly during the design of a product, then data from orders are added in the planning phase. These data are crucial for manufacturing and assembly. Data that appear in the above areas, i.e. dates/times of completing each manufacturing operation or operational loads of each machine, device and work station are included in the central data base and can be used by the planning system provided that data from the actual manufacturing and assembly units are sent back via a company's data base system or DCN – Direct Numerical Control system [2].

As computer technologies develop, better technical conditions are being created for the construction of more advanced production facilities that may run automatically, with limited participation of people. The role of the human in such systems focuses on issues such as the programming of computers and computer-controlled production equipment [2].

The growing presence of computer systems in all spheres of manufacturing company operations and integration of these systems into one all-encompassing computer system brings about many changes in technological processes. Some of these changes lead to:

– shortened time of preparing and executing production orders,
– reduction of operating costs,
– improved internal and external communication,
– more effective design, planning and preparation of production [2].

One aspect worth emphasizing is increased utilization of company's production capacity by using the company's data base, which allows to eliminate doing the same work twice. Besides, errors due to insufficient communication are avoided. The integration of computer systems enhances the flexibility of production processes, particularly manufacturing processes, thus the manufacturer is able to respond faster to customer's requests, which often refer to details of one particular order [2].

The CIM system consists of two interconnected subsystems:

1. CAD – Computer Aided Design, which is composed of the mutually co-operating subsystems:
   a) CAE – Computer Aided Engineering; its task is to design and engineer new products or to modernize products already made,
   b) CAP – Computer Aided Planning and CAPP – Computer Aided Process Planning; these are supposed to prepare the production process in terms of technology, i.e. product construction, technology of manufacturing product parts, subassemblies and the finished product, preparing technical drawings, lists of components and the organization of the machining and assembly process,
   c) CAD – Computer Aided Design, whose task is to plan the operation of the manufacturing system comprising the manufacturing of parts, assembly of components and the whole product, including measurements, packaging and dispatch of finished products,
   d) data base (DB) and expert systems (ES), which enable the functioning of all the areas of computer-aided production together with a expert knowledge base (KB) co-operating with these systems;
2. A subsystem of Computer Aided Manufacturing (CAM), which will be described in the next chapter.

3.2. The system of Computer Aided Manufacturing – CAM

The Computer Aided Manufacturing (CAM) is defined as a system for preparing programs for the process of manufacturing, control and recording data on the manufacturing output. This system also encompasses such organization functions as production planning, setting the dates of materials and subassembly supply from co-operators or the delivery of finished products.

CAM can be described as:

– a flexible manufacturing system, which is capable of manufacturing at the same time sets of various products of different series size, where quantities and assortments are changed by a computer,

– hierarchically controlled system; computer-supervised and handled by a small team, making up less than 10 percent of the company personnel that would be necessary to perform the same tasks in conventional conditions [2].

The system which generates software for the machining and paths along which parts and subassemblies will pass through work modules and stations, while these programs and paths are optimized relative to work load and the degree of utilization of machines and assembly devices, production cycles, productivity, energy consumption, environment pollution and work security [2].

In industrial practice CAM systems, apart from the manufacturing in flexible production systems, also include:

– development of software, or operating plans of machining and assembly, that as a rule are variable depending on the current production situation,

– planning of component paths and schedules of the production,
– optimal manufacturing control,
– optimal product quality control,
– production management [2].

The computer-aided manufacturing – CAM – is regarded as a development of the designed and functioning flexible manufacturing systems with some functions connected with control at a level of a specific production system. The CAM system is often treated as a transitory stage leading to the computer integrated manufacturing (CIM).

The CAM system consists of the following subsystems:

1. CAMC – Computer Aided Manufacturing Control; its basic function is programming and computer-aided control of numerically-controlled manufacturing equipment,
2. CAQ/CAQC – Computer Aided Quality/Computer Aided Quality Control; this subsystem is designed to provide the highest standard of product quality,
3. CAT – Computer Aided Testing, for examining the technical condition of machines and tools.

A production company using computer-aided manufacturing should have the following technological machines and facilities:

– numerically controlled (NC) machines tools,
– machine tools with CNC (Computer Numerical Control),
– machine tools with DNC (Direct Numerical Control),
– IR – Industrial Robots,
– IM – Industrial Manipulators,
– AS – Automated Storage,
– AGV – Automated Guided Vehicles.

The use of CIM and CAM systems requires specific input data, such as production execution orders and data on future demand for the products offered. These data are acquired from the computer system handling distribution logistics. Output data, on the other hand, after processing in the CIM and CAM systems, are production schedules, which themselves constitute input data for computer systems of materials supply and co-operation.

3.3. Computer systems of materials supply and co-operation: MRPI and MRPII

MRPI – Material Requirements Planning is a comprehensive computer system for controlling the resources and production planning, comprising the following issues:

– forecasting and determination of order size and supply dates,
– determination of production series size,
– times of starting production,
– size of inventory in storage spaces and in the manufacturing process [2].

The basic principle of operation of the MRPI system is 'scales' that 'weighs' the demand for materials and components and for co-operation against the demand for products and the demand for materials in the phase of processing and those expected to be purchased from suppliers operating within the logistic chains of materials supply and co-operation. From this perspective the MRPI co-ordinates the materials specification of a product in order to schedule the production. MRPI combines the planned production schedule with the list of materials and raw materials and subassemblies from co-operators needed to make a product, monitors the materials in stock and indicates which parts and subassemblies have to be ordered and when delivered to minimize their storage time [2].

The successful implementation of the MRPI system led to its further development aimed at incorporating more functions:

– planning and control of other production factors that appear in the manufacturing process,

– effecting feedbacks between material requirement and demand for manufacturing machines and equipment use, necessary floor space, power, labour, information and capital,

– information on the progress of production,

– feedback between the production process and planning/control of the manufacturing process [2].

The system thus extended has become a closed system in the area of production planning and control, or strictly speaking production management and control, commonly referred to as MRPII – Manufacturing Resource Planning [2].

3.4. Computer systems of finished goods distribution

There is a variety of systems created for the distribution of finished products. However, two seem to be the most common:

1. WMS (Warehouse Management System),
2. CRM (Customer Relationship Management).

WMS is a tool used to handle warehouse processes. In most cases the WMS system installed in a warehouse strictly co-operates with a superior system running the entire company (it is mainly an ERP class system). In practice, however, WMS makes up a separate functional unit, composed of several specific modules, each corresponding to a particular group of logistic processes that take place in storage, including the operations of a high pile warehouses. The WMS system is a specialized and efficient tool supporting all technical operations in the warehouse, and it generally is capable of managing any number of warehouses, their division into areas, classes and warehouse locations.

The system gathers data on the types, amounts and division of storage places, information about items (e.g. expiry dates, hierarchy and structure of packaging, methods of storage, batch numbers etc.) and a lot of information required in carrying out even elementary warehouse operations. Warehouse work can be substantially

automated by using bar codes and dedicated algorithms for placing stored items, creating pick lists etc. The primary function of the WMS system is accurate control and support of each link of the logistic chain in a company's warehouse [3].

Most frequently WMS systems are implemented in the following sectors of the economy:

- production,
- trade and distribution,
- transport, forwarding and logistics.

Main tasks WMS systems carry out are as follows:

- handling of supplies,
- input control of supplies,
- optimization of the processes and warehouse space used,
- planning and order picking for dispatch,
- handling of shipments,
- output control of shipments,
- tracking of products in the supply chain,
- support of forwarding,
- in-warehouse movement,
- stock-taking,
- reports [4].

CRM, or Customer Relationship Maganement, is software aiding data recording and collection and planning various events concerning customers, and analyzing recorded data from various angles. CRM enables company management based on excellent knowledge of customers, their preferences and needs. The system provides intelligent use of customer data to prepare an optimized custom-tailored offer. By recording each contact and transaction the customer is well known and instantly recognized, regardless of the form of contact (phone, mail, e-mail or fax). Besides, the system allows to analyze costs and potential profits connected with each customer.

Basic goals of the CRM system are as follows:

- building permanent relations with a customer,
- enhancing customer satisfaction,
- increase of sales,
- maximization of the profitability,
- advanced customer segmentation,
- minimization of customer data base maintenance costs,
- management of technical support departments and a call centre.

The CRM system is supposed to analyze, forecast, decide and plan. Therefore, the company's marketing department uses tools for advertising campaign, budgeting and setting objectives; in the area of sales it provides tools for projections and discount calculations; in terms of technical support the system is to provide customer services as promptly as possible. Catalogues are updated on a continuous basis, and updated information is available in real time to all CRM users [5].

4. Conclusion

The presented concept of integrated computer system of management in logistics makes use of computer-aided systems already employed in management and control of manufacturing processes (CAM and CIM), those used in the logistics of materials supply and co-operation (MRPI< MRPII and ERP) and in distribution logistics (WMS and CMR). The integrated computer system also incorporates computer systems supporting management in forwarding, transport, banking, insurance, customs etc.

The electronic data interchange (EDI) is the platform used for the integration all the above mentioned systems.

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