28 STRUCTURE OF COMPUTER MANAGEMENT SYSTEMS DESIGN

28.1 Introduction

The computer system of company management is of module structure. It ensures control of all the company operation areas including: planning and supply, distribution sale, maintenance, finances and accounatancy. Thanks to the module structure there is a possibility to implement only these components which are indespensable due to the characer the company operation.Attention should also be paid to the system simplicity and possibility of its adjustment to changing environmental conditions through modification or addition of new modules.

A computer management system should provide control of the company operation and the whole system of management. Thus, it should be able to record all the economic operations in the following fields: material turnover, storage management, supply, sale, production, costs, real estate, human resources and finances. Appropriate division of information into the three basic management levels is of great importance these levels include: strategic, tactical and operational.

This system is supposed to provide data with high security, both in terms of protection against unauthorized access and accidental damage due to the computer hardware failure. Particular functions and data can be available with no limits, however, practice proves that access to some functions and data contained in a program has to be selectively limited. The access range is controlled by an administrator (person who is responsible for proper operation of the system), who provides users with access to particular functions of the software. Additionally, the system should be protected with a function of data archiving, in the event of failure. Regular application of this function allows to improve its security once a failure occurs [5].

28.2 Tools for development of computer systems

Architectures of computer systems are defined by components which make up the information system of companies and organizations. Development of the architecture is the responsibility of scientific centers, consortiums and consulting companies. Some architectures are elaborated for specific areas of application. They are being increasingly used not only for construction of computer systems but also for economic restructuring of reengineering projects. In majority of architectures, the system structure, methods for its construction, software supporting its construction, are viewed as one integral concept [5, 6].

Also, the concept of reference architecture is being used. It is an architecture elaborated for a defined area of applications. It is elaborated by private consortiums, standardizing centers and official programs.

Reference architectures are characterized by the following features:

- General usability: referential architectures are of universal character and meet individual requirements of many potential users; they are not designed for specific applications but for representation of structures which are characteristic for a whole class of users.

- Variability: referential architectures are tailored to the needs of individual users in the process of 'matching' and 'deriving'; referential architectures are assumed to undergo substantial changes which makes them different from standards used without being changed.
- Consistence and transferability: referential architectures provide consistent output solutions suitable for different users [7].

Designer's tools

Referential architectures are being increasingly used as a basis for elaboration of information systems for specific conditions and demands of companies or as the point of reference for an assessment of functioning systems or those which are under development. They are useful tools for a designer of the company integrated information systems and a base for modeling of processes within reengineering projects [1].

28.2.1 CIMOSA – Open System Architecture for Computer Integrated Manufacturing

CIMOSA enables a dynamic description of a company, accounting for its goals and resources as well as organizational and technological aspects. The description is of multi-phase character. It starts with defining the company requirements to be met by the information system. On the basis of these requirements, there are implemented solutions in the form of modules CIM. The task of the framed concept of CIMOSA architecture is to provide a general description of the company processes from different points of view, at different levels of modeling, and according to different concretization degrees. Three distinguished levels of modeling include [8]:

- Requirements definition,
- Design specification,
- Implementation description.

28.2.2 GRAI/GIM – Graphes de Resultats et Activites Interrelates/GRAI Integrated Methodology

Architecture GRAI/GIM was elaborated at the University of Bordeaux in France according to it - the company consists of three basic subsystems:

- Physical system,
- Operating system,
- Information system,
- Decision system.

Physical system is connected with the flow of materials. It consists of work places or organizational structures, including: machines, employees, parts, etc. Operating system is a control system of the physical system in a real time. Decision system is connected with making decisions in the whole company and is a hierarchical structure with decision levels. Information system passes and records information, forming links between the decision and physi-

cal systems with the company environment. Each system (subsystem) can be decomposed into systems (subsystems): physical, operating decision and information.

The main tools for the systems modeling are:

- GRAI (GRAIGrid),
- GRAI (GRAINets).

28.2.3 PERA – Purdue Enterprise Reference Architecture

PERA architecture has been developed in the USA in cooperation with industry and deals with modeling of the whole enterprise, though its primary purpose was to model production systems. It depicts not only architecture of the information system but also of organization and production equipment (manufacture architecture).

PERA refers to the whole cycle of the company life, from starting operating (defining the mission) until its end. Each layer depicts tasks to be performed. They are described in the form of procedures in a language understandable for users who are not IT specialists.

Construction of the system begins with identification of the subject of consideration by the management of the corporation. Then the enterprise mission is specified which defines, first of all, which products and/or services are to be offered. In the definition phase (functional requirements) requirements concerning the employees, information policy, products and production units are specified. The layer of specification (functional project) specifies the functional requirements, such as the course of control, requirements in the field of management, distribution of equipment. The next layer of detailed design is connected with accomplishment of the project (referred to as physical design), that is, choice of equipment, specification of requirements concerning the staff, organizational planning and training programs. The layer of accomplishment refers to installation of the of equipment, training, testing. The operating layer concerns daily operation of the company, maintenance and development, and finishes with getting out of use [9].

The presented division into three parts is illustrated by PERA differentiation of information system, organization (people) and production equipment.

28.2.4 GERAM – Generalized Enterprise Reference Architecture and Methodology

It is an architecture elaborated by IFAC/IFIP federation (International Federation on Information Processing). GERAM offer includes:

- Referential architecture of GERA enterprise
- Methodology of enterprise engineering GEEM,
- Modeling languages of enterprise engineering GEML,
- Modeling tools for enterprise GEMTs,
- Models of enterprise GEMS,
- Modules enterprise GEMs,
- Theories of enterprise: ontology and meta models (GTs).

GERAM includes a definition of the concepts connected with an enterprise, with regard to its whole life cycle. The verses show phases of the company lifetime cycle and its systems: identification, concepts, requirements, design, implementation, build, operations.

From the approach to the enterprise life cycle, similarity with PERA and CIMOSA can be seen (CIMOSA indicates the same phases but without identification and concepts). Like in PERA, the problem of both technology (machines) and people is accounted for in each phase of the life cycle. In the columns there are descriptions in the form: generic, partial and particular; Each of the four points of view: generic, partial and particular; each description from the four points of view: resource, organization, information, function – similarly as in CIMOSA [9, 10].

28.2.5 Concept of semantic object modeling SOM

SOM is a concept used for object modeling of the enterprise systems and specification of functional systems. The frames of SOM are made up of the enterprise architecture, model of procedures and software architecture. The first component SOM- enterprise architecture covers three levels of modeling: the company plan, economic processes and specification of functional systems.

The company plan is a model of the system seen from 'outside' and it defines boundaries of the described system-objects of this system and its goals, which are to be pursued. Among objects of the system there are internal objects, being the direct object of modeling, and objects from the environment. Both groups of objects make up chains of values. The system goals include both formal ones as well as strategies and factors of success. Economic processes make up a model of the system, seen from 'inside', and make it possible to transfer the plan into a functional system.

Another component of SOM concept is a model of procedures, which being consistent with the company architecture, describes particular models and methodological dependencies between them. The enterprise plan is presented by means of schemes of interaction and function. Functional systems are described in the form of a concept scheme of object and an object scheme of procedures.

SOM concept offers a possibility of object modeling, which seems to be insufficient for modeling of economic processes, due to its inability to integrate the description of data, functions, organization, and the dependencies between them. Practitioners indicate the need of integration of two methods: the process and the object oriented, especially because of the necessity of documentation of the relations between processes and objects, when in a standard software there have been distinguished business objects.

28.2.6 IFIP – Information System Methodology

ISM methodology has been developed on the basis of many concepts of systems design which have found practical application since the beginning of the eighties.

ISM methodology offers a description of an enterprise from three points of view:

processes, data, maintenance of the system and its life cycle twelve phases. From the point of view of data oriented perspective there are considered types of their attributes, and from the point of view of process oriented perspective, the successive actions, that is, business activities. Points of view of data and process oriented perspective are described by static structures, whereas, dynamic behavior of the system is presented by the third point of view - behavior oriented perspective which accounts for events, including their relations in time.

28.2.7 ISA – Architecture of Information System

ISA architecture proposed in the form shows that if one of the above mentioned element of architecture is missing the balance of the whole system can be disrupted.

Placing the company strategy, which is supposed to affect all elements of the information system, on the very top of ISA architecture is of special importance. Architecture of processes and architecture of a hierarchic organizational structure is at the second organizational level. Although many companies aim at reaching an organizational structure based on processes rather than on specialized functions, it is not possible to ignore the hierarchical structure, therefore, according to the author of ISA concept, it must also be accounted for by the architecture of information systems.

The architecture of functional systems describes functions taken into consideration in the processes and their relations in functional systems. The architecture of data demonstrates static connections between data on which the organization functional systems are based. The task of architecture of the communications systems is to describe information relations and communication possibilities in functional systems. Architecture of communications systems is to be created as an extension of data architectures and functional systems. The fourth level of ISA is the architecture of infrastructure. Its task is to describe information and communications technologies, used in an enterprise, as well as indicate which of these technologies will be of biggest importance in the future. Architectures of data and functional and communications systems are supposed to be a buffor enabling a connection and adjustment of fast changing strategies and related organizational structures to less flexibly changing technological infrastructure.

28.2.8 ARIS – Architecture of Integrated Information Systems

Theoretical bases of ARIS architecture assume a five-cycle life of the information system. The successive phases are:

1. Concept of EPD oriented phase for applications of the enterprise economics. This is a non-formalized description in the user's language. It has been developed on the basis of an analysis of existing chains of processes.
2. Phase of concept (semantic models). Elaboration of semantic models, by means of which concepts of the first phase are described in a formalized way. The problem is considered separately for different 'points of view' and it will be so in each next phase. This description is close to the user, though, formalized to such an extent that it can be a point of reference for designing in the next phase. Problems connected with application of information techniques is not taken into consideration.
3. Phase of data processing concept. Design Specification. In this phase technical aspects are accounted for: information and communications technologies, such as using systems of data base, networks, software languages. This description does not refer to concrete products, available on the computer market.
4. Phase of technical implementation (technical realization). The description accounts for concrete solutions in the field of equipment and software.
5. Phase of the system operating and maintenance.

Phases of the system life cycles are connected with the levels of the description. They provide the description consistence, from the level of a primary economic problem to technical implementation of the considered system. Application of different descriptive levels allows tomake use of different methods for presentation of information systems depending on their relation with data processing technologies.

28.2.9 Methodology of a computer system building and design

Construction of an information system of a product life control, in all its existence phases (from the idea and design through construction, manufacture and operating until its utilization after liquidation or withdrawal) will be discussed in detail under the name: ISŻP – Computer system of Product Life. The phase of the product use and monitoring its life in terms of its serviceability maintenance, is an important part of this study, as there are many commercial information systems designed to control the product application.

Two methods for construction of information systems can be distinguished [1, 2, 3 ,4].

1. Structural method in which the information system is viewed as a unity of four basic structures: functional, information, technical- technological and spatial. A characteristic feature of this method dominant in practical applications is separate modeling of data and processes.
2. Object oriented method, which involves dividing the system into separate units – that is, objects and defining activities of these objects. The concept of object enables integral modeling of given data and processes. Application of the object oriented method, being under development, makes the computer system elaboration easier, lowers the costs of software, operating costs and facilitates the system extension. Design of an information system for technical objects operation management consists of:
    - Initial design
    - Technical design

Initial design is a specification of the system model (concept) in the range of its structures, processing technology, data base, input and output an configuration of equipment and it provides basis for elaboration of a technical design. Technical design is a detailed set of information containing: verbal description, comparisons, graphic illustrations, technical charts and drawings, manuals, and other elements connected with the structure and functioning of ISŻP. The process of initial and technical design ISŻP covers the design of (fig. 28.1):

- Basic processes which result from the user's needs,
- Data bases
- Support processes connected with the system operating, the system sets operating, data protection;
- Communication with the system.

Fig. 28.1 Particular elements of the design process ISŻP are connected with each other so there is a necessity of their parallel design. Thus, the design process has to include structures of data which make up the system statics and processing technology which reflects its dynamics.

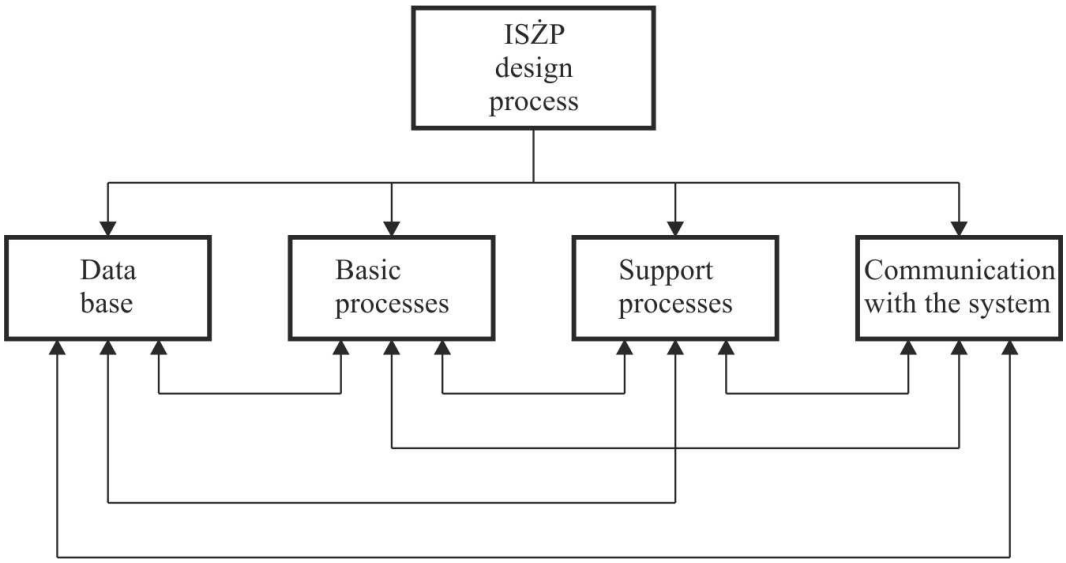

Fig. 28.1 Graphic illustration of ISŻP design process [1, 4]

Design of basic processes:
Basic processes include the following groups (fig. 28.2):

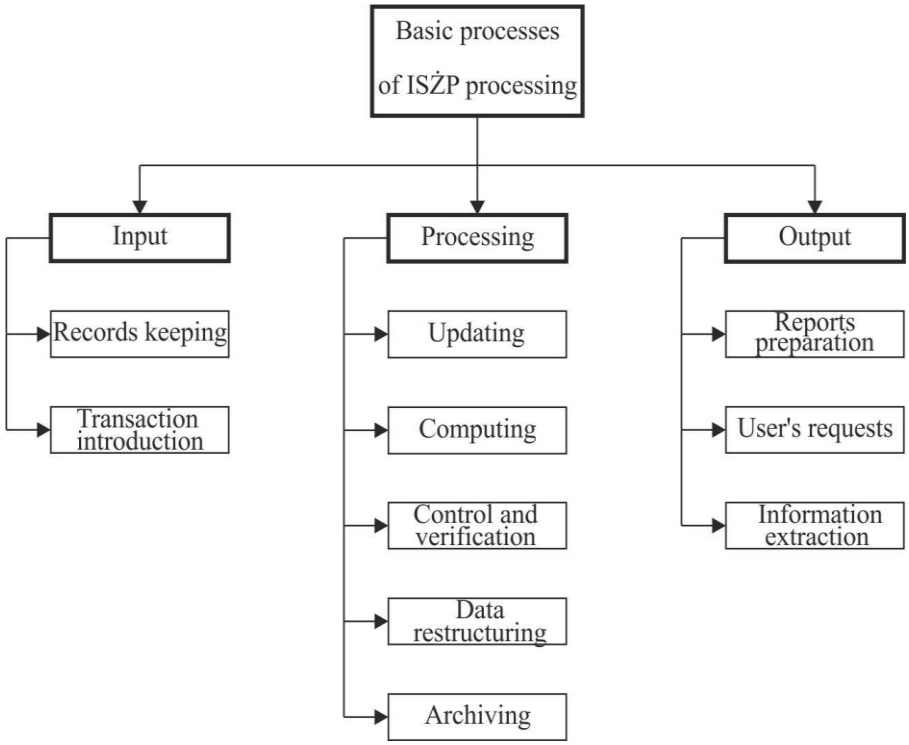

Fig. 28.2 Graphic presentation of processing operations [1, 4]

1) input processes:

- Keeping records, that is, registration of these data structures which are of permanent character within the information system and are the point of reference for other data groups;
- Introduction of a transaction, that is modification of the files content, their updating;

2) processing operations:

- Updating, a specific combination of the above mentioned groups;
- Computational, these are algorithms used for performance of appropriate processing procedures, providing basis for the whole information system;
- Control and verification. The purpose of these processes is to find a degree of the data consistence with the standard;
- Data restructuring, in other words, preparation of new structures of existing data, for the needs of further processing;
- Archiving, whose purpose is to prepare copies of particular data sets;

3) output processes:

- Preparation of reports according to the user's requirements;
- User's request, that is, methods of communication with the computer;
- Extraction of information, selection of data which is useful for the system environment, that is, users who will process it with the use of their own procedures;

The idea the design of basic processes involves transforming the functional model, being an element of the model in the field of subject oriented operating system, into the model of functional computer system (fig. 28.3).

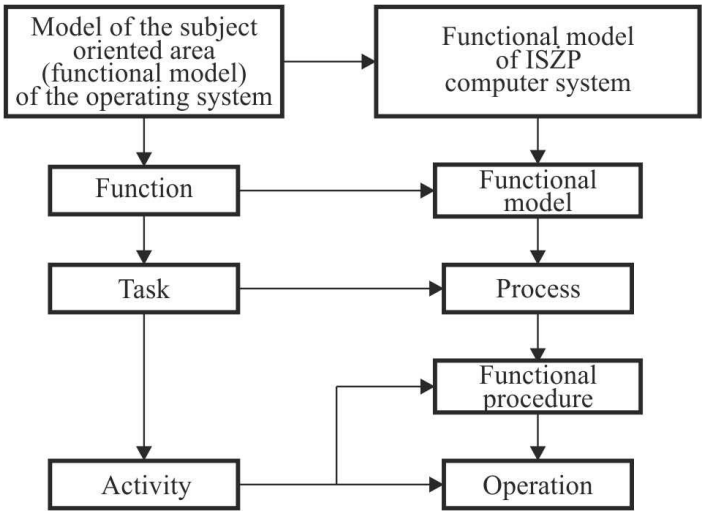

Fig. 28.3 Illustration of transformation of an operating system functional model into a functional computer system [1, 4]

Elementary type of projection means 'activity→operation", it reflects processing operations. A group of activities can be transformed into a functional procedure which is algorithmically consistent and a purpose distinguished group of operations.

One of the main elements of basic processes is a description of processing algorithms, especially in information systems of management support, of the type: providing the management staff with information, decision support and in expert systems.

Design of suport processes

Support systems of the computer system include: - fig. 28.4 [4]:

- Support of the system application,

- Service of system sets,
- Data protection.

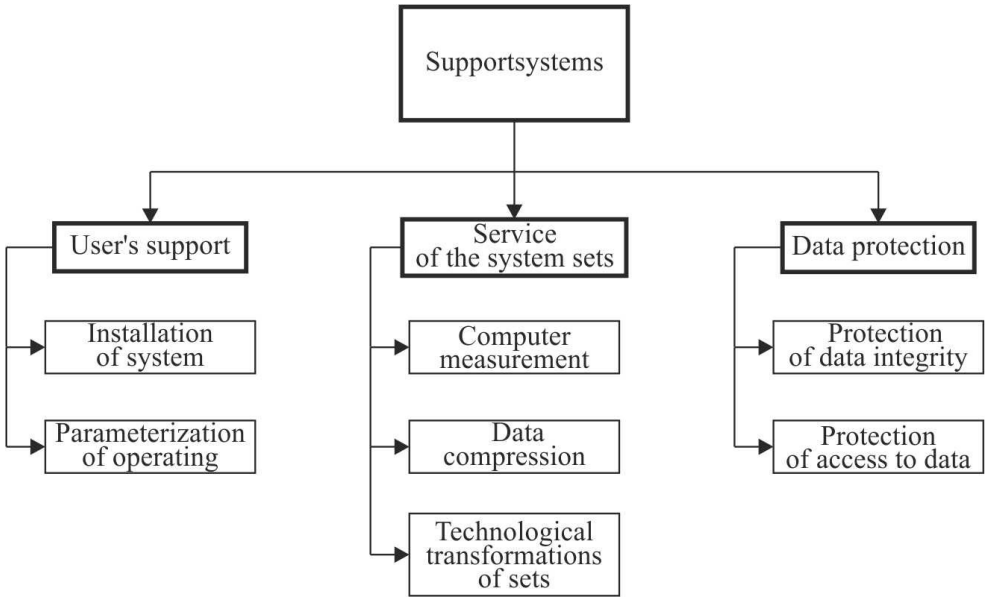

Fig. 28.4 Types of support processes [1, 4]

Due to functional and subject differences, the design of support processes has not been consistently and uniquely determined as compare to the design of basic processes. It is conditioned by the implemented processing technology, available software, creativeness and experience of designers [4, 6].

Design of the user's communication with the system

The tool for communication of the user with the computer is a set of: instructions, messages and comments. It is executed by means of the language of commands, control dialogue or quasi-natural language. The above listed elements are referred to as 'control dialogue'. Individual users of the system must be taken into consideration, that is, not IT specialists or operators, with regard to two basic rules:

- Computer is a human friendly tool,
- Constant distrust of the computer to the user's behavior.

Dialogue data entry can be performed in the following way:

- By filling in a form,
- By receiving from the computer a question about the data value,
- By completing a table (kind of a form).

Function selection methods on the screen can be performed by means of:

- Back lighting,
- Indication of the number on a list,
- By a functional key,
- Providing first identification,
- Entry of a full or abbreviated function name:

- Pictogram (scheme-picture),
- Any charakter indicator.

Presentation of results can be:

- Properly formed chart;
- Only one information item;
- Message (informative, errors).

The computer system user is usually in direct contact with its input and output, not having knowledge of its inside, that is, technology of processing.

Design of the system programs

Programming is a process involving elaboration of programs ISŻP on the basis of algorithms of its functioning. The basic element of ISŻP programming is its technical design, therefore, it has been incorporated into the design phase as its last element. ISŻP programming process, consists of the following stages (fig. 28.5) [4, 11]:

- Analysis of quality requirements (occupies 10% of the system software time):
- Specification (10%);
- Structural design of the system software (15%);
- Coding the system program modules (20%);
- Testing the system software (45%)

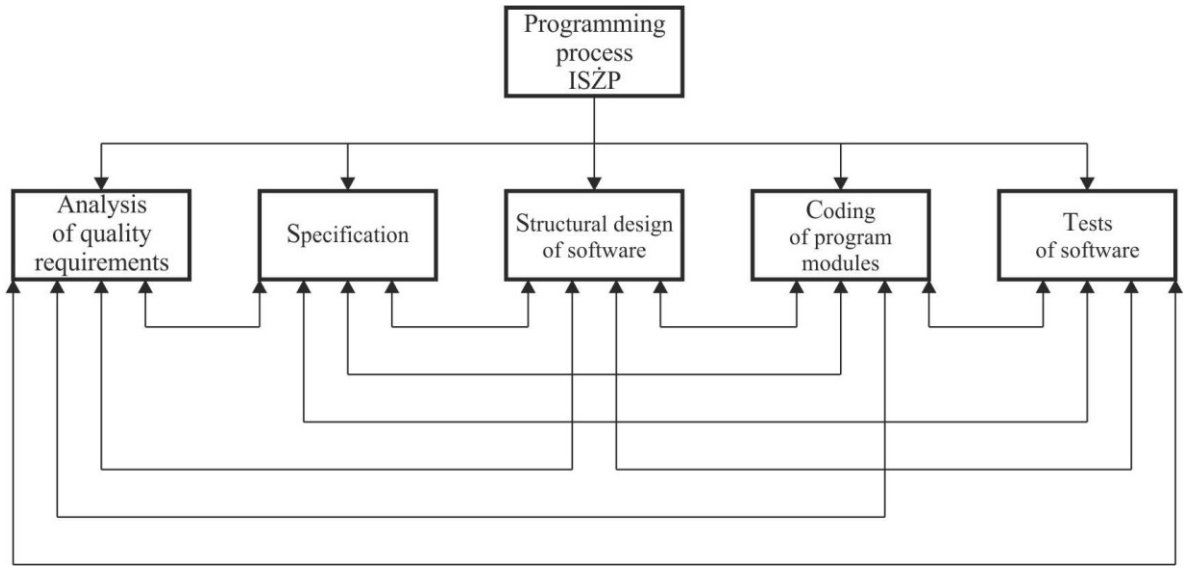

Fig. 28.5 Graphic Illustration of software processes [1, 4]

Analysis of quality requirements aims at obtaining high quality of the created software, which is determined by:

- Machine independence – means that the developed programs can be created on computers with different configurations.
- Completeness – program contains all the necessary elements;
- Accuracy, to make the system result fully consistent with its purpose.

- Consistence – is connected with the use of uniform notations and symbols and has to reflect ISŻP technical design;
- Rationality – means that the program product contains only these operations which are indispensable to perform its function;
- Structuring – all parts of the software make up one whole;
- IT aspect – programs contain only this information which is indispensable for its structure and functioning;
- Reliability – the software product performs its functions efficiently;
- Effectiveness – software product performs the required functions without redundant use of the computer system resources (eg. Production memory);
- User friendliness;
- Ability to undergo modification – structure is prone to modification;
- Ergonomics – contains all the specified above properties.

The second step of programming is specification which consists of:

- External specification of the program, designed for the user. It includes: name of the program, description of its function, list of programs, description of input data and resultant information [12];
- Internal specification for the programmer – that is, description of the program logics. It covers an algorithm and data structure.

Design of the system software structure involves adjustment of the functional modules resulting from the technical design, to the computer equipment performance possibilities. Methods used for the design of the system structure include:

- top-down, which involves defining the whole system software structure and its gradual specification at lower levels. Recognition of the most important functions which are to be performed by a given program module is aimed at, in each step of the specification process
- bottom-up, assumes actions reverse to the previous method, that is,: the smallest possible independent modules →modules of higher levels →module performing the main function of the information system.

Coding software modules means writing programs (procedures) for implementation of particular modules in the general structure of the system software.

Testing the system software is the most time and work consuming activity. It involves the necessity to make sure that:

- Each instruction should be performed at least once for a given set of testing data, whereas, the module should generate correct results,
- Each branch of the program should be tested and the program ought to generate correct results,
- Each program specification should have its own attached set of testing data in order to find out whether it is properly performed by the program.

Summing up the discussion, it can be stated that the result of the design phase are the designs: technical and of programs, that together, make up an integrated project. ISŻP (fig. 28.6).

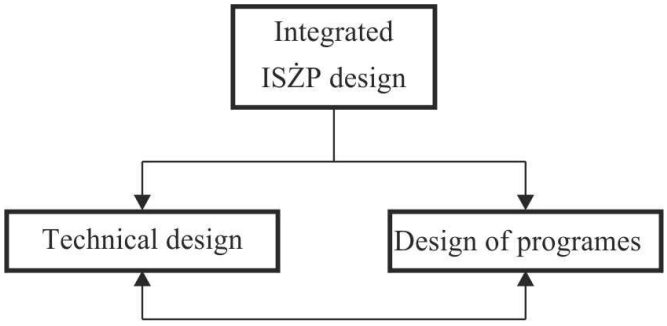

Fig. 28.6 Graphic presentation of the integrated design components

28.3 Conclusions

Elaboration of a computer system of management in production engineering enables identification of basic elements of its environment and identification of modules making up the subsystem itself. Defining functions performed by particular modules and accounting for elements of the environment allow to develop particular procedures of operation within the company structure. It also makes it possible to manage data necessary for the needs of the company efficient operation.

Diversity of the production engineering management system properties and tasks to be performed involves diversification of research methods and tools including methods and forms of computer systems for management and operation. The need for efficient management of enterprises, especially the one forced by the rules of economic transformations, determines the necessity of rational use of production factors.

Rules and procedures as well as relations occurring between the elements involved in the process of the company resources utilization largely depend on the enterprise proper organization, proper functioning of the management staff and adjustment of tasks to the company needs and possibilities.

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