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SYSTEMS FOR INFORMATION SERVICING OF COLLECTIVITIES*

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The paper discusses the problem of total servicing by a computer of the information activity of a professionally linked group of persons (a collectivity) working organizedly on given problem.

The structure of the collectivity is discussed as well as the structure of the information base and the linguistic tools for communication of the members of the collectivity with the information base and the servicing system.

The general principles and structure of an abstract system for information servicing are discussed. Through a process of concretization (specialization) it can be adapted to service a given collectivity.

1. Introduction. The use of computers is characterized by an extension of their application areas and by a trend to solve more complex problems. In correspondence with this process the methods for the use of computers are also being advanced forward.

Initially only single problems were being solved by computers. Gradually their use evolved towards the creation of processing systems comprising standard programs prepared in advance as well as other tools for automatization of the programming process (Fig. 1.).

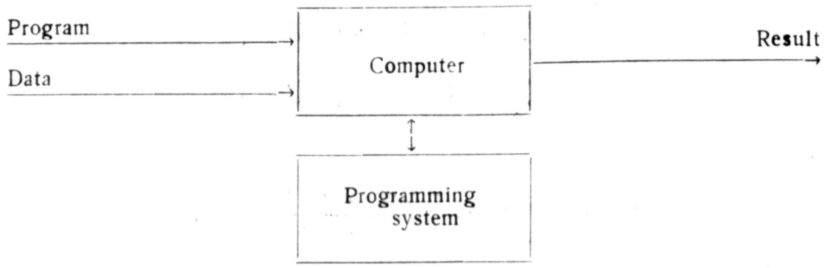

Fig. 1. A processing system

Later the attention was turned towards the processes of data collection storing and usage. Computerized information systems have emerged (Fig. 2).

Recently there has been a trend towards creation of systems comprising a data base and more or less perfect data manipulation tools. These data base management systems in which the processing tools are developed to a very high degree represent a synthesis of processing systems and information systems. In their most general form such systems ensure storage, retrieval and

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processing of information and they have a common information base containing both data and programs for processing of these data (Fig. 3).

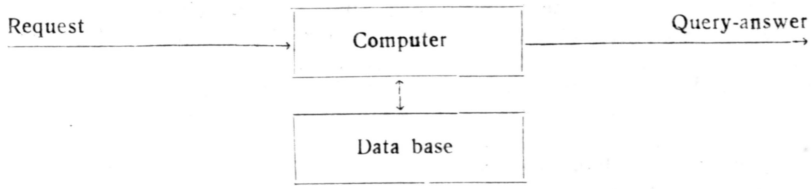

Fig. 2. An information system

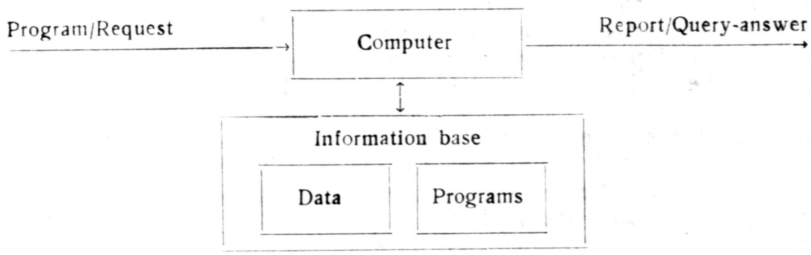

Fig. 3. A system for storing, retrieval and processing of information

The present paper is concerned with systems for information servicing by a computer of groups of professionally linked and well organized users. Such groups will be referred to as collectivities and the corresponding system will be called a system for information servicing of collectivities (SISC).

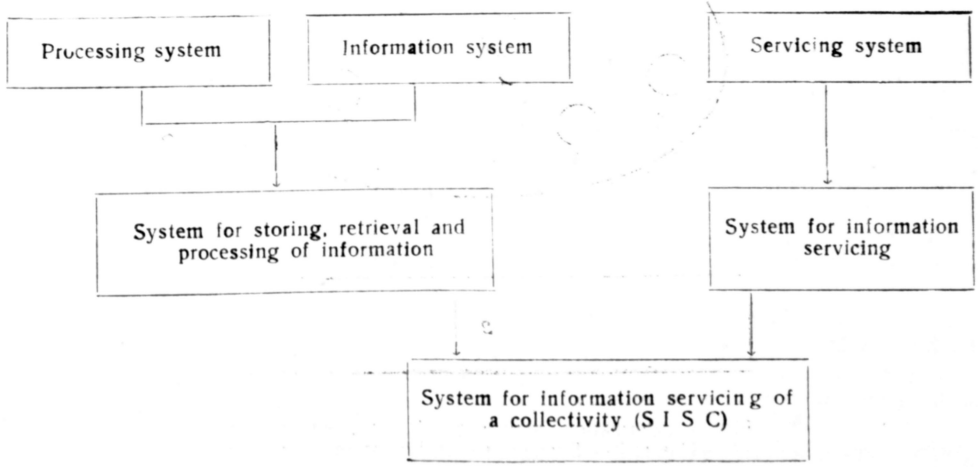

Fig. 4. A system for information servicing of a collectivity

In order to make more clear the essence and the relative position of such systems let us note that there are two ways leading to the idea of such systems (Fig. 4).

The first of them follows the already described development of the methods for computer usage. One can come to the idea of a system for total and complex information servicing by a kind of generalization of the concept of a system for storage, retrieval and processing of information. Further through specialization the concept of a SISC is reached.

The second way is not traditional for the computer system designers, although it is much more natural. It consists of a two-step specialization of the very general concept servicing systems.

Up to now there has been accumulated a vast practical experience in the creation and operation of servicing systems in different specific areas: in health care, transportation, business, etc. A special case of the general problem of servicing is the collection, storing, processing and using of the information necessary for the activities of the collectivity.

The second step of the specialization of the servicing problem is the specification of the object of the servicing — a collectivity of professionally linked users.

The collectivity being serviced informationally can be a scientific, an educational, a managerial, one engaged in production servicing, etc. Such a collectivity is characterized by its inner organization. Its activity is organized according to plans prepared in advance and it is aimed at reaching predetermined goals.

Before the advent of computers the information activities in the collectivities were performed completely by their members, some of whom were ex-

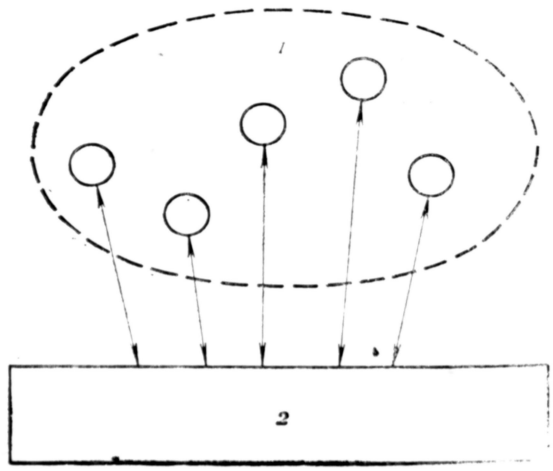

Fig. 5. Information servicing of independent users.
1 — Users; *2* — System for information servicing

perts in this field. Document files, accountence offices, information departments, etc. were being created. The contemporary computing and communication facilities aim at covering the major part of the information activity of a society.

There is a substantial difference between systems for collective use as time-sharing systems for example (Fig. 5) and SISC (Fig. 6). A system for collective use is a system for individual servicing of a group of persons who are not linked among themselves or at least the system does not take into account the existing links.

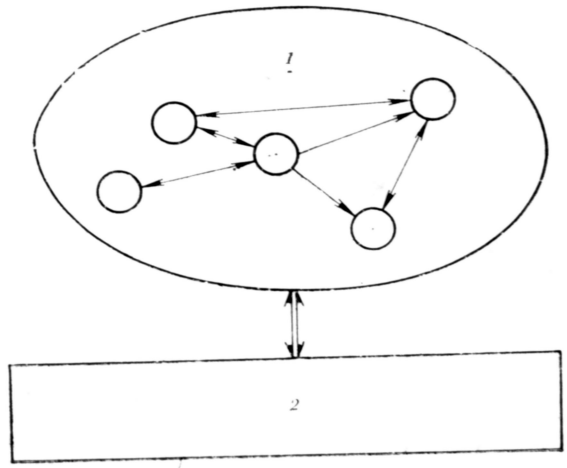

Fig. 6. Information servicing of collectivities. *1* — Collectivity; *2* — System for information servicing of a collectivity

On the other hand, the SISC should not be regarded as a system for management of the collectivity. The system does not manage the collectivity; It rather facilitates, serves its information activity.

Yet, a third approach is possible in the treatment of a SISC. It can be regarded as a peculiar extension of the concept of a computer. There is a simple correspondence between the structure of a SISC (described in Section 3, Fig. 8) and the structure of a computer.

This paper discusses an abstract model of a SISC. Various systems for information servicing of a class of specific collectivities could be created, based on this model.

The limited size of the paper does not permit to adduce all the considerations and the numerous details connected with the abstract SISC and its applications. Some of them are discussed in the referenced publications.

2. General principles. The construction of a SISC is based on the general principles, discussed below.

2.1. *The group of persons being serviced by the system is a collectivity.* For this reason:

— The collectivity is treated as a whole. The design of the SISC takes into account the aims and tasks of the collectivity, its inner structure and organization.

— The SISC may and should take into account the planning of the activity of the collectivity, its book-keeping, accounting, the reporting procedures, the duties and responsibility of the members of the collectivity.

— The SISC is relatively self-contained. It is accessible only by members of the collectivity.

— The primary information entered into the system is the one traditionally gathered by the collectivity. It is entered as soon as it appears. The gathering of the information is done according to plans and with a sense of responsibility. This prevents the storing of redundant information and permits to purge regularly the information base.

— The order of servicing is in accordance with the aims of the collectivity, the established mode of operation.

— Uniform and common information and procedures are used within the collectivity. The linguistic tools, the methods of operation are unified as well.

Let us note that the well known truism concerning the use of computers refers to the systems for information servicing as well. These systems amplify the information activity within the collectivity together with its shortcommings.

The SISC being discussed is intended or well organized collectivities with significant experience in information activity.

2.2. *The information servicing is complex.* First of all its complexity is provided by the use of an integrated complex information base (containing data and programs). On the other hand, the complex servicing comprises:

— furnishing of reliable and up-to-date information, its storage and submitting for use. The information can be used immediately after some processing. The possibilities for processing the information are combined with the options for making queries. The processing programs use the information from the base also through the query facilities;

— monitoring the techniques for managing the information;

— establishing and maintaining the information links among the members of the collectivity. The SISC is a distributor of information, a communication tool for the members of the collectivity.

2.3. *The system provides servicing.* It is constructed according to the general principles of the service activities.

As a consequence:

— The system has a subordinate role. It does not manage the collectivity but adapts itself to it. Its activity is governed by the collectivity;

— The distribution of activities between the system and the collectivity is in accordance with their abilities. The collectivity is assigned those tasks for which intellect, initiativeness, making reasonable decisions in complex and ill-defined situations are required. The system performs these operations for which reliability, speed, great capacity storage are the important factors.

The selection of the information in particular and of its structure is assigned to the collectivity;

— The implementation of the SISC should not cause serious disturbances and should not lead to undesired reaction within the collectivity including reaction of psychological nature. The best servicing is the one that remains unnoticed. The system replaces the traditional techniques for providing information services (the use of archivists, book-keepers, accountants, assistants, informants, etc.) and in the same time develops them further and improves them, but it does not outlaw the existing forms of servicing. The operating habi-

tudes of the collectivity should not be substantially changed. The terminology should correspond to the terminology traditionally used in the information activities and not to the one introduced only in the last few decades or years by the computer experts.

The influence of the computer experts on the design, development and operation of the SISC should be minimal.

— Methods and techniques, customary in the service systems, for instance subscription, are broadly used in the SISC.

2.4. *Adaptivity of the system towards different collectivities.* It is achieved on the basis of the so-called abstract SISC according to the scheme of Fig. 7.

The abstract system is a collection of interrelated techniques from which the SISC of a given collectivity is constructed through a process of stepwise and gradual specification called concretization.

The concrete SISC obtained by this procedure can be further developed, complemented, built-up and used in the process of operation.

The process of concretization permits the use of the abstract SISC by different collectivities and therefore this process makes it more universal. In the same the specification of the system for a given collectivity makes it more efficient.

The abstract and the concrete levels refer not only to the SISC as a whole but also to all its components.

Each system for information servicing for a concrete collectivity is a model of the real system for information servicing by means of the abstract SISC.

3. Structure of the SISC. A given collectivity together with its corresponding SISC forms a system. The basic components of this system are: a collectivity, a SISC and a communication language. The abstract level and the process of concretization affect not only the SISC but also the collectivity and the communication language.

The collectivity is linked by its information activity with the SISC. The concept of a collectivity is discussed in Section 4.

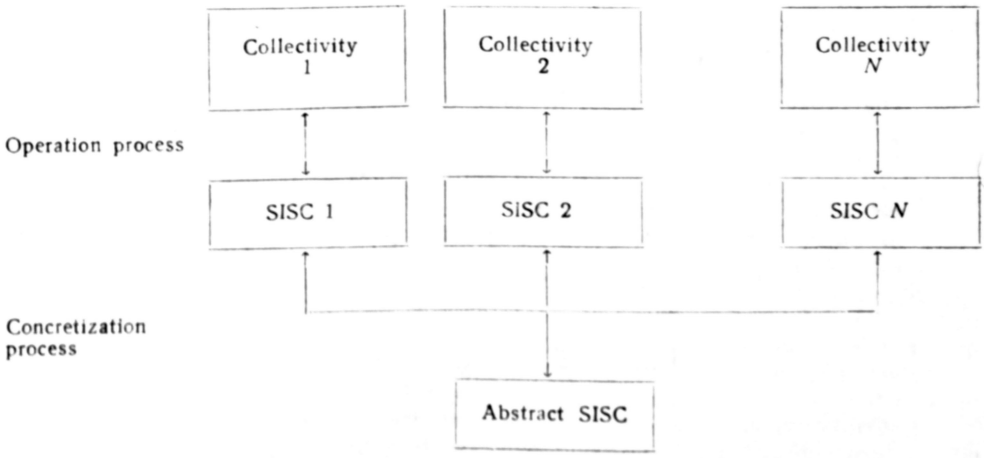

Fig. 7. Concretization of the abstract SISC and operation of the concrete SISC

The communication language ensures the two-way information exchange between the collectivity and the SISC. It is discussed in more detail in Section 6.

The SISC is composed of an information base and a processor.

The information base is the passive component of the SISC. It contains the integral information (data and programs) with which the collectivity ope-

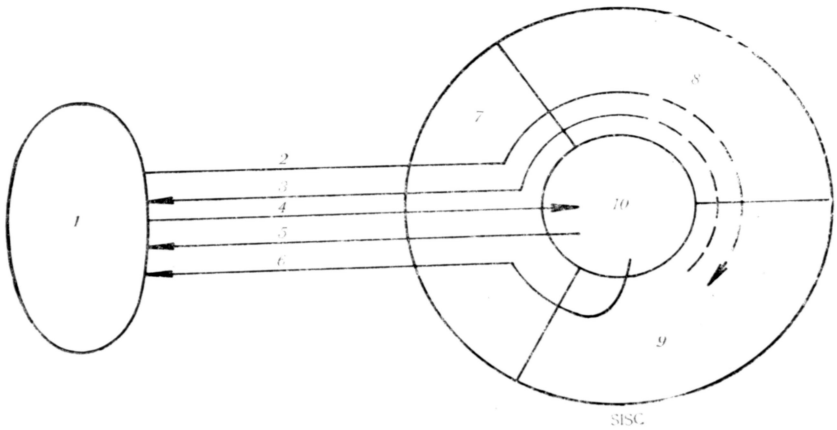

Fig. 8. Interaction of the collectivity with SISC. *1* — Collectivity; *2* — Requests; *3* — Messages; *4* — Primary information; *5*—Query answers; *6* — Reports; *7* — Exchange system; *8* — Control system; *9* — Processing system; *10* — Information base

rates and which is necessary for the functioning of the system. The information base is discussed in Section 5.

The processor is the active component of the system. It provides the interaction of the users with the information base. It is composed of three interlinked systems — a control system, an exchange system and a processing system and it may use one or several interconnected computers. The processor organizes the operation flow of the active components of the information base. The processor is discussed in more detail in Section 7.

Fig. 8 shows the general structure of a SISC and its interaction with the collectivity.

The requests transmit certain instructions, orders to the SISC.

The primary information is entered into the information base.

The query-answers contain the requested part of the primary information, satisfying certain conditions.

Reports (secondary information) are produced by a requested processing of primary information. They are not stored in the information base unless declared as primary information by the users.

The messages are issued by the SISC. Through them the system transmits to the users relevant information beyond the one requested in the queries.

4. Collectivity. A collectivity is by definition a group of persons organized on professional principle, who work systematically according to plans for solving one or more linked to each other major problems, requiring continuing

or unlimited duration. The collectivity has a fixed structure in which usually a hierarchical subordination is applied. A system for interaction and for its functioning is embodied into it. Each individual collectivity member has certain rights and obligations. For fulfilling its tasks the collectivity has at its

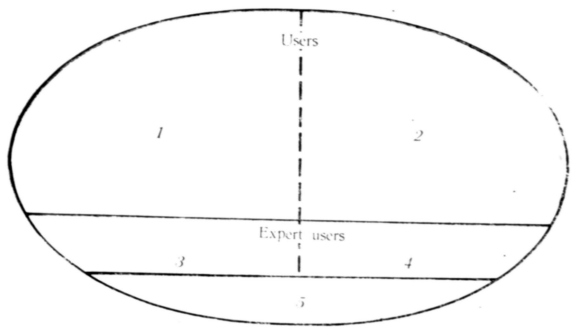

Fig. 9. Abstract structure of a collectivity. *1* — Suppliers of information ; *2* — Recipients of information ; *3*— Expert suppliers ; *4* — Expert recipients ; *5* — System maintenance personnel

disposal certain resources — machines, buildings, materials, transportation, communication links, finances, etc. It has relationships with other collectivities.

Examples: collectivity serving a hospital; research institute; enterprise collectivity; TV company collectivity; exploring expedition; lost property office; collectivity designing a major construction, etc.

Each collectivity has certain information needs. In many collectivities these needs are considerable and the information activity of the collectivities is of primary importance for their integral operation. A large class of collectivities exists which, irrespective of their varying structure and tasks, have similar information ne ds which are characterized by:

— operation with data of relatively stable structure but with variable values;

— necessity of performing various information inquiries;

— use of a limited number of specific processing procedures that are seldom changed.

This is the basis that permits the construction of a SISC for the treated class of collectivities through concretization of a certain abstract system for information servicing.

In respect to the information activity performed in a collectivity, it can be divided into 5 parts (categories) as illustrated by Fig. 9. This is the abstract structure of a collectivity. It does not depend on the specific tasks of the collectivity and the integral activity of its members, but reflects only the necessary information activities. This activity is discussed in more general aspects in Section 5 (Fig 11).

Profound knowledge of the SISC is assumed only for a relatively small number of the members of the collectivity. These are the expert users (suppliers and recipients of information) as well as the system maintenance person-

nel. The ordinary users, that form the prevailing part of the collectivity, make use of a simplified language for communicating with the system. When necessary, they address the expert users as mediators.

The concretization of the abstract collectivity is performed by determining the categories to which each individual member of the collectivity belongs.

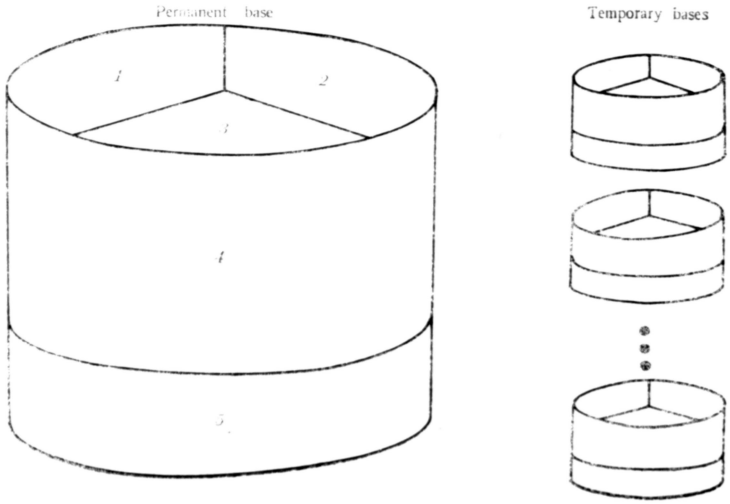

Fig. 10. General structure of the information base. *1* — Descriptions; *2* — Comments; *3* — Values; *4* — User information (data and programs); *5* — System information (data and programs)

A certain member of the collectivity may perform several abstract activities. For example he may be both a supplier and a recipient of information. The detailed concretization of the abstract collectivity is performed by linguistic tools that are accessible for each member of the real collectivity.

A general treatment of the problems concerning the concretization of the collectivities is presented in [4].

5. Information base. The general structure of the information base is illustrated by Figure 10. It consists of a permanent base and temporary bases. Each of them contains user and system data and programs.

The permanent base is the main one. The information is stored in the permanent base as concisely as possible. By definition the information stored in the permanent base is primary. It can be retrieved and submitted to the members of the collectivity in a form that does not differ substantially from the form used when the information was entered.

The stored physical representation of information in the computer memory depends on the specific implementation of the SISC. This representation is not familiar to the basic system users. Establishing the correspondence between the information representation as seen by the user and its physical representation is one of the functions of the information exchange system of the SISC processor. In nowadays computers the information base is stored usually on magnetic discs.

The temporary bases differ from the permanent mainly by their designation. They are created by the expert users for more convenient solving of some particular information problems, for example the input and update of large batches of data, more convenient layout of the information with regard to processing or its intensive use for query-answering, the debugging of user programs, non-standard physical representation aimed at improving the processing efficiency.

The initial information in the temporary base is entered by the suppliers of information and/or from the permanent base. In the process of information exchange between the permanent and temporary base a restructuring could be performed.

The use of temporary bases in many cases facilitates the users activities (for example some of the restrictions concerning information protection can be ignored), improves the efficiency and increases the security of the operation of a SISC. The update of sections of primary information can be performed in stages, awaiting the accumulation of single incomming corrections in the temporary bases, referring to these sections and entering them into the primary base in batches.

The main information in the base is the user information, since it is the object of the information activity of the collectivity. The user programs in particular perform the specific processing procedures for a given collectivity.

The system information ensures the functioning ot the SISC. With minor exceptions it is not accessible for the members of the collectivity.

The responsibilities of the collectivity for the creation and maintenance of the information base and their rights for access are illustrated in a generalized form by the table of Fig. 11.

The basic entities in the information base are the tables. There are two types of tables. The first type is a sequence of lines. The tables of the second type contain a fixed number of named lines.

Members of the collectivity	Usage of the information base			Creation and maintenance of the information base		
	user information		system information	user information		system information
	data	programs		data	programs	
Suppliers	no	no	only messages	yes	no	no
Expert suppliers	yes	no	only messages	no	yes	only data
Recipients	yes	only execution	only messages	no	no	no
Expert recipients	yes	yes	only messages	no	no	no
System maintenance personnel	no	no	yes	no	no	only data

Fig. 11. Basic information activities of the various categories of members of the collectivity

The lines consist of data items. The items can be numbers, strings or tables. The option of insertion of tables in other tables independent of their type permits the treatment of the whole information base as a table.

The number of lines in a table is unlimited. The length of a line is restricted by the requirement to hold one line in a printer page or on the display screen.

There is a special category of tables, the lines of which are sufficiently short and could be accomodated on one punched card, one printed line or one line of the display screen.

The table structure of the information base has been chosen because of the following considerations:

— It corresponds to the broadly accepted form of information representation outside the computer systems, especially within collectivities with long experience and good organization in their information activity.

— Both simple (linear) and more complex (for example trees) information structures can be represented (modelled) by tables.

— The naming of the information items and the operations on them are more convenient in comparison with the tree structures for example.

— In comparison with the linear form of representation the table form of the information gives better opportunities to the human eyesight for perception and analysis of the information.

— The table form corresponds better to the ways of communication with the computers, for example character-display videoterminals, program sheets, printer pages, etc.

Each table has three components: a description, a value and comments.

The values play the major part. The basic operations are performed on them or their components (line values, column values, item values).

The descriptions play the role of a mediator between the members of the collectivity and the SISC. The correspondence between the language and the values of the tables are established through them. Each description determines the structure and the type of the table, some of its characteristics (for example the operations permitted on the table, the right to access to it, etc.) as well as data necessary for the system operation.

The comments are a mediator, a tool for communication between the members of the collectivity on a subject concerning the corresponding table (this is even true for the communication of an individual with himself — in this case the comments play the role of a blocknote or a note book).

The input of data into the information base especially in the case of input through a temporary base is supposed to be performed in conjunction with data validation as described in [2; 5].

Some details concerning the information base structure are outlined in [7]. This paper also treats the basic operations on the entities of the information base. A general idea of these operations is discussed in the next section in relation to the communication language.

The information base of the abstract SISC does not contain user information. It contains only the system programs of the SISC (completely) and the descriptions and comments of the system data. Through these comments the contact between the designers of the abstract SISC and the collectivity, the maintenance personnel in particular, is established.

By the concretization of the abstract SISC user programs are created and catalogued into the information base, descriptions and comments of user data as well as values of system data are entered. During the operation values of user data are entered into the information base, updating and upgrading of the whole user base is performed, system data are modified. The main activity during the operation is naturally the use of the information in the base.

During the concretization and operation the individual access of each member of the collectivity to the various components of the information base is determined.

6. Communication language. The communication language determines the ways of communication and information exchange between the collectivity and the SISC. The various types of information exchange are illustrated by figure 8 and are described in Section 3.

The characteristic features of the communication are the following:

— It is conducted in two directions: collectivity → SISC, SISC→collectivity.

— The communication is not symmetrical in both directions.

— The members of the collectivity maintain with the SISC simple business conversation that leads to invoking algorithmic (proceduralized) manipulations known in advance. The conversation does not touch the essence of any problem nor does it contain any emotional components. Only an insignificant part of the human capabilities for communication is used.

— The communication is a cybernetic process that aims at transmitting certain information. It comprises the following elements: an idea, preparation for communication, establishing of the communication [10].

The construction of the communication language conforms to the following principles:

— The language and its description are constructed employing the terminology generally used in dealing with information.

— In the direction collectivity → SISC the language has a markedly artificial structure. No attempt is made to resemble the natural language.

— The procedural pattern of the communication is avoided. Only the aim sought is defined but not the way it can be reached.

— Fundamental attention is paid to the communication in the direction SISC → collectivity. The communication language for this direction is designed in advance and it is not a consequence of the implementation of the SISC. This language is also subject to concretization.

—Preliminary preparation, subscription, default options, and other means, reducing the time and the efforts of the users, are employed with the communication process.

— Complicated and undesirable activities are accomplished by inconvenient linguistic tools [8].

— The communication language is oriented towards operation on character display video terminals.

The communication is optimized with regard to the following criteria: the time span between the occurrence of necessity for information transfer until its final perception, convenience, economy, reliability [10]. Redundant linguistic tools are avoided [8].

— Collective communication and interaction is possibile among the users by means of the SISC. This can be achieved by employment of comments as

well as by sending reports or query-answers to some users on a request submitted by other users.

— The language comprises tools for protection of the SISC from undesirable activities.

The communication language can be used at two basic levels: a complete language providing its full capabilities and a reduced (restricted) language. The complete language is available only for the expert users and for the maintenance personnel. The reduced language is employed by the ordinary users.

In correspondence with the various types of information exchange (see Fig. 8) and the basic information activities of the members of the collectivity (see Fig. 11) the communication language consists of sublanguages, as illustrated by Figure 12.

In the reduced language the messages and the answers to queries have a standard form fixed in the system. The outlay of the reports is performed by the corresponding processing programs. The formatting of the primary information for input into the information base is standard. The request language is strongly simplified.

The complete communication language permits non-standard formats for messages, query-answers, reports and primary information intended for input.

The requests sublanguage is particularly developed. The requests contain the type of operations that have to be performed, information specifying one or more subsets of the information base and information, determining a subset of the members of the collectivity.

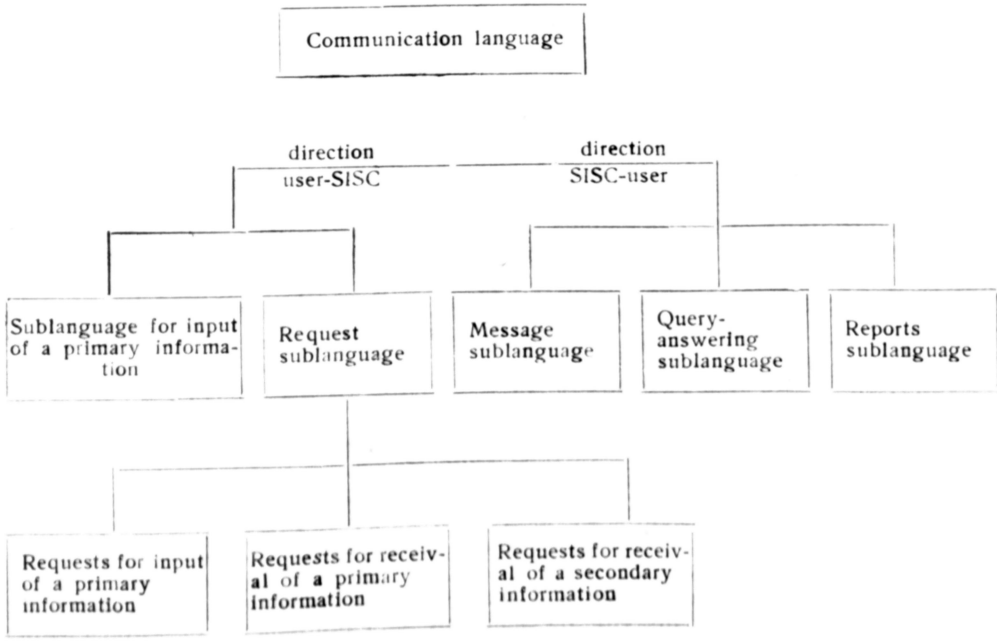

Fig. 12. Structure of the communication language

The subsets of the information base and the selected members of the collectivity serve as parameters (arguments or results) for the operations. Both types of information can contain conditions. The arguments of these conditions can be constants, entities from the information base, the current date or time of the day, some special indicators related to the functioning of the SISC.

The operations that can be performed on the information base are described in [7].

The requests in the complete language may have complicated structure. Some details in this respect are described in [4]. In that paper some other problems related to the communication language and especially to its individualization are also discussed.

The answers to queries or the reports, generated by the execution of a certain request, can be communicated to several members of the collectivity. The system and user programs included in the information base can also issue requests.

The changes having occurred in the collectivity are reflected by input of primary system information. The same is true for creation of subscriptions.

The communication language permits the use of abbreviated names.

7. Structure of the processor. As mentioned in Section 3 the processor is the active part of the SISC and consists of a control system, an exchange system and a processing system. The processor uses work areas, where the necessary system and user information of the information base, the incoming information and some data created during the operation of the processor are stored. The work areas as a rule are placed in the main memory but if necessary they are directed to the computer external storage.

The processor has a modular structure, and control tables are broadly used in its implementation.

7.1 Information exchange system. It performs the following functions:

— Two-way transfer of information between the members of the collectivity and the SISC, and the information base in particular. The exchange system includes the facilities necessary for retrieval of primary information (answers to queries) from the information base.

— Information exchange between the information base and the work areas of the processor

— Independence of the pl.ysical representation of the information in the base

— Preliminary analysis of the requests and the information relating to the exchange links in the SISC

— Distribution and management of the resources submitted by the control system to the exchange system

— Information protection.

The information exchange system comprises:

— a control program

— an input system

— an output system

— a terminal operating system

— a system for exchange of information among the different storage levels with possible restructuring of the memory

— a program for initial analysis of the requests

— a system for query answering
— system indices, buffers, work areas, etc.

7.2 Processing system. It performs the following functions:

— Ensures the execution of the processing programs catalogued in the information base
— Analyzes those parts of the requests containing a reference to processing and organizes their execution
— Astists the construction and debugging of new processing programs.

The processing system comprises:

— a control program
— a program for requests analysis
— an executive system
— a programming and debugging system
— a data validation system
— a macro definition processing system.

7.3 Control system. The control of the SISC is hierarchical and it is performed at three levels:

— collectivity (highest level)
— control system of the SISC
— control programs of the information exchange system and the processing system.

The control system carries out fhe overall management of the SISC by performing the following functions. It:

— handles the interruptions;
— distributes the resources and takes care of their optimal usage;
— maintains the requests for execution by organizing their parallel processing;
— controls the access to the system and provides protection of the information in the base;
— monitors the keeping of the approved discipline for operation of the SISC and especially for the supplying of information in the base;
— accumulates information for the SISC activity with regard to the optimization of the processor operation and the information layout in the information base;
— ensures the execution of subscriptions.

The requests execution order is determined by the following factors: importance of the problems to which the request refers, urgency of the repuest, priority of the member of the collectivity, necessity for an interaction with the member of the collectivity, possibility for convenient execution in a given instance (for example in conjunction with other requests), etc.

8. History and applicatfon of the SISC. The first projects developed in Bulgaria and containing some elements of the concept of a SISC date as early back as 1965. An abstract SISC named NEPTUNE was created in 1973—1974 for the MINSK-32 computer. The argumentation for some of the solutions in this system are given in [9]. Three concrete implementations are functioning since 1975. Some of the basic ideas discussed in this paper are implemented in the NEPTUNE system. Part of them are published [1]. An implementation of an advanced abstract SISC is under way. The first version of this implementation is carried out for the ES computer. A series of concretizations of the abstract system are prepared in parallel: for a research collectivity, processing

geological information [6], for departments for processing of seismological information in the Balkan countries [3], for the management of the Bulgarian Academy of Sciences, for a collectivity engaged in space research, etc.

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