P. CONSTANTINESCU
C. ANTONESCU
The Ştefan Gheorghiu Academy

The Structure of Data Necessary for the Management of Production

There are formulated the information requirements of the system having as a starting point the structure of informatic system built as an adaptive (closed) system. In the particular case of the informatic systems for industrial enteprises it is pointed out the relations among different information categories and there are proposed three variants of representing these structures in the data base of the system (pairs of files, network of files, separate zones of data and structures.)

1. WHIFFLETREE STRUCTURES

The structure of models of the informatic system built as an adaptive (closed) system has been established by setting out from the analysis of the outputs of the physical system- the enterprise [1]. In the multitude of these outputs a set was first determined whose elements (output variables) are considered to be most significant from the point of view of the description of the behaviour of the system, such as for example the plan fulfilment indices.

The models included in the system provide, by simulation, the decision-making elements grouped on three big hierarchical levels: strategic, tactical and operative — data in connection with the probable behaviour of the system run in keeping with various input sizes. Based on these data, the decision-making elements can adopt the most adequate policy for guiding the behaviour of the system run in the desired direction. It can be noticed that through their construction all the models of the informatic system determine the future values of the input variables in keeping with the value of the input sizes (possible decisions) and in keeping with the condition of the system when the input is applied.

Hence, a first very important conclusion, namely that within the system, the data must be most faithfully reflected in the condition of the system run, with a frequency at least equal to the frequency of the making of decisions.

This affirmation is endorsed by the following fact: besides the data received by the decision making element and which constitute answers to questions, such as "what would it happen if...", the possibility must not be excluded for the same decision element to express the desire to know also the instantaneous values of various condition variables (which did participate or not in simulating the processes in which it is interested), a desire justified by the difficulty of adopting the best decisions. If the data on the probable behaviour of the system (the outputs from the models) are generally offered to the decision-making element in the form of periodical reports, always with the same content and format, the other data describing the values of the condition variables, because of the random demand to which they are subject, cannot, as a rule, be presented in a standardized format, but in such a way that they be most useful to those using them (they form the object of the so-called "interrogations").

On the other hand, it can be noticed that due to the hierarchical structure of the management systems, through the adoption of decisions at a certain level, imposed (desired) values of the output variables are established for the lower levels, corresponding to these levels. For example, the hierarchical level superior to the enterprise-the group-establishes the "control figures" of the enterprise which will constitute its objectives. In its turn, the strategic and tactical management, by setting out from these options, establishes an optimum programme of all enterprise activities. By spacing out the plan on activities and by spacing it out in time, a number of compulsory landmarks for the operative level are established. The implementation of the informatic system as an adaptive (closed) system implies the continuous measuring of the difference between the desired value (planned, scheduled) and the real value of the condition sizes. This difference (negative or positive) must be corrected by adequate decisions at the level at which it was noticed or at levels superior to it.

The conclusion can be drawn that the infomatic system must also store the data of the "objective" type, expressed in a differentiated way at each existing level. A specification is necessary in this respect. It is possible to establish for each level, through the respective models, several variants of the ensemble of values of the output variables. All variants have a common point: they are established by reference to the same condition of the system run and differ only by the variation of the input. Following the adoption of a decision at the respective level, from the set of all variants drawn up a single one is chosen (for example, plan supply, fabrication programme) which becomes an objective. The storage of all variants established for a given level is of interest only during the period of time necessary for the making of decision; after that, the variants may be eliminated and only the objective variant is preserved.

Finnally, the existence of models, processing data of the "historical" type results from the analysis of the structure of the informatic system. These are but the output, condition or input variables for values of time smaller than the actual value.

The demands for data within the informatic system have thus been formulated, intuitively. Through their character, they can be of three types:

— data on the condition of the system run;

— data on the objectives;

— historical data (of condition, of output and/or input).

All these data are stored, extracted and handled through the data administration system (DAS) whose main element is the data base* [2].

By establishing the output variables which significantly describe the behaviour of the system, the condition and input variables pertaining to them are implicitely established. In this case, they say that from the set of all decisions which can be made at all levels of management a subset (list) was delimited, characterized by the fact that it directly influences the significant output variables.

To facilitate access to the data contained in the data base, they must be stored in an order required by the processings made on them. The beneficiary of the data contained in the data base is the decision-making element; the data can be put at its disposal either directly, through interrogations (punctual or synthesis), or indirectly, through their processing by the system models. It results thereof that the storage (organization) order of the data must answer, on the one hand, the processing needs of the models and, on the other hand, reflect the objective relations existing between various data or categories of data, reflected in the data base, a condition ensuring the decision-making element the possibility of using the data base.

All the data circulating in an industrial enterprise originate in various local sources, physically dispersed throughout the production process. Within this set of data, we notice the existence of relations between its elements, which are due to the relations between the physical objects and the phenomena described by them. It is well known from the practice of analysis of the enterprises that these relations define a very complex structure on the set of data of an enterprise (a network type structure). A classification can be made of the elements of this set of data corresponding to a grouping of the local sources around the main stages of the production process, four big categories of data being thus obtained [4]:

1) data on the totality of fabrication articles (products, units, subunits, components) or supplying articles (raw and related materials, semi-fabs obtained by collaboration);

2) data on the totality of the unit resources (production capacities, manpower);

3) data on the sale of production (the enterprise beneficiaries, the data exchanged between the two partners during the physical transfer of products, materialized in written documents, the products which form the object of transaction, terms, clauses, etc.);

4) data on supply (suppliers, the data exchanged between them and the enterprise during the physical transfer of the articles to supply, data about the articles forming the object of the contract, terms, clauses, etc.).

---

* An organized collection of data comprising the information necessary and sufficient for decisions. (This definition regards only the content of the data base and not the aspects concerning its achievement).

These four categories of data are subsets of the set of all data, defined, as necessary and sufficient for a list of decisions. It is noticed by now (this remark will deepen as a result of the analysis of the content of each category which is made further on) that these four subsets are not disjunctive, but, through their bringing together the set of data necessary to the management of production is obtained [3].

It can be demonstrated that through the division of the set of all data into four categories of data of different character, the conditions are obtained for a grouping of the data of each category on hierarchical levels, thus defining simple structures of a whiffletree type [2].

The minimum content of the information of the data base, as well as, the relations between the information which must necessarily be reflected in the base, through coded relations, identifiers and storage socket addresses, are defined by the needs of processing the decision and as such, of processing the data contained in the base. At the same time, the system models define the necessity of grouping the data on files, whose exploitation should be made in a sequence required by the processing sequence. The classification of data on files exploited in a given sequence also answers the restrictions concerning the configuration of the computing equipment which do not allow the simultaneous storage of the entire volume of data of the four categories on sockets which can be loaded (simultaneously) on peripherals.

On the other hand, the establishment of the relations between the data of the same file or contained in different files must take into consideration the facilities offered by the operating system of the automatic data processing system.

II. STRUCTURE VARIANTS OF THE DATA BASE

1. The structure of the data base can be established in a first variant by setting out from the necessity of ensuring the data a common, homogeneous socket, a unique structure, having the possibility of obtaining direct access to the required data. Considering the fact that whiffletree structures can be identified on each of the categories of data concerning the manufactured articles, the applied technologies, the supply and sale of production as well as the facilities offered by the administration system of the whiffletree structure (SCF) of the FELIX 256 computer, the data base of the informatic system for management in a first variant is presented in Figure 1.

A pair of files: main and liaison is used for each category of data. A module structure of the data base is thus obtained, in which the leading module is the pair of articles. The logical relations between the file pairs result from Figure 1. These relations are not physically obtained by addresses, but, are controlled through DAS [1] with the aid of the access keys (identifiers).

The main file of the first pair contains all the data about the products and their components up to the desired level. The liaison file of this pair contains the liaison data of a component type.

The next pairs, supply and sale, contain in their main files data about suppliers, respectively beneficiaries, the contracts and the other additional documents on the contract, the articles to supply, respectively the products

for sale. The associate liaison files keep data on the relations supplier-contract-articles to supply and respectively beneficiary-contract-products for sale.

The last pair, technologies, refers to the fabrication technology. Thus, the main file will contain besides data on products and their components, data

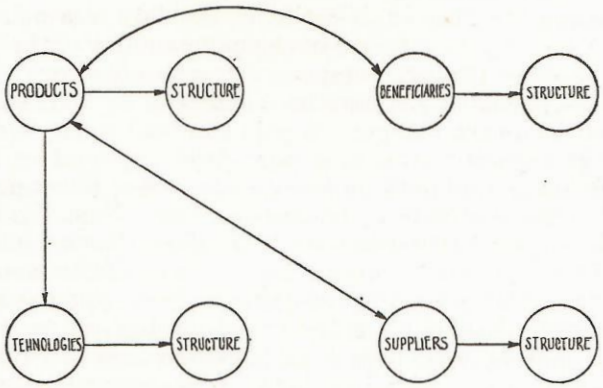


Fig. 1

describing the work places, such as the available equipment capacities, the structure of manpower, locations. The liaison file contains a technology for each product or component.

Taking into account the fact that the implementation of the informatic system starts with a first stage in which the problems of strategic and tactical management are approached, the loading of the data base can be done gradually beginning with the aggregate data at a corresponding synthetic level. This solution is justified because it is well known that the objectives of the kind of those connected with the optimum planning of production, the establishment of various influences on the implementation of the plan, the determining of the critical points of strangulation or of the insufficiently used resources, etc. do not require varied information about each equipment or component in the enterprise. The setting up of the files of data base constitutes the object of the function of the setting up of DAS.

With the deepening of the objectives of the informatic system [1], [4], up to the level of operative management, it is also necessary to adapt the data base in keeping with the new requirements of data. The deepening and refining of objectives require the lowering of the aggregation level of the data in the base, an operation which can be easily done without essential changes in the files, because of the adoption of the whiffletree structures. The problem concerning the structural transformations forms the object of a function which is different from that of creation, namely the *maitenance function.*

The updating of information in the data base (changes of condition, of objectives) is carried out through the *updating function.*

Finally, the current or exceptional demands for data in view of the substantiation of the decision are satisfied through the *interrogation function.*

This structure of the data base has a number of inconveniences which limit its use in various special conditions. The main inconveniences are:

— the separate exploitation of the pairs of files corresponding to the four categories of data, imposed for configuration reasons. This requires the storage of primary data at the same time in several pairs which obliges to additional controls for their updating;

— the passing from the exploitation of the data in a pair of files to the exploitation of another pair, because of the impossibility of their simultaneous loading, must be done through temporary transition files;

— the development of the data base achieved by increasing the volume of data connected on each category in part can lead to the surpassing of the necessary storage capacity even in a sequential exploitation of the pairs;

— the organization of data on the storage socket by using SCF for the administration of the whiffletree structures of recordings limits the class of processings which can be achieved with these data. The establishment of relations by addresses between the recordings of a pair of files results in a certain order of processing of the recordings and also in increasing the speed of access to data for the processings done in the preestablished order. Any other processings made in another order require an increased time of access or the interpolation of supplementary techniques between access and processing proper, which should achieve an adequate reorganization on another socket.

2. Another structure variant which we call filing network eliminates part of the disadvantages of the first variant. The principle used is that of deepening the division of the total volume of primary data, the thus obtained units, the modules, being connected by a network corresponding to a set of structures defined on the totality of data. Through this division of the total volume of data, a grouping of the primary data in keeping with the specified criteria is achieved in fact.

The correspondence "information module — main file" is being established as many main files (n) are obtained as many modules have been obtained by grouping all primary data.

A number (m) of structures, each structure corresponding to a processing order required by one or several modules can be established on the whole volume of primary data. By using SCF for concatenating the data according to the required structures, (m) liaison files will be obtained.

As the structures which have to be established in this way serve the processing needs, they are independent on the grouping of data into modules, previously done according to nature, source, etc. Consequently, we shall not necessarily have a liaison file for each main file. Any of the following situations can be met:

— a main — a link;
— a main — several links;
— several mains — a link.

What is, however, most important, the recordings of the main files, solely determined by grouping the primary data, can be found on one or several links, just as the main file containing them is linked to one or several liaison files.

Let us consider, for exemplification, the four structures previously defined on the set of primary data of the system. Les us also consider that the

following modules of data have been established, a main file corresponding to each of them (the names "modules-main files" mean the content in data of each of them).

— products (P);
— components to be manufactured (Af);
— components deriving from collaboration (Ac);
— raw and related material (M);
— places of work (units, manpower) (LM);
— beneficiaries (B);
— orders, contracts, consignment notes for delivery (Cb);
— suppliers (F);
— orders, contracts, consignment notes for supply (Cf).

A liaison file will correspond to each of the four structures considered in the first variant. The nine main files and the four liaison files will be connected by address links between recordings, on the basis of the specified whiffletree structures, as in Figure 2.

It is noticed that file L_1 corresponding to the composition structure of the products connects the main files (P), (Af), (Ac) and M. The same file (P) is linked by (L_3) to the main files (B) and (Cb), according to the structure of relative data upon sale, etc.

An infinite number of liaison files can be added to the 9 main files, in keeping with the various processing order of these data required by the models.

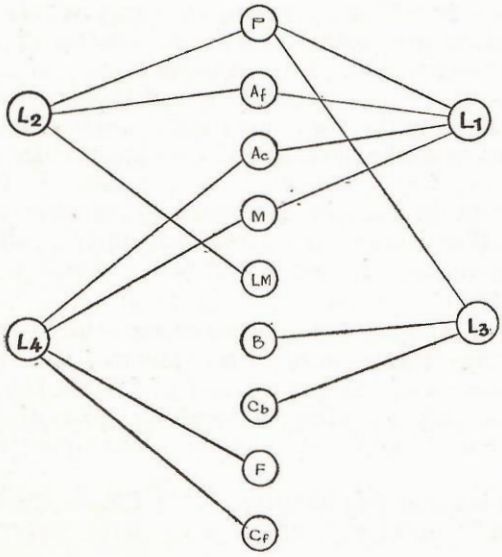


Fig. 2

For instance, to know directly, without covering the entire assemblage structure, the quantity of raw and related material required by the processing of each product, another file, L_5 might be introduced which should reflect the product-material structure. Another liaison file (only for file P) might

also be used through which a certain processing order is introduced of the recordings of products.

Such an organization of the data base has a number of advantages:

— the use of the same main file for achieving the links imposed by various structures eliminates the redundance existing in the first variant;

— by measuring the total quantity of data necessary to be stored in the data base and by establishing a succession of the loading of the main and liaison files in keeping with the succession of the chain of models, the necessary volume of external storage in direct access decreases, conditions being created for the elimination or decreasing of the number of temporary intermediate files between processings (by bringing into the available space of external storage, the main and liaison files necessary for the storage of certain results from processings);

— a greater flexibility of the structure of the data base and of the data storing system in keeping with the development of the data base is ensured. This development can be achieved in two ways: by adding new recordings to the existing files or by adding new main and liaison files;

— through the maintenance function of the data storing system, the filing structure of the data base can be continuously adapted in keeping with the new requirements of access to data, formulated either by the models of the system for management or directly by the decision-making elements.

In fact, through the establishment of links by physical addresses between the recordings of one or several files, the possibility is ensured of a rapid scan of the content of these files. The envisaged links may satisfy either the necessities of the application programmes or the necessities of direct information of the decision-making elements. The direct information of the decision-making elements, at their request (the interrogation of the data base) must fulfil an essential condition, namely the very short term in which the answers must be given. It is sufficient to make up a list of possible questions (from the point of view of content and form), to attach to it a list of structures of main recordings which contain data for formulating the answer and to draw up a liaison file for each thus formed structure. Consequently, this structure of the data base creates conditions for an interrogation which is closer to the real meaning of this notion.

The main disadvantages of this structure are the following:

— because of the statical allocation system of the external storage in direct access and because of the big number of files in the base, the unused storage space is rather big. Each file is allocated a space of maximum previsible limit of development, although its dimensions upon its drawing up are sensibly smaller;

— for the maintenance and handling of the files in the base, a specialized management system is necessary, adapted to the structure of the existing files;

— if a class of processings is defined through the specific order in which the ensemble of all recordings in the main files is scanned, it is noticed that each class requires a specific liaison file; the number of these liaison files may be very big. Actually, the number of liaison files is limited by the required storage space, but, this space may become several times bigger than the volume occupied by the main files;

— the interrogation of the data base through the scan of the specific structures makes it necessary the existence of a conversational language.

3. This structure of file network can be improved, mainly pursuing the improvement of the relation between the storage zone occupied by the main data and the storage zone occupied by the structure data.

The two previous variants have a common characteristic: the primary and the structure data are arranged in the files in a way which serves special processings, as it can be achieved, in the first place, by SCF and then by the operating systems of the batchprocessing type. In this way, a "mixed" lay out of the main data and of the structure data (access order) is obtained. Consequently, the increase in the volume of structure data makes difficult, to an ever greater extent, the handling of the main data. It is necessary, in case a diversity of access order is defined, to adopt a solution enabling the separation of the main data from the structure ones.

Setting out from the previous structure variant, the improvement of the occupation of the zones in the storage in favour of the main data can be achieved, in some conditions, in the following way:

— the main files defined by the measuring of the total volume of data should contain recordings in only two zones: the identifier (code) of primary data and the socket address in direct access where the respective data are stored. Through the liaison files associated to these code files a certain order of scan of the identifiers is being established, the useful data going to be obtained through the addresses attached to each code.

The useful data are stored separately into files which correspond or not to the code files and can be organized, by taking into consideration the facilities of the operation system, according to criteria other than those imposed by the processing order. For example, a storage in direct access in the sequentially decreasing order of the codes might answer best a demand in a random order of the recordings of these files, if the number of demands is sufficiently great.

Such an organization of data has a great advantage as regards the definition of structure. In the first two variants, the unitary definition of the structures appeared as a restriction. The most complicated structure being the whiffletree one, relatively simple structures had to be brought in a whiffletree format for using a unitary technique of their representation, precisely because of the utilization of the same files for the carrying out of all links.

The separation of the main data from the structures which can be defined on their set creates the possibility of representing structures of a different type.

The necessity of a whiffletree scan (of an implosion or explosion type) leads to the use of SCF for the drawing up and linking of files of codes and addresses. The necessity of scanning the main data in a certain order required by a programme can be outlined in a simple way through a list of codes ordered in the respective sequence, by attaching the addresses of the thus identified data.

În this variant, the data base will have two big zones (Figure 3):

— the zone of structure data;
— the zone of main data.

Access to the data contained in files F_1, D_2,... F_n, is done only through the structure zone, thus through the main files of codes P_1, P_2,... P_n. If access to the base is required for covering a whiffletree, the main input file P_i wil be linked to one or several liaison files (in SCF direction). If access to the base

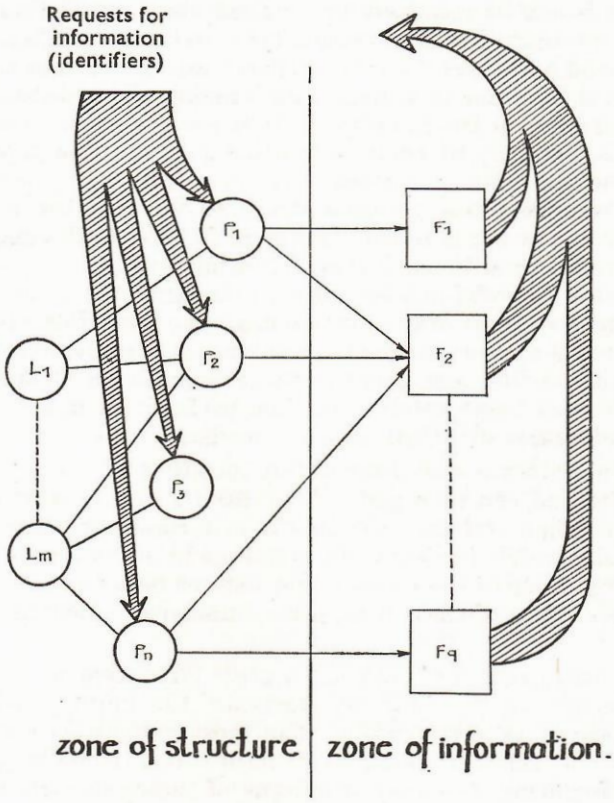


Fig. 3

is required for a sequential scan of a batch of data, the main file P_i contains the list of codes of the data batch in the required sequence. Thus, it results that one or several files P and eventually L are associated to each class of processings, as in the previous variant (Fig. 3). However, by separating the structure data from the main data, the possibility is created of their separate updating and of increasing the number of structures defined on the set of all data.

The existence of the main files of codes of a list type creates the premise for a very rapid integration of the data base.

REFERENCES

1. CONSTANTINESCU P.: *Proiectarea şi organizarea sistemelor de conducere cu mijloace de prelucrare automată a datelor.* (Design and Organization of Management Systems with Automatic Data Processing Means). Lecture. The Academy of Economic Studies, 1973
2. CONSTANTINESCU P., EFTIMIE R.: *Structurarea bazei de date a sistemelor informatice din unităţi economice.* (Organizing the Data Base of the Informatic Systems in Economic Units). Conducere-Decizie, no.6, 1974, CIDSP.
3. CONSTANTINESCU P., BEIU J., RADACEANU E., STĂNCIOU I.: *Unele caracteristici ale concepţiei sistemice pentru conducerea unităţilor economice.* (Some Characteristics of the Systemic Conception for the Management of Economic Units). Conducere-Decizie, no.7, 1974, CIDSP.
4. ANTONESCU C., CONSTANTINESCU P.: *Caracteristici ale bazei de date ale unui sistem informatic al unei unităţi economice.* (Characteristics of the Data Base of an Informatic System of an Economic Unit). Conducere-Decizie, no.9, 1974, CIDSP

STRUCTURE DES INFORMATIONS NECESSAIRES POUR LA DIRECTION DE LA PRODUCTION

Ayant pour point de départ la structure du système informatique construit en tant que système fermé, l'auteur formule les exigences en informations du système. Utilisant le cas particulier des systèmes informatiques pour les entreprises industrielles on met en évidence les relations qui existent entre les différentes catégories d'informations et on propose trois variantes de représentation de ces structures employant les données du système (paire de fichiers en chaîne, réseau de fichiers, zones séparées de données et de structure).

СТРУКТУРА НЕОБХОДИМОЙ ИНФОРМАЦИИ ДЛЯ РУКОВОДСТВА ПРОИЗВОДСТВОМ

Исходя из структуры информатической системы, построенной как адаптивная (закрытая) система, формулируются требования системы в отношении информации.

В частном случае информатических систем для промышленных предприятий выявляются отношения, существующие между различными категориями информации, и предлагаются три варианта представления этих структур в основе данных системы (сцепленные пары картотек, сеть картотек, отдельные зоны данных и структуры).