A UNIVERSAL CONCEPT FOR THE SYSTEMATIC ARRANGEMENT OF STATIC DATA

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ABSTRACT

Many organizations are accustomed to considering the strategic data in their possession as an exclusive resource that requires a specific data base structure and management software. This way of perceiving things leads them to develop exclusive management tools related to their own specific applications. This "autarky" reduces the inter-organizational information flow and creates redundancy in software development efforts. It also hinders the organizational ability to exploit the potential inherent in the correct and systematic arrangement of data since the expertise of an organization lays in the application of the information and not in its systematization. A comprehensive analysis of an organization’s strategic information needs reveals surprising uniformity as to the structure of the database, to its maintenance logics and to the forms of retrieval required.

This article presents a universal concept for the systematic arrangement of static data and reduces the differences among the needs of various organizations to mere parametric variances. This is done by constructing a general model of data arrangement, and illustrating its applicability to a wide range of cases.

INTRODUCTION

This article concentrates on the strategic data bases of the organization, their central position and their function in the management information system of the organization, their general structure and the methods that insure their design. This study

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shows that all the static data, which will be defined later, in the organization can be managed in one standard file called a the universal catalogue.

The catalogue, which is part of the data base in any organization, plays a central role in any activity (computerized or manual) depending upon organizational data bases. The maintenance of the catalogue and its development should be regarded as a prestigious task in the organization. Actually, the situation is different. Organizations are not generally aware of the importance of catalogue maintenance and do not pay much attention to the principles of catalogue building. As a result, the organization causes itself managerial impairments which will be illustrated in this work and which can be avoided.

Many sources use the term "catalogue" to designate a tool intended for the storage of a certain type of data, such as: Items catalogue of the U.S. Army, Scientific Publications Catalogue, Entities Catalogue, Patents Catalogue, and many others that will be mentioned in this work. The uses of the catalogue depend upon its type, but generally it serves as an aid to the internal and external management of the items it contains. The main information traditionally stored in a catalogue is an inventory list of the items handled by the organization and some characterizing data, such as:

- A books catalogue listing the various books available in a library, author's name, year of publication, the publisher, etc.

- A vendor catalogue listing the items on sale, prices, item description, delivery terms, etc.

In its traditional use the term "catalogue" can be defined, then, as a set of pertinent data in a relevant context. The traditional concept guiding an organization and its managers is that the catalogue is not a central data base substantiating the general information system of the organization as a whole. This way of thought is apparent when one observes the number and qualifications of personnel in charge of the maintenance of the catalogue,
in securing the information level, and in many other elements pointing to its disparaged status in the organization.

The meaning of a "catalogue" includes the management of the essential characteristics of the entities in an organization. Figure 1 shows the location of the static information modules in the general framework the managerial data bases.

Fig. 1 The location of the catalogue in the organizational structure

Figure 1 emphasizes the prominence of the static data bases in the framework of the managerial information system. All other modules of the system draw the information they need from this "center". The profitability of the computerization of the system will be examined at the end of this study following the presentation of a model of the universal catalogue.
THE UNIVERSAL CATALOGUE

Borovits has presented the fact that the managerial information in an organization consists of strategic and tactical data, or in other terms, dynamic and static data. The main difference between the two is that tactic data is largely dynamic and is fed by many sources whereas strategic data is characterized by a low level of dynamism and is maintained by a limited number of people in the organization who are experts in this field. Because of this difference, the information system in the organization will store them in files of different types having different reaction times and requiring different data security systems.

Borovits also claims that catalogue data bases are characterized by a high level of activity and a low level of dynamism. The activity level of dynamic data bases, which are characterized by high dynamism, will then depend on the specific application. Table 1 exhibits the differences between dynamic data bases and static ones.

Table 1 The main differences between dynamic and static data bases

<table>
<thead>
<tr>
<th></th>
<th>STATIC DATA BASES</th>
<th>DYNAMIC DATA BASES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data type</td>
<td>strategic data</td>
<td>tactic data</td>
</tr>
<tr>
<td>Characteristics</td>
<td>constant</td>
<td>status</td>
</tr>
<tr>
<td>Update accessibility</td>
<td>by experts;</td>
<td>update operations</td>
</tr>
<tr>
<td></td>
<td>no accessibility</td>
<td>by most users, in</td>
</tr>
<tr>
<td></td>
<td>to most users</td>
<td>the course of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>transactions</td>
</tr>
<tr>
<td>Type of update</td>
<td>catalogue</td>
<td>transaction</td>
</tr>
<tr>
<td></td>
<td>modifications</td>
<td></td>
</tr>
<tr>
<td>Data security purpose</td>
<td>ensuring commercial</td>
<td>ensuring against</td>
</tr>
<tr>
<td></td>
<td>confidentiality</td>
<td>forgeries of data,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>such as fraud</td>
</tr>
<tr>
<td>Origin of updates</td>
<td>prof. literature, tech. innovations, development of professional environment, policy changes etc.</td>
<td>current activity in the organization</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Main reasons of data base size</td>
<td>development pace, professional diversity</td>
<td>the size of the organization, early start</td>
</tr>
<tr>
<td>Update frequency</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Example</td>
<td>electricity consumption of a machine, classroom capacity, etc.</td>
<td>the task performed by the machine now, the number of students sitting in the classroom now, etc.</td>
</tr>
</tbody>
</table>

All the static data in the organization can be managed in one standard file, called the universal catalogue. In addition to this, the present study illustrates how such a standard file could successfully manage the static data of the majority of organizations known to us (if not all of them). Such an undertaking is justified by the very fact that it has the potential of creating a multipurpose tool possessing many advantages:

- a logical management system;
- similarity in definition;
- software packages;
- easy maintenance;
- easy communications (inter/intra-organizational).

Borovits, in his previous work, describes these advantages in more detail. Another justification for the development of the universal catalogue can be found in the existing literature, as reflected in the fact that a large number of researchers have reached the conclusion that there is a need for such a catalogue. But whenever an organization confronted a problem, it chose to solve it specifically and did not attempt to reach a general
solution. For instance:

- Schlesinger deals with the communications problem among several study centers using computerized aids; the author presents a solution by means of creating a uniform catalogue to be built according to pre-established characteristics that would enable data interchange and "conversation" in the same "language".
- Allan establishes standards for an items catalogue.
- Kopcev emphasizes the need for a central and homogeneous data base that will concentrate all catalogue data on periodicals.
- Tobolka proposes an international method of book classification.

It should be stressed that none of them suggested the possibility of building a universal catalogue that would enable the classification all types of items. All of the mentioned articles concentrate on the need to establish classification standards for "beings" of the same type (books, items, periodicals, etc.)

The Definition of the Universal Catalogue

A catalogue expresses the managerial semantics of the organization and embraces the exact technical definitions of the entities in it. These entities are defined in verbal descriptions and in terms of relevant characteristics, internal relationships and relations with parallel designations of the same entity in other catalogues.

The universal catalogue consists of a single data base and a number of processes (in computerized systems — a data base and a number of service programs). The system is capable of organizing the static data of the organization into a catalogue; the formal structure assures the preservation of its integrity and consistency and the preservation of the accumulated strategic data by means of easily operated retrieval systems. Apart from the internal services that the universal catalogue provides the organization, it
also constitutes a language which is common among various organizations (by means of the automatic translation of entity terms of one organization into another’s). The universal catalogue automatically merges various catalogues and manages the same entities in the framework of different catalogues (different semantics) within the same organization. The guiding concept of the universal catalogue is that it constitutes a tool to describe the world of entities.

The world of entities in an organization is divided into subworlds according to a permanent system of logic, and clear and arbitrary criteria. Various organizations may decide to divide the same world of entities according to different considerations and the present work provides them with the adequate tools to do that. The division of the entity world may be illustrated in the diagrams of Figure 2, which are intended to provide a preliminary view of the functional division of the universal catalogue. Further details will be presented in subsequent sections. The passage from one division method to another was performed in this study on a single unit of division.

An example of such a division for the world of technical items may be:

a. What are the items of interest to the organization?
b. What are the item categories in the organization — e.g. cables, resistors, connectors, etc.?
c. What is the Ohm range of resistances, the values within which there is no difference to the organization?
d. What types of resistances within the range of 10–20 Ohm does the organization use?

The Groupings in the Universal Catalogue

This section presents the universal catalogue from a different angle, through which the groupings within the catalogue will be built from the bottom upward. The method followed in this section and the previous one is supported by the “CLASSIFICA-
(A) The division of entities (of a certain type) into entities of interest to the organization, and those not of interest to it:

the world of entities → entities of interest to the organization
                     → entities that are not of interest

(B) The division of entities of interest to the organization into different categories according to a set of category characteristics:

entities of interest to the organization → C2
                                          → C3
                                          → C5
                                          → C4

(C) The division of categories into groups of entries attached to every one of the category characteristics the organization is indifferent to:

C1 → E1
    → E2
    → E3
    → E4

(D) In every such group the organization determines the models it deals with:

[Diagram of group E1 to E4]

Fig. 2 Diagrammatic division of the “entity world”.
TION” entry of the “Encyclopedia of Philosophy”. This entry explains the process of division and classification, and establishes two processes (as enunciated by Aristotle).

The classification: The starting point is the “individuals” which are organized in groups called Infame Species, characterized by the fact that they may be divided only into individuals. These groups may in turn be grouped until the formation of a group containing all the individuals to be classified. The ultimate group is Summum Genus, and all others that were formed in the process are Subaltern Genera. The present section deals with this process.

The division: The starting point is Summum Genus which are divided into smaller sub-groups; the division continues until all groups are reduced to a single individual. This process was studied in the previous section.

Our world embraces a large number of beings (we shall concentrate on beings belonging to the same entity) bearing various designations. The world of beings the organization is aware of includes all possible types of beings belonging to the same entity we are dealing with and copies of it which are or might be present in the organization. All “models” which serve the same purpose in the organization or are fully interchangeable will be grouped in the catalogue under the same entry group. The organization classifies them under a common name for internal purposes, such as “internal name”. The term “name” is defined in the Encyclopedia of Philosophy as: “A word or a group of words that serve as a concept when addressing someone.” Three types of names may be distinguished: general name, singular name, and collective name. In our case the appropriate term is “general name”. It means: “a name that can be applied to any of the members in a group of objects.” Later in this article we shall explain the importance of the “general internal name in the organization”. The reasons for an organization to manage various models having the same function differ from one entity to another.

Using the item catalogue as an example we now demonstrate
the process. The first group will then be the following grouping:

(*) screw 7/8, green with conical head made by Trx
(*) screw 7/8, red with hexagonal head made by Red
(*) screw 7/8, red with hexagonal head made by Fdb
(*) screw 7/8, golden with flat head made by Bragiconics

All are part of the entry group no. 1—7/8 screws (see Figure 3).

Fig. 3 Unification of types into entry groups.

All entry groups that serve the same purpose in the organization, and the differences among them are only quantitative, will be grouped in the catalogue under one category. The organization may describe them, for example, with the same parameters and possibly one expert will be responsible for their management. The reasons for an organization to manage a number of entry groups under the same category are almost self-evident. They shall be explained and clarified in subsequent sections. The second grouping will, therefore, be:

(*) screw 7/8 with conical head
(*) screw 5/8 red with hexagonal head
(*) screw 1 and 7/8 green with Phillipes head
(*) screw 1/8 golden with flat head

All are part of category no. 1 — screws (see Figure 4).
Fig. 4 Unification of entry groups into categories

All categories which constitute an autonomous organizational framework will be unified into a catalogue in order to let the autonomous framework build its own categories and groupings, and to realize its autonomy in practice. There is enough justification for large organizations to let internal circles manage their own worlds of entities. This point will be clarified later in this article.

The third grouping is:
(*) screw 7/8 with conical head
(*) round connector 7
(*) 5 Ohm resistors, max. temp. res. 70°C
(*) electrolytic capacitor 5μF
(*) antenna amplifier
(*) operational amplifier

All items are part of catalogue no. 1 for equipment items (see Figure 5).

All autonomous catalogues dealing with the same entity may be grouped in a large and all-embracing ensemble which we shall call, for our purposes, a meta-catalogue. This meta-catalogue will
Fig. 5 Unification of categories into a catalogue.

assure the management control process and the data interchange among autonomous units. The fourth grouping will therefore be this ensemble which is not part of the very essence of the catalogue, does not exist for every entity or in all organizations, and is dependent on various factors that will be clarified later.

We have created a hierarchy of groupings where the catalogue consists of a group of categories, each category is a group of entries, each entry is a group of trademarks or names of objects. It is therefore possible to define a certain static data base in the organization, in Set Theory terms, as: group of groups of groups of names.

The Universal Catalogue as a Multi-level Hierarchic Structure

In addition to the existence of groups in the catalogue it is now clear that there is a hierarchical relationship among the groups. Contrary to the standard grouping case, and because of the existence of the hierarchic relationships, every level (group) dictates characteristics to all other levels and sub-levels, so that the
attributes of a group in a given level are also those of the dependent sub-levels. All classified entities are related to groups all along the hierarchic structure, and every sub-level includes information on the precedent (higher) one.

The following section gives a description of the hierarchy levels among groups studied in the previous section. In the next section we shall demonstrate that the structure is final and that there is no need to define the universal catalogue by means of a number of levels different from that presented here. The universal catalogue consists of the following five levels:

*the meta-catalogue, the catalogue, the category, the entry group, the model*

*The meta-catalogue:* Unifies all autonomous catalogues managing the same kind of entity (within the mentioned limitation). As mentioned above, the meta-catalogue is not an integral part of the hierarchic structure, and is designed to assure the communication among catalogues of the same kind. Unlike other levels, the meta-catalogue level does not add any significant information to the entity and does not dictate characteristics to its "offsprings".

*The catalogue:* A tool for item management in the autonomous organization.

*The category:* A division of the managed entities according to a set of characteristics and the grouping of entities with common characteristics into one category.

*The entry group:* The value range of any category characteristic.

*The model:* The isolated physical (or logical) entity whose values' range constitutes the definition range of the entry group.

In the following examples, an associative name and a significance may be related to every level. The hierarchic structure scheme exhibited in Figure 6 will serve to exemplify the way in
which the universal catalogue adapts to a specific application. The scheme shows the hierarchic relationships among various levels and three members on each level.

![Diagram of hierarchic structure of a catalogue]

Fig. 6 The hierarchic structure of a catalogue

**Illustration**

In this section, the division into members in every level and in the dynamic data base is illustrated, in order to materialize the significance of the various levels and the relations between the dynamic and static data. The example in Table 2 shows a specific case for every division.
Table 2 Members in hierarchic levels — An illustration

<table>
<thead>
<tr>
<th></th>
<th>CASE 1</th>
<th>CASE 2</th>
<th>CASE 3</th>
<th>CASE 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER OF CATEGORIES</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>NUMBER OF ENTRY GROUPS</td>
<td>1</td>
<td>1</td>
<td>10000</td>
<td>10000</td>
</tr>
<tr>
<td>NUMBER OF MODELS</td>
<td>1</td>
<td>10000</td>
<td>10000</td>
<td>30000</td>
</tr>
<tr>
<td>NUMBER OF COPIES</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>100000</td>
</tr>
<tr>
<td>THE SPECIFIC REAL CASE</td>
<td>a warehouse of items of one type containing a stock of 10000 copies of this item</td>
<td>a collection on a certain subject containing 10000 different items in one copy</td>
<td>a museum exhibition on one subj. and holding one representative of every subject in one copy</td>
<td>an engineering organization have 100 families, 100 cat. no. in every family, some 3 interchangeable items of every cat. no. and a stock of some 100 of every item</td>
</tr>
</tbody>
</table>

EXAMPLE

|                  | The catalogue of Arlington Cemetery | The catalogue of a doll exhibition in a museum | The catalogue of the Glass Pavilion in the Museum | The catalogue of the Military Industry |

Theoretical Analysis of Hierarchic Levels in a Catalogue

Earlier in this article we presented Aristotle’s definition of the term “classification”. Aristotle establishes three logical rules governing the process of division into groups of a given population:

— The rule upon which the decision-making is based must be the same at every stage of the group definition process.
— No group or item should be omitted.
— No intermediate stage should be skipped.

This section deals with the number of hierarchic levels to be applied to the process of logical sorting of a given population into groups of individuals. Let us assume that the population of individuals that constitutes the managed world of the organization is the domain of a function. The catalogue, as previously defined, allocates a general name to every individual in the organization. In this way it maps a domain to a range of names. The catalogue constitutes, therefore, the semantics of the language for management of the organization. Two different catalogues dealing with the same subject are in fact two semantic alternatives applicable to the same domain. The number of items included in the domain is greater than or equal to the names in the defined range. The former case (greater) means that the population includes a number of alternative items bearing the same name.

The organization needs its own catalogue or has a semantic of its own, that is, it observes a policy of unifying items under a common name; otherwise it can use the natural names of the items. The special semantics of an organization expresses itself in the way it matches various individuals in the domain to common names in the range, or, in other words, in the way it defines the domain as a range of names. The semantics and the catalogue will be rational when two individuals in the domain are allocated the same name in the range; or they are interchangeable (see definition of “Name” in the Encyclopedia of Philosophy, 1967). Two individuals are interchangeable if the values of their attributes are fairly similar. “Fairly similar” means:
— categorical similarity — the set of individual attributes should be identical.
— metric similarity — the values should be similar or identical.

The set of individual attributes in the domain (alternatives inclusive) is not uniform for all individuals in it, and therefore only those in a group having a homogeneous set of attributes may be interchangeable (if there are such groups).
A rational catalogue is conditional to specific and rational semantics which is in turn conditional to the existence of homogeneous groups in the item population (as far as the content of the attributes is concerned) and of homogeneous sub-groups (as far as values are concerned). A rational catalogue consists, therefore, of three natural components: categories, entry groups and models. Consequently it is composed of four hierarchic levels:

*The catalogue* is the semantics defining the range of the domain.

*The category* is the division of the domain into groups having homogeneous attributes.

*The entry group* is the division of categories into homogeneous groups in which all members are interchangeable.

*The model* is the member of an entry group, the attributes of which (the member) relate to a category, and the values of these characteristics to the entry group.

The *meta-catalogue* may be considered as a managerial tool (dictionary) relating between two semantics (catalogues), such as an English-Hebrew dictionary which connects the semantics of these two languages. The meta-catalogue stores the logical relationships between catalogue definitions of different semantics. At this stage it should be emphasized that, as a proof of the above demonstration, the catalogual characteristics are not the aim but the means whereby the catalogue is created.

**The Adaptation of the Theoretical Structure to the Needs of the Organization**

The universal catalogue consists, then, of four hierarchic levels. This declaration may sound too final and definite. This point will indeed be clarified in the present section through the
demonstration of the following assertions:

- It is not necessary to establish an additional level under "model".
- It is not necessary to establish an additional level above "catalogue".
- It is not necessary to establish an additional intermediate level.
- No level should be omitted.

Considering Aristotle's definition and the grouping and classification method we have discussed, it can be established that: between the lowest (individuals) and the highest (all members of the same type) levels there are two intermediate groupings.

*It is not necessary to establish a level above catalogue.* There is no significance in creating an additional level containing all items of the same type. This addition could not bring in more and new information about the entity.

*It is not necessary to establish an additional level under "model".* This level is the type itself and it could be divided into further levels, but these in turn would contain other types or maybe entry groups. So that the division at this level may only be horizontal and/or upward and does not result in the creation of a new level containing data not included in any of the existing levels.

*It is not necessary to establish an additional intermediate level.* The addition of a level results in a series of operations and in the addition of more information, as will be explained in the next chapter (Catalogica). It is clear that the addition of an intermediate level is unnecessary. As a matter of fact, there is no reason to divide, say, a category into a number of sub-categories. It might very well be that an organization intends to manage separately various sets of attributes, but then the newly created sub-category is itself a category and not a new hierarchic level. If such a
grouping is needed for an ad hoc use, the retrieval may be performed by means of service programs.

No level should be omitted. As already explained, levels in a catalogue are defined by a set of indispensable concepts whereby the characteristics of the catalogue and its levels are established. The definition of the levels is of great importance and the omission of a level may result in the loss of information. For example, such an omission may define screws and antenna amplifiers under the same set of attributes which in turn will affect the freedom of choice of engineers.

Two points should be clarified: (a) There may exist catalogues with one or more “ decadent” levels; that is, a level having one member only. But still, the levels, its attributes and the information it provides should not be omitted in any case, as will be illustrated in the next section; and (b) The indispensability of the hierarchic levels is one of the building blocks of the present thesis. We shall elaborate on this principle in the section dealing with “Catalogica” and a subsequent example. But the rebuttal of this theory and its demonstration in the next section will not affect the suggested thesis. It will necessitate, though, a consideration of a level which, at this stage, does not exist.

The Uniqueness of the Meta-Catalogue

The meta-catalogue embraces all other catalogues dealing with a determined entity and for one reason or another the relationship among them should be preserved. The addition of a level above the meta-catalogue does not provide the user with new information on the classified entity. On the other hand, it will add information on inter-organizational relationships and on the hierarchic relations among sub-organizations. This kind of information should be part of the data base managing the organizational structure and not of the item catalogue. As a matter of fact, if the organizational relationships are ramified as to
necessitate documentation, it is possible to build a separate catalogue that will express these relationships. All additional information from the meta-catalogue's level is a combination of various catalogues that deal with the same entity. All catalogues of the same type, which are included under the meta-catalogues are of the same importance and may be included under one meta-catalogue.

CATALOGICA

The universal catalogue consists of five levels. Every level adds new constraints and information on the previous ones. This section presents the logic governing the various levels and the elements characterizing them. First we will present the general characteristics of the various levels of the universal catalogue. It can be said that this section constitutes the glossary of the Catalogica language.

A certain level in the universal catalogue includes a number of members of identical status. A certain member is a head of a group of a number of members (generally 1 or 0) belonging to the subsequent level. In a certain level members are grouped according to their group head in the previous (upper) level. The implication from the above definitions is that level 1, the meta-catalogue, contains one member which is the summit of the hierarchy, whereas level five, the model level, contains a number of members which are not group heads. This section describes the logic characterizing every level by means of eight elements which define the level, the relationship between the group-head and its members, and those existing among members of the group and the level. The universal catalogue is strict about the uniformity of the attributes at every level and allocates a particular significance to every characteristic at every level.

The full characterization of the catalogue is implemented by 32 attributes (8 x 4) which divide into several simple sub-
attributes and define the structure and the type of the catalogue. The eight characteristics are not a constant value or a principle underlying the present thesis. These attributes are discussed now as representing the catalogue structure but in another analysis additional attributes might be discovered or another research might reach the conclusion that some of the present ones are unnecessary. In such cases the principles of the catalogue are not affected and the additional characteristics should be defined.

The Attributes of a Level in the Universal Catalogue

The eight attributes are:

* The level and its members. This attribute, of a general character, defines the characteristic of the level and its members:
  - the nature of the level;
  - its members;
  - the character of the grouping;
  - the function of a member as a group-head;
  - the name of the level.

* The extent of the level. The number of level members and that of members attached to a group-head:
  - The extent of a level points to the nature of the catalogue and that of the organization using it; to the importance of a group in relation to others; and also to the activity volume of the organization in the field documented by the catalogue.

* Addition of a member to the group/level. This attribute defines the significance of the addition and the way in which it is made:
  - the way in which the decision is made;
  - the consequences of such an addition to the group, level and subsequent levels;
  - the operations assuring a proper addition process;
  - checking the affinity of a member to the environment it
joins;
- preventing the addition of a member which is a copy of an existing one;
- the way in which the consistency and integrity of the catalogue is preserved following the addition; and
- checking that all members supposed to be in the group are indeed in it.

*The qualities of the member in a group/level.* This attribute defines the member and its level according to their qualities:
- the characteristics of a member and the way in which they are defined;
- the significance of the qualities as related to the level and the catalogue (the quality type);
- the special programs characterizing the member and the whole level;
- the value range allowed for these attributes;
- when the value range of the attributes of a member are considered (by a decision of the organization) to be different from those of another member;
- the relationship between the value range of a group head and those of its "offsprings"; and
- the manager of the level/group in the organization.

*The horizontal relationship in the group.* This element characterizes the relations among members:
- the possible relation types among members;
- the possible relation types among various groups at the same level;
- the significance of every relation type; and
- the use the organization will make of the information on these horizontal relationships.

*Shifts in group delimitation.* This element defines the significance of changes in group delimitation and member transfers:
the significance for the organization and the significance in practice, of member transfer from one group to another;
- the significance of group unifications;
- the tools and regulations the organization should develop to enable such shifts;
- who is entitled to execute the shifts;
- the influence of such a change on other organizational systems related to the catalogue; and
- how an organization can prevent "fatal" errors by performing faulty shifts.

References among members. This element defines the various intra-catalogual references:
- the significance of the reference from one member to another (also at another level);
- to whom a member may refer;
- how an organization may assure consistency and "logicality" in mutual references;
- who creates the references; and
- the use the organization makes of the references.

The required documentation for the management of the group/level. This element defines the required documentation that enables the management of the group/level:
- the set of regulations needed for the management of the group/level;
- the set of programs attached to the level and its storage location;
- how the organization maintains the catalogue, its levels, group and members updated;
- how the relation between the regulations of the organization and the documentation describing it on one hand, and the current operation on the other hand is kept; and
- the set of tasks to be performed by the manager of the group (that is, one-time tasks performed during the building of the
group and current managerial tasks).

THE IMPLEMENTATION OF CATALOGICA AT VARIOUS LEVELS

In the previous section the logic underlying a level in the universal catalogue was formulated by means of eight elements. This section describes the application of every element for every level and exhibits the properties of every level and the new information it adds to the previous one. It can be seen that a part of the elements and the questions about them constitute the attributes of the level; others are related to the levels and others still to members (as members in a group and as group-heads). Consequently, the hierarchic application will be presented as a four-level ensemble, so that at every level the elements related to it and to the subsequent levels will be defined. For example, at the meta-catalogue level the attributes of the related catalogues will be presented. On the other hand, the model level will not be discussed at all, since its attributes will be exhibited in relation to the previous level (entry group).

The Meta-Catalogue Level

The level and its members. At this level there is only one member (for one entity type) which unifies a number of catalogues on the same subject that have the same structure. A member whose group-head is the meta-catalogue is a catalogue of a unit enjoying autonomy in classification. All members of the group are catalogues of the same entity and on the same subject.

The extent of the level. The number of the meta-catalogues, which is not of interest to the present work, points out the number of subjects it was decided to manage through the universal catalogue method. The number of members in the group,
which is the number of catalogues on a given subject, determines
the number of units attached to the meta-catalogue, the extent
of activities, the extent to which organization differs from each
other and from the extent of classification autonomy of every
unit.

*Addition of a member to the group/level.* The addition of a meta-
catalogue means that a new subject is to be managed by the
universal catalogue and such a step necessitates adequate pre-
parations. The addition of a catalogue to a meta-catalogue means
that an organization automatically transfers its entities to the
universal method and/or that an organization has decided to
reclassify its world of entities.

*The qualities of the member in a group/level.* The properties of a
catalogue are:
- who is entitled to add a catalogue;
- Which are the organizations using the catalogue (subscribers
to its services which are entitled also to update it);
- what is the organizational significance of the autonomous
management of the catalogue;
- what is the record structure of an entity in the dynamic
data base;
- what is the managed entity; and
- what are the common properties of entities in a catalogue so
  that they can be stored only once at the catalogue level.

*The horizontal relationships in the group:*
- How a catalogue communicates with another catalogue?
- What are the relations (are there such relations?) among
catalogues of different types?

*Shifts in group delimitation.* Shifts in catalogue delimitation
means merges among or splits of organizations (buying or selling
out a company). Another possibility (which will be discussed
later) is the confrontation of two catalogues organized according to the universal approach for the purpose of data retrievals or comparisons.

References among members. The reference to the meta-catalogue is directed from the catalogue identification numbers in various catalogues. The purpose is to bind together catalogue identification numbers belonging to various catalogues. The meta-catalogue serves, then, as a pin binding all catalogues on the same subject.

The documentation required for the management of the group/level:
- a catalogue of all catalogues;
- all programs and tables particular to every catalogue;
- the software and the flow chart for catalogue confrontation;
- regulations and authorization to open, merge or split catalogues; and
- the system regulations binding all entities regardless of designation and attributes.

The Catalogue Level

The level and its members. At this level all catalogues dealing with the same subject are in member status. A member which has a catalogue as a group-head is a category.

The extent of the level. The number of categories in a catalogue points out the extent to which an organization is interested in the subject and the range of accuracy it requests in the management of the attributes of the entities. A small number of categories implies a narrow range of interest and low sensitivity to differences among attributes describing an entity.

Addition of a member to the group/level. The addition of a
category to a catalogue means that the organization is enlarging its scope of interest or that a change of policy has taken place as to accuracy requirements. At this stage the organization has to make a series of decisions:

- How and by whom the new catalogue is to be managed?
- What are the attributes distinguishing the category from others?

The qualities of the member in a group/level. The properties of a category are:

- the set of attributes (and not values) according to which a member in a catalogue is characterized;
- who manages the catalogue;
- the reasonability criteria according to which the attributes of a member will be checked;
- the "family" relationships criteria according to the attributes of members;
- the interchangeability criteria among members in a category;
- the criteria according to which the addition of a member is checked (on-line and off-line checks are to be distinguished);
- other special attributes of the category characterizing all members in it (values) such as a formula applied on attribute values in order to obtain new attributes. Such a formula should be applicable to all members in the category.

The horizontal relationships in the group:

- which of the categories have the same managers;
- which categories complement each other; and
- in which category should alternatives be looked for if not found in this one.

Shifts in group delimitation. A shift at this level means a change in the approach to the attributes of a member in the category; it reflects a decision to reorganize the world of entities in the catalogue. The shift is to be performed by the following operations:
— the preparation of a set of programs to perform merges/splits of categories or parts of them;
— preparation of a check list to be gone through before performing the shift (an example will be given later); and
— examination of the way in which the shift will affect other systems in the organization using the members of the category according to the previous set of attributes.

References among members. Which are the other entities in the organization that are related to the category and what is the nature of this relation.

The documentation required for the management of the group/level. The list of the categories in the catalogue:
— flow chart (integrative) to indentify the affiliation of the entities to the category;
— a list of the programs to be dealt with in the category (the specific and the general);
— the monitor that deals with the category; and
— follow-up to the management of inputs invested in the category (if necessary).

The Category Level

The level and its member. At this level all categories in the catalogue are members. The member of the group is the entry group embracing all entities in the catalogue which, as far as the classifying organization is concerned, are interchangeable. The value range could differ from one member to another but the organization is indifferent to these nuances.

The extent of the level. The number of entry groups in a category points out the extent which the organization is flexible about the value range. It also reflects the extent of the activity of the organization in relation to this category. A small number of entry
groups indicates a high level of liberty in selecting the required entity and/or small range of entry groups which are of interest to the organization.

*Addition of a member to the group/level.* The addition of a new entry group to a category points to an increase in activity in relation to the category, to a decrease in choice flexibility, or to the addition of a new entity having attributes different from those of existing entities. The addition of a new entry group should answer the following questions:

- Does the entry group bring in any innovation?
- Does the category include a similar entry group?
- Is the added entry group related to the categories it is joining or, in other words, could it be defined in terms of the attributes characterizing the category?

*The qualities of the member in a group/level.* The properties of an entry group are:

- the value range of every attribute from the set of attributes which describe the category of which the entry group belongs to;
- the main use the organization makes out of the entity in the entry group; and
- the name of the entry group in the organization.

*The horizontal relationships in the group.* Which of the entry group in its category may complement it and vice versa? Which entry groups of other categories the entry group complement and vice versa?

*Shifts in group delimitation.* The transfer of an entity from one entry group to another and/or the merge of entry groups implies a decrease or increase in the accuracy and differentiation requirements.
References among members. This refers to various lists, which sometimes are managed as entities in the catalogue; the entry group is part of them.

The documentation required for the management of the group/level:

- the list of entry groups in every category;
- affiliation reports among entry groups of different types;
- reasonability reports for the addition of the entry groups;
- affiliation check method (to category and entry group);
- retrieval reports according to a given range of attributes;
- regulations governing the addition process of entry groups and transfers among entry groups; and
- regulations governing the relations with other systems and the reporting on entry group shifts.

The Entry Group Level

The level and its members. All entry groups that belong to a given category are members of this level. A member in a group, the head of which is the entry group, is the model (the copy).

The extent of the level. The number of models in a given entry group indicates the amount of actual models or alternatives at the disposal of the organization. The less the number of models in the entry group, the smaller the freedom of the organization to choose. An organization may decide to adopt a policy that dictates the use of a single model. In this case there will be a single model in the entry group. It may also happen that the definition of the range of attributes of an entry group is such that the group cannot include more than one model.

Addition of a member to the group/level. The addition of a model to a given entry group indicates that the organization chose to enlarge the population of the group and/or a change in the or-
ganizational approach to the entry group. In adding the model redundancy must be avoided. If the model does not already exist in the catalogue, a check should be run on the compatibility of the set of values of its attributes to the requirements of the entry group.

*The qualities of the member in a group/level.*
- What are the specific values of the attributes of the model, which describe a member in the category and of which the model is a part?
- What is the international nomenclature for this model; the international name is juxtaposed to the current name in the organization?

*The horizontal relationships in the group.*
- Which models in the entry group (or in others) have partly identical and partly complementary attributes and may be interchangeable?
- Which of the models is "better" than the other for the organization, that is, fulfills all the requirements and additional tasks?

*Shifts in group delimitation.* This item is not applicable at this level.

*References among members.*
- In which other entry groups of the organization (in this or other catalogues) is the model referred to once again?
- Which are the members the model is part of, or which members are part of the model itself?
- This refers to dynamic data bases where copies of the model are managed (this reference is optional).

*The documentation required for the management of the group/level.* The list of models in the organization.
Examples

A number of catalogues and their "translation" into the universal catalogue are presented in a more general manner. See Figures 7, 8, 9, and 10. For this purpose Figure 6 on hierarchic levels is used.

![Diagram of hierarchical structure of an items catalogue]

**Catalogue**: The items catalogue of an organization.

**Category**: The items' family.

**Entry group**: Catalogue numbers for substituted items.

**Model**: Specific item, and its name as given by its vendor.

Fig. 7 An hierarchical structure of an items catalogue
The examples are of entities which, in order to manage them, require some form of a catalogue.

**Fig. 8 Information Catalogue**

**THE ADVANTAGES OF THE UNIVERSAL CATALOGUE**

This section concentrates on the advantages of the universal catalogue and proposes solutions to the classification problems already discussed in relation to traditional catalogues. The discussion is composed of the following sections:
- the analysis of the problems and the solutions proposed by the method presented in this study;
**Fig. 9 Room Space catalogue**

- the conceptual advantages of the various discussions that arise within the organization on the classification method to be adopted; and
- examples of managerial and applicative operational tools provided by the proposed methods.

**Analysis of the Catalogical Problems**

The typical problems are:
- Identification and redundancy
- The presence of unreliable data ("junk")
- The need for expertise
Category: Type of entity.
Entry group: Profession.
Model: His or her name.

Fig. 10 Entities catalogue

- Absence of updating
- Lack of data on the classified entity
- Lack of relations hips among entities
- Unsatisfactory communication among catalogues
- Difficulties in maintaining a number of catalogues

Causes and Solutions

*Identification and redundancy.* The identification problem is caused by the lack of satisfactory information on the classified item which originates in the absence of data in the catalogue file
or, at best, by the fact that data has been stored without a logical structure. (For example, a resistor defined once according to color, and in another case according to weight). Identification problems result in redundancy so that two identical items will be managed as different beings with no stock data relating between them. This problem is solved by affiliating items to families. This operation strictly defines a set of attributes characterizing the item. The model provides the cataloguer with a simple algorithm assuring affiliation and from this stage on the program will prevent redundancies. It should be pointed out, though, that the method will not completely eliminate the redundancy problem, since human errors will always be made (for example, and error in the affiliation process). But the method reduces the frequency of error to a strict minimum.

Unreliable data. Such data exists as a result of the inadequate definition of the catalogue structure, and of the method of classification. The absence of clear-cut classification principles and field value definitions for various entities results in anarchy and unreliable data input. The lack of a systematic procedure does not prevent the design of programs intended to locate such "noise". This problem is easily solved by our method. The universal model is based upon a philosophy of classification according to families and hierarchic levels; the affiliation to a level is established according to clear cut criteria. Once the affiliation is determined, the level reflects the attributes of its members so that data input is held under strict control. The information on the types and ranges of the values enables the creation of design checking systems which locate possible discrepancies. Such errors might start at the affiliation stage and continue through the allocation of two incompatible values to a model (for example, 100 ounces weight to a 5 cm. connector). Here too, the method is not absolutely error-proof but it minimizes the damage.

The need for expertise. The lack of a well defined set of pro-
cedures creates the need for a not-so-easily replaceable expert who will gain power, and become a bottleneck in the organization. In the proposed method, expertise is needed only at the definition stage of the input data. Following that, the task of classification is simple and is based on data accumulated in the system and not inside the head of one person.

Absence of updating. This is a natural consequence of the absence of reliable data. The people responsible for the updating procedures are not strongly motivated to perform their tasks, since they have no access to the existent data and do not trust it anyway. As already mentioned, this creates a vicious circle of deterioration. The present method proposes a way of eliminating the lack of reliability and suggests tools designed to easily retrieve information in view of increasing motivation. Another motivating factor will be the need to insure communication with other organizations. An additional suggestion is to put the catalogue to the service of indispensable activities so as to create an unavoidable interest in keeping it updated. The organization might, for example, decide that no item is to be ordered without retrieving its record and including it in the purchase order. The update will naturally result.

Maintenance problems. An organization that makes use of a number of catalogues needs a number of programs which in turn constitute a serious impediment to swift operational procedures. The proposed model suggests a uniform and constant structure for the static database (catalogue). This general model provides the organization with a single all-purpose system. Another advantage is that a single software package will adapt to the specific needs of the users and at an affordable price.

Lack of data and relationships. This too is a consequence of the absence of a "disciplined" system. The lack of data on entities results in the inability to establish relationships among them.
If, for example, the colors of the hammers were not recorded there would be no possibility to relate among hammers according to color. The present model proposes to affiliate an item to a category through the definition of a set of attributes describing an item in a family. Thus, special programs designed to identify relationships may be run since the data defining these relations are already there (such as, external similarity, interchangeability, affiliation, etc.).

*Unsatisfactory communication.* A classification method having a rather local orientation prevents the establishment of communication channels among catalogues in an organization or catalogues in different organizations. Such a method does not take into account all the information needs of the organization. It is not based upon a clear cut set of principles but is always redefined for ad hoc purposes. Our model, on the other hand, features a standard and constant classification method which is, in fact, a language common to all users. Yet, the solution brought to this problem is not a characteristic of the present model. All classification methods that will solve the above-mentioned problems and standardize the procedures, will also solve the question of communication.

Conceptual Advantages

The very decision to adopt the universal model and the preliminary preparations produce advantages for the organization, even if it eventually decides not to build the catalogue. This conceptual profit results from the very definition of the universal catalogue. While performing the feasibility study the organization implements, generally for the first time, a few basic steps:

- The existing families are fully mapped.
- The relevant characteristics are defined.
- A policy and a set of criteria are determined according to which the division into families is implemented, and purchase
rules are enumerated. Thanks to these preliminary steps the organization might discover logical discrepancies in its current policy and determine new regulations. It is obvious then, that the definition of a new set of rules in terms of the universal method brings advantages even if the model is not implemented, and acts as a catalyst for the development of other managerial processes. This advantage is, in itself, a justification for a feasibility study.

Typical Applications and Managerial Tools Provided by the Catalogue

It could be said, then, that the adoption of the new method solves the majority of the above mentioned problems and provides the organization with a large number of managerial tools. For example:

- the application of ready-made software packages;
- easy communication with other catalogues and organizations;
- the possibility to choose and identify entities according to attributes;
- the establishment of a clear classification policy; and
- the definition of clear procedures (as in the case of a purchase method).

CONCLUSION

We have presented a universal concept for the systematic arrangement of static data by which the differences among the needs of various organizations may be reduced to parametric variances. The examples, presented are here only for illustration. However, it is possible to expand this concept to other areas easily. This approach has been implemented and tested in a live organization with much success.
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