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# INFORMATION SYSTEM FOR PLANNING A RESEARCH PROGRAM

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## INTRODUCTION

The developing countries face great problems in the efficient exploitation of their resources. In order to solve the top--priority problems related to social and economic development, it is necessary to concentrate to the maximum the efforts of all the organizations, mainly those of research intitutions. The solving of each one of these problems requires the implementation of complex, long-range research programs, with well-defined aims and the participation of several research and production organizations.

In this paper are presented:

Some considerations about information systems and their applications for planning purposes.

A methodology to develop the Programs Plan.

Algorithms and methods to determine the structure formed by the programs themes, and also to analize these structures in order to obtain formal criteria helping to the supervision and control of Program activities

## INFORMATION SYSTEMS CONCEPTS AND DEFINITIONS

An information system is simply a means to an end, that is, it is established so as to provide a service or form of control for an object system (LANGEFOR, 74). "Object system" within the context of this paper refers to a complex research program, for which the type of information which is relevant, as well as the extent and detail of the investigations is determined by the programs authorities. The methodology described here is orientated to wards such authorities as a guide to the acquisition of the necessary information base helping them to plan and to manage the research program.

Plans are developed in order to solve certain problems. Within the process of problem solving three main phases (DUTTON,78) can be identified: problem finding, solution finding and solution implementation. Problem finding refers to the phase in which the problem is identified and specified. In our case it refers to the determination of Program tasks and operational objectives. Solution finding refers to the phase in which we look for several solutions (if possible) to the previously specified problem and then we select the optimal alternative. Solution implementation refers to the phase in which the selected solution is implemented (Figure 1).

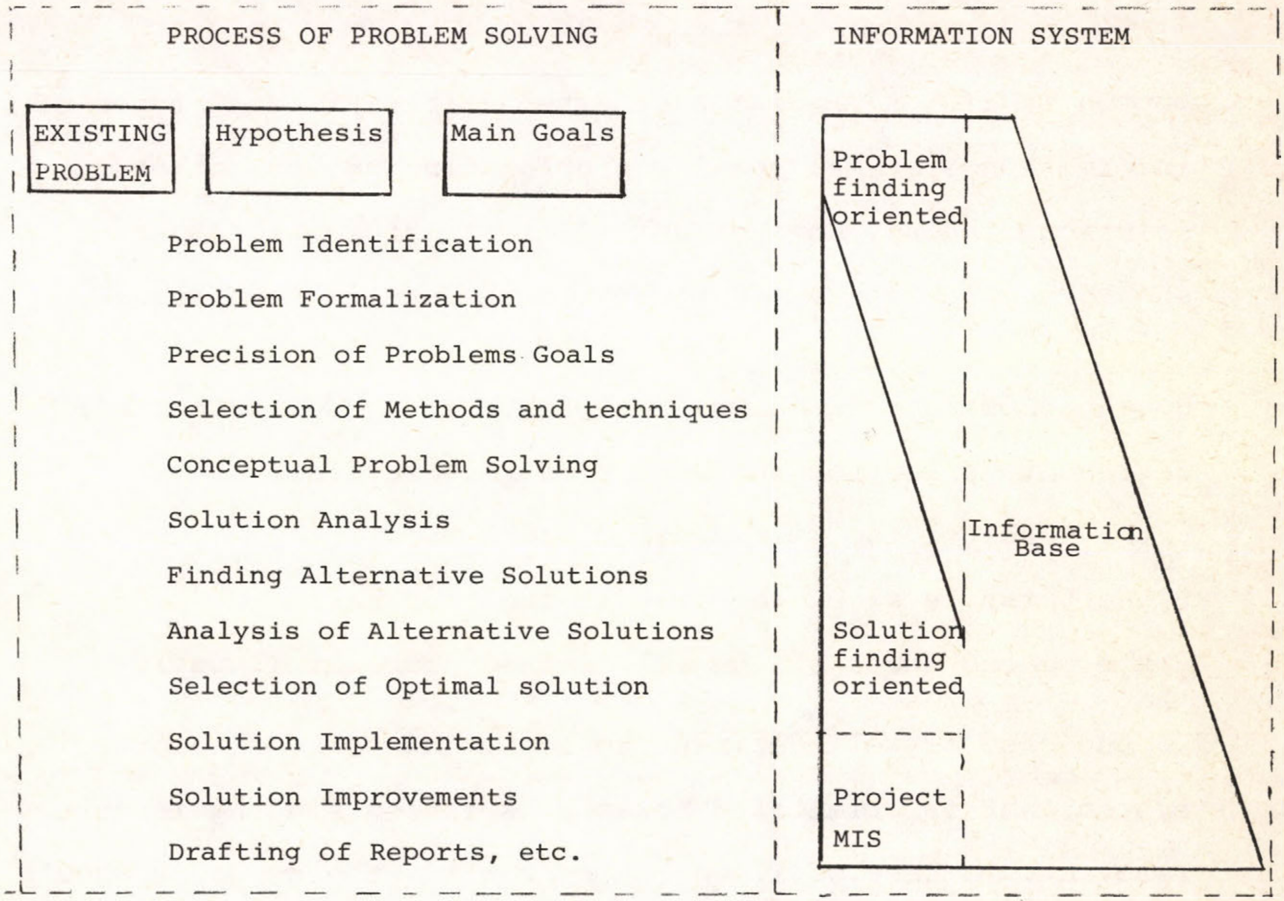



Figure 1

steps within the process of problem solving and
its associated information system (DAENZER,78; BOSMAN,73; MAN.78)

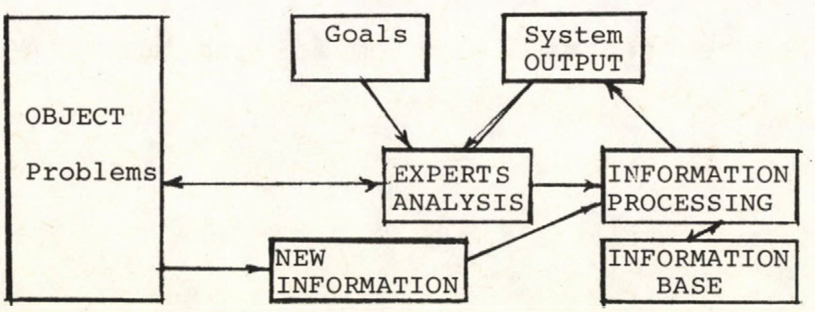



Figure 2

Problem Finding Information Sysytem for Ill-structured Problems
(DIPOTET, 79).

Dutton (DUTTON, 78) distinguish two different ideal types of information systems: one for problem finding, the other for solution finding. However an efficient information system should be flexible enough to enable its use in both stages.

Bosman (BOSMAN, 73) classifies problems according to their degree of definition in three different levels:

- the level of the well-defined problems;
- the first level of the ill defined problems;
- the second level of the ill defined problems (fuzzy).

In the case of well-defined problems, the part of information system that is orientated towards solution finding is more relevant. In case of ill defined problems the emphasis should be on problem finding information and, generally, it is necessary to develop heuristic procedures for satisfying both stages. Figure 2 shows the initial stage of a problem finging information systems which, after gradual transformation (DIPOTET-79) can also be used as a problem solving one.

## PLANNING THE RESEARCH PROGRAM

Production and service enterprises deal with concrete and well-defined tasks and subtasks. Scientific institutions deal with research themes. Thus, themes must be formulated for each institution from the activities and jobs belonging to the tasks of the program assigned to them.

Next we will present the procedures that must be carried out for collecting and processing the data that will enable us to derive the research plan.

Let a set $J = (1, \ldots, n)$ of research institutions belonging to one Organization which must carry out a research program $P$ in a given time $T$.

The Scientific Council of the Organization divides the Program $P$ into several sets of important tasks $P_1, P_2, \ldots, P_m$

Then, $P = (P_1, \ldots, P_m)$

We use the form given in Fig. 3 to obtain the listing of the institutions of the organization vs the tasks that they are going to undertake, respectively. For each $P_i \in P$; $i \in I=(1,\ldots,m)$ the Scientific Council establishes the deadline time $t_i \leq T$.

This deadline time $t_i$ depends on several factors, but mainly on the will of the user and the domestic requirements of the Organization.

The performance of each task is divided into r subtasks. In our case these subtasks are the proposed steps for the information systems development in the process of problem solving (FIGURE 1). It means the following subtasks:

1) task identification
2) formalization of the task
3) precision of tasks goals
4) selection of methods and techniques
5) conceptual task solving
6) solution analysis
7) finding alternative solutions
8) analysis of alternative solutions
9) selection of optimal solution
10) solution implementation
11) solution improvements
12) drafting of reports, hand books and users manuals.

The form shown in Fig. 4 offers the listing of all institutions vs the subtasks where they will participate, respectively.

The Research Council build up, using these forms (see fig. 4), the matrix $A^j = \| a^j_{ii} \|_{mxr}$ where $a^j_{il} \in (0,1)$; $i \in I = (1,\dots,m)$

$j \in J = (1,\dots,n)$

$l \in L = (1,\dots,r)$

$a^j_{il} = 1$ means that institute j participates in the carrying out of task i in the subtask l. The institution j lists the jobs and activities to be performed within the time interval $t_i$, for each case $a^j_{il} = 1$. The research themes are elaborated with the former list and the unification and generalization of other activities. The resources needed are established as well as the onset and completion dates.

With the information received from the themes of the Program for each task $P_i$, $P_i \in P$; $i \in I$; we establish its working stages

$(P_i(1), \ldots, P_i(t_i))$, where $P_i(t)$, $i \in I$; $t \leq t_i$ ; is the working stage in time t.

For each $P_i(i)$ we determine its resource vector

$r_i(t) = (r_{i1}(t), \ldots, r_{ik}(t), \ldots, r_{iq}(t))$

where $k \in K = (1, \ldots, q)$ is the resource number.

Then $\sum_{i \in I} r_{ik}(t) = R_k(t)$, resource requirements k in time t.

In those cases when $\sum a^j_{il} = 0$; $j \in J$; $i \in I$; $l \in L$; in other words, when none of the n institutions participate in the solution of one subtask $a_{il}$, it is necessary to find other institutions that would open new themes concerning subtask $a_{il}$

The form shown in Fig. 5 is used to list the research themes of the Program vs the subtask where they will take part, repectively. These three forms are the additional blanks that must be filled out in the organization and planning (ACC-80) of the Program. In Fig 5, $L_i, L_j, \ldots, L_z C L$.

Program P is then formed by a set $W = (1,\ldots,s)$ of research themes. Let $a^w_{il} \in (o,1)$ denote each element (subtask $a_{il}$ related to theme w) in Fig. 5, $w \in W$; $i \in I$; $l \in L$ each theme w, $w \in W$ is then related to a set $A^W$ of subtask $a^w_{il}$.

Then, $A^k \cap A^0 = A^{k0}$; k, $0 \in W$; is the set of subtasks where both themes k, 0 participate in simultaneously, cardinal $N_{k0}$ of set $A^{k0}$ is considered to indicate some relationship between themes k and 0; k, $0 \in W$.

The graph shown in fig. 6 is the matrix $N = \| N_{k0} \|_{sxs}$ formed by the cardinals of the intersections sets (See Fig. 6) will, of course, be symmetric in respect to the main diagonal.

In our case, we separate from the graph a subgraph, the maximum linked tree. Each node of the tree will be a theme. The value of the links will be given by their correspondents elements in matrix N, indicating some degree of relationship among the themes.

| INSTITUTIONS / TASKS | 1 | 2 | ............ | n |
|---|---|---|---|---|
| $P_1$ | + | | | + |
| $P_2$ | | + | | |
| . | | | | |
| . | | | | |
| . | | | | |
| . | | | | |
| . | | | | |
| $P_m$ | | + | | + |

Institutions vs Tasks

Fig. 3.

INSTITUTION j

| SUBTASKS / TASKS | 1 | 2 | ............. | r | NAME OF PARTICIPANTS |
|---|---|---|---|---|---|
| $P_1$ | | | | | |
| $P_2$ | | | | | |
| . | | | | | |
| . | | | | | |
| . | | | | | |
| . | | | | | |
| $P_m$ | | | | | |

Institutions vs subtasks

| TASKS / THEMES | $P_1$ | $P_2$ | . . . . . . . . . . | $P_m$ |
|---|---|---|---|---|
| 10180230(1) | $L_i$ | $L_j$ | | $L_k$ |
| 10280222(2) | $L_0$ | $L_p$ | | $L_u$ |
| . . . . . . . | | | | |
| (w) | $L_x$ | $L_y$ | | $L_z$ |

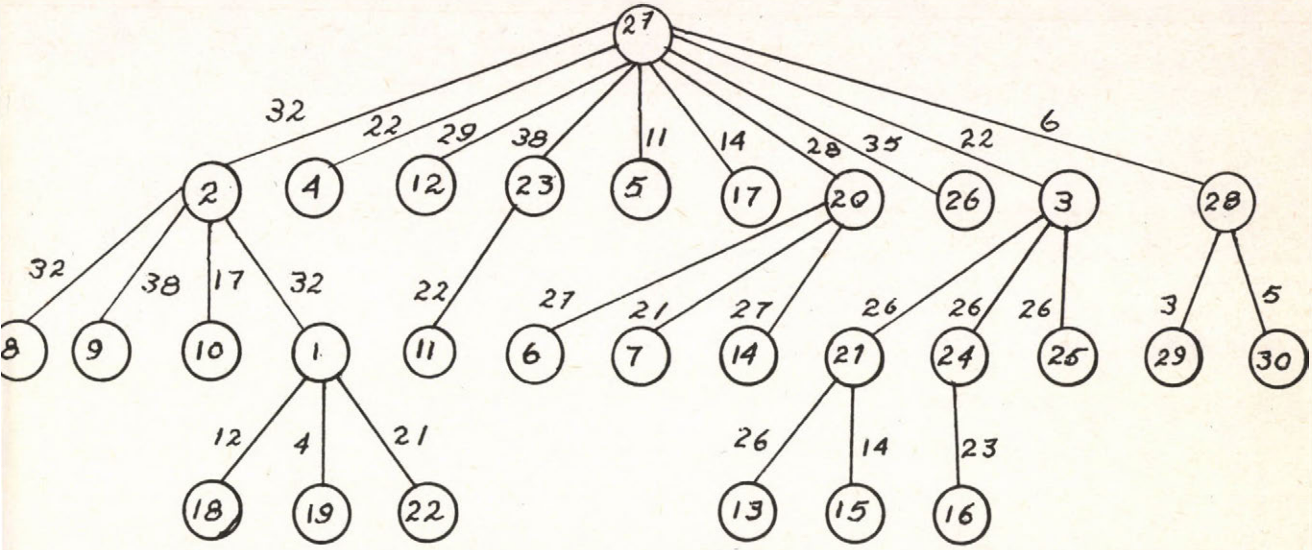
Themes vs subtasks

Fig. 5

| THEMES / THEMES | 1 | 2 | . . . . . . . . . . | s |
|---|---|---|---|---|
| 1 | $N_{11}$ | $N_{12}$ | | $N_{1s}$ |
| 2 | $N_{21}$ | $N_{22}$ | | $N_{2s}$ |
| . . . . | | | | |
| s | $N_{s1}$ | $N_{s2}$ | | $N_{ss}$ |

Matrix formed by the cardinals of the intersections sets

Fig. 6.



MAXIMUM LINKED TREE

Fig. 7.

In Fig. 7 the maximum linked tree is shown (DIPOTET, 80). In our case, this subgraph aids people in decision making concerning the management of the research program. For example:

- it is obvious that theme 27 in the subgraph is really a "bottleneck" and it is absolutely necessary to assure its resource allocation;
- the subtrees derived from nodes 2 and 3 respectively may be considered as subprograms to improve program management;
- themes 4, 12, 5, 17, 26 are practically isolated and it may be possible that works within them may begin in advance or be delayed (within time interval $t_i$) according to resource allocation problems.

What we have presented above are only examples. There are other applications of the tree and it is also possible (DIPOTET, 80) to derive other useful subgraphs from the graph shown in fig. 6.

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Összefoglalás

Kutatási program tervező információs
rendszer

A cikk információs rendszerekkel és tervezési célu alkalmazásaikkal foglalkozik. A szerző a program tervezés módszertani kérdéseitől kezdve tárgyalja a problémát. Algoritmusokat és módszereket ad a program témák strukturájának meghatározására, valamint elemzi ezeket a strukturákat a-ból a célból, hogy segitse a program irányitását és ellenőrzését.

Информационная система для проектирования
научного исследования

Перфекто Дипотет

В стате описываются некоторые информационные системы в связи с их применяемостью для проектирования научного исследования. Дается общая методика проектирования. Алгоритмы и методы прелагаются для определения структуры программ исследований, а также дается анализ этих структур для управления программами.