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About the Institute

The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

Information Management for Environmental Decision-making.

I. Introduction

- A. Historical--generation of my interest through activities and methods of the discipline within biology called taxonomy (or systematics)
1. This discipline deals amongst others, with classification of organisms.
 2. Probably oldest of the biological disciplines, with result that a considerable body of expertise developed in showing relationships
 3. Classifications are, in one sense, information storage and retrieval systems.
 4. The thought processes of the taxonomist, when making classifications is, or has been, unexpressed, with no formal methodology.
 5. Our interests in developing computer programs to aid in classification required that we make explicit and rigorous, the thought processes with results that we now know much more about classification methods, and with the further result that the methods of thought for classification are fundamentally the same, whether we deal with biological objects or with any other human endeavors.
 6. In extending the computer methods we developed, we found that we must be interdisciplinary, using the best talents of many different disciplines to be certain of accuracy and appropriateness of any particular part of the work--and this led to the development of the interdisciplinary team we have built up in the Taximetrics Lab.
 7. Our results, which are now well established computer systems, became fairly well known around the world, and one of the applications of the systems was for an organization known as GURC, which, through a contract with one of the large facilities of NASA, was to implement an environmental information management system. The particularly facility, the Mississippi Test Facility, took the lead in NASA in modifying the mission of NASA from a purely space-oriented activity to one applying the management skills and integrated systems of NASA

to problems of the environment on earth. I was invited to act as a visiting "information" specialist, to aid in putting together the concepts necessary for interdisciplinary information management, to work with a team of six disciplinary specialists representing the physical, chemical, geological, biological and social (legal) disciplines.

B. A word about the title

1. We assume we know what information is (although we find a very sloppy application of "data", "information" and "knowledge"
2. We assume we know what management is
3. We assume we know what "the environment" is we assume here an hierarchy from simple to complex.)
4. And lastly we assume we know what decision-making is.

Indeed, we know each of these things, and a management specialist will say that all that I will say here is really very old, and he is right, up to a point. The point we make is that applications of management techniques ~~ix~~ information about to problems of/the environment have only very recently been started, and further, that this recommended set of techniques is one which allows the participation/in decision-making about the environment, something that has come under very great discussion amongst scientists in that past few years. The traditional role of the scientist as "above it all", has come under question, and the scientist now is assumed to have a social responsibility for the data and information which he generates.

II. Objectives of information management for environmental decision-making.

A. To solve problems in the environment.

1. Problems seldom confined to one discipline--the environmental problems crosses disciplinary boundaries.

B. To make the decision-maker's job easier, and at the same time to provide a broader base to the decision-maker's analysis of a problem.

C. ^{Disciplinary} The breadth of environmental problems.

1. Usually involves some or all of the aspects of the environment, physical, biological, social, esthetics, recreation, etc.

2. The single scientist's results seldom solve environmental problem. Must combine his data, information, and knowledge with many others to bring best possible results for problem solving.

C. The following concepts were developed to aid in the solution to environmental problems.

Follow here with discussion of the 3 figures.

Figure I--The information management triangle. and discussion of the heirarchical "ladder".

Figure II--The Inform System, and the constituent programs.

Figure III--Steps in Decision-Making.

III. Applications of the system.

A. Through the GURC operation--Determination of effects^{on the biological environ-} of dumping old ^{ment} ammunition in the deep waters off the Atlantic coast.

1. Procedures--deep water photography, with narrow and wideangled lenses 20,000 individual photographs of bottom, to examine the organisms present. Another set of photographs taken away from the dump site to compare "normal" bottom fauna with that of dump site.

TAXIR used to record the data from (and about) the photos.

Querying system discovered those photos with some actual organisms the ~~types of~~ species of organisms, and their frequencies.

The results of the queries then run through the CHARANAL program to determine the value of each recorded datum (about 50 for each photograph).

The data with meaning (derived from the CHARANAL) run through the clustering program (GRAPH), to determine effects of the ammunition on the sites (as compared with same type of information outside the dump site). Results indicated that the same numbers and kinds of organisms (both dead and alive) found outside the dump area as in, therefore, no environmental damage from this

particular operation--the type of ammunition dumped is "classified".

III. A. 2.

Development

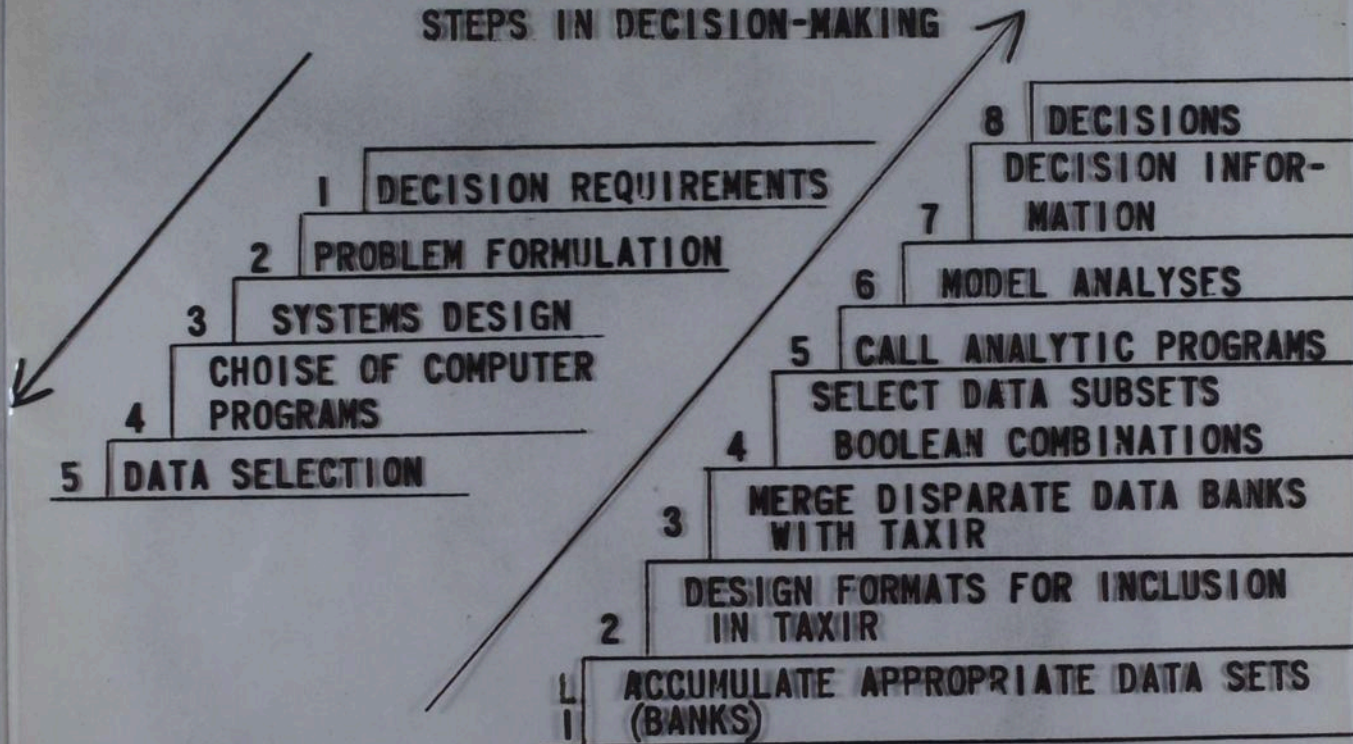
B. Through the Agency for International ~~Cooperation~~--Determination of means to increase protein consumption amongst weanling children in one city of an underdeveloped country.

1. Description--and procedures--Requirements: Info from agricultural resources, production, and problems of production, from demographic sources about the city, from economic resources available, from transportation (types, frequency, amount of food products) from marketing (marketing processes from farm to eventual consumer) from food habits of the varying ~~XXXXXX~~ types of people in the community.

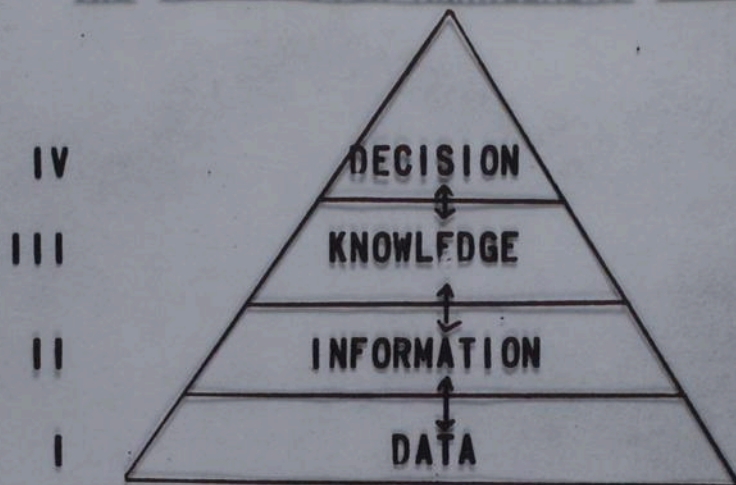
The demographic data were already in machine-readable data banks, the remainder in ordinary forms: letter files, etc., but by very hard work, we extracted the necessary information therefrom, to be input to the overall model. By use of an ad hoc model, we were able to discover appropriate points of intervention, suggest modifications of procedures in marketing, transportation, agricultural production, and social changes to recommend a set of procedures to decision makers at the various governmental agencies, including the President of the country.

There are several other applications of the systems in progress, including by the Food and Agricultural Agency of the United Nations a large scale effort/to conserve genetic resources of important food plants around the world, improvement of nutritional input in countries whose diets are largely carbohydrate. The important consideration here is that the scientist, using his own particular ~~XXXXXX~~ data, knowledge and skills can definitely have an influence in the decision-making process, in keeping with that called his "social responsibilities".

STEPS IN DECISION-MAKING



THE INFORMATION MANAGEMENT TRIANGLE



EXPLANATION

I DATA-----TAXIR---OUTPUT TO II
 II DATA "MASSAGING" FROM I } CHARANAL--OUTPUT TO III
 } GRAPH--OUTPUT TO III OR IV
 III MODELS OF THE ENVIRONMENT } [BIOLOGICAL
 } [PHYSICAL
 } [SOCIO-ECONOMIC] -OUTPUT TO IV
 IV DECISION-MAKING GAMING-MODE MODELS

**THE INFORM SYSTEM
CONSTITUENT PROGRAMS**

- 1. INFORMATION STORAGE AND RETRIEVAL--
PROGRAM TAXIR**
- 2. ANALYTICAL AND SYNTHESIS PROGRAMS**
 - A. STATISTICAL ANALYSIS PACKAGES**
 - B. INFORMATION ANALYSIS--PROGRAM CHARANAL**
 - C. INFORMATION SYNTHESIS, CLUSTERING AND
DISPLAY--PROGRAM GRAPH**
 - D. LEGAL AND ECONOMIC ANALYSIS--PROGRAM
REGEL**
- 3. ENVIRONMENTAL MODELING PROGRAMS**
 - A. ATMOSPHERIC TIME AND SPACE MODELS
PROGRAM TG4DA**
 - B. BIOENERGETICS--ODUM MODEL**
 - C. GEOLOGICAL SUBSIDENCE--STEWART MODEL**
- 4. GAMING-MODE DECISION MODELS (TO BE
CONSTRUCTED)**