

CAN THE BUILDING OF INFORMATION SYSTEMS BECOME A SCIENCE?
THE CHALLENGE

by the Canadian FID/TM Group*

Secretariat Prof. J.S. Riordon
Department of Systems Engineering
Carleton University
Ottawa K1S 5B6

ABSTRACT

There appears to be a tremendous diversity in the approach to building information systems, each being considered to be sui generis. At the same time, the systems when implemented, are often disappointing. The Canadian FID/TM group believes that it is possible to develop a well-defined methodology for the design of information systems and has set up a program with this end in view. The paper describes concepts involved in establishing a canonical structure for representing information systems and the progress of the group towards a structured discipline of information system design.

RESUME

Il semble y avoir un grand nombre de façons différentes d'aborder la mise sur pied des systèmes d'information, chacune étant considérée comme unique en son genre. Par ailleurs, une fois mis en vigueur, les systèmes ne répondent souvent pas aux prévisions. Le groupe canadien FID/TM pense qu'il est possible de mettre au point une méthodologie bien déterminée en matière de conception des systèmes d'information, et a élaboré un programme destiné à réaliser cet objectif. Cette étude décrit certains concepts visant à l'établissement d'une structure orthodoxe afin de représenter les systèmes d'information et le progrès vers une discipline structurée de la conception des systèmes d'information.

* Current Membership:

G.X. Amey	Defence Research Board
R.L. Baglow	Defence Research Board
E.W. Chadler	Bell Northern Research
P. Nador	Ministry of State for Urban Affairs
J.S. Riordon	Carleton University

Chairman: P. Nador

BUILDING INFORMATION SYSTEMS

INTRODUCTION

Although examples of successful information systems exist in great number, there are many others which have proved to be very disappointing. In the past, each system has been treated as unique: and has been built from the ground up as if it were the first of its type in the world. This is believed due to a lack of a generally accepted methodology for design of such systems. For this reason it has usually been difficult in practice to establish commonality between a proposed system and existing ones. To determine the existence of commonality requires conceptualization - the abstracting from specific examples of common functions or primitives to which a systems design calculus might apply.

CONCEPT ANALYSIS

The development and implementation of real systems require the conjunction of conceptual and pragmatic approaches. Conceptual analysis is concerned with fundamental issues; pragmatics is involved with implementation in the real world of conflicting personalities and limited resources. If an exclusively pragmatic approach is used, specific problems or opportunities are handled as they arise, possibly generating a suitable solution for each considered individually. The sum of the parts may constitute, however, a hodgepodge of disparate elements and not a total system that operates smoothly.

GLOBAL DESIGN

It often is not possible to design and implement an entire system in a single step; however, this does not obviate the necessity for conceptualizing the architecture of the entire edifice. Once the end-system has been conceived, particular components can be built in a modular manner, each contributing a building block toward the overall structure.

GENESIS OF THE FID/TM-CANADA COMMITTEE

In early 1971, a group of people who had extensive experience in developing complex information systems, began, under the leadership of Peter Nador, to meet informally to study the problems of system design. At first the ad hoc study group spent its time in sharing the experience of the members, or as one person put it, developing a common data base of terminology and experience as a basis for further study.

After much time spent in discussing the problems encountered during development of specific systems, it became the general feeling that little real progress could be achieved towards a significant contribution

BUILDING INFORMATION SYSTEMS

to the state-of-the-art in the absence of a conceptual framework in which various approaches to design could be compared and evaluated. In due course the ad hoc group formalized itself as the Canadian branch of the international FID/TM committee. (FID/TM is a committee of the Fédération Internationale de Documentation (FID) concerned with theory and methods of systems, cybernetics, and information networks).

The backgrounds of the group members bracket management information systems of industrial companies, large-scale military logistics systems, and library systems, among others. The challenge we have set ourselves is to find the conceptual primitives implicit in these and other systems.

TRADITIONAL DESIGN APPROACH

Typically, the system architect is asked to computerize an existing information system. If this is taken literally, a system analyst probably will examine the details of the current system and simply replace appropriate components by machine analogues. This approach was widely used in the sixties and was largely responsible for the dissatisfaction experienced by operators and users of information systems.

The common experience of our group has been that this superficial approach almost always is doomed to failure in the case of large or complex systems. Instead of taking a pragmatic approach that only leads to a mechanized analogue of the original system, it is imperative that the components of the total system, of which the information system is a part, must be studied, as also the environment.

SYSTEM CLASSIFICATION

Information systems appear to be of two principal types - those which are an intrinsic part of the decision-making or control process of the object system, and those which are resource systems. The former deals primarily with internally generated (endogenous) data, and the latter with externally generated (exogenous) data required where decision making is heuristic and not susceptible to complete formalization in advance.

UNIQUENESS OF DESIGN

It is not the group's belief that there is a unique and ideal design process; on the other hand, it is difficult to compare approaches proposed by particular analysts due to the lack of a common language for describing design-concepts and operations. It is very likely that a specific design problem presented to a number of designers would give rise to as many solutions as there are designers. The differences might well be superficial, but none the less very real when an attempt is made to determine the relative merits of the various solutions. If in fact, a uniform methodology were used, the evaluation could be greatly simplified.

DESIGN FRAMEWORK

Thus, the initial thrust of the group's studies has been directed not toward specific design processes, but toward developing a fundamental or canonical structure within which individual design approaches can be described (FID/TM, 1974). This should eventually lead to agreement on a well-defined set of primitive functions and characteristics that describe information systems and on a sequence of generic design steps.

GLOBAL SYSTEM MODEL

A first step in this direction has been the development of a global system model capable of describing the relationship of the information system to the various subsystems contributing to the global system. In the case of certain information systems whose origin is lost in antiquity, this may be psychologically very difficult. While it is fashionable nowadays to consider libraries as information systems, fundamental differences in characteristics immediately appear when we seek to determine the object system the library is supposed to support.

Publicity, for example, has been given recently to a library of 1,000,000 items for which a \$45,000,000 building has just been erected. Another system, which provides excellent service based on a holding of 500,000 items, is lodged in cheap, rented premises with its search-files stored in a commercial computer service located elsewhere. The different allocation of resources between housing the collection and provision of service for similar systems reflects implicit judgments about the object systems these services are supporting. It would appear that such judgments should be made explicit early in the design process so that they may be subject to rigorous scrutiny and analysis.

SYSTEM MODEL

The model represented by the information flow diagram of Fig. 1 represents one level of a nested system structure. The term nesting relates to the fact that we are isolating a particular subsystem of a hierarchical system for our own convenience. In fact, it will be subordinate to higher levels of the system structure and will itself have subordinate subsystems. If we consider the Department of National Defence (DND), for example, as the object system, it is of course, at the same time a subsystem of the total federal apparatus on the one hand and is itself served by subsystems such as the Defence Research Board (DRB) on the other hand.

The Defence Research Board in turn may be considered as the object system for the information flow arising from the Defence Scientific Information Service. Yet DRB is in essence a technical information service serving DND as the object system. Analyzing systems into their components can be a very useful exercise; for example a mission-oriented research agency often visualizes its objective as the conduct of research. Closer analysis might well show that its function is to provide mission-oriented

BUILDING INFORMATION SYSTEMS

information, some of which may be endogenous because it is the result of internal research but the bulk of which is exogenous. Because it arises from research conducted beyond the organization, a clear understanding of intrinsic function is necessary for proper allocation of resources.

DESIGN MODEL

In Fig. 1, the flow of transactions between components of the system is indicated by the directed lines linking them. If we have an accepted methodology for describing systems, this can provide a framework for the design process, which in fact consists of systematically assigning values to the parameters associated with components and transactions of the system.

GLOBAL SYSTEM

A prerequisite to the design phase is evidently the analysis of the object system, or mapping of its attributes onto those of the design model. Simulation can be used to verify isomorphism between the object system and the design model (FID/TM-Can/2). If testing proves that the simulated system has the same characteristics as the real system, the design parameters can be assigned to the information system and this can be tested along with the global system model to see if it functions as desired.

CANONICAL STRUCTURES

The process of analysis and simulation, although often used in design of complex systems, has not been reduced to a canonical form as far as we know. The principal initiative of the FID/TM-Canada group to date has been aimed toward defining a generalized methodological framework that could be used, both for comparison of the relative merits of competing designs, and for verifying at all stages of analysis and synthesis that the design is self-consistent and specifications complete. This work of course builds on the results of others (Teichrow, 1969, Langefors, 1968).

CONCLUSION

The FID/TM-Canada group is planning to hold an international colloquium on the subject of information system design methodology in Ottawa in 1975. We are looking for support from UNESCO, FID, and the Canadian government in this venture. We hope that this colloquium will bring us measurably closer to making the building of information systems a science.

REFERENCES

- FID/TM-Canada. "Towards a generic information systems design process". Proc. of meeting of the International Federation for Information Processing, Stockholm, 1974.
- FID/TM-Canada. "Object system analysis in the determination of design requirements". Proc. of the NATO Defence Research Group Seminar, Athens, Greece 23-26 April, 1974.
- FID/TM-Canada. "Design languages for information systems". Proc. of 8th Annual Princeton Conference on Information Sciences and Systems, 28-29 March, 1974.
- LANGEFORS, B. Theoretical Analysis of Systems, Student-litteratur, 2nd edition (1968) Lund, Sweden.
- TEICHROW, D. "Methodology for the design of information processing systems". Proc. of 4th Australian Computer Conf. Vol. 2, 1969, pp. 629-34.

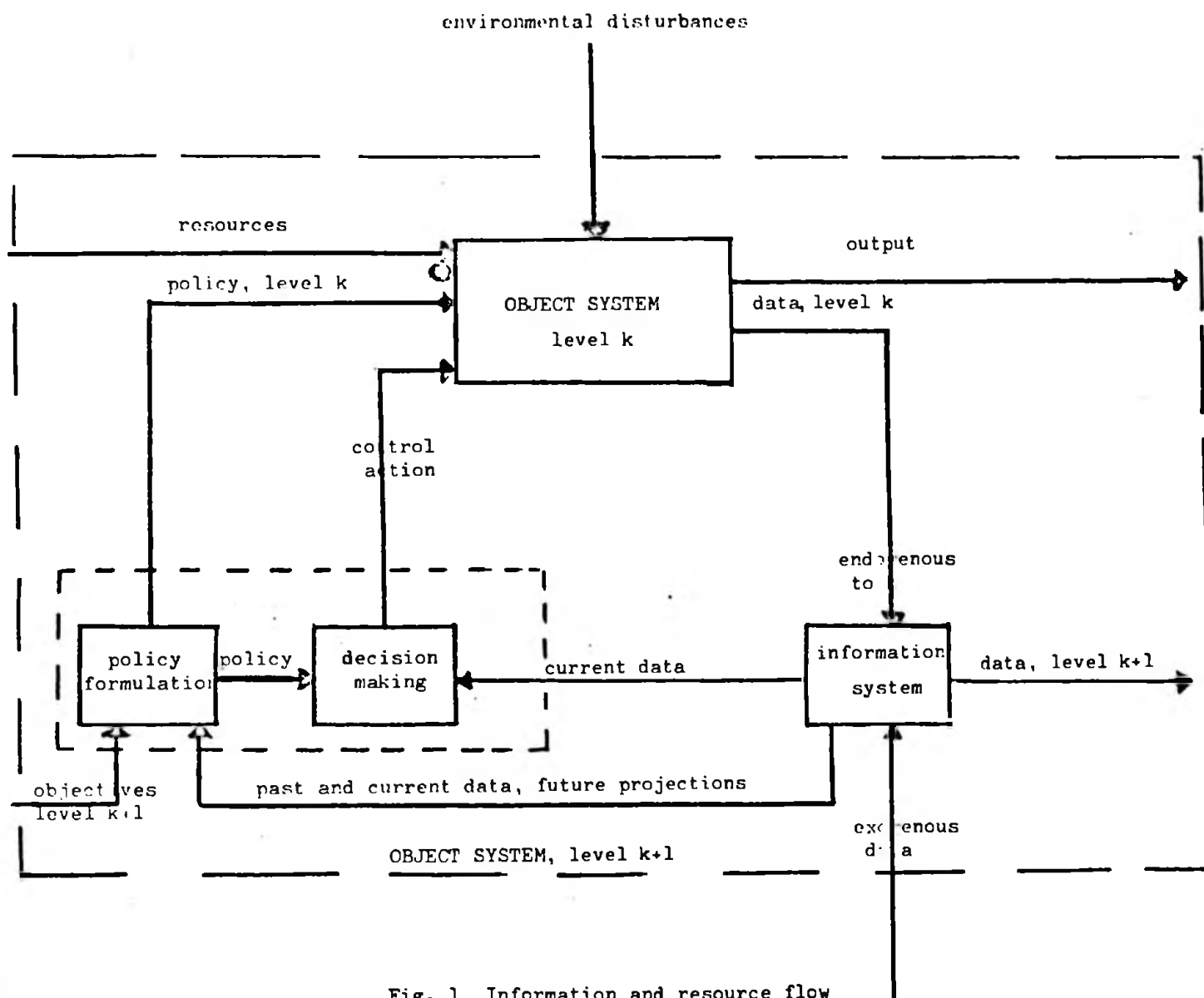


Fig. 1 Information and resource flow
(level k system)

Note. The global system at level k is the object system at level k+1