The interrelationship between information systems and science policy formulation

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Improved information systems are a significant resource through which Science and Technology policy making can be considerably enhanced. The complexity of Science and Technology and its diversity raise serious problems as to definitions, quality and quantity of information resources which serve the policy maker, and the organizational and technical methods through which available knowledge is made accessible. The interrelationship of inter-organizational, national and international information systems is discussed in this context. Internationally accepted standards and procedures should be developed and implemented but it is emphasized that international operations and conventions must have application at the national level if they are to have some permanency and be effective.

Keywords: Information systems, STI Systems, National science and technology policy, Israel, International standards.

0. Introduction

The policy maker, more than most twentieth century professionals, lives within the exigencies of the science and technology that create and permeate our societies and the information [1] explosion they occasion and feed upon. The policy maker's information needs are as diffuse as the complex environment in which he operates. Many sources of information are available for his use, but knowledge of their existence and ease of access to them and to the information they conceal is difficult at best. There is frequently too much distance between statements about and implementation of national information policies, where indeed they exist, although an effectively realized information policy is not so much integral to the overall Science and Technology (ST) policy making process, as a basic prerequisite to any such endeavour.

It can safely be claimed that many individual agencies lack awareness of already existing knowledge, and expensively duplicate previous information gathering activities or are panicked into uninformed decision making [1]. Surveys are conducted, consultants hired, research projects are started in blissful ignorance of the contents of library shelves, file cabinets and desk drawers. Inter-organizationally, nationally and internationally the absence of adequate information flows more often than not cripples decision making and drains scarce resources.

This paper will focus on some of the issues raised such as:

– Science policy making and promotion of Science and Technology can be effectively pursued only if supported by efficient information services.

– Information services for this application must be drawn from widely dispersed resources to which access is frequently extremely complex and consequently difficult and costly.

– The diffuse character of the information required, the barriers which exist in information transfer, the difficulties of users in defining their needs, all point to the introduction of standardization and compatible handling procedures as being of outstanding concern to information users as well as to information brokers.

– No attempt at standardization, compatibility, etc. will ensure an adequate flow of information for decision-making in general and policy-making in particular, if an adequate information service infrastructure has not been created.

– The information service infrastructure, being an integral part of policy making, must occur at the same level at which policy making is initiated, i.e., at least at the national level. International systems which are not used at a national level are likely to remain ineffective.

[1] Terms such as "information" and related concepts are used throughout this paper with specific definitions in mind. These definitions were set out in a previous paper [4].

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1. Information services for policy-making

A vast array of information systems have surfaced, at national and international levels, catering to the needs of scientists and technologists, specialists and practitioners in all the disciplines and interdisciplinary conjunctions. Their proliferation, and the resulting complexities of information provision, testify to the variety and the urgency of the needs, while adding through sheer size and systems complexity to the general confusion. The problems involved in putting the knowledge provided in such profusion to effective use are at least equal to the need for generating new information and progress in fundamental scientific knowledge.

As improved information systems are axiomatically and/or intuitively accepted as a requisite means for enhancing scientific and technological activities and for formulating science and technology policies, the problem of defining the relationship between national and international information systems serving the promotion of these activities in operational terms is of considerable importance. It is a problem that relates to an inherently complex system whose outputs cannot be directly measured, evaluated or even unambiguously defined.

Information systems in this context should be interpreted to mean the total cycle: the production, storage, retrieval and dissemination of information. Information inputs of a great variety are needed: scientific, technological and socio-economic data and forecasts, technology transfer data, social aspects, manpower policies, relevant statistical data, registers of expertise and ongoing research projects, etc., etc. To these must be added the conventional formal and informal reports of findings and reference materials. Much of this information is semi-visible at best, often in the form of limited editions and unpublished reports and memoranda available only if their existence and location is known and if channels of access have been secured.

Sharing information between developing and developed countries is an acknowledged aim, but practice lags behind principle and the gap between plan and actions, policies and directives, information services and information use needs attention. The pervasive nature of information and the need to ensure its free flow, disregarding any artificial barriers, make the international mode of operation ours not by choice, but by necessity. In the complex interplay of economic and political forces and attempts for scientific and technological affluence, international cooperation may often be ineffective. But there seems little doubt that genuine international efforts are obvious keys to the future development of information work and improved utilization of knowledge which stems from it.

Interest in the information system must begin where it ends, at the individual and institutional level, and expand among the interrelated national and international concerns and missions. Technologically, as well as sociologically, the media of communication become more and more interdependent, although the processes of generation, production, transmission, dissemination and storage are fragmented and subject to varying degrees of conflicting interests. Reconciliation of these interests in a mutually responsive acceptance of obligations and recognition of each other's needs is essential to the information cycle.

The best place to ensure control of bibliographic and non-bibliographic material and therefore to prepare for information retrieval and dissemination is where the information is originally generated. Most organizations have (or should have) a strong self-interest in bringing their own documents under bibliographic control. Further processing and distribution at an international level add only a marginal incremental cost in return for access to knowledge generated elsewhere.

Interest in international information networks is motivated partly by the need to make effective use of the economies of scale and the expensive sophisticated IR technologies available. Regional and global systems aimed at a coordination of resources and ensuring reliable access would seem to be a reasonable prescription of the improvement of the existing situation. Such systems could cut down on the waste of scarce resources and support the effective exploitation of available expertise. They must rely on voluntary national cooperation and active ongoing participation for input and support; a spiralling interaction that begins and ends with the individual user's needs.

2. The dimensions of the task

Increasingly the Science Policy maker's task is directed towards solving the problems of allocating always limited resources among the multitude of projects and pleas for priority that ST activities entail. As in all systems, problem definition is a principal key to finding effective solutions. To define the

problems, information must be sought and converted into knowledge.

The Science Policy maker operates within the convolutions of his national ST infrastructure, the web of institutional and organizational arrangements through which ST related activities, including the provision of information services, are performed. The differing stages of development and levels of sophistication of this infrastructure in different countries reflect differing socio-economic, organizational and cultural values. At a gross level of analysis, the policy designer must apprehend the interactions between several national subsystems as well as the relationship between national and international ST programmes. He will appreciate that cultural values and norms limit the extent to which scientific and technological advances are introduced and diffused. The need for up-to-date relevant information, derived from a large, interdisciplinary body of data bases of national as well as international origins is obvious in this context. Local input to, and use of, international information systems is only possible if a country has developed the national information infrastructure necessary to support the required exchanges of information. This poses intricate problems of reconciliation and synthesis and may obscure to some extent the communality of problems and needs.

An understanding of the functional relationships within the national ST system and between it and other national systems; political, cultural, socio-economic, educational and demographic, is needed in order to achieve clarity in the design and development of STI services and rapprochement to the problems of the users embedded in these structures. This understanding entails knowledge of the structure and functions of the disparate units and their interactions.

Sagasti's conceptual model of the nation-system geared toward the study of science and technology policy making and planning [7] provides a useful framework for analysis of some of the interrelationships which are of interest to the systems designers and policy maker. Identifying the political and cultural systems as regulatory and the others as operational, he delineates the interrelationships as based on an interchange of knowledge, manpower, goods and services and emphasizes their complex and mutually interdependent nature.

Various types of knowledge (or information) flows are modified by scientific and technological activities. These activities are in turn supported and influenced by library and information services, publication of scientific and technological literature, conferences, inventories and surveys, standardization, quality control, licensing and patent granting, and similar methods of information transfer.

A framework for analysis like this illustrates the territory involved in the Science Policy maker's environment, and in the contemplation of any improvement of information services for ST policy making. It outlines relationships within one major area of concern, and firmly relates ST policy making to policy and planning activities in other areas of national endeavour [3]. Sagasti saw these conceptual models, influenced by the work of Ackoff, Machlup and Trist, as a starting point for data gathering and for the development of new planning methods and in particular the need for the provision of the necessary information for appropriate decision making.

Ackoff also uses this concept of methodology as a worthwhile objective of a planning quest in the analysis of the scientific communication and technology transfer system in the U.S.A. [1]. The concept illustrates again the complexity of the total system, the need for conscious planning, and the involvement of all system participants in deciding what they want to do and how, and the information base required.

Science and technology policy making, then, is essentially national in character. It is a political activity, specifying objectives and priorities for the national scientific and technological system. These policies and activities are not pursued in a vacuum. They cannot be defined in a uniform way for all countries or for one country for all times, nor can they be isolated from other policies in the nation. It is this national cluster of activities which scientific and technological information systems must first and foremost support.

3. Approaches to a methodology

The information systems designer, similar to the science policy maker, needs awareness of the many faceted relationships between ST systems and other national systems. He must recognize that cultural values and norms pervade these systems and influence ways of thought and modes of operation and thereby national needs and capabilities.

The need for current, accurate and relevant information is common to all decision makers and particularly the selective acquisition and dissemina-

tion of information aimed at promoting scientific and technological competence, within the canons of national development plans. A national ST policy must accommodate these needs to the extent of defining and implementing a national information policy to support its policy makers.

Science policy makers have wide-ranging information needs including – inter alia – such familiar items as:

– organizational and institutional structures,
– national, sectoral and institutional budgeting,
– manpower resources and requirements,
– socio-economic, scientific and educational statistics and indicators,
– periodic state-of-the-art surveys,
– factors affecting the training, employment, motivation and mobility of scientists and engineers,
– R & D projects and funds, resources and requirements, the contributions of R & D to development, etc.,

and composite reports, surveys and forecasts in any or all of these areas. At the second level of complexity, comparative information on other nations and on international policies, programmes and activities is required.

In order to cater for these needs, the national information policy and services must provide for adequate access to information sources, the provision of documents not otherwise locally available, bibliographic control and depository arrangements for unpublished documents and the regular monitoring of information needs of actual and potential users, including user surveys and education. Evidently, the immense diversity of information sources necessitates coordination and integration of the services through which they are made available.

The overall pattern thus emerges as a system of overlapping networks of local, national and international activities drawn into the system through the need for, and involvement in the generation and use of, scientific and technological information. The individual information user's awesome information retrieval and current awareness needs, and his potential for information generation, are more than exponentially increased by the needs of groups, teams and interdisciplinary task forces.

Once information requirements and resources become as varied and complex as discussed here, individual institutions have no longer the capability to respond adequately. Information specialists acted by developing information resource networks based on informal or formal agreements for cooperation. As needs grow and systems expand, additional formalization of networking mechanisms follows. The network concept extends the traditional tree hierarchy of the organizational chart by emphasizing the processes of interaction between all nodes rather than their spatial rigidities. It includes the orderliness of the former and acknowledges the vitality of the informal communications system. Awareness of self-interest is the motivation for effective networking. The initial and continuing involvement of individual units in the process of developing and operating the system is essential. Acceptance of common rules of procedure, standardization and compatibility is part of the price to be paid for participation.

Networking implies by necessity the creation of coordinating functions in order to direct the network operations. Such functions will generally extend their activities outside the network proper by linking up with national and international elements with an aim to optimize the information transfer processes. The creation of National Focal Points for information is motivated, at least partly, by the consideration of the measures needed to be taken in order to cope with this challenge [6].

4. The international imperative

"The objective of international scientific cooperation is to complement and reinforce the scientific capacities or otherwise serve the national purposes of the countries that engage in it". Countries must measure the value of cooperation in connection with their national programs and organize their internal effort to take maximum advantage of the potential returns [5].

In other words, given the recognition, at all levels, of the importance of sharing imformation, the relationship between national and international scientific and technological information systems must be firmly based on the needs of users. The impetus for cooperation must come from the national level, and then be reflected in regional and international activities. Characteristics of such a relationship include an awareness of the complex interrelationships within the environments of national and intergovernmental plans and policies in all sectors. Participation and involvement must be backed by commitments to some form of standardization and compatibility as necessary instruments for the achievement of the policy goal.

International information systems and networks, whether already existing or only blue-printed for the information-society of the future, offer a potential of ever increasing access to accumulated knowledge. However, this access is by no means assured and no amount of standardization, harmonization and systems building holds at present a promise of overcoming the various constraints and barriers to a free information flow which become increasingly prominent. As information becomes ever more costly and access methods increasingly sophisticated, the attention of systems designers focuses on the apparent paradox of blessing becoming a curse, availability a barrier, need a requirement to do without. Acceptance of the indispensable role which information services and access play in any ST system implies a commitment to alleviate inconsistencies and barriers to information flow, at the local and national level and even more so at the international level. Lack of attendance to these very basic and pragmatic problems is bound to negate any attempt at systems harmonization and optimization, however well designed and intended.

The perception of the need for common procedures and removal of barriers to information flow should come from the users, but may unfortunately be blurred by short-sighted intraorganizational policies. Acceptance may be more readily achieved through national and local consultation in parallel with international agreements and modification, especially if it is explicitly accepted that this does not imply loss of local autonomy or the imposition of rules from "on high". Although the need for concerted action is not contested, and international organizations have been active in the definition and development of relevant formulae, successful implementation poses serious problems. Even at the national level universal acceptance of this need and consequent systems inter-connection and compatibility is still more desired than real.

5. In Israel now

Particularly in a small country, where only a very limited quantity of information is generated locally, world-wide scientific and technological resources must be called upon to the widest possible extent. In addition, national sources of information must be identified, tabulated and widely disseminated in order to alleviate some of the difficulties which users in a country such as Israel encounter. Effective and flexible organizational structures must be created in order to optimize the national information activity.

Some work has already been done in Israel in defining a national information policy and instituting a national planning effort. Although the incipient national information network is still largely in the blue-print stage, a national information service focal point (COSTI), a university library network (SCONUL), some voluntary subject-oriented cooperative schemes, governmental information services, etc., have been established, become operational and proven their worth. Israel participates actively in many international information activities such as UNISIST, CODATA, INIS, AGRIS, and others.

Much work remains to be done in devising explicit mechanisms of cooperation and strengthening this implicit national network for its national and international role. It is expected that increasing need for access to international STI networks will stimulate and influence the development and organization of the national infrastructure which in Israel, as in many other small countries, is still a weak link in the information transfer chain.

Together with the development of the more conventional STI services, we are compiling data banks and are building up information resources which are an integral part in the promotion of science and technology and assist the policy makers in this domain. Data banks on current R & D projects and funds administration, registers of personnel and institutional resources and similar systems provide aggregative as well as discrete items of information and together with activities which ensure document availability, data evaluation, current and retrospective information display, etc. are serving an increasingly broadening range of needs.

Necessity led to an early recognition of the need for international cooperation and, in anticipation of the sort of interactive information exchange that becomes available with modern electronic communications systems, we apply as far as possible internationally accepted standards and procedures. As an example, we have introduced the science subject classification system which was developed by the Science Policy Division of UNESCO and are standardizing on this system, in spite of the fact it does not meet all our requirements. We also took an early decision to make many of our data compilations available in English (as well as in Hebrew), again to facilitate international information exchange activities and cooperation.

We believe that meeting national needs through information systems which are designed for international exchange and use is a policy whose advantages outweigh its disadvantages and increased costs. It is an integral part of the creation of a uniform and validated interpretation of information policy and therefore an important condition for cooperation within the country, while being also a basic requirement for international cooperation. We believe that international systems develop effectively only if they have national application. From that it follows that any R & D or definition of priorities should be advantageously directed toward assisting the development of the latter, at least on equal footing with the former.

The information systems which are presently available to science and technology policy designers in Israel are insufficient, partly because of the diversity and complexity of the sources to be tapped. This statement is probably true in a great many other countries as well. It is hoped that by overcoming some of the existing information transfer barriers, by a greater acceptance of standards, procedures and other tools for compatibility, and through an emphasis on user education, the situation should improve. The lack of expressed and defined needs of users and the relatively recent coming-of-age of information systems in the behavioural sciences may also deserve attention in this context.

The improvement of existing systems and those to be created should be based on the characteristics we have itemized: a recognition of the complexity of information systems interaction and of their environments; conscious planning; the acceptance of a continuous process of knowledge accumulation; and, above all, the active and continuing involvement of all concerned in systems design and operation. International, regional and national activities which would effectively assist in that, and which properly recognize their relationship to each other, deserve full support and encouragement.

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