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ABSTRACT

The future paths of research and development towards world-wide, automated information networks in full operation are examined. From international networked planning and projects under way it appears that exploratory as well as normative approaches have been taken. To some extent adequate technolgical facilities have already come into existence but, on the whole, formalized goal-setting is still lacking. Consequently, there is also a general lack of outspoken priorities for step-by-step implementation of modular information systems to meet short-term objectives. It is emphasized that the use of system analysis expertise for policy-making and early planning is necessary before purposive design of global information networks can be envisaged. (Other papers from this conference are available as LI 003360 through LI 003389) (Author)

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by
Kjell Samuelson
Institute Information Processing-ADP
Royal Institute of Technology
Stockholm

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by
Kjell Samuelson
Institute Information Processing-ADP
Royal Institute of Technology
Stockholm

Introduction

This report on international information transfer and network communication is focused primarily on the intricate problems of goal-setting and far-sighted planning. The need for such an approach has appeared as a result of earlier work during the last few years (112, 113).

It is admittedly not until recently that teleprocessing and computer technology suitable for undertaking world-wide network planning have become a reality. Now that such planning has been initiated in several nations it is obvious that the real obstacles to face will be matters of methodology and principles, which must yield harmonious solutions to ill-defined tasks. The difficulties have sometimes been termed as socioeconomic problems and political or psychological barriers. Fortunately a new set of systems analysis tools or methods and formalized procedures have come into existence which can be applied to these problems. Therefore, the development situation for global information networks again seems bright throughout the 1970's.

Automated Information Networks

Several schemes have been outlined for networks where at least some information processing occurs. A few of these networks are already operational at least nationally, if not on a global scale. This document makes a conceptual distinction between more than half a dozen different network types, say:

- data base networks	for information retrieval from data bases
- communication networks	for messages, e.g., person-to-person
- library networks	for interlibrary exchange
- computer networks	for remote computation
- transportation networks	for airlines, trains, shipping
- mass media networks	for TV, radio, newspapers
- discipline/mission-oriented networks	for legal, police, automobile, corporate, hotel, ticket, educational, military, etc., purposes.

These networks and others to come, plus all kinds of hybrids, will be partially overlapping, sometimes embedded in each other and often using the same time-shared computer utilities. The following text is confined mainly to the first and second kinds of networks: "information networks," therefore, is used to mean mixed-media networks between data bases and multiple users and producers of full information, anywhere, at any time. This kind of information network may still become a functional part of those other networks which will use data bases and communications.

Following these criteria for automated information networks let us explore:

- Do they exist?
- What are they?
- What should they be?
- What are the differences between national, international and world-wide networks?
- How can far-sighted planning be provided?

As late as 1968 it was stated that no operating information network actually existed (9). Now, 2 years later, one may confirm that automated information networks, in accordance with our definitions, still do not exist, either nationally or internationally.

Yes, there are networks of other kinds, either in operation or in planning stages. A quick survey list will reveal their nature:

- communications	(14, 32, 79, 102, 123)
- libraries	(6, 17, 31, 37, 43, 61, 78, 86, 92, 108, 128)
- computers	(23, 33, 34, 40, 45, 50, 78, 107, 116)
- mass media	(102, 123)
- legal, Federal	(20, 36)
- educational	(15, 34, 44)
- military	(78, 79, 102)
- corporate	(18, 25, 62)
- information transfer (nonautomated)	(33, 41, 48, 55, 65, 83, 87, 88, 104, 106)

In fact, there are even real-time pilot projects and on-going experiments in information transfer from one point to another, which might serve as an embryo for future network growth.

The remaining three questions on DO's and DON'Ts and divergencies in planning for world-wide automated information networks will be described in the remainder of this document. We shall assume that the moderately early history of information transfer and the large-scale traditional operations for bibliographical records or document-handling are familiar to our readers to the extent covered by the Annual Review of Information Science and Technology (9, 48, 74, 96). The principal discussion is centered around Information and Documentation (I&D) for Science and Technology (S&T) or Research and Development (R&D).

Goal-setting and Priorities for World-wide Information Networks

For a number of years the FID/TM (International Federation for Documentation/Theory of Machine Techniques and Systems) committee has focused its studies on cooperation and work towards world-wide information networks. During the American Society for Information Science (ASIS) annual meeting in San Francisco in October 1969, FID/TM sponsored a technical session and panel on automated international information networks with emphasis on systems design concepts, goal-setting and priorities (112, 113). The panelists were FID/TM members, international systems analysts and information systems experts plus representatives of different countries and organizational bodies, projects or programs such as OECD, INIS and UNESCO/ ICSU's UNISIST.

Before the FID/TM network session the panelists were asked to submit to the chairman their comments on goal-setting and ranked priorities for systems design concepts. As a result it proved quite feasible to follow formalized procedures in expressing objectives and preferences. It also became apparent that a striking need exists to consult and co-opt systems analysts at policy-making levels at an early planning stage and not only during the systems design phase. In other words, it appears necessary to use "the systems approach" to extract ultimate desires, which can then be translated into performance objectives and design tasks for implementation which takes into consideration assigned priorities as well as nondesirable effects.

When dealing with the problems of long-range, mid-term and short-period planning for world-wide automated information networks, one is faced with a multigoal situation in an imperceivable international environment (68, 69, 70, 75, 103, 109). The use of recent methods for technological forecasting can be applied to some degree (5, 56, 57, 121, 126). However, there also exists the problem of fitting the integrated international ultimate goals for information transfer into the frame of overall national goals. Very few countries indeed have yet used systems analysis procedures for such formalization (95). This might be one reason why some policy-makers tend to avoid a workable declaration of higher goals and instead express somewhat vague general directives which can be interpreted in the way that is most convenient at a particular, future occasion.

A similar case occurred at a recent FID/TM-symposium on "Performance Evaluation of Information Retrieval Systems" organized in Stockholm for an international forum as late as June 1970 (115). The theme for the panel discussion was intended to be focused on goal-setting, ultimate desires, design objectives vs. nondesirable effects, preferences, priorities and short- to long-term improvements. About 30 of the participants were representing "users" of information, while a dozen were managers of information systems. The same experience remains, i.e., there exists a resistance against the explicit declaration of goals through formalized procedures. However, by listening to the taped discussion it seems possible to extrapolate ultimate desires from several samples of implicit wording, understanding and antithesis. To yield ultimate goals it might be feasible to rephrase the formulations and arrange a second exposure in a dialogue for reconsideration.

Instead of enumerating and discussing each national and international network, we shall examine an arbitrary nonexhaustive "menu" of formulated goals, objectives and primary purposes for information as they appear in available literature. The examples were chosen by scanning schemes from OECD, INIS, UNESCO/ICSU's UNISIST, COMECON, ESRO/RECON, COSATI, NAL, MEDLARS,EDUCOM's EDUNET, ERIC, and EUDISED, plus outlines from Canada, Japan, France, U.K., Netherlands, Germany, Hungary, Czechoslovakia, Poland, Yugoslavia and Scandinavian countries. The following list actually represents a mixture of a few higher objectives, some preliminary criteria and operational goals, many intended modes of operation and several presumptive means of eventually achieving some aims of immediate concern.

1. Information services of sciences are primarily intended for scientists, and it should be possible to collect from these all the data that are required - wishes, habits, needs, etc. - to determine a mutually agreed upon "ideal" information system (39).

2. Users are an integral part of the information transfer chain, since they alone should determine its goals and select the appropriate media. Moreover, the users of scientific information are also to a large extent the producers, so that they can exercise a great deal of influence over the form in which it

is generated and directed towards the different channels of information transfer. Users do not form a homogeneous group, with similar patterns of action and common requirements (39).

3. The goal is to connect the generators of spoken, written or other symbolic data with potential users, whoever and wherever they may be (39).

4. The objective can be summarized in one sentence: to bring about an on-going reallocation of responsibilities and resources in the switching process from producers to users of S&T information, on the basis of a continuing scrutiny of the world information complex with regard to unproductive duplications and detrimental gaps (39).

5. Convertibility will be the more general immediate goal, to establish interconnections between systems that are not directly compatible (39).

6. The ultimate goal is to provide individual users in all parts of the world with comparable conditions of remote access to scientific information (39).

7. Decentralization of responsibilities (39).

8. Maximum use of existing organizations and resources (39).

9. Minimum additional bureaucracy (39).

10. Flexibility of interpretation in local distributions of functions within the proposed organizational pattern (39).

11. Develop special need-group services, as close to users as possible (39).

12. The goal must be to assure authoritative, accurate, objective and technically sound information to governments and to industry (OECD) (113).

13. The ultimate technical goal of the EDUCOM system should be to make available answers to standard types of questions in an abbreviated form and with shortest possible turnaround time. The ultimate goal should be a conversational system with relatively short access to answers (15).

14. Sharing of resources (15).

15. Equalizing access to information (15).

16. Accelerating information processing (15).

17. Facilitating long-distance interpersonal interactions (15).

18. Providing better bibliographical services (15).

19. Making lifesaving information instantaneously available (15).

20. Decreasing production of unused copies (15).

21. Decreasing copyright infringement (15).

22. Providing information in a format appropriate for the user (15).

23. Improving continuing education (15).

24. Decreasing administrative delays in higher education (15).

25. Provision of all significant special fields in the country (Hungary) with information (7).

26. Centralized control (7).

27. Planned structure, a rational division of labour and tasks (7).

28. Flow of information in determined directions and ways (7).

29. Technical implements suitable for the tasks (7).

30. Progressive development both of the extension of the network and of the enlargement of the technical implement (7).

31. Prevention of uneconomical parallelism in work (7).

32. Information services for everybody, but first and foremost for the specialists of their own network (7).

33. Professional control of the institutions of their network (7).

34. Covering by the nationwide (Poland) information system of all domains of S&T and economy, and adaptation of information activity and its development to the changeable needs of users (76).

35. Documents should be systematized according to UDC symbols; parallel using of centre's own classification is admitted (76).

36. Author's summaries, made out according to rules accepted by the documentation service, will be published together with any articles inserted in S&T periodicals as well as in books (76).

37. The rules for coordination of foreign (outside Poland) literature purchases will be set, as well as those for making use of literature purchased or acquired in another way (76).

38. The nationwide (Poland) system should assure the full informational communication among the scientific and economic posts (76).

39. The international cooperation can be initiated and carried on directly by the centres of all categories, but with the knowledge of ministerial centres and the CIINTE (76).

40. The S&T associations will enter into cooperation with the appropriate links of the information network (76).

41. A national (Yugoslavia) network of information and communication services with rational and functional subsystems (regional and local), and with a direct link to international and large national information centers, mainly in Europe (122).

42. International-national-local mutually interlinked complexes as a referral center for emission, storage, selection, transmission activities (122).

43. Management and quality control of the indexing inputs (2).

44. Vocabulary development control (2).

45. One level of the (agricultural) network will be nationally (USA) oriented, the other will consist of national or supranational centers which will serve as members of the international network. Each of these will also serve as the principal mode in a national or regional network (71).

46. Control of the system (at NAL) as a whole (71).

47. Main storage for a national (USA) archival collection of documents (in the agricultural field) (71).

48. Provision of timely and effective information and document retrieval capability (71).

49. An information center producing bibliographic tools of national (USA) and, as assigned, international importance (71).

50. The (agricultural) information network should be a dynamic system responsive to user requirements (71).

51. The organizational arrangements of INIS do serve as a model for future activities of this kind (agricultural network) (71).

52. Specific characteristics of an international network are free information flow and access to data bases for current awareness and retrospective search (71).

53. NAL would be a node to EDUCOM's EDUNET (71).

54. Further modernization, expansion and reinforcement of national and language area I&D services for education by working

out and implementing development plans (for EUDISED) similar to those in the field of S&T (34).

55. Preparation of specialized national and regional educational I & D services to become partners in a regional and international cooperative system (34).

56. EUDISED should be considered as one of a number of regional systems within a UNESCO-sponsored worldwide educational documentation and information system (34).

57. Further development of the already existing forms of co-operation in the area of I&D in order to promote S&T economic progress in socialist countries (COMECON) (133).

58. Concentration on coordination of efforts to speed up solutions of problems of methodological and technical nature in documentation and information (133).

59. Improvement of economic effectiveness of I&D activities (133).

60. Training of qualified personnel for I&D work (133).

61. Promoting broad international cooperation through active participation in the work of the appropriate international organizations (133).

62. Joint research projects in the area of I&D (133).

63. Participation in conferences on I&D (133).

64. It should be a national (USA) objective to attain economical and easy access to every significant article produced by the world's scientific community (51).

65. Our system (COSATI) should be capable of telling what is available in the world, point out the data store that offers

the best data pertinent to one's problem, and how to gain access to this store (51).

66. For the sake of progress, we need to agree on who should have the national (USA) responsibility for the formulation of national policies with respect to the scientific and technical information systems (51).

67. Centralization of basic abstracting and indexing services for the world of S&T literature (4).

68. Improvement of I&D delivery through the development of regional services adapted to the interest profiles of local research institutes and industrial organizations and the use of modern techniques (e.g., SDI) (4).

69. Development of consolidation services (4).

70. Special libraries for S&T (4).

71. Translation services (4).

72. Extensive use of sophisticated indexing languages, using UDC for broad subject categorization (4).

73. Development of the All-Union Information Center on R&D in progress (4).

74. State Service of Standards Data (4).

75. Emphasis on the advantage of mechanized techniques (4).

76. Support of further research on many components of information switching (4).

77. Utility of special programs for the popularization of science (4).

78. Improvements of the status and proficiency of information scientists (4).

This list of course contains several overlapping statements, some of which represent means rather than ends. In addition, quite a few declarations have aspects that are controversial, e.g.:

- Centralization vs. Decentralization
- Regional or national vs. Supranational data bases
- Control and capping vs. Free flow of information
- Monolithic vs. Multilateral management supervision
- Institutionalization vs. Bureaucracy reduction
- Enlargement of existing organizations vs. On-going reallocation of responsibilities and resources

Although the human elements of information networks are mentioned in brief, the majority of items represents management's operational criteria:

- Coverage
- Availability
- Accessibility
- Response time
- Overlap avoidance
- Switching
- Cost reduction

In addition, design objectives would have to be developed which incorporate such users' constraints as:

- Timeliness
- Serviceability
- Convenience
- Presentation
- Form of output
- Privacy
- Urgency
- Priorities
- Recall
- Precision
- Quality
- Motivation
- Instructiveness

For the matter of overall network problems the listed formulations give partial answers to the questions What? and How?, while Why? Where? When? for Whom? by Whom? remain open to discuss.

Research on users' needs and behavior remains an important challenge explored partly in earlier work (12, 41, 130). There also exist explicit declarations on principles for improving engineer/scientist productivity (97) and several ways to prevent inhibition of creative research (28). The following obstacles were claimed nondesirable:

- publications imperialism
- planning imperialism

- organizational imperialism
- mathematical imperialism
- inadequate communications
- data storage, reduction and filing
- repetitive, standardized procedures which are out of date
- administration and organization of details
- handling service calls
- redundant paperwork: keeping and maintaining historical records, memos, jobs status, etc.
- superfluous reporting: nontechnical progress reports; routine reports required by government; rewrite of corrected reports; preparation of preliminary reports; time-consuming documentation of communications
- management's lack of decisive goals and of steady progress toward them; confused definition of company policies; arbitrary attitudes of administrators who have not made investigation and refuse to listen to those who have

Those are some of the items which should be considered in a well-defined goal structure and means-end analysis for automated information networks, communications and future computer utilities in order to improve the S&T users' situation.

Current International Network Planning

Among the many reasons which have been claimed to prove the feasibility (39) of information networks is the fact that among specialized literature a 75-percent overlap of document-indexed input for storage has been estimated (72). A brief survey of the 51 most common secondary services for tapes with surrogates (descriptors, abstracts, titles, citations etc.) reveals that the major bulk of machine-readable material comes from 31 U.S. packages, while a smaller volume is found among 20 varieties from the western world (Table 1).

Beside this list of secondary services (52, 118) there exists a full spectrum of primary processors/services/publishers, mediators/searchers/editors/procurists, and tertiary repackaging (synthesis/consolidation/IR/SDI)all the way to "n"--ary reprocessors. The multitude of transducers might result in such complexity that several users prefer to interact directly with information producers/sources (Figure 1.). It is not at all self-evident that interlinkage and growth of existing services (93) into networks will yield benefits and favorable procedures even if feasible. Perhaps S&T information users are better served by direct relations through communicators such as radio, TV, ETV, ITV, ITFS, picturephones and AV-media (14, 35).

Table 1.
Sources of Machine-Readable Material for Tapes with Surrogates

Package or Institution	Country	Package or Institution	Country
AERESS	UK	INIS	Austria
API	USA	INSPEC	UK
ASM	USA	INTREDIS	USA
BNB	UK	ISI (citation)	USA
BIOSIS	USA	ISI (source)	USA
BJA	USA	MARC	USA
CAC	USA	MEDLARS	USA
CBAC	USA	MRGRBI	USA
CCM	USA	MSDC	UK
CFSTI	USA	NAL	USA
CITE	USA	NDC	USA
COMPENDEX	USA	NISP	USA
CREDOC	Belgium	NSA	USA
CT	USA	NSL	Canada
DCST	Sweden	PANDEX	USA
DDC	USA	PLASDOC	UK
DTL	Denmark	POST	USA
EM	Netherlands	PULSP	USA
EMCDL	Netherlands	RINGDOC	UK
ENDS	Luxemburg	SIE	USA
ERIC	USA	SRD	Germany
GCL	USA	STIMS	USA
HRP	USA	STUR	Germany
IBS	UK	UCL	UK
IC	USA	ZAR	Germany
IDC	Germany		

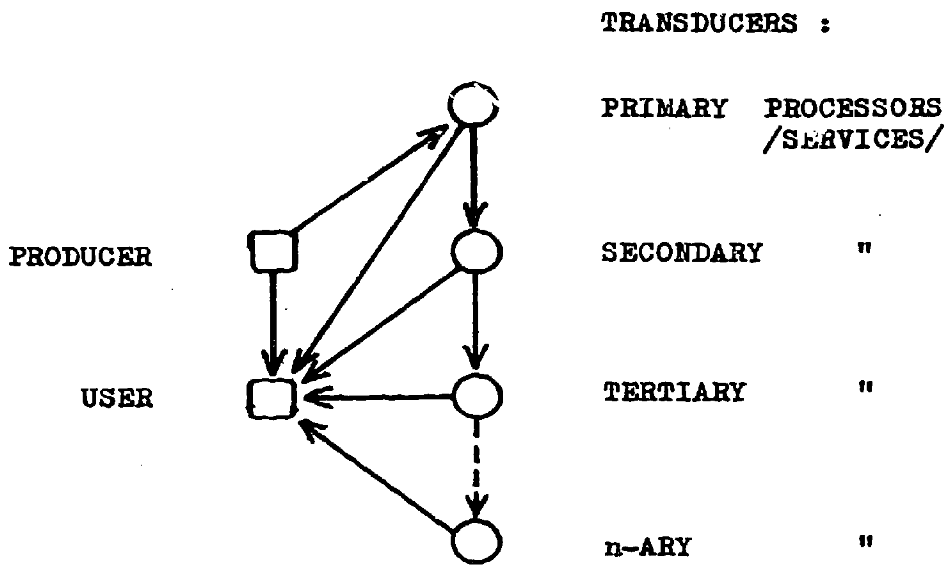

Fig. 1 Communication via recorded media.

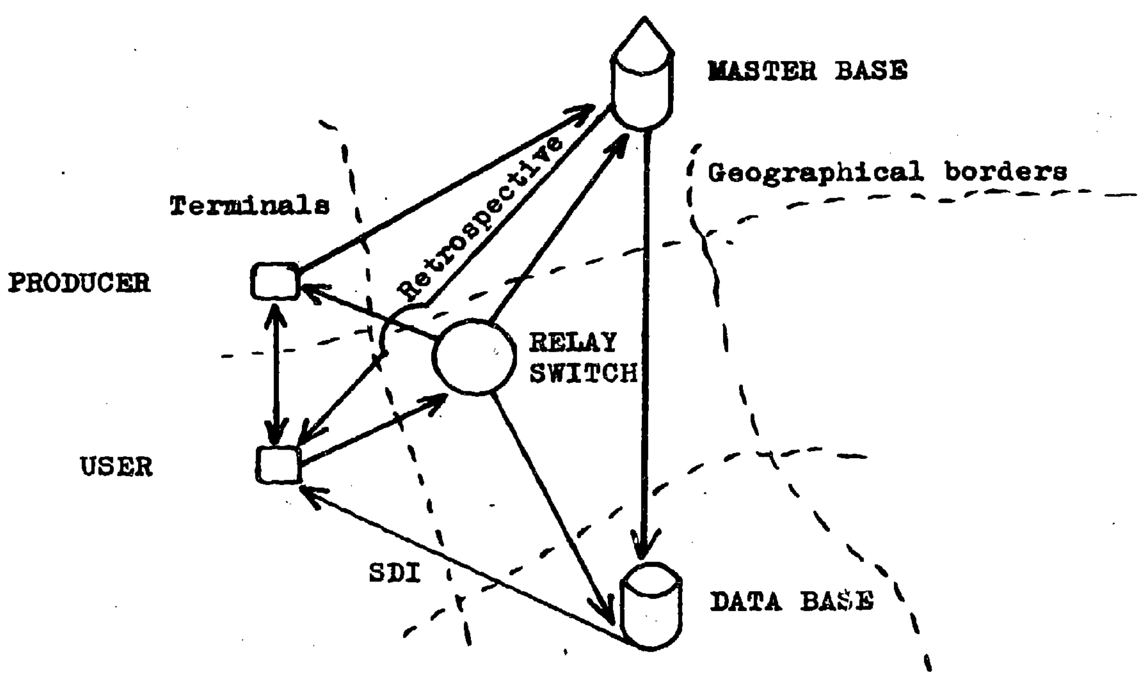

Fig. 2 Current minimal information network.

Compatibility/convertibility for hardware, telecommunications and formats may possibly come of age, but it is not certain that contents overlap will disappear. The current picture of network interconnections between user terminals and data bases tapped from master bases has been described in previous studies (112, 113). There is an obvious need for relay switches and referral directories to serve as locators among the many diversified bases. As we proceed toward a general computer utility we may compare the ever-changing placing of installations with electrical power supply (20), which will always be available for plug-in usage even though new computer generations arrive and disappear (45, 107). Because of the more complicated procedures for maintenance/housekeeping and purging/updating/downdating, the physical location of master bases, data bases and personnel is more of a basic problem.

The major distinctions between national and worldwide information networks are due to global time-zone and geolinguistic factors. At present the minimum number of components may interact as shown in Figure 2. In order to provide for fall-back and economize toward "infinite" storage, a configuration trend such as Figure 3 is possible. The drawbacks of global time-zone differences could be turned into an advantage of triple fall-back facilities (Figure 4). A manifold of hybrid structures is plausible in worldwide network thinking based on the use of relay switches and referral directories. At an advanced stage this could lead to service-routing (Figure 5)

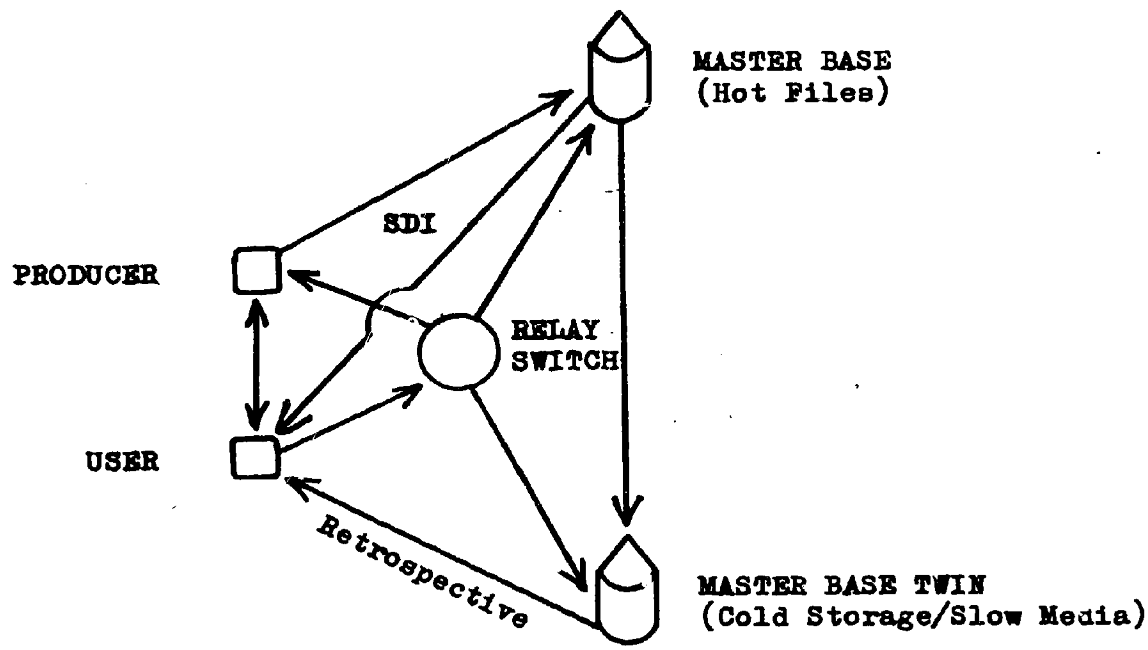

Fig. 3 Supranational allocation of information resources.

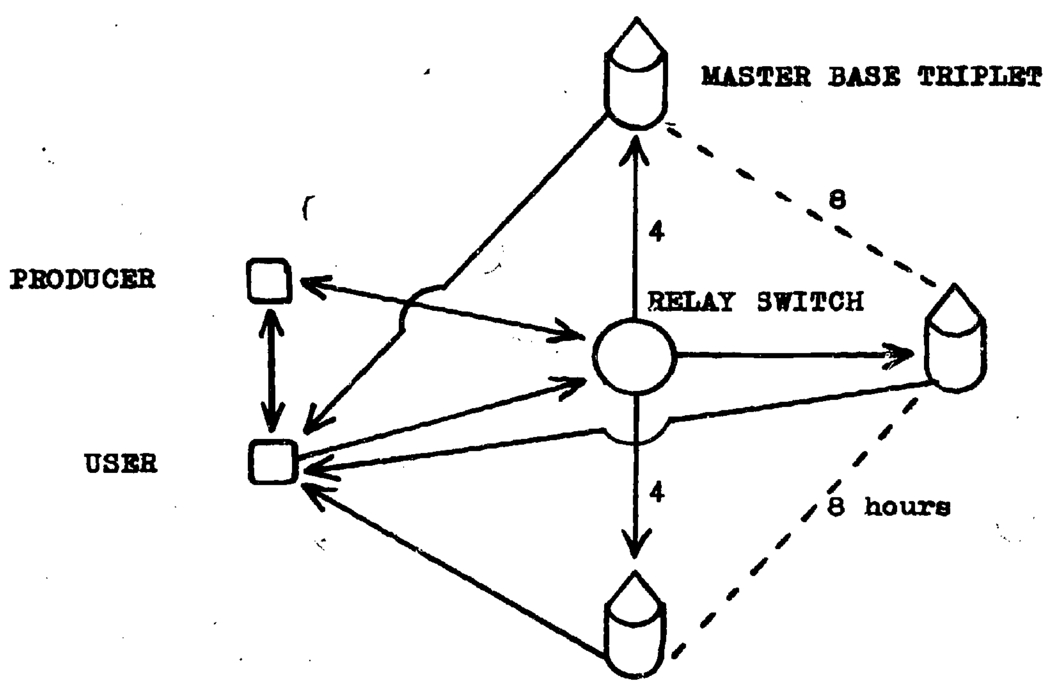

Fig. 4 Triple fall-back and eight hour global time-zone difference between master bases.

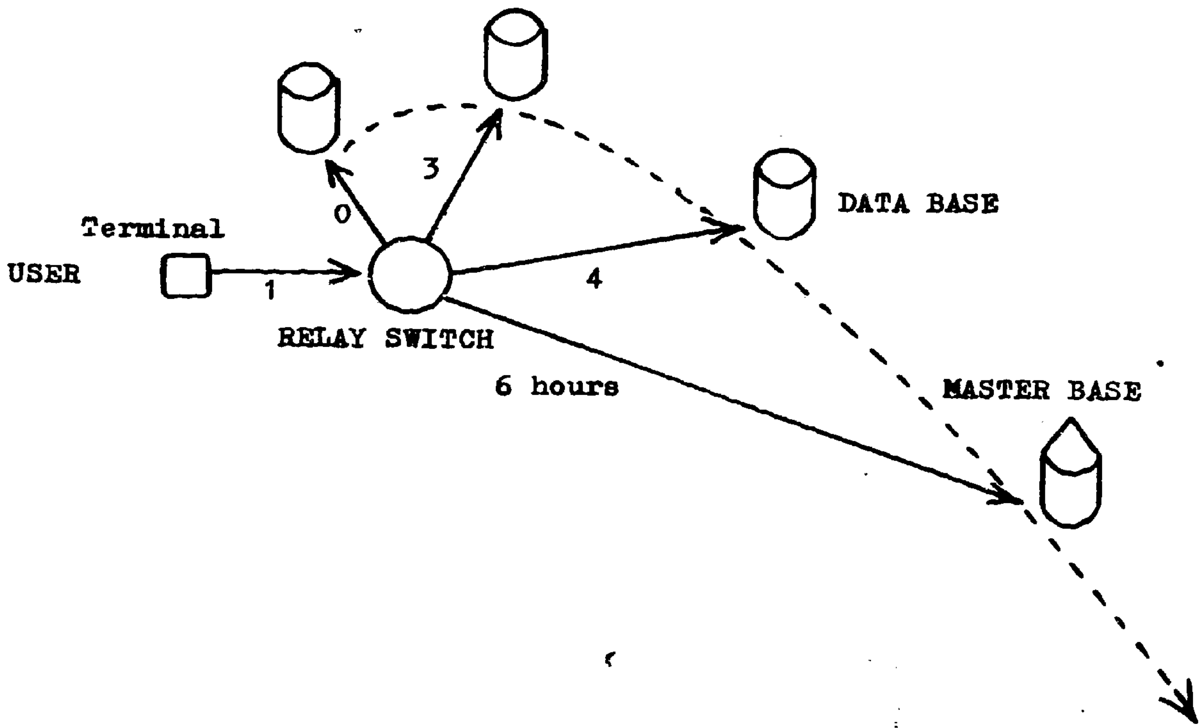

Fig. 5 Search-routing to data bases via relay switch.

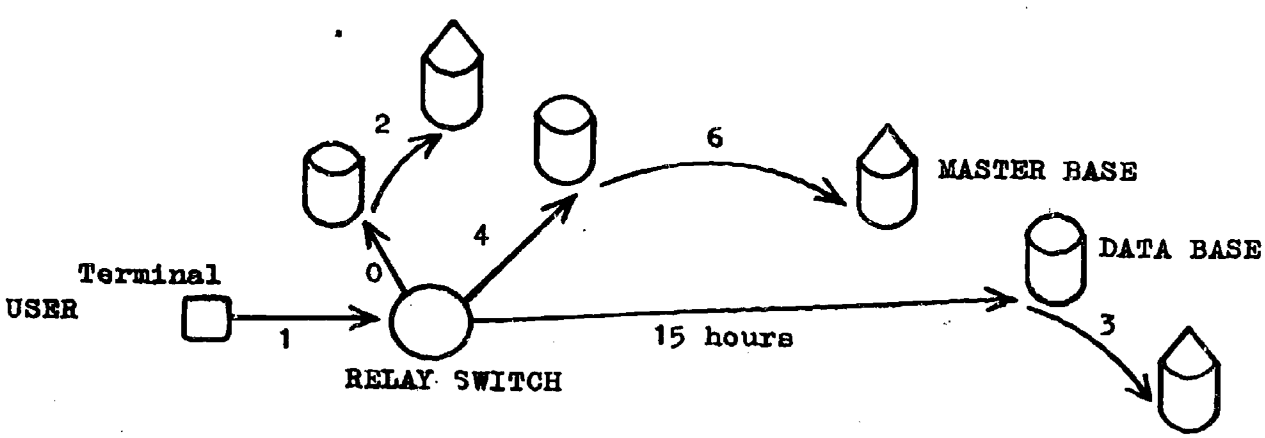

Fig. 6 Expanded search-routing via relay switch and referral directories.

and explosive searches through data bases which are operational in widely separated geographical areas (Figure 6).

The work toward a network structural solution is not to be considered as an optimizing task but rather as a problem of satisfying or creating executively optimal conditions. Traditional simulation, transportation theory and graph theoretical methods (49) or recent algorithms used for library networks (6, 22, 31, 86, 92, 94) seem less applicable in an international environment. Therefore, heuristics, bargaining (111) and a systems approach in policy-making would be feasible when economy is not the single crucial factor, but prevailing instead are political science parameters and less tangible constraints such as:

- strategic value of information
- financial responsibility
- patronage/ownership/possessiveness
- national prestige/pride
- disciplinary esteem/envy

Were it not for the strategic (109, 111, 132) nature of information, worldwide network planning could be approached by treating the usual factors: time, cost, volume, capacity and geographical distance. In our early studies there were more than 80 formalized systems design concepts, parameters and variables for automated international information networks, (112, 113, 114) and this number will increase.

While data bases, their structuring and management have been described repeatedly (45, 67, 78), the two locator components, relay switches and referral directories, deserve a closer description (114). To find one's way between interconnected master bases and data bases, one needs devices and rules-of-thumb to determine: who has how much of what, where it is, and how to obtain it. The relay switch is a frequently updated specialized data base of locator files which can be run close to or at a distance from some other master base or data base. The function is basically a table-look-up in a referral directory which is also released as a shorter hard-copy version. It indicates year span and approximate number of items. The subject contents are described at meta-level entries which allow crude concordances between diversified multiclassificatory concept notations and thesauri featuring UDC, LC, COSATI, EURATOM, ALD, NASA, TEST, IEEE, MeSH, LEX etc. A recent book (85) on its cover proclaims "The modern library and the death of the Dewey decimal system," which may eventually occur. However, a revenant classification, ordering or organizing principle is bound to "walk the earth's future mediatheques" by a different pseudonym as publishers and other primary services supply microforms and newer media which are pre-indexed at the source to facilitate detailed searches. History will recur and again logistics, topology or file-usage frequency call for practical, task-oriented class-partitioning and pragmatic, functional grouping into "fuzzy" subsystems

(109, 114) so that the computer operators/technicians at least can read "mnemo-labels" and load-requested, interchangeable disc-packs, tape reels, strips and other recorded information carriers.

Due to rapid changes and growing complexity it becomes practically impossible to handle an unsurveyable global maintenance of thesauri and vocabularies with universally consistent procedures. The updating/housekeeping jobs are manageable when performed at the particular master bases within each discipline. It is of little practical use to look for detailed concordances, transformations, conversions and distinct relators between all the vocabularies. Instead it is imperative to arrive at crisp, formalized definitions of coupling points for subsystems linkage. The task of finding, knowing and identifying these points so that they become perceivable is another matter of interdisciplinary systems analysis.

Towards Global Information Transfer and Network Communication

The planning and course of action for worldwide information networks and the implementation of proposed solutions should be pursued in agreement both with overall objectives and technological forecasting. This means that the evolutionary steps of chained events has to occur at a pace which takes into consideration not only feasibility but also desirability (5, 56, 57, 59). A crude picture (Figure 7) of the major information science events for the next 25 years can be summarized by examining available Delphi studies and other predictions (5, 10, 47, 59, 98, 126). It is emphasized that it will be partially up to our own choice to influence the development rate by sponsoring a particular R&D phase in the future. By linkage of many different national information systems into networks a whole world might be bound to a technology which will be passé before an overall integrated, operational stage has been reached.

On the other hand we could, and should, listen to the ultimate desires of the users - and there is a difference between the individual user and large user groups (39). This can lead to decisions such as: "Let us do R&D and run experimental operations and test implementation in national/regional areas while we save our resources from being spent exhaustively on today's premature surrogate techniques." Quite obviously users agree that neither abstracts with bibliographic references nor microforms are final operational goals and therefore increased

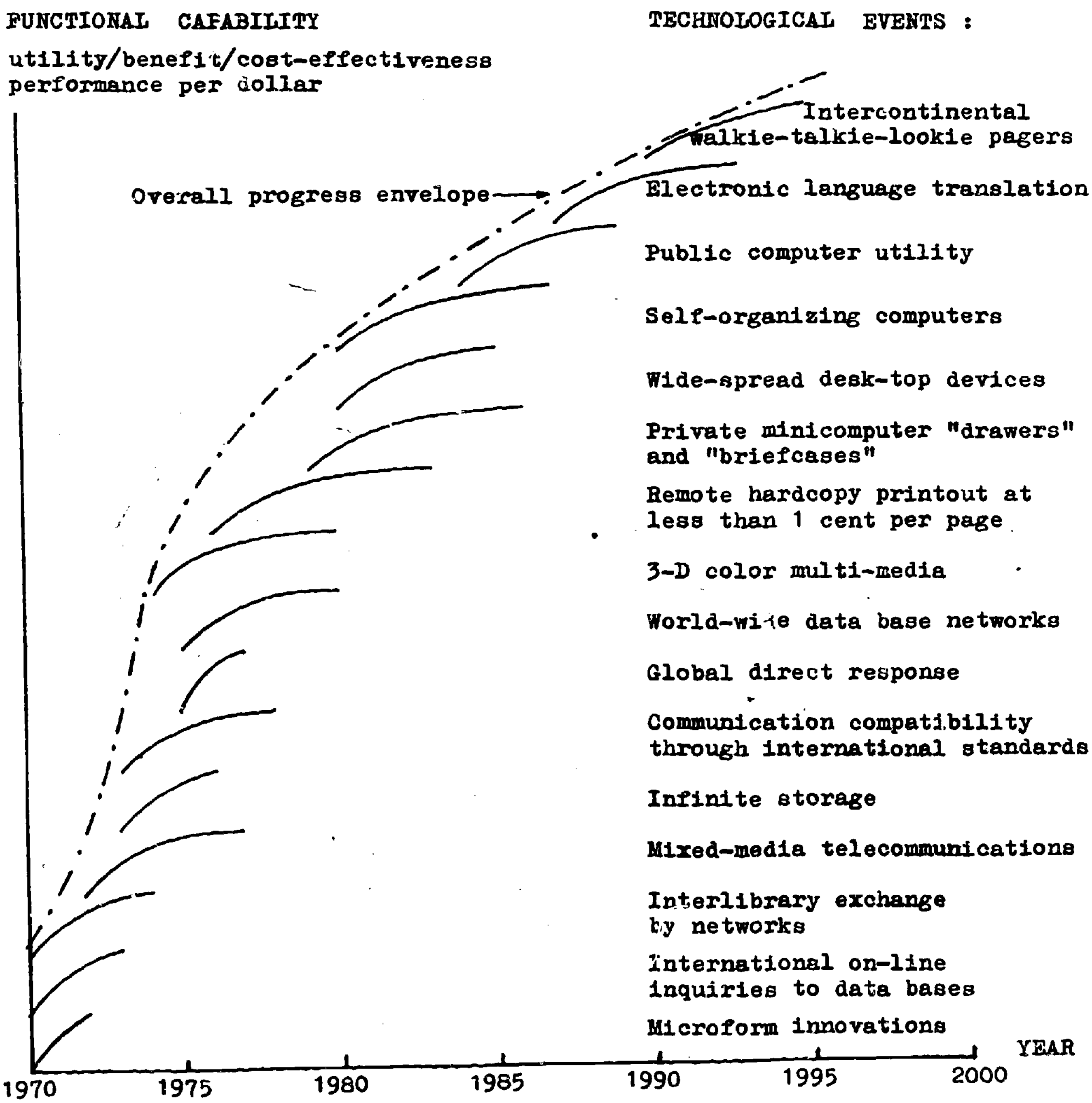

Fig. 7 Forecasting information network-related events.

sponsoring of the "invisible colleges" would be welcome by using intercontinental TV conferences and other new media in addition to quarterly travels. One will necessarily have to present substantial facts as counterevidence before labelling as "unrealistic" or "impractical" the following statements by a "Devil's Advocate" scientist or engineer (goals 1., 2., 3., 9., 17., 20., 23., 24., 52., 59., 63., 77., 78., of the list):

- increase the support of "invisible colleges" from existing research funds.
- allocate 40 percent of the scientist's yearly income to conference participation, travel, personal book and journal copies, intercontinental phone calls (27). These actions might cut his work time spent on literature and search from 40 to 5 percent and eventually almost turn him into a "nonreader".
- "tear off" a lot of "read tape" and stop "personal prestige and game-playing" within hierarchical organizations so that informal communication and personal contacts are improved (44, 100).
- organize regional, professional TV conferences and mixed-media workshops for large professional groups (35). Thus, to the benefits of information search will be added an "on the spot" learning

effect. In addition, inquiries by future scientists searching for information could be referred to recent conference participants to facilitate information availability and accessibility.

Given these kinds of support, scientific groups are goal-seeking, self-organizing and highly efficient information utilizers.

While waiting for the requested goal structure, facts and figures, one may say that global S&T information is still only a subset of the entire world information and could perhaps be partially handled in such an informal manner with full information and be cost-effective. The first on-line information networks to come tend mainly to be operational only for bibliographic references or abstracts rather than for full information. A higher level of ambition will comprise full, mixed-media transfer and justify the term "automated knowledge network." Until then, the "invisible colleges" do call for better sponsoring. Networking of full information at the relay switches will require pragmatic, mission-oriented tags and structural organization segmented so as to allocate "unit information" (109). This aspect of information has been investigated in a similar philosophical way by a few different scientists:

- "elementary message" consists of the identification of the system point, the moment of time, and measure of one of the state variables of the system in the point, as well as identification of the kind of this state variable (e-messages constituting e-concepts on e-records in e-files) (Langefors (67)).
- "informon" is a quantum of information, and flow of information for decision-making gives an uncertainty reduction (Yovitz and Ernst (132)).
- "information chunk" is the smallest identifiable unit of task-required information which, if further segmented would lose its identification and meaning with respect to the task (Berul and Karson (12)).

The possibilities of carrying into effect the higher aspirations for information networks is very much a function of how fast global telecommunication progresses as agreed by the many bodies involved: INTELSAT, COMSAT, CCIT, OECD, CEPT of EEC, ITU, EBU, IEC, ISO etc. When an agreement on 10-year planning becomes substantial it will be feasible to schedule the implementation of information network innovations. Adequate committee representation by information scientists and systems analysts might actually make it possible to formalize an information policy which can plan on "skipping" a few evolutionary low-ambition events which have too short a life cycle (Figure 7), e.g., reduce the ever-increasing card catalogue printing. Meanwhile it will be possible to increase the cost-effectiveness of existing installations (libraries, data bases, computers, communication traffic, service hours, etc.) to their tolerable level of maximum performance. This action is recommendable prior to an expansion of buildings, staff and other nonmodular investments which represent point rationalization and vain efforts to handle the ever growing workload by means of dated facilities. Committee representatives could also forward warnings against widespread exploitation of future bottlenecks, i.e., picture phones with undersized display screens, insufficient resolution and too few bits per square inch.

Trend-watching can be hazardous, as trends are not always beneficial or right. Furthermore, any institution, building, center, staff, computer, standardized format, periodical or "n"--ary service is a commitment. Why institutionalize when information will flow freely anyway? Unimaginative planning could lead to an overly ambitious establishment of surrogate productions and hierarchical (100, 110, 127) bureaucracies whereby the evolutionary benefit curve is flattened to the degree of deterioration, i.e., according to Parkinson, paper feeds paper (and the printing offices). The innovation steps and product life-cycles are partially chained in the sense that investments and support come from the same global budget set aside for I&D. Looking back only 5 years to 1965 one may recall that an extensive number of projects (symbol manipulation, parsing, tape handling, compilers, homemade languages) were never implemented. How many of today's semiautomated network dreams in capping agencies and administrative boards will ever come true? In fact, how many personal-institutional relationships will last actively more than 5 years? Implementation of operational services may be an important decision, but it is equally important to know when to give up dated routines, surrogates and storage. Marketing and promotion cannot sell inferior products and poor service when there exist more convenienct ways for scientists to obtain paperless knowledge availability. Many of the jog trot ways in hierarchical corporate structures are symptomatic and cause excessive reporting which enters the public S&T information domain and is never downdated by the authors themselves or eliminated through quality control procedures. Thus far, in most existing network schemes, the authors and producers have been left out, but should be brought into the scene. Apparently there exists a whole set of missing links which have to be traced, discovered and integrated by means of systems analysis and formalized procedures.

It has too often been claimed that overlap of information should be avoided. Some costs will be saved if a reduction of overlapping information input can be achieved, but certain overlapping (regional, interscientific, unidisciplinary) could be turned into an asset for quality control, checking and parallel systems performance evaluation. Overlapping information storage and service are quite desirable and, if eliminated, could lead to a negative chain reaction (80):

Decreased overlap→Increased relay-switching

Longer routing-search time→Growing complexity

Heavy station workload→Increased communication costs.

The existence of master base twins and triplets will help to relieve political tensions as well, but the decisions on location will remain crucial. It is understandable that the decentralized build-up of INIS has had such an enthusiastic international reception (19, 42, 64). Even in decentralized planning (60, 91, 99) the general question remains of whether master bases, relay switches, "n"--ary information processors and nodes for consolidation should be placed near technology transfer centers (39) in developing areas or rather with respect to operations economic constraints like communication and geolinguistic or geopolitical factors. An intended progression will be inhibited if one continues to squeeze a majority of information through computers, teletypes and keyboards instead of promoting multiple, mixed telemedia. A picture can say more than a thousand words of textual strings. Considering the networking task in the light of corporate structuring and management science it appears that construction at the operational level from modular, decentralized subsystems is theoretically correct even when integrated control is an aim (1, 57, 110) - a design principle which is preferred to branching off from a primarily centralized directive hierarchy. This principle applies to supranational bodies, capping agencies or steering units as well.

In summary, the international list of goal-oriented statements, which "ad hoc" has more than 78 items, will have to be thoroughly structured by using systems analysis methods (1, 13, 56, 57, 68, 69, 70, 101, 103). An exhaustive list of ultimate desires is essential and must be made subject to structuring and comparison with crude goals through iterated procedures. There exist various approaches for outlining goal functions, one (70) of which will serve as an example:

- performance goals
- coordination goals
- development potential goals
- constraints

Our previous 78-item list lends itself well to such partitioning. The next step will be to determine priorities and formalize priorities scheduling.

Most of the objectives listed thus far are normative from a management standpoint, whereas user viewpoints are left for future exploratory studies. The set of performance goals from an overall interdisciplinary user population is probably smaller and more definitive than the set of contradictory and divergent subgoals in a multitude of existing managements, hierarchical official bodies and organizational artifacts.

The universal case for worldwide, automated information networks is realistic, considering manager/producer feasibility. Approximate scheduling can be estimated by using systems analysis and technological forecasting as outlined above so that implementation will concur in pace with future innovations. Satisfactory efforts and sufficient support in order to meet desirability as indicated by the users of information remain open-ended challenges. Hopefully there will be a harmonious balance between feasibility and desirability for worldwide information networks by the end of this decade.

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