The Charter: A "Must" for Effective Information System Planning and Design*

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This is a research report. None of the research was performed by the author, and nothing reported in this paper is new. It is the product of research work by information center managers, information system supervisors, technical report file custodians, and others who undertook information storage and retrieval efforts in many different situations. These people did their research the hard way. To avoid mistakes in planning and design, many of them visited other organizations to observe more experienced designers and planners and their operations. Often those being observed had done their research the hard way, and building on this kind of experience can result in more research the hard way.

This paper is an attempt to cumulate in one document some principles of information system design and planning. These principles have been developed from observations of what was done and what was not done in a number of evolving system situations. The principles enumerated in this paper and systematized in a charter can be used as guides during the developmental phases of information systems. Planning and design will be more effective if a charter is used. The work of other designers and planners then can be observed more profitably, and more workable charter revisions can be made.

The charter should be written before work is undertaken with the understanding that it can be revised as needs dictate and as work progresses. A charter should be only a framework, a flexible guide.

This paper presents a list of suggested topics to think about in drawing up a charter. The list may not be complete for every proposed system, and in some situations not all of the points discussed need be included. The suggested topics can be considered either before undertaking system design or planning, or at the time of review of a system to determine its quality of approach and adequacy of direction and service. Some of the considerations are broadly applicable to installation of any service—others are highly information system oriented.

Some of the material presented here has been published by other authors.

There are 13 more or less specific categories of subjects to be considered and a broad area of "General Principles." The specific areas of consideration are the User Group, Coverage, Service, Organization, Personnel, Physical Facilities, Document Storage, Control, Quality Control, Scheduling, Mechanization, Compatibility, and Adaptability. Some repetitious discussion will be noticed. This

was done purposely, since different aspects of some points warranted attention in more than one category.

General Principles.—The charter should include a statement of why a system is needed. This may be comparable to a preamble or a credo. It may be based either on directives from management instructing that a system be established, or it can be prepared by system supervision to enable higher management to verbalize their intuitive feeling that a system should be established. It may be developed to sell higher management on the benefits and advantages to be derived. If such a statement cannot be written and defended, it may just be that a system is not needed in the particular situation.

For the guidance of system personnel, there should be a statement of objectives of the organization being served. This type of statement should serve to guide the patterning of the system to reflect the over-all organizational objectives and to limit and control system size.

A statement should be included to specify the principle that a technique or procedure used initially can be abandoned later if found to be unnecessary, ineffective, or too costly, but that if use of a technique or procedure is postponed "until later after we see if it is necessary," it may be too costly to go back to attempt to apply it to that which has already been accomplished.

Management's viewpoint concerning scientists and their literature searches should be specified. Should scientists be required to conduct their own literature searches? Should scientists be required to depend on information specialists for their literature searches? Should it be permissible either way? If information system specialists are to do some or all of the searching, there should be no policy barriers erected between the scientists and their literature which would deny them their right to browse and to discover potential research directions.

The charter should include a statement of principle that equipment selection should be dependent upon and should follow the selection of the philosophical approach for information storage and retrieval rather than forcing the selection of approach to be dependent upon equipment availability. Too often system approach is selected primarily because of observed equipment usage for entirely dissimilar system requirements, or on the volubility of equipment salesmen or equipment systems engineers.

Management should make some provision for compulsory usage. For example, scientists and their supervisors should be required to search the stored information thoroughly and state that they have done so before submitting reason sheets as requests for research fund authorization and before submitting patent applications for approval.

More and more new information indexes and services are becoming available, most of these covering primarily externally generated literature. Among those now well established are *Current Contents*, the University of Tulsa *Petroleum Abstracts*, the *Index to Chemical Patents*, *Index Chemicus*, the Defense Metals Information Center at Battelle Memorial Institute, and the *Battelle Technical Review*. Local information systems should operate on the principle that duplication of effort will be minimized by making maximum use of such generally available indexes and sources until it is found that they do not meet specific internal needs.

In planning and designing a system to serve an internal staff of scientists and engineers, use should be made of external aids and guides, such as "The Naming and Indexing of Chemical Compounds" by *Chemical Abstracts*, the "Thesaurus" of the American Institute of Chemical Engineers, and the ASTIA "Thesaurus of Descriptors." A charter statement should acknowledge that these aids and guides were developed for application in *external* organizations, and therefore they should be used only as guides and not as authorities. The statement should direct that no variations from these aids and guides should be permitted to develop locally if they will be obstacles to input to the local system from the external sources which use the aids and guides. In this way, a local system can economically provide access to much of the pertinent external literature for its user group.

The charter should include provision for modification and amendment and should specify procedures by which this can be accomplished. In this statement the nature of the charter as a guide should be specified and that it should be revised, amended, and modified as experience and system maturity dictate.

The personnel involved in system installation and operation will be in a unique position to observe and make recommendations concerning certain organizational activities which may not be strictly information system elements. The charter should make it possible for the organization to take advantage of these recommendations concerning: improvement in research reporting; reduction in size or number of reports; formality, content, and quality of content in reports; delay times involved in printing and publication; typing procedures; report formats; and reporting procedures.

The charter should provide that personnel involved in system operation periodically (perhaps monthly) review and check the provisions of the charter and take steps either to amend the charter to conform to practice or to keep practice in line with the provisions of the charter. This is probably more important in developmental stages than after the system has matured. After operating procedures have stabilized, review sessions will be less profitable and should be held less frequently.

Both for the benefit of upper levels of management and for those actually involved in system operation, there should be provision for periodic major program evaluations, perhaps annually or semiannually. Frequency should be dependent upon system maturity.

Finally, to minimize misunderstanding, the charter should include a glossary of the terms used in it. Particular attention should be given to those words which have special meaning in information storage and retrieval.

Only with a glossary can there be reasonable assurance that provisions will have the same meaning to all.

User Group.—An effective means for controlling the size and rate of growth of an information system is to specify clearly at the time the system is established who will be included in and who will be excluded from the user group. For example, if a system is being established to serve the engineers and scientists in a research organization, the list of users to be excluded from the service might include those in the accounting, marketing, public relations, personnel, sales, technical sales assistance, and market analysis functions. The purpose of specifying what functions will be included in and excluded from the user group is primarily to limit coverage of the system and to minimize acquisition of documents of low value and little interest to the function(s) the system is to serve. Requests for service from personnel in the excluded functions should be processed provided they understand that the system has been designed to serve a specific, limited user group and the information they seek may not be available. Information systems for accounting, marketing, public relations, personnel, and other functions are certainly justifiable and may well be incorporated with the system for the technical and scientific functions. If optimum service and return with minimum input cost is an objective, the user group must be limited to those functions which can derive maximum benefit.

The application of arbitrary, strict standards of document acquisition, selection, and screening should be regulated by a charter provision so that the system will not provide only for the more knowledgeable or longer service employees to the detriment of the younger, less experienced employees who may in fact have greater need for information.

To assure that they will use the system after it is in operation, members of the user group should be involved in preoperational phases. For example, future users may be utilized in screening, abstracting, indexing, or vocabulary editing operations, perhaps not as production workers but as sources of expert technical knowledge to aid information system personnel. After future users become familiar with the objectives and operation of the system, they can be urged or required to furnish suggested indexing terms along with documents they author to assist those who actually do the indexing. The more the future users are utilized and involved as the system is developing, the stronger will be their interest and the greater will be their confidence.

Provisions should be made for a planned program of announcements of progress prior to the system's becoming operational. Subjects of announcements might include anticipated target dates, coverage, the analytical approach being used in information analysis, how the system will operate, and types of service. A well-planned program of familiarization and indoctrination sessions should be held after the system becomes operational, providing actual drill in use and demonstrations of how services will be provided.

Identification of the user group by specifically including and excluding functions to be served exercises a realistic restraint on creeping system expansion. A well-planned program of orientation and familiarization, preceded by involvement and utilization of the users in the develop-

mental stages, greatly encourages confidence and patronage.

Coverage.—There may well be justification to specify in the charter which specific scientific or technical areas will be serviced and those which will not. Certain sciences or technologies may be represented by so few potential users in the organization, and the literature in which they are interested may be so large and complex, that effective coverage and service would be excessively costly. No internal system can hope to give thorough coverage to all areas of interest to its potential users. Therefore, the areas selected should be those for which the system can hope to provide broad coverage with maximum anticipated benefit or return.

Coverage should be specified in the charter not only in terms of content as related to specific sciences or technologies but also in terms of transience. For example, a specification should be made regarding inclusion of interim reports, preliminary reports, and progress reports, particularly if supplemented or replaced by final reports. Final reports may be so long in issuing that interim or preliminary reports should be included. Since every effort should be taken to assure that duplicate information is not stored, this may mean initially indexing the interim, progress, or preliminary reports and subsequently removing them and their index data when the final report is issued.

Specification of coverage may result in screening documents not only for content and transience but also for legal or historical value. These standards for screening should be detailed in the charter.

If an organization is of sufficient size to warrant operation of several information systems, perhaps for different departments or locations, it will be economical and efficient to divide among the systems responsibility for monitoring external sources. Duplicate abstracting and indexing of externally generated information is thus controlled. When there is only one information center and a large number of journals to be monitored, these can be assigned to individuals for screening and selection of input. If this procedure is employed, steps should be taken to assure that each monitor screens and selects for the interests and needs of the entire user group, not just his own.

Provisions should be made for an aggressive program of source monitoring, for example, to identify additional serials for subscription. This can be accomplished in part by noting journals referenced in the articles selected by monitors. It should be a stated information system responsibility to seek out new sources for coverage.

It may be perfectly legitimate for an information system to include all types of documents which contain information of interest to the user group. However, if a number of specific sciences or technologies are selected for coverage, and the system serves a large user group, the number of different types of documents which could be included might be very large, making input costs prohibitive. The charter should provide an order in which types of documents would be covered, such as: first, internally generated research reports; second, internally generated technical memoranda; third, selected articles from professional journals comparable in content to internal reports; fourth, patents; fifth, research reports from governmental or nonprofit institutions. Consideration of documents by type should be based on worth or value of individual documents in the type to the user group. Only with an attack planned in this manner can a search for information on any subject be considered complete within any type of document.

One way to assure a high quality of input to an information system, and hence coverage, is to specify the minimum level of audience direction of candidate articles. For example, articles in a specialized area of biology written for biologists specialized in that area have far different value to users than articles pertaining to that specialized area of biology but written for a readership composed of social scientists. The charter should clearly define standards by which articles are screened based on the treatment accorded subjects in reference to the needs of the particular user population.

There should be a provision in the charter to indicate whether the system will include only current acquisitions, such as reports of research as they are completed, or whether it will include in addition either the backlog of comparable documents, or projects currently in progress, or both. If backlog is to be included along with current acquisitions, then each backlog document should be carefully screened so that its residual value is at least as great as the minimum value documents selected from current acquisitions. Specifically reports on abandoned areas of research or discontinued product lines may properly be excluded. Careful consideration should be given to excluding documents which were produced during periods when only successful research was formally reported. In a system which provides for including interim or preliminary reports and then subsequently removing them from the system when the final report is issued, consideration should be given to including access to research projects in progress but not as yet reported on. To accomplish this, index periodically either laboratory notebooks or the documents in which the proposed research projects were detailed for the purpose of obtaining funds. Systems providing for retrieval of work in progress are capable of locating information not only in the less valuable, historical documents but also provide access to information as it is being generated.

Service.—The charter should specify whether the organization being set up will function as an archive, a library, an information system, an information service, or an information center. This enables users to know what they may and may not expect in the line of service. As a minimum, an information system will furnish a user with a document reference. If more sophisticated service is to be provided, the user should know whether he will receive an abstract, an extract, the document itself, or a state-of-the-art summary when a number of documents contain information pertinent to his request. The charter should clearly define what will be delivered to the user and the form in which it will be presented. Whether the system is to retrieve references, abstracts, extracts, or the original sources themselves will be a major factor governing selection of storage equipment.

The charter should specify whether the individual scientist or engineer must conduct his own searches or whether he can have his searches conducted for him by an information center specialist. This was discussed in greater detail in "General Principles."

There should be a statement indicating whether indexes

to the information will be printed and disseminated, or whether the index will be stored at one central location, such as on computer tape, uniterm cards, or optical coincidence cards. Decisions in this area will have a significant effect on quality and speed of service and on selection of equipment.

The charter should specify if documents are to be abstracted, and if they are, in what form and how frequently an abstract announcement will be prepared.

The charter should define the responsibility of information system personnel for qualitatively screening retrieved documents or whether the determination of pertinence will be left to the users themselves. A clear understanding of just exactly how much screening of output will be provided will create a much better psychological reaction among the users, particularly if a retrieval approach is used which will produce high ratios of false retrievals.

The charter should clearly define limits of extended services such as selective dissemination, permuted title indexes, preparation of the state-of-the-art summaries, or preparation of periodic topical bibliographies.

The charter should specify the extent to which a request for information will include a search for what is available externally, not only through purchased indexes, but also through direct contacts with other information organizations.

The problem of priority of services may present itself. An active information center may find itself confronted with problems of scheduling and assigning priorities to conduct of searches, selective dissemination activities, and preparation and publication of bibliographies or abstract bulletins. A distinction in the charter between "what is important" and "what can wait" can be of great assistance later to operating personnel.

A provision should specify reasonable times within which requested services can be expected to be provided. For example, what is the maximum time a searcher should be expected to wait for an answer to his question and to receive documents which contain the information he wants? How long after receipt of a new acquisition should an interested user have to wait for the selective dissemination technique to deliver the document or its abstract to him?

Finally, how users at remote locations will be serviced should be defined. Will there be information center specialists provided at the remote locations, or will the remotely located users have to depend on the specialists at a centrally located index and collection? Will they direct the questions to the center by mail, telephone, or teletype? How will documents be sent to them? Will they receive original hard copies or microrecords?

The components of this section on service point up clearly the need for a charter which is flexible and amendable to provide for revision of initial overplanning on the extent of proposed service.

Organization.—The structural organization of the information system itself is important; relationships of the system with other functions of the same organization are important; but the principal concern of this section is external relationships to counterpart functions in other corporate divisions. The charter should provide a definite indication of how and to what extent the particular organization should cooperate and work with the central organizations of other divisions or departments. The objectives of this charter provision are to minimize delay time in servicing requests and the duplication of abstracting, indexing, searching, and acquisition. The centers should be allocated specific functions, and the responsibility for performing these functions should be specified in detail. This provision can probably best be expressed by excluding areas of coverage or service which counterpart information organizations might legitimately be expected to assume.

The charter should clearly define functions if either a library or a file room, or both, operate administratively separate from the information system.

Personnel.—Since the effectiveness of an information system can be measured by the quality of input to the system and by the effectiveness of the service provided, the charter should clearly specify minimum qualifications for information system personnel and the reasons for the qualifications. Information analysis is a subjective and judgmental operation. Description of information in documents will be inferior if the analytical operations are performed by persons not professionally qualified in the subjects discussed. It may be justifiable to include in the charter data on the comparative hourly rates of clerical personnel and of professionally trained personnel to show that analysis of scientific documents by unqualified personnel saves little in comparison to the investment represented by the document. Further, the charter can defend utilizing the services of professional personnel at greater costs on the unfavorable reactions of professionally trained scientists and engineers when they are forced to look to unqualified personnel for assistance in conducting their searches.

The importance of training analysts (or indexers or information specialists) should be acknowledged by the charter, as should the length of time involved in bringing a new employee to a satisfactory level of production efficiency. This provision should relate not only to the training of employees initially involved in the system but also to replacements and later additions.

There should be provision for periodic "refresher" training for all employees so that all will have common understanding of procedures and objectives. The charter should require the development of a standardized training program so that all involved in the intellectual operations will have a common base from which to develop their capabilities.

If a library, a file room, and an information system exist as separate administrative organizations, the charter should enumerate not only the functions of each organization, as discussed earlier, but also the duties and responsibilities of the personnel in each organization and what their work relationships should be. Delineation of duties in this way will help not only the individuals involved to understand their duties but also the users to know which organization they can expect to provide specific kinds of assistance.

Information system personnel need to be kept currently aware of research programs in progress. They should also be advised of proposed research programs and those about to be started. Only in this way will the information specialists be able to anticipate users' needs and to undertake appropriate acquisition, screening, and analysis. A

planned program of current awareness for information specialists should involve at least the supervisor in research reviews and research planning programs. This procedure should be provided for in the charter.

Titles of information system personnel should be descriptive of work performed and should be specified in the charter, so that even the earliest public relations releases can mention specific titles. Detailed job descriptions and position titles will facilitate internal and external personnel recruiting programs.

If installation of an information system involves abstracting or indexing a large backlog of documents, and if this work can be spread over a period of time, it may be possible to make economical use of part-time or temporary summer employees. Qualifications, conditions of employment, and duties should be specified. If advanced undergraduate or graduate students will be employed temporarily, their hiring should be anticipated in the charter and specifications set forth concerning timing of recruiting, training, and coordination and supervision.

Physical Facilities.—While physical facilities might not be thought of as important enough to consider in an information system charter, lack of planning or inadequate planning can adversely affect efficiency. Here are some suggestions. Analysts should have offices in the same area so that they can communicate freely with each other. Location of the physical facilities with respect to the location or distribution of locations of the user group has its effect on service. A complete collection of the documents in the system should be stored near and made available to the information analysts. Mechanical equipment for storing and searching the index should be located so as to provide easy access. If the information center is to be responsible for charge-out of documents, provision must be made for storing loanable copies or for reproduction equipment.

Particularly when users are distributed over a fairly large area, or when there are users at remote locations, adequate communication facilities are most important. The charter may specify the need for teletype equipment, and there should be assigned a special information center telephone number, to be monitored at all times and not to be used for personal calls.

Desks and chairs should be provided for users in the information system area so that they may examine and review documents.

Decisions made concerning the storing of the index and documents will determine the need for microfilming equipment, microrecord readers, the reproduction of full-size copies from microrecords, copying equipment, and keypunching equipment. A charter specification concerning form of storage for index and documents to anticipate equipment needs is in order.

Document Storage.—The installation of an information system is an excellent opportunity for management to review its policies with respect to the storage of original documents. For example, the information system may store no originals—documents are microfilmed as they accede to the collection. When a copy is requested, it is reproduced from the microfilm record. In other instances, only one original is stored and copies can be reproduced for the user by xerography. The use of either

of these techniques can reduce required storage space substantially. Tied in with decisions on whether to microrecord or to store only one hard copy are decisions regarding type of shelf storage (file cabinet vs. open shelf), filing arrangement, binding of a number of reports together in loose-leaf binders, and maintenance of duplicate collections at remote locations.

The index should be easily accessible for the information system personnel, particularly if they are to provide search service for the users. If mechanical equipment is used, provision should be made for availability of time on the equipment. Another important consideration is whether or not a complete collection of the documents is to be maintained in the same area as the information system personnel and their search equipment. Unnecessary delays and costs are introduced if analysts must obtain identified documents from a separate location.

The charter should be specific on the subject of centralization or decentralization of the main collection, particularly on the extent to which decentralization may be permitted. The charter provides management an excellent opportunity to specify or restate policies concerning maintenance of personal collections and the retention of copies of reports by individuals. Management may also wish to state policy with respect to maintenance by groups or sections of specialized subcollections separate from or in addition to the central collection. Further, should groups or sections be allowed to maintain their own collections of documents without copies of these documents being included in the central collection? The problems of group subcollections and diffuse individual collections, with or without a central collection, can be solved by a uniform policy statement in the charter when a system is installed. This provision concerns primarily maintenance of document collections, but it can also be used to specify control procedures for security purposes. Controls should be developed and specified in the charter so that some function, either the library or the information system, is responsible for documents in the hands of the users and the length of time they are retained.

Documents have a way of disappearing mysteriously. A number of organizations have undertaken the installation of information systems and have been unable to find any copies of reports for which there exist records of issuance. If it could happen before the system was installed, its future occurrence should be prevented. The only way to assure that all reports of completed research will always be available is to maintain at one central location an absolutely unloanable collection. This should be in the information center. Copies in this collection should be available only to the information analysts to assist them in their work. Should users require copies of these documents, or copies of selected pages from them, they can be reproduced by xerography or can be obtained from a separate collection maintained for loan purposes.

Provision should be made in the charter that every formal research document produced in an organization be submitted to a central repository. This is a consideration closely associated with policy regarding the maintenance of decentralized collections and subcollections. If subcollections are permitted, there should be a requirement that copies of all research reports be submitted to a central indexing function. There may be very legitimate need to

restrict access to certain internally generated documents to only those users with "need-to-know." Adequate controls can be built into the index so that security of classified or proprietary information will be maintained. All documents can and should be accessible through one central corporate index, and provision for this should be incorporated in the charter.

The last consideration in the area of document storage is equipment selection, for such operations as micro-recording and reproduction. This will be dependent on charter provisions on such considerations as centralization or decentralization of the collection. Equipment should be selected to permit implementation of philosophical approach and charter provisions, rather than to select equipment first and then force philosophical approach and charter provisions to comply with equipment constraints.

Control.—The control elements referred to in this section are either operational, fiscal, or quantitative, and hence primarily nonintellectual. They have to do with "bookkeeping" records so that management will be in a position to evaluate cost of installation and operation, and efficiency of service. Management has a right to know how often the system is used, by whom, and the extent to which use is affecting economics and the duplication of research work as it was intended to do. System management or supervision should be directed by the charter to provide statistics to permit analysis of system operation. These data will include: number of searches conducted; individuals and groups for which searches were conducted; search times required; volume of input; details of "peak and valley" effects in receipt of input material; indexing times for documents by type; depth of indexing of individual documents by type; volume of material received by source; input lag time (the time which elapses between receipt of a document and its being accessible through the index); rejection rate by source and reasons (total number of documents received, the number of documents accepted, and number of documents rejected); costs of publications; delays in publication after the material is prepared until it is distributed; and if a machine is used for searching, such statistics as machine input cost per document and cost of time for machine use per search. To determine on a long-range basis the usefulness of individual documents and types of documents, continuing records should be kept on frequency of retrieval of both specific documents and types, and on users' evaluations of the pertinence of these documents to the search questions they asked.

While it may not be necessary to specify in the charter the exact types of records which should be kept, management should specify the types of questions they will ask so that operating personnel will know what answers they will have to provide.

The control records must be adequate to provide for exception reporting to management in such areas as costs, lag times on inputs and searches, number of searches, frequency of searches, and size of backlog.

Quality Control.—A number of the quality control considerations have been discussed in previous sections as they related to other specifications. Those discussed in this section concern primarily intellectual operations by professional employees.

First, standards for screening both internally and externally generated input should be specified. Screening standards should be the same for input of current acquisitions and backlog, and for removal of obsolescent material. Standardization of screening for input and removal is a most important consideration since the "aging" of backlog documents may have reduced their residual value to lower than that of minimum-value current acquisitions. Similarly, no current acquisition should be included if its apparent value is less than documents to be included from the backlog. Screening standards for input and removal should be based on the premise that the system is designed to provide for recall and reuse of information, not merely to serve as a warehouse or mausoleum for all documents that have ever been written. Individual systems must determine whether screening is to be based on (a) cost in research dollars of producing the document, (b) research dollars to be saved by retrieval of the document, (c) costs required to include the document in the index and collection, or (d) time to be saved in conducting searches. For externally generated documents, standards must be developed for equating their value in relation to internally generated documents.

A statement of policy should indicate whether information system analysts will evaluate and screen retrieved documents or whether evaluation of pertinence should be the responsibility of the ultimate user, the one who asked for the search. There is someting to be said for relieving the user of the rather odious task of screening for pertinence. On the other hand, there is legitimate claim that screening by information system personnel is a type of censorship which prevents the scientist user from exercising his own judgment.

While a code of procedures may conceivably be considered "control" rather than "quality control," if getting the right information to the right person at the right time is an intellectual effort, then routine operational procedures such as receiving and processing the documents may require codification to assure that the intellectual efforts can be performed with a minimum delay. Flow charting may be desirable to indicate how the documents shall be handled, what forms shall be used, the priority of handling them, how often they shall be processed in any one day or week, the steps through which they will pass, and maximum allowable delay times.

Every information system should be guided by a code of ground rules to assure consistency in intellectual operations such as abstracting and editing. A code of ground rules provides a basis for a training manual for new indexers and enables indexers to develop a consistent approach among themselves. It will serve to reduce substantially the effect of personnel changes. Ground rules should specify intellectual approaches such as how concepts should be indexed; how and when abbreviations may be used; how to index numerical data, mathematical symbols, and names of chemicals; and how to handle trade names and model designations. Some of the ground rules can be developed inductively before indexing is started, but most of them will result from cooperative effort among indexers after analytical work is started. Later the ground rules will specify search techniques and strategy.

A group of indexers routinely analyzing documents

tend to develop inconsistencies and to diverge from ground rules. Because of this, the work of indexers should be audited regularly for accuracy, consistency, and completeness. Auditing of indexing has been variously called "second indexing," or "review indexing." Auditing should be a complete and thorough process: when a system is just being established and all indexers are novices; when newly trained indexers take their places on the staff, or when the staff undertakes the indexing of a new type of document. This is quality control on index data input. The problem is not so great when all indexers work at one location, since their conferring with each other will have a standardizing effect. Initially a more experienced indexer should review the work of those less experienced. After all indexers in a group have become proficient, auditing can be accomplished effectively by having the indexers exchange their work. The problem is more critical when indexers work at more than one location or when there is only one indexer for a system. The lone indexer can audit completed work by periodically reindexing documents analyzed several weeks earlier and correcting for the extent to which two efforts agree or differ. Where indexers work at more than one location, auditing at a central point will be more important in order to assure consistency. The observations made here concerning consistency apply to abstracting and searching as well as to indexing.

As documents accede, they should be tagged for recall and review at a future date to determine their obsolescence or residual value. When obsolete documents are removed from the collection, the terms by which they were indexed should be removed as well as their extracts or abstracts. A planned program of obsolescence recall and review should be based on judgment of residual value in comparison to newly acquired documents at the time of obsolescence review. Such a procedure is effective in controlling system size, but its major purpose is to relieve users of the need to review obsolete documents repeatedly.

Continuing development should be modified and adjusted to reflect users' reactions to the system and how well it is meeting their needs. To provide for regular feedback on quality of service, users should be asked routinely for their evaluations and comments. To accomplish this, a log should be kept of searches, results of the searches, search strategy employed, name of the user, and other pertinent data so that management may determine effectiveness by surveys of system users.

One way of looking at indexing a collection of documents is that each document is subjected to a planned, detailed, one-time, advance literature search as it accedes to the collection, so that when information is needed at a future time, that which the document contains will be immediately available without the need for a time-consuming and costly on-demand literature search. Users' comments on how effective the system is in this function will be most valuable feedback.

The charter should acknowledge that standards for specifying information values may not be prescribed easily. Long-range value specifications may materialize as a self-correction function but only after a significant population of search questions is available to study question-asking habits of users and evaluations of their reactions to information received.

Scheduling.—Scheduling in this reference is of two types, one concerning steps in system installation, the other concerning periodic operational activities and publications.

Preoperational scheduling should include: progressive stages of design; specification of target date for start-up; recruiting and training of staff; preparation and publication of announcements concerning progress of system installation; acquisition of equipment; preparation of physical facilities; acquisition and screening of candidate documents; the duplication for remote locations of physical facilities, document collections, indexes, and equipment; indexing and abstracting of documents; editing system vocabulary; and installation of communication facilities. The most important elements in preoperational scheduling are those which must be coordinated with other organizations, such as machine operations, preparation of physical and communication facilities, and printing operations. A number of the elements considered above as preoperational will carry over into actual system operation and require regular scheduling.

The scheduling of activities such as inputs, periodic outputs, selective dissemination, preparation of the state-of-the-art reviews and bibliographies, and preparation and publication of abstract bulletins can wait until after the system becomes operational, but developing an advance schedule for these activities provides system management and supervision the necessary material to determine time, personnel, and budget requirements. The results of scheduling can put grandiose plans in proper perspective. Either more personnel and budget will be required or scope of service must be reduced. Management can obtain a good picture of what it will be expected to support.

The charter should contain provisions for scheduling the recruiting, training, and utilization of part-time summer employees if development of total system coverage indicates that some or all of the backlog can be indexed by other than full-time employees.

The scheduling of periodic review of the charter by information system personnel should be provided for, and frequency of major program evaluations should be specified. These points were discussed more fully in the section entitled "General Principles."

Mechanization.—Equipment should be selected only after a fundamental philosophical system approach has been selected. The charter should state that while mechanization is a *possibility* after system approach has been selected, the decision to mechanize will be held in abeyance until its need has been clearly demonstrated. The mere availability of equipment is very inadequate justification, per se, for the much greater expense of mechanization over manual methods. Mechanization should be undertaken only after substantial proof of need and a full study of the economics. The extent of improvement in service, speed, accuracy, and efficiency in the specific situation must be evaluated against substantially greater costs.

A computer should be regarded as no more than one alternative means for implementation of a system which otherwise should be designed free of hardware considerations, such as current availability of a specific type of

equipment. In far too many cases, equipment that had been selected for entirely different purposes was forced on the information system solely because of current availability of time and the need to sell that time. If the decision to mechanize is made, system management or supervision must have assurance from the computer organization that time will continue to be available to the system to provide for the necessary operations planned for accomplishment by computer. Unless time continues to be available, standards of service specified in the charter will not be met and user dissatisfaction will result in progressively less use. A fact of life is that too often the information system finds itself with second-class citizenship when computer time is filled up for other uses, after being enticed onto the computer when the time went begging initially.

Some computer applications can be advantageous and economical, others can be disadvantageous, time consuming, and costly. There are many justifiable applications for computers in information systems, and there are many where comparable service obtained *via* the computer will be many times more costly than other methods with no increase in effectiveness. System designers should make no decision to mechanize until they have a complete statement of costs of input, output, programming, and processing. Since the pros and cons are peculiar to each situation the charter should specify clearly the bases on which decisions will be made to computerize or to use card-handling equipment or manual methods. There are successful, efficient systems in which self-restraint was exercised in making changes. Edge-notched card systems were converted to field punched cards or optical–coincidence cards, then subsequently to printed coordinate indexes, and finally to computer storage. A planned program of this type may be an ideal solution in many cases. Costs of the past, present, and proposed approaches can be compared and decisions based on facts, not intuition.

There is still another consideration—how accessible will selected equipment be to those who are going to use it? This means not only geographical proximity but also the delay times involved before requested service can be provided. If mechanical or electronic equipment can provide a needed five-minute service operation after a twelve-hour wait for machine time, then there is no benefit if the same operation could have been performed immediately by manual methods in 30 minutes.

The last consideration with respect to mechanization is that information system management should be in a position to specify to and to expect from the equipment organization that which is needed to fulfill system objectives. There are numerous instances in which, after information system management set forth its requirements, the computer organization told the information center what it could have. While this situation conceivably can be borne of good intentions, nevertheless the facts remain that services to the user must be provided by the information system, not the computer organization. The information specialists devise the tools they need. The computer systems personnel should provide them, not revise them.

Compatibility.—In the "General Principles" section, a recommendation was made for a charter provision which would require the information system to make maximum use of sources available externally so that there would be minimum duplication of effort. In complying with this provision, it may be necessary for individual systems to tailor their indexing, abstracting, and other services to be compatible with the external source or sources which can be expected to be of maximum supplemental value. External sources include professional society publications, such as those of the American Society for Testing Materials, the American Institute of Chemical Engineers, and the American Society for Metals. Nonprofit organizations publish services such as the University of Tulsa *Petroleum Abstracts* and the Pacific Aeronautical Library *Uniterm Index to Periodicals.* Governmental sources include the National Aeronautics and Space Agency and the Armed Services Technical Information Agency.

Another type of compatibility is that which concerns indexing and abstracting by several internal systems of different types of documents. For their own purposes, separate organizations may be indexing and abstracting patents, internally generated research reports, industrial intelligence information from trade and financial journals, design drawings, and technical literature from the professional journals. Management should encourage (or perhaps require) a standardization of information methods among the several organizations, not only so that they can be merged into one over-all collection at a future date if desired, but also to provide maximum economy in the training of personnel, to provide for maximum uniformity of vocabularies, to optimize the use of forms, and to keep programming costs to a minimum.

Adaptability.—Mention was made earlier of the need to specify coverage to which the system would extend initially. A major factor in determining the nature and extent of coverage is an anticipation of the users' needs for specific types of information. It was also stated that economies could be effected by not providing coverage of a large field which would be of interest to only a small number of users. The charter should include a statement to assure that system management is continually sensitive to changes in both user group composition and intensities of interest in the scientific or technical areas covered. The number of users in specific areas can change, indicating that consideration should be given to redirection of coverage. Similarly, as a group's familiarity with a research project matures, needs for information may become more specialized or may be redirected. Frequently these changes can be anticipated and provision made for advance redirection, expansion, or contraction of coverages and services. For those situations when such changes cannot be anticipated, the system should be designed to be adaptable to changing conditions with economy and speed.

Those responsible for monitoring external sources should keep themselves informed of additional journals, sources, and services so that immediate use can be made of them when changes in needs for coverage and service develop.

Organizations of which information systems are a part have their year-to-year budgetary problems and variations in ability to underwrite supporting services. A soundly conceived charter will anticipate budget reductions by listing those functions, such as coverage and services, in an order according to which they can be suspended

during periods of reduced financial support. Experience indicates that progressive suspension of the less valuable services preserves a higher degree of over-all system efficiency than across-the-board retrenchment in all services. Reduction in financial support will inevitably cause a corresponding reduction in staff, services, or coverage. The ordering of services according to their value to the user group is a desirable self-evaluative function. If this evaluation is incorporated into the system's fundamental operating paper, it can serve as the basis for consideration of orderly system contraction when necessary.

While a charter is recommended as an excellent control device for system installation and operation, the topics proposed as candidate provisions in the charter are only suggestions. There is probably no system, planned or now in operation, which should or could incorporate all the suggested components. This composite picture of observed systems, however, may help to reduce some duplication of information system planning and design the hard way.

Plutonium—The Development of its Literature*

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Even before its discovery, element 94—later to be named plutonium—was of concern to nuclear physicists, and between 1909 and 1940 at least a dozen articles about the possibility of its existence appeared in the scientific literature. It is interesting to note that in the early part of this period the articles published were three to one in favor of the position that transuranium elements could not exist. In 1934, however, Fermi[1] and his coworkers discovered that neutron irradiation of uranium produced a number of radioactive substances, and concluded that, indeed, there were such things as transuranium elements. That revelation seems to have settled the question once and for all; no further articles denying such existence are reported.

Before proceeding further with the discussion of the literature of plutonium it seems appropriate to digress briefly to summarize some information about the metal itself.

Plutonium-239, the most abundant isotope of that element, is formed as the result of the radioactive capture of neutrons by the uranium–238 isotope and the subsequent two-stage β-decay of the intermediate products, uranium–239 and neptunium–239. That is, in reactors fueled with natural uranium (containing 99.3% uranium–238 and 0.7% uranium–235), neutrons produced by the fissioning, or radioactive disintegration, of uranium–235 are captured in uranium–238 to transmute the uranium–238 to plutonium–239.

Plutonium was the first element to be produced synthetically in large enough amounts to be seen by man, and was initially identified as a result of investigations made at the University of California during 1940–1942 by Wahl, Seaborg, and Kennedy, who were then studying the tracer properties of neptunium. In 1942 the first pure compound of plutonium was prepared, and in 1943 the first minute beads of plutonium metal, weighing less than 50 millionths of a gram, were produced at the University of Chicago. Because of the importance of plutonium as a component of nuclear weapons, much of the early work with the metal was carried on under conditions of great secrecy, and it was not until August 9, 1945, that the successful production of plutonium was heralded to the world in the terrifying destruction caused by the explosion of the atomic bomb over Nagasaki.***

The first use of plutonium was in an instrument of destruction more powerful than the world had ever before seen, but, although it continues to be used in nuclear weapons, its proposed peaceful application as a source of energy in the nuclear power reactors of the future is by far the more important. Such application has been estimated to be capable of multiplying the energy contained in the world's uranium reserves by a factor of more than 100, by converting uranium–238 to plutonium in power producing reactors and then using the plutonium thus produced as fuel in other reactors. It is small wonder that considerable scientific effort has been directed toward understanding this unusual metal.

Plutonium is not easily produced and fabricated. Some difficulties arise from its unusual physical characteristics and others from its extreme toxicity. It is highly reactive in air, and at elevated temperatures it must be protected

*** The atomic bomb exploded over Hiroshima three days earlier, on August 6, 1945, contained uranium-235, and the plutonium bomb tested on the ground near Alamagordo, New Mexico, on July 16, 1945, could hardly be said to have informed the world of the production of plutonium, because of the secrecy that accompanied that test.