ploitation of knowledge must be considered a higher goal than mere information-handling, as important as efficient handling may be in the communication processes of society. Information analysis center development is one practical answer for our community. Re-structuring of our technical libraries into new viable service centers is another.

Well, ladies and gentlemen, for the last half hour I have been competing with your digestive and other life support systems for your attention. You have been most kind in listening to me. I will return the kindness by concluding my remarks with the hope that chemists will continue to be in the vanguard of information progress.

Factors Affecting Dissemination of Chemical Information*

DAVID E. GUSHEE
American Chemical Society
Washington, D.C. 20036

Received September 24, 1971

This paper demonstrates that the value of information and, hence, the design of information systems, whether for a company, a university, a learned society, or an individual, is in the early stages of a significant change in structure. We are struggling with a heritage of source orientation in an era of increasing orientation towards problem solving. The signs of response to changing circumstances are increasing, but are still limited in number and varied in nature.

Two major driving forces are changing the structure of chemical information systems. One of these is sheer volume; the other is economics. The impact of increases in rate of generation of scientific information has been well recognized for at least two decades. But the role played by economics is changing in that economics is becoming a more stringent constraint. Currently common assumptions about the value of information will thus be challenged and, to a significant measure, overthrown in the next ten years.

As things stand today, most institutions can be counted on to buy most books and journals published in their fields of endeavor. These institutions take pride in their library holdings and tend to measure their effectiveness, at least in part, by the ratio of information requests filled from stock, so to speak, to those handled by going outside their own resources through interlibrary loans, special purchases, and other relationships.

There has been little attention paid to operations research on such matters as frequency of use, cost per use, dead time, and other variables common in inventory and distribution and their control. One must, of course, distinguish between academia and industry in such statements, because the one has essentially all of knowledge as its field and scholarship as its output, while the other has clearly defined areas of knowledge to work in and new products and processes for growth and profit as its output. Industry thus has always had a greater basic ability to quantify the evaluation of its information resources compared with academia. Nonetheless, industry's growth and profitability have been high until recently and thus have not led to sufficient pressure to cause penetrating analyses and painful decisions to become general.

The literature in this field is scattered and data are hard to get. The nature of things to come is emerging gradually, and studies of cost effectiveness and the like are beginning to appear more frequently.[1,2] These studies show that the value of an information system can be quantified, but that there must be prior agreement among those concerned on such things as objectives in speed of response, comprehensiveness, and the like.

There has been some attention paid by librarians to the consequences of continuing current policies and practices.[3,4] Most of these studies have been stimulated by proposals to build new libraries, and most have actually led to decisions to proceed with such construction (although recently some of these have been delayed). From the early post-war period to the end of the 60's, average library acquisition costs increased at over 11% per year, total holdings increased at just under 5% per year, and unit costs at about 5% per year. The average university library was projected to have holdings of almost 3 million volumes in 1980 from just about half that in 1968.

Although university librarians and administrators have been concerned about these projections (acquisition budgets, for example, would reach an average of about $2 million per year by 1980 from their current $600,000 or so), none dared to propose as a matter of institutional policy that such increases in library costs were unacceptable. Rather, they were unavoidable, according to the then-current conventional wisdom, and, I infer, the administrators concluded that growing profits, Uncle Sam, or God would provide.

These projections were based primarily on extrapolation of data from a period of unprecedented prosperity and occurred prior to full recognition of the profound changes about to occur in the funding of the knowledge industry, of which science, and in turn chemistry, is a part.

University library acquisition budgets have not grown in the past two years at the rate of the previous period. Although I do not have enough data to quantify the situation, I estimate that acquisition budgets are at best holding their own against inflation, while publishers' prices are increasing at an average rate of 20% or so per year—the ACS is no exception, having had price increases over the past three years that average about that order of magnitude.

Again from estimates not quantitatively supportable, I feel that acquisitions budgets will continue to remain at about current levels for the next several years. The basis for this prognostication is a probable leveling off of Federal funding of science, except in medicine and biology, and an

* Presented in Symposium on Appraising Technology and Information Systems, Division of Chemical Literature, 162nd Meeting, ACS, Washington, D. C., September 1971.

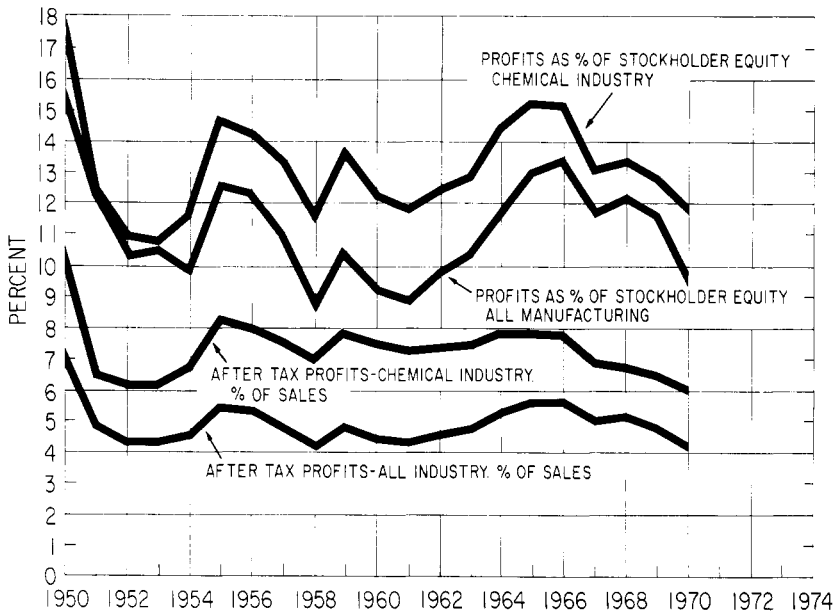

Figure 1. Industry profitability as per cent of stockholder equity and as per cent of sales, for chemical industry and all industry. Changes in industrial expenditures for R&D and for scientific information follow changes in profitability trends

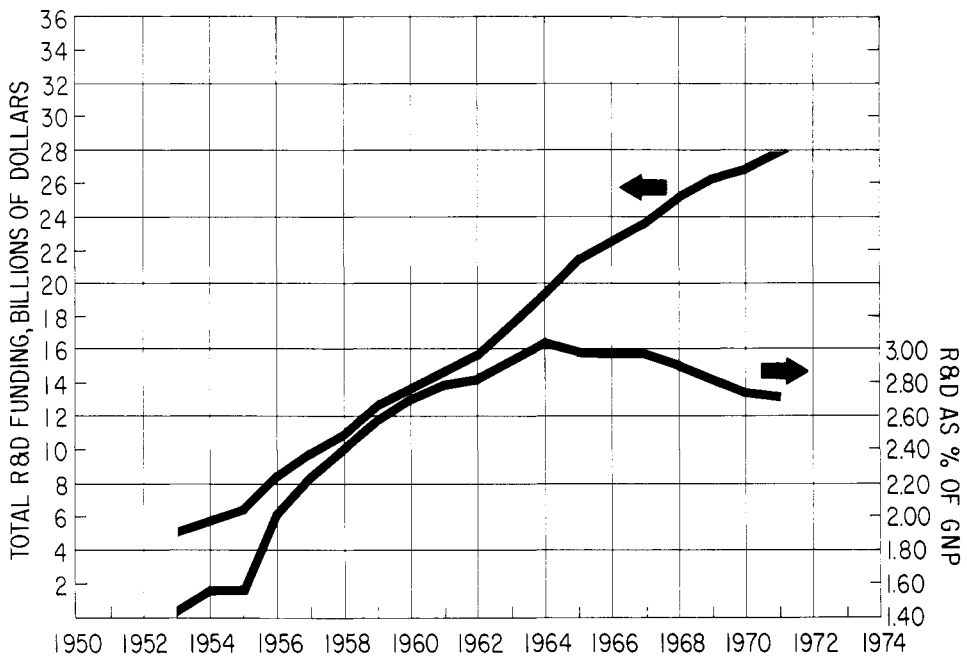

Figure 2. U.S. R&D Funding as per cent of Gross National Product and in current dollars. Changes in academic expenditures for page charges and for scientific information follow changes in R&D funding

equivalent probable leveling off of industrial profitability over the same period. There has been a consistent relationship between these two variables and acquisition budgets for years and between acquisition budgets and ACS unit sales.

Constrained library budgets have led librarians to two areas of reassessment already. One of these is reduced emphasis on experimentation in mechanized information processing and retrieval systems; the other is in acquisition practices. Very few university libraries are now seriously proposing expensive programs in mechanized retrieval without assurance of specific Federal support of most of the costs. This Federal support is now very difficult to get and, in fact, is being withdrawn from some universities that have been receiving it. University administrators are increasingly hard to convince, in view of general educational funding limitations. On the industrial side, the number of programs of mechanized information handling is relatively limited, and new entries are increasingly scarce.

On the acquisition side, the first cost-saving step is to reduce the number of multiple subscriptions to individual journals. This cuts down on journal routing but increases other library services such as table of contents routing, copying, microfilming and microfilm printing, and staff aid to chemists spending more time in libraries. It also reduces the total information transferred from publications to brains. In sum, it decreases direct cost dollars spent external to the organization, increases indirect cost dollars spent internally in information transfer, and decreases total information transfer.

The next step taken on the acquisition side is to terminate high cost publications with low use frequency.[5] This is a tricky area for librarians, both from problems of realistic costing of alternative avenues of access and the immeasurable cost of not learning or delayed learning of some

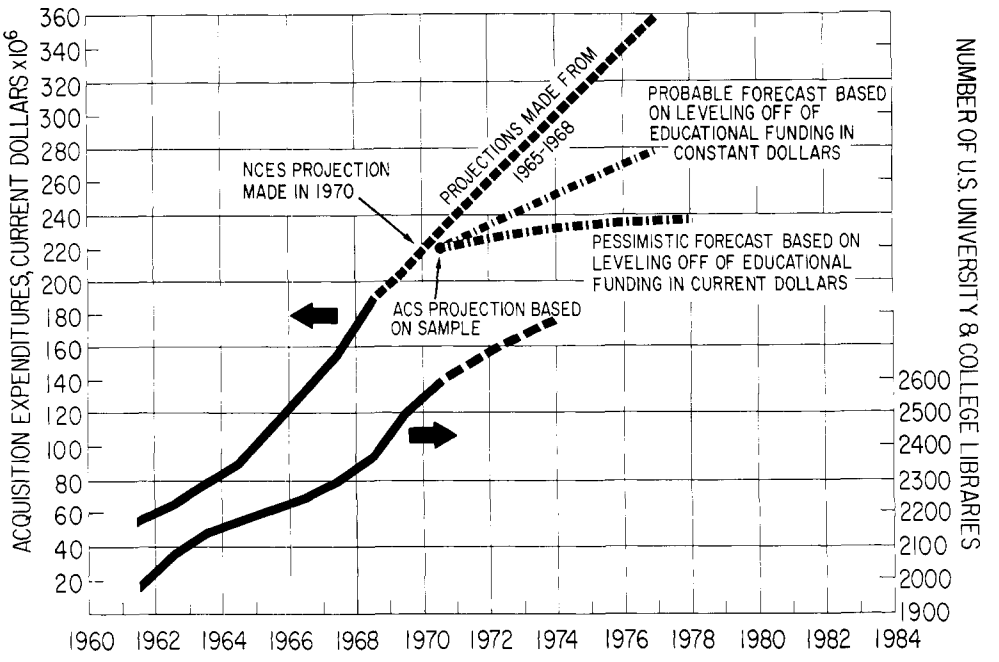

Figure 3. College library acquisitions of books and periodicals, and the number of college libraries are both growing at slower rates than forecast just two years ago

Table I. Subscriptions to ACS Journals, 1948–1971

	1948	1958	1968	1969	1970	1971 (est.)
Journals	3	7	19	19	19	20
% Mbrs subscribing	60	35	37	41	37	40
Total mbr subs	61061	47622	86805	92352	92908	92000
Total non-mbr subs	23885	40193	113869	110829	131110	121000
Subs/mbr subscriber	1.7	1.5	2.1	2.1	2.2	2.1
Mbr subs/non-mbr sub	2.6	1.2	0.75	0.83	0.80	0.76
Av non-mbr subs/jrl	8000	5700	6100	5800	6900	6000
Page charge jrls	0	0	13	13	13	13
Total mbr subs	—	—	52098	49334	44344	40500
Total non-mbr subs	—	—	45845	44860	45135	43000
Mbr subs/non-mbr sub	—	—	1.14	1.10	0.98	0.94
Av non-mbr subs/jrl	—	—	3520	3440	3480	3300

things, among which may be some fundamentally critical element in some current or future program. Nonetheless, as dollars become shorter, the necessity for evaluating probable risks increases, and the necessity for choosing among undesirable alternatives also increases.

Lest you feel that the ideas just presented are all theoretical, data showing their tie to reality are shown in Figures 1 to 3.

In examining information transfer, one must also consider the role played by individual purchasers. For most nonsociety scientific journals, subscriptions prices are so high that the number of individual subscribers can be ignored. But for society publications, a significant fraction of the specialists in any subdiscipline subscribe personally, a fact which does not particularly reduce library costs (except in reducing the subscription price and possibly in reducing the number of extra subscriptions purchased) but does increase information transfer from print to brain both in quantity and rate.

Despite the social advantages of increased information transfer and the library's advantages of reduced subscription prices, individual subscriptions are declining steadily in relative significance. In the ACS alone (Table I), they have declined from almost 75% of subscriptions to about 40% of the total in just over twenty years.

The number of individual subscriptions to journals is larger than it was 20 years earlier, although not in proportion to the increase in the number of chemists. The profession would appear to have been in transition from a value structure in which individuals provided for themselves a significant fraction of their information tools to one in which their institutions increasingly provide these tools, even those that are relatively inexpensive and essential to the continuing effectiveness of the scientists.

With the increasing budgetary constraints on the institutions, as noted earlier, the institutions are in the process of reducing, at least in convenience of access, their supply of information tools and reducing, at the same time, their investment in improving information tools.

To a marketer, this looks like an opportunity. Convenience, price, and perceived value to both the institution and the individuals are the sales variables. The design mechanism probably lies in joint efforts between the institution and the supplier of information—the publisher, or the abstracting-indexing system, or both—in some sort of multiparty cooperation.

Price constraints for such a service or combination of services are established by an institution's current equivalent cost for producing the same or more relevant services. Design constraints are established by user response, on which both institutions and publishers have or could develop a wealth of data. And production cost constraints are basi-

cally not controlling, since the publishers and secondary services are already committed to programs involving a high portion of fixed costs, significant among which are computer costs. Thus, products and services can be added at relatively low marginal costs, yet could, if properly designed, yield high marginal return, both in revenue to the supplier and in transfer of information to the scientists.

But the field of scientific information is strongly influenced by its source-oriented tradition and hampered by the unquantified nature of the value of information, by the wide diversity of information needs, by the variety of channels through which information flows, and by the variety of contexts in which any given piece of information appears.

More and more, these complex factors must be taken into account in the design of new information products and services in order for them to be accepted by users. If they are not, the flow of knowledge will slow down and, in an increasing number of instances, stop altogether from the pressure of strong economic constraints which are likely to continue for some time.

Scientists feel that the flow of scientific information has real social value and for it to diminish would be socially undesirable. The current flow rate has been made possible in essence by subsidy, in our journals via page charges, and in our secondary services by public money to finance the process improvements necessary to maintain the service in the face of rising costs and increasing volume. From the viewpoint of the user, enough funds have been available from the fact of rapid growth, both industrially and educationally.

Subsidies to the publishers are now diminishing, and the growth of the user community is decreasing, so the social value of the current flow rate of information must be demonstrated economically in order to be sustained.

The key factor affecting dissemination is clearly economics—the cost of receiving it (easily measured) compared with the value of having received it (measured with great difficulty at best). This puts scientific information into the same situation as most other commodities, where product performance, package design, distribution methods, and pricing take precedence over social and intellectual considerations. This is a difficult pill for science to swallow, as evidenced by its rather sluggish response to a situation which has been developing for five years and which was clearly foreseeable five years before that.

The additional talents needed for response are not primarily scientific, in my opinion, but rather behavioral. In this regard, scientific information is no different from scientific research, a conclusion that may provide some comfort to the statesmen of science and may make possible an increasing rate of response from here on.

LITERATURE CITED

(1) Lancaster, F. W., "The Cost-Effectiveness Analysis of Information Retrieval and Dissemination Systems," *J. Amer. Soc. Inform. Sci.* **22,** 12 (1971).
(2) Fazar, W., Improved Library Effectiveness by Use of the Planning-Programming-Budgeting System, Special Libraries, 423–33, Sept. 1969.
(3) The Harvard University Library 1966–76, May 1966.
(4) The Past and Likely Future of 58 Research Libraries, 1951–1980—A Statistical Study of Growth and Change, O. C. Dunn, W. F. Siebert, and J. A. Scheuneman, Purdue University, 1967.
(5) Panton, D., and Renken, B. G., "What do Chemists Read," *Chem. Brit.* **7,** 18–22 (1971).

Papers Presented at ACS Meetings

ROBERT F. MARSCHNER
Research and Development Department, American Oil Co., Whiting, Ind. 46394

Received October 8, 1971

National meetings of the American Chemical Society have provided a forum for presentation of information since before 1900. Numbers of papers presented at these and other-than-national meetings are tabulated by year and by subject. National meetings have grown 5% per year, but other meetings have averaged 14% growth over the past decade. Most of the recent growth has involved the disciplinal divisions of the ACS rather than the interdisciplinal or the mission divisions. Over the years, meeting registrants per paper has risen from 5 to above 10 and dropped back to 5. Further changes are imminent, and the soundness of Society policy will depend upon correct interpretations of them.

Research comes to light and contributes to the progress of science through the papers that are published in the journals. That statement is probably more right than wrong, but it is certainly not the whole story. Traditionally, research is "trial marketed" before publication: the author first presents his results at a meeting, in exchange for informed comments, and his plans for publication may be influenced considerably by them. Actually, he may have discussed his findings with others still earlier, or revealed his plans in requests for financial support even before the work was begun. But these were privileged contacts, whereas anyone interested can attend the meetings.

National meetings of the American Chemical Society are one such forum for exchanging research results and informed comments. Subjects are portioned among Divisions of the Society, and programs are supplied to all members through Chemical and Engineering News. Thousands of members regularly attend hundreds of papers at every national meeting, but most now feel that big national meetings no longer answer their needs, and should give way to