Chapter II

INFORMATION REQUIREMENTS OF THE U.S. MATERIALS SYSTEM

Chapter II

INFORMATION REQUIREMENTS OF THE U.S. MATERIALS SYSTEM

The dominant characteristics of the U.S. materials system is that it is a private system in which supply, demand, and allocations are largely determined by independent decisionmakers working through the market. In the past, Government action to complement the market's response to materials problems was minimal. This condition may be changing; many new pressures on the materials system are national and international in scope and transcend the decisionmaking capacity of the private sector. For Government materials policy to be effective, it must be based on an up-to-date understanding of the market forces and on timely, accurate information depicting its principal supply and demand parameters.

A wide variety of diffuse and disparate information systems in Government, industry, and academic institutions now provide guidance on all aspects of materials to decisionmakers. In contrast to a "national" system—which implies coordination and integration—these separate systems are better regarded as a "nationwide" information resource.

A. INTRODUCTION

In order to comprehend how information affects the flow of materials through the U.S. economy, one must be aware of the structure of the Nation's materials system and of the process by which materials decisions are made. Accordingly, this chapter presents an overview of the breadth and complexity of the materials information systems that have evolved to support materials decision making, including systems in the private sector, academic institutions, and Government.

Three topics are covered in this chapter:

a. The variety and importance of materials-related activities in the U.S. economy:

b. The diversity of materials decision making: and

c. The structure and characteristics of existing information systems in support of such decision making.

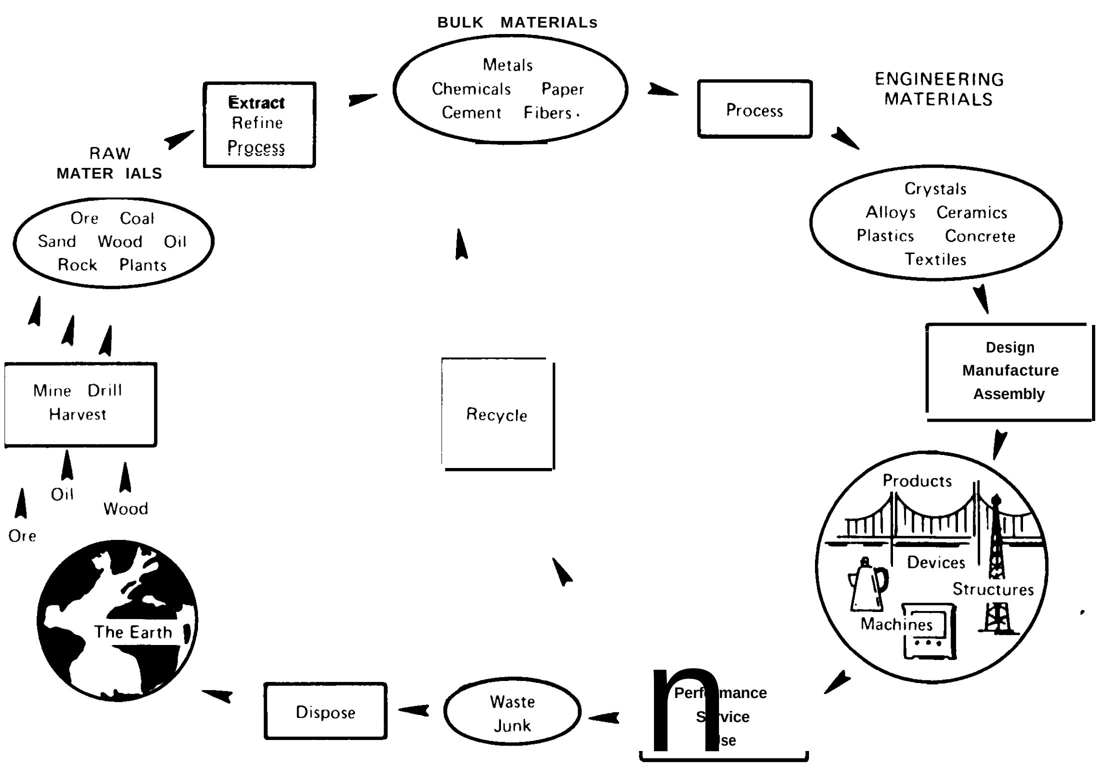
B. MATERIALS IN THE U.S. ECONOMY

The essential characteristic of the U.S. materials system is that it is predominantly a private system. It comprises many small and large firms, each making its own judgments and management decisions in determining how materials move through the materials cycle from raw state, through processing and manufacturing, distribution, and finally, to scrap or recycling. Figure II-1 depicts this cycle. Prospectors determine where to explore; miners decide what techniques to use for the extraction of ore and where to locate refining facilities; manufacturers determine which of several materials to use in a planned product, weighting cost versus material qualities: consumers decide whether to buy a product at the proffered price: and potential entrepreneurs determine whether to set up new services, such as a scrap and recycling business.

Table II-1 provides some evidence of the size and importance of the materials-oriented activities in the [J. S. economy (the data are for 1973):

- These activities accounted for $576 billion or almost 47 percent of the total Gross National Product (GNP),
- The value of the materials produced/consumed by the materials-oriented sectors account for over 80 percent of the Nation's exports and imports.
- Over 34 million Americans were employed-45 percent of the total number of full-time workers in the labor force.
- Of the 1.9 million scientists, engineers. and technicians employed by industry, 97 percent had materials-related specialties,

Figure II-I. Materials Cycle



Source: Committee on the Survey of Materials Science and Engineering, Materials and Man's Needs, Washington, D, C.: National Academy of Science, 1974.

Table 11–1.—The Materials-Oriented Sectors of the Economy

ITEM A

MAJOR GROUPINGS OF U.S. ECONOMIC ACTIVITIES

Industry	Materials-Oriented Elements
Agriculture, forestry, and fisheries	Forestry and non food Agriculture
Mining	All
Contract Construction	All
Manufacturing	All, except food, feed, and tobacco
Transportation	Freight and pipeline
Communication	None
Electric, gas, and sanitary services	None
Wholesale and retail trade	All, except food, feed, and tobacco
Finance, insurance, and real estate	None
Services	Higher education— forestry, engineering, and physical sciences

ITEM B

CONTRIBUTION OF MATERIALS-ORIENTED SECTORS TO GROSS NATIONAL PRODUCT

Billion Current Dollars

	1973	1980
Forestry	1.6	1.3
Mining	19.5	34.5
Construction	61.8	60.4
Manufacturing	297.7	637.2
Transportation, Utilities	47.3	94.2
Trade	148.6	256.2
Education	.3	.4
Total Materials	576.8	1,084.2
GNP	1,294.9	2,156.2
% Materials	46.7	50.3

ITEM C

MATERIAL EXPORTS and % IMPORTS

Million dollars

Exports	1967	1973
Materials	25,961	56,265
U.S. Total	31,238	70,223
% Materials	83	80
Imports		
Materials	21,872	59,170
U.S. Total	26,889	69,121
% Materials	81	86

ITEM D

EMPLOYMENT IN THE MATERIALS-ORIENTED SECTORS

Millions of Employees

	1973	1980
Forestry		.1
Mining	.6	.7
Construction	4.0	4.9
Manufacturing	18.4	20.6
Transportation, Utilities	1.6	1.9
Trade	9.6	14.7
Education		
Total Materials Employment	34.2	42.9
National Employment	75.9	101.2
% Materials	45.1	42.4

ITEM E

ESTABLISHMENTS WITHIN THE MATERIALS-ORIENTED SECTORS

Thousands

	1973	1980
Forestry	12	15
Mining	90	110
Construction	980	1,110
Manufacturing	322	330
Transportation, Utilities	145	149
Trade	1,899	2,233
Education	2	2
Total Materials	3,450	3,949
U.S. Total	12,759	14,113
% Materials	27	28

Source Office of Technology Assessment

- There were nearly 3.5 million materials-oriented establishments.
- There were some 250 labor unions, about 1,700 business associations, and some 800 scientific, engineering, and technical associations.
- More than 200,000 academic degrees related to materials studies were awarded, representing about 17 percent of the total number of degrees conferred that year.

C. MATERIALS DECISIONMAKING

As materials move through the materials cycle—from raw state, through processing and manufacturing, distribution, and finally, scrap or recycling-countless decisions need to be made. So accustomed are Americans to the widespread availability of material products that the complexity of these decision processes is not generally recognized.

1. Decisionmaking Complexity

The complexity of decisionmaking can be emphasized by examining the flow of materials among the major segments of a specific materials industry. Figure II-2 depicts the flow for copper and zinc products among fabricators, suppliers, and customers. It points up the involved couplings which need to be considered when materials decisions are made. Decisions made at the supply end of the cycle in the mining and scrap businesses directly affect the primary copper and primary zinc businesses and, in turn, the brass castings and other industries shown. At the other end of the cycle, demand conditions and decisions of the diverse group of customers (including primary lead users) affect imports and mining.

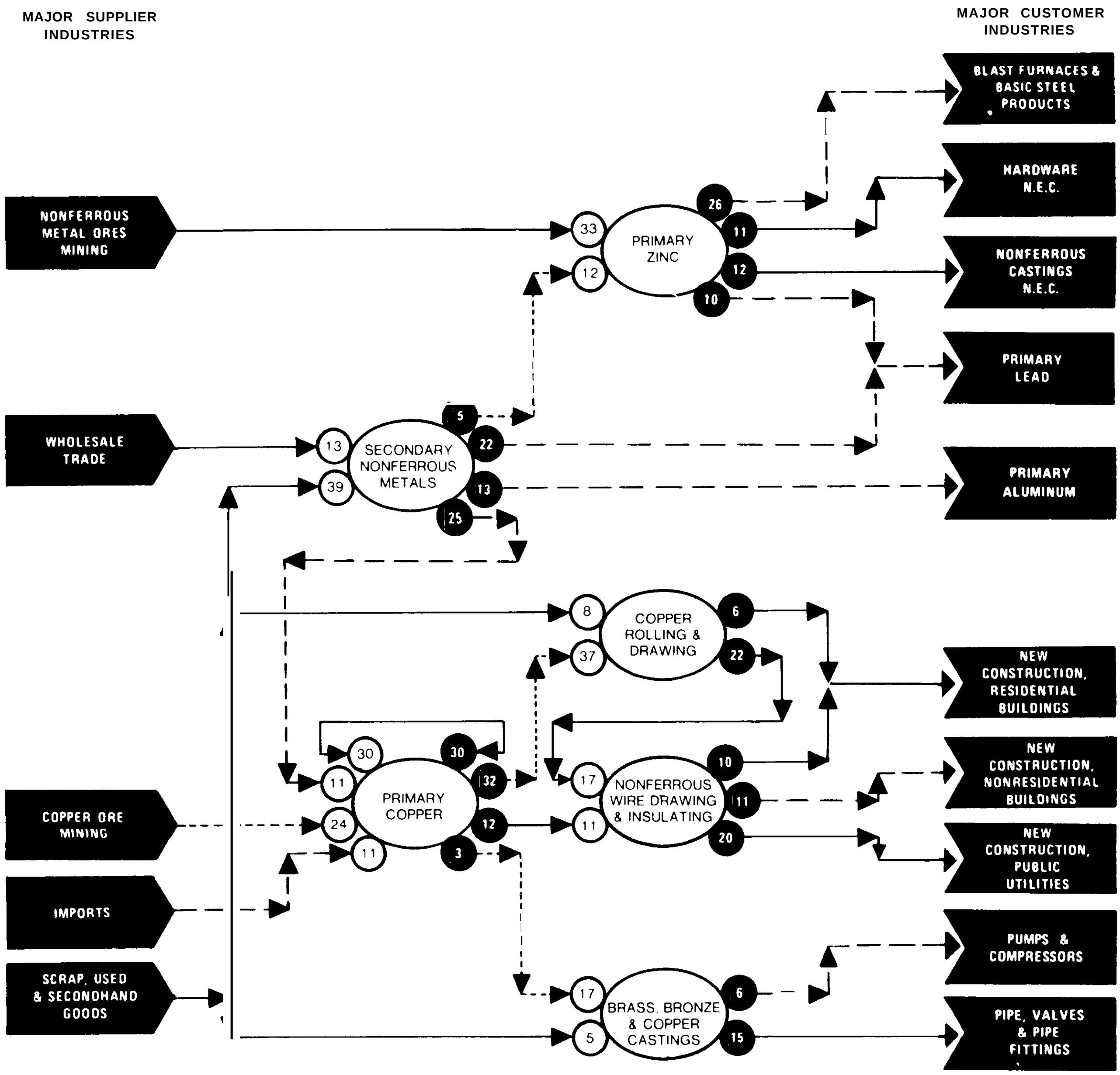
A similar example of the complexity inherent in materials decisions is shown in figure II–3 which depicts the materials cycle for aluminum. It illustrates the nature of the supply/demand interrelationships of the intermediate aluminum products from acquisition of ore to consumption of finished goods. At each stage, the supply of intermediate products is subject to and, in turn, affects the demands of the succeeding stages. Thus. various end items (automobiles, cans, household products) all compete through market forces for alum inure ingots; likewise, domestic and foreign refineries compete for the ore supply,

Guiding the decisions that control and direct the material-flow patterns in these examples and for materials generally is a body of experience and judgment that rests on the availability of information, In part, this information manifests itself automatically through the action of the market mechanism. However, when the market is unable to solve such problems. then Government materials decisionmakers may become involved. For them to make effective decisions. information on the full range of supply/demand factors and possible sectoral impacts must be available, a process discussed in the following sections.

2. Decisionmaking in the Marketplace

A fundamental advantage of the market mechanism on which the U.S. materials system now depends is the way it economizes on the need for information in reaching toward optimum allocation of resources. Sowell epitomizes this mechanism: “It has been said that nobody knows how to make (1 simple lead pencil! No single person knows how to grow the trees for the wood, mine and process the graphite for the lead, make the rubber for the eraser, extract and process the ore for the metal that holds it on, and manufacture the paint and varnish that cover the pencil. The pencil companies, of course, buy most of these materials in the market from others who do know their own small part of the process, but whose knowledge becomes very hazy and practically nonexistent as to processes a few stages ahead or behind. The alternatives available at any given stage, and

Figure II–2. Expenditures and Sales of Copper and Zinc Industries



O Percent of Copper and Zinc Industries Expenditures

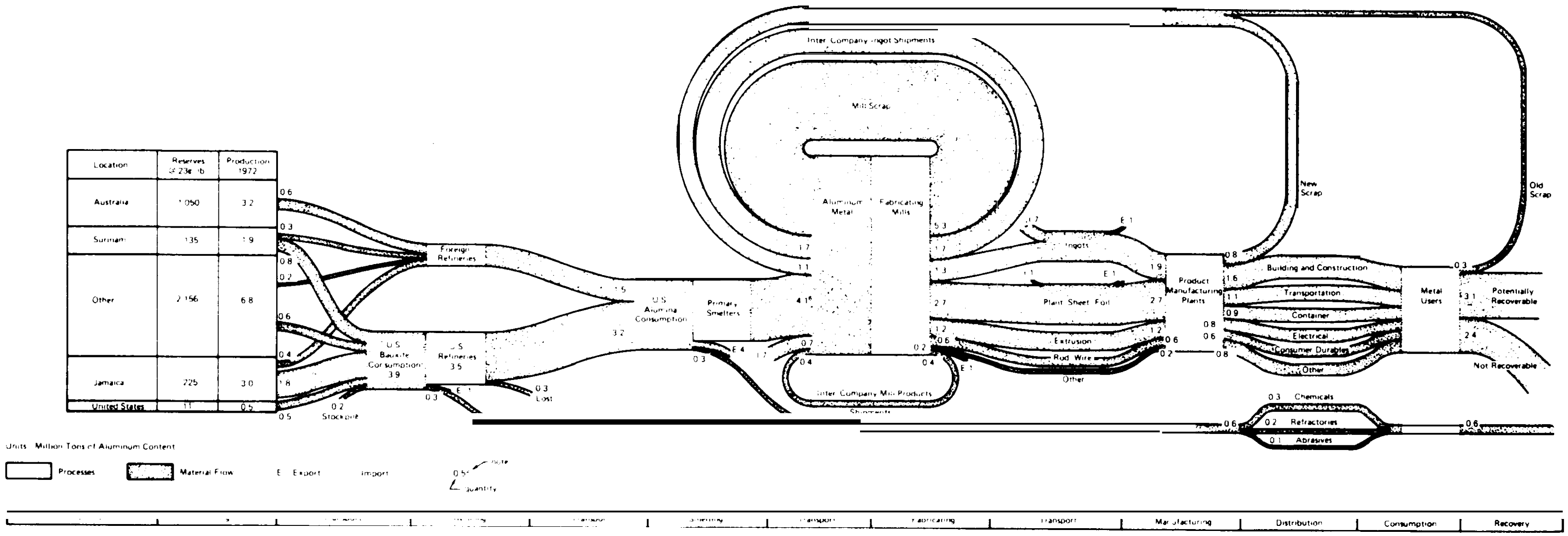
● Percent of Copper and Zinc Industries Sales

Minor Suppliers and Customers Account for percentages not Shown

See Introduction for Fuller Explanation

Source U S Department of Commerce U S *Industrial Outlook 1975* Washington D C U S Government Printing Office

Figure 3. Aluminum Cycle



the changing terms on which they are available, are likely to be fully understood only by the people at that stage. As the competition of knowledgeable people at one stage forces prices up or down in response to the underlying scarcities and technology which they understand, those further along in the process. who may not understand at all what is causing the price change. nevertheless respond to these changes so as to economize what has become more scarce. substituting what has become easier to get, increasing or decreasing their total output or changing the channels of its distribution. To achieve the same end result through a political process would require that either the public or a central planning commission have a degree of knowledge which is not needed under a price mechanism" (ref. 1).

To say that the American market system reduces the need for formally collected in formation and the amount of knowledge needed at any single decision point is not to say. however, that information is unimportant. In fact, the existence of knowledgeable buyers and sellers is one of the essential conditions for maintaining the market structure. To the extent that such knowledge is not available, the decision making structure may, at best. be inefficient: at worst. it may be incapable of coping with perturbations in materials flow.

In the United States, most materials decis ions are made by private businessmen and are based on their own projections of supply and demand. These, in turn. hinge on a wide range of subsidiary factors—technological state-of-the-art, financial conditions, international trade circumstances. and, not the least of all, Government policies as they are now understood. In recent years, particularly as many materials have come into short supply, the complexity of the decisionmaking process has been heightened and the role of Government has tended to become more important,

3. Decision making in the Federal Government

The broad range of problems posed by potential scarcities and outright shortages illustrates the growing involvement of Government in materials decisionmaking. Of concern are both short-term crisis situations exemplified by the oil embargo of 1973 and potential long-range problems such as the growing dependence on foreign sources as domestic supplies dwindle. Government attention and possible action may be required whenever shortages are projected to become so severe as to cause unacceptable distortions in the economy that cannot be addressed by the market mechanism.

In the market economy, shortages and surpluses are price-dependent. In theory, the market usually resolves them by raising prices, thereby reducing demand and increasing supply. The higher price may cause users to switch to substitutes which formerly were noncompetitive at the lower price, for exampie, copper in place of aluminum. Where acceptable substitutes are not available. use of the scarce material may be cut back; if the price rise is high enough. users may forego it completely. A similar spectrum of effects takes place on the supply side. As examples. the shortage- induced price rise could stimulate output by making unworked, lower-grade ores profitable; or it could encourage increased higher priced imports,

The need for Government action arises when a material becomes (or is projected to become) so scarce that the normal market mechanism can not prevent (or correct in reasonably timely fashion. i f at all) unacceptable distort ions to vital elements of the economy Consider. for example, a small shortfall in the nickel supply which raises the price by 10 percent. If the only users thereby denied access to nickel were nonstrategic producers (for example, toy manufacturers who could not absorb the price increase). there would not be reason for Government intervention. If the supply fell by 50 percent, however, and the resulting price rise forced producers of food machinery out of business. the problem would be of greater concern to the Government. If the supply were reduced by 90 percent. to a level that threatened defense production. the market's ability to allocate the scarce nickel on the basis of price might well break down, and governmental action could be needed to ensure vital needs and services.

In short, the principal market mechanism for allocation is price: in general. those who can afford to pay can get the scarce commod it y. Clearly, instances can arise where this criterion alone is incompatible with the public good.

The actual process of balancing supply and demand encompass a complex array of actions and is constantly at work, signaling the need for greater supplies and encouraging the most efficient ways to achieve them. Viewed from this perspective, shortages are seen to be fundamental to the market system and are neither good or bad. Examples of the wide range of normally occurring shortage-inducing factors are shown in table II–.2. Most of the factors are containable by market forces without Government intervention.

Serious shortages which could require Government action can occur for many reasons. Among the factors which could induce long-term shortages is the narrowing of relatively cheap domestic supplies of many important minerals, such as copper, lead, iron, and silver. Continued use of those materials by an expanding economy will require discovery of new deposits, development of new techniques for more efficient processing of lower grade deposits, and greater dependence on foreign sources of supply—all of which are uncertain developments, Other shortage-inducing factors result from new concerns for energy conservation and the effects of materials usage on the environment, These considerations limit the options of private decisionmakers and highlight the influence

Table n-2-Factors Tending To Diminish Supply

- A major supplier runs out of ore.
- The production system of a major supplier fails.
- Transportation breaks down between supplier and user.
- Price rise of the material causes supplier to turn to lower grade ores, which maintains throughput but lowers output.
- Capital costs rise so that maintenance of production facilities cannot be optimized and output declines.
- Facilities are diverted to removal of overburden or pockets of low yield ore and output declines.
- Operations are halted to make facility changes to satisfy safety regulations.
- Operations are curtailed to comply with environmental standards.
- Health absenteeism occurs on a major scale.
- Labor shortages occur, especially at remote sites.
- Improperly deferred maintenance occurs.
- Major accidents occur.
- Management/labor disputes occur.

Source: Adapted from F. P. Huddle, 'What Isa Shortage and What Can We Do About It?," presentation to the Society for the Advancement of Material and Process Engineering, October 1975.

Government has on the market's response. Still another factor that places some shortages beyond the reach of normal market forces is the changing situation with regard to foreign producers, the actions of OPEC being indicative.

In considering policies for any specific materials problem, the first need for Government policymaking is to anticipate which problems the market mechanisms alone are not likely to resolve satisfactorily or in a timely fashion. Once these are identified, Government policy makers can then consider a broad spectrum of responses. For example, if the shortage can be perceived early enough in terms of years, alternative sources of supply can be encouraged. Research and development programs can be emphasized to increase the productivity of domestic supplies and to find new substitutes which might be ready in time for the expected crisis. Stockpiles can be established. Policies could also be adopted to dampen demand through promotion of conservation practices or other means. However, if the shortage is near-term (or occurs without warning) and cannot be absorbed by the market, then a different range of Government responses can be invoked to supplement market forces, Past examples have included export controls, direct allocation of supplies, compulsory conservation measures (55 mph speed limit, Sunday gas station closing), price controls, and even rationing.

In general, the range of possible Government actions to deal with materials dislocations is very broad. Examples of activities and the principal agencies currently implementing them are shown in table 11–3. Table 11–4, developed by a recent National Academy of Sciences study on mineral supply, shows the possible impacts on production and consumption of a spectrum of actions that can be taken. Before any of these policies is applied, the Government policy maker must be able to

Table n-3.-Some Examples of Government Materials Activities

Policymaking Activity	Examples of Agencies Currently Involved
Support to domestic production	DOD, GSA, ERDA, National Bureau of Standards, Bureau of Mines
Development of new materials	DOD, Bureau of Mines, Forest Service, ERDA, NSF, EPA, FEA, DOI, DOA, Council on Environmental Quality, DOC
Conservation, substitution and recycling of materials	EPA, FEA, DOI, DOA, Council on Environmental Quality, DOD
Data collection and analysis	DOA, Bureau of Census, Tariff Commission, Bureau of Mines, U.S. Geological Survey
Policy, planning, and coordination	Congress, DOA, DOI, OMB, CEA
Control and regulation activities	Office of Export Administration, Nuclear Regulatory Agency, MESA, DOA
Monitoring of international activities	Department of State, DOA, DOC
Fiscal, monetary, and trade actions	Department of Treasury, Council of Economic Advisors, Federal Reserve Board, DOA

Adopted from: Meyer J. Harron and John D. Crawford, Government Materials Activities, Washington, D. C.: Federal Preparedness Agency, July 1975.

Table II-4.—Possible Government Actions in Regard to Mineral or Material Production and Consumption

Action	Impact on Domestic Production	Impact on Domestic Consumption
Financial		
Production subsidy, direct	+ to –	
Production subsidy, indirect	+	
Depletion allowance	+	
Tariff or duty on imports	+	
Federal lease bonuses and royalties	– to 0	
Government purchase and use practices	+ to –	
Exploration loans (e.g., OME)	+	
Government subsidy (including dedication of taxes) of mineral-using activities (highway, airport construction)		+
Government stockpile accumulation (domestic materials)	+	
Availability of government-identified resources	+	
Price controls	–	+
Consumer taxes		–
Production (severance, effluent taxes)	–	
Government stockpile reduction	–	
Support of materials research and development	0 to +	+ to -
Change from claim to lease system for minerals	– to +	
Incentives for foreign production	0 to –	
Depreciation	+	
Expensing of exploration costs	+	
Physical		
Import restrictions	+	
Federal land-leasing rate	+ to –	
Payment for deferred production	–	
Prohibition of production activities	–	
Zoning and withdrawal of land	–	
Prorationing	–	
Operational regulations (waste-disposal, health, land reclamation)	–	
End-use controls		–
Impurity limits (sulfur, mercury, etc.)		–
Regulations requiring building design to conserve materials		–
Regulations allowing or requiring internalization of all external or social costs of production		–
Regressive taxation of low-efficiency uses of scarce materials		–
Export controls		+

Source: Committee on Materials Policy, *Elements of a National Materials Policy*, publication NMAB 294, Washington, D.C.: National Academy of Sciences - National Academy of Engineering, August 1972.

demonstrate its need and project its consequences. For this he needs to understand how market forces operate throughout the materials cycle and to have reliable information on their current and projected status. Similarly, businessmen have need to factor into their plans the effects of possible Government actions. More than ever before, they too require quality information services and capabilities to arrive at effective actions.

This assessment is concerned with what information capabilities are required to support policy makers in the Federal Government in addressing materials-related problems. The systems in the private sector as well as in the Government that policy makers can call on were not designed for the kinds of problems expected to confront them. Rather, they evolved to meet a diverse array of public and private objectives within complex, diffuse, and pluralistic systems. Nevertheless, they represent an important national resource on which to base improvements. The structure and characteristics of these existing systems are described in the next section.

D. EXISTING MATERIALS INFORMATION SYSTEMS

There exists today a wide variety of information facilities and services with differing degrees of completeness and accuracy which support the country's materials system. In contrast to a "national" system, these information elements remain largely independent of each other. However, information from various Government, private industry, and academic locations in these systems can often be merged to address specific needs. Thus. the overall system should be regarded as a "nationwide" system—rather than a "national" coordinated and integrated system.

These existing systems were reviewed to understand how materials information is currently handled and to uncover some of the issues to be faced in deciding what improvements, if any, are needed to more effectively support materials policymaking in the Federal Government.

In its broadest context, the set of mechanisms by which people transfer, store, and use information on materials, comprises two major categories. One is the array of formal communications techniques organized around reports, handbooks, catalogs, and other documents. The other is the set of informal, largely verbal, techniques by which information is transmitted.[1] The emphasis of this assessment is on the formal systems which support policymaking decisions. However, it is necessary to recognize that in all cases policy action depends on the extraction of information from documents and other sources.

Individual information systems are varied and diffuse. as table 11–5 indicates. Like other kinds of scientific and technical information. materials information supports several kinds of activities. As elaborated in a study of the role of information services (ref. 4). these include conduct of science. generating technology and applying it in industry, public decisionmaking and policy formulation, and informing the general public. Although no simple characterization of these services is fully satisfactory. their principal components may be visualized as comprising three categories, as depicted in figure 11-4:

- Primary and Derivative Scientific and Technical Information—reports of original scientific and engineering investigations (primary sources), and compendia thereof (secondary and tertiary sources);
- Technical Trade Information—technically-oriented advertising and applications literature produced by vendor firms to promote sales; and
- Inventory and Economic Information—data and statistics characterizing the quantities and prices of materials

[1] As reported by Carlson (ref. 2) and by Wolfe (ref. 3) the informal person-to-person information channel plays a particularly important role in promoting the flow of new data and ideas among materials technologists.

Table n-5.-Examples of Elements Within Existing Materials Information Systems

GOVERNMENT

1. Interior
   a. Bureau of Mines
   b. Geological Survey
   c. Bureau of Land Management
   d. Division of Minerals Policy Analysis
2. Commerce
   a. Bureaus of Domestic and International Commerce
   b. National Bureau of Standards
      National Standard Reference Data System
   c. Bureau of Census
   d. National Technical Information Service
      Bureau of Economic Analysis
3. State
   a. Desk Officers
   b. Industrial and Strategic Materials Division
4. Defense
   a. DoD Information Analysis Centers
   b. Laboratories (AFML, AMMRC, NRL, etc.)
      Contractor Reports (DDC)
5. GSA
   a. Federal Preparedness Agency
6. Executive
   a. Council of Economic Advisors
   b. Council on International Economic Policy
   c. Office of Management and Budget
   d. CIA
7. EPA
   a. Laboratories (Cincinnati, Las Vegas, etc.)
   b. Contractor Reports
8. FEA
      National Energy Information Center
9. ERDA
   a. Laboratories (Hanford, Oak Ridge, etc.)
   b. Contractor Reports (RECON)
10. Library of Congress
   a. Congressional Research Service
11. NASA
   a. Laboratories (Langley, Lewis, etc.)
   b, Contractor Reports (RECON)
12. FPC
   a. Office of Economics
13. Labor
   a. OSHA
   b. Bureau of Labor Statistics
14. Treasury
   a. Tariff Commission
   b. Office of Raw Materials and Ocean Policy
15. Agriculture
   a. Laboratories
   b. Field Service
   c. Forest Service
   d. Economic Research Service
   e. Statistical Reporting Service
16. National Science Foundation
17. NAS/NAE
   a. National Materials Advisory Board
   b. Commission on Natural Resources
18. State Development Agencies

PRIVATE SECTOR

19. Universities/Academia
20. Industry
   a. Internal Information Systems
   b. Trade Literature
   c. Manuals and Handbooks
   d. Technical Literature
21. Trade Associations
22. Rate Bureaus
23. Technical Societies
   a. Technical Meetings
   b. Magazines, Journals
   c. Professional Papers
24. Handbooks, Textbooks, Technical Literature
25. Information and Abstracting Services
26. Independent Laboratories
27. Patent System
28. Banking and Financial Houses
29. Labor Organizations
30. Public Libraries
31. Foreign Systems and Sources
32. Newspapers, radio, TV, etc.

throughout the materials cycle. including economic analyses and projections thereof,

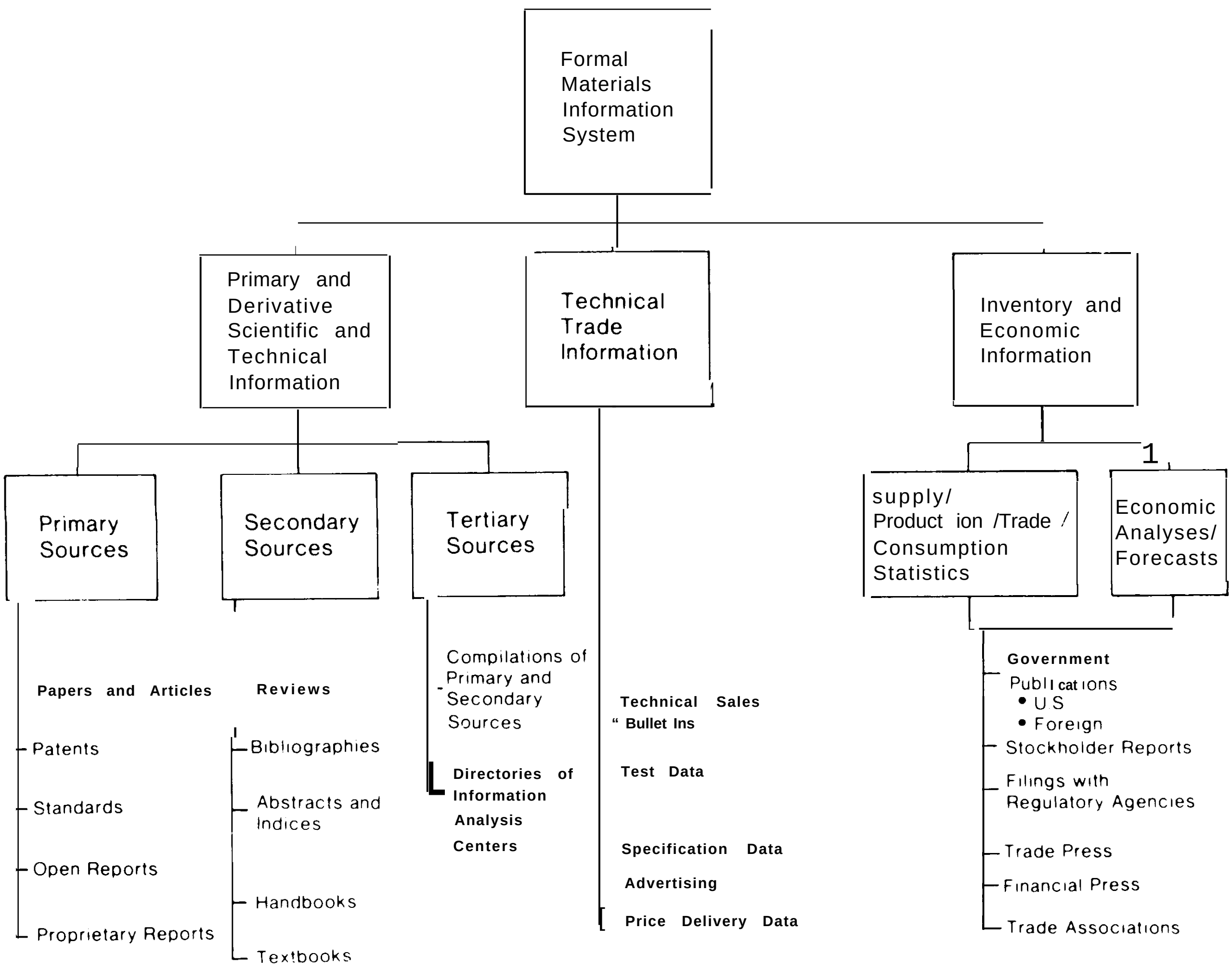
Each step in the materials cycle generates information, some more oriented toward one category than to another. In general, though, all three categories of information flow from each step. as indicated in figure II–5.

1. Scientific and Technical Information

Technical materials literature is the most common form of scientific and technical information. Its volume is large and growing, as the following instances illustrate:

- The American Society for Metals lists more than 1,000 worldwide journals that publish papers on the properties, production. fabrication, treatment, finishing. and applications of metals. About 100 of these are English language journals having metals technology as their principal thrust.
- A selective guide to sources of fibers and textile information cites 16 journals in that field.

Figure II–4. Categories of Materials Information

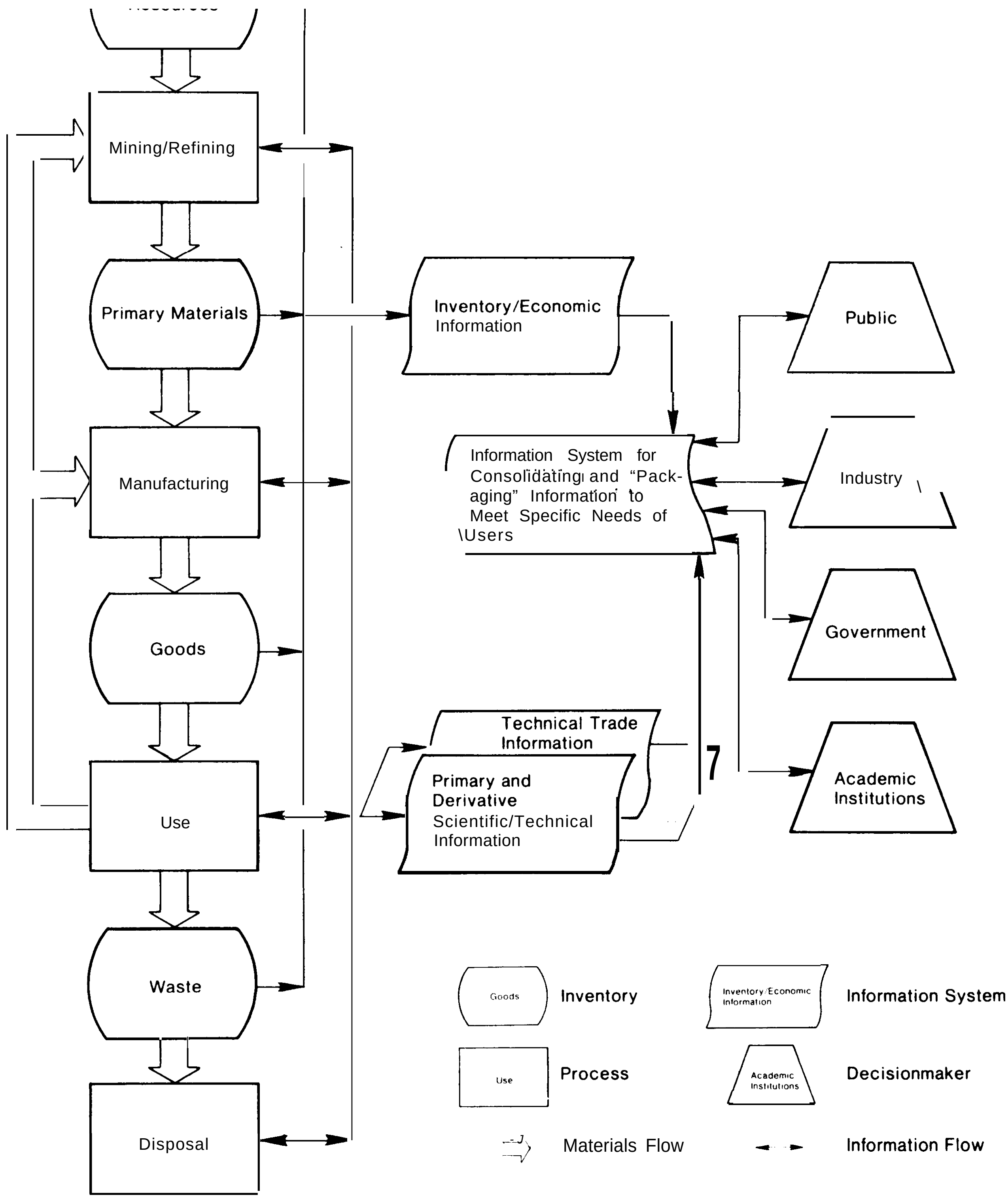


Note Depicted here are the information products per se, not the services which produce them

- A Federation of Materials Societies survey of the information services of 13 materials-oriented societies (excluding wood or fiber fields) showed publication in 1971 of 95.000 journal pages: in addition, the societies published 217 conference proceedings in a 3-year period (ref. 5). A selective guide to metallurgy literature alone cites 10 professional societies and 35 research and trade associations, man y of which sponsor primary publications.
- The number of scientific and technical reports published by the U.S. Government is estimated to be **80,000** per year. of which a substantial number deal with materials issues.
- Some 35 States and the Federal Government generate materials standards. The Department of Defense has issued over **35,000,** the General Services Administration another **6,000.** In addition. over **400** nongovernment technical and professional groups issue them.

80-678 0 - 77 - 4

Figure II–5. Flow of Information Through the Materials Cycle



- In a report prepared for the Organization of Economic Cooperation and Development (OECD), Anderla projected the number of scientific and technical articles that would be published in 1985 to be three to four times the number in 1970 (ref. 6). Anderla also projected that:[2]

—In 1967, holdings of scientific and technical information (covering all fields and including primary, secondary. and trade data) amounted to 250 million pages and were being generated at a rate of 45–50 million pages per year.

—The world stock of articles in 1967 numbered at least 20–30 million.

—Contrary to earlier predictions, the growth of technical information would continue, at a rate between 7.2 and 13.5 percent per year (corresponding to a doubling every 5.5 to 10 years).

This explosion of primary technical publications is not a recent phenomenon. As long ago as 1830, as the number of journals proliferated, secondary sources in the form of abstracting services first came into being. Garvey and Compton estimate that they have since grown exponentially, by a factor of 10 every 50 years (ref. 2). A selective guide to sources of metallurgy information lists 58 abstract journals and an additional 25 index publications. A similar guide to fibers and textile information notes 30 abstracting services. The number of abstracts published by the materials societies polled by the Federation of Materials Societies (FMS) in 1971 (ref. 5) was in the range of 125–175,000 per year. Using Anderla's "conservative" projection rate of 7.2 percent per year, the current rate of abstracts for the 13 societies alone may be approaching a quarter-million per year. Other secondary sources are handbooks and textbooks. A guide to fiber and textile literature cites 11 handbooks and encyclopedias of general interest. A similar guide to metal literature notes 31 handbooks, still other handbooks compile information on wood. The FMS survey found that the 13 materials societies polled alone published 234 technical books over a 3-year period (ref. 5).

As the volume of primary and secondary material grow, a need arises for two new information services: tertiary compilations of secondary sources and directories of information analysis centers. (References 8 and 9. sources of many of the statistics cited here. are examples of tertiary sources.) Information analysis centers are facilities for evaluating information on particular materials; they are further described later in this chapter.

2. Technical Trade Information

This second category of materials information covers technical brochures, specifications. test data and the like distributed by firms. often through sales engineers. to promote the sale of materials. For a variety of reasons. this category has not received the same development and attention as have the more scientific systems. As a practical matter, however, it probably represents the most important source of materials information for smaller companies without science-oriented staffs.

In a study in the United Kingdom. Wolfe has shown that personnel in the textile industry and in metal industries each derive 40 percent of all the written information they use from trade literature (ref. 3). Although no comparable study has been conducted in the United States, there is reason to think the percentage may be even higher.

While some observers see "a decreasing amount of good technical literature available from materials suppliers" (ref. 10), much of it appears to be excellent. Recognizing the importance of describing their products to prospective customers, many of the larger firms operate extensive trade information services. Examples include E. 1. duPont de Nemours & Co., which has implemented a telephone system for accessing a central information base that currently handles nearly 10,000 calls per month, and Climax Molybdenum Co.

[2] It should be noted that some of Anderla's conclusions are disputed by other information investigators; see ref. 7.

3. Inventory and Economic Information

Much of the information in this third category, covering quantities and prices of materials throughout the materials cycle, is generated by industrial organizations. Much of it is compiled by trade associations and by an array of special trade and financial journals. such as The American Metal Market and Metal Week, Additional information is contained in stockholders reports and in filings with regulatory agencies. Another large segment of this kind of information. however, is proprietary and not available to the general public, Government executive departments, or Congress.

A principal source of "open" inventory and economic information includes the more than 20 Federal Government agencies that collect data elements from materials-oriented organizations and publish aggregated information. While much of the data are obtained on a voluntary basis, many of the agencies derive their collection authority from specific legislation. For example, the Bureau of the Census has conducted a census of minerals (currently on a 5-year cycle) since 1840. The International Trade (Tariff) Commission reports the annual domestic product ion and sales of synthetic organic chemicals and the raw materials for producing them under provisions of the Tariff Act of 1930.

The volume of Government-generated information is very large. As one indicator of its scope, the Bureau of Mines, one of the principal agencies in the minerals field, typically issues some 750 separate reports each year. One series, the Mineral Industry Survey, covers some 250 reports containing economic data on 95 commodities: some of these reports are issued weekly, others monthly. and all are issued annually. Other series cover a variety of technical and economic subjects: in fiscal year 1975 they comprised over 20,000 published pages.

Industry as well as Government analysts rely on Government-derived information. In many instances, no alternative sources exist since individual firms are often reluctant to provide comparable data to nongovernment agencies and other firms do not accept as accurate the data that is gathered.[3]) Moreover, for legal [antitrust) reasons, individual firms or associations may be, or consider themselves to be, precluded from collecting industry wide, national data,

4. Information Handling

The methods employed for collecting, sorting, consolidating, analyzing, and distributing information to users vary with the category of materials information. The most advanced in terms of use of specialized facilities and automation are the methods for handling scientific and technical information. Since the largest portion of this kind of information is in documents, the principal means for processing is the technical library. Processing functions include all the basic library services: obtaining and controlling documents, abstracting, indexing, and providing awareness of relevant new information.

Many science-oriented materials organizations have formally recognized the importance of information and formed special information groups to supplement the normal library functions. In these groups, materials specialists who develop a first-hand familiarity with the literature perform a variety of personalized, indepth services for the researcher. A 1959 survey of science-oriented chemical industries showed that 40 percent of the responding organizations spent from 1.5- to 2,5-percent of their research budget on library/information group activities; another 15 percent of the organizations spent from 2.5 to 10 percent (ref. 11). Although more recent comprehensive data are not available, there is reason to suspect that the 1.5 to 2,5 percent-range may

[3] A case in point concerns toluene. Production statistics compiled by a trade association based on voluntary submissions have been found to differ by as much as 40 percent from similar statistics published by the Government.

still be representative. A large automobile company currently spends 1.5 percent of its research budget on technical information services; the National Bureau of Standards allocates 2 percent of its budget to information services.

Over the past .20 years, the research-oriented information processing functions have been expanded through the development of several new computer services. One application is the automatic preparation of bibliographies of selected fields, a service now broadly available for purchase or lease at relatively low cost. Another application involves advances in indexing and the use of interactive searching. in which the researcher observes the output of a computer in realtime and appropriately redirects its search rout inc. Computers have also had wide use for selective dissemination of information, in which reports are distributed on the basis of a computer comparison of individuals' interest profiles with assigned index characteristics. A variety of other advanced computer functions have also been suggested (ref. 12).

One of the other new services that have developed for scientific and technical information is the information analysis center. Information analysis centers are:

> ... formally structured organizational units, specifically (but not necessarily exclusively] established for the purpose of acquiring. selecting, storing, retrieving, evaluating. analyzing. and sythesizing a body of information and/or data in a clearly defined specialized field or pertaining to a specified mission with intent of compiling. digesting. repackaging, or otherwise organizing and presenting pertinent information and/or data in a form most authoritative, timely. and useful to a society of peers and management, (ref. 13)

Forerunners of information analysis centers date back to the 19th century, but their modern development began with the rapid expansion in major research and development programs following World War 11. Some of the earliest centers were materials-oriented. Since 1958, they have proliferated, and there are now about 100 federally sponsored centers of which about half (58) are materials-oriented, In addition there are perhaps a half-dozen materials information analysis centers that are totally privately financed. Table II-6 lists some of the federally supported materials-oriented centers, as compiled by The National Referral Center.

Typically. the services provided by an information analysis center include both center- initiated products of general interest to all subscribers and custom-tailored services in response to user requests. Examples of the former are critical data compilations (in which an authority in the field reviews and comments on the validity of newly acquired data), bibliographies. state-of-the-art reviews, and newsletters. Custom services include selective 1iterature searches and consultation on specific problems,

The essential characteristics of the materials information analysis center that distinguishes it from a library are its focused area of interest and the unique, specialized competence of its staff, The size and scope of operations of different centers vary greatly, Some are staffed by as many as 100 or more professionals, others by as few as one or two. Descriptions of a large, medium. and relatively small center are presented in table 11-7,

In addition to information obtained from the scientific - technical category, information processing in support of the designer. the engineer, the purchasing agent, and others concerned with the practical applications of materials leans heavily on technical trade information. In contrast to the approaches that have evolved for servicing the research and technology community. there are few standardized approaches for handling technica1 trade information. Most corporations, even the largest, rely on procedures that are locally devised and implemented by the various engineering groups. An exception, perhaps indicative of a trend. is the Engineering Materials and Processes Information System (EMPIS) operated by the Corporate Research and Development t group of the General Electric Company (GE). In operation for 40

Table n-6.-Some Materials-Oriented Information Analysis Centers

Name	Location	Operator	Sponsor	Staff Size
Air Pollution Technical Information Center (APT ICI	Cleveland Ohio	National Aeronautics and Space Admin		13 full -time
Alloy Data Center	Washington DC	Alloy Physics Sect Ion		2 full -time 2 part-time
Atomic Energy Levels Data Center	Washington DC	NBS	NBS	1 physicist 1 chemist 1 full -time clerical asst
Atomic Transition Probabilities Data Center	Washington DC	NBS	NBS	2 part- time physicists
Bureau of Mines Associate Director Mineral and Materials Supply Demand Analysis	Washington DC	Dept of the Interior		300
Bureau of M)nes—Mineral Supply Alaska Field Operation Center	Juneau Alaska		16 full-time 9 engrs	1 geologist
Bureau of Mines --Mineral Supply Eastern Field Operation Center	Pittsburgh PA			35 full-time
Bureau of Mines—M,neral Supply Western Field Operation Center	Denver Colo			40 full-time
Chemical Kinetics Information Center	Washington DC	Physical Chemistry Division	NBS and U S Naval Ordinance Command	3 professionals 1 semi-professional 2 clerical
Chemical Propulsion Information Agency (CPIA\	Silver Spring MD	John Hopkins Univ	Defense Supply Agency Depts of the Navy Army and Air Force and Nail Aeronautics and Space Admin	1 1 professional physicists chemists and engineers and 1 1 staff members
Chemical Thermodynamics Data Center	Washington DC	NBS	NBS	7 chemists 1 technical asst 2 clerks
Controlled Fusion Alomic Data Center	Oak Ridge TN	Oak Ridge Natl Lab	ERDA	4 Scientists 2 non technicals (full- time)
Criticality Data Center	Oak Ridge TN	Union Carbide Corp	ERDA	1 professional and 1 2 nonprofessional
Cryogenic Data Center	Boulder Colo	NBS	NBS NASA American Gas Assoc	Full- time 4 physicists 1 chemist 2 engrs 1 documentation spvr 3 clerks part-time 1 physicist 1 engr 3 clerks
Crystal Data Center	Washington DC	NBS	NBS	Full-time 3 crystallo graphers 1 technical asst
Data Center for Atomic and Molecular Ionization Processes	Washington DC	NBS	NBS	? professionals and full-time clerical support
Data Center on Atomic Line Shapes and Shifts	Washington DC	NBS	NBS	1 part-time physicist
Diatomic Molecule Spectra and Energy Levels Center	Washington DC	NBS	NBS	1 physicist
Diffusion in Metals Data Center	Washington DC	NBS	NBS	2 full-time and 4 part-time
DOD Nuclear Information and Analysis Center (DASIAC)	Santa Barbara CA	GE TEMPO	DNA	24 full-time
Earth Resources Observation System (EROS) Data Center	Sioux Falls SD	U S Geological Survey		210 full-time
Ecological Sciences Information Center	Oak Ridge TN	Oak Ridge Natl Lab	AEC	1 manager 3 Information Specialists-biologists (1 half-time) 2 information technician assistants
Electrolyte Data Center	Washington DC	NBS	NBS	2 part-time
Electronic Properties Information Center (FPIC)	West Lafayette IND	Purdue University	DSA	4 full-time 4 part-time
Energy Information Center	Oak Ridge TN	Oak Ridge Natl Lab	Nail Science Foundation RANN Program	3 full-time
Environmental Information Analysis Center (EIAC)	Columbus ohio	Battelle Mem Inst	ERDA	3 full- time
Environmental Information Division	Maxwell AF Base ALA	Alr Training Command		4 full -time
Environmental Mustagen Information Center	Oak Ridge TN	Oak Ridge Nail Lab	ERDA Natl Inst of Environmental Health Sciences	2 full-time 1 part-time
Eutrophication Information Program	Madison WIS	University of Wisconsin	Dept of the Inter Dept of Agric U S Environ Protect Ion Agency Univ of Wisconsin	1 full time 5 part-time

Table n-6.-Some Materials-Oriented Information Analysis Centers (Continued)

Name	Location	operator	Sponsor	Staff Size
Gamma-ray Spectrum Catalogue	Idaho Falls Idaho	Nail Reactor Testing Station	ERDA	12 part-time
Health and Safety Analysis Center	Denver Colo	DOI		66 engineers statisticians mathematicians and clerks
High Pressure Data Center	Provo Utah	Brigham Young Univ	NBS	2 full-time 1 part-time
Infrared Information and Analysis Center (IRIA)	Ann Arbor Mich	Environmental Res Inst of Michigan	Det Supply Agency Office of Naval Research	4 full-time 412 clerical 30 to 40 technical staff members
LMFBR Fuel -Cladding In forma tion	Richland Wash	Hanford Engr Dev Lab	ERDA	5 full time 1 part -time
Machinability Data Center	Cincinnati Ohio	Metcutl Research Assoc Inc	Army Materials and Mechanics Research Center Watertown Mass	8 lull-time 5 part tilme
Mechanical Pro Dept, es Data Center	Traverse City Mich	Belfour Stulen Inc	AMMRC Watertown Mass	13 full time
Metals and Ceramics Information Center (MCIC)	Columbus Ohio	Battelle Memorial Institule	AMMRC Watertown Mass	100 paft time 21 full time
Microwave Spectral Data Center	Washington DC	NBS	NBS	1 sclentist
Molten Salts Data Center	Troy NY	Rensselaer Polytechnic Inst	NBS	Director and postdoctorate and predoctorate co workers with specialties in fused Sal S physical properties and electroochemistry ,
National Oceanographic Data Center	Rockville MD	NOAA		76 professionals and 43 nonprofessionals
National Space Science Data Center	Greenbelt MD	GSFC	NASA	92 full [(me
Nondestructlve Testing Informafion Analysis Center	Watertown Mass	AMMRC	AMMR	4 part time 3 technical professional and 1 clerk
Nuclear Data Project	Oak Ridqe Tenn	Oak Ridge National Lab	FRDA	1 1 professionals and 8 nonprofessionals
Nuclear Safety Inform a! or Center	Oak Ridge Tenn	Oak Ridqe National Lab	ERDA	12 part time
Phase Diagram Y for Ceramists	Washington, D C	NBS	NBS American Ceramic Society, Inc	3 part time
Photonuclear Data Center	Washington D C	NBS	NBS	3 nuclf, ar phy sicsts 1 clerk
Physical Data Group	Livermore Calif	University of call fornia		1) fu r time
Plastics Technical Eva 111a tion Center (P: ASTEC)	Dover N J		Army Materia Con	1 7 fu time
Radiation Chemistry Data Center	Notre Dame Ind	Radiation : ab	NBS ERDA	4 full time 2 pa, t tme
Radiation Shielding I. formation Center	Oak Ridge Tenn	Oak Ridge Nat, onal Lab	F RDA De fense Nuc ear Agency	1 2 fu, tme 4 p, rt t n e 5 member technic a advsor, c mmittee
Rare Earth Informati on Center (RIC)	Ames Iowa	Io wa State University	ERDA	1 5 ful time 1 part time 1 half l ime
Reliability Analysis Center	Griffiss Air F err,. Base N Y	RA DC (RBR AC)	Grifiss Air Force Base Andrews 4(I F orceBase	1 5 fulltime
Rock Properties Information Center (RPIC)	West Lafayette Ind	PurdueUni, ersit,	Nat, ona Science F oundation (RANN) Purdue s Thermo phys cal Properties Research Center	6 part time
Shock and V! bration Information Center	Washington O C	NavalResearch . ah	Dept of De fense & Natl Aeronautics 8 Space Admin	F ful time
Superconductive Ma terials Data	Schenectady N Y	General Electric Research & De v C tr	NBS	? partt me
able of Isotopes Project	Berkeley C alf	Univ of Call forni d	NBS ERDA	1 seni or omple r 4 fu time ? p art time t typist 1 computerprogrammer
hermophysical Properties Research Center (TPRC)	West Lafayette Ind	Purdue Univ	U S Government Agencies	Approximately 37
oxic Materials Informati on Center (TMIC)	Oak Ridge Te nn	Oak Ridge N u Lab	Natl Science F undat I on AEC	5 professiona s
USAF Environmental Tech Applications Center	W ashington D C	Nav y Yard Anne x	U S Air Force	200
(flay Attenuation Coefficient nformation Center	Washington D C	NBS	NBS Defense Nuc lear Agency Dept of Defens I=	1 fu ltime 1 1 4 time

Source National Referral Center *Directory o f Federally Supported Information Analysis Centers* Washington D C Library ot Congress 1974

Table n-7.-Large, Medium, and Small Specialized Materials Information Analysis Centers

METALS AND CERAMICS INFORMATION CENTER (MCIC) Battelle Memorial Instltute Columbus Laboratories Columbus Ohio 43201 SPONSOR Department of Defense Off Ice of the Director of Defense Research and Englneerlng under a Defense Supply Agency contract monitored by the Army Materials and Mechanics Research Center, Watertown, Mass YEAR STARTED 1955 STAFF 100 part-time professional technicals (20 percent), 7 full-time professional technicals, 4 full-time information specialists and 10 full-time typing and clerical MISSION To provide technical assistance and information on materials within the Center s scope, with emphasis on application to the defense community SCOPE Metals Titanium, aluminum and magnesium beryllium refractory metals high-strength steels, superalloy (primarily nickel- and cobalt-base alloys) and rhenium and vanadium *Ceramics* Borides, carbides, carbon/'graphite nitrides oxides, sulfides silicides intermetallics, and selected glasses and glass-ceramics Composites of these materials, coatings, environmental effects mechanical and properties materials applications, test methods sources suppliers, and specifications other materials mutually agreed upon by the contractor and the Government HOLDINGS Reports on Government-sponsored research journals patents data, trade literature books PUBLICATIONS Monthly newsletter (disseminated free by the Center to anyone engaged in materials research development, or utilizatlon), a series of weekly reviews on developments in metals technology, a monthly review of ceramic technology, a variety of engineering reports and handbooks related to the utilizatlon of advanced metals and ceramics The reviews, reports and handbooks are available at cost from the National Technical Information Service SERVICES Answers to technical inquiries, bibliographies, literature, searches and special studies are provided on a fee basis depending on the time involved QUALIFIED USERS Services are available to the technical community without restrictions	**MACHINABILITY DATA CENTER** Metcut Research Associates Inc Clnclnnati Ohio 45209 SPONSOR The center is operated by Metcut Research Associates Inc under contract to the Defense Supply Agency with technical aspects being monitored by the Army Materials and Mechanics Research Center Watertown, Mass YEAR STARTED 1964 STAFF 7 machining data analysts (3 full-time and 4 part-time), 3 systems and data processing personnel (2 full-time and 1 part-time), 1 document acquisitioner (full-time), 1 user/inquiry controller (full-time), and 1 management (full-time) MISSION To collect evaluate, store and disseminate material removal information including specific and detailed machining data for all types of materials and material removal operations both conventional and unconventional SCOPE All kinds of material removal operations such as turning milling drilling grinding, electrical discharge machining electrochemical machining chemical machining, etc with strong emphasis on engineering evaluation for the purpose of developing optimized material removal parameters such as speeds feeds depths of cut tool material and geometry cutting fluids and other significant variables HOLDINGS Over 32000 evaluated documents that can be retrieved specifically by content using a computerized system PUBLICATIONS *MDC Machining Briefs* (distributed free to MDC Users) *NCECO-N/C Maching Costs* (computer program 1 973) *Machining Data Handbook* (2d ed 1972), *Machining 01 High Strength Steels with Emphasis on Surface Integrity* (1970), *Determination and Analysis of Machining Costs and Productlon* Rates Using Computer *Techniques* (1968), *Machining Data for Nurnerical Control* (1 968) and 1968 *Supplement to Machining Data for Numerical Control Grinding Ratios for Aerospace A//oys* (1966) *Machining Data for Beryllium Metal* (1966), *Machining Data for Titanium A//oys* (1 965) SERVICES Answers inqulrles, provides consulting, reference literature-searchlng abstracting and Indexing, and reproduction services, provides R&D information conducts seminars, lends materials, makes referrals to other sources of Information, permits onsite use of collection Answers to inquiries that can be handled quickly over the phone are provided free, other services are provided on a fee basis QUALIFIED USERS Anyone, with certain limitations in foreign disseminatlon	**RARE-EARTH INFORMATION CENTER (RIC)** Energy and Mineral Resources Research Institute Iowa State University Ames Iowa 50010 SPONSORS The Ames Laboratory of the U S Atomic Energy Commission and over 40 U S and foreign rare earth producers and advanced technology corporations YEAR STARTED 1966 STAFF 1 5 full-time professional (chemistry) and 1 part-time professional (metallurgy) 1 half-time nonprofessional MISSION To serve the scientific community by collecting storing evaluating and disseminattng rare earth information from various sources SCOPE The Center is concerned primarily with the physical metallurgy and solid state physics of the rare metals and their alloys but it also maintains files on the analytical Inorganic and physical chemistry geochemistry ceramics and toxicity of the rare earth elements and compounds HOLDINGS About 5 000 reprints reports and books PUBLICATIONS *Rare Earth Information Center News* (quarterly distributed free) technical reports state-of-the-art reviews data compilations bibliographies SERVICES Answers inquiries, provides literature-searching and abstracting and Indexing services, prepares in-depth reports, makes referrals to other sources of Information, permits onslte use of collection A minimum charge of $25 has been set to cover the expenses involved in answering most typical inquiries QUALIFIED USERS Anyone

Source National Referral Center *Directory of Federally Supported Information Analysis Centers* Washington D C Library 01 Congress 1974 years, EMPIS provides a systematized materials description service for GE operating departments. System output is principally in the form of coded pages of text, tabulations, and diagrams. Currently EMPIS contains over 21.000 pages: about 3,000 are added or updated each year.

Some of the technical library services described previously are also used to support engineering information needs. So too are the materials information analysis centers; many offer focused consul tat ion on particular problems.

For support to management and related planning functions, inventory and economic information is of principal interest; of course. information from the other categories is involved as well. Even less than procedures for handling technical trade i n format ion, standardized processing procedures for the management and planning functions are undeveloped. To be sure. materials industries have always recognized the need to be able to project the demand for their products. This is an essential element in planning plant capacity and related production inputs, and a variety of planning tools have been developed for the purpose, each unique to a particular business. But the emphasis was uniformly on projected demand. Although some significant materials shortages occurred in the 1950's, it was not until 1973–74, when supplies suddenly became exceedingly short, that the need surfaced to consider seriously the supply side of the equation as well, In the face of the more complex materials problems now emerging, more sophisticated planning tools have had to be developed which take a variety of supply factors into account. Thus, a company which converts raw materials to an intermediate material needs to consider not only the effects of interruptions in raw material supply but also shifts in demand brought about by a shortage in a substitute raw material as well as the uncertain intent ions of competitor producers.

The analytical techniques for accomplishing such industrial analysis are still in the very early stages of development, The problems are very difficult and beyond the capability of most companies. Only a very few large organizations have formed special materials strategy groups to deal with them. While the analytical methods vary from one industry to another, several common concepts are evident:

- The strategy analysis draws on information from every aspect of the business: resource and development, engineering. purchasing. finance, and marketing. It demands a level of comprehensive skill that is usually in very short supply and is probably beyond the capability of smaller companies to develop for themselves. Specialized consulting companies are beginning to offer this capability.
- There is heavy reliance on information that is available only from Government sources.
- Computers play only a minor role in the analysis. At this stage of industria1 supply/demand model development, there are few realtime constraints ca11ing for computers. The principal challenge is for analysts to derive proper analytica1 rela - tionships. In the future. planning systems conceivably might weigh the effects of very short interval changes in supply and demand estimates and in other exogenous variables and report them to policy makers in near real-time. but it is not clear when, or if, this will ever be necessary.

While industrial organizations are concerned with analysis of their own supply/demand variables, Government agencies are concerned with aggregated analysis. both of selected industrial segments and of the economy as a whole. A large number of agencies are involved in developing these analysis procedures, A recent review of Government activities to avert and alleviate materials shortages showed that some 57 executive agencies, 15 congressional committees, and 3 congressional offices are involved in policy planning (ref. 14), Just as inventory and economic information is collected by agencies on an autonomous basis, so too the Government's systems for processing inventory and economics information have largely been uncoordinated. As an outcome of the materials shortages of 1972–73, efforts are now underway to improve this situation, especially to effect closer coordination within individual departments {such as among the different groups in the Department of the Interior). Nevertheless, the state of development of combined supply/demand analytical models is still relatively immature, Until the late 1960's, few Government agencies were using sophisticated analytical techniques. Probably the most advanced were those in the Department of Agriculture for renewable materials, which were patterned along those used for food commodities. With regard to mineral commodities, the responsibility for tying supply and demand together has not been clearly established.

E. SUMMARY

The review of existing materials information systems confirms several impressions and indicates several trends. Although largely uncoordinated. individual systems in industry, academic institutions, and Government have all played important contributing roles in the development of U.S. materials policy, In the past, and continuing even today, the most formally developed information systems deal principally with scientific and technical information. Least developed are the systems dealing with economic and inventory information, and particularly lacking are the analytical information processing techniques for interpreting data. In the face of the growing need that policy makers have for materials information, these deficiencies become even more significant.

Whether or not, in light of emerging issues and considerations, these systems adequately meet the particular needs of Federal policy makers is examined further in chapter III.

F. REFERENCES

1. Sowell. Thomas, Economics Analysis *and Issues*, Glenview. Ill.: Scott, Foresman and Company, 1971. p. 87.
2. Carlson, Walter M., cited in Garvey, William D., Compton, Berlita E., "The Flood and How to Survive It, " *The John* Hopkins Magazine, Fall 1967.
3. Wolfe, H. N., et al., The Economics *of Technical* Information Systems, New York, N. Y.: Praeger Publishers, Inc., 1974.
4. Organisation for Economic Co-Operation and Development, Information *for* a Changing *Society*, Paris, France: OECD Publications, 1971.
5. Wachtman, John B., Jr., Report on Survey *of* Materials Oriented Scientific *Information* Services, Task Force Group on Implementation of the Steering Committee of the Proposed Federation of Materials Societies, June 1, 1972.
6. Anderla, Georges. Information in 1985, A Forecasting Study *of* Information *Needs* and *Reso* es, France: Organisation for Economic Co-Operation and Development, 1973.
7. National Science Foundation, Growth *of* Scientific and Technical Information, A *Challenge*, Washington, D. C. January 1974.
8. Hyslop, Marjorie R., A *Brief Guide* to Sources *of Metals Information*, Washington, D. C.: Information Resources Press, 1973.

9. Sommar. Helen G.. A *Brief Guide to Sources of Fiber and Textile Information*. Washington, D.C.: Information Resources Press. 1973.

10. Editorial. *Materials Engineering*. November 1975. p. 5.

11. Knox. W. T., "Administration of Technical Information Croups," *Industrial and Engineering* Society, Vol. 51, No. 3. March 1957.

12. Kemeny. John G.. "*Library of* the *Future*." Dartmouth College Library Bulletin. April 1972.

13. The Weinberg Report, as quoted in *Engineering*, Scientific *and Technical Communication*. Washington, D.C.: National Academy of Sciences. 1969.

14. Harron. Meyer J.. and Crawford, John D.. *Government Materials Activities*. Washington. 13. C.: Federal Preparedness Agency. July 1975.