SUMMARY

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A. BACKGROUND

The processing and use of materials account for almost 50 percent of the U.S. Gross National Product, some $576 billion. In 1973, materials-oriented sectors employed over 34 million workers—45 percent of the full-time work force. In 1973, these sectors consumed over 80 percent of the total value of all U.S. imports. Significantly, materials imports have been rising since 1967, and there have been periodic scarcity-related situations since the 1950's. But it was not until the 1973 oil embargo that many people realized the United States could in fact run short of some vital materia1s, especially those from foreign sources of supply.

To address emerging problems, and to provide materials at reasonable prices throughout the mine-to-consumer process requires effective management, and effective management in turn requires a broad spectrum of information and analysis. Scientists and engineers need technical data[2] on materials properties and processes. Businessmen need information on materials supply and demand. Government policy makers need information and analysis to decide whether emerging materials problems can be solved by the existing market system or whether some type of Government action in support of the market is required.

In response to the need for effective management as well as for timely information and analysis, a large number of formal and informal materials information systems have been developed, both in the public and private sectors. Table 1 indicates the diversity of materials activities in just the public sector which depend upon these systems for information and analysis.

These information systems have served the Nation well for many years. However, new issues, like those surrounding the availability of imported materials. have raised questions regarding their continuing effectiveness. Not only are concerns about potential scarcities and outright shortages intensifying, but policy makers must deal today with a wide range of difficult and interrelated questions for which existing information systems were not developed. For example, will a shortage in a particular critical material develop and when ? Where will the impact be felt most severely ? How might affected industries ease the resulting economic distortions? What policy options (stockpiling. conservation, substitution, expanded production capacity, export controls. import tariffs, price controls, subsidies. research and development grants. Federal land leasing. etc.) might be adopted?

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[1]Materials have been defined in a number of ways. including: "Natural resources intended to be utilized by industry for the production of goods. with the exclusion of food". (This definition is taken from Title II of Public Law 91-512. the Resources Recovery Act of 1970.) Another definition that is suggested when using materials is the modern sense of addressing the "Materials Cycle". It is an all-encompassing one. Frank Huddle defines "materials" in *Science Policy: A Working Glossary*. as "the stuff that things are made of or with. or could be".

[2]As used here. data are specific facts—usually numerical. quantitative. and measurable. Examples are the properties of materials. the populat inns nf c it ies. and t he d imens ions of 1,1 nd masses. Being prima rily numerical. data are fa ir ly read i I y stored and manipulated in automated systems Information is the broader class of knowledge. encompassing judgments experience. art. behaviorial considerations. etc Examples include di rec t ions on how to do some thing expressions of policy. socia I considera tionses the t ics. :1 I t ernat ives Because i t is expressed in words. the broader aspects of 'in formation', 1 remore d ifficult to mechan i ze Data are ,1 category of i n form a tion These cons idera tions are significant when one contemplates the implementation of an aùtomated i n format ion system

Table 1: Selected Examples of Government Materials Activities

Policymaking Activity	Examples of Agencies Currently Involved
Support to domestic production	DOD, GSA, ERDA, NBS, Bureau of Mines
Development of new materials	DOD, Bureau of Mines, Forest Serv , ERDA, NSF, EPA, FEA, DOI, DOA, CEQ, DOC
Conservation, substitution, and recycling of materials	EPA, FEA, DOI, DOA, CEQ, DOD
Data collection and analysis	DOA, Bureau of the Census, Tariff Comm,, Bureau of Mines, U.S. Geological Survey
Policy, planning, and coordination	Congress, DOA, DOI, OMB, CEA
Control and regulation activities	Ofs. of Export Admin., Nuclear Regulatory Agency, MESA, DOA
Monitoring of international activities	Department of State, DOA, DOC
Fiscal monetary and trade actions	Dept of Treasury, CEA, FRB, DOA

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

Finally, each question must be considered within the context of specific materials properties and characteristics, as well as changing domestic and international political situations.

B. SCOPE AND OBJECTIVES

The purpose of this assessment is to provide background and analysis so that Congress can consider: (1) how adequate existing materials information systems are in supporting governmental policymaking, particularly in regard to potential scarcities or outright shortages; (z) what improvements, if any, are needed to furnish policy makers with the information and analysis they need to deal with scarcities or outright shortages, and (3) what impacts, if any, might stem from such improvements.

In contrast with past studies which considered only isolated aspects of materials information, this assessment addresses materials information in a comprehensive manner by looking at the demand, supply, and other related factors influencing materials flow throughout the materials cycle—from exploration, mining, production, utilization, and recycling to eventual disposal.

The assessment was thus organized and conducted to address the following questions:

- Are information systems which currently support Federal materials policymaking adequate to address complex materials problems?
- If the systems cannot provide the needed capabilities, what kind of improvements are required ?
- How might these improvements be achieved—by what organizational authority, and under what kinds of institutional arrangements?
- What impacts, if any (institutional, economic, social, international, and legal), might result from implementing such improvements?
- Finally, what public policy issues might accompany such improvements, if implemented?

C. IMPROVEMENTS REQUIRED IN EXISTING MATERIALS INFORMATION SYSTEMS

In view of the growing importance of materials issues and the role of public policy in dealing with them, existing materials in formation systems were found to be inadequate to

support Federal policy makers responsible for anticipating and coping with scarcities or outright shortages. The assessment found that some of the analytical and coordinative functions needed to address these new issues were performed inadequately; some not at all. It should be emphasized, though, that these limitations result not so much from a lack of data, as from the stringent requirements for information management, analysis, and coordination associated with the increasingly complex problems now facing policy makers. In particular, the Government's materials information services are limited in their ability to address issues of supply and demand because they are neither organized or managed within a comprehensive, integrated framework,

The following inadequacies in existing materials information systems were identified:

- Lack of consistent, standardized data definitions and formats, which inhibit aggregation of data, analysis, and exchange among users (often an interested official does not know that the information he seeks exists, or if he does know, where it can be found in another agency, differences in format and definitions often make it hard for him to understand the data);
- Incomplete coverage and lack of current data bases, particularly with respect to data on foreign resources, reserves, production, and consumption;
- Inadequate analytical models and techniques for projecting the effects of changes in supply and demand;
- Reporting formats that do not meet the practical needs of decisionmakers; and
- Inability to respond quickly to complex, policy-oriented questions.

These shortcomings apply in varying degrees to most existing systems, However, they are more evident in those systems handling nonrenewable resources, where responsibility is shared by a larger number of agencies, than in those systems which handle renewable resources like timber and natural fibers.

In order to improve current Government materials information systems, it is not sufficient merely to develop new, or improve existing, data gathering and analysis functions: they must be organized and operated within an integrated framework. Such a framework could enable policy makers to understand and evaluate the principal factors influencing materials supply and demand in their proper perspective. While these improvements WOUId be designed to address specific problems concerning scarcities and materials shortages, they could also be used to address the complete spectrum of materials-related issues.

The following analytical functions were identified through a detailed literature search and an extensive series of interviews as being basic requirements for Federal decision makers responsible for addressing materials policy:

- Monitoring and projecting inventories of resources and reserves;
- Monitoring and projecting the status of industrial stocks as well as strategic and economic stockpiles;
- Monitoring and projecting imports and exports;
- Monitoring and projecting the status of recycled materials;
- Monitoring and projecting quantities of materials produced and available production capacity;
- Monitoring and projecting quantities of materials consumed in end products;
- Forecasting supply
- Forecasting demand; and
- Forecasting the interaction of price, supply, and demand.

Of course, other analytical functions could be added to the basic set listed above to provide a more comprehensive assessment of policy alternatives, covering such considerations, for example, as the possible impacts on

the materials cycle of changes in availability of transportation, trained personnel, and capital.

Implementing these analytical functions within an integrated framework could provide the improved capabilities to indicate what quantities of material are likely to be produced and used at each stage of the materials cycle, The Government policy makers could then use these improved capabilities to decide whether or not the market could absorb the impacts of scarcities or outright shortages. If it could not, and unacceptable dislocations in the economy might occur, then the improved capabilities could be used to test the effectiveness of alternative Government responses in averting or alleviating the scarcity or shortage situation.

These improved capabilities will not be realized by simply allowing existing systems to evolve, however, these systems do constitute a strong base on which to make improvements, Some of the current systems, in particular those used for forecasting agricultural food and fiber commodities, have been in development for over 40 years. Other systems, covering minerals and metals, are rapidly undergoing improvement; in fact many of the existing systems are either performing or could be performing some of the necessary monitoring and projecting functions identified above.

D. OPTIONS FOR IMPROVING MATERIALS INFORMATION CAPABILITIES

Four possible options for providing materials information systems capabilities were identified and assessed as follows:

1. Evolution of Current Systems Without Direct Action

The first option available to Congress and the President is to do nothing, that is, to let current materials information systems continue to evolve without direct intervention. This option assumes that such existing limitations as the lack of consistency or standardized data definitions and formats would be resolved in time to deal effectively with emerging issues.

2. Legislative Branch Options Short of New Authorizing Legislation

Congress could take a number of possible options short of legislation to provide various kinds of improved materials information and analysis. First, Congress has the ability to act through existing congressional offices and agencies which already have a general mandate compatible, at least in part, with the need for improved materials information and analysis. Second, Congress has the ability to provide improved materials information via the executive branch through congressional hearings, exercise of oversight and investigative powers, or congressional resolutions requesting executive branch action. Third, individual members of Congress can issue policy statements designed to stimulate private sector efforts toward providing improved materials information.

3. Executive Branch Options Short of New Authorizing Legislation

Another option is to make use of the power of the executive branch. First, a Presidential proclamation or policy statement—while not having the force of a law-can set an overall direction towards improving materials information. Although the President's power to issue Executive orders has been restricted by Congress, some materials information needs can also be met through Executive or agency order. Another option could involve grants and contracts to the private sector to improve information capabilities,

4. Options Requiring New Authorizing Legislation

The first three options can be implemented within the framework of existing systems and

institutions, This last option assumes that some type of change in existing materials information systems is necessary. Underlying this option is the assumption that upgrading current Government materials information systems would be beneficial to the Nation in dealing with problems of materials supply and demand. While the existing information systems do constitute a base on which to build, they are fragmented and dispersed throughout the public and private sectors and are programmed for many diverse purposes.

In order to illustrate how this last option might be implemented, three possible systems approaches for implementing the improved capabilities were defined in the assessment and are discussed as follows:

(a) Systems Approach A.—The establishment of an interagency Federal committee or congressionally authorized group to standardize the formats of the current materials information systems. Under this approach, various agencies would maintain their present information systems, but improved coordination would encourage increased communication and cooperation. Agencies could be assigned additional responsibilities. such as collection of new data, which would be required to improve overall capabilities. This approach involves little, if any, organizational change.

(b) Systems Approach B.—The creation of a full-time organization to make step-by-step improvements in existing information systems and add new supplementary capabilities as required. The organization would closely monitor the development of existing systems and direct and focus activity required to improve overall capabilities. It would determine what resources were needed. compare them with present capabilities, and then fill the gaps by assuming responsibility itself or assigning it to other agencies.

(c) Systems Approach C.—The creation of a central program management office to first design the improved capabilities from the "top-down" and then implement the new design, using portions of existing information systems whenever possible. This central management group would then direct the revised Federal materials information system.

Seven institutional arrangements were identified as possible means of implementing the three systems approaches discussed above. An analysis was then undertaken to determine where the improved capabilities could be located. The possibilities of locating them in the private sector and within a quasi-governmental institution were considered; however, it was determined that the executive branch was the most appropriate location,

The seven institutional arrangements are described in table 11. To differing degrees. all of these arrangements could assist in providing the improved information systems capabilities. It should also be noted that each institutional arrangement involves progressively more authority than the preceding arrangement.

Under approach A, an interagency Federal committee or congressionally authorized group would establish a Materials Information Referral Office or a Materials Information Coordinating Board. The new groups would be located in existing agencies, most probably the Departments of Commerce or Interior, or perhaps within the Executive Office of the President. A Materials Information Referral Office would direct information queries to the appropriate information services in the public or private sectors and survey materials publications. It would, in essence, be a clearinghouse.

A Materials Information Coordinating Board would guide the operations and incremental improvements of existing information systems. The board would monitor the systems and suggest operational and upgrading guidelines. All of the board's proposals would be advisory in nature. Decision making powers would remain in the various agencies but the board would promote more uniform operation and improved cooperation between existing systems.

Table 2.—Alternative Institutional Arrangements

	1 Materials Information Referral Office	2 Materials Informal Ion Coordinating Board	3 Bureau Of Materials Statistics	4 Bureau of Materials Statistics & Forecasting	5 Materials Statistics Administration	6 Materials Statistics Forecasting Administration	7 Materials Information Commission
Location	Existing or new office within existing agency	Existing or new office within existing agency	New office with - in existing agency	New office with - in existing agency	New executive agency	New executive agency	New independent agency or commission
Parent Agency	Existing (parent) agency should afford the office sufficient opportunity to develop and/or acquire the necessary resources competence credibility. and reputation				None	None	None
Directorship	Director appointed by agency or office head	Chairman and members selected from agencies & user groups may be appointed by President	Director appointed by President with Senate advice and consent	Director appointed by President with Senate advice and consent	Administration appointed by President with Senate advice and consent	Administration appointed by President with Senate advice and consent	Commissioner appointed by President for fixed terms of office with Senate advice and consent
Source of Authority	OMB directive Executive agency order and /or Act of congress	OMB directive Executive agency order and or Act of Congress	Act of Congress	Act of Congress	Act of Congress	Act of Congress	Act of Congress
General Authority	The general scope of authority for all alternatives includes the acquisition and analysis of Information and related data processing collection support necessary for implementation of designated capabilities and options in areas relating to materials/commodities and supply utilization life cycles including secondary factors (e q labor capita l energy environment prlce techno lology and transportation) and interrelatlonships (e g between materials energy and the environment)						
		Authority to make recommendation's (and take actions to the extent possible under applicable law) for improvement of existing Federal Government materials information systems coordination and Integration of existing systems standardization of existing systems Improvement of reporting forms and data classification etc Authority to provide support for private sector development of capabilities and services necessary					
					Authority to promulgate rules and regulations to carry out the above activities		
Specific Authority Capabilities	Referral	Referral	Referral Clearinghouse Statistical	Referral l Clearinghouse Statistical Forecast ing analytical	Referral Clearinghouse Statistical	Referral Clearinghouse Forecast - ing/analytical	Referral Clearinghouse Statistical Forecast - ing analytical
Data Collection and Protect Ion	All alternatives rely primarily on the existing authorities of relevant agencies (usually a mix of voluntary and mandatory reporting) subject to existing protections of data sources and trade secrets and other proprietary confidential or privileged Information						
			Authority to require that relevant agencies submit summary data in aggregated form) to the office/agency subject to existing or new protections of data sources Authority to collect original data that is not otherwise available from existing sources				
					Authority to promulgate rules and regulations for collection of original data by other agencies		
							Authority to require that 'agencies submit detailed data
Data Validation	All alternates rely substantially on the existing authorities of relevant agencies subject to existing protections of data sources						
			Authority to use statistical techniques, sampling, and other methods of data verification and where necessary, to require submission of original data from the relevant agencies, subject to existing or new protections of data sources				
					Authority to undertake, where necessary, direct validation of materials data at the original source subject to new or existing protections		
Data Access	The Freedom of Information Act (FOIA) sets the basic guidelines for access to data in all configurations Data information not falling within an exempted category would be available to the public Congress and the President either directly from the NIMIS office agency and or in the case of Congress, via the CBO (or some other lead congressional office) and, for the President via OMB (or some other lead executive office)						
User Charges	The Freedom of Information Act also sets the basic guidelines with regard to user charges for public access which may be no greater than the cost of search plus reproduction In general, there would be no charge for standard referral services with the charge for other services no greater than the cost of search plus reproduction Special services for other agencies or private users may be charged on cost-reimbursable or subscription basis						
Oversight	All configurations would be subject to normal oversight of OMB and congressional committees, supplemented by GAO (which would be required to maintain continuous monitoring of office/agency activities, in addition to any investigators or data validations requested by Congress)						

Under approach B, a Bureau of Materials Statistics or a Bureau of Materials Statistics and Forecasting would be established. Either bureau would be located in an existing agency, again most probably the Departments of Commerce or Interior. Both would have a materials information clearinghouse/referral service through which users could locate and obtain materials information. Both would have a statistics capability to provide summaries, trend reports, and other materials information. Both bureaus would have data processing and collection capabilities. They would supervise the development of effective information exchanges between existing agencies and build up a summary materials data base. The bureaus would verify data through various methods to insure the reliability of materials information and would facilitate improvements of needed capabilities in existing agency information systems. The Bureau of Materials Statistics and Forecasting, would, in addition, be able to produce materials forecasts and analyses,

Approach C would involve the greatest amount of change in existing systems. A new agency would be set up—a Materials Statistics and Forecasting Administration, a Materials Statistics Administration, or a Materials Information Commission. A Materials Statistics Administration could perform all the functions of a Bureau of Materials Statistics. It would also have the authority to promulgate rules and regulations to improve existing Federal systems, including rules related to data classification and verification, and to validate data at the original source. A Materials Statistics and Forecasting Administration could perform the same functions as a Materials Statistics Administration, and, in addition, would be able to generate materials forecasts and analyses. An independent Materials Information Commission could carry out the same functions as the other two agencies. It would also have authority to establish its own detailed data base which could supersede portions of existing agency data bases.

E. IMPACTS RESULTING FROM THE IMPLEMENTATION OF THE THREE SYSTEMS APPROACHES

Analysis of the three systems approaches and the seven institutional arrangements indicates that approach A, the “incremental level” of change, could result in some benefits. Establishing a Materials Information Referral Office or Information Coordinating Board could produce only minimal impacts. The office or board might promote more uniformity in existing information services and encourage coordination of agency materials policies. They could provide a central referral office which could ease difficulties in locating and obtaining information. But neither the office or the board could solve most of the problems resulting from differing agency policies, nonuniform standards, and incompatible information systems.

Of the three systems approaches, approach B, could produce the most benefits with the least cost. Overall, the impacts stemming from this approach should be positive. and possible detrimental impacts could be largely avoided , or controlled. Approach B is especially attractive because of its flexibility and adaptability to new circumstances. The step-by-step development could ensure review before each commitment was made. This arrangement would also provide continuity with few technical problems. The main task would involve setting up links between existing information services and the new referral/clearinghouse. Existing systems could continue to operate and collect data, and the new bureau could be operational within months. Its administrative

authority could be strong. Financial costs could be low or high, depending, on how far the bureau could take full advantage of the investment in existing information systems. Moreover, Congress would have the opportunity to review each step before funds for expansion were appropriated, While approach B does have several potential weaknesses—the possibilities of weak budget control or the possible problems in getting access to needed expertise—the overall impacts of approach B are positive,

The assessment also concluded that under approach B the best institutional arrangement was 4. This institutional arrangement would establish a Bureau of Materials Statistics and Forecasting. The difference between arrangement 3, establishment of a Bureau of Materials Statistics, and 4, is that the latter arrangement would include the authority for producing forecasts of materials supply and demand, and further analytical support for planning and policy formulation. Also, 4 could provide a focus for the integration of existing Governmen t materials information serv ices. Policy makers would be able to go to a central source to be directed to the most timely and complete information and analyses. Also, other agencies and private industry could check their own projections with the forecasts issued by the bureau, Thus, contingency planning for materials shortages could be improved, The forecasting and analytical capabilities of such a bureau could provide more consistency in the long-range planning of agencies and Congress. Potentially, there could be a broader consensus on materials-related issues, With improved analysis, policy makers could be able to better handle shortage situations and plan for possible future scarcities, especially those related to the Nation's growing dependency on foreign source materials.

In the private sector, improved forecasts and analysis from such a bureau could aid industry in its long-range planning. The centralized functions of the bureau could provide a focal point for Government-industry cooperation in developing and carrying out materials policies. Access to more comprehensive and timely materials information could affect competition. Business could better select from among various materials substitutes. New information could lead to more efficient production processes, more effective allocation of resources, and improved products. If such new products last longer and are more useful, the quality of competition could be enhanced and scarce resources conserved.

Information and analysis from such a bureau might point to areas where savings could be made and profits realized. Research and development priorities could be altered; activities could be expanded in areas where resources are available and reduced in those where key materials are short. Industrial R&D could increasingly focus on ways to reduce waste and recycle materials or develop substitutes. The result could be lower costs. Smaller firms lacking analytical and data-gathering capabilities could benefit. If better data were accompanied by analysis, smaller companies could improve their competitive positions relative to large corporations.

Trend projections and analyses from such a bureau could aid States and localities with their materials problems, especially smaller States and localities which lack information capabilities, The increased availability of information could be especially helpful to State and local governments in dealing with energy and land-use problems. The added convenience of obtaining information from a central source could greatly increase Federal-State cooperation in the materials area,

The greater availability of information should also increase participation by public interest and environmental groups and trade associations in the materials policy process, The easier access could improve public understanding of materials issues and could lead to more informed and valid criticism of specific policies,

Approach C, which would mean a "top-down" restructuring of existing materials information systems, could result in the greatest amount of improvement and change. Most of the impacts growing from the establishment of a new agency or independent commission could be much the same as those resulting from approach B, the intermediate level of change. Many of these impacts could be highly beneficial. However, this sweeping level of change could also generate potentially significant detrimental impacts and costs.

Under approach C, administrative authority could be very strong and budget control could be total. The new agency could provide long-term continuity, but it could take years for the agency to get into operation. The dollar costs could be high, staffing could present problems, and there could also be technical problems. An information system of this scope has never been designed before; however, a successful restructuring of existing systems assumes that policy makers can precisely define the requirements of such a new system. Given the uncertainties in defining materials problems and the rapid pace of change in information technologies, this approach may involve unacceptably high risks.

Nevertheless, if approach C were chosen, it could provide an additional benefit to those generated by approach B. The new agency could have much stronger authority to validate data at the original source. Thus, the data and resulting information provided by the agency could be more complete and reliable. At the same time, this authority raises a sensitive point. Proprietary information gathered from private corporations might not be sufficiently secure because of the interconnections between computer data banks. Some technical safeguards could be built into the data bank, but additional legal safeguards might be needed.

With its greater viability, authority, and influence, a new agency like those in approach C could provide a powerful stimulus for long-range and contingency planning, both in Government and in the private sector. The agency could probably improve industry's ability to meet national materials needs through better planning and clarification of materials substitutes and R&D options, The agency's unique analytical capabilities could provide great help to policy makers in a wide range of areas—from stockpiling and materials conservation to international trade negotiations and national security affairs,

The high visibility and strong authority of approach C, however, are likely to arouse controversy over the growth of the Federal bureaucracy and the role of Government in economic and social planning. For example, benefits to State and local policy makers may be offset by distrust or resentment of Federal involvement in their affairs.

Various combinations of the three major approaches are possible, For example. a promising approach might be one that combines the stronger authority of an approach C agency. with the less risk and cost in the Step-by-step, incremental restructuring utilized by an approach B agency,

F. PUBLIC POLICY ISSUES

Some important public policy issues likely to arise in the planning, implementation, and operation of the improved information systems capabilities concern the relationship of the public and private sectors in providing materials information to each other.

Much of the technical data needed to implement the improved capabilities could be obtained through the highly developed information services that already collect, organize, and disseminate scientific and technical information. The corresponding services for handling information on the economic aspects of materials are less developed. Thus, much of the needed information would still have to be obtained directly from private firms, In tapping the available sources of data and for-

mulating supplemental programs to extend them, the data acquisition program would need to improve the completeness. currency, and timeliness of the data bases: and improve the ease of access to them by encouraging uniform usage of terms and units of measure. and by promoting development of procedures for ensuring the security and proprietary nature of the data.

The assessment also examined the sources of Federal authority to gather information from the private sector and found that if the public sector required the private sector to provide specific materials information:

- Such a request would be consistent with existing, recognized Federal regulatory powers;
- It would not greatly, if at all, expand Federal authority over the materials industry; and
- The private sector could be protected from public disclosure of corporate proprietary information through adequate attention to checks and balances in system implementation.

Most of the detailed data submitted by individual companies in the private sector would be considered confidential, and would be exempt from public disclosure under the Freedom of Information Act and related Federal statutes. Additional safeguards however, could be incorporated in any legislation establishing a new Federal materials information structure or authority.

G. CONCLUSION

The conclusions that emerge from this assessment are (1) that action to improve existing Federal materials information systems is both necessary and the concepts suggested herein are technically feasible, and (2) that. under the conditions stated herein, the potential benefits of implementing the improved capabilities as defined would probably justify the financial and social costs of making such improvements.

The analysis provided in the assessment indicates that implementing the improved capabilities through systems approach B, institutional arrangement 4, could probably achieve a reasonable balance between benefits and costs. However, various combinations of the systems approaches also merit further consideration. For example, one approach that might be considered could combine the strong authority of approach C with the less risk and cost associated with the incremental changes suggested in approach B. Other external factors. which suggest more or less change, should be considered in the context of their cost/benefit tradeoffs during the course of future congressional deliberations. Any implementation of these findings should, for example, be preceded by detailed requirements and systems engineering studies.

Any of the three systems approaches described in this assessment could be expected to achieve, in varying degrees, improvements in U.S. materials information gathering and analysis, Implementing the new institutional and analytical capabilities along the lines identified in this assessment is a complex question with far-reaching implications. What is certain, though, is that the potential impacts of emerging problems require more comprehensive integrated information and analysis capabilities to support Federal materials policymaking.