Chapter IV

POTENTIAL OF EXISTING FEDERAL MATERIALS INFORMATION SYSTEMS TO SUPPORT THE INTEGRATED CAPABILITIES

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Review of a limited set of materials information systems currently in use by Federal agencies indicates that they provide a reasonably strong base for developing the integrated capabilities. Many of the basic functions are already being implemented or are in development, and much of the required data is being generated and collected.

However, since the existing systems were developed by different agencies, for different purposes, and at different times, integrating them to achieve the improved capabilities requires:

- **Improving the completeness, currency, and accuracy of their data bases;**
- **Improving the access to them and the ability to interrelate them by adopting more uniform usage of terms and developing procedures for ensuring data security; and**
- **Improving their capabilities for analyzing the data and presenting results to decisionmakers in meaningful formats.**

A. INTRODUCTION

Many of the Government agencies involved in materials policymaking operate materials information systems comprising people, procedures, facilities, and data in a variety of forms, Some are predominantly manual; some make substantial use of automation. All have evolved over man y years as institutions and all have been assigned varying responsibilities for different classes of materials. They all gather and analyze relevant data to monitor conditions in particular materials sectors and measure the effectiveness of Government policies thereto. Most systems publish their statistics on supply or utilization as a service to industries and the public, Many of the systems have been very stable. For others, missions and techniques have changed over the years as new needs and priorities arose, and these have been augmented to meet special, time-critical requirements.

This segment of the assessment examined a selected set of these systems to find how they might support the integrated capabilities. A collateral aim was to understand the operational problems these systems encountered so that their experience could be factored into the consideration of how the integrated capabilities might be implemented. It should be emphasized that, except for those cases where the systems specifically matched the integrated capabilities, no attempt was made to evaluate how well the current systems are accomplishing the jobs for which they were built.

Personal interviews, using a formalized questionnaire, were conducted with personnel of 10 Federal agencies. Additionally, the assessment reviewed descriptions of materials information systems used by Congress, four other Federal executive agencies, and several State governments. In all, over 60 interviews were conducted with managers and users of materials information systems.

B. CONGRESSIONAL INFORMATION SYSTEMS

Congress obtains information to support materials policymaking from three principal sources: (1) the Federal and State executive systems; (2) the private sector, including industry, trade associations. academic institutions, lobby groups, and the general public; and (3) its own information systems. The legislative systems are oriented to the special kinds of information Congressmen and their staffs require. These cover:

- Fiscal-budgetary information, such as:
  - —New budget requests,
  - —Past budget and expenditure data,
  - —Funding by line item entry and special subject category,
  - —Long-range budget projections;
- Program evaluation data, such as:
  - —“Hard” data (inventory and economic data),
  - —“Soft” data (numbers of people served by programs, social impact);
- Program oversight data, such as:
  - —Authorizing statutes,
  - —Relevant appropriations (initial and follow-on),
  - —Executive branch implementation actions;
- Data on status of legislation, such as:
  - —Pending bills,
  - —Expiring laws,
  - —Historical data; and
- Research information, principally scientific and technical information.

The congressional agencies that provide this information include:

- Congressional committees and administrative offices,
- Congressional Research Service (Library of Congress),
- National Referral Center (Library of Congress),
- Congressional Budget Office,
- General Accounting Office, and
- Office of Technology Assessment.

Table IV-1 lists some of the information sources.

In calling on all these agencies for information, Congressmen and their staffs correlate and reconcile discrepancies in the different inputs and integrate the mass of data—a major task. Two centralized legislative information systems have been established. The Bill Status

Table IV-1.—Congressional Agencies Serving Legislative Information Needs

Information Source	Type of Information				
	Fiscal-Budgetary Information	Program Evaluation Data	Program Oversight Data	Legislation	Research Information
U.S. Congress, committees and administration		x	X	X	
Congressional Research Service		x	X	X	X
National Referral Center					X
Congressional Budget Office	X	x	X		
General Accounting Office		x	x		
Office of Technology Assessment		x	X	X	X
Executive sector input	X	x	X		X
Public sector input		x			X

System (Aquarius) provides legislative history, tracking, and statistical data and printed status reports. Indexing is done by subject matter (metals, forestry, aluminum, resources, timber, etc.), sponsor or co-sponsor committee, date, and number. The Legislative Information System (Scorpio) provides a bill digest, major issues, material, referrals to organizations related to technology and the sciences, and printed reports. These systems provide a searching and retrieval capability based on the subject matter indexes or more specific parameters. Their use does not replace the analysis of documents. but they do provide access to legislation, bibliographies, reports, and references to pertinent organizations. They can alleviate the problem of receiving too much information, since searching can be refined to reduce the number of relevant references.

Still other information services are routinely provided by the Library of Congress. The Senior Specialist Division of the Congressional Research Service provides information in the form of analyses, interpretive studies, projections, chronologies, facts, and special bibliographies. The National Referral Center (NRC) also provides research information in terms of referrals to organizations and individuals who can answer specific questions in scientific and technical fields. NRC uses a subject-indexed data base containing profiles of 9,000 organizations. The Center's referral specialists provide names, addresses, telephone numbers, and their areas of expertise in response to queries.

These legislative information systems do not have sufficient analytical or integrating capability of the kind needed to provide forecasts of the possible effects of policy decisions on the economy, For this, Congress must rely on the executive branch and the private sector. Thus, while Congress can improve its own systems, its most effective avenue for obtaining better policy planning information appears to be to strengthen the existing Federal executive systems and to establish procedures guaranteeing access to them.

C. EXECUTIVE MATERIALS INFORMATION SYSTEMS

The Federal agencies covered in this review are listed in table IV-2. Additional contacts were also made with agencies of some 13 States; of these, data bases maintained by Alaska and Illinois were pertinent to the review and were included.[1]

In questioning managers and users of these materials information systems, the survey focused on:

- Data bases;
- Information management systems, i.e., the techniques which build and maintain the data bases, and retrieve, sort, and produce reports: and
- Mathematical/analytical models and tools used for interrelating supply and demand factors to arrive at forecasts.

1. Data Bases and Information Management Systems

Table IV–3 summarizes some of the institutional characteristics of the 23 data bases and the associated information management systems that were examined. The table shows the automated information management system, if any, which the data base supports; the agency responsible for operating the systems; the geographic location of the data base; and the purpose of the system. Except for the data bases sponsored by Alaska and Illinois, and a few cases in which States support SRS and EPA data bases, virtually all funding for these systems is borne by the Federal Government. (In the case of the DOD Information Analysis Centers, user fees provide for a substantial portion of the costs; however, most users are DOD contractors and these costs are ultimately borne by the Government,)

The review indicated a trend away from specific programs to support special data bases towards generalized data management systems which support multiple data bases more easily and with better response time for special requests. These data management systems also support proprietary files and limit access by nonqualified users.

Table IV–4 summarizes the materials information provided by the selected data bases. The sponsoring Federal agencies are the main data base users, primarily due to limited access to proprietary data maintained at the company/site level. Data from some bases, like CRIB and TIMLUC, are currently restricted to Federal and State employees, but this restriction may change under the Freedom of Information Act. When the proprietary data is summarized to a sufficient level of aggregation, it is considered open to other agencies and the public. However, provisions and facilities for public access are not available on a regular basis. United States Geological Survey has a study to make the CRIB data base available to users via CRT terminals at Menlo Park, Calif., or Denver, Colo.

As shown in Table IV–4, there is a concentration of effort with apparent redundancy in the energy fuels area, USGS, BOM, FEA, FPC, ERDA, and the Bureau of Census are all involved in data collection either on a voluntary or a mandatory basis. Most of the data bases indicated in the table suffer from a lack of adequate international data. Many countries do not collect the data or are unwilling to make it available. The State Department's CERP and USDA's Foreign Agricultural Service account for the most of the international data.

Tables IV–5 and IV–6 list some of the data processing characteristics of the data bases. As

[1] Contacts with the others (Arkansas, Arizona, California. Colorado, Georgia, Iowa, Maryland, Montana, New Mexico, Texas, and Utah) indicated that their resource-oriented information systems were developed for soil, land use, and water resources rather than for materials, per se.

Table IV-2.—Agency Personnel Interviewed During Survey

Agency	Title
Department of Agriculture	Analyst, Office of the Secretary
Economic Research Service (ERS)	Director
Forest Service (FS)	Administrator of Service
Statistical Reporting Service (SRS)	Chief Research Division ADP Technical Personnel
Department of Commerce	
Bureau of Census	Director
Bureau of Economic Analysis (BEA)	Analyst
Domestic and international Business Administration (DIVA)	Associate Director, ADP
National Bureau of Standards (NBS)	Chief
department of Defense information Analysis Center (DOD/IAC)	Staff Specialist
department of the Interior	
Bureau of Land Management (BALM)	Chief,ADP Analyst
Bureau of Mines (BOM)	Department Manager Program Coordinator Chief of Statistics Branch Commodity Specialist
Office of Mineral Policy Development (OMPD)	Director Minerals Analyst (Mining Engineer)
U.S. Geological Survey (USGS)	Branch Chief Commodity Specialist Branch Chief
department of State	
Industrial and Strategic Materials Division	Assistant Chief
Energy Research and Development Administration (ERDA)	Assistant Director for Raw Materials
Environmental Protection Agency (EPA)	Project Director
Federal Energy Administration (FEA)	Director Chief,~ADP Project Manager
Federal Power Commission (FPC)	Director, Plans and Program
General Services Administration (GSA)	Staff Analyst

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Table IV-3.—Institutional Characteristics of Selected Data Bases and Associated Information Management Systems

Data Base	Information Management System	Agency	Location*	Purpose
CRIB	GYPSY	USGS	R	Organize, analyze, summarize mineral resource data
NCDB	GYPSY	USGS	R	Report world coal resource data
FAS	DMS II	BOM	D	Maintain petroleum, coal, and natural gas statistics
MAS	DMS II	BOM	D	Provide mineral resource and reserve data for materials policymaking
CDB	DMS II	BOM	D	Maintain mineral production and capacity support MAS
PD Inventory	—	BLM	D	Select field plots for sampling, predict field data, provide timber inventory and data for modeling
Minerals	—	BLM	D	Manage mineral resources in planning and utilization systems
Census	—	Bur. of Census	S	Develop and produce reports, and support other agencies
TIMLUC	INFORM	FS	FC	Keep inventory of Federal timber for long-range planning
SRS	—	SRS	W	Estimate agricultural commodities
Stockpile	—	GSA	W	Maintain data on stockpiled strategic materials under GSA control
Fuels	—	FEA	W	Moniter and regulate energy industry
Sec. Index	FEILS	FEA	W	Maintain directory of energy data and information sources
Environment	—	EPA	RA	Inventory point and area sources and amounts of emissions
Air Quality	—	EPA	RA	Maintain nationwide air quality data
Water Quality	—	EPA	W	Maintain nationwide water quality data
Uranium	ORCHIS	ERDA	G	Maintain uranium statistics to project U.S. supply and demand
World Energy	ORCHIS	ERDA	G	Survey energy reserves in all countries
RIS	RIS	FPC	W	Support decisionmaking, regulatory activities, productivity, and cost
MCIC		DoD/IAC	C	Provide technical advice and assistance to DOD agencies and contractors
CERP	CERP	Dept. of State	W	Facilitate retrieval of foreign economic data
Basic Coal	Coal Data Sys.	Illinois	U	Provide energy data for survey research
Gas/Oil	—	Alaska	A	Maintain gas and oil well statistics for State production tax revenue forecasting

*Location: A—Anchorage, AL C—Columbus, OH D—Denver, CO FC—Fort Collins, CO G—Germantown, MD R—Reston, VA RA—Raleigh/Durham, NC S—Suitland, MD U—Urbana, IL W—Washington, DC

Table IV-4_Content Characteristics of Selected Data Bases

Data Base	Agency	User*	Materials Covered: Nonfuel Minerals	Materials Covered: Mineral Fuels	Materials Covered: Forest Products	Typasof Data	Number of Records	Functional Areas: Resources	Reserves	Production	Price	Consumption	Imports	Exports	Waste Products	Stockpiles	Recycling	Transportation	Energy Req.	Capital Investment	Labor	Other**	Domestic	International
CAIB	USGS	All	X	X		Minerals & coal location:geology; prod.; reserves, resources eat.	50,000 in 1975 150,000 by 1977	X	X	X												1	X	X
NCDB	uSGS	All		X		Coal resource est. & reliability; geology: depletion rate; chem. analysis	5,000,000 by 1980	X	X	X												1	X	X
FAS	BOM	All		X		Coal prod., reserves, resource est:oil, oil shale, &gas prod:oil imports:chem. anal.	1,000,000 in 1975	X	X	X	X		X	X	X	X			X				X	
MAS	BOM	F, S, I	X			Minerals (alum., gold, tin, nickel)resource est.; extraction volume &costs, transporta tion profile; capital & operating costs	1,000,000 in 1975† 35,000,000 by 1980†	X	X	X								X		X			X	
CDB	BOM	F	X	X		Minerals prod. & prod. capacity: secondary recovery		X	X	X	X	X	X	X	X	X	X						X	X
PD Inventory	BLM	F			X	Field sample profiles; timber resource est.	420,000 in 1975	X	X														X	
Minerals	ELM	F. S, I	X	X		U.S. public land reserves & resources eat.; leasing; map coordinates	797,000 by 1982	X	X	X													X	X
Census	Bur of	F, T, U	X	X	X	Prod., recycling, import, export statistics				X	X	X	X	X		X	X	X					X	
TIMLUC	FS	F, S, I, U			X	Field samples profiles; timber resource est.; aerial photo descriptions	70,000 by 1980	X	X	X	X	X	X	X				X					X	
SRS	SRS	F, S	X			Field sample profiles; prod. by crop	20-30,000,000 in future††	X		X		X	X	X		X							X	X
Stockpile	GSA	F	X			Quantites by location; chem. analysis	7,000 in 1974	X	X				X			X							X	
Fuels	FEA	F		X		Coal & oil statistics			X	X	X	X	X	X					X				X	X
Sec. Index	FEA	F		X																		2	X	
Environment	EPA	F, S	X	X	X	Area prod. & prod. capacity; consump- tion; waste prod.; energy req., esp. for coal	70,000 in 1974			X	X	X			X		X		X				X	
Air Quality	EPA	F, S		X		Air pollution measurements, esp. for cod									X								X	
Water Quality	EPA	F, S		X		Water pollution measurements,esp. for oil									X								X	
Uranium	ERDA	F	X	X		Uranium resource estimates		X	X	X													X	
World Energy	ERDA	F, 1, T	X	X					X						X								X	X
RIS	FPC	F		X	X	Reserves; prod. & prod. capacity; price & cost; consumption; capital investment	1,000,000 in 1975 5,000,000 in future		X	X	X								X				X	X
	DOD IAC	F	X			R&D abstracts;term index; bibliographic details	100,000 in 1975			X	X		X	X				X		X	X	1	X	
CERP	Dept. of state	AAI	X	X	X			X	X	X	X	X	X	X		X	X		X	X				X
Basic Coal	Illinois	S		X		Ill. reserves & resources est.; prod.; chem. analysis	35,000 in 1976 250,000 by 1981	X	X	X												1	X	
Gas/oil	Akaska	s, 1, u		X					X	X												3	X	

* Users: F - Federal
S - State
I - Industry
T - Trade association
J - University

** Other: 1 - Physical and chemical properties
2 - Energy data sources
3 - Drilling and tax revenues

† Characters per mineral
†† 400 to 500 crops for 5 to 10 year period and 25 goegraphic areas

Table IV-5.—Data Collection and Handling Characteristics of Selected Data Bases

	Data Sources								Data Collection Methods									Update Frequency						Data Base Form				Storage Media			
	Primary			Secondary																											
Data Base	Government	Industry	Other	Federal	State	Trade Assoc.	University	International	Voluntary Questionnaire	Mandatory Questionnaire	Remote Sensing	Data Exchange	Published Reports	Voluntary Industry Report	Mandatory Industry Report	Data Transfer	Aerial Photo.	Annually	Weekly	Quarterly	Daily	Monthly	Ad Hoc	Manual	Automated	Numeric	Text	Disk	Tape	Card	Microfilm
RIB	x	x	x	x	x			x					x	x									x		x	x	x		x		
ICDB	x	x	x	x	x			x	x					x									x		x	x	x		x		
AS	x	x		x	x		x	x	x				x	x				x	x	x	x	x	x		x	x	x	x	x	x	
IAS	x	x	x	x	x	x			x				x	x									x		x	x	x	x	x		
DB	x	x		x		x		x	x				x	x				x	x	x	x	x		x	x	x	x	x	x		
D nventory	x	x	x						x		x						x	x							x	x			x		
linerals	x		x	x	x		x										x	x							x	x		x			
		x		x	x				x	x		x	x	x	x							x			x	x		x	x		x
IMLUC	x		x	x	x			x	x								x				x		x		x	x		x	x		
RS	x	x						x	x									x				x			x	x		x	x		
tockpile	x			x												x				x					x	x			x		
uels		x		x											x			x	x	x		x			x			x			
ec. Index		x		x					x													x	x		x	x	x	x			
nviron-ment	x		x	x					x	x			x	x	x	x							x		x	x	x	x	x	x	
ir Quality	x			x	x						x	x		x						x					x			x	x		
Vater Quality	x			x	x				x	x	x	x											x	x	x			x	x		
Iranium	x	x								x		x	x	x	x	x		x						x	x	x		x			
Vorld Energy		x						x								x							x	x	x	x		x			
IIS	x			x					x							x		x	x	x		x			x	x	x	x			
ICIC		x		x		x			x	x			x	x		x		x						x	x	x			x		
ERP			x					x	x				x	x		x							x	x	x	x		x	x	x	
asic Coal			x					x					x	x									x		x			x			
as/Oil		x													x							x			x				x		

Table IV-6.—Data Maintenance and Reporting Characteristics of Selected Data Bases and Associated Information Management Systems

Data Base	Information Management System	Location	Data Maintenance: Batch	Data Maintenance: Online	Data Maintenance: Specialized	Data Maintenance: Generalized	Data Retrieval: Batch	Data Retrieval: Online	Data Retrieval: Teleprocessing	Data Retrieval: Query Language	Data Retrieval: Special Program	Analysis Technique: Statistical	Analysis Technique: Modeling	Analysis Technique: Simulation	Analysis Technique: Gaming	Analysis Technique: Other	Output: Printout	Output: Tape	Output: Card	Output: Graphics	Output: Tables	Output: CRT	Turnaround Time*
CRIB	GYPSY	R	X	X		X	X	X	X	X		X					X	X		X	X		
NCDB	GYPSY	R	X	X	X	X	X	X	X	X		X					X	X		X	X	X	
FAS	DMS II	D	X	X			X	X				X	X			X	X	X		X	X		
MAS	DMS II	D	X	X			X	X	X		X	X	X			X	X			X	X	X	1
COB	DMS II	D	X	X			X	X	X		X	X	X			X	X			X	X	X	
PO Inventory	—	D	X			X	X					X	X	X		X	X	X					2
Minerals		D	X			X	X	X	X			X	X	X		X	X	X				X	3
Census	—	S	X	X			X	X				X					X	X		X	X		4
TIMLUC	INFORM	FC	X	X			X	X				X	X				X	X		X	X	X	3
SRS	—	W	X	X			X	X	X			X					X			X	X	X	
Stockpile	—	W	X				X	X				X	X				X						5
Fuels	—	W	X	X			X			X		X	X								X		
Sec Index	FEILS	W	X	X			X	X								X	X				X		2
Environ-												X	X			X	X	X			X		
ment	—	RA	X				X			X		X	X			X	X	X	X			X	
Air Quality	—	RA	X				X																
Water Quality	—	W	X	X			X	X	X	X	X	X	X			X	X	X	X	X	X	X	
Uranium	ORCHIS	G	X				X					X				X							
World Energy	ORCHIS	G	X	X			X	X				X				X							
RIS	RIS	W	X	X			X	X	X	X		X	X	X									
MCIC	—	C	X	X			X	X	X			X	X	X			X	X		X	X	X	
CERP	CERP	W														X	X	X				X	2
Basic Coal	Coal Data Sys	U	X			X	X				X						X						2
Gas/Oil	—	A	X				X					X	X			X	X						

*Turnaround Time 1—72 hours 2—24 hours 3—immediate (online) 4—48 hours priority, up to 1 month- normal 5-3 hours

listed in table IV–4, the primary data sources are questionnaires and surveys conducted by the agencies and reports from industry, both mandatory and voluntary. Secondary data sources are publications from other agencies. For some files (trade data from the Bureau of Census and MAS data from BOM), magnetic tapes are used to exchange computer-sensible data between data bases.

All the data bases verify the data to some extent. Most use historical trends and inspection; some use error analysis programs. The frequency of update ranges from monthly to every 10 years. Table IV-5 also lists the form of the data bases and the types of storage media employed. Table IV-6 shows that for some of the automated systems, direct-access disk files are being used and others are moving toward adopting them. These permit online file maintenance and retrieval from remote typewriter and CRT terminals. The GSA network INFONET provides online maintenance and retrieval capabilities for several agencies,

Table IV-6 also indicates the types of analysis techniques used in the information management systems. The analysis support capability, which becomes increasingly important as more complete and reliable data are gathered and maintained, includes mathematical and statistical functions. Report program generators are available, both online and through remote processing, to support particular formats and aggregations required by users. The types of output formats available from the various systems are listed in table IV-6.

2. Mathematical/Analytical Models

Although the distinctions are not clearcut, the models used in materials information systems fall into four general categories: (1) econometric regression models, (2) input/output models, (3) linear programming models, and (4) simulation models. Econometric regression models, the most widely used, are generally developed on an ad hoc basis for specific purposes, thus their strengths and weaknesses are model-specific. In contrast, input/output and linear programming models permit generalizations of their capabilities and limitations. Simulation and other specialized models are only occasionally used in forecasting/planning.

As indicative of their states of development, a survey of 39 models was conducted to determine how well they could accomplish the analytical functions for the improved capabilities. Table IV–7 lists the models surveyed, their users, the areas of application/analysis, and the functions supported by the models. In a general way, the table indicates the functional areas for which forecasting models are more developed than for others, notably in the areas of demand models and production distribution models.

a. Econometric Regression Models. The Aluminum Forecasting Model (AFM), developed by Charles River Associates of Boston, Mass., is representative of available econometric models. It is a form of regression modeling consisting of simultaneous equations fitted from historical data by means of regression techniques. It has been formulated to analyze the interaction between aluminum supply and demand and, in particular, the impact of Government actions on the price movements of aluminum ingots, For example, it can be used to analyze the effects of alternative GSA aluminum disposal policies. The model's scope and capabilities to support materials management are summarized as input and output in figure IV–I.

AFM, as well as other econometric regression models, relies heavily on extrapolation from historical trends. This inhibits consideration of dynamic changes in economic, demographic, or technological trends. Capacity installations are projected on the basis of information from the aluminum industry, but no significant technologically induced structural changes were contemplated during the model's planning horizon (1972-76), Furthermore, model performance is very sensitive to discontinuities in the required time-series inputs, Another limitation is that AFM accounts only for the market clearing mechanism for one stage of the aluminum industry (production of aluminum ingots); it does not account for price, supply, and demand patterns in other segments of the industry (in the bauxite mine segment or the final aluminum user segment), The model appears to be very rigid in that the set of equations describing the market adjustment mechanism does not apply during periods of rationing, Indeed, it is a limitation generic to econometric regression models that they are special-purpose tools and are only appropriate for a narrow range of applications,

b. Input/Output Models. The information-generating capabilities that input/output models offer to materials management are shown in the information flow summaries of Figure IV–2 for (1) CIAS (GSA's Contingency Impact Analysis System), (2) EEPPM (University of Illinois' Energy -Employment-Pollution Policy Model), (3) INFORUM (Interindustry Forecasting Model—University of Maryland), and (4) SEAS (EPA's Strategic Environmental Assessment System). The similarities and dissimilarities between input and output among these models are apparent. In general, they account for the demand side of the materials

Table IV-7.-Mathematical/Analytical Models Surveyed

Model	Name	User	Area of Application/Analysis	Resources/Reserves	Stockpiles	Imports/Exports	Recycling	Production, Production Capacity	Consumption	Demand	Price Impact on Supply/Demand
APM	Aluminum Forecasting Model	GSA	Effects of GSA aluminum disposal policies on the price movements of aluminum ingots			X	X	X	X	X	X
BEAFPM	Bureau of Economic Analysis Fiscal Policy Model	DOC	GNP forecasting								
BEAIO	Bureau of Economic Analysis Input Output Model	DOC	Interindustry forecasting							X	
BEAQM	Bureau of Economic Analysis Quarterly Model	DOC	GNP forecasting								
BESOM	Brookhaven Energy System Optimization Model	EROA	Alternative production and distribution techniques, policies on energy materials					X			
CACM	Copper-Aluminum Competition Model	...	Dynamics of competition between aluminum and copper			X	X	X	X	X	X
CAIDM	Copper-Aluminum Industrial Dynamics Model	...	Dynamics Of competition between aluminum and copper					X			
CIAS	Contingency Impact Analysis System	GSA	Materials demand forecasting							X	
CMIDM	Copper Market Industrial Dynamics MUM	...	Dynamics of copper market fluctuations					X			
CPCM	Commodity Production Cycles Model		Dynamics of commodity production cycles					X		X	
CPPM	Cost-Price Pressure Model	DOC	Interindustry impact assessment of changes in tha prices, productivity, profits, materials, or labor costs of an industry								
DEMOS	Demographic Economic Modeling System	...	Demographic and economic forecasting	X						X	
DESM	Dynamic Energy System Model	...	Dynamics of interfuel competition	X					X	X	
ONRUM	Dynamic Natural Resource Utilization Model	...	Dynamics of natural resource utilization							X	
EEWM	Energy-Employment Pollution Policy Model	..	Energy materials demand, employment levels, and pollution residuals forecasting								
EETM	Economic-Environmental Tradeoff Model	..	Trade-offs between economic growth and environmental quality								
EFRM	Energy Facilities and Resources Model	...	Production and distribution facilities for energy materials					X			
EMuS	Energy Model for the United States	...	Demand forecasting for energy materials							X	
EQM	Energy Quality Model	ERDA	Response of fuels supply, demand, and prices to postulated e ir quality requirements					X			
FREPAS	Forest Range Environmental Production Analytical Sys.	USDA	Alternative plans for the management and protection of range resources					X			
GIOM	Generalized Input/Output Model	..	Interindustry impact assessment of new energy technologies							X	
INFORUM	Interindustry Forecasting Model-University of Maryland	EPA	Interindustry forecasting			X				X	
MANERGY	Energy Management Modal for the United States	..	Effects of resource and fuel alternatives, environmental controls, and technological advances					X		X	
MEM	Metal Endowment Model	..	Estimation of metal - W from geophysical data	X							
MRIO	Multi-Regional Input/Output Model	DOT	Regional interindustry forecasting							X	
NIRAP	National Interregional Agricultural Projection System	USOA	Demand and supply projections on agricultural commodities					X			
NSEM	National Socio-Economic Model	...	Dynamics of economic fluctuations, growth, and environmental/resource restraints								
PIES	Project Independence Evaluation System	ERDA	Effect of fuel prices, potential of fuel substitutions, and technological constraints inhibiting energy materials supplies					X		X	
QMCWEM	Queen Mary College World Energy Model	...	International energy production and distribution system							X	X
READY	Attack Simulation and Damage Assessment Model	GSA	Attack simulation and damage assessment								
RFFM	Resources for the Future Model	EPA	Material resources demand and pollution residuals forecasting							X	
ROPE	Runout Production Evaluation Model	DOC	Early post-attack capabilities of US. economy								
SAM	Shortage Allocation Model	OOC	Interindustry impacts of commodity shortage								
SEAS	Strategic Environmental Assessment System	EPA	Material resources, demand, required reserves, and pollution residuals forecasting	X		X	X	X	X	X	X
TPECM	Tax Policy and Energy Conservation Model	EPA	Effect of tax policies on the demand and supply of energy materials								
WAIF	Wharton Annual and industry Forecasting Model	...	GNP and interindustry forecasting								
WIM	World Industry Model	...	International material resources demands and associated depletion forecasting and effects of consumption on worldwide environmental quality								
WORLD3	Limits to Growth Model	.-	nam worldwide econom and demographic growth under environmentat and material resource constraints	X					X		
WRIO	World Regional Input/Output Model	...	Worldwide industry forecasting								

economic system, with the supply side treated in a rudimentary fashion. The basic input for each model is a set of fundamental demographic and macroeconomic projections. The lists of output, however, reveal the differences due to the number of industries into which the economy is divided by the various models (86 for CIAS, 185 for INFORUM, 367 for EEPPM), the number of material groups for which requirements are computed on the basis of industry output (9 I material groups for CIAS, 23 material groups for SEAS), and the extent of further operations on the output, such as computation of employment requirements, capital requirements, and pollution residuals.

Figure IV–1. Econometric Regression Model Information Flow Summary

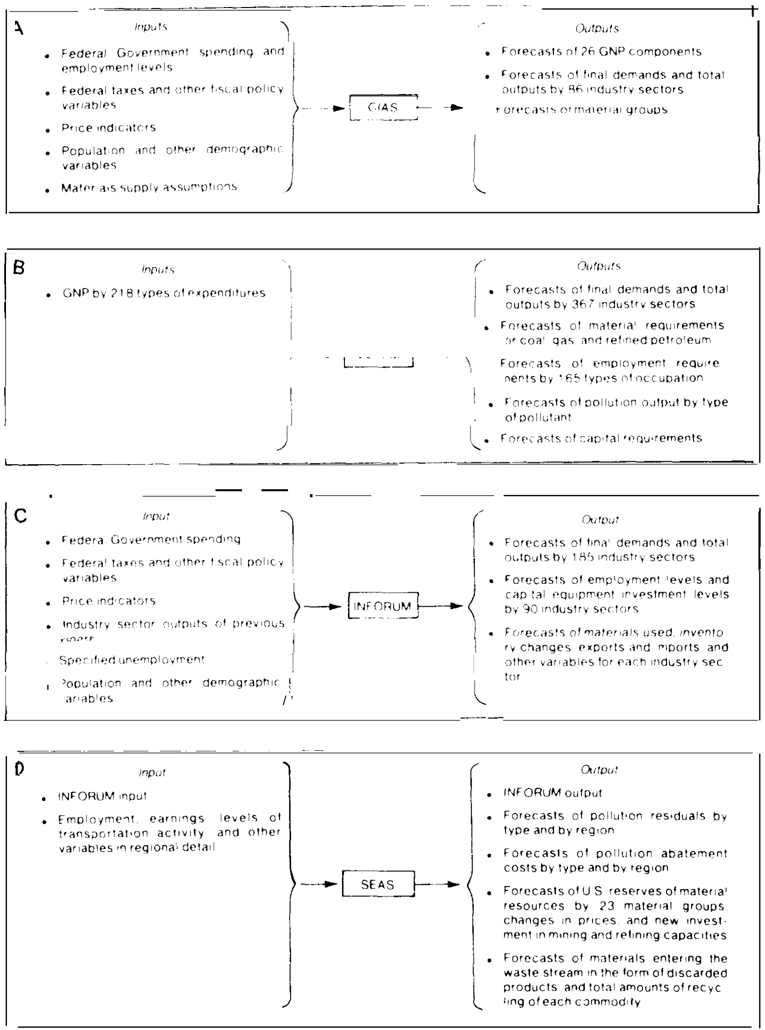
Inputs

- Unit costs of bauxite production factors
- Unit costs of aluminum ingot production factors
- Net GSA aluminum sales
- Aluminum production capacities by world areas
- U S. Disposable income and other macroeconomic indicators
- Exchange rates and other international trade indicators

outputs

- U.S. aluminum ingot shipments by utilization categories
- Aluminum scrap recovery by world areas
- Prices of aluminum ingots and aluminum scrap
- Wage Indices and other national and international indicators for the aluminum industry

Figure IV-2. Input/Output Model Information Flow Summaries

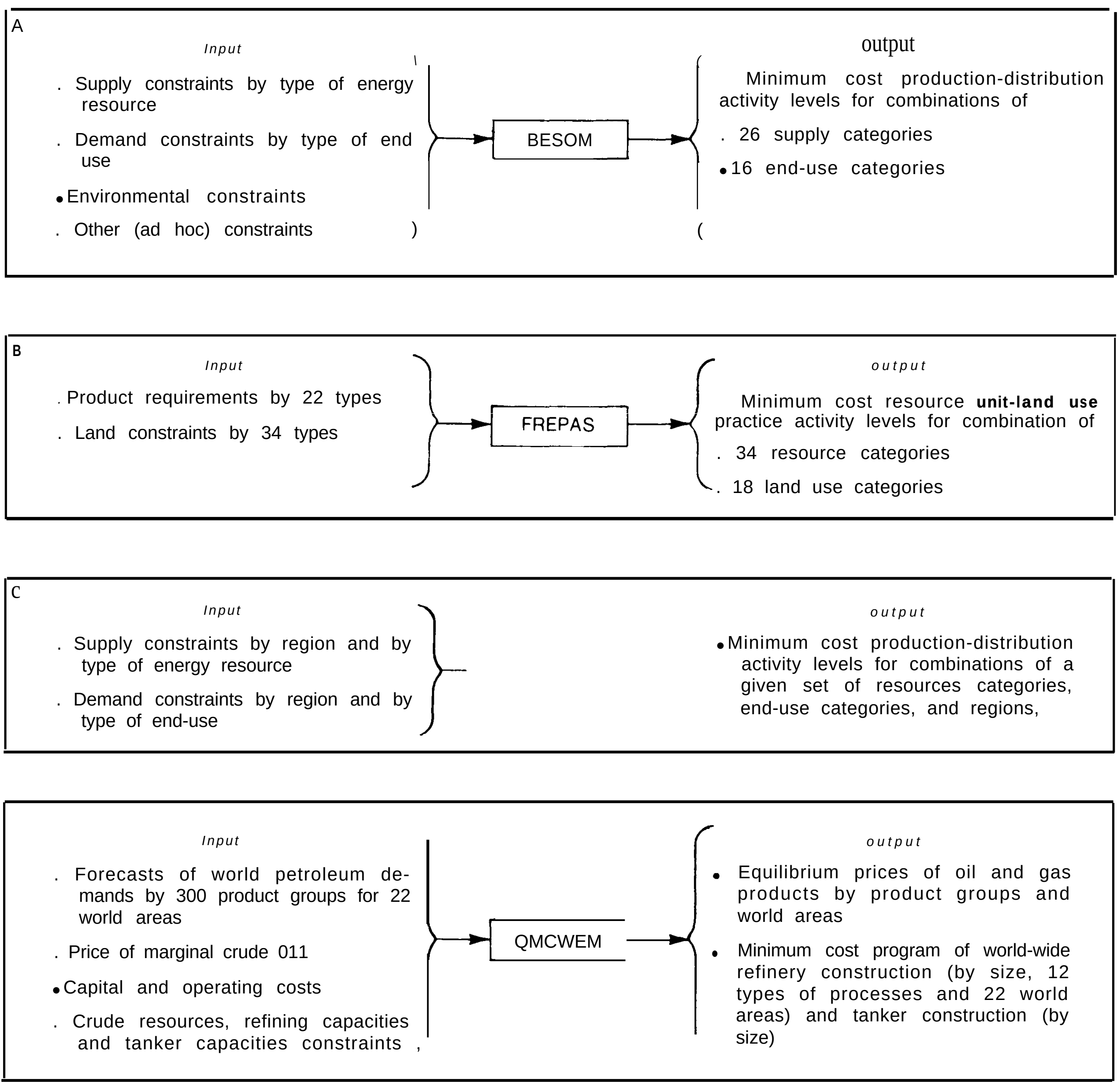


An input/output model typically does not offer the richness in detail of an econometric regression model such as AFM for a particular industry or application, but it does offer an integrated framework for the analysis of interactions among the various industries of the economy and a wide range of applications. The basic capability of such a model is to compute the total output required from each industrial sector of the economy to satisfy a given set of final demands for the products (goods and services) of each sector. In doing so, the input/output computations take into account both the first and second order effects of a change in the demand for a product on the output requirements of all industries. Thus, a change in the demand for autos will have an impact not only on the output required by the auto industry, but also on the output required by the steel industry and all other industries supplying input to the auto industry.

Although input/output models are basically a tool for macroeconomic analysis, their importance for environmental and resource policy is that they can be modified or extended (by using additional matrices of appropriately defined coefficients) to compute pollution residuals and material resource requirements for a given level of economic activity. However, as noted, only the demand side of the economy is considered, although SEAS has been developed to the point where certain feedback effects between supply and demand have been taken into account. It also must be pointed out that, while it is easy to extend the analytical input/output framework to incorporate both materials residuals and material resources, it requires a considerable amount of time and effort to develop the required data base, with the data collection and reduction requirements becoming more severe as the level of disaggregation of either industry sectors or material groups increases.

c. Linear Programming **Models.** The capabilities of linear programming models to format materials production and distribution is illustrated in the information flow summaries of figure IV-3 for four such models: (1) BESOM (Brookhaven's Energy System Optimization Model), (2) FREPAS (USDA Forest Range Environmental Production Analytical System), (3) PIES (FEA's Project Independence Evaluation System), and (4) QMCWEM (Queen Mary

Figure IV-3. Linear Programming Model Information Flow Summary



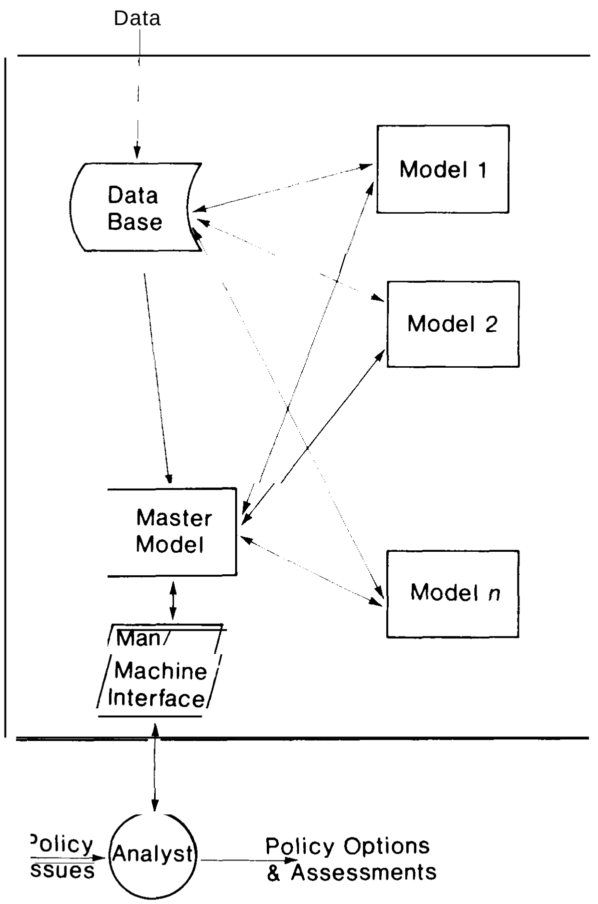
College World Energy Model). In contrast to the input/output models' rudimentary treatment of the supply side of the economy, linear programming models provide a detailed treatment. The supply structure is the web of extraction, processing, conversion, and transportation activities required to make materials actually available for use by industry and the final consumer, These activities can be represented conceptually in the form of a network and, for the case of several materials measurable in the same physical units (e.g,, energy materials in BTU's), are amenable to mathematical formulation as a linear programming model.

The treatment of the demand structure of the economy in BESOM, FREPAS, and QMC-WEM is limited to an exogenous specification of demand requirements for the various materials, PIES offers more macroeconomic content. It has been developed to provide a comprehensive framework within which to evaluate specific energy policy issues and changing world and domestic conditions and to assess the impacts of alternative policy options. Specifically, it is designed to generate projections and impact assessments required for Project Independence, including planning estimates depicting possible states of the U.S. energy system, recognizing the effect of relative prices, the potential for fuel substitution, and the technological constraints on energy supplies. PIES is composed of an econometric demand model and a linear programming supply model coupled together, and it forecasts both quantities and prices of fuels on the basis of a market-clearing mechanism which iteratively yields a balance between supply and demand. More specifically, the demand model is embedded in the supply model. In searching for the equilibrium point between supply and demand, the model iterates in a recursive fashion until the market-clearing prices and quantities of energy products for a given year are found. The demand model used by PIES does not offer as much detail on the demand structure of the economy as the previously discussed input/output models, but it does provide the means for examining policy questions that can be stated in terms of changes in supply and demand curves, modification of energy production distribution technologies, or operational constraints on the energy supply system. However, an unlimited physical availability of fuels is still implicitly assumed, and there is no provision for consideration of second-order effects.

d. Break-Integration Method of Combining Models. The process of using models to produce materials in format ion for policy makers involves both human judgment and data processing. Although in theory much of the judgment might be programmed into the models, in fact, a break-integration concept—whereby human judgment interacts with the various models for any given analysis—presently offers the most effective way to utilize available models. Thus, in forecasting the demand for a given material, the analyst will break in between the analysis of the time series and the computation of the forecast to select the appropriate forecasting model. Similarly, in assessing the economic ramifications of demand or supply adjustment options to solve an anticipated shortage, the analyst will break in after exercising the respective materials consumption and production models in order to analyze intermediate results.

Figure IV–4 depicts a concept for a break-integrated policy analysis facility, The system is composed of a data base, a number (n) of forecasting and impact assessment models, a master model, and a man/machine interface, For a materials policy support facility, the *n* models could be, for example, the nine models outlined in figures IV-1 through IV–3, Each model includes its own individual data base in addition to the generic data base. Furthermore, each model can be used either individually or in conjunction with other models via the master model, The master model would provide the interface between the analyst and each model, and between each pair of models. To interface between the analyst and the data base, the master model would include data analysis programs and model-building techniques in addition to tabular and graphic display capabilities. To interface between the analyst and the models, the master model would include programs to access and exercise each one of the models. Furthermore, for one or more pairs of mutually complementary models, it would include programs to transform the output of one model into input for the other model. In order to validate the decisions of the analyst at the break, his actions should be recorded along with the reasons for his selection,

Figure IV-4. Concept of a Break-Integrated Policy Analysis System



Active involvement at the break by policy makers would be another way of ensuring valid decisions. In any case, policy makers should understand the assumptions that were made in running and/or integrating the various models. As an example, the break-integration method could be used in an analysis of the use of energy materials in the United States, This involves consideration of energy requirements and the energy production and distribution system. These systems interact; moreover, they are affected by foreign considerations. Thus, a domestic economic energy system model, such as INFORUM, should be complemented with an international model, such as QMCWEM, Because of the difficulties associated with operating large-scale models, it may not be possible to accomplish their full integration. However, it may be possible to develop the capability to exercise both models by using the break-integration technique. The structure and information content of INFORUM and QMCWEM, presented in figures IV-2 and IV–3, are indicative of some of the interfaces that would have to be worked out to use them in a break-integrated fashion.

D. REQUIRED IMPROVEMENTS IN MATERIALS INFORMATION SYSTEMS

Although the review was necessarily limited, and the results should be interpreted with care, several areas of deficiency, vis-a-vis the integrated capabilities were noted. With respect to the ways agencies (a) collect, handle, and analyze data and (b) present resulting information, there appear to be six key areas in which significant improvements would have to be made to achieve the kind of performance envisioned in the integrated capabilities. These are summarized in table IV–8 along with an assessment of their criticality.

1. Completeness of Data Bases

Among the most serious deficiencies are insufficient data on private domestic reserves and inadequate data on foreign holdings, resources, reserves, productive capacity, consumption, etc. The number of materials now covered by existing systems may also be inadequate for the integrated capabilities. For example, the Bureau of Mines' MAS currently has reasonably complete coverage on only four minerals; plans are in place to increase that coverage to 36 minerals over the next 5 years. In addition, current systems do not cover all the different kinds of data the improved system would require. Thus, for example, more complete information on recycling would need to be acquired.

2. Accessibility

This problem area refers both to problems in obtaining needed data, primarily from private industry, and in transferring data and information among agencies. Experience of existing materials information systems in acquiring data from industry show these issues to be particularly sensitive. Controversy abounds on the merits of setting voluntary versus com - pulsory submission requirements. Many of the agencies, often those that have established close working relationships with industry, believe that voluntary methods yield higher quality data than do mandatory regulations. Other agencies feel that only mandatory methods can ensure necessary completeness and reliability. There appears to be little objective experience available to weigh the claims, Experiments to perfect techniques for collecting geological and other kinds of data via remote sensing from satellites are underway. Such a capability could make it easier to obtain needed information, especially in undeveloped areas where data on resources and

Table IV-8.-Criticality of Problem Areas in Selected Systems

Information System Elements	Problem Areas					
	Completeness	Accessibility	Standardization	Reliability/ Accuracy	Resoponsiveness/ Timeliness	Statistical/ Analytical Capability
Data Collection	Serious	Critical	Critical	Serious	Moderate	Serious
Data Handling	Moderate	Serious	Serious	Moderate	Serious	Not Applicable
Analysis	Moderate	Moderate	Moderate	Serious	Moderate	Critical
Reporting	Serious	Serious	Moderate	Moderate	Serious	Not Applicable

Critical-Critical level of concern; critical need for improvement inferred.
Serious—Serious level of concern; serious need for improvement inferred.
Moderate-Moderate level of concern; occasionally cited as area in need of improvement.

reserves are sparse. Early results are promising. However, much refinement is apparently needed before fully practical satellite systems can be applied.[2]

With regard to data/in formation transferability, the review indicated that only a limited interchange was being made among agencies at the unprocessed data level. Most information transfer occurs via formal, serial reports published by the various agencies. Sharing of information at the raw data level and use of processed results before formal publication (conditions inherent in the conceptual system) have been inhibited by several factors, Because of agreements made with firms supplying needed information, some data is not available to all interested parties; for example, data collected by ERDA was not made fully available to the Bureau of Mines, Often, an interested party does not know that the desired information exists, or the data is not available in a suitable form to enable transfer from one agency to another, Even when the information exists in a computerized format, differences in format and definition often make it difficult for a second party to understand it,

3. Standardization

This problem area refers both to common standards and data formats (technical details) and to the more difficult issue of establishing common definitions of terms. Shared use of current systems is impeded by inconsistent use of units of measure (long versus short ton); confusion over meanings of terms (bauxite and aluminum are used interchangeably); and incompatible time-tagging of data (some data corresponds to shipping date, other data to contract date), These conditions introduce double counting and gaps and limit the ability to compare and aggregate data from different sources. It is particularly troublesome to the industrial user of the information, who normally has no means to reconcile inconsistencies.

4. Reliability/Accuracy

While each agency applies judgment in accepting data submitted to it, there appears to be limited formal opportunity or technique to validate input. This applies particularly to data submitted voluntarily, but it also applies to data which must be provided by law.

5. Timeliness

This problem area refers to the turnaround time in responding to requests. Timeliness does not appear to be a critical constraint. However, it would be an important consideration in responding to unanticipated shortage situations. For many planning studies, the acceptable turnaround time may be measured in weeks, but for crisis situations, it may be days or even hours. Assuming other system deficiencies (completeness of data bases, standardized formats, etc.) have been reconciled, improved timeliness, if needed, could be achieved (but at higher cost) through use of more powerful data processing hardware.

6. Statistical/Analytical Capability

This problem area refers to the use of forecasting models. The review disclosed that while no agency was using models covering all the functions included in the integrated capabilities, many agencies were experimenting with using several models akin to those discussed here.

[2] Experiments to perfect these methods are underway. A new satellite, LANDSAT D. with approximately three times the resolution of current satellites. LANDSATS A and B, is planned to be launched, but not before 1981.

E. SUMMARY

The large number of agencies operating materials information systems, each focusing on particular aspects but dependent on many agencies' systems for input data, confirms the need for more integration. The existing array of Government systems provides a strong starting point for that development. Many of the deficiencies noted in the systems examined here have been recognized by their developers. In many cases, programs are underway to correct them. particularly in upgrading the data bases.

It should be recognized that some of the existing systems have been in the developmental phase for decades; most of the more automated systems are relatively new. Almost all were designed to address specific, pressing single-agency problems. Coordinating and integrating them, particularly as they expand, to achieve the kind of functions envisioned in the integrated capabilities will present a significant challenge, The options for effecting this upgrading are discussed in the next two chapters.