V. SUMMARY OF THE CONFERENCE BY THE CHAIRMAN

At this third Henniker Conference on National Materials Policy five themes emerged.

First, there was a great stress on the need for closer cooperation of Government and private industry.

Second, the conference again demonstrated the pervasive nature of the information function and the need to strengthen its performance and organization.

Third, there was renewed recognition of the importance of ethical or moral considerations in materials management, trade, and engineering design.

Fourth, attention was called to the need for definition of both the capabilities and the limitations of the free enterprise system.

And fifth, the conference brought out the need of national materials policy to search purposefully for the right trade-off between national independence and international interdependence.

In my opening remarks to the conference I spoke of the rising tide of national interest in materials policy. I presented the charge to the conferees to suggest ways in which this concern might best be put to use by the Congress, the Administration, and the public to motivate sound implementation of the Paley Report of 1952, the National Commission Report of 1973, and the other great studies of the subject. I reminded you that the title of this conference was Requirements for Fulfilling a National Materials Policy.

In his welcoming remarks as incoming president of the Federation of Materials Societies, John Wachtman recalled that the Federation itself had been brought into being, in part, at the first Engineering Foundation conference at Henniker on national materials policy. As a federation of materials societies with a half million members, FMS had a broad charter to support the interests of these members and to serve the public interest as well. The Federation, he said, had contributed a report on materials conservation to the National Commission on Materials Policy and was currently evaluating national materials information systems for the Office of Technology Assessment.

KEYNOTE ADDRESS

In his keynote address, Mr. Emilio Q. Daddario, director of the Office of Technology Assessment, made three points. First he documented thoroughly that the Congress is responsive to the results of these Henniker conferences, because they help to identify where legislative action is needed. And he showed that the Congress has a keen interest in national materials policy.

Second, he called attention to the Mansfield bill, S. 3523, which proposes to create a temporary commission on supplies and shortages. This commission would have two functions: it would design a permanent institution to keep tabs on materials, sound the warning in case of threatened dislocations, and propose remedies. And second, it would serve in place of the permanent institution until Congress acted to create it.

Mr. Daddario's third point dealt with OTA'S plans for assessing national materials problems and opportunities. The OTA had been asked by the House Committee on Science and Astronautics to review the extent and seriousness of U.S. dependence on imported materials, and assess the role of research and development in alleviating uncertainties of foreign supply.

OTA'S plan, still in the formative stages, has a short-range and a long-range component. The short-range element consists of:

—an assessment of the present adequacy of materials information systems;
—an assessment of ways to conserve energy through materials management;
—an assessment of ways to ease U.S. materials vulnerability through production of domestic materials; and
—ways to use the stockpiling principle to encourage domestic materials production, put materials recycling on a sound economic footing, stabilize prices, and reduce vulnerability to foreign actions.

Mr. Daddario referred to work already underway by the Federation of Materials Societies to assess materials information systems for OTA. He described the formation of an ad hoc advisory committee by OTA in national materials policy. And he appealed to the third Henniker Conference on national materials policy to address both national and global problems of supply stability, frugal use and recycling, and cooperation to share expertise in the solving of world wide problems in materials.

MATERIALS RESOURCES—R&D RESPONSE

In an unscheduled Monday evening presentation, Dr. Julius Harwood of the Ford Motor Company's Scientific Laboratory described a study of materials shortages and policy responses developed by his company.

Materials costs, he said, were at an all-time high and were expected

to rise still higher. In response, the automobile industry proposed to mount a strong R&D effort directed toward "materials substitution, recycling, solid waste disposal, and materials processing, to provide new sources of materials, reduce scrap generation, and increase productive utilization of available materials . . ."

The energy crunch was a related problem. It made weight reduction a must in the auto industry; and the speaker identified technological options toward this goal.

Considerable attention was being given to the materials and processing problems associated with the recovery and recycling of useful materials from junked cars.

And, in summary, the interdependent relationship among materials, energy, and environment required the auto industry to integrate "materials, design, and processing into a materials system approach".

Address by Dr. Richard W. Roberts, Director of the National Bureau of Standards:
"Materials Research: A Strategy to Improve the Performance of Materials."

Dr. Roberts opened his address with a succinct statement of the problem. Increased population and economic growth posed rising demands for materials. To meet future U.S. needs for materials required attention to every phase of the materials cycle—supply, usage, and recycling.

A program of action implied first that policy was needed, and second a means of implementing it.

With respect to the materials cycle itself, it was necessary to give more attention to the improvement of performance of products and therefore to the improved performance of the materials used to make them. Attention should be given to life cost of products, safety of the consumer, and meeting consumers needs more closely. Substitute and alternate materials needed study. Energy conservation was an important criterion, and also materials with special properties needed to build new kinds of capital equipment for energy generation.

To achieve better product performance required: new materials, new processing techniques, improved manufacturing and fabricating methods, better nondestructive inspection techniques, and improved design theories and concepts. To stimulate this betterment we should learn how to reward the innovator, to promote cooperation at every step in the development process, and to exploit the scientific and technical resources of industry and Government more fully. There were technical opportunities in many directions, and others on the horizon.

To activate these kinds of actions called for strengthened national materials policy. There were many policy Acts on the books, but they tended to cluster around the supply and disposal ends of the materials cycle. More attention should be given to the middle—to the usage part of the cycle. New policy was needed but how was it to achieve political acceptance? Said Dr. Roberts:

"Despite the great effort by these groups, until there is a well-defined organizational structure to take the recommendations of advisory groups such as this one and fight for them through the legislative process, I can guarantee that no unified materials policy will ever be established or implemented".

He cited the move in the Executive Branch to construct a new coordinating committee on materials within the Federal Council for Science and Technology. He recognized the existence of the Office of Technology Assessment, and its developing relationship with private industry and technical societies—particularly the Federation of Materials Societies. He saw these developments as evidence of the evolution of an ". . . organizational framework necessary to guide the development and implementation of a unified materials policy. We have to see that framework through to completion if we are to receive the support we need to carry policy and strategy through at the technical level". Then he concluded with a challenge to the conference:

"The time has come for us, as individuals, as technical managers, as members of influential societies, as concerned citizens, to call for, to participate in, and to implement a national materials policy".

TUTORIAL PAPERS

The purpose of the tutorial papers was to provide a technical information base to help the task forces to deal more knowledgeably with their subjects. There were four of these papers.

Dr. Jack Westbrook: Federation of Materials Societies Interim Report on Materials Information Survey.

Dr. Westbrook noted that some 4,000 questionnaires had been sent out to the materials community and that 668 responses had been received, about evenly divided among university, industry, and Government. The questionnaire addressed information supply and needs within a matrix of materials functions and classes of materials.

The findings to date have been that about nine out of ten respondents judged materials information to be important or highly critical in the conduct of their affairs. The major need was for solid compilations of up-to-date, machine-readable information. There were important needs also for better availability of information, for resolving problems with proprietary information, and for better supply-demand statistics.

The respondents divided about evenly as to whether they preferred a single national information system or a pluralistic network of systems. About half identified gaps in the existing information supply.

Only one respondent in three was concerned with the lack of foreign information.

Nearly all respondents said there was a need for better education in the use of information systems. More than half favored the sharing of the costs of information management among Government, users, and technical societies.

One remarkable fact was that of the 668 responses there were 574 different "prime sources" of information identified.

Less than half the respondents regarded present scope of information systems as good, with many needs not served. Two-thirds spoke of deficiencies in quality and almost half criticized the accessibility of information.

It was also significant that about half of the respondents were critical of the extremely technical language in which information was presented.

In short, it could be concluded that information systems were important and imperfect; and that the needs for improvement were clearly evident.

Sheldon Wimpfen: The International Flow of Materials and U.S. Vulnerability.

The thrust of this report, based on a series of slides describing the dynamics of international trade in materials, was that U.S. minerals supply was falling behind demand and that there was an urgent need to improve U.S. technology of mineral discovery and extraction.

The economy of the United States now requires more than four billion tons annually of new minerals. The 1973 deficit of exports over imports was $8 billion. This lag, further exacerbated by the rise in petroleum prices, threatened to upset gravely the U.S. balance of international payments. There was further reason to be concerned with the prospect of expropriations and forced agreements, competition for world mineral supply, and domestic problems with financing, transport, and environmental quality.

The information base for decisions on national minerals policy was grossly deficient.

Left undetermined was whether the United States could afford to rely on the operation of a free market to determine the flow of minerals, in view of the possibility that it could lead to an increased "dangerous and costly dependence on imports. "

Ira G. Hedrick: The Designer and Materials Conservation.

This paper recalled with approval the FMS definition of "materials effectiveness':

> "In the most general sense and in relation to materials use and conservation, it means that in a given application or product, our aims are:
>
> "(1) To develop, select, and design into products materials that most efficiently meet application requirements, that have optimum durability and life, and that are recyclable;
>
> "(2) To process and fabricate materials so as to consume, waste, or disperse the least amount of materials for equivalent performance'.

There were two obstacles in the application by industry of these principles:

> How could the design engineer be trained, equipped, and motivated to implement this shift toward materials conservation?

How could industry be motivated to overcome its "traditional reluctance" to accept new materials and processes?

With respect to the first point, the design environment involved a trade-off between customer appeal and price, The first included appearance, performance, reliability, maintainability, durability, and life. The second included development, overhead, direct labor, marketing, and raw materials.

When materials cost was an important factor, conservation tended to be motivated in design, But when it was not, there were three possible courses: a shift in customer appeal, an introduction of a pricing mechanism to stress the true value of materials inputs, or the introduction of "artificial constraints and controls". While customer appeal was not easily swayed by logical appeals, the Federal Government as a major consumer could tailor its purchases to materials conservation requirements, and could also influence design codes and general rules. (The speaker regarded this last item without enthusiasm.)

However, the Federal Government could help the design engineer by providing better means to integrate cost into the design process to quantify at that level the "costs and the performance of the building blocks which will ultimately comprise his completed design".

Another approach was life cycle cost. (For example, first cost was only one-third of the total cost of an automobile to the user.) Choice of materials determined this cost to a large extent.

Dr. Hedrick's second point dealt with ways to accelerate the utilization of new materials and processes. He noted that the time span from laboratory development to widespread application was on the order of 10 to 15 years. Continuous boron filaments, for example, were reported in **1959;** they involved development costs exceeding $400 million over the succeeding 15 years; and now show promise of wide application.

There were four causes of delay: technical, economic, managerial, and contractual. Attention was called to a recommendation of the National Materials Advisory Board for the ". . . establishment of a continuing function under the auspices of an interagency Government organization to assist in providing the necessary guidance, knowledge, and funding for the development of materials and processes which show potential for wide application to national problems".

Seymour Blum: Materials and Energy Conservation through Recycling.

The time is at hand to find ways to reconcile the traditional motivation of materials recycling for individual profit with the new social motivation to conserve materials and reduce the costly accumulation of space-consuming wastes. A systems approach is needed to plan and direct incremental growth in recycling of materials. Three factors are involved: technological, institutional, and economic. The system will be incomplete without adequate attention to all three items, and their interactions.

For example, recovery can supplement and ease shortages. It can prevent pollution. It can reduce the energy costs chargeable to production of new materials. It can reduce the wasteful use of urban land for disposal sites. The combustible content of the waste stream can be used to generate energy.

There were four broad issues in the national approach to systematic management of solid waste: formulation of national policy, evaluation of alternatives, validation of relevant information about the state of the art, and action for enforcement of the program selected. However, these four issues could not be approached separately; they were closely interconnected and required iterative analysis.

In this approach, the technical ingredients appeared to be most highly developed; the economic, less so; and the institutional, least of all.

N. E. Promise]: International Problems and Opportunities; A Role for the Technical Societies and Many Others. *

Mr. Promisel's paper called attention to the controlling role of materials in many national and international problems, and to the absence of an international institution to provide a focus founded on materials and processes. "There is no such organization, " he said, "able to serve as a knowledgeable and adequate forum or mechanism for discussion, information exchange, mutual planning, international cooperation, or even integrated response to materials problems and needs . . . ."

The world, he declared, can no longer afford "random, incidental, casual, or limited international cooperation'. Among the areas requiring such cooperation were:

Interactions of materials with energy and environment;
Assistance to developing countries;
Shared technological problems;
Information exchange;
Personnel interchange;
Exchange of information on policies, organization, and administration;
A formal mechanism for exchange of critically useful information;
A mechanism to define the world's materials problems; and
A means to mobilize a global effort to solve these problems.

Mr. Promisel called for the formation of a global mechanism for international discussion, to formulate international programs, to facilitate communication, to stimulate advances in materials sciences, to promote appreciation of the importance of materials to national and international policy, and to provide a source of materials expertise to international bodies in other fields.

A suggested approach, in Mr. Promisel's view, would be a six-step operation, beginning with the formation of a U.S. planning group toward an international materials union, the formulation of a plan to engage existing societies as the basis for organization, the enlargement of contacts abroad to form an international planning group, the activation of a related plan for an International Materials Year, the setting of time schedules, and the provision of funding for the enterprise.

*This paper was not delivered at the conference, but was supplied to the editor later. This summary is inset-red at this point for the sake of completeness.

In the absence of Mr. Promisel, it was suggested by Dr. Wachtman, who chaired the session, that a number of the conference participants might be called on to offer their views pertinent to the topic of the role of the technical societies. Six volunteers were invited, and spoke as follows:

D. W. Ballard, Sandia Laboratories

He presented a brief account of a recent conference in England on materials conservation. The conservation ethic, including materials recycling, was stronger in the United Kingdom than in the United States. The British were eager to cooperate with this country by exchange of reports and visits, and by joint international technical conferences.

S. V. *Radcliffe, Science and Technology* Policy Office

The opportunities for international cooperation among institutions appeared to be increasing. Reference was made to the government-to-government activities of NATO, and OECD, and to the leadership roles in the United States of the National Science Foundation and the Bureau of Mines. One possibility was that the technical societies could mount programs to support these agency activities internationally.

C. M. Cosman, United *Nations*

Attention was called to the information resources, and international contacts of the United Nations. This institution had as one aim the building of a data base on the materials resources and trade of member countries, and could provide a medium for international contacts among technical societies,

Edmundo de Alba, Science Attache, Embassy of Mexico

The nations of the world, small and large, rich and poor, whether they accept it as a policy or not, are condemned by the circumstances of the world we live in to global interdependence. There must be recognition of this practical fact, and an understanding of its consequences for national behavior.

J. P. ***Hugon, Ministry*** of *Industry, Republic of France*

In the modern world no nation could be self sufficient in materials. While the different nations had different patterns of resources, and differing needs for imported materials, there were many problems of national materials policy shared by all nations of the world, Interdependence was thus both a necessity and the source of wide opportunities for cooperation among nations.

P. J. Fallen, Assistant Science Attache, Embassy of the United Kingdom

Of all major industrial nations, Britain had the largest stake in the

development of a global policy of interdependence. It had many institutions that dealt with materials and each of these was searching for options in the orderly global management of the flow of materials.

THE TASK FORCE REPORTS

Task One, Materials Information: The two task forces that dealt with the first task handled it quite differently. One report recognized the need for an institution to survey continuously the adequacy, completeness, and timeliness of U.S. information on materials, and to provide guidance on sources. It called for a study of means to fund information systems. It urged a world survey of the management of materials information— who gathers it and who needs it—leading to creation of a ‘‘world referral center’. With respect to the Federation of Materials Societies survey, the report observed that it confirmed our suspicions concerning the imperfection of our systems, and should not be unduly prolonged; it would be enough to make a modest effort to close gaps in the matrix of coverage.

The other report proposed an elaborate structure in the form of a Cabinet Department for materials in which the information function would be vested. Information was considered essential for decision making in three areas:

Scientific and Engineering Measurements
The Resource Base for Materials
The Production, Consumption, and Reuse of Materials by Society.

Management in each of these three areas would be supported by an information system.

For the first area, it would suffice to build on existing information centers, with shared public/private funding, and with operating standards prescribed by a monitoring activity. The second would be coordinated geographically; it would be grouped into geologic, agricultural /biological, and sea-air information; these functions would be assigned to existing agencies grouped in the proposed Department, with the professional societies providing to each mission their publication and advisory support. In the third area (involving quantitative, economic, industry flow, and market information) the need was for standardization of statistics among agencies, a finer grain of data, and a higher degree of staff professionalism.

With respect to the FMS survey, the task force called it “a very important first step”, urged the broadening of its scope to other disciplines, proposed further follow-on surveys, and urged stronger OTA funding support for evaluation of the materials information system.

In the comments from the floor on these two papers it was suggested that fragmentation of functions among agencies was costly, and might justify the otherwise unsupported proposal for a Department of Materials. The question was raised as to whether information was a service function that needed to be intimately attached to all Government and

private activities, or whether it could and should be institutionalized (i.e., centralized) in one agency. It was pointed out that the costs of centralizing the management of information were enormous. For example, to abstract and index one document costs $35 to $50 and a national center for materials information would contain many millions of such items. Another question was whether more attention should be given to bibliographic information—the management of author-prepared abstracts—and to the collection of preliminary research findings. Classes of information needed to be sorted out and perhaps separately managed. Specifications and standards were also insufficiently recognized as important classes of materials information.

Task Two, International Flow of Materials: The two reports on this subject established similar goals: generally sound, stable economic growth, human betterment, adequate materials and energy resources, protection of the environment, and adaptability to change. Means to achieve these goals led variously to a number of second-order goals, including general reliance on market forces, acceptance of global trade interdependence and U.S. export of technology for mutual benefit, stockpiling to stabilize materials supply, and a search for an optimum mix of these strategies coupled with conservation and recycling. Timely information on materials supply and flow would be an indispensable element in these second-order goals.

Institutional changes to achieve the desired goals were less explicitly stated. Existing institutions could be better used, both nationally and internationally. Corporations engaged in international trade could be brought into closer functional relationship with the U.S. Government. Other suggestions included a wider information base, protection for foreign investment, a "world" materials stockpile in the form of an "international trade inventory". The role of the United Nations might be extended to the encouragement of information systems and the establishment of standards for such systems. Obstacles to international cooperation appeared to include differences in patent law, national self-interest and mistrust, disinterest, and shortage of trained manpower.

The issues that arose out of the discussion of these two papers could be expressed in the form of a series of questions:

How effective was research and development in the United States as the source of an exploitable "renewable resource" of technology?

Was international cooperation a credible goal, with the dismal events of the oil crisis in the immediate past?

Were new ideas needed about international financing under conditions of global instability?

What should be done about the issue of growth and what were the trade-offs ?

In other words, how is growth controlled by the marketplace, if it is? And if it is not, can we trust the marketplace?

The discussion ended on a sour note: one conferee declared, "Never have materials been so short, at so many places, at the same time". And another asked, "What chance have we got to influence international

materials legislation when the obviously essential metric system Legislation is rejected"?

Task Three, Materials Conservation through Design: Both reports recognized the opportunity of achieving large gains in the conservation of energy and materials through engineering design. They identified barriers as technical, economic, and institutional—specifically (1) lags in field data and feedback, inadequate scientific knowledge, insufficient characterization of materials, and insufficient technology transfer; (2) the economic tyranny of manufacturing process rigidity associated with rigidity of industrial equipment and practice, consumer resistance to change, and costs and scarcity of capital; and (3) deficiencies in the system for training and educating skilled manpower and other institutional/managerial restraints. Both reports called for innovative motivation toward the acceptance by industry and the public of a "conservation ethic'.

However, at this point the two reports diverged. Each offered some 15 or 20 specific recommendations for approaches to achieve conservation through design innovations but there was remarkably little duplication. Those interested in the opportunities for materials conservation should look to the reports themselves; they are concise, meaty, and creative. Both reports stressed various needs for improved information and technology transfer. Both explored opportunities for Government intervention to promote research, standards, and—through Government purchases—better product design. One interesting proposal was for Government sponsorship of an International Materials Conservation Year.

Task Four, Materials Recycling: The two reports on this task were quite different in content. The "A" report presented a concise discourse on the nature and occurrence of secondary materials and the technology of handling the municipal waste stream. It then proposed Federal, State, and local government action, vigorously pursued, to promote recycling through positive incentives, reduced obstacles and disincentives, improved technology, source separation, control to eliminate unmanageable classes of waste, and the improved marketability of recovered metals. It also called attention to the reduction of waste through improved product life.

The "B" report went directly to the question of action. The cost of water quality should be factored into the waste disposal account. Field data on wastes were poor and unstandardized; improvement was urgently needed. Federal funding could help communities achieve optimum economy of scale in disposal facilities. Other Federal action was needed to help overcome consumer resistance to recycled materials, to continue research and development. "Incentives based on designs which facilitate recycling should be considered". University courses in waste management and recycling should be considered.

The comments on these two papers were equally constructive. Among suggestions from the floor were these:

It is important to deal with packaging excesses;

Externalities like environment, health, and energy values and savings, should be internalized;

We need to develop standards for recycled materials and to eliminate prescriptive (i.e., "virgin materials") standards and specifications;

The systems concept in waste management should be further exploited;

Freight costs of transporting wastes and recovered materials are still controversial; the issue should be resolved;

Waste paper, the largest component in the waste stream, has many chemical and fuel values (e.g., conversion into alcohols);

Something analogous to the depletion allowance for mineral extraction should be devised for waste recovery processes;

Other countries manage waste recycling better than we do—why not try to learn from them?

Task Five, Role of the Technical Societies: The two reports on this topic were both closely reasoned and analytical. Report "A" distinguished national goals and shared international goals. An example of the former was buying cheap and selling dear. An example of the latter was shared basic research information and educational improvement. International exchange of information was already well in hand. Studies by technical societies could be better coordinated by a National Materials Policy Commission. There was a need to promote closer cooperation between industry and Government, particular y with respect to the achievement of national policy objectives through international exchanges. Technical societies and federations could contribute international y by the gathering of fundamental scientific information, technical advice in the negotiation of exchanges or sales of technology, assistance in assessments and forecasts of technological trends, targeting objectives of international bargaining, and managing technology transfers. The report did not call for an international federation of materials societies but suggested technical liaisons among national federations. In the transfer of technology nationally or internationally there was no substitute for the face-to-face relationship of the expert possessing the technology and the user seeking it.

Report "B" called for a more self-conscious and defined materials community concerned with meeting human needs of the world. A basic goal was the creation of a global climate to secure the free exchange of materials, goods, and services, The report proposed as an agenda for action:

(1) Improved utilization of energy, fuels, and materials through enhanced effectiveness, extension of product life, and reduction of social costs;

(2) Minimized dependence on imports through substitutions:

(3) Consumer acceptance of "stringencies" and moderation of attitudes toward growth;

(4) Minimized waste and improved recycling.

"Dissemination of information concerning these national objectives should be sponsored through the professional societies by Government and industry . . ."

The report recommended the establishment internationally of "closer links with corresponding engineering and scientific societies to coordinate efforts and improve collaboration". It was therefore appropriate to launch an International Mineral Resources Year. The rest of the report was devoted to an elaboration of this theme, calling upon the conference to support the compilation of an Inventory of Minerals and Materials Societies as a first step.

It was interesting that discussion from the floor centered almost entirely on ways and means by which the proposed International Minerals Resources Year (or perhaps *Materials* Resources Year) might be made a reality. One comment was that the "Materials Community" needed defining. Another was that concurrence and support should be drawn from a wider public, including, for example, the League of Women Voters.

FRIDAY MORNING SPEAKERS

The first speaker this morning was Fred Buttner of Battelle. He offered some interesting insights into ways in which the stockpiling—or as he prefers to call it, the "trade inventory''—concept could be combined with other policies to mitigate and even control shortages of materials. According to Dr. Buttner, stockpiling is one of four tools to combat commodity shortages; the other three are standby capacity, substitution, and recycling. These four can be combined in an effective trade-off system but none is complete in itself. The advantage of a stockpile is that it is instantly available for use in time of shortage. Its disadvantages are cost to buy and maintain, long lead time to acquire, and disruptiveness of markets. Stockpiling fuels would be prohibitively expensive; metals and minerals would be costly but within our capability to stockpile.

Standby capacity also offers advantage of speedy availability on a short lead time. Its disadvantages are large commitment of capital, rapid depreciation through obsolescence, high cost, and industrial disruption.

Substitution reduces criticalness and when used pays for itself, but development of anything even approaching a full system of substitutes for potentially critical items requires a long lead time, much research and development, and—again—high costs.

Recycling has many advantages. It is a pay-as-you-go means of converting exhaustible resources into renewable resources. It conserves energy. But again the technology is incomplete and total recovery is unrealizable.

The solution is to apply all four strategies selectively in a complex trade-off, that will differ for each material according to its special circumstances. Stockpiling is only one of the four tools but it is the keystone of a rational plan for the future.

One possible approach to reducing the cost of the stockpile is—in effect—to monetize it, by using it as a base of the currency.

A value of stockpiles is that they can be used as buffer stocks—the Japanese have already started a national stockpile for this purpose. The principle of buffer stocks is equally appropriate for national or international management. Faced with the prospect of future scarcities of materials and rising prices we could expect stockpiles to gain value. It could buy cheap and sell dear. Moreover, it could be designed to operate insulated from political intervention.

If a number of countries adopted the buffer stocks principle they could work against each other to drive up prices. This risk could be obviated by making the buffer stocks an international enterprise. Its dominant objective would be to "reduce the amplitude of world price fluctuations . . ."

A National (or International) Trade Inventory would benefit consuming countries by normalizing materials procurement on a long-term basis, eliminate sudden shortages, stabilize prices, stabilize national currencies, provide a basis for enlarging investment credit, and improve currency convertibility. It would benefit producing countries by stabilizing demand, prevent sudden surges of demand, stabilize prices, stabilize national currency, provide a basis for enlarging investment credit, and improve currency convertibility.

Dr. Buttner did not mention two other possible applications of the buffer stocks principle: to provide a means of stimulating recycling by the purchase and upgrading of materials recovered from scrap, and to stimulate new mineral development by placing long term contracts to buy materials from newly discovered deposits for future delivery.

Our second speaker this morning was Mr. Yngve Vesterlund, assistant scientific attache, Swedish Embassy. He stressed the need for fairness in international materials management, toward the goal of equality among nations, developed and developing.

Global scarcity of materials, he said, is secondary to the need to achieve a fair distribution of world wealth. Political independence is only a first step. Economic independence must follow—based on permanent national sovereignty over natural resources. This requirement does not preclude economic interdependence for mutual benefit, The multinational corporation tends to undermine economic independence; , it must therefore be controlled and held accountable. Foreign aid should be closely integrated with global materials policy. All nations are consumers of materials and supply must be balanced against demand with this fact in mind. International trade must be conducted on a basis of fairness to all participants.

Our third morning speaker was Dr. Victor Radcliffe, of the Science and Technology Policy Office. This is the unit that supports the Director of the National Science Foundation in his recently assumed role as Science Adviser to the President.

Dr. Radcliffe cited several warnings of materials shortages, widely separated in time, in order to pose the question of whether the world had reached a major turning point. The oil crisis was one "triggering" episode. The vulnerability of the United States to supply cutoff or

price increase of essential imported materials warranted analysis. Was there indeed a "materials OPEC" threat? His observation was that, while still uncertain, the risk was sufficiently real to justify analysis on two time frames: actions in response to the immediate threat and actions for the long range future.

For the short range, supply vulnerabilities could be eased by a mixed strategy that involved material substitution, process substitution, system modification (i.e., function substitution), and stockpiling.

For the longer term—beyond the year 2000-the question of balancing materials supply and demand is one of employing technology to hold down prices to manageable levels, by both increasing supply and reducing demand.

On the supply side, technological advances would be helped by applied science in mineral occurrence, plant biochemistry, development of new materials and processes, and improved performance of both materials and processes.

Conversely, demand could be eased by conservation in materials selection, hardware design, materials performance, and materials recycling.

Dr. Radcliffe concluded his remarks by raising the question as to the appropriate role of the Federal Government in dealing with national materials policy. He cited both the National Commission report and the COSMAT report as useful guidance on this question. Together they offered suggestions for sound Government action for both the short- and the long-range future problems of meeting materials needs effective y.

A FEW CONCLUDING OBSERVATIONS

For me this has been a rewarding and instructive conference. I shall leave here with a great many more ideas than I had when I came. The virtue of bringing together a hundred concerned and knowledgeable people for a week of discussion is that everybody has a chance to contribute and to learn.

The themes that I heard debated were:

How can we improve our national management of materials information?

How can Government and industry achieve closer cooperation?

Can we reconcile the ideas of coordination and pluralism in our various materials programs?

How can we achieve the widest possible acceptance of the Conservation Ethic?

What shall we do about Growth?

Are materials becoming more scarce or is it the materials-energy-environment complex that is deteriorating?

How can we invoke the systems approach at every point in the Life Cycle of Materials?

What sort of national institution do we need to collect, manage, and apply materials information?

Should we aspire more strongly to the consolidation of materials information on a global basis?

Is international cooperation possible in the field of materials? Or conversely,

Is it a fact, as one of our conferees suggested, that we are "condemned to interdependence" so that we should make the best of it?

POSTSCRIPT*

THE MATERIALS PROJECT OF THE OFFICE OF TECHNOLOGY ASSESSMENT

John B. Wachtman, Jr.**
Project Leader for Materials
Office of Technology Assessment

In his remarks at the beginning of this conference, Mr. Emilio Q. Daddario, Director of the Office of Technology Assessment (OTA), described the early stages in the development of the OTA Materials program. In the following five months, this program has continued to develop.

An assessment on materials information systems is now underway. Assessments are also being designed in the areas of: a) national stockpile policies, b) resource recovery, materials recycling and reuse, and c) institutional constraints on domestic mineral accessibility. Further assessments on other aspects of the cycle of materials use, including conservation of materials and conservation of energy through more effective materials utilization are under consideration.

These assessments were developed in response to Congressional requests. The House Science and Astronautics Committee, which has since become the House Science and Technology Committee, made a broad request. In their first letter, dated January 22, 1974, Chairman Teague and ranking minority member Mosher emphasized four areas for possible OTA study including a technological data base for Congress and research and development programs to lessen United States dependence on importation of critical materials. In their second letter, dated December 13, 1974 they specifically requested studies of 1) materials information systems, 2) national stockpile options, and 3) reuse of materials.

The Senate Commerce Committee, in a letter from Senator Magnuson dated January 24, 1974, requested studies of the solid waste problem

*Added January 1975.

**On assignment from the National Bureau of Standards.

including I) reduction of waste at the source, 2) recycling and resource recovery, and 3) energy recovery.

Representative Morris Udall, a member of the Technology Assessment Board, in a letter dated September 19, 1974, raised several questions to be answered by assessments:

"What means do we have to deal with impending resource scarcities? What kinds of roles will such methods as substitution of new materials for scarce ones, rationing, altered pricing systems, reuse and recycling. new efficient production technologies and new regulations governing land use play under these conditions?"

Senator Ted Stevens, a member of the Technology Assessment Board. requested a study of mineral accessibility in a letter dated November 6, 1974.

In addition to the interest in materials shown by these specific requests to OTA, there is widespread Congressional interest in Materials.

As Chairman of the Senate Commerce Committee, Senator Warren Magnuson in a letter dated January 15, 1975, endorsed a request by Senator John Tunney for a study of means of conserving materials through reducing wastage of materials by reducing corrosion and other wastage processes. Senator Magnuson asked for: " 1) an assessment of the kinds and amounts of materials wastage; 2) techniques for reducing wastage; and 3) technical and institutional impediments to applying these techniques, "

Over 140 separate bills on Materials were introduced into the 93d Congress in the areas of Materials management, Materials recycling, Materials shortages, and Materials stockpiling. One bill which subsequently became law established the National Commission on Supplies and Shortages. This new commission is required to make recommendations

> "with respect to institutional adjustments. including the advisability of establishing an independent agency. to provide for a comprehensive data and storage system. to aid in examination and analysis of the supplies and shortages in the economy of the United States and the rest of the world. "

In addition, the Commission is required to report on

> ''necessary legislative and administrative actions to develop a comprehensive strategic and economic stockpiling and inventories policy which facilitates the availability of essential resources."

The development of materials assessments is being assisted by a Materials Advisory Committee Chaired by Dr. James Boyd, former Director of the United States Bureau of Mines and former Executive Director of the National Commission on Materials Policy. The committee members are:

Earl H. Beistline University of Alaska	James Boyd Materials Associates
Seymour L. Blum The MITRE Corporation	Lloyd M. Cooke Union Carbide Corporation

Frank Fernbach
United Steelworkers of America

Edwin A. Gee
E.I. Du Pent de Nemours and Co., Inc.

Bruce Hannay
Bell Telephone Laboratories

William J. Harris, Jr.
Association of American Railroads

Julius Harwood
Ford Motor Company

Harry H. Herman, Jr.
Consulting Engineer

Hans H. Lansberg
Resources for the Future

Elburt F. Osborn
Carnegie Institution of Washington

Nathan E. Promisel
Consultant

Lois Sharpe
League of Women Voters

George A. Watson
Ferroalloys Association

Jack H. Westbrook
General Electric Company

The OTA Materials Advisory Committee studied the technical urgency of various aspects of the total Materials cycle, the legislative interest, and the feasibility of assessment. On the basis of these factors they recommended that OTA carry out a technology assessment in each of the following areas:

1. Devise Materials Information Systems for Reliable Input to Policymaking.
2. Establish a National Stockpile Policy.
3. Stimulate Efforts to Hasten Materials Recycling.
4. Develop means to encourage and assist manufacturing industries to use materials in fabricating products employing materials more effective! y.
5. Manage materials so as to conserve energy, but in a manner to minimize economic and social dislocation.
6. Expand and strengthen domestic minerals industry.
7. Stimulate education, research and development in the mineral extraction and processing fields.
8. Assess the interaction of environmental concerns with effective utilization and production of materials.
9. Manage materials so as to conserve materials, but in a manner to minimize economic and social dislocation.
10. Examine land use in relation to laws regarding mineral exploration and production.

The OTA staff, assisted by the Materials Advisory Committee, next proceeded to prepare work statements for the four assessments mentioned previously. These were chosen from the Committee's list as those of highest immediate Congressional interest and were submitted to the Technology Assessment Board and Technology Assessment Advisory Committee for their review.

The first assessment, on Materials Information Systems, will evaluate pertinent features of these systems in terms of their past, present and

expected stages of development. Major deficiencies in the existing information systems will be identified and alternatives for their removal described and evaluated. The establishment of a materials information system may call for the creation of a new comprehensive system, expansion of present activities, or the establishment of an institution charged with insuring efficient and effective use of existing systems.

This assessment is designed primarily in response to the request by the House Science and Astronautics Committee but is also designed to assist the new National Commission on Supplies and Shortages. The assessment is now underway. Pertinent portions of the Henniker Conference, including the results of the FMS Materials information survey, will be used. An interim report is due on February 21, 1975, and a final report on November 15, 1975.

The second assessment. on national stockpile policy, will examine the attributes and consequences of alternative national stockpile policies. The possible uses of a national stockpile for broader purposes than the limited national security purposes for which the "Strategic and Critical Materials Stockpile" was established, will be assessed.

This assessment is expected to begin in February, 1975: the final report will be due in late summer of 1975.

The third assessment, on resource recovery, materials recycling and reuse, will examine the institutional barriers to, and incentives for, achieving substantial resource recovery from urban refuse using the best current technology. To accomplish this task. assessments of interrelationships among (1) technology requirements, (2) economics, (3) institutional barriers and incentives, and (4) social factors will be made. The assessment will include consideration of barriers to policy-making and to decision-making as well as to operational implementation of resource recovery technology.

The fourth assessment, on institutional constraints on domestic mineral accessibility, will consider the potential effects of modifying the structure of Federal laws and other institutional factors affecting the accessibility of domestic mineral resources. This study will include consideration of all steps leading to and including the application of technology for the purposes of mineral exploration, development, extraction, processing. and delivery.

In developing detailed plans for each of these assessments, OTA has drawn upon relevant portions of the Henniker conference proceedings which have been very useful. It is anticipated that these proceedings will continue to be very helpful in the continued development of OTA'S Materials program.