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# A Decision Model for U.S. Computer Export Administration, A Preliminary Investigation

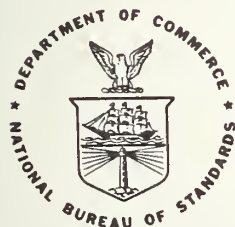
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Dr. Patrick L. Eagan

Institute for Computer Sciences and Technology  
National Bureau of Standards  
Washington, D.C. 20234

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Final



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U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS



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## SUMMARY AND RECOMMENDATIONS

This is a preliminary report on the feasibility of designing a statistical decision model of U.S. computer export administration.

The study is based upon interviews with U.S. Government officials involved in export administration and with academic analysts of U.S. and Soviet decision-making. Published materials related to East-West trade in high technology were also consulted.

The report addresses three general questions:

- (1) Is a statistical decision model of U.S. computer export administration feasible?
- (2) What method(s) will be required in developing a model?
- (3) How can the model assist those responsible for U.S. computer export administration?

Interviews and research materials indicate that a decision model of U.S. computer export is feasible. The major difficulty in designing such a model arises from the lack of commensurable indicators of the national security. Political and economic priorities are at stake in computer export administration. Without comparable measures of these priorities, operational utility statements for a decision model must be derived from estimates and informed value judgments of persons having substantive expertise in the strategic, political, and economic ramifications of U.S. high technology exports.

Development of the model will require the use of two techniques. The first is the writing of several scenarios projecting the outcomes of alternative decision sequences involved in the export of U.S. computers to the Soviet Union. Written by those knowledgeable in U.S. and Soviet strategic, political, and economic decision making, these scenarios should incorporate three contingencies which are increasingly salient for contemporary U.S. computer export administration -- 1) improved safeguard technique, 2) erosion of COCOM\* effectiveness in regulating the transfer of strategic goods to communist nations and 3) the instability of a U.S. competitive advantage in computer development and applications.

A second methodology is required for deriving the model's utility functions. Using Delphi techniques, questionnaires developed from the scenarios can be administered to panels of government officials, technical experts and academic specialists. In this manner, the estimates and

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\* COordinating COMmittee of the group of all NATO nations except Iceland, plus Japan, which have agreed to cooperate in controlling exports to Communist Block countries.

informed judgments of various organizational, technical, disciplinary, and political perspectives can be organized and pooled into operational utility functions for the model.

Development of the model can be of assistance to those responsible for U.S. computer export administration in three ways.

- (1) The model will facilitate a more efficient administration of U.S. export policy by providing interagency decision makers and technical experts with a common grounding of communication and analysis.
- (2) The model will contribute to a more effective administration of U.S. export policy by serving as an analytical framework for assessing present policy options in the context of changing international political and economic conditions, e.g. erosion of COCOM controls over high technology export.
- (3) The model will provide policy makers with a common frame of reference for
  - (a) responding to current constraints upon the administration of U.S. computer exports, e.g. technology export by multinational corporations, and
  - (b) assessing alternative policy choices that will better secure U.S. priorities in response to anticipated shifts in the environment of international trade, e.g., increasing U.S. reliance upon foreign energy resources.

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## INTRODUCTION:

This report explores the feasibility of designing a statistical decision model of U.S. computer technology export administration. Methodological issues and potential uses of the model are discussed and a schedule for designing the model concludes the report.

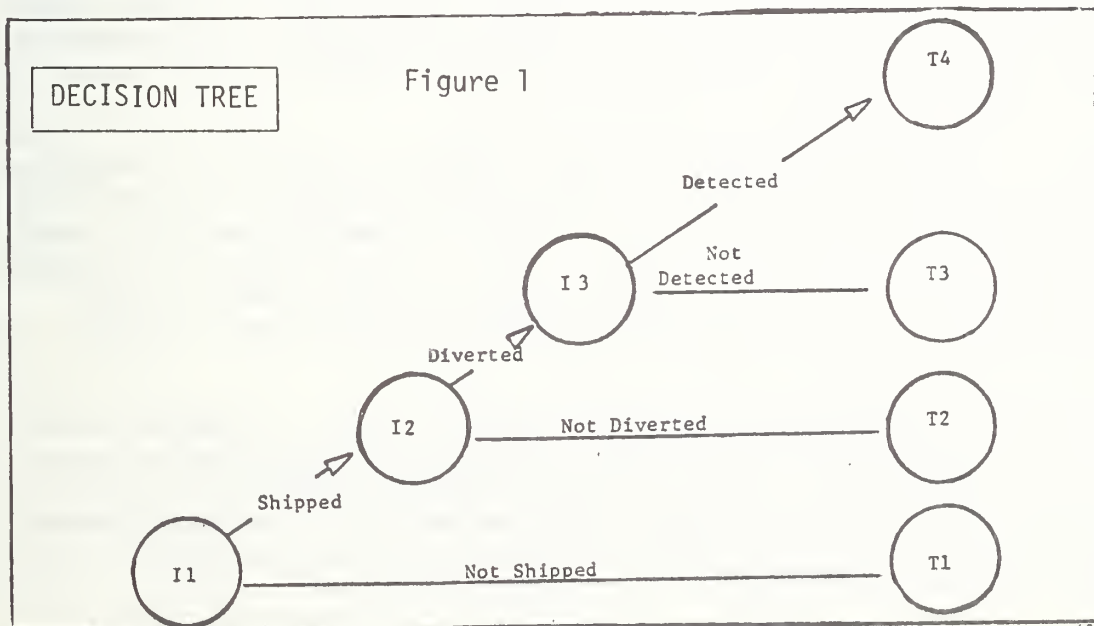
Material for the report was obtained from interviews with U.S. government officials involved in the administration of the export of strategic material and with academically based analysts familiar with the policy priorities and decision processes of the Soviet political system.<sup>1</sup> Other perspectives were obtained from published policy research dealing with the transfer of U.S. computer technology to the Soviet Union. This report is especially indebted to and draws freely from the published work of R. E. Klitgaard, N. Leites, J. Stein, C. Wolf, and others who have extensively analyzed various dimensions<sup>2</sup> of East-West trade, particularly exports of U.S. computer technology.

## PART I - FEASIBILITY OF MODEL

This section of the report examines the policy options and constraints for a model of U.S. computer export. The objective is to determine the feasibility of converting the policy options of the model into operational utility functions.

The initial model identifies two decision nodes -- the U.S. decision to license or not license the export of a given computer system, and a Soviet decision to divert or not divert the system from stated end uses.<sup>3</sup>

The model also contains a "safeguard" variable. "Safeguards" function as a constraint on both decision-makers, depending upon perceived efficacy of alternative devices or systems. (Figure 1)



To ascertain the feasibility of specifying operational utility functions for the alternative policy options in the model, some specific characteristics of East-West trade in U.S. computer technology will be reviewed. The basic problem will be defined, characteristics of the decision-makers and the decision-making process reviewed, and the costs and benefits of the alternative policy options examined.

## 1. The Problem

Interview respondents and published research consistently emphasize the central analytic problem for decision-makers involved with East-West trade in U.S. computer technology:

How are national security, economic, and political costs and benefits of this trade to be weighed, compared, and translated into effective policy choices and administrative practices?

Interview respondents differed on the effectiveness of existing export policies and administration, and most were critical of the present process for administering high technology export policy. Vagueness of existing policy, undercutting by high-level diplomatic initiatives, competing perspectives among agencies participating in export administration, and an increasing unreliability of COCOM cooperation as a brake on the transfer of strategic goods were mentioned as reasons for change in existing policies and administration.

Interviewees discussed mounting pressures for change in the current patterns of U.S. export administration. Allies don't like the system; it impedes their economic development. Less developed nations don't like it; they perceive the necessity of new technology for their own economic growth. U.S. business firms don't like it; they view the commodity control lists as consistently reflecting archaic technology assessments. Finally, the Soviets, Chinese, and Eastern Europeans don't like it; they perceive it as contradictory to stated U.S. diplomatic postures, and they want access to sophisticated computer technology that they may understand but cannot produce.<sup>4</sup>

Within U.S. government itself, the three agencies traditionally involved in export administration adopt distinct postures towards the task.<sup>5</sup> The Department of State tends to favor relaxation of export controls. The Department of Defense tends to oppose relaxed controls and the Department of Commerce has mixed positions with Office of Export Administration officials generally opposing the East-West trade promoters favoring liberalizing the commodity control lists.

Nevertheless, consensus on the basic puzzle was clear -- the administration of U.S. computer export requires measuring the tradeoffs of potential losses in national security against potential economic and political benefits. The proposed model should reflect the structure of this fundamental problem and this may be the most difficult task in constructing an appropriate model.

## 2. The Decisionmakers

Decisionmaking in the control of U.S. computer export is superficially multilateral.<sup>6</sup> Internationally, the flow of strategic materials to communist nations is regulated by a consortium of nations, COCOM. U.S. preferences, however, have traditionally held sway, although much less so in recent years.

Within U.S. Government, many agencies (DOD, DOS, DOC, et al.) are called upon to review the Commodity Control Lists and to decide upon exception requests in interagency committees composed mainly of middle-level administrators and technical advisors. Administrators from DOD and the intelligence agencies have held virtual veto power in exception requests.

Despite appearances of diversity of decision-makers, ultimate formal power for export control decisions rests in the White House. Some interview respondents noted recent signs of a more assertive leadership from the White House in the general area of international technology transfer, indicating growing concern with the lack of coordinated policy objectives in this area.<sup>7</sup>

## 3. Export Administration Process

Representatives from the U.S. Department of State, Commerce, and Defense make up the interagency committees which review the lists of embargoed commodities. Drawing upon technical expertise from their own agencies and the intelligence community, these committees identify goods and processes which have military use(s) and which are beyond the production capabilities of restricted nations. Items so identified are entered on the lists of embargoed export. Generally, the U.S. Government has been able to secure the cooperation of COCOM members in maintaining embargo of listed goods.

Exception requests to export embargoed items to restricted nations are received by COCOM delegates. U.S. Government's response to these exception requests are the result of an adversary, case-by-case process in which an absent petitioner attempts to provide evidence that the proposed export is clearly intended for "civilian" purposes, and that this end-use can be safeguarded. Decisions from these proceedings on exception requests can be appealed, with occasional cases going to the White House for final disposition.

From interviews and research materials, it must be concluded that eroding effectiveness of the COCOM arrangement significantly affects both the U.S. and Soviet utility functions. Although COCOM members have traditionally followed U.S. leadership in the embargoing of "strategic" goods to communist nations, there are clear indications that continued COCOM deference to U.S. preferences is eroding.<sup>8</sup> Economic pressures and the incentive to exploit their own technological development prompt some COCOM members to reassess the value of COCOM cooperation for their national interest. The consequences of this trend upon decision-maker's utilities should be weighed in developing the model.

#### 4. U.S. Utilities

##### a. National Security Utilities

Calculation of utilities for decision makers in administration of computer export administration requires the weighing of risks to national security arising from decisions to permit export of computer technology to a potential adversary.

Current U.S. policy practice appears to define national security as technological lead. Shipment of many items to communist nations is allowed despite their potential "strategic" value as resource-freeing goods. Goods and processes that might enhance military capability are restricted. All items considered essential to upgrading an adversary's military performance levels and requiring significant time investment for development are embargoed.<sup>9</sup> The overriding assumption is that U.S. technological lead indicates a qualitatively superior national security position.

This assumption is too restrictive for a useful model of U.S. computer export administration.<sup>10</sup> Defining national security primarily in terms of technological lead (assuring superior military capability) obscures several important considerations. As the Vietnam experience indicates, military lead may not be a valid indicator of strategic advantage, nor does technological lead imply superior military performance.

Acquisition of advanced technology by an adversary does not necessarily translate into loss of U.S. national security. Better Chinese anti-tank weapons along the Sino-Soviet border might indeed enhance U.S. national security. The position of advanced technology cannot be equated with gains in military performance if that technology is used to execute functions (inventory control) already being performed by other means. Soviet acquisition of high performance U.S. computers may bring on the same resource-freeing effects that resulted from U.S. wheat sales to the Soviet Union, without significantly improving their military performance levels.

These considerations simply indicate that the cost of securing a technological lead may not be equal to the value of having it. The relationship between the measure of technological lead (time to get it, performance differential, cost to get it, cost for others to catch up) and national security is not clear. Just how the costs, price and value of technological lead impinges on national security is the primary problem in stating the utility functions for a model of U.S. computer export.

##### b. The Political Utilities

In addition to the metrics of national security, there are political utilities to be calculated for a model of U.S. computer export administration. Interviews and research have focused on four general areas of political costs and benefits associated with sales of U.S. computers to the Soviet Union.<sup>11</sup>

One political benefit from less restrictive U.S. trade policy may be the reduction of communist hostility towards the West. Increased trade, it is claimed, will promote better communication and establish a pattern of inter-action that may ease tensions in other areas of East-West conflict. It is also suggested that increased trade will foster communist adoption of Western economic practices, establish a network of common interests, nourish Eastern economic development and stimulate the civilian sector of communist nations. These developments would reduce hostility towards the West.

A second political benefit of increased trade may be to lessen cohesion among communist nations and provide incentives for independent initiatives by Soviet satellite countries.

A third benefit of less restrictive trade may be the gratitude of COCOM allies whose economies are thirsting for expanded export markets. Less restrictive trade practices may also result in the gratitude of less developed nations who perceive advanced technology as essential to advancing their own political and economic objectives.

Finally, it is suggested that increased trade with the Soviet Union will favor the U.S. as its effect may be to blunt the threatening aspects of potential U.S. dependence upon them, e.g. energy resources.

All these anticipated political benefits may be offset by the potential liabilities of a relaxed U.S. export administration. Relaxation of current trade restrictions may whet the strategic appetites of the Soviets rather than reduce hostilities. While increased trade will surely foster more communication, more U.S. penetration into the Soviet Union and Soviet adoption of Western economic practices, these are hardly convincing indicators of altered Soviet intentions. Increased U.S. computer imports clearly serves Soviet self-interest which may be best served by adopting conciliatory and moderate appearances without altering long-range goals. Given this perspective, the political gains from reducing hostilities through relaxation of export administration policies are short-run if they exist at all.

There is little evidence, especially since Czechoslovakia's experience in 1968, that increased East-West trade will prompt independent political movement among the satellite communist countries. Nor can the gratitude of COCOM partners be assured, given a relaxation of present U.S. trade policies. The negative consequences of a U.S. competitive advantage, especially in the information technologies sought by the Soviet Union, might quickly outweigh the anticipated gains for new export markets. Finally, increased exports of U.S. computer technology may simply compound U.S. dependence upon foreign (Soviet, LDC) energy resources (oil in payment for computers), and simultaneously permit potential adversaries to "catch up" with U.S. production technology.

In conclusion, interviews and research indicate that the political effects of U.S. computer export administration defy precise calculation. As a result, their incorporation into operational utility functions for

a decision model will have to be based upon the informed value estimates of experts acquainted with the political priorities and processes of U.S. and foreign policy makers.

### c. Economic Utilities

The economic costs and benefits for a decision model of U.S. export administration are also beyond the tools of precise analysis and reliable data.

While U.S. computer manufacturers focus on losses in sales resulting from present export controls there are two reasons for not affixing a positive value to less restrictive U.S. computer export administration.

First, export regulations are only one block against the benefits of increased computer sales. Increased Soviet purchases of computers are constrained by hard currency limits, trade balance priorities, political decisions and other national economic goals. Relaxed controls on U.S. computer exports to the Soviet Union may simply result in decreases in other U.S. exports. These contingencies factors make estimation of the impacts of present export administration policy extremely speculative.

Second, it is not at all clear as to just how large a demand for U.S. computers really exists. Stein attempts to estimate demand by first assuming removal of export controls, communist ability to pay and U.S. ability to deliver computers meeting Soviet specifications.<sup>12</sup> By subtracting estimated Soviet production capability from this upward limit of demand, he concludes that through the next ten years the U.S. could expect yearly computer sales of \$289 million, which represents 75% of the total estimated Western nations' computer sales to the Soviet Union.

It is not clear from present trends and available data what the economic burdens and benefits of U.S. export policy and administration really are. Specification of operational economic utilities, like national security or political utilities, for a decision model of computer export will have to depend upon the informed judgments of substantive expertise in various fields and organizations concerned with East-West trade in high technology.

### 5. U.S.S.R. Utilities

Estimating Soviet national security, political and economic utilities associated with U.S. export administration decisions is an extremely speculative task. Interviewed Government officials and academic experts generally agreed on the enormous difficulties and uncertainties of ranking Soviet priorities or anticipating Soviet responses to relaxed U.S. export administration.

Definition of Soviet utility functions applicable to a decision model of U.S. computer exports may have to rest upon tenuous knowledge of Soviet budgetary allocations. Interviewed experts expressed great

reservation about the reliability of this data. There was clear disinclination to suggest patterns in Soviet decision-making as a grounding for operational utility functions in a decision theory model.

The impediments to defining Soviet utilities cannot be underestimated. It has been shown that comparing national security risks, political effects and economic benefits of U.S. export policy is a problem of measuring and ranking incommensurables. A Fortiori, the metrics for comparable Soviet utilities must rely upon compounded uncertainties.<sup>13</sup>

## PART II - METHODOLOGY

Without an acceptable theoretical base or reliable empirical indicators, assessment of the national security, political, and economic effects of U.S. computer exports to the Soviet Union must rest upon the estimates and informed judgment of experts. This section examines procedures for selecting, organizing, and pooling the judgments of experts into operational utility functions for a model of U.S. computer export administration.

### 1. Selection of Experts

The compounded uncertainties of defining and comparing the security, political, and economic priorities of computer export indicates that a broad range of expertise will be required. A variety of generalists and specialists with different disciplinary backgrounds would be desirable. Experienced representatives from U.S. agencies responsible for export administration, academics and analysts from policy research institutes will have to be used to identify U.S. and Soviet priorities. In addition, technical expertise in computer operations will also be required for assessing alternative safeguard possibilities. The use of nongovernmental experts is especially advisable for identifying strategic, political, and economic aspects that may have been obscured by the organizational biases of conventional export administration.<sup>14</sup>

### 2. Organizational Format

The formation and administration of U.S. export policy involves various organizational and technical areas of expertise. The proposed model provides an analytical framework which served as a common base of communication for those interviewed, regardless of their distinct organizational commitments or technical backgrounds.

Repeatedly, the interviews with government officials and academic analysts focused on three contingencies which were cited as increasingly important for calculating utilities in an export model -- 1) more effective safeguard techniques, 2) diminishing effectiveness of technology embargoes, and 3) decline in U.S. competitive status in computer production. These developments were mentioned in interviews and published research as increasingly important for analyzing the effects of present policy and for anticipating future U.S. export policy needs. It is

concluded that these factors should be systematically incorporated into the derivation of the model's utility functions.

### 3. Pooling Expert Judgment

Derivation of operational utility functions in a model involving compounded uncertainties can be accomplished by pooling the judgments of informed experts. This is a two-stage process.

First, experts in U.S. and Soviet decision making can be utilized in writing a series of scenarios of U.S. decisions to export computers to the Soviet Union. These scenarios would incorporate the expert's informed estimates of decision responses and take into account variations in safeguard technology, COCOM effectiveness, and U.S. competitive advantage in computer production.

These scenarios can then serve as a base for generating questionnaires to be distributed to interagency officials, technical specialists (safeguard technology and computer capabilities) involved in U.S. export administration, as well as analysts of U.S. and Soviet strategic decision making. Initial responses to these questionnaires can then be used to quantify expertise into operational national security, political, and economic utility statements for the model. This Delphi technique has several advantages in the process of pooling estimates of experts with distinct organizational interdisciplinary backgrounds and ideological dispositions.<sup>15</sup>

Anonymity of respondents is secured by a formal means of communication (written questionnaires or on-line computer consoles) and responses are not matched with respondents. Concealed identity of participants avoids psychological pressures of face-to-face discussion. Discussion is replaced by exchanging information through a central management group which feeds back the results from initial questionnaires to participating experts who can then revise estimates. This iterative process and controlled feedback tends towards convergence. Although unanimity on estimates of decision utilities is unlikely, a statistical index (usually median) can be used as an indication of the group estimate.

Proper use of Delphi for forecasting the utility functions in U.S. computer export decisions will require the selection of experts representing different schools of thought on the issues involved in export administration. Interviews indicate this will not be difficult to do, given the controversial character of international technology transfer in general.

Research in Delphi suggests that this technique has been particularly useful for projecting technological and social events as well as value judgments. This suggests that Delphi may be particularly suitable to the problem of identifying utilities for a decision model of U.S. computer export administration. Several interviewees indicated a willingness to participate in both scenario writing and deriving utility functions from Delphi questionnaires.



### PART III - UTILIZATION OF MODEL

Following a review of previous modeling of international U.S. technology transfer, the uses of a U.S. computer export decision model will be noted.

#### 1. Previous Modeling Effort

Interviews and research provided some indications of previous efforts to apply decision theory technique to the policy problems of U.S. computer export administration. Two interviewees made reference to a model of U.S. computer technology transfer designed by a private contractor(s) for the President's Council on International Economic Policy (CIEP). One interviewee mentioned a computer decision model related to the international transfer of high technology which had been designed for the Department of Defense.

Accessibility, development status, or names of analyst(s) involved in either of these projects was not ascertained. The information sources expressed clear reservations as to the value of either project. It is difficult to determine, however, if these negative attitudes reflected 1) essential doubts about the utility of decision models in policy analysis generally, 2) experience with clumsy first attempts to address a difficult task, or 3) doubts as to the usefulness of modeling policy problems involving the mixed priorities and uncertainties of high technology export.

In 1975, an extensive comparative study of U.S. and Soviet computer needs and capabilities was completed by Rand Corporation for the U.S. Air Force. As one part of this study, E.W. Paxson addressed "relationships between computer technology and strategic capabilities and present(ed) a game theoretic model for quantifying these relationships in a form that could contribute to policy decision-making."<sup>16</sup>

The model designed by Paxson is based upon many of the assumptions which are currently employed in the administration of U.S. export policy. For example, Paxson's definition of "strategic advantage" appears to assume that "resource-freeing" gains equal gains in military capability. The model also assumes that technological gaps translate into gains in military performance levels. These assumptions cannot stand the scrutiny of empirical evidence.

Several of the U.S. Government officials noted a recent assignment of the White House Office of Science and Technology to coordinate a large-scale interagency study of international technology transfer. It was indicated that this study will involved over twenty different government groups,<sup>17</sup> coordinated by the Office of Science and Technology in the White House.

It is concluded that the proposed project to design a decision model of U.S. export administration has by no means been made superfluous by previous analyses of the problem. In view of the current administration's interest in further analyses of U.S. international technology transfer to

be coordinated through OST, the enterprise would seem an especially appropriate task at this time.

## 2. Recommended Model Use

Decision models of strategic policy making and administration cannot and should not be the grounding for choice in export administration. The uncertainties confronting decision-makers in specific cases are beyond resolution by known techniques of policy analysis. Interviewed Government officials and academics were, without exception, agreed as to the limits of decision modeling.

However, interviews and research revealed several problems with U.S. computer export policy and administration which might be clarified if not resolved by means of a decision model. A particularly troublesome characteristic of U.S. export administration is the numerous political dispositions, technical commitments, and agency allegiances involved. As previously indicated, analytic models, particularly when they are designed by the analysts and technical experts participating in the processes of administration, provide a common perspective and a basis of communication which may overcome knowledge and organizational biases. In the case of export administration, a decision model can serve to expedite the process simply by providing a shared basis for understanding the problem, and quantifying relationships between goals, available options, constraints and uncertainties.

The interviews and research gave indication of technical, political, and economic developments that may significantly impact U.S. export policy and administration in ways which are not now clearly understood. What is the effectiveness of existing safeguard techniques? Can more effective safeguards be developed and applied to larger U.S. computer systems? Is the COCOM arrangement for control of strategic exports eroding? How fast and with what results? What is the competitive status of U.S. computer production relative to COCOM members? What is the potential market for U.S. computers given relaxation of East-West trade embargos? The development of new safeguard technology, COCOM controls and U.S. computer production advantage will certainly affect U.S. export policy and administration, and the structuring of these factors into a decision model would at least be the start of an investigation as to how they might impact the present process.

Finally, analytical models are useful for clarifying and anticipating the costs and benefits of decision making in complex situations involving numerous uncertainties and non-quantifiable judgments. The administration of U.S. export policy clearly falls into that class of problems.

As indicated in Part I, the national security risks of U.S. computer exports need redefining. Currently, export controls lists are based upon simplistic criteria which may not be appropriate, given shifts in the strategic, political and economic environment of international technology transfer. We need to know more about the relationships between

technological lead, strategic advantage and military capability to fully appreciate the national security risks involved in U.S. computer export. We need to explore further the political and economic consequences of present U.S. export policy and administration in order to identify effective responses to 1) the erosion of COCOM effectiveness, 2) a diminishing U.S. competitive advantage in computer production and declining estimates of computer demand in communist nations.

A computer export administration model designed by export policy administrators and technical experts in conjunction with specialists from academic and research institutions could contribute significantly to a redefinition of our measures of national security, political and economic objectives. This refinement of priorities is essential for adjusting to current conditions and anticipating future U.S. export policy options.

#### PART IV - SCHEDULE FOR MODEL DESIGN

Design of the proposed model should be accomplished in six steps -- 1) Scenario prospectus, 2) Scenario Writing, 3) Questionnaires design, 4) Selection of Delphi experts, 5) Administration of questionnaires, and 6) Derivation of utility functions. Each step is briefly described, including personnel and time allocations for each sequence.

##### Stage One: Scenario Prospectus

The scenario prospectus will provide a set of instructions or guidelines to scenario writers. The prospectus will include an exposition of the initial decision tree model of licensing U.S. computer exports to the Soviet Union. It will also include explicit instructions to scenario writers to consider the implications of improved safeguard technology, diminished effectiveness of embargoes on international technology transfers, declining U.S. computer production competitive edge and potential variations in the Soviet and "Bloc" nations computer market. Scenario writers should also be provided with data concerning U.S. state-of-the-art in computer science, international trade trends in information technology, as well as projected computer applications in the Soviet Union and "Bloc" nations.

Preparation of the scenario prospectus could be made by an academic analyst in consultation with government officials familiar with current U.S. export policy administration as well as trends in high technology export. An appropriate prospectus could be completed in a month.

##### Stage Two: Scenario Writing

Utilizing the parameters of the scenario prospectus, three scenarios should be prepared, and would provide an adequate basis for generating the initial questionnaires required for implementing a Delphi process. The scenarios would generally involved projecting responses to the alternative decisions and events outlined in the initial decision tree model.

The scenarios should be prepared by academic or research institute-based analysts familiar with the general patterns of U.S. - Soviet decision processes and strategic goals. Three scenarios could be completed within eight weeks.

#### Stage Three: Questionnaire Design

The questionnaires to be administered to experts in export policy and administration will consist of a series of preferences rankings extrapolated from the scenarios. Construction of an appropriate questionnaire can be executed by the same party(s) responsible for the scenario prospectus and could be prepared in consultation with government officials involved in U.S. computer export administration within eight weeks.

#### Stage Four: Selection of Delphi Experts

Selection of the experts to respond to the initial and revised questionnaires should reflect the variety of organizational, technical, and political dispositions now involved in the U.S. computer export administration process. Respondents should include expertise from government agencies, academic and research institutions, and representatives from affected industries. Organization of a list of expert respondents to the questionnaire should be completed within one month.

#### Stage Five: Administration of Questionnaires

The administration of questionnaires is a critical stage in a successful application of Delphi technique as it entails revision of initial responses through a controlled feedback process in order to finally derive the statistical group response. Ordinarily, at least three rounds of revised responses are sufficient for obtaining a mean position reflecting the consensus of expertise.

The administration of questionnaires and subsequent rounds of estimate revision can be executed by the designer(s) of the scenario prospectus and questionnaires. Completion of this stage and specifications of the group statistical responses should be completed within twelve weeks.

#### Stage Six: Derivation of Utility Functions

The statistical group responses derived from the iterative feedback estimate responses to the questionnaires are translated into utility functions for the decision model of U.S. computer export administration. This task can be completed by the individual(s) responsible for constructing the questionnaires and monitoring the revision of estimates. Completed specification of the model's utilities should be completed within four weeks of final revised responses to the questionnaires.

SUMMARY OF DESIGN SCHEDULE

Stage One: Scenario prospectus	Stage Two: Scenario writing	Stage Three: Question- naire Design	Stage Four: Selec- tion of experts	Stage Five: Ad- ministra- tion of question.	Stage Six; Deri- vation of utility functions
Four Weeks	Eight Weeks	Eight Weeks	Four Weeks	Twelve Weeks	Four Weeks
Academic policy analysts in consul- tation with government officials	Academic or re- search based substantive experts	Same as Stage One	Same as Stage One	Same as Stage One	Same as Stage One

Time for  
Completion

Personnel  
Responsible

## NOTES

1. See Interview Personnel, Appendix I and Interview Schedule, Appendix II.
2. These are authors of a series of Rand Reports on International Technology Exchange with Communist Countries. The reports were done during 1973 - 74 and were sponsored by the Advanced Research Projects Agency and the Council on International Economic Policy. Also consulted were general studies of the effects of technology on international politics and public policy, including Victor Basiuk's Technology, World Politics and American Policy, Columbia University Press, New York, 1977, and Haas, Williams and Babai, Scientists and World Order, University of California Press, Berkeley, 1977.
3. This model, proposed by Paul Roth of the NBS Institute of Computer Sciences and Technology, was presented at an interagency computer safeguards committee meeting by Dr. Joseph Harrison in a draft paper, "A Decision Theory Approach to Evaluating Computer Safeguards."\*
4. John Diebold, "Business, Government and Science: The Need for a Fresh Look," Foreign Affairs, 1975, pp. 555-572.
5. Robert E. Klitgaard, "National Security and Export Controls," Rand Corporation, Report No. R-1432-1ARPA/CIEP.
6. Robert E. Klitgaard, "Export Controls: A Summary for U.S. Policy," unpublished manuscript, March, 1974, p.3.
7. Interview with Mr. Gus Weiss, August, 1977, Old Executive Office Building.
8. Robert E. Klitgaard, "Export Controls: A Summary for U.S. Policy," op.cit., p. 5
9. Ibid, p. 6
10. Ibid, p. 14.
11. Nathan Leites, "The New Economic Togetherness: American & Soviet Reactions," Rand Corporation, Report No. R-1369-ARPA, 1974.
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13. Interview with Adam Ulam, September 1977, Harvard University.
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## APPENDIX I

### List of Interviewed Personnel

#### A. U.S. Government

<u>Name</u>	<u>Agency</u>
1. Michael Boretsky, PhD	DOC
2. James Colbert	DOS
3. Ronald Finkler, PhD	IDA
4. Oles Lomacky, PhD	DOD
5. Maurice Mountain, PhD	DOD
6. Rolf Piekarz, PhD	NSF
7. Arthur Reichenbach	DOS
8. William Root	DOS
9. Gus Weiss	CIEP

#### B. Academic

<u>Name</u>	<u>Discipline</u>	<u>University</u>
1. Abram Bergson, PhD	Economics	Harvard, Russian Research Ctr.
2. Joseph Berliner, PhD	Economics	Brandeis, Russian Research Ctr.
3. Robert Campbell, PhD	Economics	Univ. of Indiana
4. Marshall Goldman, PhD	Economics	Wellesley, Russian Research Ctr.
5. Erik Hoffman, PhD	Soviet Politics	SUNY, Albany
6. Robert Klitgaard, PhD	Econometrics & Decision Analysis	Harvard, Kennedy School, RAND
7. Adam Ulam, PhD	Soviet History & Government	Harvard, Dept. of Government, Russian Research Ctr.



## APPENDIX II

### Interview Schedule

- A. Do we know enough about Soviet strategic priorities and decision processes to project potential responses to U.S. decisions related to the export of U.S. technology, particularly information technology?
  1. If yes, what are the Soviet strategic, economic, scientific, and political priorities at stake in their effort to procure information technology? Can these priorities be compared or ranked?
  2. If not, what are the major gaps in our knowledge and to what extent is analysis likely to overcome them in the immediate future?
- B. In addition to those now in the basic model, what policy options and constraints should be incorporated in a model of U.S. information technology export to the Soviet Union?
- C. What are your suggestions/recommendations for how to utilize substantive expertise in operationalizing and comparing potential Soviet responses to U.S. export administration decisions?
- D. Would a statistical decision model with linear utility functions derived from expertise in strategic preferences and decision processes be useful in the administration of U.S. technology export? If so, how? If not, why not? Illustrations?
- E. Are you familiar with other attempts to apply statistical decision theory to the administration of U.S. exports of high technology?
- F. Can you name others in government, industry, universities or policy research organizations whose knowledge and experience in the area of high technology transfer might be useful in determining the feasibility of this project?

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15. SUPPLEMENTARY NOTES			
16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)			
This is a preliminary report on the feasibility of designing a statistical decision model of U.S. computer export administration.			
The study is based upon interviews with U.S. government officials involved in export administration and with academic analysts of U.S. and Soviet decision-making. Published materials related to East-West trade in high technology were also consulted.			
The report addresses three general questions:			
<ol style="list-style-type: none"> <li>1) Is a statistical decision model of U.S. computer export administration feasible?</li> <li>2) What method(s) will be required in developing a model?</li> <li>3) How can the model assist those responsible for U.S. computer export administration?</li> </ol>			
Interviews and research materials indicate that a decision model of U.S. computer export is feasible. The major difficulty in designing such a model arises from the lack of commensurable indicators of the national security. Political and economic priorities are at stake in computer export administration. Without comparable measures of these priorities, operational utility statements for a decision model must be derived from estimates and informed value judgments of persons having substantive expertise in the <u>strategic, political, and economic ramifications of U.S high technology exports.</u>			
17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)  Computer export model; computer model; decision model; export administration; export model; model; Soviet Union; U.S.S.R.			
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