RR-76-17

THE STATE-OF-THE-ART QUESTIONNAIRE ON APPLIED SYSTEMS ANALYSIS: A REPORT ON THE RESPONSES

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AUGUST 1976

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PREFACE

This publication is the second report by the Survey Project on the structure and content of a proposed Series of monographs and a Handbook to survey the state-of-the-art of applied systems analysis. In the first report (RR-76-16, *Systems Analysis: An Outline for the State-of-the-Art Survey Publications,* July 1976), we presented a revised outline and current guidelines for the Survey Project publication program; in the present document, the sequel, we discuss the response to a questionnaire--distributed widely throughout the systems analyst community--upon which our revised outline is based.

This report should be of interest to the questionnaire respondents, and to a wider audience as well, in that it reflects what some 160 analysts and others associated with systems analysis think about systems analysis, what they consider to be vital and important in this area, and what they think to be peripheral or of minor relevance.

SUMMARY

IIASA's Survey Project, established to generate and oversee the publication of a Series of monographs and a Handbook on the state-of-the-art of applied systems analysis, sought help in formulating the program from analysts and users outside IIASA by means of a questionnaire. This questionnaire, distributed through the National Member Organizations (NMOs) to scientists and managers in the member countries, asked respondents to rate the importance of and comment on items for inclusion in the proposed Series and Handbook. The questionnaire was designed in the form of an outline of the domain of applied systems analysis.

As a result of the response to this questionnaire, the outline was amplified considerably and numerous changes were made, both in the outline and in plans for the publications. Many perceptive comments and criticisms were received; these, together with a statistical analysis of the importance ratings by the respondents, were taken into account in developing guidelines for the Series and Handbook and in preparing a revised version of the outline.

Although a number of respondents saw no compelling reason for IIASA to engage in an extensive publication program, the general reaction was favorable and often enthusiastic. Several persons advised against an attempt to prepare a conventional Handbook that would serve merely as a ready guide to small problems, and alternatives were suggested. In rating the importance of topics for inclusion in the publications, no pattern of differences based on the national origin of the respondents was found.

Although the opinions expressed were extremely varied and sometimes contradictory or ambiguous, three areas of greatest interest for the Series seemed to emerge:

- *In-depth case studies,* presented in a way that provides methodological insights, particularly new ones into the processes of systems analysis, but written in a more or less standard format.
- *Policy studies of areas of current international interest,* e.g., in energy, health care systems, urban development, to bring into focus complex problem situations, reveal constraints, suggest possible lines of attack, and provide essential data and information.
- *The analysis of analysis,* i.e., epistemological and sociological studies of analytical activity, techniques of argumentation, control of the quality of analytic results, and institutional factors that hinder or facilitate the use of analysis.

In addition, two important concerns were expressed. One was the possibility that the IIASA publications on applied systems analysis would neglect the *social, political and institutional aspects of systems analysis;* the other was a warning that they would place *excessive emphasis on technology.*

ACKNOWLEDGMENTS

In preparing the outline and establishing criteria and guidelines for the Series and Handbook, the IIASA Survey Project had help from many persons. We particularly want to thank the more than 160 analysts and users of systems analysis who answered our questionnaire or wrote letters with comments and suggestions. Their names and addresses are listed in the appendix. We also wish to express our gratitude to the liaison persons in IIASA's National Member Organizations who assisted in distributing the questionnaire and helped in countless other ways.

CONTENTS

INTRODUCTION

One of IIASA's goals is to improve the quality of analytic assistance available to decision makers throughout the world and to narrow the gap in understanding between these decision makers and the systems analysts who provide the assistance. An approach to achieving this goal is to promote comprehensive and quality publications on applied systems analysis. Two types of publications are proposed to implement this approach, a Series of state-of-the-art monographs that would survey the domain of applied systems analysis and a Handbook of Applied Systems Analysis.

To obtain advice from systems analysts and managers throughout the world on the content and structure of these proposed publications, IIASA's Survey Project made use of a questionnaire containing an outline listing topics in applied systems analysis for possible inclusion as volumes or articles in the proposed Series or Handbook.

Packages containing this questionnaire and the necessary explanatory material were sent to each National Member Organization (NMO) for distribution. More than 300 persons--faculty members, scientists, heads of ministerial scientific departments, managers of industrial concerns, etc.--were given an opportunity to respond. In reply, 101 completed questionnaires and about 60 informal letters were received, the latter largely from U.S. respondents.* Responses were received from all NMO countries except three. These responses were analyzed and the various comments and suggestions taken into account in formulating a revised version of the outline and in defining criteria and guidelines for the Series and Handbook.**

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*Rather than distribute the questionnaire, the NMO in the United States wrote a separate letter to respondents asking several key questions about the content of the outline and the proposed publication plans.

**Available from IIASA as RR-76-16, *Systems Analysis: An Outline for the State-of-the-Art Survey Publications*, July 1976.

THE QUESTIONNAIRE AND THE RESPONSES

The outline of systems analysis on which the questionnaire was based was divided into four sections: Foundations, Processes, Applications, and Reference Materials. Within these sections, subsections were arranged in a multilevel hierarchy. The left-hand column of Table 1 reproduces the features of the outline that were the subject of questions. The descriptors, that is, entries that were associated with the unnumbered items and designed to provide an indication of their scope, are omitted in Table 1.

The objectives of this questionnaire were to:

- Identify and clarify the difficulties, problems, and contradictions in the interpretation of the topics in the outline of systems analysis.
- Delineate the general pattern of preferences for the various topics and aspects of systems analysis with respect to their representation in the forthcoming Series and Handbook.
- Gather useful suggestions to rearrange, refine, and improve the outline structure and formulate plans for the Series and Handbook.

Respondents were asked to rate the first-level items (i.e., the items numbered in the left-hand column of Table 1) for importance* using the following scale:

I = very important, definitely include.

M = moderately important.

P = possibly include.

E = exclude.

These ratings appear to the right of the numbered items.

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*The rating of the "importance" of topics was designed to help determine the relative emphasis of parts within the entire structure, the number of volumes to be devoted to the various parts and sections, and the number of authors to represent separate scientific directions to achieve a sufficient coverage of alternative points of view.

For the second-level (unnumbered) items, the respondents were merely asked to indicate "Yes" (include) or "No" (exclude). The pattern of responses appears in the right-hand column of Table 1.

In addition to rating the topics, the respondents were asked for written comments and suggestions as well as for the names of persons who could contribute to the proposed publications, either as authors or reviewers.*

Table 1. Tabulation of the questionnaire responses.[a]

I. Foundations of Systems Analysis		I: 52	M: 31	P: 7	E: 3
I.1	Development of Systems Analysis	I: 36	M: 28	P: 15	E: 8
	Precursors	Y: 53	N: 30		
	History	Y: 60	N: 24		
	Main themes	Y: 75	N: 8		
	Classical cases and typical procedures	Y: 72	N: 10		
	Current status	Y: 63	N: 20		
	Needs and future directions	Y: 70	N: 11		
I.2	Meanings of Systems Analysis	I: 40	M: 24	P: 19	E: 4
	Alternative definitions	Y: 68	N: 20		
	Capabilities and limitations of systems analysis--in practice	Y: 69	N: 17		
	Relationship to other disciplines	Y: 76	N: 11		
I.3	Bases of Systems Analysis	I: 62	M: 18	P: 5	E: 2
	Systems approach	Y: 83	N: 6		
	Systems analytic concepts	Y: 83	N: 4		
	Systems structural/functional concepts	Y: 85	N: 5		
I.4	Philosophical Aspects of Systems Analysis	I: 29	M: 31	P: 20	E: 7
	Capabilities and limitations of systems analysis in principle	Y: 69	N: 25		
	Relationship to various philosophical systems and questions	Y: 47	N: 37		
	Role of the analyst in the decision making process	Y: 69	N: 17		

* These names have been recorded in Survey Project files for later use.

I.5	Human and Social Aspects of Systems Analysis	I: 45	M: 30	P: 8	E: 4
	Human beings in systems: implications for systems analysis	Y: 77	N: 7		
	Social groups and organizations in systems: implications for systems analysis	Y: 80	N: 4		
II.	Processes of Systems Analysis	I: 80	M: 9	P: 2	E: 1
	A. Art of Systems Analysis	I: 56	M: 26	P: 7	E: 4
II.A.1	Features of Systems Analysis	I: 43	M: 24	P: 14	E: 6
	Participants	Y: 60	N: 19		
	Inputs	Y: 78	N: 6		
	Models of analysis	Y: 74	N: 8		
	Possible outputs	Y: 80	N: 3		
II.A.2	Types of Systems Analysis	I: 24	M: 25	P: 12	E: 6
	Simplest type	Y: 52	N: 24		
	Most complex type	Y: 58	N: 17		
	Other types	Y: 43	N: 27		
II.A.3	Stages of Systems Analysis	I: 51	M: 22	P: 11	E: 3
	Problem formulation and information gathering	Y: 79	N: 6		
	System identification and specification of alternatives	Y: 78	N: 5		
	Assessment of alternatives and presentation to decision makers	Y: 78	N: 8		
	Assistance in implementation	Y: 67	N: 14		
	Evaluation of implemented alternative	Y: 71	N: 10		
II.A.4	Case Studies	I: 53	M: 29	P: 9	E: 6
	Critical examination of individual successful and unsuccessful systems analyses	Y: 74	N: 7		
	Comparisons of different analyses of similar subjects	Y: 73	N: 7		

II.A.5	General Guidelines	I: 40	M: 25	P: 16	E: 6
	Pitfalls and common problems	Y: 68	N: 11		
	Rules-of-thumb and tricks-of-the-trade	Y: 55	N: 21		
B. Methodology of Systems Analysis		I: 76	M: 10	P: 3	E: 4
II.B.1	Basic Concepts and Methods of Decision-Making Theory	I: 65	M: 14	P: 5	E: 3
	General concepts of decision-making theory based on systems principles and the systems approach	Y: 74	N: 7		
	Methodological problems in decision making	Y: 74	N: 6		
II.B.2	Analytical Frameworks for Practical Decision Making	I: 60	M: 19	P: 6	E: 2
	Traditional investment analysis	Y: 52	N: 20		
	Cost-benefit analysis	Y: 64	N: 11		
	Cost-effectiveness analysis	Y: 67	N: 8		
	Multiattribute impact assessment	Y: 66	N: 9		
	Decision analysis	Y: 68	N: 7		
	Possible new analytical frameworks	Y: 68	N: 6		
	Comparison and evaluation of alternative frameworks	Y: 70	N: 5		
C. Techniques of Systems Analysis		I: 75	M: 12	P: 3	E: 3
II.C.1	Description Techniques	I: 55	M: 23	P: 7	E: 2
	Data gathering	Y: 76	N: 5		
	Data handling	Y: 72	N: 7		
	Data analysis	Y: 76	N: 4		
II.C.2	Modeling Techniques	I: 71	M: 14	P: 0	E: 2
	General model types	Y: 76	N: 5		
	Specific model types	Y: 76	N: 6		
	Systems of models	Y: 76	N: 5		
II.C.3	Forecasting Techniques	I: 57	M: 24	P: 3	E: 3
	Qualitative	Y: 79	N: 5		
	Quantitative	Y: 78	N: 6		

II.C.4	Measurement Techniques	I: 54	M: 25	P: 6	E: 2
	Input--cost and resource use measurement	Y: 77	N: 4		
	Output--performance measurement	Y: 76	N: 7		
	Risk measurement	Y: 74	N: 9		
	Common measurement issues	Y: 67	N: 9		
II.C.5	Synthesis, Design, and Optimization Techniques	I: 60	M: 19	P: 6	E: 2
	Qualitative	Y: 76	N: 6		
	Computational	Y: 76	N: 6		
	Optimization	Y: 77	N: 6		
	Experimental	Y: 74	N: 6		
II.C.6	Planning and Management Techniques	I: 50	M: 27	P: 8	E: 2
	Program-oriented planning and budgeting	Y: 66	N: 9		
	Event-oriented planning and scheduling	Y: 69	N: 7		
	Sectoral planning and management	Y: 63	N: 13		
	Regional planning and management	Y: 68	N: 8		
II.C.7	Implementation Techniques	I: 52	M: 19	P: 12	E: 4
	Program specification (in detail for implementation)	Y: 62	N: 13		
	Program introduction	Y: 62	N: 13		
	Program monitoring and revision	Y: 61	N: 14		
III.	Application of Systems Analysis	I: 78	M: 14	P: 1	E: 0
III.1	Resources and Environment	I: 69	M: 12	P: 5	E: 1
	Mineral resources, including energy resources	Y: 77	N: 4		
	Water resources, including energy uses	Y: 82	N: 2		
	Climate	Y: 60	N: 19		
	Environment	Y: 64	N: 6		
	Ecology	Y: 78	N: 3		
	Agriculture, including forestry and animal husbandry	Y: 76	N: 6		

III.2	Human and Societal Systems	I: 65	M: 17	P: 3	E: 2
	Population	Y: 65	N: 5		
	Urban and regional planning, development, and management	Y: 71	N: 1		
	Housing	Y: 56	N: 14		
	Transportation	Y: 68	N: 4		
	Communications	Y: 68	N: 3		
	Education	Y: 63	N: 6		
	R&D (basic, not applied to specific sectors)	Y: 60	N: 11		
	Health services (planning, organization, and management of health care)	Y: 66	N: 6		
III.3	Economic Systems	I: 67	M: 17	P: 2	E: 1
	International trade and economics	Y: 63	N: 13		
	National economic planning, development, and management	Y: 74	N: 4		
	Sectoral and industrial economic planning, development, and management	Y: 67	N: 9		
	Planning, development, and management of economic organizations	Y: 64	N: 11		
III.4	Industrial Systems	I: 58	M: 23	P: 5	E: 1
	Functions	Y: 73	N: 7		
	Sectors	Y: 71	N: 10		
III.5	Biological and Medical Systems	I: 48	M: 28	P: 8	E: 3
	Elementary biological systems	Y: 51	N: 20		
	Human biology and psychology	Y: 56	N: 14		
	Medical systems and health care: diagnostic and treatment techniques for the individual	Y: 67	N: 10		
	Bionics: modeling of human and other biological functions	Y: 53	N: 19		
	Artificial intelligence: modeling of psychological functions	Y: 59	N: 14		
III.6	Information Systems and Computers	I: 57	M: 23	P: 5	E: 2
	Telecommunications systems and computer networks	Y: 67	N: 9		
	Information storage and retrieval	Y: 66	N: 10		
	Computer systems: software and hardware design and choice	Y: 59	N: 15		
	Management information systems	Y: 67	N: 8		

III.7	Integrated Systems	I: 57	M: 18	P: 7	E: 5
	Food and agriculture-population-economics	Y: 66	N: 7		
	Energy-environment-industry	Y: 67	N: 6		
	Industry-environment-health care	Y: 59	N: 9		
	Territorial-industrial complexes	Y: 58	N: 10		
	Global modeling	Y: 65	N: 12		
III.8	Functional Systems	I: 42	M: 22	P: 14	E: 9
	Distribution systems	Y: 58	N: 10		
	Allocation systems	Y: 62	N: 7		
	Monitoring systems	Y: 58	N: 10		
	Supply systems	Y: 58	N: 10		
IV.	Reference Materials	I: 52	M: 27	P: 10	E: 2
IV.1	Glossaries	I: 42	M: 25	P: 8	E: 12
IV.2	Bibliographies	I: 53	M: 21	P: 4	E: 9
IV.3	Directories	I: 30	M: 30	P: 16	E: 11

[a] Importance ratings were I = very important, definitely include; M = moderately important; P = possibly include; E = exclude. Respondents voted Y (yes) or N (no) at the second (subsection) level.

COMMENTS AND SUGGESTIONS FROM THE RESPONDENTS

OVERVIEW: GENERAL COMMENTS

Certainly the modifications made in the outline and in plans and criteria for the Series and Handbook as a consequence of the questionnaire effort were largely due to the opinions expressed rather than to the pattern of items checked "yes" or "no" on the questionnaire.

Because expressions of agreement were often intermixed with criticism, a precise count of favorable and unfavorable replies is particularly difficult. However, a perceptive remark was helpful, even if it represented the opinion of a single respondent, rather than a large group of persons.

There were also a few semantic misinterpretations, for systems analysis is a relatively new field in which the terms are not yet standardized. A number of respondents, in fact, pointed out a lack of clarity in some of the items of the questionnaire as well as insufficient explanation of the concepts used.

In the discussion that follows, we consider comments referring to the publication program as a whole and then those related to individual topics.

The favorable comments focused on the

- Comprehensiveness of the outline and publication program.
- Need for an authoritative survey and systematization of the field.
- Opportunities implicit in the international character of IIASA.*

The critical comments,** on the other hand, were particularly helpful. These comments were largely from respondents in

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*This point was made only by a few American respondents.

**The comments noted have, in a number of cases, been abbreviated, edited, and paraphrased; this, as well as their selection, represents the subjective judgment of the authors of this report.

the United Kingdom and the United States. These remarks were often quite detailed and the arguments carefully developed. In a rough classification of these comments we may distinguish between the almost completely negative positions, and those--the vast majority--that recognized the potential usefulness of the Survey Project publications, while suggesting changes in the structure and basic philosophy of the publication program.

The gist of the negative comments seems to be that the Series would only "add to a list already far too long," and that it would absorb too much of IIASA's financial and manpower resources. One commentator stated that if a Series is to be published at all, it should maintain a low profile and emphasize economic and institutional issues. ("We are much weaker at organizing our lives along these axes than along the axis of mathematical sophistry.")

One respondent found the questionnaire unconvincing; for him, it is "difficult to believe that the IIASA staff who wrote this description really understand how much effort, time, and luck it takes to develop the right manuscript for the available audiences." He also conjectured: "No senior person at IIASA will devote the time and provide the continuity needed to create a first-rate series"; and he was dubious about the notion of a Handbook for systems analysis.

Not many comments were specifically addressed to the proposed Handbook and those that were seemed to be critical. For example: "The plan of the handbook is about fifteen years out of date, and should be completely reconceived"; "Handbooks have been successful when there has been a large number of technicians who needed ready guides for small problems." Another respondent remarked: "It has just the right ingredients of science, busy work and international bureaucracy to be used as an international service organization's justification for its existence." Another added: "I am wary of handbooks in this area on three counts: (1) the length of time it takes to assemble adequate material; (2) the unevenness of the contents, despite the very best editing; and (3) the scarcity of good (say, as in physics, chemistry, etc.) material."

The criticisms expressed by the second (less) negative set of respondents are grouped rather arbitrarily under the following headings.

Social, Economic, Organizational, and Political Aspects of Systems Analysis Treated Too Briefly or Not at All

This point was brought out by a number of commentators: many respondents (primarily from the West) expressed a strong desire for more emphasis on social issues, including organizational problems. Thus: "...the success of a systems analysis

depends precisely on the extent to which careful social and economic analyses are incorporated...." And "...a generalization to human behavioral systems, the study of state planning and social welfare, the development of a generalized approach to subjective value assessment, and the study of the creative aspects of design..." are needed.

Other comments were "...a major problem is to find means of assessing human, social, and political factors, all qualitative, and weighing them against the quantitative factors which are likely to be so much easier to deal with"; "...it is important to take into consideration the interface between 'hard' mathematical analysis and measurement of physical systems and the 'soft' analysis of human systems"; and "...managers are the key to effective implementation. A need for recognizing the bureaucratic, political and organizational aspects of systems analysis is a must, and we need to get at the managers."

On the same issue but with a somewhat opposite point of view, we received few questionnaires which implied that the human and social aspects of systems analysis should be deemphasized because there is insufficient meaningful research to make such factors important, according to one of these.

A few respondents questioned the ability of IIASA to deal adequately with social and political issues, postulating a tendency to avoid ideological conflict by concentrating on mathematics rather than on basic economic and social issues. One commentator stated: "Governments, politics, conflict, and human behavior exist and are being increasingly treated to systems analysis. One knows the probable reason why IIASA shuns such areas, but it would be silly to omit such studies from a comprehensive survey."

Excessive Emphasis on Formal Techniques, Particularly on the Decision-Theoretic Approach

One concern was that emphasis on formal techniques might lead the Survey Project to duplicate already existing publications. (Most British respondents, in particular, held this view.) Other somewhat similar opinions were: "...too much stress on methodology too early can detract from the study of real problems and lead to hollow debates about methodological fads...." "Methodology and Techniques seem too strongly oriented toward measurable quantitative aspects. Methods for dealing with ordinal or qualitative aspects need to be developed...." Still others thought that the publication plans reflected old conceptions of operations research and management science rather than a new approach. Yet, in contrast, there was the opinion: "...mathematical modeling seems to have been given a perfunctory treatment. This is central; one should look for a treatment to cover problems in all classes of systems."

Insufficient Attention Given to Institutional Factors That Facilitate or Hinder the Use of Analysis, Particularly to Winning Acceptance for the Analysis and to the Implementation of the Results

The Canadians gave particular attention to this point but many others also commented.

One view was that the project "...covers the production of analysis but not its consumption. There is no place for implementation, organizational politics, translation of results, and so on. Yet, it is likely that over 90% of all analyses are rejected by the organizations for which they are intended." Other remarks were similar: "...There do not seem to be any plans for systematically investigating issues related to the social utilization of systems analysis, and the problems and perspectives of the user..."; "Most public administrators are afraid of and do not understand systems analysis. The objective...should be to attack this ignorance..."; and "...too often the analysis stops at the recommendation stage." Another critic stressed the importance of the "sociology of implementation."

On the other hand, opposite viewpoints were: "...do not overlook the importance of the decision environment (how about doing good systems analysis in a bad decision environment?)" and one respondent noted a possible "...dissonance between analytical and political paradigms, for instance, in the latter, to admit even the existence of alternatives may imply 'losing.'..." Another commentator was doubtful about how far the analyst "...should dilute his effort studying how to get a decision maker to accept the results. One danger is that the science (or art) of selling options is open to abuse."

Applications Should Be Practical and Limitations Noted

One respondent stated that it will be "very easy for IIASA to wind up with a large number of abstract pieces that have little relation to modern policy analysis in practice today." Another stated "...if the IIASA survey intends to include all those studies that self-classify themselves as systems analysis, it will be hopelessly swamped...." Respondents also expressed the view that the Project staff should not overrate systems analysis, for it has "only a modest contribution to make, albeit an important one...." One advised "...give an answer but do not claim more authority for it than it deserves."

Similar views were: "...I am worried that systems analysis will prematurely acquire limitless pretensions which are insupportable, arrogating to itself or attempting to embrace too many specialized fields..."; and "include

down-to-earth cases, not too much emphasis on 'government' situations...." Another respondent supported this idea: "...great care should be taken to present only those aspects of applied systems analysis that have been tried or that can be tried without great difficulty. Many potential applications are too grandiose. They deserve support in the academic and research community, but are of little practical value to users...."

One respondent emphasized that "...comments on the limitation on the role of analysts as aids to decisionmakers should be included." Another remarked that "...all too often, systems analysts have acted as if they were policy makers. Rarely in dealing with complex problems can analysts come up with [the] preferred course of action--except when dominance is found." One critic went further: "...the analyst soon learns the only decisions he can make are in how to carry out a study."

There were other comments on the limitations of the outline. One saw it as too theoretical and academic, not directed to practitioners and, especially, to managers. Others considered the proposed Series and Handbook too ambitious, too detailed, or not sufficiently selective.

Too Narrow and Isolated an Interpretation of Systems Analysis

On this point: "...the principal need is for systems analysis to provide 'overview' models and concepts in an 'integrated systems' manner..."; "...a main thrust of systems analysis is to integrate disciplines, to provide a coherent interdisciplinary basis for the methodology, ...above all, to unify"; and "...to assign a special role to economics, for example, when the behavioral aspects are just as important, is to negate the systems approach. ...[A] basic concept is to avoid fragmentation."

Related views were: "...I am not sure it is interesting to compare the coal industry in one country with that in another--what is interesting is how different types of organizations operate, e.g., centralized versus decentralized..."; and "...the relationship to other disciplines is important, but the method of comparison needs to be worked out, e.g., comparison at the level of thought, then methodology...."

With respect to narrowness, one respondent made the important point that insufficient attention is given to *synthesis*, as opposed to analysis, and to "metaproblems," e.g., the way one decides on an approach to a problem. The same point was made about *iteration* and the need for an *explicit analytic framework*. Others noted the lack of a clearly expressed underlying philosophy, which for several respondents should be some version of the Popperian philosophy of science; for others, it should be general systems theory.

Miscellaneous Comments

Contrary to the view of a number of respondents that the history of systems analysis should be eliminated, one respondent remarked that it is important to trace the history and philosophy of systems thinking back to its roots. ("It is nothing new, only a restatement of holistic ideas originating with the Greeks, [which] incorporates much of Hegel, Whitehead, and Logical Positivism; it generalizes scientific method, and adds mathematical modeling to the thinking process.... Ordinarily mental thinking tends to simplify when [one is] faced with multivariate problems, so systems analysis can be seen as computer-aided thinking.")

There was a warning from another commentator that many so-called applications are theoretical analyses of identifiable areas, and not "applications" in the sense of being implemented in the real world.

Computers and algorithms came in for comment: "Much of the section on Information Systems and Computers is misplaced. There are certainly similar applications of systems analysis to computer systems as such, but a systems analyst must know a great deal about computing as a tool of his 'profession' whether or not he is studying computer systems as systems, whereas he need not know anything about (say) water resources unless he is concerned with problems of water resources. Thus, all the other applications areas are (in general) peripheral and exemplary, whereas the elements of computer techniques are central and becoming steadily more so."

Lack of attention to validation was criticized with the comment: "In a recent discussion on the relevance of scientific method in systems modeling, there was general agreement that the most important single factor in successful operational research/systems analysis was continued criticism of theories, models, solutions--the attempt to disprove 'hypothesis' or to refute 'conjectures'...."

There were a few critical remarks about the potential audience and the publication scheme in general. For instance: "...the managerial audience is a very important one and we think the kinds of publications that reach this audience should be quite different. Perhaps there should be three series--one on methods, one on theory, and one on applications."

One possible design for the Handbook emerged. It would consist of three volumes, outlined as follows:

- Volume I--Foundations as well as the art and methodology of systems analysis with

  a) An integrated approach to various aspects of systems analysis covering problem formulation,

synthesis of alternatives, data generation, modeling, forecasting, evaluation, decision, and implementation.

b) An extensive essay on the philosophical and historical bases of systems analysis.

c) Another extensive essay on the mental processes of thinking, solving, and deciding, and how they are externalized by systems analysis to deal adequately with problems of complexity and variety.

- Volume II--Techniques of systems analysis, organized according to the structure of Ia above.
- Volume III--Applications providing a matrix of case studies in which each application is treated in a uniform way following the structure of Ia.

COMMENTS ON SPECIFIC NUMBERED SECTIONS OF THE OUTLINE

I. Foundations of Systems Analysis (I: 52; M: 31; P: 7; E: 3)*

The majority of respondents thought that Foundations** should be included, but the number of those who considered it very important (I) is not as large as the number who supported Section II, Processes, and Section III, Applications, with this rating. The reason is clear from the nature of the responses and comments on the individual items. In Section I, Foundations, even more than in other parts of the questionnaire, the numerical information is not very meaningful, since there seem to be semantic problems at a number of points in the section.

I.1 Development of Systems Analysis (I: 36; M: 28; P: 15; E: 8)

Many respondents seemed to feel that History should be treated briefly, if at all, and that a discussion of Precursors

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*Only the basic statistics for the overall structure and for first-level topics are given here. For a complete count of responses to the individual items, the reader should consult Table 1.

**Throughout this report the actual outline sections and topics are capitalized to distinguish them from respondents' suggested topics.

would be better included in the historical sketch. Proposals have been made to discuss the historical background of systems analysis together with Philosophy. It should be noted that Precursors and History received a large number of negative votes: 30 and 24 "no," respectively; 53 and 60 "yes."*

Several respondents made the point that identifying precursors in different cultures is a difficult and highly controversial task. Among forerunning disciplines suggested were "scientific method," operations research, systems engineering, microeconomics, praxeology, systems concepts in physics, "scientific management," gestalt psychology, and logical positivism.

One respondent called attention to the distinctions between evaluation *for* decisions and evaluation *of* decisions and between changes over time and dynamic behavior.

A sizable minority (20) would exclude Current Status, possibly because any such discussion will be outdated before it appears in print. On the other hand, an American respondent stated that it is an important topic, especially for the most difficult "open" problems of systems analysis, and this opinion is shared by others.

There were a number of comments concerning Needs and Future Directions. Observations included: "This is of limited value unless related to specific national or other problem contexts"; and "The Handbook, if it is comprehensive, does not need a speculative section." However, one opinion was that this item was sufficiently important to have a section of its own.

I.2 Meanings of Systems Analysis (I: 40; M: 24; P: 19; E:4)

This topic drew a number of criticisms, especially from respondents from the British empiricist tradition. There were objections to the search for definitions, largely based on the beliefs that a variety of definitions can confuse rather than help and that IIASA should adopt an appropriate definition and adhere to it. One respondent expressed fears of scholasticism and "verbal gymnastics," while another made the observation that admitting the existence of alternative definitions may imply a loss of conviction in the political arena. We were also reminded that operations research has been bedeviled by definitional arguments and that this is not a profitable area.

A number of respondents found the collocation of Capabilities and Limitations--in Practice under Meanings of Systems Analysis rather inappropriate. One, however, stated that discussion of capabilities and limitations is important for the "self-consciousness" of the discipline.

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*Here, as elsewhere, the totals are not equal for different items because some respondents failed to answer all items on the questionnaire.

Concerning the Relationship to Other Disciplines, it was brought to our attention by several commentators that systems analysis is *not* a discipline. Among the disciplines mentioned: operations research, cybernetics, statistics, "numerical mathematics," (numerical analysis?), functional analysis, behavioral science, psychology, biology, econometrics, political science, and international relations. Another commentator observed that at least half of systems analysis takes place within other disciplines. A number of respondents suggested a reorganization of this section because, as one expressed it: "It is more logical to determine the place of systems analysis among other disciplines initially, than to provide the necessary definitions, and only then describe the problems of systems analysis."

I.3 Bases of Systems Analysis (I: 62; M: 18; P: 5; E: 2)

Few objections have been raised against this group of topics. Systems Approach to one respondent was "pure hot air." Concerning Systems Analytic Concepts, this same commentator wondered why uncertainty and temporal factors have been singled out: in some problems they are vital, in others they are a distracting irrelevance; and, he went on to state, the analyst should concentrate on spatial factors and on overall capacity and constraints on availability. Others found the section "thin," and thought this material was probably covered adequately in other sections.

Several respondents did not understand the distinction between Systems Structural and Functional Concepts. One respondent sharing this opinion would add here "fuzzy implications and their representation in systems analysis," and "connection between local and global behavior." He thought that systems theoretic concepts should be treated together with systems-analytic ones. Other respondents viewed general systems theory as the *basis* of systems analysis.

Several commentators from the USSR emphasized the distinction between the systems approach and the mechanistic point of view. They also called attention to the problem of "wholeness," i.e., to the need to consider the craft as well as the scientific aspects of systems analysis and to include the possibility of applying the systems approach to scientific knowledge.

I.4 Philosophical Aspects of Systems Analysis (I: 39; M: 31; P: 20; E: 7)

The distribution of the ratings for this set of topics was rather skewed toward the lower end of the preference scale. This was confirmed by the high number of "No's" on individual items. In particular, Relationship to Various

Philosophical Systems and Questions received the highest number of negative ratings of all items on the questionnaire: 37 "No" and 47 "yes."

As some respondents pointed out, the role of the analyst is a practical, rather than a philosophical issue and, as such, it belongs to the "art" aspect of systems analysis.

Two respondents stressed the importance of Popper's epistemological theories and his school for applied systems analysis. On the other hand, significant relationships were noted between systems analysis and the holistic thinking of some Greek philosophers, Hegel, Whitehead, and the logical positivists (others, incidentally, thought that holistic philosophies are incompatible with Popper's views, and mentioned that these philosophies have been criticized by him in some of his best-known works). Still another commentator would like to see a good discussion of "foundations for understanding systems and information and other important categories like decision, operation." One systems analyst from the USSR mentioned the possibility that a discussion of capabilities and limitations in principle might involve "too close a connection with ideological problems."

I.5 Human and Social Aspects of Systems Analysis (I: 45; M: 30; P: 8; E: 4)

Most respondents obviously considered these topics important, although a few had difficulty understanding the formulation contained in the outline. Thus, we have the questions: Does it pertain to more treatment of alternative implementation strategies in systems analysis? Does it mean more consideration of organizational behavior in systems analysis? One observer stated that the section represented "...a pitifully small part, bearing in mind the extensive systems activity in behavioral science, political science, etc." We also have the suggestion: "It may be important to achieve a good match between the characteristics of the decision-making system (which may not find exact organizational expression) and the methodology chosen for analysis, as well as for definition of the system to be analyzed. For instance, global modelling does not seem to relate to any conceivable decision system and thus differs fundamentally from, say, transportation modelling."

One respondent would add Human Values and Purposes (economic, personal, social), while another stressed the importance of man/model/machine synergies. Still another remarked that the most difficult methodological problems of systems analysis are met precisely in the analysis of human and social systems.

General Comments on the Foundations of Systems Analysis

Even though a large number of respondents commented at length on some aspects of the Foundations of Systems Analysis

section, it produced very few general comments. One respondent found this section to be in many ways the most important one: "...in that it lays the conceptual foundation" on which the following sections are based. He and others, however, took exception to its organization, particularly to the separation of the Art and Methodology of Systems Analysis from the Foundations.

One respondent remarked that Systems Structural/Functional Concepts is the key to the Foundations section; others, as noted earlier, failed to understand the meaning of the outline in this case. Another respondent called attention to operational gaming, arguing that, particularly with real players, it is worth extended treatment, while game theory is not.

II. Processes of Systems Analysis (I: 80; M: 9; P: 2; E: 1)

There were no comments of any significance on the structure of this part of the outline, although a number of changes were suggested in terminology.

II.A Art of Systems Analysis (I: 56; M: 26; P: 7; E: 4)

The characterization of some aspects of systems analysis as "art" was the concern of many respondents. Thus: "...an idea I would prefer to see diminished in emphasis is the matter of whether systems analysis is art or science. Systems are not new; the ancients had systems which were analyzed after a fashion. ...Let's accentuate the positive of current accomplishments and not worry whether this is art or science." And "...if there is any 'art' in systems analysis it does not lie in the routine approach. Rather, it lies in the 'feeling' of the analyst for the nature of the problem and the appropriateness of methodologies.... If any space is devoted to systems analysis as an art, it should come after the science is made clear."

II.A.1 Features of Systems Analysis (I: 43; M: 24; P: 14; E: 6)

Many respondents were not enthusiastic about this collection of topics. One found it a "somewhat uninspiring list" that left many things unanswered. In his opinion, implementation plans and recommendations should also be included here. Another felt that a discussion of the Features and Types of Systems Analysis was not "worth much more than a paragraph...." For a third commentator, discussion of such topics should only be included in the Handbook and not in separate monographs.

Similar comments were received on the topic of Participants. One respondent remarked: "The role players should emerge in the case rather than being defined." For another, those also

affected by the decision should be included, while in a second opinion, the important question was: "Who are the real decision makers?" A suggestion was made that, at this point, different types of specialists be listed: "engineers, designers, physiologists, political scientists, etc." We were also reminded of the growing importance of citizen participation.

As for inputs, comments from several suggested that constraints should be mentioned explicitly and that values (held by the various parties involved) and purpose be added.

Several respondents found Modes of Analysis somewhat confusing. One would include operational gaming, while another wondered whether simulation and gaming or social experimentation should be included here. The importance of comprehensive sensitivity analysis was also emphasized to indicate what is important in final outcomes. An interesting observation was made: "It should be stressed that accurate values of the input parameters will probably not be provided until the supplier has seen the consequences. So the most valuable output is sometimes a realistic set of input data.

Various respondents would include, under Possible Outputs, "classification of values and purpose," as well as "designs, optimal trajectories and/or policies, insights, clarification of structure and/or behavior."

II.A.2 Types of Systems Analysis (I: 24; M: 25; P: 12; E: 6)

This section was severely criticized by a number of respondents, largely from the United Kingdom but also including several from the United States, the German Democratic Republic, and elsewhere. The distinctions are called "curious," and "simple minded"; "classification by complexity" was not considered appropriate. One commentator asked which criteria would be used to classify analyses as simple or complex, and wondered whether we really understand the proposed categorization. Tongue-in-cheek, another wrote: "The proposed outline correctly suggests that these are caricatures."

Another remark was: "[The] simple type [is] not a good paradigm for [the] more frequent, complex type" and, in a similar vein, it was noted that the distinction is not very helpful, inasmuch as "...the most complex type is the general case in studying policy issues." In addition, the classification was said to have more pedagogical than practical value and to be "meaningless at the present state of the art."

We also have the remark: "By all means discuss [Types of Systems Analysis] as a continuous spectrum, but it would be wrong and non-scientific to suggest that endpoints can be identified. No doubt there are variations of type but I doubt this structure." According to still another critic, types of systems analysis cannot be separated from concrete applications.

II.A.3 Stages of Systems Analysis (I: 51; M: 22; P: 11; E: 3)

This section stimulated, together with some criticism, a number of proposals for additional topics. According to one remark, the section represents "standard stuff," which does not deserve to be given too much importance; another would exclude it, with the exception of Evaluation of Implemented Alternative. Also: "This reads to me like a pre-Popperian description of the process of systems analysis."

One systems analyst found the meaning of Assistance in Implementation unclear, and, at any rate, "never as a separate chapter or volume." Another did not understand Evaluation of Implemented Alternative and observed that "criteria have yet to be established. It would be dangerous to imply we know how to do this. The system adapts and changes." This same commentator proposed replacing the term "Alternative" with "feasible decision space."

The iterative nature of the cycle of analysis should receive more emphasis, according to one view, and another would add sensitivity tests of outcomes for key assumptions and major uncertainties, as well as evaluation of alternative implementation strategies and program evaluation. To Problem Formulation and Information Gathering another respondent would add criteria formulation; he proposed two additional items: system simulation and comparison with real or standard systems behavior. Finally, in connection with Assessment of Alternatives and Presentation to Decision Makers, the importance of problems of multi-person decision-making bodies, e.g., executive committees, was emphasized as well as a separate work on management systems audit.

II.A.4 Case Studies (I: 53; M: 29; P: 9; E: 6)

The number of positive responses in this section reflected the importance that respondents attach to good case studies. However, doubts were expressed about the criteria to be used to judge successful and unsuccessful systems analyses. In particular, as one critic noted, there will always be the difficulty of not knowing whether a program is successful because, in some cases, the time lag may be ten years!

Comparisons of Different Analyses of Similar Subjects was well received; "useful," "excellent," and "marvellous idea if you can get anyone to write them," were some comments (by British respondents).

An analysis of the location of the third London airport was suggested by one U.K. respondent as a good case study because it can provide "...an interesting example of the

relationship between [a] systems analysis team and formal processes of public inquiry." A second U.K. respondent suggested this third London airport study as one of the first Series volumes; however, he gave a negative opinion on both types of case studies listed in the outline as being too difficult.

II.A.5 General Guidelines (I: 40; M: 25; P: 16; E: 6)

The importance of this section may not have been correctly perceived by a number of respondents, partly because of semantic problems. Some did not understand the meaning of Rules-of-Thumb and Tricks-of-the-Trade; others were definitely against the section, but unfortunately, gave no reasons. One commentator found the section useful but warned against triviality. Several others would treat "General Guidelines" and "Case Studies" as one topic. One would include the subtopics mentioned here in a discussion of techniques.

A constructive proposal was offered by one U.K. respondent: Contributions of no more than 100 words could be obtained from IIASA scientists; these proposals could then be sent out to other contributors for modifications and additions. "The essential point," he emphasized, "is that these topics should have a very large number of contributors and a firm editor."

II.B Methodology of Systems Analysis (I: 76; M: 10; P: 3; E: 4)

II.B.1 Basic Concepts and Methods of Decision-Making Theory (I: 65; M: 14; P: 5; E: 3)

The three respondents who would exclude this topic unfortunately give no reasons. Most of the explicit criticisms emphasized that "decision-making is *not* the only methodology in systems analysis," or else stated the opinion that methodological problems of decision making should be treated in the context of empirical studies of decision making in practice. One critic warned against the danger of finishing "...with a very esoteric discussion and not much else." For another this topic and the next ("Analytical Frameworks for Practical Decision Making") belong solely in the domain of the Handbook (presumably because they have been adequately covered elsewhere).

A significant methodological point was made: "The most important dichotomy in optimization methods is not between deterministic [search] and random search. It is between methods for problems where a local optimum is acceptable and methods for problems with several local optima. The latter may be tackled by random search, though other methods

(tree-search, other integer programming methods, or dynamic programming) are usually preferable."

A number of additions were suggested by one U.K. respondent: basic concepts and methods of systems design, modeling and analysis of fuzzy systems, and the system approach to the problems of general values and social welfare. Other topics he suggested were control theory, modeling and analysis of human behavioral systems (political systems, conflict systems, etc.), quantification problems in social systems, and modeling and analysis of biological and physiological systems.

One respondent would add an item on human aspects of decision making: value systems, human information processes, personal versus institutional objects, etc. Another would add "objectives structure" for hierarchically structured systems, while a third noted that, in addition to analytical methods, algebraic methods are important for large-scale systems, and that "the new approach of the integration of multi-dimensional evaluation is a current topic."

II.B.2 Analytical Frameworks for Practical Decision Making (I: 60; M: 19; P: 6; E: 2)

A relatively large number of respondents (20 out of a total of 72) would exclude Traditional Investment Analysis as "far too removed" from systems analysis. For others, it should be included, but it should be treated critically with attention given to limitations. (This also applied to Cost-Benefit Analysis.) One commentator considered topics such as Decision Analysis and Multiattribute Impact Assessment, Cost-Benefit Analysis and Cost-Effectiveness Analysis suitable only for the Handbook, since "no new books or monographs are needed," while another would exclude them entirely. For a third, much of this topic could be handled as a technique of systems analysis, while a fourth wrote: "My uneasiness about the whole field is that theorists about systems analysis are apt to overlook the most important feature of many systems analyses, which is essentially a data reduction exercise." Concerning Decision Analysis, the same respondent stated: "My 'no' to decision analysis is intended as an objection to the proposition that the utilities and prior probabilities of the decision-maker (whoever he may be) should be ascertained first and that the whole analysis should be based on these data. The analysis may then be useless to anyone who does not share these particular prejudices." A fifth commentator remarked: "Yes, but damning."

One respondent saw "little point in speculating about Possible New Analytical Frameworks." Other respondents made a number of suggestions on what might be included. Thus, we have the suggestions: the decision maker's interaction with models, the combination of systems analysis concepts with participative decision making, social experimentation, a fixed

budget case, a fixed utility case, vector optimization, trade-offs among conflicting objectives, and fuzzy sets.

II.C Techniques of Systems Analysis (I: 75; M: 12; P: 3; E: 3

The only general comment on this section was by a U.K. respondent, who thought that it belonged in the Handbook, with the exception of Planning and Management Techniques: "No other is work for a whole volume. There are already hundreds of them."

II.C.1 Description Techniques (I: 55; M: 23; P: 7; E: 2)

Special problems were brought to our attention that arise when dealing with social and fuzzy systems in which data generation using Delphi techniques should be included. We were also reminded of the importance of techniques for handling nonmetric data. One commentator expressed the hope that the treatment of regression analysis would cover Kalman filtering thoroughly, while another pointed out the dangers of regression analysis. A third would like to see Bayesian analysis of information value treated adequately, while still another would add data-reduction techniques.

II.C.2 Modeling Techniques (I: 71; M: 14; P: 0; E: 2)

A number of respondents thought this section had not been sufficiently developed; two would exclude it altogether. One found the proposed classification blurred "the fundamental distinction between simulation models and optimization models." Another said he did not understand the meaning of Systems of Models.

A number of additional topics were proposed: interactive models, conflict and competitive models, validation of models, fuzzy models; there was a suggestion that a distinction be made between models for classification purposes and quantitative models.

II.C.3 Forecasting Techniques (I: 57; M: 24; P: 3; E: 3)

One respondent considered qualitative forecasting techniques "out of place in systems analysis," while others thought that adequate texts already existed. Another warned against too much "futurology," and still another hoped that univariate time series analysis would not be given too much space.

For one critic, "the important thing here is to *avoid* forecasting the future per se. [One] must usually deal in terms of alternative futures, e.g., base case plus "excursions."

Suggestions for addition were: forecasting with the help of fuzzy implications, Delphi techniques, cross-sectional methods, morphological methods (qualitative techniques), and various simulation techniques.

II.C.4 Measurement Techniques (I: 54; M: 25; P: 6; E: 2)

Again, some respondents doubted whether new texts were needed in this area. Another found the section "very confused," but saw much need for good material on the principles of measurement, for an analysis of which operations are valid for different forms, and for operational tests of scales (which are obvious for physics but not for additive utility axioms). One remark emphasized that we must consider more than "management-type" measurement techniques, since measurement of social and political systems and of value are equally important. Similarly, another respondent noted: "We may also need means of assessing if not measuring the social, political, and environmental impacts of the output."

With regard to the topic Input Measures--Cost and Resource Measurement, the importance of cost modeling was emphasized; Output--Performance Measurement was considered a difficult problem area (i.e., obtaining good proxy measures). One respondent warned against giving the impression that measurement equals precision, while for another the treatment of uncertainty is difficult but important, and fuzzy set methods are useful. Other items considered to be important were common measurement issues, the residual value problem and the distribution of benefits and costs.

II.C.5 Synthesis, Design, and Optimization Techniques (I: 60; M: 19; P: 6; E: 2)

A number of respondents expressed the opinion that there is already a sufficient number of texts in this area. Thus, several voted "no" on all items except for "recent unpublished developments or for a very basic handbook." One respondent, however, considered these topics "the heart of the whole subject." Additions suggested were simulation, learning processes in modeling, design morphology, and systems engineering.

About Optimization, it was said: "The contrast between computational techniques and optimization looks odd: optimization nearly always involves computation. I regard 'mathematical programming' as covering optimization subject to constraints, so I would put unconstrained optimization in as a first subheading. I would also include dynamic programming as a separate subheading." This same critic would also add simulation, with subheadings automatic simulation and machine interaction.

Others thought the treatment of optimization should be more detailed (e.g., include dynamic programming, graph theory, heuristic methods). They would also add sequential decisions. An opposite view was that optimization is possible only at very low levels, while another respondent wondered whether we would include "criticisms of optimization as a concept," and discuss alternatives. Several stated that Optimization had been covered adequately in the literature, and one considered the experimental approach for the design of complex systems very promising.

The term "Experimental" in this section did not mean the same to all respondents; one respondent, for instance, interpreted it in terms of large-scale social experiments, which he considered important. Some respondents felt that Qualitative Methods were "out of place in systems analysis," but would make an exception for scenario writing.

II.C.6 Planning and Management Techniques (I: 50; M: 27; P: 8; E: 2)

Several respondents found this section "an unsatisfactory and incomplete list of planning and management techniques"; one asked: "what about, say, gaining general acceptance of proposed solutions?" For another, the section appeared to be thin and lack homogeneity, but he was unable to offer an alternative. Two would exclude it, while a third remarked that the topics together "merit a good, complete, and cohesive book. Existing publications are variable in quality." He suggested adding national planning and management, and multinational corporate planning and management.

For another, Program-Oriented Planning and Budgeting is "surely outmoded." Suggested additions were manpower planning, phenomenon-oriented and project-oriented planning and management, human resource management, ergonomics, and management by objectives. One respondent asked why we chose regional and not, say, urban planning. For the respondents from the group PRACSYS,* the topics of this section (with the exception of Regional Planning and Management) do not belong to systems analysis, but to its applications.

II.C.7 Implementation Techniques (I: 52; M: 19; P: 12; E: 4)

For some this topic was suitable only for the Handbook, while others would exclude it because they felt that

*Association pour la Promotion et la Recherche de l'Analyse et de la Conception de Systèmes, affiliated with IIASA's French National Member Organization.

implementation is not a technique of systems analysis. One respondent found the approach "fairly traditional, suitable for hierarchical/authoritarian situations (or at least manipulative, e.g., reference to incentives at this late stage in a project)." The great importance of incentives was emphasized also by a U.S. respondent, who suggested that perhaps program evaluation should be added.

In one opinion, the section is misplaced: "Implementation is part of systems analysis since the decision maker is part of the system being analyzed. Either the section refers solely to the introduction of specific computer programs--hardly worth a section of its own--or it is part of the art of systems analysis." Another respondent would include design/selection of policy levers, and added: "In many instances the decision-making body has only partial influence and therefore (a) cannot specify in detail, (b) does not exert its influence by a single "plan" but by successive (adaptive) interventions."

Additional topics suggested were program specification, design as an implementation process, simulation languages (general features), dialogue techniques for systems analysis, and global modeling (general features).

General Comments on the Processes of Systems Analysis

In addition to the detailed comments on specific items reported above, a number of respondents made observations of a more general nature.

One respondent thought that the section should include a discussion of the general characteristics of the systems analytic process (e.g., its iterative nature, the interaction between analysis and judgment), and of the hierarchical nature of goals and objectives.

One commentator referred to his previous comments on the lack of reference to the scientific method: "It needs to be made clear early on whether systems analysis is seen as a scientific activity, to what extent it uses the scientific method, and to what extent it perhaps goes beyond it. I think this links with the small attention at present given to 'validation of models.' In a recent discussion of the relevance of scientific method in systems modeling there was general agreement that the most important single factor in successful operations research/systems analysis was continued criticism of theories, models, solutions--the attempt to disprove 'hypotheses' or to refute 'conjectures'--and that these ideas were central to the methods of science. On the other hand, many parts of systems analysis go beyond the scientific method. Whatever line is taken on this, it needs to be clearly and firmly dealt with."

A suggestion was made that throughout this section a clear distinction should be made between courses of action available to the decision maker, and their outcomes; and the value that is placed by the decision maker on the outcome, which should be apparent in relation to his purpose.*

This same respondent added: "The evaluation of implemented alternatives depends on establishing the values placed by the decision maker on achieving his purposes. Effectiveness, benefits, utility have all, ultimately, to be related to [the] purpose of the individual, organization, society." He also suggested dividing competitive system models (which he previously proposed as a possible addition) into two separate items, both specific examples of man-machine models: (1) interactive models in which the analyst and the decision maker are relating to each other through the medium of a "man-machine" model; and (2) conflict and competitive models, and gaming models of all types as research tools in human behavior experiments.**

Some points of general interest about Planning and Management Techniques were: "Many practising systems analysts have no knowledge of planning and management techniques, except for project control/PERT/cost estimation, because of deficient education in political/military history, macroeconomics, incompetence in handling statistics, unfamiliarity with econometrics. The problems which beset many serious systems management people and executive managements in practice today are most pronounced in (a) relating their organizations' plans to national plans or to the intervention or regulatory powers of governmental agencies, (b) planning and control of multi-national corporations, (c) influencing inflexible educational systems. Systems analysis which ignores these problems in order to concentrate on (e.g.) Urban Planning will be abdicating its responsibilities. What is a systems description of the national transportation resources of a country taking into account regulatory agencies (e.g., C.A.B. in the U.S.A.)? Is the system inherently unstable? and why? How should it be planned and managed?"

According to a U.K. commentator, a major step in publishing in this area would be case studies in the practice of systems analysis--not as a single project but as an ongoing activity. The work of the British National Coal Board, he feels, might be suitable here.

One respondent's general comment was that this is a well-developed list: "My one concern is a slight emphasis on assessing benefits and output only in monetary terms. In some cases

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*From Russell Ackoff and Fred E. Emery, *Purposeful Systems*, Aldine Publishing Company, Chicago, 1972.

**Based on the work of K.C. Bowen, a colleague of the respondent.

this will be impossible, and in others not sufficient. In most major systems analysis studies, there will be human, social, political, and perhaps environmental factors which will be impacted by the study. One of the major problems in systems analysis is to find means of assessing these qualitative factors and weighing them against the quantitative factors which are usually so much easier to deal with."

III. Applications of Systems Analysis (I: 78; M: 14; P: 1; E: 0)

One U.K. respondent proposed adding the following topics:

- Technological systems
  - Transportation (land/sea/air)
  - Communication (telecommunication/media/entertainment)
  - Automation (artificial intelligence/robotics)
  - Defense and surveillance
- Systems reliability
  - Reliability analysis
  - Fault diagnosis
  - Reliability allocation and design
- Systems assurance
  - Self-repair and maintenance systems
  - Logistic support
  - Integrated assurance design
- Other applications
  - Legal systems
  - Arts (kinetic art, critical analysis, music synthesis)
  - Historical analysis.

Another pointed out that the list proposed in the outline is not the only way to classify applications. It might be better to classify by the type of system, i.e., by the type of goal, or the way in which it is organized. He thought that perhaps one should distinguish between goal-seeking systems, e.g., a regional planning authority; and those elements of such systems which can be isolated, e.g., a transportation system.

Some respondents would divide Biological and Medical Systems into its two separate components and delete Integrated Systems. One remark was: "All really interesting systems are 'integrated'--perhaps it is a matter of degree." Others found the topic Functional Systems a little vague.

There were some complaints of overlap and suggestions to exclude Human and Societal Systems, as well as Biological and Medical Systems. One opinion was that Industrial Systems is already covered under Economic Systems, Integrated Systems, and Functional Systems.

One comment was that Information Systems and Computers should be rated as M (moderately important) because the field is already well covered and is changing too fast for any book to remain definitive for long; similarly, Functional Systems should be rated as P (possibly include) because this area is too general for cohesive treatment.

Under Human and Societal Systems one analyst would include social services and criminal justice systems; under Economic Systems, banking, finance, and insurance; automation he thought should be discussed under Information Systems; transportation-energy-urban and regional planning could be treated as examples of Integrated Systems, while disposal systems and decision-making systems would be good examples of Functional Systems. He also suggested changing Biological and Medical Systems to human behavior, modeling of psychological functions.

A separate section on transportation systems was also suggested. Still another analyst thought that almost all these topics are important: "The problem is to get a number of good examples." Concerning Integrated Systems: "It is probably going to be hard here." For Functional Systems: "Perhaps some of the most interesting examples here are in the military area. Is this out of bound?"

III.1 Resources and Environment (I: 69; M: 12; P: 5; E: 1)

A relatively large number of respondents (19) were against the inclusion of Climate. (For example: "What can you do about climate?") One commentator thought that it might be necessary to limit the considerations to problems of possible impacts of anthropogenic factors on global climate and the study of climate for reliable forecasting and prediction. Others would like to see a discussion of impact assessment, with examples, and some remarked that solar energy should be given extensive treatment.

Several respondents found Environment too broad and indicated that it should be more precisely specified, e.g., air management, land use, recycling, marine environment, global resource management, etc.

Another opinion was that, unless these fields are related to human and societal systems, the decision orientation of systems analysis will be missing. A number of additions were proposed: technological forecasting, technological assessment, human resources and human systems, including educated manpower, since this can be a determining factor in the implementation of change.

One respondent would exclude Mineral and Energy Resources, Climate, and Agriculture, while another considered Agriculture the most important item in this section.

III.2 Human and Societal Systems (I: 65; M: 17; P: 3; E: 2)

Housing, with 14 respondents rated "No," received the largest number of negative votes among the potential application areas considered here. Research and Development was also viewed critically (11 "No" ratings).

Two main areas for systems analytic work were identified for Transportation: individual modes, e.g., railroads, airlines, pipelines, highways, etc.; and integrated systems, including different modes, optimum mixes, etc., where little systems analytic work has been done. A suggestion for Communications was to "address the problems of international organization versus national and relate [them] to transportation." One respondent proposed to treat public opinion "as a system."

The observations were made that Housing, Transportation, and Communications are not easily separable from urban and regional planning, and that these topics, with the addition of Education, are subsystems and cannot be discussed in isolation. Others were skeptical about the inclusion of Education; one critic warned that while a lot of work has been done here, most of it seems to be rather poor.

Among additional suggested topics were: social security systems, social services, criminal justice systems, international relations, urban service systems, government systems, police systems, and political systems.

III.3 Economic Systems (I: 67; M: 17; P: 2; E: 1)

The items with the highest number of negative ratings were International Trade and Economics (13), and Planning, Development and Management of Economic Organizations (11). One opinion was that there is insufficient material in the area described by the latter item. Another respondent objected to the inclusion of "economic" in the section heading: "Of course there are economic aspects, there are also, e.g., behavioral aspects. To assign a special role to economic aspects is a negation of the systems approach." A third asked: "What is an economic organization?"

One respondent was not certain where the important problems of spatial analysis of economic systems would fit in the outline. The utility of cybernetic models in the area of national economic planning was stressed by one analyst, while still another stated: "The role of government in the economic system is an important topic."

III.4 Industrial Systems (I: 58; M: 23; P: 5; E: 1)

Some respondents objected to a separate treatment of Industrial Sectors; for instance: "I am not sure that it is interesting

to compare the coal industry in one country with that in another; what is interesting is how different types of organization operate, e.g., centralized versus decentralized."

Among specific suggestions for additions were: industries--pharmaceutical, paper, and printing; communication media construction--television, telephone, data transmission (with the opinion that in the future this sector will be in competition with that of transportation vehicle production); machine tools; chemical plants; and energy.

One respondent urged us to emphasize organization as well as planning and management, while a second added the theme of human satisfaction and fulfillment in work.

III.5 Biological and Medical Systems (I: 48; M: 28; P: 8; E: 3)

Several items in this section received a large number of "No" ratings: Elementary Biological Systems (20), Bionics (19), Artificial Intelligence (14), Human Biology and Psychology (14). The reasons are well summarized by the following: "...only as Handbook entries. The fields are too specialized and either too well-covered or too well-understood to merit special claims by systems analysis--unless it is accepted that cybernetics is the same thing." In a similar vein, another wrote: "I am not sure how much space should be given to these systems--it depends [on] how much light the material sheds on other systems areas. Especially true of human biology and psychology, e.g., we do not go into details about purely physical, engineering, or chemical systems." Also: "Some of the hardest analytical problems in all branches of biology are characteristic of those of many other disciplines." Another would emphasize the relationship between human biology and social systems.

Considerable interest was shown in Medical Systems and Health Care: Diagnostic and Treatment Techniques for the Individual (with the highest number of "Yes" ratings in the section: 67), although one commentator was quick to point out: "Societal, medical and health care systems are also relevant areas."

One respondent would like to see detailed treatments of medical care delivery systems: planning and resource allocation within and between specialties, population groups, and chronic/acute care; evaluation of medical systems: criteria and measurement. To these proposals, others added medical information systems, health care expectations, and general biological theory.

III.6 Information Systems and Computers (I: 57; M: 23; P: 5; E: 2)

Computer Systems received the largest number of negative ratings (15). There seemed to be a general feeling that, as one respondent expressed it, "These items are either concerned with technical problems, or else the studies are subsumed within information theory." Also, the treatment of Telecommunication Systems and Computer Networks as well as Computer Systems should not be oriented to technologies: "The field is changing too fast"; "Handbook entry only for each"; and "There are many readily available good sources of information."

One respondent was against the inclusion of Management Information Systems because "In my opinion, no real success achieved so far," while a second stated that utilization of computer networks with terminals would be useful for citizen participation in the execution of systems analysis.

Suggested additions: organization of information processing, computer-aided design, automata, automation, artificial intelligence, and information systems in relation to managers' work satisfaction and fulfillment.

III.7 Integrated Systems (I: 57; M: 18; P: 7; E: 5)

The respondents who commented on this section were critical. Thus, for one analyst, "...the title is misleading"; for another, "There is a much greater variety of interesting combinations"; and five respondents would exclude the entire section. One would prefer "to see these systems defined by reference to 'issues' rather than to what they contain, e.g., health as an issue would penetrate into some (but not all) aspects of industry, population, housing, education, etc., as well as health care."

A large number of "No" ratings were received for Global Modeling and Territorial-Industrial Complexes (10). Several respondents were skeptical about global modeling; one thought that the topic is "too complex to be successful; another would exclude it because it is, to his mind, a technique and not an area of application. But one respondent would exclude everything *except* for global modeling, if the topic were treated with care, and added: "...but do not handle this subject too early in a Handbook!" Another voted "No" on the entire section, except for global modeling.

Others would add socioeconomic systems and the theme environment-work-leisure-income-quality of life, while one respondent suggested energy-environment-industry as well as zero-growth problems and predictions of world population development.

III.8 Functional Systems (I: 42; M: 22; P: 14; E: 9)

The paucity of comments and relatively small number of I ratings (very important, definitely include) reveal a substantial lack of interest in this topic. The general feeling is probably best expressed by the respondent who stated: "I do not really understand this section--these systems sound rather similar to one another but far from a complete or clear category." One respondent suggested that Functional Systems be treated in the context of case studies. Two said that they did not understand the meaning of Monitoring Systems.

Additional suggested topics were: marketing systems, disposal systems (waste, sewage), and decision-making systems (behavioral, purposeful).

General Comments on Applications of Systems Analysis

The most extensive general comments on the Applications section of the outline were offered by a U.K. respondent. His main points were: "I am worried that systems analysis will prematurely acquire limitless pretensions which are insupportable...attempting to embrace too many specialized or difficult fields .... The principal need is for systems analysis to provide 'overview' models or concepts in the 'integrated systems' manner because it is the integration that is so much lacking. *Even the structure of this questionnaire reflects some tendency towards decomposition which I found unpalatable. E.g., how urban planning, transportation systems planning, communications planning can be sensibly separated and not related to land use (agriculture, etc.) and population I do not know. Clearly this is what is done now, but the results are frightful.* A start with some integrated even if highly-aggregated system models is desirable and a (polemical) tract might be a good idea" (italics added).

A number of suggestions for additional topics were made: transportation (land, road; land, tracked; water, canal/inland; air traffic systems; sea, freight containerization; energy and land requirements); technological systems; systems reliability; systems assurance; other applications (legal systems, arts, historical analysis). Other suggested additions were for: protection systems (police systems, police and information networks, etc.); welfare and health care systems; systems analysis applied to "ghetto" situations, to problems of developing countries, to national defense, and to peace protection.

One respondent emphasized a point made earlier that, since the analysis of social systems is particularly difficult, we should include many examples of analysis of this type in the Series and Handbook. Another commentator would arrange case studies according to different types of analytic problems, rather than by areas of application.

IV. Reference Materials (I: 52; M: 27; P: 10; E: 2)

IV.1 Glossaries (I: 42; M: 25; P: 8; E: 12)

IV.2 Bibliographies (I: 53; M: 21; P: 4; E: 9)

IV.3 Directories (I: 30 ; M: 30; P: 16; E: 11)

As the distribution of the ratings suggests, the overall response was less than enthusiastic. Most comments referred to Directories. While one analyst thought that directories of individuals active in systems analysis would be very useful, a contrary opinion was that such directories will not be too useful to practitioners, and "will be a headache to maintain." Similar opinions were expressed by others: "A citation index might be more useful in practice than directories"; "The institutions would hopefully remain fairly constant, but individuals might well not"; "Since systems analysis is a team effort it seems invidious to name individuals. The institutional setting is a strong factor. Also, mention of individuals raises questions of standards of competence"; and "Change too quickly to be kept up to date. Better to consult institution's membership lists." One commentator, however, thought that it might be interesting to try. Directories of data sources were also suggested.

Other comments were: "The bibliographies might usefully be classified by (a) subject area, (b) date of publication, with some form of keyword index based on the titles. It would be advantageous if these were supplied (annually or semi-annually) by supplements in microfilm through an intelligent terminal (e.g., the 3M's system).... The directories of institutions should give information on size and if possible main areas of interest. However, as IFORS and IFAC are interested in almost everything defined as systems analysis in this questionnaire, there will be problems."

STATISTICAL ANALYSIS

Of the approximately 160 respondents, only 87 filled out the questionnaire in sufficient detail to enable a statistical analysis. Of the others, approximately 60 responded by letter alone (including all except one respondent from the United States, where the NMO distributed letters raising key questions in place of the questionnaire). Thus, unfortunately, the 87 replies analyzed in this section represent only a partial cross-section of the responses.

A simple inspection of the tabulated responses (Table 1, page 4) shows that although a majority favored retention of every section and item, there were clear differences in the enthusiasm with which the various items were endorsed. For further insight, two types of statistical analysis* were applied to the importance ratings associated with the 30 second-level items (designated with arabic numerals) tabulated in Table 1. The first type was designed to establish a concordance rating or measure of agreement among the respondents; the second, to divide the respondents into groups having similar opinions.

The approach used to establish the concordance was defined with the help of the Institute of Control Sciences (USSR, Moscow) [1,2] and adapted for use with the Survey Project questionnaire [3]. The results are presented in Table 2. Since a concordance of 0.4 represents a high degree of agreement, this analysis indicates substantial consensus among the respondents.

The degree of agreement among the respondents, however, is only one aspect of interest. It is also interesting to note the geographic origins of the experts and their fields of specialization. Indeed, because of the international and interdisciplinary character of the proposed IIASA publications, it is of importance to investigate whether the national origin of the respondents and their fields of specialization significantly influenced the responses and thus the conclusions with respect to the content and structure of the state-of-the-art publications.

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*This section was prepared with substantial help from A.P. Iastrebov (USSR).

Table 2. Statistical analysis of completed questionnaires (N = 87).

Main Sections of the Outline	Concordance[a]	Importance[b]				Subsections of the Outline	Concordance[a]	Importance[b]			
	V	1	2	3	4		V	1	2	3	4
I. Foundations	.2406	52	31	7	3						
						1. Development of Systems Analysis	.0840	36	28	15	8
						2. Meanings of Systems Analysis	.1164	40	24	19	4
						3. Bases of Systems Analysis	.4060	62	18	5	2
						4. Philosophical Aspects	.0632	29	31	20	7
						5. Human and Social Aspects	.1960	45	30	8	4
II. Processes	.6670	80	9	2	2						
A. Art	.2643	56	26	7	4						
						1. Features of Systems Analysis	.1347	43	24	14	6
						2. Types of Systems Analysis	.0805	36	28	13	10
						3. Stages of Systems Analysis	.2330	51	22	11	3
						4. Case Studies	.2457	53	29	9	6
						5. General Guidelines	.1101	40	25	16	6
B. Methodology	.5764	76	10	3	4						
						1. Basic Concepts and Methods of Decision-Making Theory	.4514	65	14	5	3
						2. Analytical Frameworks for Practical Decision Making	.3715	60	19	6	2
C. Techniques	.5588	75	12	3	3						
						1. Description Techniques	.3021	55	23	7	2
						2. Modeling Techniques	.5899	71	14	0	2
						3. Forecasting Techniques	.3436	57	24	3	3
						4. Measurement Techniques	.2975	54	25	6	2
						5. Synthesis, Design, and Optimization Techniques	.3715	60	19	6	2
						6. Planning and Management Techniques	.2475	50	27	8	2
						7. Implementation Techniques	.2348	52	19	12	4

Table 2 (continued)

Main Sections of the Outline	Concordance[a]	Importance[b]				Subsections of the Outline	Concordance[a]	Importance[b]			
	V	1	2	3	4		V	1	2	3	4
III. Applications	.6349	78	14	1	0						
						1. Resources and Environment	.5353	69	12	5	1
						2. Human and Societal Systems	.4641	65	17	3	2
						3. Economic Systems	.5092	67	17	2	1
						4. Industrial Systems	.3570	58	23	5	1
						5. Biomedical Systems	.2235	48	28	8	3
						6. Information Systems and Computers	.3373	57	23	5	2
						7. Integrated Systems	.3091	57	18	7	5
						8. Functional Systems	.1115	42	22	14	9
IV. Reference Materials	.2138	52	27	10	4						
						1. Glossaries	.1241	42	25	8	12
						2. Bibliographies	.2563	53	21	4	9
						3. Directories	.0502	30	30	16	11
Mean Value: V = .4508						Mean Value: V = .2719					

[a]The range of concordance is between 0 (complete disagreement) and 1 (complete agreement).

[b]The importance rating reflects relative emphasis to be given to sections and subsections, possible number of volumes or articles to be devoted to the various sections, and number of contributors to the separate subsections to ensure sufficient coverage. Importance ratings are 1 (I, Very important), 2 (M, Moderately important), 3 (P, Possibly include), and 4 (E, Exclude).

A grouping procedure was used to determine whether respondents of the same national origin or field of specialization tended to hold the same views with respect to systems analysis. In using this procedure it was assumed that if the national origins and fields of specialization influenced the consensus, it would be shown by a similarity of importance ratings given by the experts from the same country and/or by the experts who identified themselves as interested in the same scientific discipline. The procedure for grouping operates similarly to the algorithms of coupling matrix diagonalization proposed in reference [3].

The results of the grouping are shown in Table 3. The experts are divided into 15 groups, the 5 largest of which are shown in the table. The remaining 10 groups are insignificant, for they each consist of a single expert. In these groups the experts' ratings of the 30 subsections are shown as 30-tuple vectors.

The opinions of the respondents within each group defined by this clustering procedure are closely related. To make this even clearer and possibly to give some insight into the reasons for the similarities, consider Table 4. In this table the numbers of experts who have assigned importance ratings to the 30 topics are shown for the five nontrivial groups. An inspection of Tables 3 and 4 shows that

- Groups 1 and 2 consist of respondents who strongly supported the proposed structure of publications; only a small minority in these groups was against including some topics; in fact, in Group 1 over 90 percent of the ratings were 1 (very important) or 2 (moderately important) and more than one-half of the 67 did not exclude a single item.

- Group 3 did not agree with the proposed structure; the two respondents in this group expressed strong and similar interests in the applications of systems analysis and in bibliographies but would exclude almost everything else. It is interesting to note that these two respondents are from different countries (the USSR and the Federal Republic of Germany) and somewhat different disciplines (biomathematics and information processing).

- Groups 1, 3, and 4 contained respondents from both East and West; Group 1 had essentially the same proportions as the total set of respondents from which it was selected.

- Group 1 contained 36 respondents who would exclude no items. Of the 31 who would exclude some, only one suggested excluding as many as five topics; for the most part, proposals to exclude were concerned with relatively few items--Reference Materials and four other topics.

Thus, geographic origin did not seem to be a significant factor; there was certainly no overall difference of opinion about the content of the outline between East and West. There was also no evidence that different fields of specialization affected the results but this was probably to be expected because so many respondents had similar backgrounds; of the 20 respondents from the East in the first group, eleven were from the same institute.

Table 3. Classification of respondents, by importance ratings for each of the outline subsections.[a]

Respondent Number	Importance Ratings for Outline Subsections (30 Topics)[b]																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
GROUP 1[c]																														
68	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
74	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
76	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
79	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
77	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
54	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
71	2	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
46	1	1	1	4	1	3	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
60	2	1	1	3	1	1	4	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
35	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
82	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	4	1	1	2	1	1	1	1	1	1	1	1	1	1	1
57	2	2	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2	3	1	1	1	1	1	1	1	1	1	1	1
86	1	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	4	1	4
78	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	1	1	1	1
72	2	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
9	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	3	2	1	1	2	1	1	1
18	2	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3	4
28	1	2	1	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
70	1	1	1	1	1	4	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	2	1	1	2	2	2	2	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	4	1	1	1	1	4	1	1	3	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	2	1	1	1
23	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	2	1	1	1	1	1	1	1	1	2	2	2
27	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	3	2	1	1	1	1	1	1	1	4	1	2	1	3
16	3	2	1	2	1	1	4	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	2	3
20	3	1	1	3	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	4	2	1	2
66	2	2	1	2	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	2	2	1	1
17	1	2	1	1	1	3	3	3	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	3
75	1	2	1	2	1	2	2	2	1	2	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	4	1	1	2
14	1	3	1	1	1	2	2	2	1	2	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	3	2	2
56	2	1	1	3	2	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	2	3	2	2	1	3	1	1	1
30	1	1	1	1	1	1	1	1	1	1	3	3	1	1	2	3	1	1	1	1	1	1	1	2	2	1	2	1	1	2
51	2	1	1	3	3	1	1	1	1	1	2	3	1	1	2	2	1	1	1	1	1	1	1	4	1	4	1	1	1	1

Table 3 (continued)

Respondent Number	Importance Ratings for Outline Subsections (30 Topics)[b]																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
GROUP 1 (continued)[c]																														
2	3	2	1	3	2	2	1	2	1	2	1	1	3	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	2
31	3	2	1	2	1	2	2	2	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	3	1	1	2	1	1	2
45	2	2	1	3	2	3	3	1	1	3	1	1	1	1	1	1	1	1	1	1	4	3	1	2	1	1	1	1	1	3
84	1	2	2	3	2	3	3	2	1	2	1	1	2	1	1	2	1	1	4	1	1	1	1	1	1	1	1	1	1	2
29	1	2	2	3	1	2	2	2	1	3	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	3	1	1	1
65	1	3	1	3	2	3	3	2	2	3	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	2
24	2	2	1	1	1	3	2	1	1	3	2	2	1	1	1	1	1	3	3	1	1	1	1	1	2	1	3	1	1	1
62	1	2	2	2	1	2	2	2	1	2	1	1	1	1	1	1	1	1	2	1	1	1	2	2	2	1	1	1	2	1
53	2	1	2	2	1	1	1	1	1	1	1	1	2	1	2	1	1	1	1	1	2	2	1	3	2	2	1	1	1	1
41	1	1	1	2	3	1	1	1	1	1	3	2	1	1	1	1	1	2	1	1	1	2	2	2	1	1	3	2	1	2
8	1	1	1	4	1	3	3	3	3	3	1	1	1	1	1	1	1	3	1	1	1	1	1	1	2	1	3	2	2	2
4	4	3	1	2	1	2	2	3	2	3	1	1	3	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2	2	3
58	1	1	1	3	1	2	1	2	1	3	1	2	2	1	1	1	2	1	2	1	2	1	2	1	1	1	1	1	1	3
64	3	3	1	1	1	2	3	2	1	1	1	2	1	1	2	2	3	2	2	1	1	1	1	1	1	1	1	1	1	1
67	2	3	1	1	1	1	2	1	1	1	1	1	1	1	2	2	3	2	2	1	1	1	2	1	1	3	1	2	1	2
73	1	4	1	3	1	3	1	1	1	2	1	1	2	1	1	1	2	2	1	1	2	1	1	2	1	2	2	1	1	2
12	3	3	1	1	1	1	1	1	2	2	1	1	2	1	1	1	1	2	1	3	1	1	1	2	1	2	2	2	2	3
87	3	1	1	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1	2	2	2	1	1	2	1	1	1	4	3	3
80	4	3	1	2	2	2	4	1	3	3	2	2	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	3	1	2
69	1	2	1	3	2	2	3	2	1	2	1	1	1	1	1	1	2	1	1	2	2	1	2	3	1	1	2	2	1	2
26	1	1	1	2	3	2	2	1	1	2	1	1	2	2	2	3	2	1	1	1	1	1	1	3	3	1	1	1	1	3
25	4	3	2	1	1	4	2	3	3	1	1	2	3	1	2	3	1	1	1	1	1	1	1	2	1	1	1	3	1	1
33	3	1	1	2	2	2	2	1	1	1	1	1	1	1	2	2	1	2	1	2	2	1	1	2	2	4	4	2	1	2
44	3	2	1	1	2	1	1	3	1	3	1	1	2	1	2	2	1	1	1	1	1	1	1	2	2	3	4	4	4	4
36	2	3	2	2	2	2	2	2	2	3	2	1	1	1	1	1	1	1	2	2	1	1	1	2	2	1	1	2	2	3
22	4	3	2	2	1	3	2	1	1	3	1	1	1	1	1	1	1	1	1	1	1	2	3	2	3	3	3	4	4	4
59	2	3	1	3	2	2	2	1	2	2	1	1	2	1	1	1	1	2	2	2	1	1	2	1	1	2	2	4	4	4
52	2	1	1	4	1	3	2	3	3	1	1	2	1	1	1	1	1	2	1	1	2	2	2	2	1	2	2	2	2	2
13	2	2	3	1	1	1	2	1	1	1	1	1	2	2	2	2	2	2	3	1	1	1	1	2	1	1	3	3	2	3
47	1	2	1	1	1	2	2	1	1	2	2	1	2	1	2	2	1	2	3	1	2	1	1	2	1	2	2	3	4	3
3	3	1	2	1	4	1	2	2	3	1	1	1	2	2	2	2	2	2	3	1	1	1	1	1	1	1	1	1	3	2
39	3	3	2	3	3	3	2	2	3	2	1	1	2	1	2	2	1	1	3	1	2	1	1	2	1	1	2	2	1	2
7	3	2	3	2	2	2	2	2	2	2	1	1	2	1	2	1	1	2	1	1	2	1	1	1	2	2	2	4	4	4
34	2	2	2	2	3	1	1	2	1	1	2	2	1	1	1	2	2	2	2	1	1	2	2	1	2	1	2	1	1	1

Table 3 (continued)

Respondent Number	Importance Ratings for Outline Subsections (30 Topics)[b]																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
GROUP 2[c]																														
32	2	2	2	1	1	3	3	3	3	2	1	1	2	2	2	2	2	2	2	1	1	3	2	1	2	2	3	2	2	3
42	3	3	3	2	2	3	3	3	2	2	2	2	2	2	2	2	2	2	2	1	1	1	2	2	2	2	3	2	2	2
40	2	2	3	2	2	1	1	2	1	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	2	2	2	1	1	2
11	1	2	1	2	2	1	1	1	1	1	2	3	2	2	2	2	3	1	3	1	1	1	2	2	2	1	3	2	1	2
GROUP 3[c]																														
49	4	4	4	4	2	4	4	4	2	2	4	3	4	4	4	2	4	4	3	1	3	2	2	1	1	3	4	4	2	1
85	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	1	2	1	1	1	1	2	2	4	1	4
GROUP 4[c]																														
19	1	3	1	3	2	2	4	1	4	2	2	3	3	1	3	1	2	2	2	2	2	1	2	2	3	1	4	3	2	2
37	1	1	1	2	2	2	2	2	3	3	2	2	1	1	1	2	1	2	2	2	2	2	2	2	1	1	2	2	2	2
GROUP 5[c]																														
43	1	3	2	3	1	1	2	2	4	1	3	2	1	2	2	1	2	3	3	2	2	2	2	2	2	2	1	1	2	2
48	2	1	1	3	1	2	1	1	4	4	3	3	3	2	3	3	3	3	3	3	2	2	2	2	2	1	3	1	2	2

[a]The level of statistical significance is P = 0.100.

[b]I = very important, M = moderately important, P = possibly include, 4 = exclude.

[c]The groups are defined as follows. Group 1, N_1 = 67 respondents (77 percent): USSR, 15 persons; United Kingdom, 13; Federal Republic of Germany and Austria, 7 persons from each country; France, 6; Canada, 5; Italy, German Democratic Republic, and Japan, 4 persons from each country; Bulgaria and the United States, 1 from each country. Group 2, N_2 = 4 respondents (4.6 percent): Canada, 2 persons; United Kingdom and Austria, 1 person from each country. Group 3, N_3 = 2 respondents (2.3 percent): Federal Republic of Germany, 1 person; USSR, 1. Group 4, N_4 = 2 respondents (2.3 percent): United Kingdom, 1 person, Bulgaria, 1. Group 5, N_5 = 2 respondents (2.3 percent): Canada, 1 person, France, 1. The remaining groups were statistically insignificant -- N_6 through N_{15} = 10 respondents (11.5 percent): USSR, France, and United Kingdom, 2 persons from each country; Bulgaria, Federal Republic of Germany, German Democratic Republic, and Japan, 1 person from each country.

Table 4. Importance ratings of the groups of respondents, by outline sections.

Section of the Outline	Sub-section (30 Topics)	Importance Ratings (Number of Votes for Each Topic)[a]																			
		Group 1				Group 2				Group 3				Group 4				Group 5			
		I	M	P	E	I	M	P	E	I	M	P	E	I	M	P	E	I	M	P	E
I. Foundations	1	30	21	12	4	1	2	1	-	-	-	-	2	2	-	-	-	1	1	-	-
	2	33	20	12	2	-	3	1	-	-	-	-	2	1	-	1	-	1	-	1	-
	3	54	11	2	-	1	1	2	-	-	-	-	2	2	-	-	-	1	1	-	-
	4	27	22	15	3	1	3	-	-	-	-	-	2	-	1	1	-	-	-	2	-
	5	41	20	5	1	1	3	-	-	-	1	-	1	-	2	-	-	2	-	-	-
II. Processes																					
A. Art	6	36	18	11	2	2	-	2	-	-	-	-	2	-	2	-	-	1	1	-	-
	7	30	23	9	5	2	-	2	-	-	-	-	2	-	1	-	1	1	1	-	-
	8	43	17	6	1	1	1	2	-	-	-	-	2	1	1	-	-	1	1	-	-
	9	48	11	6	2	2	1	1	-	-	1	-	1	-	-	1	1	-	-	-	2
	10	37	16	12	2	1	3	-	-	-	1	-	1	-	1	1	-	1	-	-	1
B. Methodology	11	58	7	2	-	1	3	-	-	-	-	-	2	-	2	-	-	-	-	2	-
	12	59	9	2	-	1	2	1	-	-	-	1	1	-	1	1	-	-	1	1	-
C. Techniques	13	48	16	3	-	-	4	-	-	-	-	-	2	1	-	1	-	1	-	1	-
	14	63	4	-	-	-	4	-	-	-	-	-	2	2	-	-	-	-	2	-	-
	15	52	15	-	-	-	4	-	-	-	-	-	2	1	-	1	-	-	1	1	-
	16	47	15	4	1	-	4	-	-	-	1	-	1	1	1	-	-	1	-	1	-
	17	55	9	3	-	-	3	1	-	-	-	-	2	1	1	-	-	-	1	1	-
	18	47	18	2	-	1	3	-	-	-	-	-	2	-	2	-	-	-	-	2	-
	19	46	13	6	2	1	2	1	-	-	-	1	1	-	2	-	-	-	-	2	-
III. Applications	20	61	5	1	-	4	-	-	-	2	-	-	-	-	2	-	-	-	1	1	-
	21	59	9	-	1	4	-	-	-	-	1	1	-	-	2	-	-	-	2	-	-
	22	60	6	1	-	3	-	1	-	1	1	-	-	1	1	-	-	-	2	-	-
	23	57	11	3	-	1	3	-	-	1	1	-	-	-	2	-	-	-	2	-	-
	24	43	19	4	1	2	2	-	-	2	-	-	-	-	2	-	-	-	2	-	-
	25	52	13	2	-	-	4	-	-	2	-	-	-	1	-	1	-	-	2	-	-
	26	50	10	3	4	1	3	-	-	-	1	1	-	2	-	-	-	1	1	-	-
	27	41	15	7	4	-	1	3	-	-	1	-	1	-	1	-	1	1	-	1	-
IV. Reference Material	28	39	17	7	4	1	3	-	-	-	-	-	2	-	1	1	-	2	-	-	-
	29	47	12	3	5	2	2	-	-	1	1	-	-	-	2	-	-	-	2	-	-
	30	28	21	12	6	-	3	1	-	1	-	-	1	-	2	-	-	-	2	-	-

[a] I = Very important, definitely include; M = Moderately important; P = Possibly include; E = Exclude.

CONCLUSIONS

No unique set of conclusions about the desired nature of the publications sponsored by the Survey Project can be derived from the analysis of comments that would be completely acceptable to all respondents. There are several reasons for this. First, there were many different kinds of views expressed. Second, the questionnaire sought assistance in defining the content of two types of publications: a Series of monographs and a Handbook. Although each is to survey the state-of-the-art of applied systems analysis, they have different purposes and are to be written for different sets of readers; hence, they may need to differ considerably in nature. It was not always possible to ascertain which of the two types of publications a respondent had in mind when observing his comment or check mark--unless the respondent made the distinction apparent.

It is clear that the changes to be made in the outline and in criteria and guidelines for the Series and Handbook could not possibly be in accordance with *all* the views expressed. A choice based on Project staff opinion was necessary. Certainly, as mentioned earlier, the thinking of the Project members was greatly stimulated by the criticism and suggestions, but the conclusions drawn must unavoidably reflect their scientific background and methodological biases. Thus, arguments for or against a given approach could not claim objective validity but were judged in terms of relevance and adequacy, which in turn depend on specific Project objectives. Even where opinions were shared by a large number of respondents, the subjective element still entered in deciding how best to take those opinions into account.

The statistical analysis (Tables 1 and 2) indicated that three of the main sections--Foundations, the Art of Systems Analysis, and Reference Materials--were considered of lesser importance than the remainder of the outline. Even in these cases, however, more than 85 percent of the respondents judged the section "very important" or at least "moderately important" to include, and less than 5 percent thought than any section should be excluded. Later, as the Series and Handbook are developed, these importance ratings will help to guide the Survey Project editors in their decisions about material to encourage. In fact, although the respondents were asked to express an opinion as to the inclusion or deletion of all items in Table 1, *in no case was there a majority vote for deletion*. Hence, on the basis of the numerical results alone, all items would be retained. Taken in conjunction with the

comments, however, a reasonable interpretation might be that those items with a high negative rating belong in the domain of systems analysis and hence in the outline but certainly should not be topics for Series monographs or Handbook articles.

The grouping or cluster analysis indicated no major differences of opinion among a majority of the questionnaire respondents (67 out of 87) about the content of applied systems analysis. There were differences, of course, but they involved relatively few people and seemed just as marked between, say, respondents from various Western countries as between those from the East and the West. An attempt to find a disciplinary influence brought no success.

Many suggestions included with the questionnaires were for the addition of items to the outline. These were followed, except for a few cases in which it was found that the item was already represented elsewhere under a different heading. The number of entries added in the revised outline represents an increase of more than 50 percent over the number in the original outline sent to the respondents. When the importance ratings and votes to exclude topics were considered in conjunction with the written comments (despite the small number of votes to exclude), some topics were deleted or downgraded. For example, the first unnumbered item in Table 1, Precursors, received a relatively high vote for deletion--36 percent to delete and only 64 percent to retain. Since there were suggestions that it would be better to treat this item under History, Precursors was downgraded in the revised outline to a descriptor of History. To cite other modifications of this sort, the idea of classifying types of systems analysis in terms of complexity was abandoned, and the presentation of concepts and methods of decision-making theory was drastically changed in the new outline.

There were opinions shared by many respondents about areas of interest for the Series that can be taken into account only as the Series evolves; those views cannot be reflected very effectively by changes in the structure of the outline. The three areas that seemed to be of most interest were the following:

- In-depth case studies, presented in a way that provides methodological insights, particularly new ones into the processes of systems analysis, but written in more or less standard format.

- Policy studies of areas of current international interest, e.g., in energy, health care systems, or urban development, to bring into focus complex problem situations, reveal constraints, suggest possible lines of attack, and provide essential data and information.

- o The analysis of analysis, i.e., epistemological and sociological studies of analytical activity, techniques of argumentation, control of the quality of analytical results, and institutional factors that hinder or facilitate the use of analysis.

There were also two strongly expressed concerns about the nature of the Series. The first was the possibility that the social, political, and institutional aspects of systems analysis might be neglected. A survey of systems analysis that does not include the most recent contributions of systems thinking to the elaboration of social policies would be incomplete and out of date. Critical discussions of these topics, however, require handling organizational, political, and institutional problems of all sorts. The character of IIASA may make this difficult; a definitive effort is necessary to ensure that these "social" factors are treated in the Series. The alternative is a "retreat to technology," which would deprive the Series of much of its interest.

The second concern expressed was a corollary of the first: a warning that the Series might exhibit an excessive emphasis on technology. Applied systems analysis with an emphasis on decision problems does not imply that decision theory provides the only suitable conceptual framework. On the contrary, it is much too restricted in scope. Good systems analysis should concentrate on the objective aspects of policy problems and, in particular, on the constraints facing the policy maker; it should strive to be "robust" in the sense that results can be utilized by decision makers in different contexts using a variety of utility functions and approaches to probability assessment.

Although the comments and suggestions received were extremely helpful, many problems remain to be solved if the IIASA Series and Handbook are to achieve the expectations of those who conceived them. From the responses received, it seems fair to infer that part of the analytic community sees no compelling reason for IIASA to engage in its proposed publication program. Some believe that the manifest goals are already being pursued, or can be pursued by other channels; others think that the international character of IIASA can justify only a small number of Series monographs of a comparative nature.

It will not be an easy matter to guide the Series in the directions indicated by our interpretation of the respondents' wishes or by the objectives of IIASA itself. One indication of the difficulty is that to date almost all proposals for volumes to be included in the Series are highly technical in nature and tend to favor a theoretical rather than an applied treatment of their subject matter.

The few respondents (primarily from the West) who specifically commented on the proposed Handbook stated that it would

be a serious mistake for the Survey Project to expend effort on a conventional Handbook designed as a "ready guide to small problems." As a consequence of such views, the Handbook as now envisioned will be international and "nontraditional"; it will attempt to embrace problems ranging from the purely technical to those that include social, economic, and human aspects and to answer at least partially why systems analysis--which seems to some such an essential approach--has so often failed to help. The preparation of a satisfactory Handbook of the above type presents a challenging task, which the Project accepts in full recognition of the difficulties.

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