IIASA-PC-4

International Institute
for
Applied Systems Analysis

PROCEEDINGS
OF
IIASA PLANNING CONFERENCE
ON
URBAN AND REGIONAL SYSTEMS

July 30-August 1, 1973

Schloss Laxenburg
2361 Laxenburg
Austria

The views expressed are those of the contributors and not necessarily those of the Institute.

The Institute assumes full responsibility for minor editorial changes made in grammar, syntax, or wording, and trusts that these modifications have not abused the sense of the writers' ideas.

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OPENING OF THE CONFERENCE

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS

Research Planning Conference

"URBAN AND REGIONAL SYSTEMS"

Parkhotel Baden, July 30th - August 1st, 1973

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INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS

Agenda
for
Research Planning Conference
on
URBAN AND REGIONAL SYSTEMS

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30 July to 1 August, 1973
Park Hotel, Baden (bei Wien), Austria
Chairman: M. Michel Rousselot

30 July

9:00 - 10:00 Welcome and introductory talk about IIASA and about purpose of the Conference by the Director, Professor Howard Raiffa.

10:00 - 10:30 Introductory talk by the chairman about the organization of this Conference and the main issues to be discussed.

[a. Distribution of a questionnaire for participants.

b. Participants are urged to inform the chairman in writing, before the resumption of the afternoon session, whether they would be interested in giving an oral presentation (of at most 20 minutes) the following day. Each proposed topic should be clearly stated with a very brief (one or two sentences) explanation. The chairman will attempt to organize these proposals in a coherent fashion for discussion in the afternoon.]

10:30 - 11:00 Coffee

11:00 - 12:15 Presentation by conference participants of:
- national institutions working in the field of systems analysis applied to urban and regional systems;
- main orientations of their current work;
- first broad proposals for the IIASA research program in this field;

Answers to questions raised by other participants.

12:15 - 2:00 Lunch

2:00 - 4:00 Presentations by conference participants (continued).

4:00 - 4:15 Coffee

4:15 - 5:30 Proposals by the chairman for the organization of the presentation and discussion of case studies to be made during the next day. Discussions of these proposals.

6:00 - 7:00 . Cocktails, Park Hotel.

7:00 - Dinner, Park Hotel.

***

31 July

[Completed questionnaire forms will be collected at opening of the session.]

This day will be devoted to presentations by conference participants of specific research works (or case studies) undertaken -- or planned -- by their own scientific organizations. These presentations will be arranged so that different orientations of applied systems analysis in this field may be clearly illustrated in order to emphasize differences as well as similarities in approach. Theoretical and methodological issues will be raised. Each presentation will be followed by a brief discussion.

Presentations that are already announced are:

a. Regional Systems . . . . . Prof. R. Domanski (Poland)

b. An Urban Housing Policy Model. . . . . Mr. Frank deLeeuw (USA)

c. An Approach to Urban Systems. . . . . Mr. Yves Barel (France)

The Conference will be in session from 9:00 to 5:30 with the following breaks:

10:30 - 11:00 Coffee

12:30 - 2:00 Lunch

3:30 - 3:45 Coffee

7:00 - 9:30 A "Heuriger" get-together. Bus transportation will be arranged to bring the conference participants and wives to an informal dining establishment where local Austrian wine is designed to foster international relationships.

***

1 August

9:30 - 10:00	Introductory remarks by the chairman on the results of the previous two conference days and of the survey. Tentative working definitions for urban and regional systems analysis. - Prof. Rousselot
10:00 - 10:30	Specific suggestions for IIASA research and reactions to the January paper of Prof. Rousselot Presentation by Dr. Sokolov Presentation by Dr. deLeeuw
10:30 - 10:45	Coffee break (The discussion on each of the following three topics will be opened by a short summary of the corresponding survey results.)
10:45 - 12:30	Discussion Topic 1: Proposals for different kinds of cooperation between national institutions and IIASA. Topic 2: Proposals for Laxenburg in-house research projects. Topic 3: Proposals for international conferences.
12:30 - 2:00	Lunch (picnic) and tour of IIASA facilities
2:00 - 3:15	Interproject cooperation in the IIASA Research Program Presentation by Dr. Thompson
3:15 - 3:30	Coffee break
3:30 - 5:00	Proposals for cooperation between national research institutions and IIASA Presentation by Prof. Domanski

Further Remarks:

1. This preliminary agenda is open to further modification at the participants' request.

2. In addition to the answers to the survey, all participants are invited to express their main observations and proposals, as well as afterthoughts, through written statements which will be reproduced and distributed as far as is possible to all conference participants and attached to the minutes of the Conference. The answers to the survey, however, will not be included in these proceedings.

3. No attempt will be made to arrive at a formal set of conference recommendations. The minutes will reflect all views presented. The chairman of the conference, the Director, the Deputy Director, and other research scholars of the Institute will make use of the opinions advanced in formulating a proposed research program in urban and regional systems for presentation to the November meeting of the Council.

Introductory Remarks by the Institute Director

H. Raiffa

On behalf of the Institute, I would like to welcome you to this Planning Conference on Urban and Regional Systems. This is part of a series of meetings which the Institute is holding to seek expert opinion in better defining the most promising directions for Institute research. The Institute hopes these conferences will provide a frank, open airing of viewpoints, opinions, and controversies. To encourage such exchange, the minutes of the conference will reflect the varying sentiments of the participants but will avoid attribution of positions without prior approval of the speaker; however, remarks by the Chairman and by discussion leaders will be attributed. Any written statements from the participants will be welcome and shall be included in the final proceedings. The minutes of the conference will be distributed among the participants and the Council members.

Before outlining for you the Institute research plans, I would like briefly to sketch the history of IIASA. Early in 1967, Mr. McGeorge Bundy, representing the President of the United States, met in Moscow with Dr. Jerman Gvishiani, Deputy Chairman of the State Commitee of the U.S.S.R. for Science and Technology. Their discussions dealt with a proposal of the President "to explore the possibility of establishing an international center for studies of the common problems of advanced societies." That meeting opened a five-year period of planning conferences and multi-national negotiations held under the Chairmanship of Lord Solly Zuckerman of the United Kingdom and convoked with the goal of establishing such a center.

At the risk of slighting many people who contributed greatly to the planning for the Institute, it is only just to mention that major roles were played by Monsieur Pierre Aigrain of the French government, Prof. Philip Handler of the U.S. National Academy of Sciences, Dr. O. Leupold of the German Democratic Republic, Signor Aurelio Peccei of Italy, Dr. Friedrich Schneider of the Max Planck Gesellschaft, Prof. D. Smolenski of the Polish Academy of Sciences, as well as by Messrs. Bundy, Gvishiani, and Zuckerman. A representative national scientific institution from each of their countries and, in early 1972, from Bulgaria, Canada, Czechoslovakia, and Japan were invited to join the Institute, bringing the founding membership to twelve.

On 4 October 1972, these founding members signed the Charter creating IIASA as a non-governmental international institute; at the same time, they selected Laxenburg, Austria, to be the site of the Institute headquarters. The Austrian government had proposed to renovate the former Habsburg palace there, and the first set of offices was completed on schedule in June, 1973. Work on another wing of Schloss Laxenburg is in progress and should be finished by the end of 1973. We expect completion of the first major phase of renovations by the end of 1974, with a second phase to begin in 1975.

The timetable for development of the Institute has three overlapping phases: organization of the Institute administration (October, 1972 through June, 1973); research planning conferences, of which this is one (July through October, 1973); and expansion of the research program (already begun and continuing in the future at an accelerated pace).

The number of scientists in residence will treble between now and September, 1975, when approximately ninety scholars will be working in Laxenburg. These scientists will be chosen with consideration of geographical distribution among the member nations. They will be invited to work at the Institute for short terms or for periods up to three years, with most coming for one year.

In addition to normal administrative support for the scholars, the Institute is developing scientific support to include three essential services: an in-house library connected with libraries in Vienna and abroad, an information distribution system, and computer facilities. The Institute currently has time-sharing arrangements with the Honeywell-Bull Mark I and Mark III systems, using terminals already installed in the castle. The computer section is presently selecting an appropriate mini-computer, and investigating the possibility of eventually purchasing a large, primary machine.

This gives you an overview of the background and physical structure of the Institute. I would now like to describe the Institute plans for its research program, and then finally, to express our goals for this conference.

The Institute has two branches: the Council, which is responsible for broad policy, and the Directorate, which implements, directs, and administers the research program. Planning for this program has gone through various stages of refinement. The Council has determined what the broad areas of Institute research are to be, and now, using ideas and suggestions gleaned from the research planning conferences, the Director, Deputy Director, and other IIASA research leaders will propose for approval by the Council a more formal research strategy. In the interim, the Directorate has had a partial mandate to invite scholars to begin work this year.

The Council outlined ten broad research areas with overlapping boundaries. To overcome problems which the breadth of these areas could create, the Institute chose two approaches. Its scholars will work on topics with obvious interrelations, and, in addition to this in-house research, will exploit the infrastructures of other groups such as the national member organizations, United Nations groups, and other national and international institutions engaged in projects related to IIASA interests.

However, the Institute will be neither a project-oriented consulting group, nor merely a data-collecting institution. Rather, it will attempt to strike a balance between methodological and applied studies in seeking solutions for real world problems.

It is further essential that we maintain a healthy geographic balance across the research team structure. The teams must be so designed that scientists of different nationalities supplement each other, communicate, and learn from each other. The structure should be such that this occurs naturally, with guidance from the leadership, but without constant interference.

As important, and perhaps as difficult as the balance of nationalities, is the balance of disciplines. Applied and methodological researchers, applied mathematicians and engineers, statisticians and organizational theorists, social scientists and operations researchers, economists and decision analysts have much to contribute to one another. IIASA projects should be structured so that each group feels vitally a need for the others. We feel that perhaps the best way to achieve this is through concentration upon applied projects, as the project in Urban and Regional Systems, in which the disparate disciplines must interact with each other in order to produce concrete results.

During the course of this conference, the Institute expects you to voice your opinions, to map out alternate designs for approaching the research, to isolate theoretical research topics, to suggest ways to collaborate with other groups, and to discuss possibilities for choosing a concrete problem for analysis if this course appears fruitful. We further hope that the conference will produce preliminary suggestions for a basic library in the urban regional systems area, and guidelines for necessary computer support.

The conference participants should explore the value of reanalyses by IIASA scientists of current outside projects, or the desirability of retrospective critiques of past projects. Here IIASA could bring to bear its wealth of cross-cultural and cross-disciplinary viewpoints in seeking out lessons from

other projects could improve its own research efforts in urban and regional systems.

We should also discuss what types of experts could usefully complement and support a project in urban or regional systems. For example, how might such a project benefit from the contributions of urban and regional planners, economists, sociologists, geographers, political scientists, engineers, lawyers, psychologists, demographers, or organizational experts?

Finally, the conference participants should identify points of natural contact between the urban/regional systems project and other Institute projects. The question of nuclear plant siting, for example, could involve researchers from the projects in urban or regional energy, and environmental systems.

Valuable suggestions have emerged from our previous conferences. We feel that the discussions in this planning conference will further identify what we might term "the distinctive competence" of IIASA. Only then can we shape a research program for the Institute which will make a unique contribution to research in the area of Urban and Regional Systems.

Opening Remarks by Conference Chairman

M. Rousselot

Professor Raiffa has just defined the outlines and the main purposes of this conference. Let me give you now further comments about these purposes, and about the difficulties of our task, and you will better understand the organization that I suggest for our three days' working time.

I. In my opinion, the expected outputs of this conference are:

a) clear, but eventually different, definitions of the types of research work which may be undertaken by IIASA in the municipal and regional systems field;

b) suggestions, open but already operational, of various research topics that may be put on the IIASA agenda, giving due attention to interaction with other IIASA projects; and

c) other practical suggestions about the organization of IIASA research work and of the international cooperation to be set up in this field.

The future director of the urban or regional systems project must be able to work out from these outputs the definite research project which will be submitted to the Executive Committee of IIASA.

With these goals in view, Prof. Raiffa asked, in his April 2 memorandum about research area meetings, each member country to bring information about the national institutions "performing research within the subject area, and suggestions for the IIASA research program."

This information and these suggestions will be presented by the participants at the very beginning of our conference, so that each one of us may get an overview of these activities and think about them.

The last part of our conference will be devoted to thorough discussions based on these presentations. Our discussions should be organized around four main topics:

- Proposals for different kinds of cooperation between national institutions and IIASA
- Proposals for project evaluation studies in different countries
- Proposals for Laxenburg in-house research projects
- Proposals for international conferences.

II. But between these two parts of our working schedule, I propose two other kinds of reflections, which seem necessary to me in view of the difficulties of the task assigned to us.

Conference chairmen usually stress the difficulties and pitfalls of the subject to be discussed. But I do not fear to make any overstatement of the difficulties in the urban and regional systems field. For, if we look at this field, we get a very kaleidoscopic view of current research work and of scientific thought in this field.

1) Research topics are very different in breadth and complexity, some dealing with neightbourhood planning, others with municipal services management, others with long term planning of land use and urban settlements.

Some research work is made to improve the scientific knowledge of complex social evolutions, while others are geared towards immediate improvement of decision making processes. Evaluation of success or failure is therefore very different from one case to another, but there is a general attitude of disenchantment towards urban planning.

2) More puzzling is the observation that I made during preliminary contacts with some member countries of IIASA that we are very far from a general consensus about what is systems analysis applied in this field. Is it an outgrowth of operations research, using more and more sophisticated instruments? Is it a kind of economic studies more directly linked to the decision making processes? Is it a branch of the general systems theory using concepts common to biological sciences and cybernetics? Opinions differ widely from one country to another, and from one scientific group to another, and we should not try artificially to reduce them during this conference. But for the sake of rational organization of IIASA work, we should at least clearly delineate these different meanings of applied systems analysis.

3) Furthermore, we fall into the usual difficulties of any international venture. Poor communications are due to language problems, to cultural differences among researchers, to the different cultural, political, and economic contexts of applied research work. The apparent and superficial similarities that we may see in various research efforts in different countries must not hide the deep structural and contextual differences, both between the investigated domains and between the methodologies. This kind of underestimation has led to shallow international comparisons of little scientific significance.

Let me add another thorny question: where and how will IIASA scholars get easy access to relevant data about urban and regional development--data necessary for sound research work, even limited to theoretical and methodological problems?

4) Obviously, we must be careful in the course of our discussions. We shall not reach valuable outputs if, along the way, we encounter such pitfalls as:

> vague and ambiguous definitions of the goals of the research, which make impossible any proper evaluation of success or failure;
>
> consensus on projects which may be impossible to carry out properly for lack of relevant data and insufficient information about political, economic, and social mechanisms involved; or
>
> proposals for transfer of scientific tools and of know-how from one country to another, without enough caution, thus leading to gross failures in applied studies.

5) To avoid these pitfalls, let us remember the basic cautions recommended by Prof. Raiffa: we do not have to reach artificial consensus, nor to draw premature conclusions.

Furthermore, Prof. Raiffa and I thought that it would be useful to prepare a survey asking each of the delegations to take--if possible--positions on a set of questions designed to specify the problems upon which we are working, to eliminate many of the ambiguities, and to offer opportunities to state and to clarify all the significant differences that may appear in the conceptions and proposals of the different countries.

We know that it is additional work we ask of you in an already heavily loaded agenda. Of course, you can give only partial answers. But I think it will be very useful for all of us to read carefully this survey and to think about these questions which will certainly come out, in one form or another, in the last phase of this conference.

6) Another way to approach directly the main issues of our conference and to avoid costly misunderstandings is to spend time on specific scientific communications. Tomorrow's session can be devoted to presentations made by some conference participants of research work undertaken--or planned-- by national scientific organizations. This will illustrate clearly what kinds of research work are actually considered as systems analysis on the different countries. Speakers and discussants should therefore concentrate their attention on the orientations of the efforts described and on the theoretical and methodological issues which they raise. These issues are to be stated as clearly as possible, but it will not be in the purpose of our conference to reach to any definite solution of these issues.

III. In the light of my comments about our conference, we may now have a quick look at our agenda. As you see, our working schedule can be divided into three parts.

1) The first part, beginning now, will be devoted to the presentation by conference participants of the national institutions working in the field of urban and regional systems, of the main orientations of their current work, and of first broad proposals for the IIASA research program. For some countries, these presentations may have been prepared in advance in written form. In that case, I ask the delegates of these countries to let the secretariat reproduce these papers for distribution to all participants, especially for the part dealing with proposals. This may help all the delegates to prepare the discussion about the IIASA research program.

As there will be many speakers, I ask each of them to make a brief presentation lasting not more than ten minutes. Questions may be asked at the end of each of these presentations. But I think that they should be rather factual questions as we are in an informative part of our conference. We shall try to avoid any discussion on research proposals at this stage of our work.

2) The second part of the conference will be devoted tc the presentation of specific research work, in the spirit that I have just defined. As I said, discussion should be directed towards clear understanding of the orientations, methodological choices, theoretical implications, and practical backgrounds of each of these research projects. But we shall not try to solve any of the major problems which shall come to light during this day.

The practical organization of these presentations and discussions may be a little bit difficult. So we shall spare some time at the end of this afternoon to discuss the practical arrangements.

3) Finally, we will come to the final--and most important--discussion about the proposals for IIASA research program and international cooperation.

From a practical point of view, I shall ask the participants asking for the floor to raise their hands. I apologise in advance if the heavy schedule of this conference forces me into interrupting some of our discussions. I hope that we shall impose some restraints upon floor time so that this will not be necessary.

Since many participants may find it difficult to express their full views in a short period, I may call upon them to make a written statement. In such a case, please note on your statement whether you agree that your name be quoted with the statement or not.

I am open to all suggestions.

NATIONAL RESEARCH

IN

URBAN AND REGIONAL SYSTEMS

AUSTRIA

Institutions:

Institute of Urban and Regional Research

Institute of Public Finance

The Technical Universities of Vienna

The Austrian Academy of Science

The Social Science Division of the Federal Ministry of Science, Vienna

Research:

1. SA of the health sector in Austria. Authored by a team of the Institute of Advanced Studies, Vienna. Used by the Federal Government. Methodology: systems dynamics integrating social classes and the political system.

2. Cost effectiveness studies: public facilities planning, structural reform of local authorities (territorial unification of several communities). Authored by the Austrian Institute of Regional Planning, Planning Unit of the Government of Lower Austria. Used by Government of Lower Austria.

3. Verbal systems analysis - pricing in urban transport. Authored by Documentation Center of Urban Studies, Vienna. Used by Austrian League of Cities.

4. Land use model for Vienna - spatially extended urban dynamics. Authored by Batelle-Frankfurt in co-operation with Municipal Planning Unit in Vienna. Used by City of Vienna.

5. Land use model of Vienna - Lowry-type model. By Institute of Public Finance, Technical University, Vienna. Used for teaching and pure research.

6. Elements of a theory of urban intervention. Institute of Public Finance, Technical University, Vienna. Critique of existing theory with the aid of SA.

7. Simulation of urban and regional growth and decay. Institute of Regional and Urban Research, Technical University, Vienna. Methodology: theory of infrastructure, of migration, and of decision theory.

8. Same author as 7. Simulation of international migration. Methodology: differences in locational equipment and different public investment strategies considered as crucial hypotheses.

9. Same author as 7. Changes in settlement patterns. Central place hierarchy and spatial distribution of infrastructural stocks by change in technology.

General Comments

Up until 1960 research in this area was done only within the various disciplines. Since the 1960's a more integrated research approach has been taken. Currently, systems analysis for evaluation of public facility programs is used for decision making at the provincial level. At the local level it is applied to reform of local authority structure.

Remarks on the Application of Systems Analysis in Urban and Regional Planning - Austrian Experiences

D. Boekemann and E. Matzner

(See "National Proposals for IIASA Research Topics" for remainder of this paper)

The development of research in the urban and regional planning field in Austria can be broken up into three periods. The first period is characterized by that type of research which almost exclusively used the traditional scientific disciplines, classical methodology. This period ended approximately by 1960. During the second period increasing problems in the cities rendered necessary more comprehensive planning based on a broader view in research. The third period began in the early seventies, when at first an inter-disciplinary approach was attempted by establishing an Urban and Regional Planning Department at the Technical University in Vienna including two research institutes for regional development problems. Both institutes use formal languages and more sophisticated methods of systems analysis as a basis of research and teaching.

Theoretical background (based on research done on the Institut fuer Stadt- und Regionalforschung, T.H. Wien)

Locations (plots, communities, regions) can be considered as discrete products defined by their suitability for a specific use. They are a result of a production process and are sold on a market like other products.

As a consequence of this view, the terminology of the classical location and landscape theory (which serves as the most important basis for urban and regional optimization models) has to be extended by the location-specific terms: "production-function," "production-factor," "land owner," "land user," "competence and limits of disposition," "interest in utilization." The new terminology allows a set of new hypotheses. In the classical location and landscape theory, the single location used to be considered as a given and constant value mainly defined by the distances to other locations. According to the concept suggested here, locations are attributed variable values depending upon the access to different communication and supply systems. Thus, the location and landscape theory can be connected with the infrastructure theory. This connection allows simulation effects of

alternative strategies in urban and regional planning and helps to develop new and more effective strategies.

On the basis of such a theoretical background a relating set of structures problems may be better managed by applying systems analysis.

CANADA

Institutions:

(From "Some Avenues for Urban Systems Analysis" by Harry Swain and Allan O'Brien).

In each of Canada's thirty-five colleges and universities there are at least a few individuals who are concerned with problems akin to the ones mentioned. Likewise, all levels of government and specialist firms in the private sector have experts on these matters. A comprehensive list is therefore impossible. The following is a short list of leading institutions including contact persons:

1. Institute of Animal Resource Ecology, University of British Colombia, Vancouver 8, B.C. Professor C.S. Holling, Director. Systems stability and resilience.

2. Institute of Urban Studies, University of Winnipeg, Winnipeg, Man. Professor Lloyd Axworthy, Director. delivery of social services; inter-governmental financial systems; decision processes in large organizations. Center for Urban and Community Studies, University of Toronto, 150 St. George St., Toronto 181, Ontario. Professor W. Michelson, Acting Director. Associates include Professors L.S. Bourne, J. Simmons, and R.D. MacKinnon, all of whom have made substantial contribtions to Canadian urban studies. National urban policies; methodology of indicators for social well-being and urban environmental quality.

3. Institute for the Quantitative Analysis of Social and Economic Policy, University of Toronto, 150 St. George St., Toronto 181, Ontario. Professor A. Breton, Acting Director. Inter-governmental financial systems; delivery of social services; methodology of indicators for social well-being and urban environmental quality.

4. Institute for Behavioural Research, York University, Downsview, Ontario. Professor M. Lanphier, Director. Methodology of indicators for social well-being and Urban environmental quality.

5. Research Branch, Ministry of State for Urban Affairs, Ottawa K1A OP6, Ontario. Professor L.O. Gertler,

Director-General; Dr. H. Swain, Director External Research. This is the largest single group of urban analysts in Canada and is involved in all aspects mentioned above except delivery of social services and methodology for measuring quality of life. An abstract of some work by Professor P. Pergler relating to decision processes is in the Appendix.

6. Canadian Council for Urban and Regional Research, 151 Slater St., Ottawa, Ontario. Executive Officer: Robert Cournoyer. Research granting and clearing-house functions, particularly active in study of decision processes.

7. Centre de recherches urbaines et régionales, Institut national de la recherche scientifique (INRS-Urbanisation), 3465 rue Durocher, Montréal, Québec. Professor G. Fortin, Directeur. (Enquiries about the work of other INRS centres, for instance, INRS-Eau, -Energie, -Océanologie, -Education, should be directed to the Scrétaire-Général, Dr. G. Reeves, INRS, Complexe Scientifique, Cité Universitaire, Ste. Foy, Québec).

8. Government Studies Program, Dalhousie University, Halifax, Nova Scotia. Director: Dr. M.J. Kirby, Department of Mathematics. A promising new group with capabilities in operations research and management science applied to urban and regional problems.

9. Institute for Policy Research. Contact: Professor Allan O'Brien, Department of Political Science, University of Western Ontario, London, Ontario. New group just getting organized.

10. Ecole Nationale de l'Administration Publique, Québec, Québec. Beginning to work on municipal systems.

Research:

1. MUPIM (Macro-urban program impact model): model of national urban economy disaggregated to about 75 regions, mostly bigger cities, with 7 major sectors (population, income, activity location, public finance, environmental quality, etc.). Project leader: Dr. Martin Ulrich, Ministry of State for Urban Affairs, Ottawa K1A OP6, Canada. The model is very inclusive; policy effects can be traced. Current structure has about 1000 data data input series of which about 350 are policy variables. It puts out over 100 indicators--annual predictors for 7 to 10 year time horizons. Begun in 1971, expected to be operational in 1977.

2. There is other work along the same lines on less ambitious scales, for example, at the University of Toronto.

3. Work on organizing and channelling scientific information for decision purposes. Professor P. Pergler, MSUA, Ottawa K1A 0P6, and others. A summary of this work appears in the Appendix.

General Comments

Serious governmental use of SA techniques is just beginning. It is concentrated in the Federal Government (MSUA) and in the provincial governments of Ontario and Quebec. Of the big cities, only Toronto and Vancouver actually use advanced techniques as decision making aids on a regular basis.

SA is widely used in universities, primarily as part of basic research.

F.R.G.

Institutions

Battelle, Frankfurt

Universities and Institutes

Two Academies: Stadt Bauer
Landes Planung

Boards in large cities, e.g. Munich and Berlin.

Research

1. Information system "Kompass" - a basis for all municipal planning. Includes a detailed data bank, programs for statistical analysis, and computer cartography. By Reterat fuer Stadtforschung und Stadtentwicklung der Landeshauptstadt Muenchen.

2. Simulation model of the housing market of Munich using systems dynamics. Based on classical micro-economics and a deterministic view of causality. Takes into account feedback mechanisms and the importance of delays in any social and economic system. By Volwashen, Sieverts, and Blum at Technische Hockschule Darmstadt, Department of City Planning.

3. Systems analysis case study of the Rhein-Rhur industrial area, combining a traffic model, a demographic model, a housing model and a model of industrial development. By Stadt Bau Plan GmbH, Darmstadt & Bonn, Darmstadt, Wilhelm Leuschner Strasse 6.

4. Polis model elaborating an earlier, American, Lowry-type model. More emphasis on a sophisticated consideration of traffic aspects. Batelle Institute, Frankfurt.

5. OR methods like linear programming, used for regional and federal planning. Emphasis on economic growth and environmental quality. By Prof. Thoss at University of Muenster.

France

Institutions

A. Government Agencies and Groups

MATELT: Ministère de l'Aménagement du Territoire, de l'Equipement, du Logement, et du Tourisme. (Formerly - MEL: Ministère de l'Equipement et du Logement.)

DAFU: Direction de l'Aménagement Foncier de l'Urbanisme (Ministère de l'Aménagement du Territoire, de l'Equipement, du Logement et du Tourisme).

SAEI: Service des Affaires Economiques et Internationales (Ministère de l'Aménagement du Territoire, de l'Equipement, du Logement, du Tourisme, et Ministère des Transports).

CESDR: Centre d'Etudes Statistiques sur le Développement Régional (Institut national de la statistique et des études économiques).

DATAR: Délégation à l'Aménagement du Territoire et à l'Action Regionale (Ministère de l'Aménagement du Territoire, de l'Equipement, du Logement, et du Tourisme).

B. Research Institutes and University Groups

CERAU-BETURE: Centre d'Etudes et de Recherches sur l'Aménagement Urbain/Bureau d'Etudes Techniques sur l'Urbanisme et l'Equipement.

OTAM: Omnium Technique d'Aménagement.

CSU: Centre de Sociologie Urbaine.

COFROR: Compagnie Française d'Organisation.

IPEPS/IREP: Institut de Prospective et de Politique Scientifique/Institut de Recherche Economique et de Planification (Université de Grenoble).

EPHE/CECMAS: Ecole Pratique des Hautes Etudes/Centre d'Etudes et de Communications de Masses.

ESA: Ecole Speciale d'Architecture.

Research

1. Housing market model at a city level (with OTAM). Allocation of a 5-year housing program within a city. Land use model at a disaggregate level for the Lyon region. Evaluation of the satisfaction of citizens in large new housing estates. At CERAU-BETURE by G. Mercadal, F. Taieb, J. Azcarate, G. Depuy, A. Pitrou, and others.

2. Noise control in Avignon. At SERETES.

3. Transportation models. At OTAM by Le Boulanger and R. Fichelet.

4. Simulation of regional development. At CSDR by P. Carrere.

5. REGINA: A regional development model within a national macro-economical development simulation model. At University of Paris by M. Courbij.

6. PPBS applied to a policy for the urban core. At CAFU/MEL by M. Cousquer.

7. PPBS applied to urban transport in Toulouse and Strasbourg. At SAEI/MATELT by M. Plaud.

8. COSSAR. Regional development game for Brittany. At OTAM by M. Lacour and others.

9. Slum rehabilitation policy game. At OTAM by M. Haumont.

10. Duopolis: Competition between two cities. At OTAM by A. Antunej and C. Durand.

11. Superbuilder. Builders' competition at a city level. At CSU by J. J. Chapoutot.

12. SIM. Political processes in Angers. At OFROR by M. Salmona and D. Vicas.

13. City consolidation. At CERAU by M. Dupuy.

14. SESAME. Trend and contrasted scenaries for urban and regional development of France until year 2000. At DATAR/MATELT by J. Durand and others. Also at OTAM.

15. Scenario for transportation techniques development. At OTAM by Lacour and others.

16. Two systems analysis case studies of social change at the urban level: Nice and Grenoble. At IPEPS/IREP, Grenoble, by Y. Barel and others.

17. FOS/MER: Cybernetic model of social movement appearance and decay in a new town. At CECMAS/EPHE, Paris, by E. Morin and others.

18. Historical approach to socio-economic development of Rouen and Grenoble. At ESA Paris by A. Medam.

19. Planning and political conflicts at the "commune" level. At ESA Paris by B. Archer.

General Comments

French research in this field can be divided into three groups: scientific empiricism (studies 1-5), decision and control oriented studies (6-15), and cognitive research (16-19). The first group of research is geared to the production of decision making instruments. Topics are defined according to governmental criteria. Mathematical programming is the main theoretical tool, but most of the work relies upon ad hoc computer simulation. Sociological functionalism is often implicit. The decision and control oriented studies are attempts to transfer US efforts to the French context in the fields of PPBS (6, 7), political gaming simulation (8-13) and scenario techniques (14, 15). Cognitive research pursues scientific knowledge per se. Proponents of this approach assert that better control of society will be achieved when the decision making and research processes themselves have been subjected to scholarly investigation. So far it has been directed to research on cities or regions. A few projects are now being conducted at lower levels of aggregation. Sociology and political science serve as references for models dealing with societal conflict.

The three approaches were introduced sequentially, although work is continuing in the older ones.

Prospects for Urban Analysis in France

M. Conan

(From "Urban Systems Analysis in France: Difficulties and Prospects" by M. Conan. See Appendix for rest of this paper.)

We shall review here some works of interest for a program to be developed in Vienna. We could write down the general ideas of a small number of research projects which are presently underway in France and which make explicit use of a systems terminology. This would yield a very deceitful image of the contribution that can be made by contemporary urban research to the field of urban systems analysis because most of these research eschew the fundamental question "why should we call any urban phenomenon a system?" Moreover, many scholars who scorn the systems vocabulary because they distrust the ideological and analogical references that it conveys, are actually contributing to a study of questions which are of direct interest to systems analysis.

Let us state very briefly a series of such questions and provide a quick survey of the ongoing research that may help lead to an answer. It must be clear from the start that another set of questions would lead to another choice of research projects. Thus, the present list is but tentative and does give a full account of the urban research effort in France.

The first and foremost question is about specific definitions for social systems. This problem is set directly by such authors as Y. Barel [3], M. Castells [7], and in a different context by M. Godelier [18]. Whatever the definition used, one is led to consider two hierarchical criteria--dominance and determination--as if they were both a manifest and latent hierarchical arrangement of social systems.

Dominance characterizes the relationship between systems at the manifest hierarchy level: it points to the reciprocal or directed graph of control from one system to another. To a great expert, this type of control is consciously manipulated by social individuals. On the other hand, determination refers to another hierarchy of control social actors are not aware of. Despite its common use this is not a clear-cut difference, and it might be worthwhile to describe both the various types of social systems that have been found in urban research and the different ways of channeling control from one

system to another. It is clear, for instance, that laws and regulations are one type of control, but social norms are another, entirely different one. Profit is supposed to be an essential control that regulates market economy; ideology is probably another.

This effort might lead by itself to a confusing network of systems. Actually, when trying to identify a system, one must constantly keep in mind a two-pronged question:

1. How did such a system come into being and how did its position with respect to other systems come about?

2. What is keeping it in order and what is changing it with time?

The whole difficulty of the matter must be apparent in the very wording of the question. If it is as necessary, as we claim it to be, to provide an answer to those questions before one has defined a system in order to avoid an idealistic definition, then one should have an a priori definition of the system before working out the answers, and clearly this a priori definition may be idealistic. One way to circumvent this difficulty in the urban field would be to collect a number of studies on the production of the urban setting as well as on the production of institutional arrangements at the urban level and of all municipal services* on the one hand and on the other to collect a number of studies on social change and regulation at the urban level.

Research on the Production of the Urban Setting

This is probably the aspect of urban research that has developed most the last few years. A few groups of economists and sociologists have been writing surveys or monographs in order to define the social, institutional, and economic forces that shape the urban use of land.

One may mention studies on builders and on land ownership by C. Topalov [40], on large housing estate financing by D. Combes [11], on City Planning Policy in Paris and Lyon by C. Lojkine [25] [26], on Urban renewal in Paris by F. Godard [15], on the relationship between the steel industry national policy and the development of the Dunkirk region by F. Godard et M. Castells [16], and on process of production for large housing estate by E. Preteceille [36]. Other studies include research on the building industry by A. Ascher [2], on state and private enterprise partnership in zoned urban development by M. Marie [28], on the role of economic pressure groups in actual urban development by H. Coing [10], on public policy with respect to

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* We keep the distinction between municipal and urban services to allow for an analysis of both state and local initiatives and institutions.

housing by S. Magri-Cloarec [27], and on the development and destruction of mills and manufactures in Paris by M. Daumas [14].

In a slightly different perspective one may be interested in the research conducted by F. Guattari, C. Deleuze and M. Foucault on the historical development of various municipal services [9].

In a historical perspective it would be interesting to study such works as "The History of Urban Planning in Paris since 1900" by A. Cottereau [12], "The History of Urban Planning in France since 1920" by P. Rendu and E. Preteceille [37], the "Comparative Research on Urban Systems growth and Change in Grenoble and Rouen" by A. Medam [29], or the study on "Urban Renewal in Lyon at the End of the XIXth Century" by A. Bruston [6].

Social Change and Regulation at the Urban Level

One of the most successful models of the working of organizations in France has been proposed by M. Crozier [13]. It amounts to saying that the use of power within the French organization leads to a self-aggravating process whenever the environment exerts some pressure on an organization. This aggravating process may lead to a crisis which is a prologue to a new cycle of the same type. This current of thought has led to a very interesting study of self-maintaining processes within society. For instance it is very interesting to look at the professions in a similar fashion. But there has been a definite effort to see through the model and to try to understand how a cycle may differ from the preceeding one, and to look at the various types of social forces that are at work in such processes.

For instance, a report on a professional group--architects--by R. Moulin J. Lautman and others [32], a study on an Italian city by Dominique Schnapper [38], a report on a group of civil servants in the French Ministry of Urban Affairs by J.C. Thoenig [39], a report due shortly on emerging city planning in Rouen by X. Gaullier [15], and on the case of the halles in Paris by J.P. Worms [15], provide a series of examples of analysis that show how some organizations tend to remain constant despite external demands and how internal forces are working towards change.

This type of approach has challenged scholars to propose alternate models of social change wherein the observed changes are to be explained in the long range by processes that link the organizations to larger social processes. This may provide a hint for tentative definitions of a dynamic hierarchy of systems or for a systemic view of change processes themselves.

This is the line along which B. Jobert [22], works on the relationship between urban industrial growth and the "accumulation" of knowledge in the precincts of universities. Processes at the urban and regional level are studied in connection with manufacturing growth in addition to the logics of knowledge dissemination and production by Boisgontier [5]. In an altogether different way, Amiot [1] is trying to understand how an urban university development and output relate to the local market of labor (Nice and Lille).

Most of these pieces of research are attacking the problem from a very narrow point of view. A few studies such as the work by Peron et. al. on Rennes [35], or the work by E. Morin [30] on the new industrial town of Fos-sur-mer propose a much wider attack on the problem of social change. Actually, the work by Morin is cast entirely in systemic terms with a heavy reliance on feedback and feedforward concepts.

A few other studies are attacking very critical aspects of urban change, such as the new aspects of violence in the cities by M. Fichelet [19]. In this line of thought it may be interesting to follow the work by M. Castells and others at the C.E.M.S. on urban protest in France and South America.

Everyday Life in the Cities

A third type of question has to do with the types of communication that exist within urban systems. This is clearly a must if we want to avoid being trapped in narrow analogies between the machine and the social systems. The reason for this is very simple: all the previous questions have left aside the relationship between men and systems in order to concentrate on the macro picture that may help understand and master the urban phenomenon. In this type of approach men can be treated as if they were parts of the system, and systems may themselves become the makers of history. This is not a necessary consequence of systems analysis in our view but it seems a likely pitfall. Hence we feel it necessary to insist on the fact that some types of human communication that are not to be found in the machines must be investigated in order to explore how individuals relate to systems and relate to one another through system-made channels. Clearly enough this is very difficult, but how confident could we be in a picture of urban society that would make no room for symbolic communication, fetishism, aesthetic creation, fashion?

There, it may be worthwhile to try to use research on everyday life in the cities in order to get a rough feeling of the kind of communication between men and systems we should concentrate upon. A city planner is mostly concerned by everyday life, hence it is not surprising that a series of urban research works should have been launched under such a heading.

For our present purpose it would probably be enough to take note of those studies that are an attempt to decipher some of the little-advertised modes of communication that exist in our cities. Two studies by Edgar Morin are of interest in this respect: La Rumeur d'Orleans and Le Retour des Astrologues. Of course there is a lot to learn from La Critique de la Vie Quotidienne by H. Lefebvre [23], although this is not a very recent book.

It might be interesting to refer to a few studies on the relationship between people and housing such as "Les Pavillonnaires" by H. Raymond, N. et A. Haumont [20], or "La Dialectique du Logement et de son Environnement" by J. Palmade [33], or the forthcoming study on the ideological content conveyed by private housing developers to the middle and lower class owners by J. Ion [21]. There have been many attempts in this field but most of them are lacking in theoretical rigor. An exception is worth noting: the study of urban symbolism by J. Palmade [34].

There is much more to be said about this field of urban research, and there is certainly a lot to be learnt about systems analysis but the central concern should be with the choice of the main theoretical paths to be explored. It is our own prejudice that no urban research will bear any impact on social development and control until we have mastered both the process through which social systems channel different sorts of meaning to men and the way hierarchies of systems respond to new meanings.

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G.D.R.

General Comments

Systems analysis is used at the national level in developing basic guidelines for housing policy and industrial development. At the district level it is used for regional planning. Mathematical programming is used for statistical analysis. At the municipal level it is used for land use planning, for neighborhood planning, for evaluation of public facilities programs, and for service delivery planning.

Italy

(From "Notes on the Preliminary Research Program in Urban and Regional Planning" by the Italian Delegation)

Institutions and Research

1. ISPE (Instituto Studi Programmazione Economica Ministero del Bilancio e della Programmazione Economica)

   The ISPE particularly contributed to the draft of the "Project 80." preliminary report to the national economic program 1971-75, widely involved in the environmental problems concerning urban development.

   Its stated goal is to lead urban development towards a framework of metropolitan systems which should cover the whole national territory. Each system must display fundamental characteristics such as: the minimum number of inhabitants; the maximum travel time inside every system; the existence of an economic structure sufficiently complex and differentiated to offer employment opportunities in a wide range of activities; a minimum number of institutions for civil, social, and cultural services; and the spatial availability for leisure time.

   The subsequent study, "Territorial Projection of Project 80." develops furthermore the analysis of goals and actions regarding land use.

2. ITALSTAT (Societa finanziaria del gruppo IRI)

   The Company is composed of many departments some of which deal with typical problems regarding territorial system engineering--e.g. transportation planning, spatial economics, and improvement of mathematical models programmed for computers.

   Research efforts of this group include studies of: the East trunk motorway "tangential" to the Lazio region and forecast of traffic demand; the Leonardo da Vinci airport of Rome Fiumicino (vehicular traffic); the East-West trunk motorway tangential to the city of Naples; the traffic induced by the new iron mill in Taranto, both internal and external, including the journey to work of the workers; a study on feasibility of a truck center in

Bologna; and other applied research using assignment models.

3. TECNECO (Societa del Gruppo Ente Nazionale Idrocarburi)

Pollution and land use problems are the main interests of this Company. It has developed studies about Italian regions: the project of the sub-regional plan of Venice requested by the regional authority in cooperation with IRSEV (Regional Institute for Economic and Social Development of Venice) and Co.S.E.S. (Union for Economic and Social Development of Venice), and a sub-regional plan for the industrial development of the Sardinia central area (preliminary report). This plan is considered as a further development of a preceding ISVET project, "Study of a General Plan for the Industrial Area of Central Sardinia". ISVET is another Company of ENI group which merged, for the studies on urban and regional economics, with TECNECO.

4. SOMEA (Societa del gruppo Metra International)

This is a Company for research in mathematical field applied to economics, with main orientation to regional planning, and more generally, to use of mathematical models programmed on computers, for instance:

a) demographic projections and migration forecasts related to the creation of new jobs in Sardinia;

b) a study on Calabro-Lucane railways; and

c) "Atlante Somea", including systematic research issues on economic and commercial structure for all the Italian regions.

5. Cassa per il Mezzogiorno

One branch of systems analysis studies problems related to water resources use and planning, keeping in mind the increasing importance of these problems in developing industrial areas. The spatial planning problems are now handled empirically, but the need of a systemic approach is strongly felt. In the economic planning field models related to the South Italy development are now under study.

6. SVIMEZ (Associazione per lo sviluppo dell'Industria nel Mezzogiorno).

This group has studied problems of spatial organization connected with economic development, with infrastructures

planning, and agricultural development. It has also done research in population and manpower allocation in Italian regions with the aim of reaching in the 1980's the principal sectorial and territorial reequilibrium goals which are the main government orientation.

Particular attention is given to courses on urban modelling, and very important studies are made on the Lowry model.

It seems interesting to note also the studies in regional programming, with particular reference to developing regions, in which are used mathematical methods nearest to the systemic approach for managing problems connected with land use. The dynamic models studied in this work take account of spatial variables to incorporate structural variations, the principal characteristic of the real growth in the underdeveloped areas. This methodology applied to Puglia region and to various provinces in oriental Turchia shows interesting considerations in the behavior of economic variables.

7. FORMEZ (Centro di Formazione e Studi per il Mezzogiorno)

Its principal activity is addressed to training professional and managers of local administrations and public corporations more directly involved in economic and social development in the Mezzogiorno. The Center has held training courses for this; among these one could particularly note the course called "Problems and techniques of territorial and regional programming" (27/11/1972; 13/4/1973) which examined the theme of Southern regions specific increment, through a comparison with extra national experiences like, for example, the one of the "Department of Architecture and Planning" in Coventry.

8. Istituto di Architettura di Edilizia e Tecnica Urbanistica (Facolta di Ingegneria dell'Universita di Roma)

The activity of this Institute is mainly directed to teaching and training research. Problems currently under study include:

a) interpreting the process of progressive population concentration on the territory, particularly referring to the southern transversal reequilibrium system (lower Lazio and Abruzzo) proposed by the Project 80;

b) finding an interrelation model for localization problems, based on sectorial submodels, characterized by homogeneous and comparable parameters. Application to a disturbed situation of territorial equilibrium (like that which the Fiat factory

created in Cassimo).

9. Istituto di Urbanistica (Facolta di Architettura dell'Universita di Napoli).

This Institute is particularly interested in didactic research. Thére have been studies on the application of static (Czmanski model) and dynamic (Markov chain type) models to the urban system of Campania, trying to determine the usefulness of the model for forecasting and decisional purposes.

Other research includes the testing, through application of the Lowry model, the alternative hypothesis of spatial arrangement in southern Italian areas and particularly in Abruzzo.

10. Istituto dei Trasporti (Facolta di Ingegneria dell'Universita di Roma)

This Institute performs research on transportation planning in urban areas through the study of traffic models on both railway and road networks (particularly studies on public transportation in Lazio region and on traffic forecasting for an expressway in the town of Catania).

The problems treated are examined through interaction models and solved by typical operations research methods.

11. Istituto dei Trasporti (Facolta di Ingegneria dell'Universita di Napoli)

This Institute is mainly involved in statistical studies applied to transportation and traffic game simulation: past research includes parking planning for Napoli, and Calabro-Lucane railways traffic problems. Future work will include study of traffic control problems and methods regarding transportation planning on the regional level.

12. Pubbliche Amministrazioni

Other governmental groups are involved in studies concerning territorial problems of Southern Italy, as the "Mezzogiorno" is one of the more important problem for Italian social and economic development reequilibrium.

Research includes the action program undertaken in Campania region for both the hypothesis of regional planning and the proposal for the "Nola new town" that would be inserted in "metropolitan systems" of Progetto 80. A special project for Campania regards the pollution relief for the Gulf of Naples and the interregional and local road system for the

Campania region.

13. Istituto di Programmazione Territoriale e Progettazione (Facolta di Architettura del Politecnico di Torino)

The Institute is now involved in two main research programs. The first concerns all the various aspects of land use planning, from the decision making process to action planning, from the management of municipal and regional institutions to the legal and technical procedures involved in urban development. The second research effort deals with simulation game modelling (like the Forrester model) and with its application to a sub-regional planning study in the Piemonte area.

14. Gruppo Nazionale di Automatica e Sistemistica del Consiglio Nazionale delle Ricerche (Istituti di Automatica, Elettronica, Elettrotecnica delle Universita di Roma, Padova e Milano).

The group is an association sponsored by the National Research Council and has a wide program of research in cooperation with other public agencies and groups mainly in the improvement of regional and urban modelling with special regard to dynamic aspects, i.e.

a) construction of descriptive and interpretative models of urban phenomenona;

b) decisional models;

c) application of Operations Research techniques to well-defined problems originating in the urban context (particularly important in the transportation field); and

d) socio-economic and spatial structure inquiries.

It is important to remark that these studies, although beginning, are clearly in the development phase in Italy. It seems necessary to cope in a rational, systemic way with the complex problems created by rapid urbanization and by socio-economic development.

Other Research Not Detailed in the Above Paper

The National Research Council is sponsoring two relevant projects:

1. Management and control of urban development through analysis of the decision making process, formal and informal pro-

cedures, financial and legal constraints, institutional framework. By a team in the Faculty of Architecture of Turin in co-operation with the Political Science Faculty and some municipal authorities.

2. Urban systems analysis and modelling applied to land use planning through construction of descriptive and interpretive models. Sub-project oriented towards transportation planning. By the National Group of Automatics and Systems Theory in several Engineering Universities (including Rome, Milan, and Padua).

General Comments

Systems analysis is used for decision making in the regional and central governments as well as in some public corporations (mainly for industrial development). It is used by regional governments for the design of information systems.

SA is applied to problems of regional development, especially in the south and other less-developed regions. It is also applied to public transportation planning, econometric models of national housing policy, evaluation of transportation and hospital facilities, rehabilitation of historical centers, and decision making in municipal physical planning.

Disciplines used include mathematical programming (for regional economic planning), stochastic process theory (urban housing market models), decision theory (cost-benefit and cost-efficiency analyses), classical economics, and political science (analysis of local government functions and institutions).

POLAND

Institutions and Research:

1. Instytut Geografii PAN / Institute of Geography, Polish Academy of Sciences / Warszawa, Krakowskie Przedmieście 30.

   Urban-industrial agglomerations, systems of cities, threshhold analysis, internal structure of cities, history of settlement.

2. Instytut Urbanistyki i Architektury / Institute of City Planning and Architecture / Warszawa, Królewska 27.

   Re-designing of old towns, programs for housing development, optimal choice of new residential areas, information system, systems analysis.

3. Instytut Planowania Przestrzennego, Politechnika Warszawska / Institute of Physical Planning, Technical University, Warsaw / Warszawa, ul. Koszykowa 55.

   Among others: design of cities, complex designing of new residential areas, urban infrastructure.

4. Instytut Architektury i Urbanistyki, Politechnika Wrocławska / Institute of Architecture and City Planning, Technical University, Wrocław / Wrocław, ul. Prusa 26.

   Among others: simulation models of cities.

5. Zakład Geografii Społecznej, Uniwersytet Wrocławski / Department of Social Geography, Wrocław University / Wrocław, Plac Uniwersytecki 1.

   Settlement complexes (urban and rural).

6. Zakład Planowania Regionalnego, Wyższa Szkoła Ekonomiczna, Kraków / Department of Regional Planning, Kraków School of Economics / Kraków, ul. Rakowicka 27.

   Systems approach to regional planning.

7. Zakład Geografii Ekonomicznej, Wyzsza Szkota Ekonomiczna, Poznań / Department of Economic Geography, Poznań School of Economics / Poznań, ul. Marchlewskiego 146/150.

   Optimal shaping of open regions, theory of spatial processes.

8. Central Statistical Office, Warsaw
   Design of information systems.

General Comments:

Systems analysis is used in Poland for the planning of regional development by use of decision theory tools.

There are three institutional forms of research: in research institutions under the Polish Academy of Sciences, in universities and other ceters of higher learning, and in planning boards at the local, regional, and national levels.

United Kingdom

Independent Research Institutes

1. Centre for Environmental Studies
   5 Cambridge Terrace
   Regents Park
   London NW1 4JL

   Director: D.V. Donnison

   Urban and regional planning research

2. Local Government Operational Research Unit
   Reading
   Berkshire

   Director: B. Whitworth

   Research to improve local government operation and services

3. Institute for Operational Research
   56-60 Hallam Street
   London W 1

   Director: J. Stringer

   Research on planning processes: especially concerned with inter-agency problems and decision making organization

University Groups

1. Centre for Land Use and Built Form Studies
   16 Brooklands Avenue
   Cambridge

   Director: L. March

2. Centre for Urban and Regional Research
   University of Manchester
   Manchester 13

   Director: Professor J. Parry Lewis

3. Centre for Urban Economics
London School of Economics
Houghton Street
Aldwych
London WC2

Director: C.D. Foster

4. Pollution Research Unit
Mathematics Building
University of Manchester
Manchester 13

Director: N. Lee

5. Urban Systems Research Unit
University of Reading
Whiteknights
Reading
Berkshire

Director: Professor P. Hall

6. Centre for Transport Studies
University of Leeds
Leeds

Co-Director: Professor A.G. Wilson

7. Centre for Transport Studies
Cranfield Institute of Technology
Bedford
Hertfordshire

Director: J. Clarke

8. Science Policy Research Unit
University of Sussex
Fulmer
Sussex

Director: Professor C. Freeman

9. Institute of Local Government Studies
University of Birmingham
Edgbaston
Birmingham

Director: Professor H. Maddick

Government Groups

1. Building Research Establishment
Garston
Watford
Hertfordshire

Director: J.B. Dick

Operation of urban services; development of new towns

2. Transport and Road Research Laboratory
Crowthorne
Reading
Berkshire

Director: A. Silverleaf

Needs of transport consumers; effect of transport provision on activities of people and, hence, on land use; social, environmental, and economic impact of freight movement and of public transport; planning information systems; planning in developing countries.

General Comments

Urban systems analysis in the UK is devoted mainly to design of decision making instruments, to study of how urban systems work, and to policy analysis. It covers strategic land use planning, including planning of neighborhoods and new towns, regional development, and municipal services. Optimization techniques, stochastic processes, and Monte Carlo and computer simulation techniques are used for problem solving.

Information Note

M. Cordey-Hayes

The Centre for Environmental Studies (London) is an independent research body charged with the furtherance and dissemination of research into problems connected with urban and regional planning. It was established in 1967 and operates both as an institute (doing its own research) and as a foundation (sponsoring research at universities). Most of the Centre's finances have come from the British Government (through the Department of the Environment), the Ford Foundation and other private foundations. Current annual expenditure is approximately £300,000 of which about one half finances an in-house research team and the remainder is used to sponsor research at universities and to provide a focal point for urban research in the U.K. by organising conferences, seminars, fellowships, and related activities. D. V. Donnison is the Director of the Centre.

A large proportion of the Centre's in-house work is concerned with advancing the understanding of how urban systems work, for example, how migration affects labour market areas, how housing markets operate, and analyses of determinants of growth, agglomeration, and decentralisation. Alongside these are a number of more qualitative studies of social policy and studies of urban management and the planning process. All of the work aims to be policy orientated. The in-house research team currently comprises four main groups:

i) urban economics

ii) urban systems analysis

iii) social policy and administration

iv) urban planning processes.

Each group contains 4-6 researchers. Current in-house projects include:

- Quality of urban residential environments
- Economics of the urban housing market
- City size and national urban development policy
- Analysis of the local government strategic planning process

- Movement of minorities to new and expanding towns

- An analysis of migration movements between the city regions of England and Wales in terms of the changing characteristics of these labour market areas

- Input-output analyses in operational planning.

Perhaps the work of the urban systems group is that which is most closely related to the interests of IIASA. This group is concerned with the theoretical analysis of urban structure and the concurrent development of urban simulation models. Techniques are being developed which aim to elaborate and test alternative planning strategies in an attempt to evaluate the consequences of differing policies for urban growth and change. Early work of the group focussed on the design and development of operational models that, for example, analyse the repercussions of alternative arrangements of transportation networks, land development regulations, location of industry and public service facilities on the spatial distribution of population. This work was carried out in collaboration with local planning authorities, and experience gained from the research suggests that systems models intended for operational use by planners need to be conceptually simple, relatively easily constructed and implemented, and should be capable of integration with other more intuitive methods of design and evaluation to form a continuous adaptive planning process where flexibility, a gradual learning process and monitoring are of greatly increased significance. Particular attention was given to "how" and "where" models are useful within such a cyclical learning process of strategic planning. An hierarchical set of simple models was considered to have numerous advantages over large scale system wide models and that research on planning methodology requires an on-going dialogue between theory and practice.

More recently research of the urban systems team has had three main foci, namely "urban dynamics and migration studies," "input-output methods and activity analysis," amd "industrial location theory." Papers are available on each of these. The above projects aim to comprise an inter-disciplinary programme of research. One of the distinctive feaures of the approach is that it attempts to integrate the need to look at the "whole system" with the traditional approach of science and which is based on breaking down global problems into discrete and soluble ones. It is based on a hierarchical form of analysis which aims to provide a common conceptual framework for both the researcher and the planner involved in strategic planning. The process is one of structured learning as well as identifying and testing policy options.

Some recent publications of the group are:

An operational urban development model of Cheshire. R. Barras, T. Broadbent, M. Cordey-Hayes, D. B. Massey, K. I. Robinson and J. Willis, Environment and Planning Vol. 3, Number 2, 1971.

The use of models in structure planning. D. B. Massey and M. Cordey-Hayes, Town Planning Review Vol. 42, Number 21, 1971.

A hierarchical interaction model for a two level spatial system. T. Broadbent, Regional Studies, Number 5, 1971.

Urban velocity fields. S. Angel and G. Hyman, Environment and Planning Vol. 2, pp. 211-224, 1970.

Dynamic framework for spatial models. M. Cordey-Hayes, Socio-Economic Planning Sciences Vol. 6, pp. 365-385, 1972.

Urban spatial interaction. S. Angel and G. Hyman, Environment and Planning Vol. 4, pp. 99-118, 1972.

Migration movements and the differential growth of cities in England and Wales. M. Cordey-Hayes and D. Gleave, Centre for Environmental Studies, Working Note 368, 1973 (to be published in Papers of the Regional Science Association).

The development of an urban interindustry model: 1. Building the input-output accounts. W. I. Morrison, Environment and Planning Vol. 5, Number 3, 1973.

I.O.R. Planning Processes Program--Project Notes

John Friend

(This set of notes has been prepared in order to describe in outline the range of past and present activities coming within the field of IOR's Planning Processes Program. The list will be brought up to date at intervals as current activities are completed and new ones are initiated.)

Project:	POLICY RESEARCH FOR LOCAL GOVERNMENT
Duration:	4 years, December 1963 to December 1967
Client or Research Sponsor:	Nuffield Foundation
Budget:	£42,000
Staff (IOR):	W. N. Jessop, J. K. Friend, P. Spencer
(associated):	Dr. H. Murray, Human Resources Centre, Tavistock Institute
Other Organizations Associated:	Coventry City Council

Outline:

The aim of this project was to discover what kinds of contribution operational research could make, in association with the social sciences, to the processes of policy making and planning in local government, with particular references to strategic issues involving coordination between departments and communication between officers and elected members. Coventry City Council provided opportunities for extensive observation of processes of decison making at departmental, interdepartmental, committee, and political levels; individual discussions were also held with many senior officials and elected members. Issues analysed included development plan review, capital budgeting procedures, transportation and re-organisation of secondary education. From this base, a general approach was developed to local authority policy planning as a "process of strategic choice," pointing to the possibilities of advancement towards more coordinated decision making without heavy initial investment in the new forms of technology, control system, or management structure.

Outcomes:

The book "Local Government and Strategic Choice" by J. K. Friend and W. N. Jessop was published in April 1969 and has since appeared in paperback. A German translation is under contract. It is structured in four parts. The first analyses processes and problems of policy making in Coventry; the second develops a general framework; and the third and fourth parts build on this framework to indicate, through use of fictitious case example, opportunities for innovation both in the "technologies" of decision making and in organizational arrangements. The book has been extensively reviewed at home and overseas; has had influence on the development of management systems in Coventry and elsewhere; and forms the foundation from which all subsequent research, consultancy and teaching activities in the IOR planning processes program have grown.

Project:	THE LOGIMP (LOCAL GOVERNMENT IMPLEMENTATION) EXPERIMENT
Duration:	6 months, March to August 1970
Client or Research Sponsor:	Center for Environmental Studies
Budget:	£5,200
Staff (IOR):	J.K. Friend, M.C.J. Elton, P. Hornby, J.M.H. Hunter, D.W. Millen, A. Sutton, C.J.L. Yewlett, Miss G.M. Overton
(associated);	F. Wedgwood-Oppenheim and P.A. Eddison (Institute of Local Government Studies) J. Willis (CES)
Other Organizations Associated:	Greater London Council Cheshire County Council Hampshire County Council Hertfordshire County Council Coventry City Council Teesside County Borough Council London Borough of Barking London Borough of Havering St. Alban's City Council Fareham Urban District Council

Outline:

The aim was to test the practical value of the aids to local authority decision making proposed in "Local Government and Strategic Choice," including the technique of AIDA (Analysis of Interconnected Decision Areas) and also systematic methods

for the management of multiple uncertainty. Six teams of local authority officers worked in parallel, each advised by an IOR consultant, each attempting to apply the approach to a selected local planning problem where there were current pressures for decision yet difficult long term uncertainties to be managed. Over thirty people took part actively in the project, including representatives of planning, finance, engineering and other departments, coming together at monthly intervals to exchange experience on progress and any difficulties encountered. The problems selected concerned environmental improvement in an industrial town, recreational use of green belt land, traffic congestion in a cathedral city, planned expansion of a seaside commuter belt and promotion of multi-purpose central area developments.

Outcomes:

The results were reported in CES Information Paper IP25. This includes reports on the six constituent projects written by the local authority officers concerned, and a summary of the results of a questionnaire which invited views on the value and shortcomings of different aspects of the methods used. Several of the local authorities concerned have continued to make use of the methods in the further analysis of policy planning problems, with or without assistance from IOR staff.

Project:	DECISION NETWORKS IN REGIONAL DEVELOPMENT (with pilot project "Operational Research Methods of Multi-Organizations Planning Public Services)
Duration:	Pilot Project - 1 year, September 1968 to August 1969 Main Project - 2½ years, September 1969 to March 1972
Client or Research Sponsor:	Social Science Research Council
Budget:	Pilot Project - £ 9,600 Main Project - £24,500
Staff (IOR): (associated):	J.K. Friend, J.M.H. Hunter, C.H.L. Yewlett Dr. J.M. Power, Department of Government, University of Sydney
Other Organisations Associated:	Worcestershire County Council Droitwich Development Committee Droitwich Borough Council Department of the Environment, West Midlands Region Various New Town Development Corporations

Outline:

The aim of this work has been to develop practical approaches to the special problems posed by decision making and planning in situations where the divergent interests of several different public authorities may be involved. The field work has focused on an overspill scheme managed by a joint committee of County and District Councils, but the accent of the research has been on obtaining results of more general relevance to problems of organizational design and inter-organizational relationships, with special reference to the imminence of local government reform.

Outcomes:

An open conference was held in London in December 1971, on the theme of "Beyond Local Government Reform: Some Opportunities for Evolution in Public Policy Networks." The two papers presented on that occasion have been published as an IOR Monograph. One of these papers was submitted as evidence to the Committee on Management Structure for the new local authorities. The final output will take the form of a book entitled "Public Planning: The Inter-Corporate Dimension." The first section of the manuscript has been circulated in draft, with the remaining two sections scheduled for completion in 1972.

Project:	URBAN MANAGEMENT PROJECT, BAROD, INDIA
Duration:	2 weeks, August 1970
Client or Research Sponsor:	Ford Foundation
Budget:	£500
Staff (IOR):	J. K. Friend
(associated):	Dr. Eric Miller, Centre for Applied Social Research, Tavistock Institute
Other Organizations Associated:	Baroda Municipal Corporation Operations Research Group, Sarabhai Group of Industries Baroda Community Development Project M.S. University, Baroda

Outline:

This brief consultancy assignment was undertaken in order to evaluate proposals which had been formulated in Baroda

for a large-scale Urban Management Project to be mounted in the City, to involve components of physical, economic, and management studies. Representatives of different departments of the local authority and several other local and regional agencies were interviewed during the course of the ten-day visit.

Outcomes:

A short report was submitted suggesting that circumstances could be favourable for the establishment in or near Baroda of a management training center for local government along the lines of INLOGOV at Birmingham University, with the municipality and its planning problems providing a "laboratory" for development of management methods and techniques. No further initiatives appear to have been taken in Baroda itself; but INLOGOV has since been active in discussing management training for local government with Indian Institute of Public Administration.

Project:	SEMINARS FOR SENIOR LOCAL GOVERNMENT OFFICERS
Duration:	Three two-day seminars, June, September, and November 1971
Client or Research Sponsor:	IOR programme development initiative
Staff (IOR):	D.A. Hickling, K.R. Carter, J.K. Friend, A.S. Sutton, P. Hornby, J.M.H. Hunter, B.R.Quarterman
(associated):	F. Wedgwood-Oppenheim and P.A. Eddison, INLOGOV
Organizations represented:	County Councils - Devon, Durham, East Sussex, Essex, Hampshire, Isle of Wight, Leicestershire, Warwickshire, Westmorland, West Sussex County Boroughs - Coventry, Derby, Liverpool, Preston, Stockport London Boroughs - Camden, Hammersmith, Southwark Scottish Development Department Essex River Authority Warrington New Town Development Corporation Birmingham Regional Hospital Board

Outline:

The two-day residential seminars on the theme of "Aids to Strategic Choice" were held at an hotel outside Coventry and attended by senior representatives of departments concerned with Finance, Engineering, Education, Planning, and Administrative Services. Topics covered included techniques for strategic choice, organizational implications and areas of past and potential application of the methods. Formal lectures were interspersed with work in small groups, built around the analysis of interconnected issues arising in "Problem Street," a decaying inner area of a hypothetical County Borough. Shorter "visiting seminars" have been conducted for Teesside County Borough and Cheshire County Councils.

Outcomes:

The "Problem Street" exercise has been written up in the form of a monograph, and the experience of the initial set of seminars has indicated ways in which the aids of strategic choice can be further developed for practical use by inter-departmental working groups. It is envisaged that further series of seminars will be conducted after the new local authorities have been established. A series of eight seminars at six major centers across Canada is presently being arranged for the spring of 1973 by the Centre for Continuing Education under the auspices of the Greater Vancouver Regional District Council and the University of British Columbia.

Project:	METHODS OF PROBLEM STRUCTURING
Duration:	6 months, October 1971 to March 1972
Client or Research Sponsor:	Federal German Government, Ministry of the Interior
Budget:	£11,400
Staff (IOR):	D.A. Hickling, J. Stringer, J.K. Friend, Dr. R. Harris
(associated):	Professor F.W. Scharpf, University of Konstanz; W. Fach, University of Konstanz; Dr. H. Schunk, GMD (Government Mathematics and Computer Institute); Dr. Andreas Faludi, Oxford Polytechnic

Outline:

This was a pilot project to establish the feasibility of a systematic approach to the setting up of interdepartmental long-range planning groups in the German Federal Government. The approach involved identifying clusters of closely related areas of policy, on the basis of measures of their similarity of impact on the total physical, social, economic, and politicocultural environment of the Federal Government. It was envisaged that such planning groups would be able to make use of the techniques of AIDA (Analysis of Interconnected Decision Areas) developed by IOR to explore sets of related policy options within the areas of policy so identified. The pilot project concentrated, however, on development and testing of the basic computer method and on conducting trials with civil servants and others to establish the feasibility of collecting the necessary data.

Outcomes:

A full report (in English) on the pilot project was submitted in early April 1972, and a second (in German) during June 1972. Both confirmed the basic feasibility of the approach and identified further work required before it could be introduced in operational form. The proposals for further work are currently under consideration by the interdepartmental Project Group for Administrative Reform, located in the Ministry of the Interior.

Project:	COMMUNITY DEVELOPMENT THROUGH AREA IMPROVEMENT
Duration:	3 months, December 1971 to March 1972
Client or Research Sponsor:	Home Office (Community Development Project)
Budget:	£2,800
Staff (IOR):	K.R. Carter, C.J.L. Yewlett, J.K. Friend, G.M. Luck
Other Organizations Associated:	Coventry Community Development Project Coventry City Council

Outline:

This exploratory project was designed to find out ways in which the area improvement provisions of the 1969 Housing Act could assist in meeting the needs and aspirations of

residents of inner city areas, with special emphasis on how to develop more effective channels of communication between residents and the local authority. Decision problems arising in the course of implementing Coventry's first inner-city area improvement scheme have been analysed, with special reference to the difficulties of inter-departmental working or communication with community interests, and interviews to discuss problems of future policy.

Outcomes:

A report has been produced which points to the need for a "forward scanning function" as a means of collating and monitoring information of all kinds which may be relevant to the planning and implementation of future GIA's. A series of meetings to discuss the implications of the report with officers at Coventry has been held and an internal working party at officer level is considering ways of implementing the recommendations. Presentations to CDP teams from other parts of the country and to civil servants concerned with area improvement are likely to be held later in the year.

Project:	PLANNING PROPOSALS AND THE NATURAL ENVIRONMENT
Duration:	3 months, May to August 1972
Client or Research Sponsor:	Natural Environment Research Council
Budget:	£2,500
Staff (IOR):	K.R. Carter, J.K. Friend, D.A. Hickling
Other Organizations Associated:	Scottish Development Department Nature Conservancy Countryside Commission University of Edinburgh

Outline:

This is the first stage of a program intended by NERC to establish a clearer basis for identifying those priorities of research which will assist those responsible for major physical planning decisions in taking fuller account of ecological and environmental implications. The Tayside Regional Study has been selected as a basis for the pilot project, and discussions have been held with a variety of people concerned both in its preparation and with its effects on the natural environment.

Outcomes:

A report is to be produced in August 1972 to the steering group and to MERC: These bodies will then consider the details of the mounting of the second stage of the program.

U.S.A.

Institutions

A. Universities

1. University of Pennsylvania (Planning)
2. University of California, Berkeley (Planning)
3. School of Urban and Public Analysis, Carnegie-Mellon University (W. Cooper)
4. Institute for Public Policy Analysis, University Michigan (P. Crecine)
5. MIT/Harvard Joint Center for Urban Studies

B. Non-Profit Firms

1. The Rand Corporation, especially New York City-Rand Institute
2. The Urban Institute

Research

1. New York City Rand Institute projects--Fire Research Program and Housing Policy Program
2. Work on New York Ambulance System by Saras
3. Northeast Corridor Project on inter-city transportation

General Comments

The national government is responsible for a high percentage of the work in urban research and much--although less than half -- of the planning work. Except for PPBS, it does not do this work in-house but supports work elsewhere. Since the government has the money it exerts some control over the type of research done. Outside of the government, work is done in universities (both in the traditional discipline departments and in special centers), in profit-making firms (which work on particular narrow projects for local or the federal government), and in non-profit organizations. In addition, every city has a planning and zoning board to define minimally the constraints on the private sector. The largest cities--New York, Los Angeles, Chicago, Washington--have planning bodies with competent professional staffs. In general, urban analyses are undertaken to design decision making instruments or for pure research purposes.

U.S.S.R.

(From "Study Programme for the Problem 'Control of Development and Functioning of Towns and Conurbations' " presented by the USSR Delegation)

Control of Town and Urban Development

A. Institutions

1. Central Research and Design Institute for Town Planning attached to the State Committee of Civil Construction and Architecture (head organization).

2. Institute of Control Problems (Automatics and Telemechanics) of the USSR Academy of Sciences.

3. Kiev Research and Design Institute for Town Planning attached to the State Committee of Civil Construction and Architecture.

4. Leningrad Research and Design Institute for Town Planning attached to the State Committee of Civil Construction and Architecture.

5. Central Research and Design Institute for Industrial Building attached to the USSR State Building Committee (Gosstroy).

6. Central Research and Experimental Design Institute for Engineering Equipment attached to the State Committee of Civil Construction and Architecture.

7. Central Research and Design Institute for Automatic Systems in Building attached to Gosstroy.

8. Central Institute of Economics and Mathematics, USSR Academy of Sciences.

9. Research and Design Institute for Moscow Master Plan.

10. Council for Productive Forces Evaluation, State Planning Committee of the USSR.

11. Research Institute for Building Economics attached to Gosstroy.

12. Research Institute of the USSR Central Statistical Department.

13. Central Statistical Department of the USSR.

B. Experts

1. L.N. Avdotin (Central Research and Design Institute of Town Planning).

2. A.V. Kochetkov (Central Research and Design Institute of Town Planning).

3. V.B. Sokolov (Institute of Control Problems, USSR Academy of Sciences).

4. A.G. Mamikonov (Institute of Control Problems, USSR Academy of Sciences).

5. V.V. Kulba (Institute of Control Problems, USSR Academy of Sciences).

6. S.S. Shatalin (Central Institute of Economics and Mathematics, USSR Academy of Sciences).

7. L.E. Vand (Central Research and Design Institute for Automation in Building).

8. G.I. Lavric (Kiev Research and Design Institute for Town Planning).

Control of Town and Urban Functioning

A. Institutions

1. Pamfilov Academy of Municipal Economy (head organization).

2. Institute of Control Problems (Automatics and Telemechanics), USSR Academy of Sciences.

3. Central Institute of Economics and Mathematics, USSR Academy of Sciences.

4. Research Computation Centre of Moscow Executive Committee.

5. Moscow Research and Design Institute for Automation of Municipal Economy Systems Control.

6. Research Institute for Master Plan.

7. Institute of Industrial Economics and Organization, USSR Academy of Sciences.

8. Institute of Integrated Transport Problems, USSR State Planning Committee.

9. Moscow Research and Design Institute for Housing.

10. Technical Department of Moscow Executive Committee.

11. Research Institute of the USSR Central Statistical Department.

12. Central Statistical Department of the USSR.

13. Central Research and Design Institute for Industrial Building attached to the USSR State Building Committee.

14. Institute of Engineering and Sanitary Equipment.

B. Experts

1. F.A. Shevelev (Academy of Municipal Economy).

2. Y.A. Popkov (Institute of Control Problems, USSR Academy of Sciences).

3. I.A. Faradjiev (Institute of Control Problems, USSR Academy of Sciences).

4. Y.A. Oleinik-Ovod (Central Institute of Economics and Mathematics, USSR Academy of Sciences).

5. A.T. Belevzev (State Committee of the USSR Council of Ministers for Science and Technics).

6. Y.K. Kozlov (Research Computation Centre).

7. Y.P. Ivanilov (Research Computation Centre).

8. Y.I. Zavaruhin (Leningrad).

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Experts' Commission

Scientific Leader - G.N. Fomin

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General Comments

In the USSR, research of urban problems is carried out in the following fields:

- control of town development
- control of town functioning
- elaboration of principles of establishment and organization of information systems, providing the analysis of the state of towns and production of data for working out control actions for town development and functioning
- computerized design of buildings and towns
- application of fundamental research results to solving practical problems of controlling towns and conurbations of different size and objective.

The town is one of the main subsystems of national economy, and its development is effected in accordance with the five-year and long-term development plans of the entire national economy. At present, elaboration of a long-range plan for the period of 1976-1990 is in its final stage.

Controlled development of towns and reconstruction of populated areas is based on the country's production forces distribution and development schemes corresponding to its economic regions.

Distribution of production forces is effected in accordance with the USSR general population distribution scheme and its economic zones. They underlie the state policy and influence location and development of the entire population pattern, improvement of its territorial distribution, as well as the structure, the large-scale town and aglomeration growth control, small and medium-size town development and formation--where necessary--of new towns and settlements. In forecasting development of a town and its subsystems, various mathematical programming models are used, the most common of which are linear models. Methods of the "pattern" type and many others similar to it have come into use, as well as various extrapolation methods. A systems approach involves a variety of sociological, transport, and other studies.

In urban planning, the town structure optimization is meant as town object optimal location and formation of their communications. Integrated object optimal location is an extremely difficult problem and its solution is impossible without a systems approach.

Changes in already shaped population distribution patterns by application of new systems development control techniques are envisaged as gradual formation of systems (constellations) of towns, settlements, and conurbations, interrelated economically and as parts of one construction scheme. These systems (constellations) provide the whole population with equal housing comfort, public service facilities, employment choice, as well as effective measures in protecting the natural environment. It is effected in the regional planning projects. The regional planning schemes incorporate location of enterprises, towns and settlements, the transport network, recreation zones, water supply system, engineering infrastructure, preservation of the natural environment. The optimal solution of these tasks implies a systems analysis.

The regional planning schemes are based on the general town planning schemes, an official guiding document in multi-aspect activity in town development, planning construction and improvement.

The process of re-planning the towns already constructed and of construction of new towns is effected in the following directions: creation (formation) of the city base, employment provision (with a development margin), improvement of the town planning structure, gradual modification of the existing transport network and formation of new ones, development of communal activity centers and public service systems, improvement of dwellings lacking some conveniences, a more efficient utilization of urban territories and its engineering systems, improvement of part and green zone layout, improvement and development of the urban architectural aspect.

Town and conurbation planning as a most important part of control is effected in compliance with the town construction standards. These standards are based on the modern requirements for town development control in population distribution systems, their classification according to size and economic function, functional territory organization, efficient space utilization, and adequate public service systems. This complex task finds an optimal solution through application of computer techniques.

In urban planning and research, new mathematical methods and computers are used more and more extensively; in specific fields as demography, transport, engineering, economics, and construction, the new methods, models, and computer programs are being materialized already. These new methods will be also used in handling more complex major problems which are being investigated at present. The most important of them is development of computerized automatic design systems of regions, towns, industrial zones, and specific objects.

Town development control implies a lot of urban research and development which is effected under the auspices of Gosstroy of the USSR and its State Committee for Civil Construction and Architecture, as well as Gosstroy bodies of Union Republics. This system incorporates research and design institutions engaged in urban research, town construction, and regional planning and elaboration of town construction standards.

Efficient urban economy functioning aims to satisfy the population's needs in the production and services of the urban subsystems, the function of which is provided for by correlated short term and long term plans.

The urban economy subsystems are controlled by the local governments which coordinate their functioning. The local governments consider and adopt short term and long term plans for housing, communal service object construction, cultural activities, road construction, public health care, etc., and exercise control of materialization of the plans.

The existing urban economy control system can be improved through application of economico-mathematical methods and creation of automatic control systems (ACS). The urban economy ACS implies social communities as well as hardware and software which are both responsible for urban subsystems control functions.

The models and techniques used in ACS can be subdivided into control of the system design and the system design. The system's optimal structure determination problem consists of the determination of its subsystems, their interrelations, the task distribution (done by the system's hardware) among its levels and subsystems, and creation of hardware providing for their timely solution. At present there are no techniques simple enough to make synthesis of optimal ACS structures, whereas most ACS structure optimization tasks are represented by models of mathematical programming.

The ACS urban economy information subsystem has a multi-level structure. It is interrelated with its numerous internal subsystems as well as with external organizations.

In the USSR, ACS development is being carried out at all levels of management (city, region, republic, economy). Computer information centres are set up at Ministries of municipal economy of a number of Union Republics (the Russian Federation Republic, Latvia, the Ukraine, Byelorussia, Azerbaijan).

In a number of big cities (Moscow, Leningrad, Kharkov, and others), ACS "Cities" are established and being developed. They have "housing," "transport," and many others as their subsystems.

PRESENTATION AND DISCUSSION

OF

EXAMPLES OF NATIONAL RESEARCH

Modelling of the Complex, Dynamic Urban Systems

Ryszard Domanski

The purpose of this paper is to present an approach to the problem of modelling of the complex, dynamic urban systems. Upon what does this approach rely?

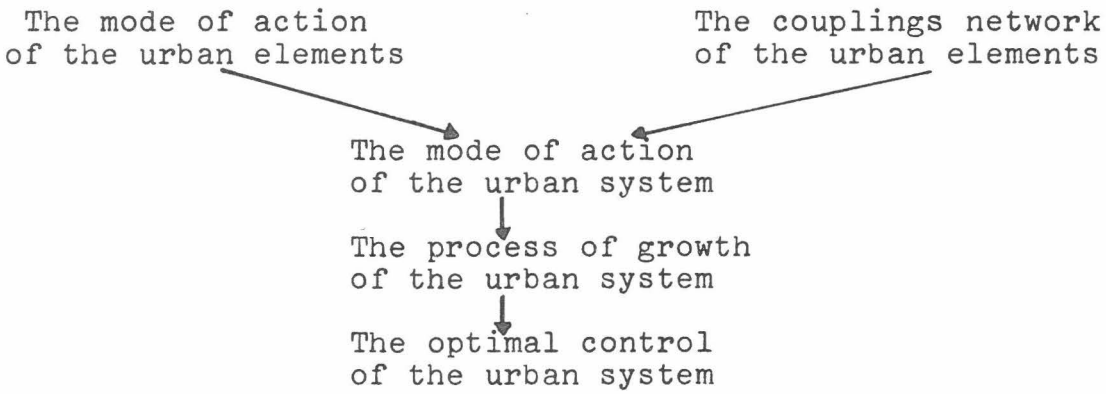
Firstly, it starts from few primary notions and leads to a general model of interactions, growth, and optimal control of complex systems. Two of them underset the whole construction. The derivation of complicated models from a mere few notions results in their consistency. The consistency of theoretical constructs is regarded as a merit from the point of view of methodology, especially with regard to systematization and integration of knowledge.

Secondly, the procedure of modelling does not stop at the general model. It is extended to fit better to various types of urban systems or problem situations. There are two possible ways of such an extension: a) complicating of assumptions underlying the general model and derivating, in consequence, several specific models; b) systemization of existing models built for various purposes and establishing linkages between them and the general model.

The first way yields a compact and elegant logical construction, but may often be difficult to actualize. The second is less elegant, but more promising and effective. The author sets down several earlier, specific models, whose common feature with the general model is that they are based on the same method (dynamic optimization) [2, 3].

Cities, conceived as living organisms, are moulded mostly by socioeconomic activity [4]. This activity is organized by economic enterprises and social organizations. Performing their economic and social functions, these enterprises and organizations get in contact with other enterprises and organizations. The behaviour of these urban elements, their interactions with each other and the environment, form complex economic and social systems.

The modelling of urban systems, in the meaning accepted in this paper, relies upon a generalized and partly formalized depiction of the interactions, growth and optimal control of these systems. The structure of the model resulting from this procedure can be presented concisely:



Two primary notions underlying the model are: the mode of action of the urban elements and the couplings network of the urban elements.[1] From these two notions the mode of action of the urban system and the law of motion of this system can be derived. The latter, in turn, determines the law of growth of the system as well as the properties of the growth process. We proceed from the law of motion and the law of growth to the optimal control by including the first law as a condition which must be satisfied in the optimization procedure.

The behaviour of urban elements will be formalized by its expression in input-output fashion. Such an approach is suitable for economic units. The behaviour of social organizations could be also expressed in this fashion, if there were satisfactory--i.e. quantitative and comparative--ways of its handling and valuing. By now the behaviour of social organizations may be approached in input-output fashion in particular cases or in particular domains.

Let us now turn to the procedure of modelling. It consists of four steps. In the first step we define the two primary notions. The mode of action of individual urban elements will be expressed as a transformation of the input vector x into the output vector y

$$y = T(x) \quad . \tag{1}$$

Urban elements act and develop in an urban environment. One element receives the output of another element and uses it as its input. The transformation of the components of the output vector of one element into the components of the input vector of the other element is called coupling. The couplings

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[1] A general framework for such a modelling has been created by O. Lange [8]. The basic notions as well as mathematical operations concerning the structure and growth of systems are drawn from this book.

of element E_1 with element E_2 can be presented in matrix form:

$$C_{12} = \begin{matrix} 0\ 0\ 0\ .\ .\ .\ 1 \\ 1\ 0\ 0\ .\ .\ .\ 0 \\ 0\ 0\ 1\ .\ .\ .\ 0 \\ .\ .\ .\ .\ .\ .\ . \\ 0\ 1\ 0\ .\ .\ .\ 0 \end{matrix} \qquad (2)$$

The elements of this coupling matrix have the value 1, if the coupling takes place, and the value 0, if this is not the case. The coupling of the given element with an element preceding it in the chain of couplings is known as feedback.

Let us generalize the coupling matrix for all (N) elements constituting an urban system. It takes the form:

$$S = \begin{matrix} 0 & C_{12} & . & . & . & C_{1N} \\ C_{12} & 0 & & . & . & C_{2N} \\ . & . & . & . & . & . \\ C_{N1} & C_{N2} & . & . & . & 0 \end{matrix} \qquad (3)$$

This is a square (N x N), zero-one matrix, whose elements (submatrices) are coupling matrices of individual pairs of city elements. Since it represents the network of couplings of the system, or its structure, it is called the structure matrix of the system.

In order to be realistic we have to permit our system to maintain feedbacks and contacts with its environment. The last problem can be solved by the introduction of boundary elements of the system. These can be either output or input boundary elements. In the first case, the components of the output vector are not transformed into components of the input vector of any other element in the system. They are transferred to the environment. In the second case, the components of the input vector originate from the environment.

Feedbacks are embraced by submatrices C_{rs}, such that $s < r$. This relation defines their position in the structure matrix. If $s < r$, the submatrix C_{rs} lies below the diagonal of the structure matrix. This means that there is coupling

with an element preceding the given element in the chain of couplings.

The second step in the modelling of an urban system is the determination of its mode of action. This can be made by the combination of the effects of transformations and of couplings. For this purpose we substitute the transformation

$$y^{(r)} = T_r(x^{(r)}) \quad , \qquad (r = 1,2,\ldots,N) \tag{4}$$

into the couplings equation

$$x^{(s)} = C_{rs}\, y^{(r)} \quad , \qquad (r,s = 1,2,\ldots,N; r \neq s) \tag{5}$$

and subject the couplings equation (5) to the transformation (4). The results of such a combination follow:

$$x^{(s)} = C_{rs}\, T_r(x^{(r)}) \quad , \tag{6}$$

$$y^{(s)} = T_r\, C_{rs}(y^{(r)}) \quad . \tag{7}$$

These are transformations which assign new values of city elements to given initial values of these elements.

The above transformations can be generalized for the city system. For this purpose input and output vectors of the elements are replaced by the compound vectors of the city system. To distinguish the compound vectors expressing the new state of the inputs and outputs, their state after transformation is denoted by X' and Y', respectively. The coupling matrix C_{rs} is replaced by the structure matrix of the system S, and a diagonal matrix T is introduced, whose non-zero elements are the transformation operators of individual elements of the city.

Using these notations, the mode of action of a city system can be presented as follows

$$X' = ST(X) \quad , \tag{8}$$

$$Y' = TS(Y) \quad . \tag{9}$$

The relation between inputs and outputs in an acting system can be derived from equation (5) and written in the form

$$X' = SY \quad . \tag{10}$$

Transformations (8) and (9), may be given an interesting interpretation [8]. They give an insight into the character of the mode of action of the system. As can be seen, this mode differs from the mode of action of the elements. The latter is expressed by the transformation matrix T, whereas the former is denoted by T as well as the structure matrix S.

The difference, then, depends upon the structure matrix S which represents the network of couplings of the elements. The structure expressed by the matrix S constitutes a new property which belongs only to the system, and with which the elements are not endowed. This is a property of the system as a whole.

A system, hence, functions according to its own specific mode of action. The same set of elements with the same modes of action may form different systems, if they are coupled in a different way. A difference in the couplings network, i.e. in structure, implies a difference in the character of the system and in its mode of action.

Let us proceed now to the problem of a system of cities. We talk about the system of cities if at least one element of city U_1 is coupled with at least one element of city U_2, or vice versa. Such a pair of cities forms a new system U', i.e. a system of the second order.

Its structure matrix assumes the following form:

$$S' = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} . \tag{11}$$

The couplings of city U_1 with city U_2 are represented by submatrix S_{12}, whereas the feedbacks are represented by submatrix S_{21}. The submatrices S_{11} and S_{22} are the structure matrices of cities U_1 and U_2, respectively. The number of cities can be further enlarged.

The system of cities (the system of second order), like the city as a system, also has a new property, which cannot be derived merely from the properties of individual cities constituting its elements. This is a specific mode of action depending both on the modes of action of individual cities and on the structure of the system defined by the matrix S'.

In similar fashion, as in the case of the system of the second order U', we can build the system of the third order U".

In the third step of modelling we move from the mode of action of the urban system to the process of its growth. For this purpose the factor of time is introduced into (8) and (9) as the states of the inputs and outputs of the urban elements change.

$$X_{t+h} = ST(X_t) \quad , \tag{12}$$

$$Y_{t+h} = TS(Y_t) \quad , \tag{13}$$

where h denotes the reaction time, it is the time interval between the changes in the input of the system and a change in its output.

Writing

$$P = ST \tag{14}$$

and

$$R = TS \tag{15}$$

we obtain

$$X_{t+h} = P(X_t) \tag{16}$$

$$Y_{t+h} = R(Y_t) \quad . \tag{17}$$

Equations (16) and (17) determine the changes in the state of inputs and outputs of the urban system occurring in time. They establish the relation between the state of the system at the initial moment t and the state after reaction time at the moment t+h. They are called the law of motion of the system.

As can be seen, the law of motion of the system assumes the form of vectorial difference equations. Solution of these equations yields the process of growth of the system.

In deriving the systems law of motion we assumed that the process is sudden. Under this assumption, a certain time after the change in the input state occurs a single change in the output state. But the process may be gradual and proceed discretely or continuously. Let the process under consideration be gradual and discrete. Its law of motion takes the form

$$X_{t_1} = \sum_{t=0}^{h} P(X_{t_1-t}, t) \tag{18}$$

where t_1-t = initial time (elsewhere t_0), t_1 = terminal time, t = the length of time changing in the course of reaction, not greater than the longest reaction time. If the process is gradual and continuous, then

$$X_{t_1} = \int_0^h P(X_{t_1-t}, t)\, dt \quad . \tag{19}$$

The fourth and last step in modelling of our systems relies upon the control of the process of growth. The control is undertaken with intent to optimize the process of growth of the system.

It is performed by the choices of suitable values of control variables. In economic problems these variables are usually the allocations of scarce resources (typically in the form of investments). Thus, they cannot assume arbitrary values but are subject to certain constraints.

By suitable choices of the time path for the control variables $U(t)$ from the set of admissible controls V, alternative courses of the process can be achieved. In case of economic processes there is usually a possibility of valuing alternative courses. For this purpose a dynamic objective function (objective functional) should be established and accepted as a criterion for judging economic growth and choosing the optimal growth path. It is frequently the amount of consumption which must be maximized during the process of growth.

In addition to the maximization of consumption or other magnitude, the objective functional may be assigned a value of the state achieved at the end of process

$$F(X_1, t_1) \quad . \tag{20}$$

In this way the decision maker ensures the basis for future growth.[2]

The general model of the optimal control of complex urban systems, in case of gradual and continuous processes, assumes the form

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[2]For further discussion of optimal control theory, see L.S. Pontryagin et al. [9]. K.J. Arrow, M. Kurz [1], and M.D. Intriligator [5] apply it in the discussion of economic problems. R. Kulikowski elaborated the model of optimal control of large-scale systems [7], and A. Straszak the model of hierarchical control of environment, development and resources [17].

$$\max_{\{U(t)\}} J = \int_{t_0}^{t_1} f_0(X(t),U(t),t(dt + F)X_1,t_1)$$

$$\dot{X} = P(X(t),U(t),t) \quad , \quad P = ST$$

$$X(t_0) = X_0 \qquad (21)$$

$$X(t_1) = X_1$$

$$\{U(t)\}\varepsilon V \ .$$

The procedure of modelling presented in this paper may be regarded merely as the first approximation to the processes of interaction, growth, and optimal control of complex urban systems. Many problems arise when we approach these processes more concretely and think about the applicability of the modelling as a tool of planning and decision making.

What are the directions of desirable extensions of the general model? One of them is the inclusion of the concept of basic and service sectors (exogeneous and endogeneous sectors). The city is a heterogeneous system. The variety of its elements can be ordered in many ways. The division into basic and service sector is certainly one of the most meaningful. The functions of these sectors are different, and this fact carries consequences in the sphere of financing, investment, organization, and management.

Both sectors determine the welfare of city population. The basic sector mainly by job creating activities, and the service sector by delivering housing, services, and recreation.

The municipal as well as central government are often considering strategies which would increase the welfare of the city population in the long term. They try to answer the question, for instance, what allocation of investment could achieve this goal? What funds should be invested in exporting, job creating industries and what in services of public goods? Both types of investment exert influence on the level of welfare, although not in the same way. Hence, the allocation problem is not insignificant.

The extension of the general model in the case of two-sector urban system requires some reformulations. The objective functional changes and assumes the form

$$\max W = \int_{t_0}^{t_1} e^{-\delta(t-t_0)}\left[c(t),k_s(t)\right] dt + F\left[k_b(t_1),k_s(t_1)\right] . \qquad (22)$$

It integrates all instantaneous contributions to the welfare derived from the consumption as well as from the service sector trajectory over the relevant time interval from t_0 to t_1. The future welfare at different times is discounted relative to the present to allow for the fact that present consumption and services are preferred to future. It also assigns a value to the final state of capital in the basic and service sectors.

The law of motion derived from the behaviour of one-sector economy states, in per-worker terms, that the time rate of change of the capital, $k(t)$, depends on the output, $f(k(t))$, maintenance of the level of capital, $\lambda k(t)$, and consumption, $c(t)$. In our two-sector system the output depends on the capital of both the basic and service sectors. The term $f(k(t))$, then, is replaced by $f[k_b(t),k_s(t)]$ to form a modified law of motion

$$\dot{k}(t) = f[k_b(t),k_s(t)] - \lambda k(t) - c(t) \quad . \tag{23}$$

Under the assumption that transferability of capital between sectors exists, we may total up the capital of both sectors to obtain one state variable

$$k(t_0) = k_0 \tag{24}$$

$$k(t_1) \geq k_1 \quad . \tag{25}$$

The decision maker may choose different levels of capital in the basic and service sectors. Hence, $k_b(t)$ and $k_s(t)$ on a par with $c(t)$ constitute the control variables. The time paths (trajectories) of these variables are chosen so as to maximize the objective functional.[3]

The two-sector model requires further extension. In the form developed so far it characterizes a closed system. Therefore, it can be used for the consideration of a limited class of problems.

The drawback peculiar to the model of a closed system can be partly overcome. Namely, it is possible to include a discontinuous change in one or more state variables. Such jumps in the state variables may express a large appropriation or subsidy received by the system from the central budget to spur the growth of the basic or service sector. The transfer of capital from the system might be expressed by negative changes.

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[3]For further discussion of the optimal growth of two-sector economy, see K.J. Arrow and M. Kurz [1].

The problem of control systems with jumps in the state variables is discussed by K. Vind [12]. More relevant approach, however, is to posit the open character of urban systems as a starting point and basic assumption. H. Ryder applied a similar approach in his work on optimal accumulation and trade in an open economy of moderate size [10].

The open character of the city comes forth when one considers its territorial expansion. The process of the spread of urban services, commodities, capital, and way of life is one of the most significant features of modern times. Modelling of this process may help to derive a deeper insight into the interactions underlying phenomena recorded by statistics and presented by cartography.

An interesting attempt in this direction has been made by W. Isard [6]. His work reveals the complexity of the problem and methods required. I will limit myself to the presentation of the simplest model.

The problem under consideration concerns development over time and space, where the development is sparked by a technological advance. Some notion about how the production, consumption and productive stock grow over time and space underlies the model. Assumed over time are: a) positive additions to the productive stock of plant and equipment for any location at which the stock is non-zero, and b) a spatial spread of this stock, and its fall off with distance from the initial location at which the advance is generated.

The structure of the model follows:

1. The production function at each space-time point (x,t)

$$Y(x,t) = bK(x,t) \ , \tag{26}$$

where K(x,t) is the capital per unit length at (x,t), b is a positive constant having dimensions of $\frac{1}{\text{time}}$, and Y(x,t) is the output per unit length per unit time.

2. It is posited that imports, (I(x,t)), and exports, (E(x,t)), of capital are the only flows.

3. The basic consumption equation

$$C(x,t) = bK(x,t) - \dot{K}(x,t) - p\hat{K}(x,t) \ , \tag{27}$$

where C(x,t) is consumption per unit length per unit time,

$\dot{K}(x,t)$ is investment, taken to be identical with the time rate of change of capital, $p\hat{K}(x,t)$ is the balance of the transfer of capital.

4. The objective is to determine the space-time pattern of capital stock K, so as to maximize welfare

$$\max W = \int_0^{\infty} \int_0^{t_1} C(x,t)\, dx\, dt \quad . \tag{28}$$

Territorial expansion is only one of the factors of use of the environment gathering momentum in the process of urban growth. The other is water and air pollution. The quality of environment exerts influence on social welfare. Therefore, the society controls the interactions between socio-economic activity and environment.

How can the problem of environmental pollution be included into the model of urban growth? We can refer to an attempt made by G.R. Walter [13]. It is concerned with the optimal level of air pollution for a city.

The city is characterized by the state variables K and R, where K denotes a stock of productive capital, to which emissions resulting from production are attributable, and R denotes a stock of pollution existing at a point in time. The industry located in the city causes a flow of emissions G. There are two types of consumption goods: good Y polluting in consumption, and good X not polluting. The flow of consumer emissions (per capita) is V. The emissions associated with capital K are abated by a flow of good Z (anti-pollution devices), and the emissions associated with good Y by a flow of good A. The labor force is posited as a proxy for population and denoted by L. (Per capita magnitudes are represented by lower-case letters, except of V which is per capita by definition.)

The change of pollution per unit time, $\dot{R}$, is determined by the emissions V and G, reduced by natural decay, whose rate applied to the stock of pollution is n. The time rate of change of capital $\dot{K}$ depends on investment I, and on the depreciation of capital, μK. The above is stated in the equations of motion.

The control variables are: y, x, a, Z, I, and L. By the manipulation of these variables a socially best time path of stock of pollution and productive capital may be obtained.

The objective functional expresses the welfare accruing to the city through consumption of good X and Y, diminished by the disutility D(R)L suffered by the community.

These can be written concisely

$$\max W = \int_0^{\infty} e^{-\delta(t-t_0)} \left[C(x,y) - D(R)L\right] dt \qquad (29)$$

subject to

$$\dot{R} = V(y,a)L + G(K,Z) - nR \qquad (30)$$

$$\dot{K} = I - \mu K \quad . \qquad (31)$$

We suggested four desirable extensions of the general model. They start from four additional assumptions. These are: discrimination of basic and service sector, open character of urban systems, territorial expansion over time, and pollution of the environment.

Of course, these are only examples; however, their choice is not accidental. Their common feature is that they lean on the same method. Further work in this direction might lead to a system of models of dynamic optimization of urban systems.

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Discussion

One of the participants asked what data would be required if ten cities in ten different countries were to apply the model presented. Mr. Domanski replied that one would need all economic inputs and outputs, investments, depreciation rates, rate of population growth, and information on pollution stocks, all in dollar units. Someone else asked where the various functions, V,G,D, come from; they could not simply be taken from the data. Mr. Domanski replied that V is a utility function which in principle one could establish empirically, although he had not done so. The speaker questioned the value of a model which could not be applied.

Mr. Rousselot asked whether Mr. Domanski intended to produce methodological or theoretical work of use in practical work or to produce specific decision making tools. Mr. Domanski replied that both are his object. The literature an optimal economic growth, on pollution, on the environment, is growing rapidly. There is a need for new techniques and devices for dealing with these problems. The advantage of his conception is that it is general enough so that it can be applied in different countries. Of course, this generality also has drawbacks.

One of the participants asked how the various matrices and functions are specified. The problem is to express the transformation functions and structural matrices. Mr. Domanski replied that the structural matrix generalizes the coupling matrix C_{12} for example is the coupling of two elements, such as two industrial plants with respect to water supply. Each matrix element represents delivery to and from various components. The questioner noted that the urban system is not unambiguous; there are subjective designations. Mr. Domanski said that he did not know of any worked out empirical examples, for example, with structural matrices specified.

Someone else noted that the discussion of the equations of motion appeared to assume that one could go easily from the static input-output matrix to the dynamic case. One would have thought that time lags, for example, would vary depending upon precisely what processes were involved. The equation $Y_{t + \Delta t} = T(X_t)$ seems to assume that all relationships are of the same order and have the same critical time lag. Mr. Domanski responded that the work so far is based on Markov chains with laws of motion set as functions of time. When the initial time is determined, one can determine the state of the system at the next moment in time. He has not yet worried about order

or type of function; he has just assumed that this approach is possible. The questioner offered a simple example. If one simplifies the chain, farm, warehouse, retailer, consumer, by omitting the warehouse and the retailer, one gets a first instead of third order relationship and misses intermediate changes.

One of the participants suggested that what one really should consider are the technological coefficients of processes. He asked a different question. How is the difficulty of establishing evaluation functions, especially for services and for environmental effects, overcome? Mr. Domanski said that this question has the same answer; he has not yet considered the practical problems. At this stage all of the work has been on theory; the data enters at the next stage. Mr. Rousselot asked whether there is an intention to go from theory to application. Mr. Domanski replied that it depended in part upon the outcome of the discussion.

One participant remarked that he had understood that Mr. Domanski's model was deterministic. It was unclear to him that that should be the case. He asked where in the model was there room for that conflict--between objectives, between groups--that characterizes urban development. Mr. Domanski replied that of course he was aware of the research being done on stochastic processes but felt that deterministic models were more suitable.

Mr. Raiffa interjected that, although he does not know the literature in non-market economies very well, this type of modelling is very popular in the United States. The claim is that it gives a framework for better understanding complex and interactive phenomena. The question is whether IIASA should work in this field. Is enough already being done elsewhere? He noted that he could see reasons for developing mathematical models beyond simply their elegance; they can aid deeper understanding, predictions and forecasts, data collection, and decision making. However, is this an appropriate initial activity for IIASA?

Mr. Domanski replied that the field is young and contains many problems. In particular, the open character of these systems has not been satisfactorily explored. One must examine whether all of the drawbacks of the approach have been removed. If they have not, then it is a fruitful field for research, especially for its urban applications.

Another participant suggested that the discussion of what IIASA should do should lie at the somewhat abstract level of, for example, stochastic versus non-stochastic approaches, rather than at the more specific level of coupling matrices.

Mr. Rousselot said that the discussion would return to such questions later. He noted that Mr. Domanski had raised the suggestion that IIASA undertake theoretical work which might be coupled with urban problems.

Models of Urban Land Use in the USA

F. deLeeuw

(Note: Mr. deLeeuw spoke from notes rather than from a written paper. The following outline is taken from those notes.)

I. Introduction: "State of the Art" summary; land use is one important area of urban research in the USA.

   A. Presentation will discuss 3 models: Lowry, EMPIRIC, Urban Institute Housing.

      1. The first two are representative of a class of land use models of the 1960's focusing on transportation needs (support too). They are the only two actually used; on the whole, the others are not typical, not "best" representatives.

      2. The Urban Institute model is representative of more recent focus on housing and land use policies. Work on it is in progress.

      3. All three models are empirical (in contrast to purely theoretical models). All are urban, rather than regional, models.

      4. All three models reflect the capitalist nature of the USA--that is, the system of private contracts between buyer and seller, or between owner and user of land. The system is constrained by using a system of private contracts. But all are models of a capitalist land market.

   B. What we will say about each model:

      1. How it works.

      2. What the main ideas about behavior are.

      3. How the model represents four important characteristics of the system of land use, at least in the USA.

         a. Multiple markets

            i. There are many different users and

different parcels of land.

ii. We care about who gets what--whole detailed set of outcomes.

iii. This contrasts, for example, with potatoes as a commodity (the question of degree of aggregation of the market).

b. Durability - Buildings last a long time (people are reluctant to move--this is less important). Past decisions influence present outcomes heavily for land use.

c. "Neighbourhood effects" (externalities) - For example, people care about who their neighbors are and about how accessible certain services are. Formally, each participant looks at detailed outcome in making his decision. In classical economic markets, "the" price summarizes all this. The household cares about neighborhood characteristics as well as about price and physical quantity. All this leads to complex models, to non-unique solutions.

d. Multiple policy channels

i. These channels include taxes, subsidies, construction standards, zoning.

ii. The USA has little direct public building; the private market is subject to public constraints.

4. I would like to say how good each model is. But as we will see, we do not know. Some remarks about use.

II. The Lowry Model

A. How it works

1. It describes location of people around places of employment and of "service" employment around people.

2. Employment is distributed between "service"--e.g. stores, banks (serve local population) and "basic" --e.g. manufacturers, corporation offices (serve a wider population).

3. It takes the "basic" employment location as given. Then it simultaneously solves for service employment location and for household location.

4. There are two fundamental behavioral reslations; both are relations between location and distance.

   a. Households working in "A" spread around A as a decreasing function of distance from A

$$\left[\frac{\partial h}{\partial d} = ad^{-x}\right]$$

   b. Service employment serving population in "A" spread around A as a function of distance, e.g.

$$s = (a + bd - cd^2)$$

5. Each of these is applied to each pair of locations. There are 100 or more locations in the area. Three identities close the system

$$E_j = E_{bj} + E_{sj}$$
$$Es_j = \sum e_{ij}$$
$$N_j = \sum n_{ij}$$

6. Extensions - Constraints are: minimum E_j^s, maximum N_j, several kinds of service, "distance" in time related to highways, etc.

B. Behavioral ideas

1. Transportation is costly, hence clustering occurs.

2. The demand for services is proportional to population.

C. Four characteristics of the model

1. Multiple market, though not explicit price system.

2. Durability is not taken into account. The model creates an "instant city."

3. Neighborhood effects are not taken into account.

4. Two policy channels. E^b location and policies affecting "distance"; not taxes, income changes, zoning, many others.

D. The model is not used in the original place (Pittsburgh), but has been tried many places, especially in the United Kingdom.

III. EMPIRIC Model

A. The basic focus is change over time in the location of several kinds of employment and of several kinds of household.

1. Employment: by industry group
   Household: by zone

2. Each of 100+ zones has given exogenous characteristics in period "t".

   a. Several weighted accessibility measures, by mode.

   b. Sewer and water availability.

   c. Availability of developable land.

3. Since it is a model of changes, outcomes in period "t-i" are also exogenous.

B. The model.

Δy_j^i = change during some time interval in share of activity "i" in zone j.

$$f\left(x_j^1,\ x_j^2,\ \ldots\ y_j^1,\ y_j^2,\ \ldots\ \Delta y_j^1,\ \Delta y_j^2\ \ldots\right)$$
$$i \qquad -1 \quad -1$$

e.g. Δy_j^i depends on exogenous character of j, on past activities in j, on current changes in other activities in j.

C. Ideas about the model: everything depends on everything else. Criticism: it is purely an empirical exercise, weak in theory. "Implausible" results are discarded.

D. Evaluation - The model meets all four criteria in principle:

simultaneous - 2 SLS (two stage least squares)

durable - Δ's (changes)

neighborhood - Δy_j^1 (uses)

policy - x's.

E. Uses: several US and one Canadian application, some in operation. There are no cross-application comparisons.

IV. Urban Institute Housing Model (I work on this model.)

A. Focus is on 10-year change in housing quality and location within an urban area.

1. Household and dwelling are represented by "model" household and dwelling--30 or 40 of each. They search, bargain, reach solution. It resembles a game.

2. Residential use only; measures are reflected only in accessibility measure.

3. Exogenous variables include:

a. each "model" dwelling--initial Q, zone (4 - 6; small number)

b. each "model" household--family type, race, income

c. costs--of operation, capital costs, and new-construction costs

d. accessibility--average travel time to work by zone.

B. The model.

$$U_{ij} = f\left(Q_j, Y_i - P_i Q_j, T_j, W_j, R_j\right),$$

where

U_{ij} is a utility,

Q_j is quantity of housing per month,

Y_i is income,

P_i is price per unit of housing,

T_j is travel time,

W_j is wealth of zone, and

R_j is race of zone.

Each evaluates U_{ij} for every j (including new), and maximizes.

$$Q_j = g\left(P_j, P_o, P_c, Q_o\right)$$

Each dwelling has a supply curve; higher $\frac{P - P_o}{P_c}$, more Q_j position depends on Q_o. New construction available any Q at $P_n = P_o + P_c$.

(Zone of new construction--artifact)
Government can set minimum Q by zone, subsidize P, redistribute Y, etc.

C. Theory: the model contains four ideas.

1. Budget choice between housing and other goods (Y, P).

2. Transportation costs time.

3. Attraction to wealthy area, racial similarity.

4. Supply: distribute between supply of new and existing housing (the latter is harder to alter, but can be cheaper).

D. Evaluation: the model meets all four characteristics.

E. The model is fit to solutions for four areas by a complex process of trial and error. Many of the nine parameters are similar, and a few are different.

1. The model is restricted to residential use alone.

2. There are possible multiple solutions--true in reality, faced here.

3. It is hard to expand the number of households, zones, etc.

V. Conclusions.

A. None of these models are working tools yet. It is impossible to say whether we are 10% or 90% of the way to having policy making tools. We can only work on hunches, intuition.

B. I can mention three areas that seem to me ripe for further work.

1. Multiple solution problem. Theoretical exploration should give insight into problems of city planning.

2. Systematic cross-city empirical work. Fit the same model to many places and compare results. See if (a) fits (b) same parameters. This would help discard worthless features.

3. Explore "normative" implications of models. (Given certain goals what is desirable or undesirable, contrasted to what happens or does not happen.) This is not yet a guide to useful policies but would reveal what needs to be added to models and what needs closest attention to make the models useful tools.

Discussion

Someone stated that if one doesn't define "system," then it can be anything the analyst wants and one cannot have a sciences. Any discipline can enter. One of the results is a push towards large models. This has bred disenchantment because of the excess data, the errors, and the inadequate output for day-to-day decision making. Our theories are inadequate for the elaboration of large models. One gets the illusion of writing sciences rather than science. Mr. ddeLeeuw disagreed, noting that he and the speaker come from different traditions and that there was not enough time then to discuss their differences.

One of the participants asked whether exogenous inputs entered the dynamic model during the course of its run. Mr. deLeeuw replied that it is a model of ten year changes. Each decade can contribute inputs to the following one. Demand is specified for the end of the ten year period. The model tells you how the structure will change over the ten years to accomodate the demand.

Someone else noted that the Lowry model is deterministic and asked whether or not the Urban Institute model is. Mr. deLeeuw said that it is probabilistic in the sense of allowing for stochastic differences between actual and forecast outcomes. It is deterministic in the sense that each household examines all alternatives and chooses so as to maximize its utility. The questioner inquired how the time of moves is generated. If there are not enough dwellings to satisfy everyone, the solution depends upon the time generation of demand. Mr. deLeeuw agreed but felt that this could be done within a deterministic framework.

Mr. Raiffa asked whether Mr. deLeeuw had thought about the transferability of these models to non-market economies. Mr. deLeeuw responded that he had only given this a little thought and would appreciate reactions on that point. Mr. Raiffa said that this point is related to the question of what IIASA should study. He could see the appeal of such work for the market economies but wondered what part of it would be transferable to the non-market countries. He asked whether similar models exist in these countries. He went on to remark that the question of the stability of solution configurations relates to the Canadian proposals and to the problems of equilibrium states and resiliency which will be included in the IIASA project on ecological systems. At the cross-cultural level, one could look for statistical invariances between cities across national boundaries. Such

a survey might be useful before IIASA undertook the other project in-house.

One of the participants remarked that, especially from his viewpoint in an economy more mixed than that of the United States, multiple solutions definitely exist. They represent different externalities. A model showing them is valuable as it shows what are the possibilities available with only a fairly small governmental push. Mr. deLeeuw interjected that this is the theory of urban renewal. The other participant went on to say that the examination of alternative solutions and their externalities in different market situations could be profitable. One question is the extent to which multiple solutions exist in socialist economies. He suspected that they are independent of the assumption of capitalism but are inherent in the situation and in individual's utility functions. One possible line of research is to examine what multiple solutions exist after abstracting away from the market. This requires looking at value judgements and behavior in different systems.

Someone else noted that a major question in all of these models is the type of technology taken into account as a constraint. Is it today's? One must be aware of the very long lead times required for implementing new technologies. Thus, it may be valuable to include the type of technology as an explicit variable. Apparently minor events can produce instability and great consequences; thus technological assessment is important. This may be a good cross-cutting theme for IIASA, especially since the purpose of IIASA is to assess systems problems and to identify problems in advance. Mr. deLeeuw agreed with these remarks, stating that his model embodies the current state of technology. One could introduce technological changes into the model by changing the supply functions. Mr. Rousselot pointed out that, moreover, this model is short range; it covers only ten years.

Another participant noted that in this model the transportation network is an input and land use is an output. Transportation specialists usually proceed in the converse manner. One question is how to combine these two approaches; this might be a fruitful field for IIASA research. Mr. deLeeuw confirmed that his model takes the transport system as given. However, one could add or subtract highways or subways in such a model to examine the effects of transportation changes. The model does not try to explain changes in the transportation system.

Someone else remarked that although he liked the model's stress on behavioral ideas he felt uneasy about them. For example, the work of Matelon and Poincard has indicated that the utility functions people actually use for decisions change over time. It is difficult to build an aggregate

model from disaggregate behavior. Also, although a distinction between market and non-market economies had been mentioned, it is unclear in what it consists. For example, profit to builders is very complicated and is a function of, among other things, financial markets. The speaker urged that such important points be made very explicit.

Another participant suggested that land-use models would not be an ideal area for IIASA work. They tend to be more retrospective than forward looking and furthermore are not very transferable between countries. As for the land use and transportation interaction, in his country work on each is done with a rough sketch of the other. One gets more detail through several iterations.

Mr. Rousselot said that his own view was that after reflection upon these models IIASA might well decide to study the behavioral questions rather than try to transfer models.

The Rand Corporation Research Program on Delivery of Municipal Services in New York City

P. Kolesar

(Mr. Kolesar spoke from notes rather than from a written paper. The following summary was prepared from his oral presentation.)

Mr. Kolesar explained that New York City is a direct client of the New York City Rand Institute. Thus, although the Institute does work on longer term planning problems, it concentrates on immediate operating problems including law enforcement, fire protection, hospital services, and housing.

The fire project is one of the oldest. It deals with a simple physical problem; firemen are sent to extinguish fires which occur randomly time and space. The Institute researchers are studying how best to organize, deploy, and use the fire fighting resources of a city. However, even this simple process has proved difficult to model. The motivation for the project arises from the great increase over the last decade in costs and number of fires and false alarms which have had to be met with fixed resources:

1962	1972
100,000 fires	250,000 fires
330 fire companies	330 fire companies
$150 million budget	$350 million budget

A successful attack on the fire problem could free resources for other even more important needs. The city's initial question was whether it had the "right" resources located in the "best" (most efficient, most equitable) way.

The five to ten member project team was composed almost entirely of physical scientists, computer experts, and mathematicians. At the beginning they did not understand the system or the possible means of affecting it. In order to gain an understanding they built a complex simulation model of fire fighting operations. The model, detailed down to individual fire engines, moves these companies on a

computerized map graphically locating companies and fires. Using the model it was possible to test alternative communications and control methods, including location and dispatching strategies. For the previous decade the fire department had been collecting detailed data on every alarm; they had one million cases on file. This data greatly facilitated setting up the model.

At first the team was unsure what to do with its model. One of the goals was to learn enough from it to replace it with simpler models. Moreover, the team was sure that one useful experiment would be to vary the number of companies. Finally, the team focused on simulating experiments for development of two kinds of analytic models: a queuing model, and a response distance and time model. The first assessed random demand and measured the effectiveness of the sewers in terms of delays in responses. For this the team built a new queuing model incorporating the fact that at each fire there are a multiple number of sewers working for different periods of time. The model was tested with the simulation and then used alone. The response distance and time, or travel, model incorporated both parts of delay: time for processing the alarm and time en route. This study led to the hypothesis that average distance is proportional to the square root of the density of five companies. This was verified by experiments with the simulation model.

The next step was to conduct empirical experiments. Only limited experiments are are possible because of risks to life and property from reduction in fire protection and because of the costs of an increase. However, the experiments that have been done supported the model. Up to this point the model was purely descriptive.

At the next stage a prescriptive element was added. From the beginning it was clear that computerization of dispatching would provide efficiency increases equivalent to an increase of twenty-five companies. Thus the focus was on development of models to make or assist in making dispatching decisions, that is, deciding what engines should go to which fire and what adjustments should be made in case of emergencies. The prescriptive model uses linear programming techniques. Since what is wanted is not so much optimization as development of plans generally accepted as good, "robust optimality" was sought using a series of integer programs with different objective functions. One goal was to provide a "fair " standard of protection to every part of the city. A fast algorithm has been developed which, with a small computer, can provide immediate answers. The model has also been used for long-range planning to estimate, for a given number of

five companies and expected number of alarms, the probabilities of adequate response times and of having a sufficient number of engines.

The Rand Institute has worked in other areas as well, such as

- Improved delivery of services (Fire, Police, Sanitation)
- Economics of the New York City housing market
- Water pollution
- Operations of the New York City hospital system
- Operations of the New York City Welfare system.

It has used similar methodologies for studies of fire, police, and sanitation services. A group led by Lowry has studied the economics of New York City public and private housing markets. A small water pollution project is using computer simulations of tidal flows in shallow estuaries to determine the effect of installing sewage-disposal facilities on Jamaica Bay. Finally, the Institute has studied aspects of the City hospital system: required system size (number of beds), utilization of nursing staff, and provision of emergency care.

The fire study did have an impact. As of November 1972 both the response policy and the location of seventeen fire engines were changed. The day after these changes, the firemen's union filed a suit in court. The Rand Institute is using the models to generate counter-arguments.

Discussion

One participant began by recounting a story he had been hearing although he thought it must be untrue. A study group in New York City had investigated sewerage and garbage treatment there and had decided that there should be larger trucks for removals. However, introduction of the larger trucks did not affect performance, as the drivers only loaded the cars half full so as to have an equal number of trips and, hence, an equal number of coffee breaks. On the second try, a weighing procedure was introduced. At first the system improved, but then again there were an equal number of trips. The drivers were taking on water for half of the weight. The point is how complex reality is. Models and optimization are one thing; behavior and conflicts are another. Mr. Kolesar mentioned the problem with unions in his fire protection study. Are the right categories being used here? Or are other categories required to describe conflict situations? Perhaps IIASA should work on the identification of proper categories for dealing with these problems and systems. Mr. Miller had developed categories for living systems; we require such an approach for all systems.

In response, Mr. Kolesar first confirmed that the story is true. He then pointed out that analysis is never a substitute for management and for responsible behavior. His own reaction was that one must be sensitive to such issues at the outset and throughout the study, but they cannot be modeled. One must do what one knows how to do and model physical and economic relationships.

Someone else mentioned that a press story on the fire protection study had reported that RAND had found a response time of eleven minutes. He asked whether this was a mean or maximum time and whether it had changed since last November. So far, the only visible output of the analysis is the court trial. Mr. Kolesar replied that the eleven minute figure applied to extreme circumstances inaparticular part of the city. One of the project tasks was to reorganize that part of the city to lower this response time. In general, it takes three minutes from receipt of an alarm to arrival on the scene. The changes stemming from the analysis have resulted in marginal improvement and better balance across the city; standards have been equalized.

Another participant acknowledged the importance of what Kolesar's group had done but questioned the amount of potential for innovation in it. Such problems seemed one-dimensional with solution methods given by classical operations research. He felt IIASA should instead work on more complex problems. Mr. Kolesar responded to this question by

saying that the level of complexity and abstraction one attacks is a matter of taste. He favors a mixed approach. Also, he did not want to leave the impression that the fire study was simple. It looks clear now but did not five years and two million dollars ago. The point is that if this problem required so much effort, other problems will require that much more.

Mr. Rousselot said that he had a closely related question. He recalled that when he spoke to Mr. Kolesar in New York, the latter thought it would be difficult to transfer the results and methods of New York to other countries and cities. Perhaps the means of effecting such transfers would be a good field for IIASA study. Secondly, the originality of the work in New York comes in large part from the close relationship between the decision makers and the analysts. This itself is an interesting situation to study since the relationship is not usually so clear.

Mr. Kolesar felt that this question of "transferability" was difficult. First of all, what other city has a budget of $300,000 for fire protection? Perhaps the research method, though, is transferable. There is work at MIT on spatial services in cities operating under random demands. IIASA might tackle some of the methodological problems; for example, the fire project brought to light new problems in queuing theory and integer programming. His group did not have the luxury of spending time on these aspects. Another possible aspect to study is the decision maker/analyst relationship; perhaps it could be generalized. From experience, it seemed that the best results came when the decision maker had a vested interest in the project from an early stage, especially if he identified the development of his career with the success of the project. For the analyst to encourage this, he must have credibility.

One participant said that there is an attempt currently to transfer some United States models to his country. He acknowledged that the RAND group had a good relationship with the managers, but asked whether any representatives of the fire union had worked with the group. Mr. Kolesar said there had been none, and that shortcoming was a lesson learned from the project. The researchers are now trying to involve the police union from the outset, although so far this has not been successful.

Control of Development and Functioning of Towns and Conurbations

G. Fomin

Professor Fomin orally presented the main ideas contained in the paper prepared by the USSR delegation, "Study Programme for the Problem Control of Development and Functioning of Towns and Conurbations." This paper appears in part in the section of these proceedings on "National Research on Urban and Regional Systems." The remaining section of this paper appears in full in the section entitled "National Proposals for IIASA Research in Urban and Regional Systems."

Discussion

One participant made several observations. First, there is a large research program in the United States on seismic phenomena and the design of buildings. It would be easy for IIASA to organize a conference or communications program in this field. Secondly, there has been much research but little application of methodologies for the optimization of mass services. A conference geared towards summarizing existing knowledge in this area would be very useful. Third, and most importantly, the speaker asked Mr. Fomin whether he intended to say that there should be not independent research at IIASA. This participant felt that the most attractive aspect of IIASA was that great minds from all nations could come to work together in an independent and free manner. Although he favored an organizing, coordinating, and information disbursing role for IIASA, he would be discouraged if there were no in-house research. Mr. Fomin replied that his remarks were not meant to exclude individual research at IIASA. However, he thinks that the results most useful for most countries would come from the other research.

Another participant commented that the three functions specified by Fomin were central to IIASA; the question is how best to perform them. Clearly an international group like IIASA should coordinate and exchange information; no one else is doing it. But how could IIASA best fulfill this role? Those whose job it is to coordinate are least able to do so. Scientists do not want to be coordinated, especially not by coordinators. Scientific development moves by national networks which keep in touch without coordination. Similar international mechanisms do not yet exist. In the opinion of this participant, IIASA, by bringing together scientists for projects, will create coordination without explicitly intending to. When co-workers return home, networks will have been formed. IIASA's research contributions will necessarily be small; however, this research can establish connections and communication. Mr. Rousselot suggested that perhaps the speaker was suggesting cooperation more than coordination as the role of IIASA.

Mr. Fomin remarked that when he spoke of coordination he did not mean to limit the ways of achieving it. Clearly, there are many ways. Joint work programs are one of these. The efficient use of scientific resources and research institutions would dictate that the more facilities a country has, the more topics and themes it could cover. The efficient and rational distribution of scientific effort is what is meant by coordination. The USSR experience indicates that such an approach is worthwhile.

Mr. Raiffa thanked Mr. Fomin for the prodigious amount of work his group had done. The success, or lack of it, of IIASA will be a function of the coordination efforts within the various nations. He commented that throughout all of the conferences, a recurring theme had been that IIASA should maintain a catalogue of all research being conducted. He said he hoped such a task would not be too consuming of the time of IIASA's talent. The circulation of information as an obligation of IIASA had also been discussed. At the energy conference it was suggested that IIASA might be a "sophisticated clearing-house," not just a post-office that collected information and mailed it back, but a body that organized it. Each research area has the obligation, as a form of annual accountability to the public, to publish its results. IIASA documentation policy is currently being formulated. There will be an IIASA monograph series and perhaps IIASA journals; IIASA scholars will be encouraged to publish in the open literature as well. Reports will be signed, and will represent their authors' opinions rather than IIASA positions.

Mr. Raiffa went on to say that he personally felt that it would be good for IIASA to sponsor international seminars. Baden has facilities for large conferences. However, any conferences should be well-planned with in-house experts to structure problems and to get good people to attend the meetings. The notion of IIASA organizing consultative meetings of international experts also arose in the water resources conference. There it was suggested that IIASA convene panels to do post-analysis or retrospective studies of recently completed large scale analyses. Mr. Raiffa said that he thought that this was a good idea and consistent with Mr. Fomin's proposals. Moreover, once IIASA has some experience with such analyses, it could invite persons currently working on problems to use IIASA panels as critical sounding boards on what they should be doing. He said he saw no ideological or philosophical problems with any of these approaches; the only problem might be manpower. However, IIASA can supplement its budget and personnel from outside, for example, from the national member organizations.

Finally, while IIASA has an obligation as a coordinator and information disseminator, it also has an obligation to bring experts together to interact. Much of the know-how of analysis is not in the literature. This is especially true of the thought processes involved; these are not in the literature and require proximity to be learned. In addition to its obligation to coordinate information, IIASA must provide the atmosphere of an institute of advanced study to facilitate the communication and learning of thought processes. The question is how much weight to give these two different roles. The answer depends critically on the level of available manpower. To be candid, Mr. Raiffa said, he began his tenure with the idea of IIASA scholars undertaking more basic research.

However, as he saw the problems, he was coming closer to accepting the role of sophisticated information exchange. He ended with the hope that the next day he would get concrete ideas for implementing this type of work.

Mr. Rousselot said that he had some questions along the same line. There seemed to be general agreement on the orientation and main lines of IIASA work. Now there were questions more directly related to the municipal project. First, the agenda in the USSR document was quite large; a program for the first year must be chosen. Mr. Rousselot asked if, in Mr. Fomin's opinion, should priority be given to scientific discussions and exchanges on large models, such as those of regions or cities as wholes, or rather to smaller models such as those discussed in the morning session, e.g. models of housing, transportation, fire protection? In some countries there is disenchantment with large models. Smaller ones are preferred for being closer to the actual decision process and to real behaviour. What was Mr. Fomin's view? Secondly, what are the domains in which current USSR research is most advanced, in which first results are almost ready, and hence which might be most fruitful for cooperation and discussion. Third, interesting IIASA projects could come not only from coordinating existing work but also by starting its own in-house efforts, particularly on methodological problems. In the urban field, there are great cross-country differences. These cannot be escaped except by focusing on methodological rather than practical problems. In the urban field, there are great cross-country differences. These cannot be escaped except by focusing on methodological rather than practical problems. Thus, Mr. Rousselot said he agreed with Mr. Fomin's focus.

Mr. Fomin responded that he fully agreed with the last point. In international research, theory and methodological cooperation must come first, although this does not eliminate the desirability of getting to know the concrete results of developments in different problems. With respect to the first question, Mr. Fomin said that, frankly, he would like both large and small models. In the first field, i.e. control of development, priority should be placed on large scale analyses for the optimal solution of major problems. For the control of town and region functioning, smaller models on specific subsystems should have priority. This might include, for example, models for optimization of transportation flows or medical aid. Finally, in response to the remaining point, Mr. Fomin said that the best results in the USSR are being obtained in the fields of global problems in regional development and of general planning schemes based on present technology with objectives based on the human population.

One of the participants agreed with Fomin with respect to the role of IIASA in information coordination. Its primary job is to generate bilateral contacts independent of the problem areas. It can do this reasonably quickly by forming experts panels working together on narrowly defined topics. They could begin by attempting to discover the state of the art. He noted that in the field of information transfer IIASA might be able to learn from the OECD scheme for documentation of international road research. This work is unusual in that it operates successfully in several languages.

This participant had a final question on the automatic planning control systems mentioned by Mr. Fomin. He wondered to what extent and in what way the decision makers would interact with these automatic systems. Would these systems replace humans, or merely provide them with better information? Mr. Fomin replied that they fit into the man-machine-man scheme. The first stage is done by man. Then the machine calculates to investigate variant versions. The final stage is for man who must take a decision using information from the machine calculations.

Someone urged that the realities of human psychology not be excluded from these complex schemes. He suggested creating a new mathematic including all human sciences. The problem is synthesis in order to get a meaningful representation of human behaviour.

Someone else added to the discussion of small versus large scale models the observation that, while the small scale models are of course easier to work with, they create artificial boundaries. For example, the New York City fire analysis had its outcome altered by an omitted variable, the union. The advantage of large scale models is that they include all of these things. They break down now because of their size but because of the disparate conceptual spaces or units used to study the problems. Most of operations research deals with physical flows through space, as do two of the studies presented earlier in the day--the Lowry model and the fire study. These are successful in part because it is easier for us to think in physical space. The point is that large models must be built from commensurable spaces. The problem arises in trying to combine, for example, nuclear physics, climate, economic measures, and sociometric spaces, since we do not understand the relationships between these. Thus, large models require, for success, a precise conceptual system which can tie these spaces together. Mr. Rousselot remarked that this seemed to be a proposal for theoretical work within IIASA. The speaker agreed.

IOR

ABSTRACT OF VERBAL PRESENTATION AT IIASA RESEARCH CONFERENCE ON MUNICIPAL SYSTEMS, VIENNA, 30TH JULY TO 1ST AUGUST 1973 - John Friend

An Experiment in Practical Application of Systematic Methods of Decision Analysis to Urban Planning Problems

During 1970, Mr. Friend and his colleagues at the Institute for Operational Research in Britain became involved in a practical exercise which brought research scientists together with decision-makers in seeking solutions to ongoing urban planning problems. The programme involved six studies running in parallel, using comparatively simple methods of systems analysis and comparing notes continuously on the difficulties which arose and the insights which were gained. An evaluation was in progress during 1973 of the long-term effects of this experience on the decision-makers concerned and on the local authorities from which they came. Preliminary indications were that in some cases the methods had been carried forward successfully in dealing with other problems without subsequent help from the researchers; in other cases, there had been little apparent effect; and in other cases again, attitudes towards planning had changed in a subtle way even though there had been little further use of the methodology.

Mr. Friend indicated that he intended to discuss in turn the origins and general philosophy of the analytical methods concerned: the way in which the experiment was structured: and the general lessons which might be drawn, bearing in mind especially the concern of IIASA to foster new forms of interaction between research scientists and decision-makers on an international scale.

The Institute for Operational Research was founded in 1963 within the matrix of a larger research institute - The Tavistock Institute of Human Relations - and had been concerned to develop relevant approaches to public policy problems through a combination of the contrasting approaches of operational research and the social sciences. Mr. Friend's team had been concerned with research in planning processes, especially at the urban and regional levels. This work had started with a four-year project in the city of Coventry, the aim of which had been to explore at a broad level the potential relevance of OR and the social sciences to urban policy-making. The City Council of Coventry had provided free access to their departmental and committee meetings, and to the private meetings of the rival political groups. This had given the researchers an exceptional opportunity to observe and try to understand the many complex interactions between functions, departments and committees in the decision-making process.

Through this experience, the team found themselves beginning to abandon their original preconceptions that they should attempt to construct large-scale comprehensive models of the interactions within the municipal system. Instead, they found themselves developing a basic conceptual framework which focused upon the sources of difficulty or uncertainty which were repeatedly faced by the decision-makers. This framework is illustrated in chart 1. The central circle indicates the focus on some current situation of difficulty in decision-making, while the three sectors surrounding it indicate different forms of response advocated in group decision situations, which can in turn be interpreted in terms of awareness of different classes of uncertainty. These classes of uncertainty were concerned respectively with the operating environment, with value and policy considerations, and with the state of knowledge about other choices in related fields of future action outside the current decision focus. Each form of response implied demands on different types of resource, and there was an implicit need for intelligent selectivity in deciding which of these types of action should be initiated in any particular situation. It was easy to demand moves towards greater comprehensiveness in any or all of the three dimensions: comprehensiveness in information systems, in structures of goals and objectives, and in the mobilisation of planning activities. However, this was to ignore the very real limitations on the time and effort that could be devoted to improving the confidence of decisions in real and often urgent problem situations.

From this general point of view, a series of general dynamic models were developed. Chart 2 shows one of these. The loops represent responses to different forms of uncertainty, showing in particular how the perception of uncertainties about preferences in related fields of choice could take the exploratory process into a broader context than hitherto. It was useful to think of the original decision process, with its basic stages of problem perception, exploration of solutions and commitment to action, as being embedded within a policy system consisting of a set of actors taking repeated decisions within some defined "action space" according to certain commonly understood policy guidelines. These policy guidelines could often more realistically be seen as more in the nature of constraints than directly motivating factors. The extension of an

exploratory process to a higher level, as shown in chart 2, could often take the process outside the bounds of the original policy system, either into a higher-order policy system in which the policy guidelines were more loosely-formulated, or often into a much looser "decision network" with little shared policy content. In these circumstances, it was observed that commitments to action usually emerged incrementally at many different points, within the broad context of a much more diffuse process of decision-making, which would very often transcend the boundaries of many different agencies.

Most planning activities could be regarded as responses to uncertainty in decision-making through extensions of the exploratory process beyond the confines of urgent and immediate issues, and this gives rise to a view of planning as a process of strategic choice. Chart 3 shows a flow diagram for a basic process of strategic choice, beginning down the left-hand side with the formulation of a problem and leading ultimately into a decision box relating to the question of whether a preferred solution can be chosen with confidence, or whether strategies should be sought for the reduction of different sources of uncertainty. In the centre of the diagram, certain analytical techniques are indicated (in parenthesis) which were found useful in structuring the process of strategic choice in a more systematic way. The method of AIDA (Analysis of Interconnected Decision Areas), as developed through earlier work in IOR, provided a simple logical method for the structuring of the "decision space" and for bringing out more explicitly the range of uncertainties and the ways these might be managed.

The view of planning as a process of strategic choice, and of relevant analytical techniques, was put forward in 1969 in the book Local Government and Strategic Choice (Friend and Jessop, Tavistock Publications, London). Subsequently, the question arose as to how these techniques could be applied and tested in relation to practical urban planning problems. It was therefore decided to set up a collaborative experiment, which was code-named LOGIMP (standing for the local government implementation project). This was set up by IOR in 1970 in conjunction with the Institute for Local Government Studies at Birmingham University, and was financed through a grant from the Centre for Environmental Studies.

Some aspects of the design of the experiment might be of interest to the conference, from the point of view of lessons which could be applied to the organisation of comparable experiments at the international level.

The first step in organising the experiment was to set up a one-day seminar to which a number of local authorities were invited. The approach to planning as a process of strategic choice was introduced, and the idea was launched of a parallel experiment in which researchers would work alongside teams of planners and other local officials in testing the methodology on selected current problems of urban planning. After this seminar and after confirmation of finance for the research, each of the authorities represented was approached to ask whether they would be willing to take part in the experiment over a six-month period. Meetings were held with several of these authorities to select a suitable problem, the main criteria being (1) that it should be a problem where there were certain urgent pressures for decision, (2) that there should also be longer term uncertainties which made decision-making difficult and (3) that the problem should be fairly localised in scale, relating for instance to the whole of a small town or to a sector of a larger town. A fourth, implicit, criterion was that the problems should be reasonably consistent with the six-month time-scale of the experiment. It was soon revealed that there was no shortage of possible problems on which to work, and as a result the experiment was launched in February 1970 in association with six teams representing local authorities in different parts of England.

Chart 4 illustrates the way in which the experiment was organised. The six ellipses represent the six collaborating teams, each of which had an adviser attached to it from IOR, as shown within the bounds of the central circle. Some teams were larger than others; some included specialists other than local authority planners, such as finance officers and engineers; while others were drawn from two different levels of local government. There were also differences in the nature of the problems tackled, as indicated around the periphery of the diagram.

Interactions within the experiment took place at three levels. First, once a month there was a one-day seminar at which different aspects

of analytical technique were introduced - roughly in the sequence shown in chart 3 - and in which information on progress was exchanged between teams, helping to maintain something of a competitive spirit between the six groups. Secondly, every two weeks the IOR "link men" made site visits to their respective local authorities to give detailed advice and to learn of any difficulties in applying the techniques to the practical problems concerned. Finally, there were periodic co-ordinating meetings of the research workers, at which methodological difficulties were discussed and forthcoming seminars were planned.

Chart 5 gives one example of the way in which the problems were structured within these teams. Using the basic AIDA conventions, the circles represent interconnected areas of choice, with certain mutually exclusive options within each and with certain relationships of structural or policy incompatibility between these options. It will be noticed that some of the decision areas refer to spatial choices, and others to the choice of action in particular sites; in other teams, the crucial choices sometimes related to other considerations such as choices of timing or agency. There was often a great deal of argument about the best way of formulating a problem, and, although there were often difficulties in setting out mutually exclusive patterns of options and constraints, the method provided a useful means of structuring debate on the main elements of each problem and on the choice of a focus for the problem-solving process. Subsequently, the range of possible solutions available could sometimes be elaborated in the form of a type of decision tree. In the case of the problem illustrated in chart 5, one of the two available solutions to the problem of motorway line was found to be very much more flexible or "robust" than the other in terms of the range of choice available in the other decision areas. In terms of systems analysis, the methods used were very much in the nature of an "intermediate technology"; nevertheless, they helped to promote some constructive arguments about what levels of systems analysis were most relevant to different decision situations.

Another of the studies concerned a set of related problems of traffic and car parking in an historic town. Some of the main choices within the town depended on future decisions by central government, so a

set of local alternatives was generated for each of six possible external contingencies. This process indicated that it was possible for the municipal authorities to avoid any investment in parking facilities within the next one or two years, whatever the central government might decide. This was a useful, though apparently negative, outcome to the decision process.

Some of the other studies involved more difficult issues and were less conclusive in their immediate outcomes. Nevertheless, return visits to the people participating in the experiment three years after the event had revealed a number of surprises. In some of the situations which were thought to be most promising, use of the techniques had not been taken as far forward as would have been expected, sometimes because staff had moved on elsewhere. Conversely, there had been unexpected changes of attitudes and further applications of the method in some of the authorities whose early efforts were less promising. The evaluation of these lessons was still continuing. A general impression was that those people who were still using the methodology most successfully were doing so at a very informal level; where people had formed the impression that the entire logical process indicated in chart 3 had to be gone through in a rigorous way, commitment had tended to lapse. On the other hand, the more enthusiastic users had experimented widely in combining the techniques with other new methodologies, and had been prepared to draw on them informally in response to what they saw as the requirements of different types of situation.

The purpose in describing the way the LOGIMP expercise had been conducted was to raise some questions as to what lessons might be learnt of relevance to IIASA in the mounting of its research programme, and in particular whether there might be ways of adapting this type of experimental design to an international setting. Mr. Friend had felt encouraged to raise this possibility after reading the paper by the Chairman of the Conference, which spoke of the importance of working close to real problems and decision-makers, and of stimulating numerous and varied interactions. Whether this kind of framework was considered for the testing of the particular analytical methods Mr. Friend had mentioned or of other contrasting techniques, it was important that such techniques should be of a nature that they could be

"slotted in" fairly quickly and easily to ongoing decision-making processes. This would preclude the use of such an experimental method in the application of large-scale and perhaps even medium-scale models of urban processes. The value of the method was that it could create a practical context for exchange of experience between researchers and decision-makers; hopefully, the comparatively abstract language of decision areas and relationships could provide a terminology within which some of the semantic problems of cross-cultural communications could be reduced.

The experience of LOGIMP indicated that there was considerable scope for improvement in any future application of similar experimental methods. The task of organisation proved to be a formidable one, and a period of one year would be a more realistic allowance for the conduct of such an exercise than the six months actually allowed in LOGIMP. It was also concluded that more time should have been allowed for both the setting up process and the subsequent evaluation. There was a general view that a monthly frequency was too high for the main seminar cycle, and that more allowance should have been made for advising the individual teams between seminars. If such an experimental process was to be adapted to international circumstances, then it would appear appropriate to hold seminars of two, rather than one-day's duration, spaced at two or three monthly intervals. Within each participating country, it would be important to secure the commitment firstly of at least one municipality which was willing to submit its current decision problems to this kind of experimental process, and also some research institution or university which was willing to provide supporting skills and resources.

The possible outputs of any such exercise could be of several different kinds. Firstly, the chosen analytical methods would be subjected to practical testing from the point of view of their relevance to some specific level of planning; secondly, information would be gained on the influence of organisational variables in different systems of local government; thirdly, new insights would be gained into priorities for adapting decision methodologies to practical problems; and finally, broader insights would be obtained into ways of briding the difficult gap between broad-scale systems studies and the ongoing decision processes they are intended to influence.

In conclusion, Mr. Friend felt that operations researchers had in the past been too ready to claim that their discipline gave them both a decision orientation and a systems orientation in dealing with complex problem situations. He believed that the analyst very often faced a difficult choice between the extreme forms of these two orientations: should he concentrate on taking up a stance close to the decision-makers and their problems, or should he try to stand far enough back to take a wider, global view? Mr. Friend himself felt that the "total systems view" was in practice an unobtainable ideal, and that the decision orientation provided a practical means of choosing what level of systems analysis might be most relevant in practice in contributing to problem-solving in different types of environment. This indeed was the implicit assumption on which the LOGIMP experiment had been built.

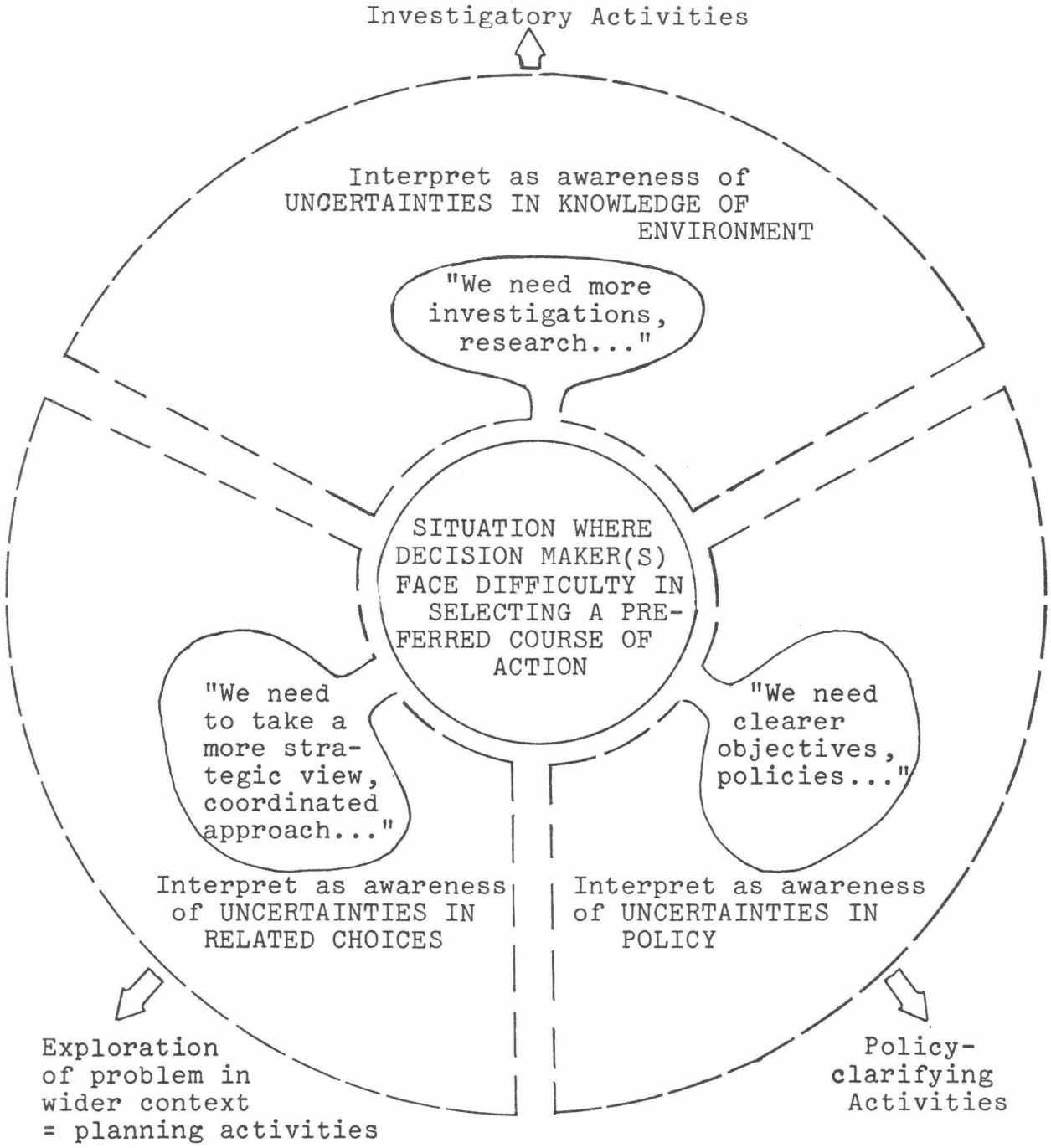


Chart 1: A Decision-Centered Approach to Planning

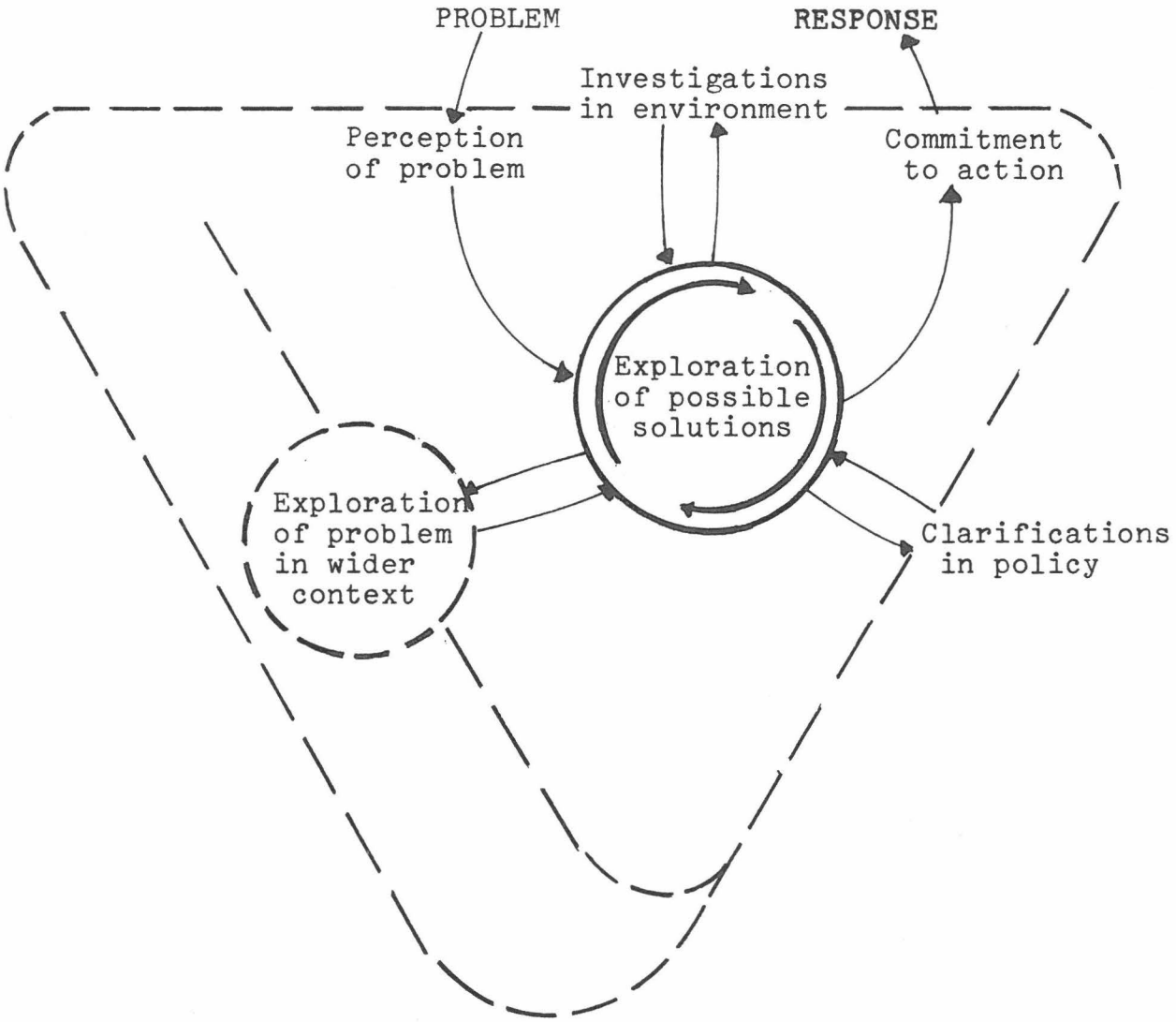

PROBLEM
RESPONSE
Investigations in environment
Perception of problem
Commitment to action
Exploration of possible solutions
Exploration of problem in wider context
Clarifications in policy

Chart 2

PROCESS OF STRATEGIC CHOICE

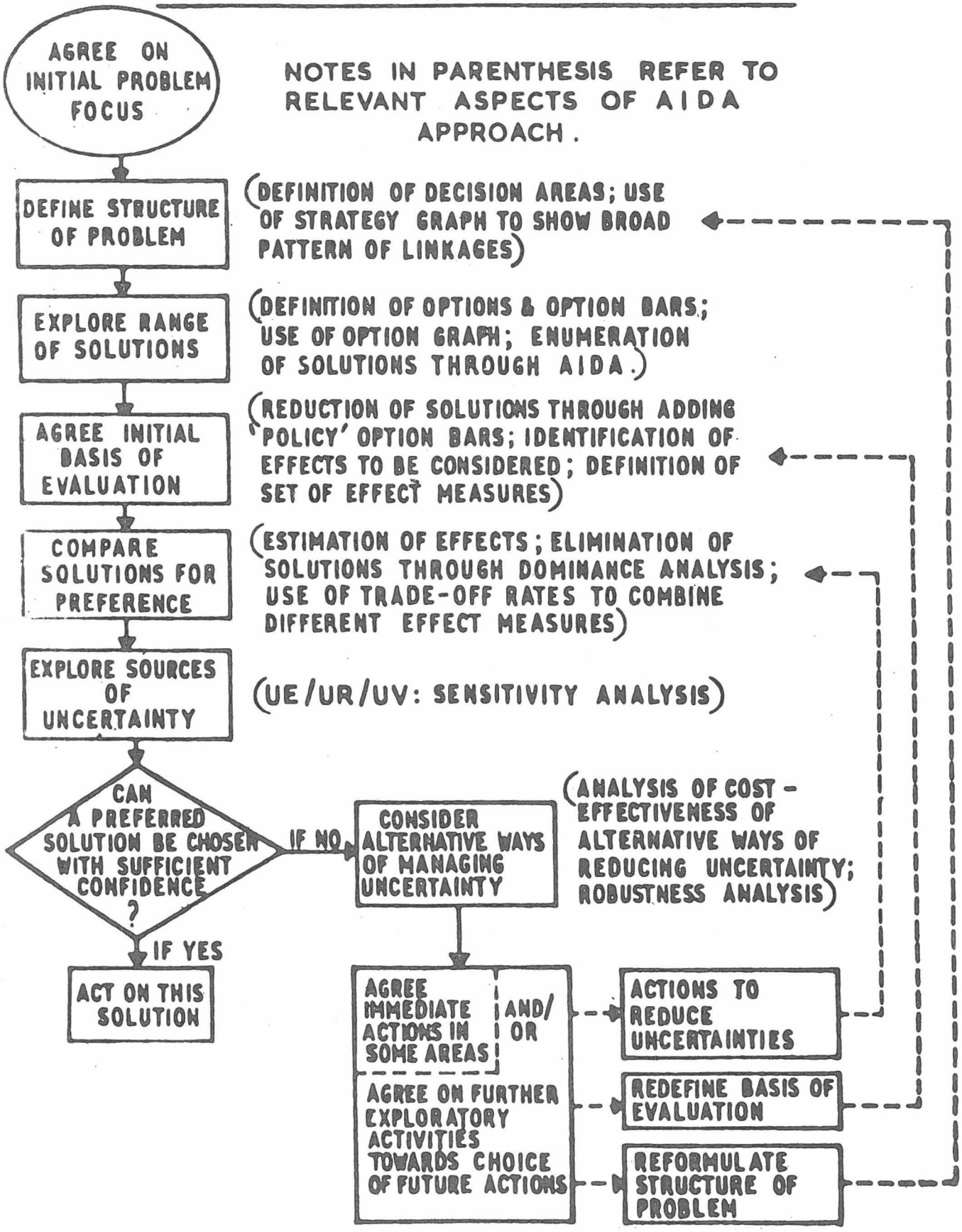


Chart 3

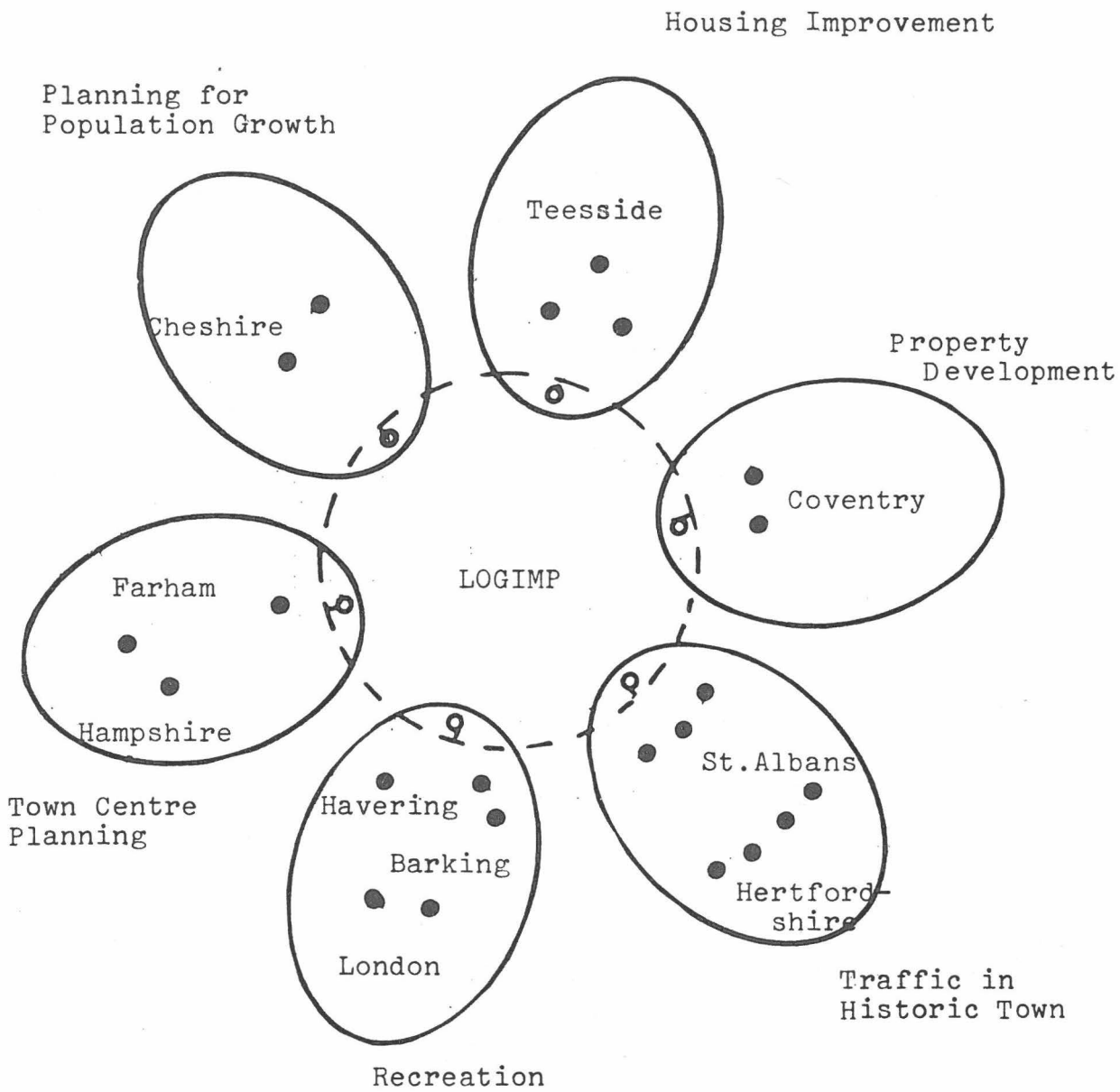
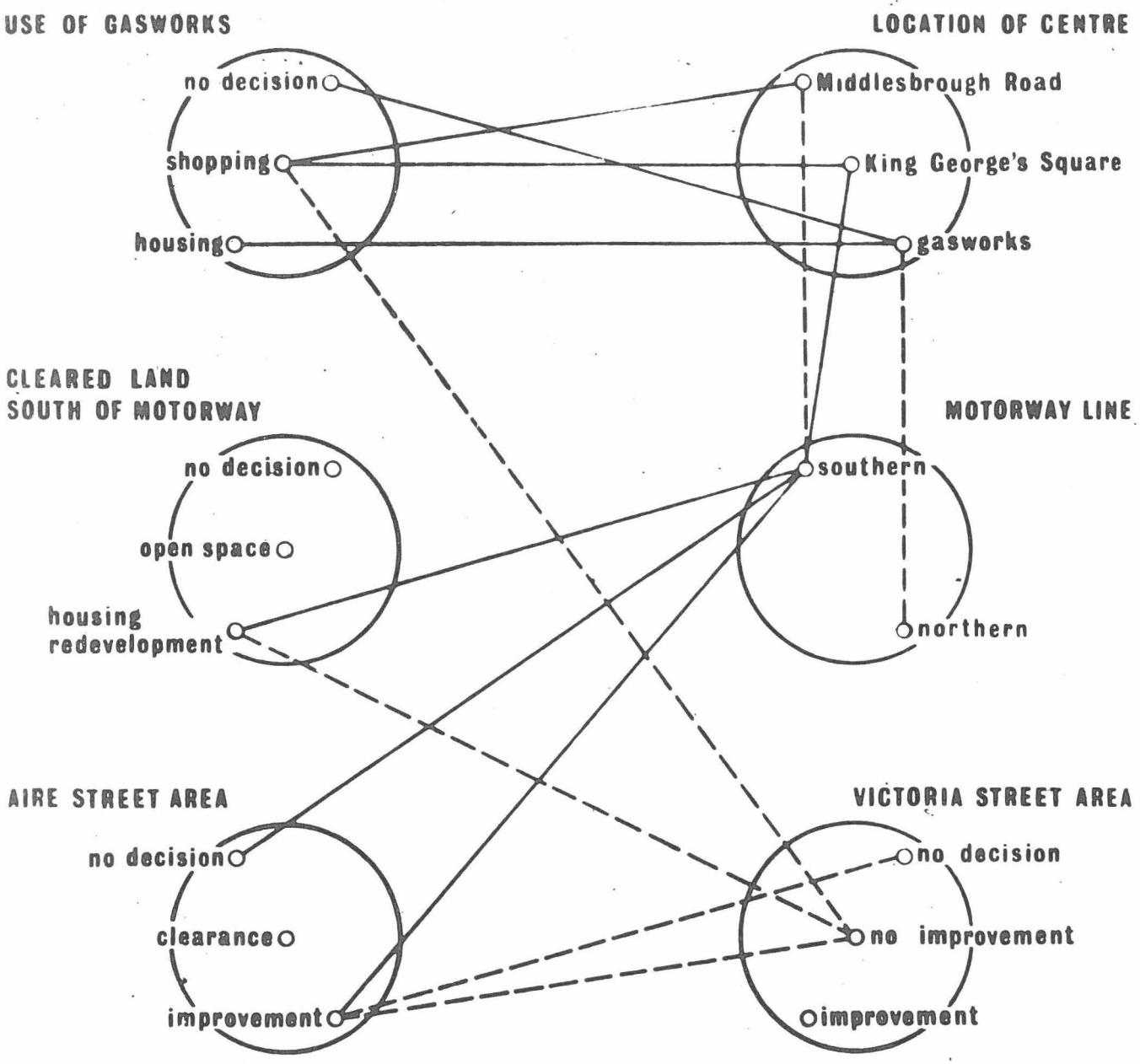

Housing Improvement
Planning for Population Growth
Teesside
Cheshire
Property Development
Coventry
LOGIMP
Farham
Hampshire
Town Centre Planning
Havering
Barking
London
St.Albans
Hertford-shire
Traffic in Historic Town
Recreation

Chart 4



NOTE:

Strict option bars denoted by solid lines

Broken lines denote value judgements

SOUTH BANK - option diagram for immediate decisions

Chart 5

Discussion

Mr. Rousselot asked Mr. Friend to specify more precisely the positions of the "decision makers" in his project. Mr. Friend said that they did not hold elective office; they were officials in planning agencies one or two ranks below department heads. Mr. Rousselot observed that the experiment seemed to be a good learning experience for the people involved but questioned whether there was any influence on the real decision makers, the elected officials. This point relates to the previously mentioned communications problem. Mr. Friend replied that the lack of contact with politicians was a necessary limitation of the experiment. The politicians' commitment was not very apparent. In one interesting case, the planning team offered the political body six possible solutions with no guidance as to which was preferable. The politicians were very hostile, saying that the work was useless unless it produced recommendations. Thus, there is a need to extend the experiment past the working groups and look at strategic questions.

Mr. Raiffa remarked that one of the recurring themes in the Planning Conference on the Design and Management of Large Organizations was that systems analysts and operations researchers often do not supply what is needed or wanted by decision makers. There is a gap between advice and decision. He said he is interested in bridging that gap; research designs like the present one seem useful for that purpose.

One of the participants commented that the previous discussion implied that one of the difficulties IIASA will face is that it will require a common methodology for dealing with the problems in different countries. He suggested extending the experience of his group and using systems dynamics, not to build simulation models--as done by Forrester and Meadows--but rather as a technique to describe problems in terms of chains of causal relationships.

Some Provocative Remarks

Yves Barel

(These oral comments refer to Mr. Barel's paper "An Approach to Urban Systems", included in full in Appendix II below.)

1. I should like, not to summarize my paper which you can read if you are interested in a particular point, but only to insist on those points which seem to me the most interesting because they are the most difficult and controversial.

2. I do not know yet if systems analysis in general and applied systems analysis in particular, are of interest for urban research and urban action and planification. But it seems to me that if they must be so, it is because of the hypothesis that if towns are socio-cultural systems, then they have a particular behavior, a systemic behavior, different from the behavior of socio-cultural sets which are not systems. This is a truism which shows that the first and most important problem to resolve is: What is a system, and especially an urban system? And how can we proceed to identify them?

3. My assumption, subject to controversial discussion, is that the problem of the existence and identification of urban systems has not yet been studied seriously. Lovers and enemies of urban systems have epidemic and romanticist reactions about this problem. Some people say: there is no urban system, because the city is neither an autonomous nor a coherent and closed set of relationships. Some people answer: there is an urban system, because we can identify numerous interrelations between the elements of the set, or because I decide that the city is a system, just like I can decide that Apollo project is a system. In general, the existence of a decision center seems to be a sufficient reason for the existence of a system. It does not seem that these arguments are sufficiently convincing.

4. It seems more realistic to suppose that the emergence, development and functioning of urban systems--if they exist--is not only the result of the action of visible and institutional factors, but also the result of a sort of "invisible hand," that is, the action of thousands of heterogeneous micro- and macro- decisions distributed between numerous economic and social processes.

5. Properly speaking, the problem is not to analyze an urban system per se, but to remember that what is analyzed is not an isolated system, but a hierarchy of systems, of which some are urban systems, and others are not, overlapping with the former. Speaking only about the urban part of this hierarchy, we must emphasize the strategic importance of the study of urban levels. It seems to me that insufficient attention has been invested in this question of levels. What are we speaking of? Urban system as a particular city, or as an urban area, or as an eco-system, or as some particular social structure...? Problems of dimension, of domination and control, of complexity, arise when we try to identify the different urban levels.

One of the most important questions is to try to know if different specific urban systems have succeeded, for instance, during the life span of a particular city, from a dynamic-discontinuous point of view.

6. It seems better to adopt a "hard" definition of an urban system, rather than a loose one. My approach is to treat an urban system as an auto-reproducible system. The reproducibility is the capacity of a living system to take advantage of its relationship with the environment (and of the relationship between sub-systems), in order to re-create its relative identity, specificity, and autonomy, even though some aspects always keep changing.

7. It is impossible to distinguish automatically, once and for all, those socio-cultural sets which are systems from those which are not. A set is more or less systemic. As it is easier to study systems in their mature state, one can decide conventionally that urban systems are self-reproducible urban structures.

8. To give to the urban system the name of self-reproducible structures would be only a manifestation of fetishist semantics, if the notion of social reproduction were not able to help us in the identification of urban systems. The help we can hope for lies in the association between the notion of social reproduction and two connected notions: contradiction and feedback. To my eyes, contradiction and feedback (or regulator) are not separate notions, but two different manuals of describing the same social reality. The urban system, if any, is not a coherent machine according a functionalist point of view. If the hypothetical urban system changes, adjusts itself to internal and external disturbances, it is because of its contradictory character (and of its contradictions with other systems). It is because of this possibility of adaptation, that feedbacks (kind of programs of adaptation) are created. Feedback is possible and necessary because of contradiction. Conversely, contradiction is possible because of feedback.

9. Reliable authors tend to believe that there are no urban feedbacks. Perhaps they are correct. Perhaps, too, they are partially wrong. We do not possess, as far as I know, any serious method for identifying feedbacks as concerns socio-cultural systems, and particularly urban systems. It would be very important to try to advance in this direction. In particular, we should consider the particular meaning and content of the notion of social feedback. The notion of feedback is yet too linked to its scientific origins: the cybernetics of physical or biological systems. Uncautious transposition to social field would be dangerous. The main task--and the most difficult--in the identification of a social feedback is certainly the identification of some kind of "finality" (in the cybernetic sense) and of a link between this finality and the interplay of socio-cultural factors. The difficult problem arises of the quantitative or qualitative forms of regulation of a system. It is possible that social feedbacks, especially in complex systems, are mainly qualitative.

10. All these very theoretical and abstract problems should and could be studied in the context of a practical analysis of concrete urban systems.

Discussion

One participant commented that in some social science work, although in all likelihood not in Mr. Barel's work, "social feedback" is an excessively holistic notion carried directly over from cybernetics. The routes followed by that feedback are not precisely specified as they are in the control and natural sciences. If such ideas are used, for example, in feedback to policy makers, one must identify the actors and trace the information flows. The feedback loops must be precisely determined; vague approaches are not helpful. He ended by reemphasizing that these comments were not criticism of Mr. Barel's work but instead a suggestion about how to work on his ideas.

Mr. Barel replied that he agreed with the speaker and offered an example of a real social feedback. In Paris today automobiles are so numerous that they cannot all move at the same time on the available road space. However, traffic does move; the system does work. The hypothesis is that it works because thousands of micro-decisions work together to ensure flow.

The whole is a self-regulating organization with feedback loops. Someone else noted that his experience with housing models suggested that the behavior of developers and landlords could only be explained by a feedback system. Time delays complicate such systems.

Mr. Haefele said that he was still looking for cross-cutting themes for IIASA work. He noted that there are a number of schools of thought on public acceptance of risk and risk evaluation, and wondered whether municipal planners have their own approach.

Someone commented that the attitude to risk expresses unconscious personality. He presented an example of a non-regulating feedback situation based on unconscious attitudes. The housing problems in his country create a system of attitudes and behaviors stemming from frustration which create stable attitudinal, cultural, and economic equilibria. However, they also work against any new housing policy introduced to ameliorate the situation.

One participant noted that throughout the discussion the question "what is a system?" had been arising, but that Mr. Barel had taken it one step further. He had suggested that in some contexts it is not useful to apply systems analysis to urban situations. Perhaps this is true, for example,

if the evaluative variables are not variables of the town but, say, those of the nation. There can be solutions "bad" for the town but "good" for the country. It is important for IIASA to see the limitations of treating a town as a system relative to the problems at hand. Mr. Barel agreed, adding that an urban system is never isolated but is always a part of a hierarchy of systems. Research on these interactions and on their relationships to other systems is important. However, he has no answer yet to the question of whether or to what extent a city is a system; he was only cautioning against too quickly assuming that it is one. Another question to study is how the city modifies inputs from other systems.

Mr. Rousselot said that his own viewpoint, as expressed in the January paper, is that the identification of urban systems, of their control mechanism and feedback loops, is an important beginning study. Since then, Mr. Barel has begun working on a reproduction of systems approach to the question of whether or not a city is a system.

Someone suggested that a very important early research topic would be the definition of a differential typology of systems. Secondly, some systems necessarily imply the existence of complementary systems. IIASA should study these complementarities. Mr. Rousselot noted that these suggestions were rather different from those made earlier. The problem, in this original field, was to determine precisely what IIASA could study.

Another participant suggested that it would be useful for IIASA to follow through on several different ideas of what systems are and to study the same topic with several different methods in different countries and groups.

Mr. Raiffa commented that this kind of discussion would be pursued in detail on Wednesday. The conference topic was more diffuse than in the three previous conferences, and it would probably be more difficult to define a researchable program. He urged the participants to think of concrete in-house projects, keeping in mind that IIASA work upon these projects would not be pursued in isolation. He could easily envisage IIASA research upon topics raised in the conference, e.g. the cooperative efforts and sophisticated conduit role suggested by Mr. Fomin. However, Mr. Raiffa felt the participants had not yet explored possibilities for a tangible in-house research program and hoped he might get some ideas on that the next day.

DISCUSSION OF SUGGESTIONS

FOR

IIASA RESEARCH AND SURVEY RESULTS

Remarks by Chairman

Mr. Rousselot opened the session by thanking Messieurs Conan, Cordey-Hayes, deLeeuw, Domanski, Sokolov, and Thompson for their work in analyzing the responses to the survey. He then presented some of their findings. First, most participants did not encourage preparation of a handbook on the state of the art in analysis of municipal systems, some because they felt that the techniques are not advanced enough for IIASA to be able to write something consistent, others because they feel that the field is changing rapidly. However, a handbook of the mathematical tools might be useful, as might a substantive handbook linked to the research program. It was suggested that IIASA circulate first-rate case studies among the member countries, perhaps by means of a periodical publication. Mr. Raiffa interjected the observation that the circulation of case studies could be done from an in-house base. In particular, IIASA could be occupied for a long time with sifting through case studies already collected elsewhere. One participant added that parts of the scientific community say they would like to have these studies available, but it is difficult to get them published in the journals. Thus, IIASA might make a positive contribution by publishing them. Mr. Rousselot observed that this activity could be linked to other proposals for IIASA work, such as those for IIASA to be a coordinating body.

Someone suggested that IIASA develop and circulate a standard outline for case studies to promote comparability. Mr. Rousselot noted that a handbook of mathematical tools relates to the proposal at previous conferences to develop a handbook on the state of the art in systems analysis. Mr. Raiffa confirmed this. One participant, while agreeing that there is little point to a survey of the art in municipal systems, suggested that it might be worthwhile to bring together experts to develop such handbooks for smaller, more specialized fields (e.g. land use models). The communication that would result would be valuable in itself.

Mr. Rousselot continued his comments on the questionnaire answers by noting that there had been few answers and some cautions on the topic of international conferences. Some respondants were opposed to any such conferences, noting the difficulty of proposing topics different from those already covered by other groups. Topics should be closely tied to the IIASA research program. Mr. Fomin had suggested holding conferences with limited purposes and closely tied to the research program proposals.

Mr. Rousselot suggested that the conference not try to develop even a working definition of systems analysis but attempt only to keep in mind its possible characteristics as suggested in the question itself: use, nature, and scope of the topics investigated, and main references to scientific disciplines.

He suggested four broad categories of research. First, there is large scale modelling, e.g. for optimization of urban settlement or growth, in which the model is large and its scope is large. Secondly, there are smaller scale models, such as those of municipal service management or, more generally, control of the functioning of subsystems. Third, there is the study of methodologies for both kinds of modelling. This includes work on the structure of models, mathematical tools, and information systems. Finally there are methodological studies from the general systems theory point of view, such as the work proposed by Mr. Barel.

Mr. Rousselot also proposed three categories of classification from the point of view of the kind of in-house organization required. First, IIASA could undertake "second-hand" research, that is, evaluations of studies and planning projects already completed in one of the countries. Secondly, it might organize on-going national research efforts, encouraging cooperation and comparisons of problems, and perhaps offering advice and orientation. Finally, there can be research at Laxenburg independent of this kind of intensive international cooperation. This would include studies on papers or publications and on theoretical or methodological problems. Mr. Rousselot noted that his two classification schemes overlapped but suggested that they might be useful in evaluating proposals.

One participant interjected the comment that he was uneasy that a definition of systems analysis was being avoided; there seemed to be no constraint on the field of study. He also asked for some idea of the resources available to this group before decisions were made on the partition between collaborative and research work. Mr. Raiffa responded that IIASA has an operating budget of three and a half million dollars with some possibilities for getting other funds. At one time he had thought that this could support one hundred scientists; he now thinks that seventy might be perhaps a more reasonable figure. The proportion of this devoted to in-house work on urban systems depends upon the quality of the proposals; it could be as much as twenty per cent, or close to zero. In the latter case, some funds would be spent to pursue potential ideas for research. Also, if IIASA had an exciting program, it could tie its work to NMO research and multiply the budget for this work by as much as a factor of ten.

Mr. Rousselot asked that further discussion of these questions be deferred to later. He called for opinions on in-house research and on possibilities for international cooperation. He noted that one had also to speak of the difficulties in in-house research, such as access to data, diplomatic difficulties, and the problem of a small team making any more than a theoretical contribution. Someone asked Mr. Raiffa whether it was correct that the main purpose of the discussion was to determine what approximately ten people could do, either by themselves or as a catalyst for larger programs elsewhere. Mr. Raiffa said that ten was a reasonable figure as long as it was understood that these ten would not be primarily concerned with methodology. There would be other methodologists at IIASA cutting across the projects. Ten man-years may be allocated to municipal systems, but there may in fact be forty or fifty people working on the project.

Next, Mr. Sokolov presented the first report from the working committee on the surveys. He had compiled the suggested topics for IIASA research.

Presentation by Mr. Sokolov:

"Suggestions for IIASA Research Topics"

Mr. Sokolov described the method for classifying the proposed topics, noting that the limited information he had rendered the task difficult. The construction of the list of topics went through two stages: all explicit and implicit topics were first extracted from the documents and then classified. Five schemes were considered. The first--the Rousselot scheme--had six categories for topics: large models, small models, decision maker interactions, methodology of modelling, general system theory, and epistemology. The second scheme classified topics by the type of models used in the problem solutions--e.g. mass service, queuing theory, linear programming. The third scheme categorized by implementability of the project: by time of expected output, for example. The USSR proposal--the fourth scheme--divided problems into two classes: functioning and development. The last scheme divided problems as static or dynamic.

However, none of these schemes covered all of the topics in the list, in part because some topics were described in very general ways, in part because there was no data on the amount of financial and other support available for a given topic. Thus, the final scheme uses a mixed basis for classification (a comprehensive listing, Table 1, and schematic diagram, Figure 1, follow this presentation). It is definitely open to modification. Mr. Sokolov said that in his opinion the subjects in the list are too broad for research; they should instead be considered as guidelines for a survey which must precede any serious research work. In response to a comment by Mr. Rousselot, Mr. Sokolov agreed that the classification was functional, that is, by field and expected output, rather than methodological. He said that that was the only classification possible with the available amount of information.

One participant remarked that he found the classification scheme useful. It seemed to put descriptive and positive research on the left hand side and specific policies and objectives on the right hand side in a reasonable way. There were any number of ways to make a classification; this one seemed interesting and useful. As the number of topics to be discussed was quite large, he suggested that the only thing the group could do in its remaining time would be to indicate boundaries for research: very high and very low priority items. Refinements would not be possible under those conditions.

Table 1

A Comprehensive List of Proposed Research Topics for IIASA in Urban and Regional Problems

(Extracted from Papers Presented 30-31 July 1973)

I. First Grouping

Plant Description, Analysis, and State Evaluation

1. Quality of life and social indicators
2. Determination of goals and performance criteria
3. Interrelationships of conurbation components
4. General systems properties of cities--e.g. stability, resilience, adaptability, reproduction, hierarchical structure

Macro-level

5. Migration
6. Architectural and esthetic considerations
7. Interrelationships of local, regional, and national governments
8. Cross-city comparisons

Micro-level

9. Effects of technological change
10. Demographic classification schemes
11. Density of land use

II. Second Grouping

Control Systems

12. Control system structures
13. Evaluation methodologies for urban policies

Information Systems

14. Information systems for urban and regional planning control and management

Automation

15. Automation of planning and management processes

III. Third Grouping

Decision Making

16. Modelling, control, and optimization of urban subsystems--e.g. land use, transportation, energy, water, sanitation, health care, waste disposal, communication
17. Decision and control principles
18. Accounting and control of urban resources
19. Management of urban subsystems--e.g. the housing stock, waste disposal, transportation, health services
20. Decision making processes in large organizations
21. Distributional equity aspects of urban policy
22. External effects in urban areas
23. Development of institutions
24. Epistemological results on systems analysis

Forecasts

25. Economic, environmental demographic, and social forecasting

Strategic Planning

26. National settlement policies
27. Integrated engineering and transport infrastructures
28. Environmental preservation and disaster control
29. Planning of housing, construction, and land use
30. Long term and short term planning of urban functioning
31. Planning for new towns
32. Integrated delivery of social services

Tactical Planning

29. Planning of housing, construction, and land use
30. Long term and short term planning of urban functioning
32. Integrated delivery of social services

Supervision and Current Control

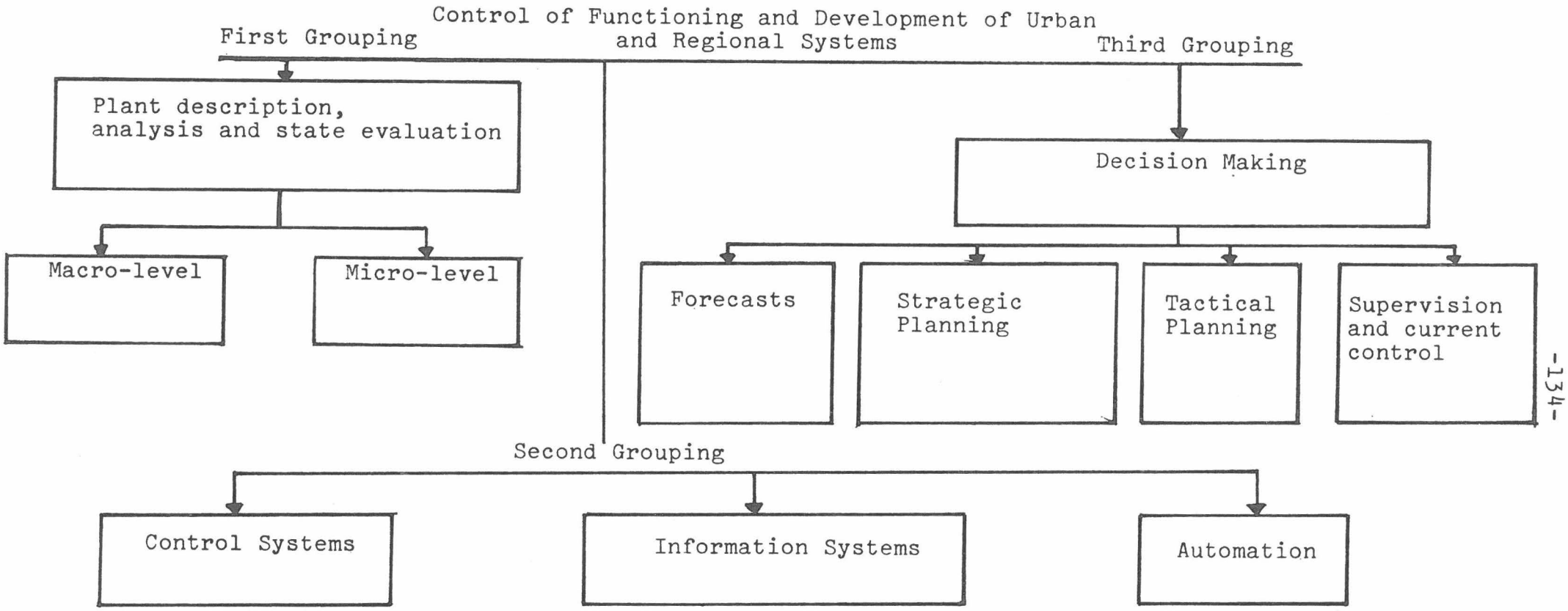
28. Environmental preservation and disaster control

Mr. Rousselot suggested beginning by discussing the relative importance of the three large groups of proposals and then examining each group in more detail, particularly to see whether the research would be better done in-house or through international cooperation.

Mr. Letov also suggested that the discussion focus on assigning relative importances to the different topics.

Mr. Rousselot then called on another committee member, Mr. deLeeuw to report on the comments on the topics proposed in the January paper.

Figure 1


Control of Functioning and Development of Urban and Regional Systems
First Grouping
Third Grouping
Plant description, analysis and state evaluation
Macro-level
Micro-level
Decision Making
Forecasts
Strategic Planning
Tactical Planning
Supervision and current control
Second Grouping
Control Systems
Information Systems
Automation

Presentation by Mr. deLeeuw
"Responses to Topics Proposed in January 9 Paper"

Mr. deLeeuw stated that the USSR booklet effectively contained the USSR responses to the survey and was not included in his report as everyone already had a copy of it. His report was based on responses contained in eight copies of the survey.

Five proposals received favorable reactions from three or more of the respondents. These were A2, analysis of urban and regional institutions; A4, application of systems analysis to the economic growth of cities; A5, application of systems analysis to regional economic growth and strategies; A7, application of systems analysis to some important sectors of activity in the city; and A9, the theory and practice of planning.

Other proposals received both negative and positive reactions, principally on the grounds of political sensitivity. In particular, B4 (study of urban violence) was rejected by more than one respondent as requiring an unlikely amount of cooperation. On the whole, proposals to study abnormal situations received less support than those to study usual or normal developments.

Most of the open-ended responses were already included on the list prepared by Mr. Sokolov. The only additions were: 1) the institutional behavior of local governments, 2) the distinctive problems of medium-sized cities (e.g. rehabilitation of the city core), and 3) epistemological research "to call attention to the common fallacies in all systems research."

Plant Description, Analysis, and State Evaluation

The discussion began with consideration of the topics included in the first grouping under "Plant Description, Analysis, and State Evaluation." Someone suggested that all speakers indicate for each topic whether it is appropriate for: 1) IIASA in-house research, and if so, whether it is of high, low, or uncertain priority; 2) international conferences sponsored by IIASA; or 3) bilateral cooperation. Another participant urged keeping sight of the criteria of concreteness and relatedness to other projects.

Mr. Raiffa referred to a comment by an earlier speaker characterizing the topics on the left as prescriptive and on the right as descriptive, while those on the bottom refer to methodology (Fig. 1, page 134). Mr. Raiffa said that if that is true, he could not imagine prescriptive decisions that did

not take account of topics on the right side. If there is no slippage in the list, then some topics must belong in several places. Mr. Sokolov responded that there is no slippage; both sides are surely related. One cannot make decisions without a method of description. The subdivision is conditional, not strict: each topic relates to all of the topics below it. Someone asked Mr. Sokolov to indicate how much support the various proposals had received. He replied that the idea had been to depersonalize the list and just present all viable topics as material for discussion. If desired, he could extract data on degree of support.

Mr. Raiffa observed that in the other conferences the discussion had often turned to the quality of life and determination of goals and criteria. Thus, Topics One and Two were important to the other groups as well and could be included in the methodological research whatever program of municipal research is finally chosen. Mr. Rousselot supported this idea. However, with respect to the urban and regional aspects of that work, he noted that international cooperation already exists for development of social indicators. He advised against great IIASA efforts in that field. At most, IIASA should look at existing work and select elements for methodological work.

One participant suggested choosing the general methodological topics out of the list; for example, Topics Twelve and Seventeen are general in that sense. Mr. Rousselot added One and Two to that list and remarked that these could be subjects for in-house research cutting across the projects. Topics Eleven and Four were added to this list.

With respect to the latter, someone asked Mr. Barel to describe more specifically his research and the areas of possible cooperation with IIASA. He said that three or four people will be spending fifteen months at Grenoble studying two or three French cities to determine in what sense, if any, these constitute a system. The researchers will examine among other topics, fundamental organization and the feedback structure. Mr. Barel said these people would welcome contact with IIASA and suggested that one researcher could remain at IIASA permanently or that the two institutions should at least maintain liason.

Someone noted that there was a proposal very similar to this in the original Canadian paper where work on resilience and stability properties was suggested. This relates closely to the IIASA project on ecological systems to be headed by Mr. Holling. There should be high priority for IIASA in-house theoretical work. It would be good to connect this effort to more empirical work, such as that which Mr. Barel is undertaking.

Another participant observed that the social indicator movement already has many resources. The IIASA role in this field should be to bring people together rather than to sponsor a great in-house effort. This is also somewhat true of Topic Two which, although it must be considered in any analysis, need not necessarily be studied in the general sense.

Someone asked whether this was an area in which intercultural transfers would be valuable. For example, is United States work in this field of any use in other countries? The previous speaker noted that this work is going on not only in the U.S. but also in Japan and Western Europe.

Mr. Rousselot commented that this is a difficult field. It has a factual appearance, but behind that there is a whole complex of cultural and social factors. Comparisons may prove to be superficial, difficult, and elusive.

Mr. Raiffa said that he was unsure whether or not this is a good area for research, but felt it merited further investigation. Questions include its ramification for developing countries and its differential appeal, if any, to market and non-market economy countries. It might also be a suitable topic for coordination with the United Nations. Groups at the Geneva Conference and in the OECD are currently working on social indicators.

A participant from one of the socialist countries responded by saying that social indicators are related to the information side of control and management problems; IIASA should pay attention to the methodological aspects. Proper information is essential for all problems. The methods of preliminary processing vary across problems. Thus, information processing occurs in several stages: gathering, preliminary processing, final processing. Information gathering can be done in several ways--for example, by interviewing people in the city, or by using automatic devices. An important methodological problem arises here, namely, how to generate general purpose data banks containing the necessary parameters. What constitutes necessary and sufficient data depends upon the description of the system and upon the criteria used to evaluate it. Often, in the filtering and aggregating processes, a large part of the necessary data is lost. Thus it would be worthwhile to study the design of information systems and the problem of gathering information. Social indicators are parameters that must be dealt with while working with control systems.

To take account of this, Mr. Rousselot suggested discussing indicators along with Topic Fourteen. Someone suggested also discussing Topic Ten there.

One of the participants noted that worldwide information systems in science exist. However, these systems are chiefly useful to specialists and thus are less helpful for the interest of the conference participants, namely their interest in general systems. The accepted way to locate an item of information is to seek smaller and smaller subsets rather than to embrace commonalities, as this discussion indicated. He suggested looking at other ways to store and to analyze information. Mr. Rousselot added that this could be a piece of cross-cutting IIASA in-house research. Mr. Raiffa noted that a later conference on "computer methods" will pay attention to informatics and, thus, to such questions.

Another participant said that he had understood Topic Fourteen in a different, less abstract sense; he felt it referred to information on a town for planning and control purposes. He added that there is much current work on the development of information systems for this, and much might be gained by a cross-cultural exploration of these systems.

Mr. Raiffa said that for future conferences it would be useful to hear from modellers and planners what type of information they would want collected. For example, so far there exists little longitudinal data; most of it is static. Mr. Rousselot stated that an experience he had a year earlier indicated that interaction between data experts and modellers is hard to organize. Mr. Raiffa responded by asking whether, for example, it might be worthwhile for IIASA to work on sample survey techniques or other tools for gathering information. Several participants responded affirmatively.

Another participant noted that information is gathered locally for specific local purposes at great cost; IIASA could not duplicate this. The question is what could be done better at IIASA than elsewhere. Mr. Raiffa said that it had already been decided that IIASA is not the place for data collection. The Institute could, however, sponsor feasibility studies to see if the data modellers desire could be collected and then urge other groups to pick up that task.

Someone suggested studying the marginal productivity of different methods of data collection. The costs and characteristics of data obtained from such methods as social statistics and interpretation of aerial photographs should be examined. Here, Mr. Rousselot urged the participants to limit themselves to their broad reactions so that there would be time to cover all subjects.

One participant noted that plant description is common to all IIASA projects and is a basic systems analysis problem. Thus, it would be worthwhile to pay attention to methodological problems in this field and to include them in the in-house research. Mr. Raiffa explained that it is envisaged to organize

IIASA as a matrix in which such a methodological study, perhaps under the name "informatics." might cut across all projects.

Someone else suggested linking Topic Twenty-one and the "exposure of the fallacies of systems analysis" with Topics One and Two. Topic Twenty-one seemed to him extremely important and ignored in the foregoing discussion of One and Two. Distributional aspects are important to politicians; neglect of these aspects presents the danger of loss of contact with reality. For the other topic, one of IIASA's roles should be to ensure a decrease in the time currency of fallacies.

Mr. Rousselot directed attention to the "Macro" and "Micro" level topics. He noted that there have been many studies of migration in different countries, some of them rather successful. He suggested connecting these studies at an international conference.

One participant commented briefly on several topics:

He felt that most countries are interested in migration (Topic Five); it relates to national urban policies and settlement patterns. There are specific studies in different places. IIASA's role would be to bring workers in this field together, for example, at conferences, to encourage information exchange. This should be a high priority undertaking. As in-house research, however, the field is not very promising.

Topic Six could either be part of Topic One or simply exist as a reminder that systems analysts often tend to be heavily quantitative and to push aesthetics aside, thus ignoring important aspects of problems. IIASA work on this topic would help "keep the world honest" in non-quantifiable, central issues of human welfare. Perhaps IIASA should consider how to quantify them. This subject has uncertain priority and is near Topics One and Two.

Topic Seven seems to be shared by a number of western nations although perhaps not by eastern ones. Many people are working on it; IIASA could encourage bilateral exchanges or perhaps sponsor a world conference, but is a low priority topic.

Topic Eight should be studied only if it grew from a case study in one of the functional areas or from an indicator study.

Topic Nine is of much concern today; it is a low priority topic that IIASA could keep track of by bringing people together.

Topic Ten was already discussed with social indicators.

Topic Eleven is part of the more general area of land use policy; its priority in IIASA research is uncertain. It is a "hot" issue on which there is currently much work and on which more is needed. Perhaps it should be on the agenda.

Another participant said that he saw nothing on the "micro" or "macro" lists to which he would give high priority for in-house research. However, some of the topics might be suitable for conferences. Interest would be generated by their relationship to national settlement policies; problems of regional disparity, migration, and land use enter here. Perhaps there could be an in-house project on the effects of technological change, for example, as it relates to urban form and structure and patterns of energy demand and use.

Someone else noted that in his country there is interest in the migration problem, but he would not recommend it for IIASA work. It might be interesting to examine Topic Seven from the viewpoint of hierarchical systems; this could be done both within IIASA and in cooperation with national teams. However, current research now in progress in this field which should be surveyed before any new project is begun.

This same participant next referred to Topic Eight to point out that Intermet in Toronto, Canada, is already making city comparisons of a number of very large cities throughout the world. IIASA should look at their work before deciding what to do in this field. He suggested approaching Topic Eleven from the viewpoint of asking why density of land use is a problem, why throughout the world the process of concentration of people is continuing out of control. The Chinese have been successful in doing something about this; their success should be examined. Here, Mr. Haefele added that a major point of discussion at the energy conference had been man's impact on climate and the weather pattern. This may not prove of prime importance for towns, but it does present a constraint. Thus, Topic Eleven is a point of connection between the energy and municipal projects.

Next, Mr. Raiffa added remarks about certain topics:

Topic Five - The Council had debated researching migration models augmented to include demographic and population problems. It had decided not to make this one of the broad areas of research, but it might be included in the project on urban or regional systems.

Topic Six - As an earlier speaker had commented, it is true that past systems analysis studies have paid little attention to "soft" values. An important methodological question is how might all studies systematically include this topic. This relates to topics One and Two.

Topics Seven and Eight - These would be of interest to the organization project team, for example as a study of the role of hierarchies in planning. Theoretical work in this field exists; IIASA might seek examples and attempt cross-cultural comparisons.

Topic Nine - As an earlier speaker indicated, this topic is salient for the municipal project. Here, energy considerations play an important role.

Topic Eleven - IIASA might be interested in this. One IIASA scholar, George Dantzig, is concerned about the efficient use of land and about design of cities of the future (Mr. Dantzig wrote The Compact City).

Someone said he thought that Five would be a good topic for a conference; there is much work and much interest in this field. Topic Eleven is an area in which it would be interesting to compare rates of conversion of rural land into urban in different countries. In his country, one small study came to the unexpected conclusion that the rate is not directly correlated with population growth. Instead, it seems to be more dependent upon increases in standards. Someone else supported a IIASA project on migration, noting that the influx of foreign labor into certain European countries creates great problems.

Another participant remarked that many of the topics on the list could be related to each other. For example, the migration problem should be considered in conjunction with the land use and technological change questions. Not too much work has been done here; sociologists have described motivations and geographers have catalogued flows, but there remain such questions as the effect of government income strategy on infra-structure and hence on migration. This is a serious problem for an international institute to handle. For example, the flow of workers from Yugoslavia to West Germany is in part determined by the strategies of the respective governments. Someone else rejoined that although this problem is probably very important, there is already much work being done on it in Europe.

Control Systems

One participant said he thought that control systems were generally important. It is a general method. However, there is a low probability of successful application of control models to urban development. Twenty years ago Simon thought to use control theory ideas for the non-physical aspects of production processes. However, even this suggestion, for systems much simpler than urban ones, has yet to be fulfilled. Mr. Sokolov replied that there might be a misunderstanding of the intended meaning of "control". Perhaps the word should be replaced by "management" and "control of management."

Someone else thought that Topic Twelve was related to Topic Seven. In his country, and probably elsewhere, severe problems arise from the fact that the central government lacks variety in its control policies. Thus, it is not realistic and tends to be rigid. This is a difficult area in which IIASA might

perhaps contribute, at least to the conceptual framework. Mr. Rousselot observed that part of the IIASA in-house methodological research will be on the optimization of large scale systems.

Another participant commented that a number of countries are facing the problem of where to place large new installations such as airports, roads, and power plants. Especially for these last, a group of "interveners" has arisen. Planners must try to understand them even better than they understand themselves and must consider their view in assessing policy. A formalization of the debate on assessment of policy is one possible approach which in fact is currently occurring in the United States. The point is that sociological dynamics profoundly affect these problems.

One participant suggested that Topic Thirteen should be broken into two categories. First, there are methodologies for evaluating the overall urban system, i.e. for evaluating how the welfare of citizens varies with policies. These require measures of welfare, of distributional equity, and of efficiency and approach indicators of "the quality of life." Secondly, other methodologies are aimed at evaluating the functioning of urban subsystems. There is interesting and important work on the measurement of the output of public services. This would be a field in which IIASA could play a coordinating and convening role, although this area would not have high priority as internal work.

Another participant supported an earlier comment on the importance of research about the relationships between local and central governments. The relationships between local and central management and planning bodies are both complicated and important to understand.

Someone else noted that much useful work on control structures is being done in many different countries. However, the direct transfer of results across cultures is likely to be difficult. Thus, it may be useful to study the technique of transferring.

One participant remarked that the word "control" is not necessarily appropriate. In society, there is not control, but instead a whole system of controls at different levels, with conflicts between them. The situation is analogous to that which prevails in the psychoanalytic idea of regression. Conflict between different controls, leading to societal destruction of its own controls, can lead to social regression. IIASA should perhaps research different theories of conflict and attempt to resolve their contradictions.

At this point, someone suggested that systems analysts would lack modesty if they included aesthetics and psychoanalysis within their field of competence. He asked where the limits lie.

The first response gave an example of a hard-headed problem with "soft" overtones. The amount of energy consumed per capita is increasing very rapidly in some parts of the world. There are two alternatives: to use energy more effectively, or to control energy use. The question of whether we accept rising consumption levels is related to aesthetic questions and to the "quality of life." but also has a hard-headed, physical science component.

The previous speaker agreed that in decision processes there exist both quantifiable and qualitative aspects. However, he thought that the purpose of systems analysis was to bring the quantitative points to bear, to be hard-headed, and to develop mathematical techniques, not to usurp the Ecole des Beaux Arts.

Mr. Rousselot remarked that in any field, there are two ways to make progress. One can perfect present techniques, or one can ask new questions to broaden the field.

The previous speaker then rephrased his query to ask "Is IIASA an institute of systems analysis? Or is it an institute of management?" He suggested that if that question could not be answered, then it was unlikely that IIASA could limit itself at all.

A participant responded that IIASA is an institute of systems analysis, not one of management. It will always have solid subjects and themes. The point is that these will be approached from the generalist's point of view, keeping the entire problem in sight. "Systems analysis" means that all the disparate parts will be put together. We must explain the unexplainable.

Someone else remarked that one need not worry about the intrusion of non-quantitative aspects into systems analysis; IIASA in any case will be dominated by quantitatively-minded people. The point of the discussion is to let the non-quantitative people "through the door."

Mr. Rousselot moved on to the next topic, "Information Systems," but noted that it had already been discussed that morning, and suggested proceeding directly to "Automation."

Automation

Someone asked for a clarification of the meaning of the topic. Was it automation in the sense of using machines to replace routine management functions in the way that machines are used to replace people in the manufacture of cigarettes?
Mr. Sokolov replied that the topic refers to special automated procedures developed to ease the process of planning and management and to furnish information for high level executives. An information system is the initial stage of the automation pro-

cess; the final stage is the development of optimal procedures for planning through use of computers. Engineering design is just part of this problem.

Mr. Rousselot suggested that the topic as defined at that point would be better discussed after consideration of the decision making topics. It makes more sense to discuss optimization after the process had been discussed. Thus, he directed the group's attention to the decision making topics.

Decision Making

One participant commented on Topic Sixteen to say that IIASA could best serve as a facilitator in the field of subsystem design. However, the Institute needs to make an early contribution in the field of urban systems study, and Topic Sixteen would be particularly appropriate for such work. IIASA's main role should be as a facilitator of national work--e.g. through sponsorship of conferences, coordination of bilateral contacts. But IIASA should make an exception to this rule in its early years and choose one specific subsystem--such as transportation--for research with a high probability of being useful that would demonstrate the value of systems analysis. Someone else suggested choosing such a project only after checking the results of the conference held in Sweden by Per Holm on housing research.

Mr. Raiffa suggested the waste recycling subsystem as a suitable topic. Other topics might include the municipal management of water, pollution control, and health aspects. He noted that the Medical Systems Planning Conference would likely also touch on these topics. He welcomed discussion of particular subsystems which would be of interest.

A member of the Soviet delegation said that any of the subsystems already mentioned in the Soviet booklet would be topics that he would favor. These include transportation, public services, urban engineering equipment, and all of the specific problems just mentioned by Mr. Raiffa.

Someone asked whether it would not be possible to compress the list of topics in this area. The method of compilation of the list probably generated items that use different words to describe the same topic. Another participant agreed, saying that Topic Nineteen is the same as Sixteen, while Topics Seventeen, Twenty, and Twenty-four probably belong in the methodological overview section.

Another participant suggested examining the relationships between the subsystems from the point of view of their substitutability and of their multiplicative effects. Mr. Rousselot observed that these suggestions seemed to enter the strategic and tactical planning fields.

One participant urged the group to select a few very specific programs to recommend for IIASA in-house work in the next year. He noted that a time-honored technique, when one does not wish to consider more than a part of a system, is to call the other parts environment or externalities. IIASA's end goal is the modelling of a large city or region, but it should build up to this by working on a few subsystems. Mr. Rousselot observed that this is precisely why Mr. Raiffa had requested an indication of priorities.

Another participant said that much good work is currently being done in this field. IIASA's most important contribution would be to hold a conference to facilitate the exchange of models and other ideas. The work itself is very expensive, requiring concrete problems, data, and computing. IIASA could use the conferences as a means to help choose the research program for later years. Mr. Rousselot added that such a conference could be used to help set priorities. He noted that there are methodological problems in the decision making field (e.g. Topic Seventeen) and suggested that these might make a good IIASA in-house project.

Mr. Raiffa responded that this area is so close to his own field that the only danger was that IIASA would have too much work on it. He could easily see undertaking a review of past work in decision and control theory and seeing how it was applied to urban problems. Mr. Rousselot said there were two ways to work in this field: the first would be to study the more technical problems; the second would be to focus upon the linkages and interactions between analysis and the decision making process itself. Someone had presented such a study the previous day and others exist. These less mathematical topics would come under Topic Twenty or perhaps under Topic Seventeen. Mr. Raiffa commented that an important point at the organization meeting had been that there is a "missing chapter" between the analysis and the implementation phases. Currently, models are inadequate to represent the administrative and political realities. This gap poses an important problem.

One participant addressed himself to the problem of disaggregation of criteria. Each subsystem has its own local criteria which it uses for its own sub-optimization. The global system works according to a new, aggregated set of criteria. In going from the global systems to the subsystems, one introduces additional criteria. This disaggregation has a structure which may or may not be rational and which must be explored. Someone else said that this point is profoundly important; subsystem decisions may look irrational from the larger point of view. If one wishes to be effective as an analyst, one is almost forced into using the same set of criteria as the subsystem in question. Mr. Rousselot remarked that these notions relate to the theoretical and economic studies of decentralization. Rules, regulations, and criteria are determined at the subsystem level so that the overall system can function.

Someone else re-emphasized the gap between models and the real world and suggested specifying an additional topic--implementation.

Mr. Raiffa added that there will be an in-house methodological project on decision making processes in large organizations in which hierarchy theory and feedback controls will be covered.

Someone called attention to the existing large amount of data on time budgets. He said that time imposes the outer constraint on urban systems, on control of large systems, and on decision making, and suggested trying to work with this data. He also agreed with previous speakers that Topic Twenty-one is very important and not well dealt with in current work. In his country there is now some effort in this field, and there is an attempt to instruct planning officials in cost-benefit techniques for resolving equity questions. However, there is more to the topic and it seems an appropriate field for IIASA.

Another speaker mentioned that there is much interest within the urban planning field in time budgeting. The Swedish school of geography has developed time-space models which may be applicable to planning decisions.

One of the participants pointed out the relationship between Topics Twenty and Twenty-three. There are two ways to look at control: first, as a powerful hand controlling a hierarchical set of subsystems, or second, as a set of controls socially distributed over different types of services. One of the facts of large organizations is that people find it very difficult to break away from their pattern. Social processes founded with small blueprints still grow large. An important issue, perhaps suitable for IIASA work, is how to break this apparent causality. Mr. Rousselot noted that these topics would also be covered by the design and management of large organizations project.

Mr. Raiffa added tangentially that the organization conference had discussed the possibility for IIASA to suggest the creation of new organizations to deal with certain problems. For example, many different groups are involved in planning for the Danube. IIASA could study these organizations and the institutional constraints on affecting use of the Danube, and then suggest new ways of organizing the groups to deal with this area. He asked whether there were analogous situations in the urban and regional field.

Someone said that of all of the concrete proposals made up to then, this one made the most sense to him and promised the greatest impact in the shortest period of time. Another person noted that there are many examples of commissions that have not succeeded; it is harder to find those that have.

Mr. Rousselot asked if there was any support for Topic Twenty-four. One participant said that he strongly supported it because one of the purposes of IIASA is to clarify systems analysis and its methodologies.

Forecasts

Mr. Rousselot moved the discussion to the next topic, "Forecasts," and said this was a field where there is already much work and in which much data is required. He had difficulty seeing what IIASA involvement could be. Forecasting is a strange field in which much depends upon the group for whom you make the forecasts. Also, most forecasts seem designed to point to those things which you do not want to occur and thus are difficult to evaluate. A Dutch economist, observing that population forecasts grow every year, has suggested that it is less annoying to forecasters to underestimate than to overestimate. Mr. Rousselot suggested that IIASA pick one aspect of urban forecasting and make a cross-national study of good forecasting technique.

One of the participants said that IIASA's strategy should be to look for "areas of leverage" where small but critical inputs could be made. Forecasting, reducing the uncertainty of the future, is fundamental to the entire research agenda. One must distinguish between positive and normative forecasting; there are interesting problems in both parts. In the normative case one makes conditional predictions: "If these policies function, then we will get such and such a situation in the future." In the positive case, one foresees problems in order to be able to take steps to prevent them. There is room for research on both of these. For example, in spatial forecasting there are large degrees of spatial autocorrelation. The fact that there is not independence means that simple regression routines are not available. It is like the economists' time series problem, but over space instead. Analytic solutions seem distant, but there may be possible numerical approaches.

Mr. Raiffa commented that there are currently bilateral negotiations between the US and USSR academies of science. One of the topics included in the discussions is the whole area of econometric techniques--hard and soft ware and data handling methods. Another area is the role of the computer in municipalities. IIASA could make this bilateral exchange multilateral.

With respect to forecasting, Mr. Raiffa said that numerous people have worked on econometric techniques for many years. IIASA could serve as a conduit for information via conferences. The techniques available for long-range technological forecasting fall far short of the needs. (This was also discussed at the energy conference.) This is an area in which good methodological work might be possible. People are repeatedly making the same mistakes. There has been intermediate range forecast-

ing in the corporate sector for many years. One might be able to carry these techniques over to the governmental sector. There, decisions are usually sequential, so that near optima are obtained in the medium range; moreover, the long term tends not to be important. By contrast, technological decisions have very long term effects. If we are concerned with the longer range, we should discuss the metropolis of the future.

Mr. Rousselot said that there are two sides to the forecasting question: a) the available techniques, and b) the psychological, social, and political environment for use of the forecasts.

Mr. Haefele expanded on that point by saying that it is important to sketch long term scenarios in order to determine which near term scenarios are compatible with the desired future. In the energy conference it was mentioned that there are many near term (ten years) national studies but few looking to the far future. Such a study would be a task for IIASA. In the future, what are currently side effects may become first order parameters, as has happened in the last twenty years with waste disposal. IIASA should focus on identifying the compatibility of existing options with preferred futures.

Someone else said that he would support undertaking this project at both the national and IIASA levels. The national work would be more specific, the IIASA work more on theory and methodology. Long term forecasting is especially important for municipal problems because once a town is constructed one has a plant which will last for many years. In his country there has been some attempts to carry out this kind of forecasting.

Another participant said that he had tried to consider whether there was a single problem not covered by the other IIASA research projects which might serve to organize the entire IIASA urban research program. He concluded that such a problem does exist: that of urban and regional processes, especially when considered in a theoretical setting. This includes three subjects: a) the information system required to explore these processes, b) the problem of planning based on the theory of processes, and c) optimization and control. This would give the project a logical and ordered structure.

Mr. Rousselot asked whether what was envisioned was a set of mathematical representations or rather a general (cognitive) analysis of how the systems evolve and, thus, a study near to Barel's proposal. The participant replied that his conception was closer to the second suggestion.

Strategic Planning

Mr. Rousselot directed attention to the "Strategic Planning" topics. He noted that they covered a very broad field in which there already exists some work. The question is what IIASA could do.

One participant referred to Topic Twenty-eight, "Disaster Control," and said that the previous day he had tried to indicate that we must develop both quantitative and non-quantitative methods for risk evaluation, especially of rare events with large consequences. This has effects on the design of large scale systems. He asked what the topic originator had meant by disaster control. Systems are larger than in the past, their consequences greater.

Rather than respond to this question, one participant remarked instead that he found Topic Twenty-six important. Every country is confronted with settlement issues; they are profound questions in developing countries. A common thread is the need to find appropriate criteria for assessment. The problem tends to fade into the question of national and individual welfare and arguments about future discounting, but it is an attractive, challenging, and demanding field for IIASA. It does not require great resources but rather conceptual development and analysis.

Mr. Rousselot saw two levels of approach: 1) look for an optimum or desirable settlement pattern for a specific country, work out the criteria, and compare the results to work elsewhere, or 2) admit ignorance of what is best in the long term and merely assert that certain current processes are clearly bad and attempt to devise corrective policies. The economic organization of the countries would alter the levels. There is room here for interesting research on possible public policies and on overall strategies. Again, the question is: What could IIASA contribute?

One participant supported the previous speaker. He noted that the question of national settlement policies connects with many other issues and affects all nations. Interesting work can be done in a fairly short time period. Such research would have strong links to other IIASA work: to resilience in the ecological project, and to resource management in the energy and water projects. Since the problem exists at the regional or national level, it is not constrained by instrumentalities, institutions, or policy leaders. Moreover, as particularly it is a new field, it is relatively easy to do original and interesting work. There should not be great concern at this point with specifying an ideal distribution or structure, but instead work should be done on the theory of urban and regional process and spatial interaction. Much of Topic Thirty-one is contained within this area. IIASA's first step should be to conduct a comparative survey among the more advanced nations and perhaps to convene expert conferences to identify key problems.

Mr. Rousselot said that a comparative study by OECD does exist in this field, but that the questions were formulated too generally to produce fruitful results.

Someone observed that these proposals relate to the suggestion for studying urban processes. There are dynamic questions here--e.g. why does one city grow faster than another? Two approaches are needed: a longer term, systematic study that covers the hard policy questions, and a shorter term study of some subsystems. Finally, he noted that the problem of settlement policies had frequently been mentioned, and thus appeared significant.

One participant cautioned against trying to explain results by policies. Society is a large system; policy has but a small input. For example, in one region of his country, transportation policy has followed the same guidelines since the beginning of the century, but the results have been changing over time because of changes in the regional power structure. In comparing the policies of different countries, one must be careful not to neglect the differences in the ways they enter the social framework. Government, economic, and social forces all affect implementation. There is a need to specify the kinds of questions that should be examined and to establish a tractable framework. IIASA should have a small team, or even one man, to do this.

Another participant believed that IIASA will run into difficulty at the level of the reasons behind national settlement policies, and data will not be available. He suggested combining Topics Twenty-six and Twenty-eight and studying how settlement policy affects environmental quality and disaster control. Most disasters occur because some threshold was not observed by planners. Topic Thirty-one could also be linked to this.

It was pointed out that policy evaluation problems--e.g. "How well do national settlement policies perform with respect to disaster prevention?"--are interesting but sensitive. There are less normative questions that could be chosen for research.

Mr. Rousselot remarked that the discussion to that point indicated agreement that this was an interesting and difficult field in which IIASA should begin cautiously. This puzzled him, as one of the major proposals seemed to support going far in this field.

Another participant understood the discussion differently: he thought the consensus had been that these problems are important, but IIASA must not be optimistic about finding solutions. However, small contributions would be quite possible, especially if more effort were invested in the field.

Someone else supported study of the disaster control topic, noting that perhaps it should be called "prevention" rather than "control." There are many aspects to this in seismic areas, for example, or in areas subject to flooding, or tsunamis. It would be desirable for IIASA to collect information on disaster prevention in different countries and on the technical instruments they use.

One participant commented at length about disasters. He noted that solving the modelling problem and being able to predict disasters does not solve the social problem. Men resist facing the possibility of disaster because they resist thinking about death. All social systems evade disaster and refuse to consider them. To forecast disaster, the system requires enough courage to overcome its inbuilt resistances to such forecasting. This psychological reality must not be ignored in constructing a rationalist approach.

Mr. Raiffa summed up this part of the discussion by saying that study of planning of new towns might be a politically reasonable approach leading to the problem of national planning policies.

Someone pointed out that Topics Twenty-six and Thirty-one are related as are Thirty-two and Thirty-one. There are interesting problems in the field of planning for new towns which tie these topics together. Examples include determination of town location, function, and size in terms of national settlement policies, and designing the integrated delivery of social and other services. This latter could give rise to a small but interesting in-house project focusing especially on the externalities generated by services.

Mr. Rousselot said that the proposed work would be important and interesting and noted that there is much work currently being done on new towns. However, the planners have little time for theoretical or general problems. It would be interesting for IIASA to undertake a topic such as the organization of municipal services in new towns.

One participant said that there is already much work on this problem. The expected marginal productivity of IIASA in this field is rather small, especially since there are so many different motivations for building new towns, ranging from populating Siberia to emptying London. IIASA should not put too much energy into this problem, and should undertake systematic comparisons rather than empirical work. On another point, he noted that there had been much discussion of material, or physical, infrastructures. He suggested paying more attention to the information channels in systems and to their role in institutional development.

One person remarked that a problem in the planning of new towns is that the construction lasts much longer than the government policy. It would be interesting for IIASA to make a theoretical study of the robustness of land use planning in the face of policy changes.

Tactical Planning

Mr. Rousselot suggested discussing the tactical planning topics, noting that they overlap the strategic planning area.

Someone asked whether the short-term portion of Topic Thirty was really the same thing as Topic Sixteen stated in different terms.

Mr. Rousselot replied that Topic Thirty, considered as a tactical subject, suggested study of the management of the planning system and of municipal services and of the interaction between these. He also remarked that there were proposals for building large scale models for the optimal planning of town growth. He pointed out the cross-cultural problems in building such models and asked whether perhaps IIASA would do better with less ambitious models, like those which Mr. deLeeuw discussed the previous day.

One participant cautioned against speaking of optimizing in the context of complex systems. Only simple and clear systems can really be optimized; with the others, one can at best examine different results. Someone else said that optimization of complex systems did not mean achieving strict optimality in the sense of linear programming.

Another participant said that the only operational large scale models he knew of in his country were those built for short and medium term planning in the industrial sector. Mr. Haefele stated that complex long term models exist in the energy field.

The first speaker on this topic replied that a major fallacy in planning is to assume that one can optimize an objective function. The objective function in planning however, does not exist, unlike in business where there is a single goal. Mr. Raiffa objected to this point, saying that it is a fallacy to assume that business has only the goal of maximizing profit. In fact, there are many goals and trade-offs and strategic decisions must be made.

Another speaker agreed with the first speaker that in general optimization is not being done in the planning sphere. He suggested deferring further discussion for private conversation. He added that he had only seen large scale models used in his

country for trivial planning problems. One participant objected, saying that the World Bank had been using such models for agricultural investment decisions.

Mr. Rousselot suggested discussing how IIASA might work in this field rather than comparing different kinds of modelling. He mentioned the previously proposed idea that IIASA evaluate past planning efforts or models, i.e. that IIASA not develop models as an in-house project but evaluate those done elsewhere in its program of international cooperation. He noted that Topic Twenty-eight had already been discussed, hence the group had discussed the entire list. He invited further comments.

One participant suggested working on problems easily accessible from Vienna as it is important to have easily available data.

Mr. Rousselot noted that the January paper had already raised this question of the organizational format for IIASA. It will be difficult for IIASA to carry out field work. It can have a small in-house group, coordinate work in different countries, and promote exchanges. With respect to the last suggestion, IIASA should identify topics of high priority and then discuss with the Austrians, and with others, specific potential cooperative projects.

Mr. Raiffa welcomed further comments on concrete problems for IIASA interaction with national research, especially with research in Austria.

One of the Austrian participants said he would be very willing to do this and added that he was anxious to establish the relationships between the urban and the other IIASA projects. He asked Mr. Raiffa to comment on what the next step would be in developing the research program.

Mr. Raiffa said that he would encourage the people at the coming conferences to consider the overlaps between projects. The IIASA staff would be preparing Proceedings of the conference; he encouraged the participants to submit after-thoughts in the following weeks and later. No firm decision would be taken after the conference. Instead, all of the conferences would produce tentative conclusions. Then, a conference of experts representing all of the research fields would discuss overlaps and attempt to devise a program.

Mr. Raiffa thanked the participants for attending the conference and urged them to maintain close contacts with IIASA. Mr. Rousselot added his thanks, and adjourned the conference.

Presentation by Mr. Thompson: "Linkages between the Urban and Regional Systems Project and Other IIASA Work"

Mr. Thompson reported on the survey responses to the question about interaction of the IIASA municipal project with other IIASA projects. A breakdown of these responses is shown in Table 1.

He said that the responses were encouraging. All of the previous IIASA planning conferences had been interested in coordinating with the municipal project. In particular, the energy group saw connections with the municipal project for the siting of power plants, for land and water use, and for climatological considerations. The papers received in the first two days of the meeting had suggested ties to the projects on energy, water, management, health services, ecology, and information systems. One paper had suggested five specific topics that could be studied across projects: international airports, power plant siting, design and management of new towns, the automobile in the urban situation, and intergovernmental relations (comparative research on interaction between central and local planning agencies).

One of the respondents commented that so long as IIASA remains small, interaction will be no problem if IIASA has a good restaurant.

Another suggested strengthening links by using a common methodology for all of the projects. He proposed systems dynamics.

Finally, someone felt that the two most important ties were those between the urban project and the ecology and computer projects. The first tie suggests the study of the biological meaning of life within the urban context. The second tie suggests a syntatical method for dealing with the interplay of urban phenomena and for resolving the tensions inherent in control of a dynamic system.

Table 1

Number of survey responses suggesting specific projects linking the Urban and Regional Systems work with other IIASA topics.

Water Resources	2
Design and Management of Large Organizations	3.5
Energy	5
Medical	2
Ecological	10
Computer	2
Control of Integrated Industrial Systems	5.5
Optimization and Control of Complex Dynamic Systems	5

Presentation by Mr. Domanski: "Cooperation between IIASA and National Institutions"

Mr. Domanski reported on the responses to the questions on possible cooperation between IIASA and national research institutions.

He said that the broadest response was given to the question asking for potential institutions for participation in such cooperation. Thus, he foresaw extensive international coordination.

The question about the benefits expected from cooperation with IIASA elicited such responses as: improved communication with other countries, direct contacts with other scholars, IIASA sponsored conferences on specific topics, and improvements in models and methodologies.

The third question, on the potential benefits to IIASA of cooperation with national institutions, brought forth such answers as: opportunities for IIASA scholars to discuss their work with national institution researchers, possibilities for acquainting IIASA scholars with empirical research being done in the cooperating countries, exchanges of scholars, and the opportunity to assess national research in this field.

The above comments had been made in response to the questionaire. The same day, the Soviet delegation had presented a special document on cooperation between IIASA and other bodies. The most important points included the suggestion that IIASA develop a joint research program for national institutions, exchange information on the results achieved, organize conferences and panels, and form expert panels for assessing this work and making recommendations.

NATIONAL PROPOSALS

FOR

IIASA RESEARCH TOPICS

AUSTRIA

1. Collection, production, and organization of data and the production of new data, e.g. by interpretation of aerial photos. IIASA should study how this might be done and the marginal costs associated with different methods of production. Clearly, such work presupposes definition of problems and objectives.

2. Strategies for generation of new hypotheses.

3. Model construction on the basis of new planning instruments--infra-structure, control of infra-structure by individuals, tax management, and information strategies.

4. Development of a terminology adequate to cover all of the various disciplines which contribute to systems analysis studies.

A Broad Outline to Aid Definition of Specific IIASA Research Projects in Urban and Regional Systems

D. Boekemann and E. Matzner, Austria

I. Theoretical Structure

A. Production of locations

1. basis: hierarchical structure of territories according to competence of disposition: plot of land, community, state, federation

2. single and compound characteristics of communication and supply systems according to prerequisites of interregional division of labour

3. production functions of locations according to a special utilization

4. hierarchical differentiation of the locations' production function according to the administrative and territorial characteristics of public objectives

B. Use of locations

1. specification of land owner and land user interests in utilization

2. role of infrastructure in production and consumption (stock and flow of locational facilities)

3. location potential of settlement (to calculate for plots, communities, or larger regions)

4. changes in land use effected by infrastructure investments (in the special case city: core and fringe)

C. Effects of hierarchically differentiated competences of disposition on locations: cumulative tendencies in the physical system

A Tentative Suggestion for a Research Project on Urban Planning

E. Matzner, Austria

1. Cities can be defined as areas with particularly intensive externalities. Positive externalities are regarded as a major source of urban growth. Negative external effects (e.g. pollution) are an important factor of urban blight. The knowledge of the nature of externalities in urban areas, therefore, are a precondition of their domestication. Urban planning, in its turn, is not possible without an effective control system of externalities.

2. A IIASA research project is therefore suggested which could:

a) investigate the nature of external effects in urban areas. The distinction of externalities in separable and non-separable ones, as proposed by D.A. Davis and A. Whinston* could serve as a workable starting point;

b) classify important externalities in relevant urban functions in separable and non-separable ones; and

c) design control-systems for the most important urban externalities, first, for isolated urban functions (e.g. transport) and second, for urban functions in their real world contact.

3. Research on externalities in urban areas would integrate problems of environment, energy, management, water supply. It offers, therefore, a basis for cooperation with other IIASA projects.

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* Cf. D.A. Davis and A. Whinston, Externalities, Welfare, and the Theory of Games, in: Journal of Political Economy, Vol. 70, 1962, p. 241-261

1. properties of location markets

2. role of budget in changes in location potential of settlement

3. potential of disturbance for other users effected by one used location

4. general problem: external effects, spill-over and spill-in effects

D. Demographic effects

1. determinants of migration in infrastructure planning: education system and working place investments

2. migration in different scales: international, national, urban-directed and intraurban (problem of "Gastarbeiter"--workers from other countries)

3. determinants of slum development

4. social erosion in different scales: poor inner-urban districts, poor regions, underdeveloped countries

E. Political aspects - decision processes on the basis of institutional structures

II. Methodological Problems by Cross-section through I

A. Strategies for collection, production, and organization of data: databanks, photo interpretation (use of experience in the military field for generating new data for energy, pollution, and other congestion characteristics,

B. Strategies for generating new hypotheses for applications in the field of planning, on the basis of existing data

C. Strategies for model construction based on planning instruments (intervention by public instruments) as exogenous variables

CANADA

1. The question of national policy for settlement of the country. Spatial distribution: problems in this area keep recurring on several different spatial scales.

2. The integration of services and delivery systems. Relationships between central and local governments; bargaining among levels. (De)centralization.

3. Social indicators, which depend on the theory of what constitutes a good society as part of an information system so that one hears about problems and in terms which permit corrective action--e.g. in terms of budgets rather than of fertility rates.

4. The theory of regional planning as it relates to the stability of eco-systems.

Some Avenues for Urban Systems Analysis

Harry Swain and Allan O'Brien*
Canadian Committee for IIASA

(Note: The concluding section of this paper will be found elsewhere in these Proceedings under "National Research on Urban and Regional Systems.")

It is with no little humility that we venture to put forward some suggestions about the possible directions IIASA might take with respect to research on municipal and regional systems. Both of us have been involved in research planning exercises before, and both of us know that there are usually vast differences between those glowing statements of intent we all start with, and the post facto rationalizations of what actually happens. Indeed there is a fundamental sense in which all real research is inherently unplannable: the best one can do is to select truly excellent scientists, within a broadly defined domain, and turn them loose. The output of this Planning Conference may be the construction of a test of this hypothesis.

We will begin with some remarks on the kinds of constraints we perceive IIASA to be operating within, which ought to be susceptible to restatement as guidelines for the choice of a particular research strategy. With these in mind, we go on to suggest several areas in which research by the Institute might be able to make substantial contributions to the areas identified.

What Choices Are Possible, and Which Desirable?

1. IIASA is an international non-governmental organization operating in a most interesting political context. There will probably be grave difficulties in performing research which strikes too critically at the ideological foundations of member countries, or which could embarrass them in the pursuit of present policies. On the other hand, the Institute is the product of many fine minds working together over a long period of time. Great expectations are reposed in this unique organization. To some small but finite extent, the course of multinational cooperation in research on critical social problems depends on the quality of the Institute's output over the

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next three to five years. The demands for innovative brilliance will be extraordinarily high.

2. Stemming from this political context will be the temptation to create a kind of Institute of Advanced Studies concentrating on the most abstruse theoretical and methodological questions for their own sake. This should be resisted, at least as a program for the entirety of the Institute's activities. There should be a conscious attempt to seek avenues for the translation of research results into action: we should be looking for a critical and independent kind of policy research, with all that that implies in terms of timeliness and attention to what Etzioni calls the "differential malleability" of elements in our urban environments. Basic theoretical and methodological work has to be part of the IIASA program, we believe, but even then, should be directed towards areas where there is a strong potential for application. Applied work, in turn, should presumably seek to attach itself to opportunities for policy change in member nations or in the international arena.

3. One way to view the purpose of the Institute, we would suggest, is to see it as providing a common context and language for research on social and economic policy, broadly conceived. The chosen language is systems analysis. This in itself imposes a sort of constraint, for not all urban research problems are equally amenable to analysis by these methods--though that depends to some degree on the catholocity of the definition of systems analysis: our esteemed Director sometimes makes it sound as if it encompasses all the methods of rational science!* To put it another way, there are problems in urban policy which stem from the failure to implement solutions; and there are problems which stem from scientific ignorance of causal mechanisms. With an important exception which we shall come to later, it is problems of the second sort that ought to concern the Institute.

4. A short point, but an important one:
commonalities in methods of analysis ought to be sought among the nine areas chosen for emphasis by the Institute. Relations and synergies with projects in the other fields ought to be assiduously cultivated.

5. Presumably the projects chosen should be of interest to more than one or two nations. Parochial problems are not the Institute's concern, and we should be seeking more-or-less fundamental problems common to many of IIASA's sponsors. While this should not be allowed to become an excuse for the sort of overly abstract approach alluded to above, it does raise an interesting question to which we think the Director must give some explicit attention in his recommendations to the Council. To what extent do the problems of IIASA's sponsors include the concerns of the poor nations? This is not without importance in choosing projects in the urban field, as the problems

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*Howard Raiffa, "An Initial Research Strategy for the International Institute for Applied Systems Analysis," Feb. 1973.

of Lima, Manila, and Calcutta are radically different in human urgency and policy prescription than those of our more comfortable homelands. While some of the suggestions below have attributes of universality, we have in the main elected the conservative assumption that we are basically concerned with urban research in the context of advanced industrial societies.

6. The extent of IIASA's resources is another obvious constraint, probably the more interesting because it raises the question of the kinds of relationships that should be sought with other organizations with collateral interests. In the international field alone, urban research is pursued by, among others,

- Organization for Economic Cooperation and Development;
- various UN agencies, including the Economic Commission for Europe and the Vienna Centre (UNESCO) down-town;
- the International Union of Local Authorities;
- the International Federation for Housing and Planning;
- the World Bank; and many others.

Another general question which we would like to address to the Conference, then, is the nature of relationships that should be sought with these kinds of organizations. On the one hand, duplications of effort could be costly in more than monetary terms; on the other, machinery to assure complete harmony could easily account for the Institute's entire budget.

Suggested Areas for Research Projects

The preceding comments must be seen as a short, non-exhaustive and non-dogmatic set from two individuals whose interest in IIASA is only matched, unfortunately, by their ignorance of discussions which must already have taken place. Nevertheless, it has been helpful to us to attempt to box in a feasible set of possible research areas from the universe of all interesting things. And we have one or two ideas to propose which seem to survive this kind of screening.

1. We were glad to see in M. Rousselot's preliminary paper the prominence given to the subject of national urban policies. Specifically, the research question par excellence is the relation between policies on the spatial distribution of population and economic activities on the one hand (which tend to be, like transportation, only instrumental goals) and the more usual criteria of social well-being on the other. Nations as diverse as Canada, Poland, Israel, Holland, Hungary, USSR, UK, France, and Australia have in practice now, or are trying to develop, explicit policies and programs related to the settlement pattern of the country. There is a profound need for research on the relation between the distribution questions, at national and macro-regional scales, and such commonly accepted goals as economic

growth and development, social mobility and opportunity, equity and justice, environmental quality, and so forth. A considerable but rather inconclusive literature can be cited on either side of this question, but a reliable relation is absent. This in turn is due to the absence of robust theory on the relations between town and city, city and country, nodal hierarchy and circulation system which are the fundamental questions of central place theory.* One could propose the development and empirical testing of theory in this area, using continuous and probabilistic mathematics rather than the sterile deterministic geometries of the past, arm in arm with an explication of the causal links between spatial economic processes and the 'quality' criteria. Practical offshoots are many: in the location and functional planning of new communities, in dealing with regional disparities, and in giving some foundation to national (spatial) urban policies in general.

A different kind of question would be a comparative study, leading to formalized models, of the process of development of urban policies in differing national systems: unitary states versus the various kinds of federal states. There is considerable evidence that intra- and inter-governmental bargaining and negotiating processes are themselves strong determinants of the kinds of policies that ultimately result. Simeon's Federal-Provincial Diplomacy puts the case well for the Canadian context albeit in different substantive areas. Arranging for participation in planning by the affected publics becomes doubly problematical when the real choices are settled interbureaucratically.

2. At the scale of the city or metropolitan region itself, there are a large number of useful questions. Some will be dealt with in considerations of health care systems or other topics on the IIASA agenda, and deliberate links should be sought with the urban projects. Several stand out as being uniquely important to this theme, however.

a) One has to do with the integrated planning of the delivery of social services. If fire, police, health, welfare, community services, dog licensing, etc., as offered to the public by three or four 'levels' of government could be planned in an integrated fashion, substantial economies should result, as well as some less tangible spin-offs in terms of convenience, neighbourhood identity and cohesion, and so forth. A good empirical study, looking at the supply and demand characteristics of a wide range of services together, paying special attention to so-called second-order benefits, could establish a general method for transfer to other places.

b) All nations, whatever their political structure, have to wrestle with financial relations between levels of government. Perhaps the comparative analysis of inter-governmental financial systems for urban development purposes, with emphases

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*These questions are treated at length in H. Swain, Central Place Networks, University of Minnesota, 1970 (University Microfilms, Ann Arbor, Mich.), esp. chapters 6 and 7, pp. 113-60.

on the redistributional effects of tax and expenditure policies, on the efficacy of tied or conditional funding by senior governments, and on distortion of local priorities and planning processes could be undertaken. Questions of fiscal squeeze, urban-suburban exploitation, and the spatial distribution of costs and benefits of urban programs all arise here.

c) A theoretical basis for indicators of social well-being and urban environmental quality is badly needed universally. The question is, how do we reliably measure important ingredients of the quality of life, however it might be defined in different societies, and how do we tie those measures to Etzioni's "malleable policy variables"? How do we arrange meaningful public participation in the articulation of goals and the selection of measurement techniques and indices? Again, the research to be done is largely theoretical and conceptual, tying together a mass of local empirical fits and starts, and is a classic for systems methodologies. Perhaps IIASA could start where OECD left off.

d) The general relationships between energy sources and urban form are but dimly perceived. Our societies tend to take petroleum and the automotive society to be some kind of resource-in-perpetuity, and to plan and worry within that framework. Better to ask, what will be the effects on cities in advanced economies when the price of gasoline, relative to other prices, climbs three or five times over its present levels? More mass transit, fewer cars (or vastly more efficient ones), better insulation in buildings, etc.: these may be obvious, but the second-order reverberations through economies so finely tuned to the availability of cheap fossil fuels will be enormous. This falls within the general, and fashionable, area of technology assessment,but is a peculiarly important one from an urban point of view. Closely related is the question of the impact of new communications technologies on patterns of urban life; the connection may be in careful measures of the income-elasticities of demand, and substitutability among, transportation and communications.

3. More generally, or at any rate independent of spatial scale, is the question of moving the planning mentality away from single-point "optimal" or equilibrium-centered modes of thought. This ties in directly with Prof. C.S. Holling's Institute project on mathematical ecology, where the thrust is to demonstrate that perturbations of complex systems may have minor effects on equilibria but major ones on the boundaries of system stability. Much more work needs to be done with human systems to understand the nature of the stability limits, beyond which random or 'straw-on-camel's-back perturbations may induce the crashing of the system into weird and unpredictable new configurations. The translation of Holling's work into urban and regional planning frameworks should be an IIASA priority.

4. Earlier we noted that there were two kinds of policy problems: those with known, or at least tryable, solutions, and those without. We suggested that the bulk of IIASA's attentions should be turned toward the latter. The exception, however, is so singular that it requires special mention. We refer to the role of scientific information in the policy or decision making process. Too often we have seen the acceptance of the facile assumption that better information means better decisions. As a last and open suggestion to the Symposium, we would urge the consideration of projects, either in this theme or in others, which seek a comprehensive understanding of the decision process in very large organizations, and of the roles played by rational analysis therein, and which would try to design more effective routes and formats for the condensation and transmission of research results into the decision process. In fact, a kind of experiment or demonstration could be arranged in the planning of the Institute's own interactive computer graphics, library, and publication systems.

A Concluding Comment

Most of the suggestions we have put forward in this section relate more or less directly to that elusive object called the quality of (urban) life. It is but partly facetious to say that the only thing known about a desirable quality of life is that it seems to vary a lot, among individuals as among societies. What should never be forgotten, however, is that a systems analysis which does not have a place for human values, aspirations, and even frailties is a pretty sterile instrument. Elegant theories, mathematical abstractions, and rational causes earnestly pleaded will continue to enjoy only their present tenuous and haphazard connection to the realities of policy and decision unless they can be illuminated by the confounding complexity of human cussedness.

F.R.G.

Use of common methodology (e.g. systems dynamics) rather than just content relationships, to tie IIASA research projects together.

FRANCE

Proposals for IIASA Research Topics

Applied systems analysis needs more fundamental research both at the methodological and theoretical levels. But it has to be applied, otherwise it will be considered as useless.

Two great dangers:

1. Having only applied work begging for theory.

2. Having applied and theoretical research that do develop separately.

The leader of the project will have to keep the balance between the two and to make communication compulsory within his team.

This proposal attempts to sketch a way of doing this. Clearly there are far more possibilities than can be really achieved. This is meant as a mere example, hopefully realistic from an organizational point of view.

Topic	In-house Scholars	Outside Scholars
General Systems Theory & Epistemology This scholar is a member of a small group cutting across all the projects: he is in charge of clarifying the logics of systems reasoning, making clear the faults, the difficulties, the differences and the similarities both at the theoretical and methodological level. After calling attention to all common fallacies in current systems analysis, it would be useful to attack the problems of causality, hierarchical dependance, and dominance.	1 (part-time)	Another scholar in each of the other projects and possibly a small international group. One or two Frenchmen could be interested.
State of the Art in Urban & Regional Systems Research This work should call upon all sorts of research that could help attack fundamental method questions: how to identify a system, how to identify a hierarchy of systems, are there different types of reproduction within urban systems, how to describe the various flows of information, how to study the various forms of control. This requires secondary analysis of first rate field research.	1 (part-time)	In each of several member countries there might exist a panel of scholars working along the same line. The IIASA scholar could visit them several times a year. With possible international meeting of those experts in Vienna once or twice a year. A French group could be set up.
Field Research on Methodology This small team should make a modest attack on actual cities. It should try to show the effectiveness of a set of common methods in order to identify as many systems as possible in each city. Those systems should be fully described and documented.	3 (part-time)	Multiple connections within IIASA: In 3 countries or so, they should select a team working on a large study encompassing many aspects of the urban phenomenon. These teams should have a strong knowledge of this field and be committed to theoretical research. Otherwise, cooperation may be very ineffective. This may require special surveys

		Nice, Grenoble or Fos/Mer could be possible fields for that research. They should call a convention of scholar and study teams after 24 cases.
Evaluation of Already Completed Schemes This scholar should work on a project evaluation. It would be necessary for him to make a historical study of the scheme and to trace the various decisions and control levels that did interfere. There he would be in a position to decide along which criteria the scheme should be evaluated. He would then proceed to evaluate it.	1	Within IIASA he should be connected with the large organizations project. One task force in the country where the scheme is located should be associated to the whole work. This is an absolute necessity to avoid grave misunderstandings and diplomatic difficulties. Possibility for this could be investigated in France at the urban level or at the regional level
Model Case Study Generalization Three scholars whose work on a specific government oriented problem (municipal services, land use, housing, transportation) has proven outstanding in their own country could be invited to spend one or two years in Vienna in order to prepare a large conference associating scholars in their field and urban political leaders from the various member countries. They would have to show 1) under what conditions their work can be transferred to other countries, 2) at what cost, and 3) what kind of benefits the member countries would reap from using their techniques. This work should be compared to the field research on three towns done at IIASA in order to see whether this raises unexpected questions. One might seek to simulate a transfer of this new technique in each of these 3 cities, for instance.	3	Each of them should assemble a group of experts from various cities in the member countries and start explaining to them their own work as well as the context in which it was made. Then they would proceed to a study of 1) the technical changes in the models and the data gathering process that would be required for the technique to be transferred, and 2) the organizational change or set-up necessary to implement the new solution (they should call upon people from the large organizations at IIASA). The work should be carried as far as possible by each member country and a report delivered at a final international conference held by IIASA. No proposal from France may be associated.

G.D.R.

1. Define a cómmon language and, if possible, methodology to promote linkages between IIASA projects.

2. Prototypical pilot studies on the specific problems of medium-size towns--for example, the problems of rehabilitating the city core and of the changing physical structure.

ITALY

1. Urban economics.

2. Social changes.

3. Technological education.

4. Review and improvement of models linking land use and transportation facilities planning by treating them as simultaneous output.

5. IIASA should begin by studying sub-systems.

6. Project "linkage" topics:

   a) urban uses of water (e.g. pollution abatement);

   b) local government organizations in municipal operations, planning procedures, investment allocation;

   c) energy development policy as a constraint on urban and industrial development;

   d) planning of the organization of medical care at the local level;

   e) the sharing of scarce physical resources;

   f) information production, gathering, and recording for planning purposes;

   g) policies diversification in less developed regions and studies on cumulative effects of industrialization;

   h) methodological research on urban growth, competition between areas, distributional effects.

Notes on the Preliminary Research Program in Urban and Regional Planning

The Italian Delegation

The excellent preliminary report prepared for this meeting explores the wide range of the themes concerning urban and regional planning in the light of applied system analysis. Our task is now to focus upon them in the aim aim of sharpening the proposal for a program research to be carried out by the IIASA and in cooperation by national institutions. The purpose of this paper is therefore:

a) to add suggestions to the preliminary report, and

b) to inform about scientific work done in Italy by many organisations in this and related fields.

Improvement Needed in Urban System Analysis

An increasing attention is now being paid to research which can improve systems analysis in urban and regional planning. The use of models should not be bound to recognition of interaction and feed-back mechanisms in city evolution but in some way could be enlarged with the aim of directly incorporating technique for:

1) evaluating the global balance of resources in spatial planning (not only physical but also human, economic, and cultural resources) and the distributional issues of plans among groups and areas. In this sense the available techniques such as planning balance sheet and goal achievement matrix, used under separate procedures, would be better introduced in more comprehensive and perhaps more flexible models of "social accounting" built upon planning goals and referring to the normative as well as to the cognitive aspects;

2) improving the tools for control and guidance of city of city (region) development and operation. Under this heading should be useful a better understanding of relationship existing between the planning process (the decision making area) and the organisational structure for implementation (the management authority).

This is not only related to the old question of optimal government level for the different functions--e.g. technological operations, provision of personal or environmental services, and control of development (a concept which could help to overcome the dichotomy of urban and regional analysis). It is also connected with a better understanding of the intersection between national and local policies which could affect the hierarchy of planning goals (for example, in municipal transport investment, or strengthening of competition among areas for limited financial resources) and would in any case stimulate a wider use of rational program choice and budgeting (like PPBS or "rationalisation des choix budgetaires") for municipal authorities;

3) fitting to specific conditions of the region or of the city under analysis without loss of generality and effectiveness of the models, thus allowing structural and policy planning comparison among the different national contexts. In this way, for instance, the urbanization process in Italy could be better understood: through a compact urban network the well-known economic dualism displays its "over-urbanisation" effects in many Southern regions. In another sense, the national policies centered on the new towns strategy--like those based on urban renewal and development--with the consequent effort for the rehabilitation of the historic centers, can be thought of as two merging aspects of governmental action intended to allocate in different ways the growth process in a systemic framework. And finally the "abnormal" case (like innovating infrastructure, or city decay process) may become a particular sub-model of a more general class, helping to point out the means for an action program oriented by the comparison to a desired or "normal" state; and

4) finding a broad orientation for setting up information systems (data choice and gathering) that may enable us to promote international cooperation with a common language and a systemic approach.

Planning a Research Program for IIASA

Drawing up the future research program for the IIASA may thus follow the tentative list of the arguments illustrated in the 'Suggestions for a Systemic Approach to City and Region' by M. Rousselot ("A Preliminary Research Program in Urban and Regional Planning," Jan. 1973). In discussing the procedures

described in the section, "Towards a System of Research Programs," one can agree with the proposal of working very close to real problems. However, a preliminary effort seems necessary for refining and getting general acceptance of the methodological tools before work starts on the case studies. In this earlier phase the national organisations should cooperate for a broad exchange of information and for a common orientation on the theory and practice of the system analysis applied to planning research. Further seminars and meetings for this purpose would be probably needed and would take place informally, although under the sponsorship of IIASA.

Poland

1. The theory of complex urban and regional systems. This theory should answer the questions of what urban and regional are and how they develop.

2. Automatic systems for management of cities and regions.

United Kingdom

1. Important that projects be both policy-oriented and timely for research.

2. List and describe, on a comparative basis, the institutional structure of towns in different jurisdictions and cultures. This could be undertaken to different depths--minimally, it would produce a checklist to facilitate communication with city officials. In more detailed form it becomes topics A2/A4 of Mr. Rousselot's January paper (see Appendix).

3. Comparative study of fire station location decisions.

4. International "action research" projects structured in a way similar to the LOGIMP experiment in which policy makers worked closely with analysts.

5. Information systems and their uses.

6. The problem of demographic classification--age and sex characterization often does not suffice, but much data is required for more complex schemes, and it is unclear which schemes would be best.

7. Linkages between social systems and policy, such as those between national settlement policies and differential urban policies and differential urban growth, migration, and employment opportunities.

8. As a complement to broader studies, a narrowly-defined project on municipal services.

9. Projects "linking" to other IIASA work:

   - urbanization effects and design of international airports
   - location of power stations
   - design and management of new towns
   - comparative research on interrelations between central and local governments and other planning agencies in different countries.

Research on Urban and Regional Planning

M. Cordey-Hayes

This note puts forward a research programme on "Urban Growth and National Settlement Policy" as an example of the type of research that the Centre for Environmental Studies would like IIASA to consider including in its research programme. Already a few researchers at CES are working on some of the UK aspects of the problems listed below, but to develop this as a formal programme requires further research effort. It is tentatively suggested that this may be an area of study that could, in part, be carried out effectively through a collaborative effort between IIASA and CES, for example, by the exchange of research staff and/or through the sponsorship of further research at CES.

The programme of research would be primarily concerned with the processes of urbanisation and especially with the growth and structural change of cities. It would include studies of decentralisation, migration, and their relationship with national urban policy. Existing urban geography and regional economics are largely concerned with the location of specific activities in largely static and independent terms. But the complex forces that shape growth or decline are mostly dynamic disparities in the supply and demand of various interrelated resources. We need to know much more about the relationship between changing economic structure and the differential growth of cities. Research should relate, as far as possible, to labour market areas (city-regions) and attempt to bridge the gap between urban and regional theory, considering the issues involved in national urban development strategy. It would relate analytic theory to policy and lead to methods which would enable an elaboration and testing of policies.

The kinds of questions which would be addressed by research projects within this programme include:

a) Studies of the relationship between migration and employment opportunities. What is the relationship between migration from one labour market to another and the changing characteristics of those areas? What are the feedback effects of such migrations on the "origin" and destination" areas (e.g. in terms of multiplier effects, congestion, depletion of skills, infrastructure, and resources)?

b) Studies of the phenomenon of decentralisation within city regions. How far is it to be understood in terms of a "filtering" interaction between employment and residential developments? What are the effects for decentralisation of policies which influence industrial, social and residential mobility?

c) Studies of the feasibility of developing simulation models of the relationship between city growth and regional imbalance. Such models would be used explicitly to "conduct policy experiments" in an attempt to trace the often unexpected repercussions of a policy so that a fuller assessment of the advantages and disadvantages of alternatives may be examined.

d) Studies of the relationship between economic structure and the growth or decline of cities. What is known about the question of optimal city size? What private and public costs and benefits are related to city size?

Each of these studies involves interactions between several components of the urban system and is certainly a problem in applied systems analysis. They have not been described explicitly in systems terminology because it is is considered more important in this brief outline to emphasise the type of processes and problems of interest. The projects can be described in more detail at a later stage.

Possible Research Projects for IIASA

A. Hitchcock

In its early years, one of IIASA's objects must be to carry out some work which will come to fruit tolerably quickly so that it can be seen, in each of its fields of endeavour to be useful to its sponsors. Without therefore wishing to denigrate important methodological and global systems analyses, it may be useful to mention two fields in which relatively short term output could hopefully be obtained.

1. Planning Information Systems and Local Government Information Systems

Urban planning, and even more the implementation and control of plans requires a vast body of information about employment, housing, transport, population and the like. Much of this information is in fact available to local or central government departments for the efficient discharge of such functions as construction, housing management, employment services, health etc. Experience indicates, however, at least in UK, that this information is not used by urban planners because

a) its existence is not known to them;

b) it bears referencing systems which it is too laborious to correlate with others;

c) it is confidential; and

d) it is not held in readily communicable form.

Over the last few years, a number of attempts has been made to construct global data banks. In many cases, results were disappointing, both because the labour of maintenance prove excessive, and because the actual data held was not perfectly related to the processes of the planning authority, to the administration of which it was a part, and to the associated political decision process--the information system in fact had not been designed as a system. New "evolutionary" approaches to this problem are now fashionable.

It would be a useful research area to examine the operation of planning bodies from the point of view of

information flow. It is likely that this involves looking at information systems for local governments as a whole. Differences in the organization, in the processes and in the decision making machinery will affect what is needed. Nevertheless, some general principles can now be conceived and the validity of them and other principles, to be determined by the research, can usefully be proven in detail.

2. Demographic Classifications

In almost any systems analysis of urban and regional problems, it is necessary to consider people as being of different kinds. The standard breakdowns by age, sex and socio-economic grouping are not always relevant or sufficient. It would be very useful to study the processes of planning and analysis, with some attention to the successes and failures of particular existing projects with the object of arriving at classification schemes which are useful over general areas of research and systems analysis.

It is reconized that these proposals are partial. There are many other important fields. These programme areas, however, meet the following criteria, which can usefully be applied to the selection of applied research programmes more generally:

a) There is a reasonable prospect of "success," and if success is achieved, a reasonable prospect of implementation.

b) They can be carried out with the number and kind of workers available at the Institute.

c) One can see how to start.

U.S.A.

1. The (proper) role of the private automobile in cities.

2. Information systems for local governments (as proposed in written statements by Mr. Hitchcock, the USSR delegation, and the Italian delegation).

3. The theory of social indicators (mentioned in report on U.S. National Academy of Sciences Panel and in proposal by Canadian delegates).

4. Migration (within a country), well-being, and government policies (mentioned in NAS Panel report, and in Canadian proposal). Especially important here are a) what is the objective function? and b) how does the current system function? How can this be altered?

Summary of the Discussions of National Academy of Sciences Panel on IIASA Urban Program, July 10, 1973

W. Gorham

This summary is organized hastily in three parts: grand strategy, research strategy, and study topics, and reflects more or less the deliberation of a panel of experts (see attached list) convened at the National Academy of Sciences on July 10th.

Grand Strategy

The survival of IIASA requires, most importantly, avoiding political gaffes which offend member nations. This may seriously constrain the research, but probably still leaves a large enough feasible space to achieve success.

Beyond survival, two ideas for success, other than the obvious one of high-quality and useful work, emerged: (1) Analysis which showed various member countries' research or policy successes would be good; (2) the program should not concentrate too much on either methodological, theoretical, or highly abstract work, or on "nuts-and bolts" problem solving. The former leaves IIASA open to criticism for failure to produce early payoffs, and never producing anything "useful"; the latter is open to the criticism of working only on trivial problems.

An issue as to staffing was raised: Do the directors (at what level?) of IIASA define the problems and then select staff who are qualified and interested in those problems, or do the directors hire "the best people" and let them define the problems? Obviously, some kind of mixed strategy should be and is being followed, but choice as to the particular mix is nevertheless important, especially considering the small size of the urban group.

Research Strategy for the Urban Program

Many of the topics that were discussed remained as unresolved issues. In some cases the panelists did not agree; in others they simply wanted to point out that certain issues face IIASA and should be resolved consciously rather than accidentally.

The discussion was based on an assumed annual budget of about $500,000. A figure of 20 professionals (after a few years) was assumed.

Type of Activity

Three different types of activities--not mutually exclusive--were mentioned:

1) Research by staff, on-site. This is clearly the principal mode of operation.

2) Coordination of research done at other institutions in member nations. This was felt to be virtually impossible. However, IIASA obviously will want to develop and follow its own special skills, complementing the work of others and, appropriately ambitiously, breaking new and important ground. IIASA is also expected to be a valuable focus for information exchanges--which leads to the next point.

3) International symposia. IIASA could have a more-or less regular program of international conferences (both working meetings and presentations of results) on appropriate subjects. Some panelists were more enthusiastic about this than others.

Meaning of "Urban" or "Municipal"

Panelists noted that these words could imply very different scopes of inquiry, ranging from more narrowly-defined urban or regional spatial concerns to the whole gamut of "urban problems" (i.e. any problems that occur in urban areas). There was no clear consensus; some panelists favored a relatively broad interpretation of the words, while others felt that narrower interpretations would reduce the likelihood of political problems.

Type of Research; Nature of Users of the Results

Several different types of research were discussed:

1) Methodological or theoretical work.

2) Problem solving:

   a) problem assessment, i.e. identifying the most of important and most researchable problems

b) "big" problems, e.g. national patterns of settlement

c) "small" problems, e.g. how best to collect garbage.

3) Learning more about how a given system behaves (in economic jargon, "positive" research; hypothesis testing).

As mentioned already, the panel felt that a mix of (1), (2b), and (2c) would be desirable. (1) and (2b) are seen as "important" and "non-trivial"; (2c) permits some quick and "useful" results. Most panelists also felt that problem-solving analysis in most areas is severly constrained by lack of understanding of how the system in question works, and therefore that (3) was also necessary; however, they questioned whether IIASA would or shoud put much emphasis on (3). Given IIASA's name, predelictions, and limited resources, the best strategy might be a few problem-solving projects on topics where available knowledge is relatively good, plus some methodological or theoretical work.

Many panelists felt that IIASA should also give high priority, at least initially, to problem assessment. In a sense this is what the panel itself was charged with, but the definition of problems that are both important and researchable needs continued attention. The expected high caliber of IIASA staff was also a factor in the panel's recommending this emphasis.

Most panelists felt strongly that IIASA should not limit itself to mathematical modeling. Many suggested research topics (listed below) may be best approached by means other than explicitly formulated models.

Topics for Study

Methodology/Theory

The two criteria mentioned for picking topics in this area were:

1) Find problems where further research progress is most constrained by methodological or theoretical inadequacies.

2) Pick areas where one country does it better than others.

Topics mentioned were:

1) Research on quality of life, or social indicators, needs some theory.

2) Detailed, usable urban land use/transportation models need mathematical or computational improvements to permit handling many variables, high spatial disaggregation, and many interactions.

3) The U.S.A. may have much to learn from the U.S.S.R. on handling large-scale input-out (material balance) calculations--a tool for which demand may be growing here and which has long been used there.

4) The typical general systems model, which usually assumes one decision maker with a consistent objective function, and analyzes the nature of equilibrium or near-equilibrium solutions, has severe limitations for many urban problems. Further development of models that deal with conflicting objectives and continued disequilibrium could be very useful.

"Big" Problems

One large area mentioned was, of course, national patterns of settlement. While most panelists agreed that lack of understanding of how the system works is a major constraint, they felt that some modeling, synthetic work, and policy analysis would be productive. Relatively strong understanding of the underlying behavioral system was suggested as criterion for selecting topics; however, some of the suggested topics seem to violate the criterion. Topics mentioned were:

1) Migration; synthesis of economic and demographic behavior.

2) Effect of growing tertiary and higher-order activities on patterns of centralization/decentralization. Such work might include effects of changing corporate structures and relationships (conglomerates; multi-national firms) and of communications technology.

3) Assessment of effects of technological change, not limited to (2) above.

4) Policies to deal with de-populated areas; in particular the possibility of concentration of the remaining population.

Another major topic suggested was the links between research results and policy decisions, and between those decisions and implementation. Panelists felt this should be studied in the context of a particular problem or process,

such as:

1) Policies to affect settlement patterns

2) How do different cities go about solving similar problems?

As suggested by the last point, the general question of comparative studies naturally arose. In spite of IIASA's apparent advantages for such work, most panelists were not enthusiastic because of the unusually low quality of comparative studies. However, two specific suggestions were made: a) that in the paragraph immediately above, and b) that predictive or simulations studies in one country may analyze policies actually in force in other countries; a comparison of predicted and actual results, and attempts to explain both similarities and differences could be instructive.

Studies of relationships between local and national governments were suggested.

Yet another topic is the adaptation of political institutions to economic and demographic outcomes. What are the adaptations; how functional or disfunctional are they?

Finally, there was considerable discussion of expanding land use and physical planning to focus on the density of use --i.e. not only type of activity, but level of activity per acre. This has obvious implications for transportation, pollution, pricing, and efficiency.

"Nuts-and Bolts" Problems

In listing a number of smaller problems, the panel noted that many of these could also be studied in ways that would make them "big" problems. Topics suggested were:

1) Management of housing stock

2) Industrialized production of new housing units

3) Solid waste collection/disposal, especially the latter

4) Intra-metropolitan traffic and transportation

5) New towns--perhaps a comparative study across countries

6) Delivery of health services.

U. S. S. R.

(Note: These proposals are from the "Study Programme for the Control of Development and Functioning of Towns and Conurbations" submitted by the USSR Delegation. The other section of this document may be found elsewhere in these proceedings under "National Research on Urban and Regional Systems.")

Dramatic growth of towns and urban population is the most salient display of modern urbanization resulting from rapid scientific, technological, and social progress. Emphasis on urbanization of social development makes, in turn, global urban problems and various aspects of urban development (social, economic, ecological, aesthetical, town-planning) more complex and significant.

The town and its systems are among the brightest and most complex achievements of the human civilization. They consist of a set of interrelated sub-systems, mostly active, of diverse nature and mode of operation. Control of towns and conurbations essentially involves all aspects of fundamental and applied studies carried out in the field of system analysis and control.

Continuous increase of town growth rates and complication of interrelations inside and outside the town pose a number of aggregate problems which might be answered by a united approach in the terms of systems analysis. Among these problems are, for example, study of economic and social state of the town and ways of its development, elaboration of urban functioning and development control principles, elaboration of principles and development models for conurbations, etc.

Many urban control problems are not specific to a single country, but are present in countries of various social and political systems and might be solved with due regard to their integration. Actuality of these problems to various countries may be naturally different. What they have in common is the need for significant resources, powerful computers, and highly trained specialists to solve urban and conurbational control problems and to implement the solutions. Thus the necessity for IIASA to study this matter becomes evident and corresponds to the principles and aims underlying its creation.

The main targets of studying the problem "Control of development and functioning of towns and conurbations" are:

- Generalization of the experience gained in design and control of development and functioning of towns and

conurbations
- Elaboration of formal methods to describe towns and conurbations as control plants
- Working out development and functional models of towns, conurbations, and their subsystems; elaboration of development and functioning control methods for them
- Verification and refinement of the principles, methods, and models elaborated for a number of systems
- Development of computerized automatic town and conurbation design systems
- Elaboration of standard programmes for control of development and functioning of towns and conurbations, making use of the systems analysis
- Elaboration of principles and organization of information systems analyzing the state of towns and conurbations and preparing data for optimal decision making in control of their development and functioning
- Solution of practical problems in development and functioning control for a number of systems.

The work is being carried out in two main fields:

1) Control of town and conurbation development
2) Control of town and conurbation functioning

The Problems Involved in Control of Town and Conurbation Development.

1. Elaboration of aims and effectiveness criteria for changes in already shaped population distribution pattern and for information of conurbations.

2. Elaboration of scientifically-based principles underlying the design of a general population distribution scheme on a national, republican, or large economic area scale. Development of techniques for urban and rural population analysis and techniques for forecasting conurbation formation taking into account the progress and distribution of productive forces.

3. Development of principles and methods for forecasting and effectiveness evaluation of complex interrelations (involving economics, labour, cultural and communal services, recreation, spatial organization of architecture) between the center, and towns and settlements of a conurbation.

4. Development of united engineering and transport infrastructure models for conurbations.

5. Elaboration of scientifically-based principles of environmental preservation and improvement in towns and

conurbations. Development of effective anti-seismic measures, measures against mud and rock torrents in mountainous regions, etc.

6. Development of methods for analysis and forecasting of economic basis and perspective population of towns. Forecasting of population employment and its internal and external migration.

7. Forecasting of growth and structure of material and intellectual requirements of the population in towns and other settlements.

8. Forecasting of shifts (in proportion and content) of labour and leisure time of the population of towns and other settlements.

9. Development of scientifically-based principles for planning, housing construction distribution, and rational use of urban space taking into account social, economic, ecological, architectural, and spatial interrelations between towns and their environment.

10. Development of models of the following systems: cultural and communal services, urban traffic and transport, as well as engineering equipment and improvement of towns.

11. Elaboration of scientifically-based principles underlying formation of architectural and aesthetic appearance of towns.

12. Application of the mathematical methods and designing of an automatic planning system for towns and settlements involved in a conurbation, at all stages of planning (regional planning scheme and design, planning scheme of conurbation, master plan of town, detailed lay-out, and construction plan.)

The Problems Involved in Control of Town and Conurbation Functioning

1. Development of methods of analysis and synthesis of urban and conurbational control system structures.

2. Development of decision making principles and methods for control of town and urban systems and subsystems.

3. Development of methods and algorithms for long term and short term planning, and for operative control of town and urban systems and subsystems allowing for their interaction.

4. Development of models and optimization methods for transport flows (human, material, informational, etc.) in towns and conurbations.

5. Development of models and optimization methods for mass service systems (shops, medical aid, culture, etc.) in towns and conurbations.

6. Development of models and methods of accounting and control of town resources (land, material resources, etc.), and their development and use forecasting.

7. Development of methods and optimization models for control of municipal economy subsystems.

8. Development of methods and models for control of existing town migration.

Provision of Work with Information

Within the framework of each field the following information provision problems are studied:

1. Scientific principles of information system development and structure providing for analysis of the state, development, and functioning of towns and conurbations.

2. Questions related to the development and establishment of computer system providing for functioning of control subsystems and solution of control and forecasting problems.

3. Development of software for registration and analysis of the state, development, and functioning of a town or conurbation.

4. Questions related to the development of special information subsystems.

The list of subjects for each field and its information provision is not, of course, exhaustive. It contains only the most general, most actual or ready for practical application problems.

Anticipated Results

1. In both fields of investigation during the years 1974 and 1975 analysis, systematization, and generalization will be done of the experience gained by various countries in controlling towns, conurbations, and their subsystems.

Results of this generalization will be published in the form of information materials, methodological directions, or recommendations concerning solution of particular problems.

2. The following results may be anticipated during 1974 through 1980 in the area of control of town and urban development:

a) General concepts, principles, mathematical models, languages enabling one to define the basic aims of urban and conurbational development with the regard to the national economy as a whole. The main factors influencing development of a town or conurbation as a whole and their subsystem will be identified.

b) Methods of system analysis and forecasting development of economic, social, etc. relations between towns and settlements, preservation and improvement of conurbation environment.

c) Methods of programme-and-aim planning and forecasting the economic basis of employment and requirements of the population, the structure of labour and leisure time, planning pattern, the development of cultural and communal services, the engineering and transport infrastructure, the architectural and aesthetic appearance of towns.

d) Analysis of a number of towns and conurbations (situated in various parts of this country) and their control systems.

e) Development of standard development control models for towns and conurbations. Experimental verification of the developed control models and methods. Recommendations of introduction of the most resonable principles of town development and control of the development.

3. The following results may be anticipated during 1974 through 1980 in the area of town and urban functioning:

a) Methods enabling one to define and establish reasonable control structures for towns and urban systems, and control principles taking into account the active nature of interaction between elements, internal and external links, distribution of functions between system levels and parts, optimal number of structure levels, and the hardware for control of the municipal economy.

b) Methods of programme-and-aim planning for town functioning optimization. It is envisaged to implement the methods through their pilot use for execution of the master plan of one town or one conurbation.

c) Algorithms of long-term and short-term planning and operative control of development and functioning of town and conurbation as a whole, their functional systems and specific projects.

d) Study of possible interrelations between programme-and-aim, functional and regional planning, and operative control.

e) Algorithms for optimal distribution of industrial, economic and social centers over towns and conurbations. Determination of main factors underlying the distribution.

f) Methods defining optimal functioning of mass service (shops, medical aid, culture, etc.) systems and their performance.

g) Methods of transport flow optimization, algorithms of optimization of their structure.

h) Methods of system analysis of interrelations between functional subsystems of the town.

i) Methods and models for accounting and control of the municipal resources (population, land, etc.), and forecasting of their optimal use:

- Analysis of the existing municipal resources accounting system.
- Methods of strategic and tactical planning of municipal resources and their operative use.
- Methods for defining a reasonable design of the computer system for accounting and control of municipal resources, including exchangeable ones.
- Software for accounting and control of municipal resources.
- Algorithms and programmes for accounting and control of municipal resources in a number of Soviet towns and conurbations.

j) State analysis of existing control systems for urban functioning and municipal systems in various parts of this country.

k) Experimental verification of the developed methods and algorithms, and recommendations concerning their application.

The above mentioned studies will be supported by the following:

1) Procedures for choosing the optimal structure of a computer system oriented to the control of development and functioning of towns and conurbations, and procedures for the choice of hardware necessary for its implementation.

2) System of languages for control of the data bank (information structure description language, information access language, etc.)

3) Principles defining structure of a common data bank for the control system.

4) Principles underlying implementation of the data bank software enabling one to use the data bank for diverse development and functioning control problems at various levels and within a wide range of computer system configurations.

5) Experimental implementation of the above points 1 through 4 for a large town or a conurbation.

Work Organization

All the studies within the framework of "Urban Control" problem should be carried out in compliance with the coordination plan developed by the problem experts and approved by the IIASA leaders.

The experience gained in controlling towns, conurbations, and their subsystems is analyzed, systematized, and generalized at IIASA by an international team of experts (6 to 8 persons). Each IIASA member nation organizes a similar enlarged team (17 to 19 persons) of experts within the country.

The studies in the fields mentioned above are carried out by head organizations and attached organizations. Within the framework of head organizations special departments are envisaged.

Experts of the member countries are also responsible for planning and checking of the work done by the organizations of their country in accordance with IIASA plans.

Organization of the work in accordance with the coordination plan and monitoring of the work is done by a special coordination group of 2 to 3 experts within the USSR Committee of System Analysis.

To improve the effectiveness of IIASA experts and of the participating countries, and to collect quickly data related to the problem, and International Urban Control Conference should be organized under the sponsorship of IIASA in the near future (1974).

Coordination of the work, planning of research establishment of general concepts and urban control principles are to be done at joint conferences of IIASA and local experts held in different countries at least twice in a year.

The possibility of sending IIASA experts on a mission should be provided for and financial conditions stipulated for. The most important and essential results obtained within IIASA by separate countries are to be published in scientific and technical periodicals and special publications. To this end IIASA should also organize a standing educational seminar of "Urban Control." The plan, schedule of meetings, and location of the seminar are to be determined by IIASA experts.

On the basis of analysis and generalization of the work on the problem, the researchers of IIASA should a) work out a general procedure for applying systems analysis to control of towns and conurbations, b) solve the most interesting and complex problems, c) search for standard solutions and procedures, d) carry out their experimental verification, and e) advise individual organizations of the IIASA member nations.

It is reasonable to put the responsibility for the development and introduction of particular projects, subjects, problems, models, methods, and algorithms on the organizations of the IIASA member nations in compliance with the coordination plan which is to be worked out by the end of 1973. The detailed analysis of the work carried out in particular organizations may be suitably done by the local experts of the member nations. The general evaluation of solutions is to be done by IIASA experts.

IIASA may serve as a general contractor by taking orders for the study of particular problems.

Additional Proposals of the USSR Delegation

International cooperation on a number of research themes mentioned in our proposals would be very useful. We consider it most reasonable to shift the main emphasis on research done on a national level since the few IIASA scientists are capable of conducting research on a limited number of specific problems. In this connection, IIASA's main task is to organize and coordinate scientific effort as well as to inform all the member countries of the results of this research.

Two aspects in the organization of research require priority:

a) development of joint research program, and

b) establishment of national institutions (committees or expert panels in two or regional development.

Establishment of such groups would enable the member countries, in addition to cooperation within IIASA framework, to effect bilateral relations.

Coordination consists of determining the main research lines for different countries taking into account the level of research of an individual country. This would enable us to utilize more efficiently the possibilities of national research institutions and to eliminate duplication in research. Such coordination can be effected on the basis of research conducted in compliance with the general research program.

Organization of information for member countries can be conducted in the following fields:

- Periodic distribution of lists of the problems being investigated and problems on which research is already accomplished

- Publication of the results of accomplished research and circulation of these results at the request of the member countries

- Organization of international conferences and seminars

- Organization of consultations for countries who need them. These consultations can be given by countries with advanced research in a particular problem

- Formation of international expert groups to study the results achieved by the research done on a national level and to elaborate recommendations concerning the most significant results.

A number of the problems outlined in the "Study Programme for the Control of Development and Functioning of Towns and Conurbations," submitted by the USSR delegation, would be priority topics for future conferences and seminars.

In the area of "Control of Town and Conurbation Development," problems suitable for such meetings would include 3, 4, 5, 6, 9, 10, and 12.

Suitable problems listed in the area of "Control of Town and Conurbation Functioning" would include 2, 3, 4, 5, and 7.

All four of the problems of information systems within these fields would also be appropriate priority subjects for future conferences and seminars.

APPENDICES

A Preliminary Research Program in Urban and Regional Planning

M. Rousselot

The Urban Challenge

1. In most countries, politicians and professionals are aware of:

the growing importance of urban problems in modern societies, especially in industrialized countries, and

the paramount complexity of these problems, in which everything affects everything else.

Moreover, politicians and professionals are very much concerned by the huge gap existing between the aims and the practical results of the urban policies conceived and applied by various public national, regional, and local institutions.

Consequences of this gap are very serious, especially in some countries. They range from clear physical shortages, such as lack of housing, lack of public utilities, to misfunctioning of important urban mechanisms, such as insufficient public transportation and traffic congestion, and to serious social diseases such as segregation and minority problems.

Part of the failures caused by this gap have been attributed to urban planners. Most of these professionals are aware of the growing difficulty of their task, due to the general acceleration of the urbanization process and to the larger field of questions which are raised by decision makers. There is a wise consensus that the techniques generally used for analysis, forecasting, and aids for the decision making processes--no matter how sophisticated some may be--are often irrelevant, and that major progress in this field is urgently needed.

2. This interest in urban and regional planning is strongly reinforced by the consideration that most of the problems of modern societies are, in one way or another, urban problems. The city is a particular place where the conflicts arising from the coexistence of the urbanization process appear clearly. In the city the contradictions between

economic growth priorities and preferences for better living conditions are strongly felt. These types of contradictions and conflicts are considered as most characteristic of modern societies. Progress in the field of urban analysis and urban planning can bring strong support to the solution of the societal problems.

The importance of the question has generally been recognized by national governments which are all involved in some kind of national urban policy, even in countries where the political structures are strongly decentralized. As a result of this involvement, there is also a growing interest in regional problems appearing at an intermediate level between the national and urban levels. Some of these problems arise naturally from the existence of very large towns and systems of towns. Others appear as problems of articulation and coordination between national (and international) policies and urban policies. It is interesting to observe that many non-federal countries have recently given more and more emphasis to these regional considerations.

3. However large the differences may be between cultural, political, and economic conditions from one country to another, there are many similarities in the nature of problems that are to be solved.

These differences are more awkward when the analysis of urban and regional problems is only a superficial one, applied to specific problems and particular techniques. On the contrary, strong similarities appear when a deep analysis is undertaken which takes into account all the complexity of the urban and regional reality. For all these reasons, an attempt to apply systems analysis to urban and regional problems seems of great interest, especially if it is undertaken in an international framework.

The City Considered as an Ecosystem

1. A strong proportion of the failures of urban planning can be explained by the inadequate kind of instruments which have been used. Most of the urban models and most of the decision making techniques have been produced in the framework of a questionable scientific approach of the urban reality. In this approach, the urban complexity is split into different parts, artificially cut from one another and dealt with separately. The urban complexity is thus artificially reduced to some kind of functionalism.

This reduction had limited drawbacks as long as the aims of urban planning were also limited. For a long time, urban planning considered only the external physical appearance of the city. The interest of the urban planner was then extended

to the programming of infrastructures and, lately, to the programming of the main urban functions: housing and public services. For all these purposes, the reduction of urban complexity to functionalist models was legitimate. But it is no longer acceptable when urban planning extends its ambitions to the large range of problems described above.

Dealing with complex real problems, the decision makers in the city are dropping the policies based on such inadequate analysis and are already experimenting new empirical policies arising from open dialogues with the population, flexible strategies, training processes, and so on.

At the scientific level, new studies of urban planning are also necessary and possible, using applied systems analysis considered as the adequate scientific approach to the problems of complexities. More precisely, systems analysis should provide some kind of understanding and management of the complexity of urban development which should allow the needed progress of urban planning practice or even the creation of new policy making processes in the cities. For one may think that the growing aspirations for new standards of living, giving more freedom to individuals and groups, and more flexibility to institutions and organizations, may rapidly become incompatible with the planning procedures in their classical aspects.

2. Let us describe, very roughly some aspects of systems analysis applied to the city.

At a first glance, the town as a physical object, appears to be a very good example of a system. It has a huge number of components: individuals, houses firms, communities, shops, shopping centers. In a limited physical space, there is a huge amount of interactions between these components: information flows, exchanges of goods, financial transfers, power relations, cultural influences, decisions.

All these interactions and their results seem to be monitored and controlled by different control centers (in the firm, in the community) which in turn seem controlled by a main control center--the urban government. Such a typical system seems easily compared to a living organism (and many biological words are used in the urban literature).

But this is only an oversimplified view of the urban complexity. None of the main phenomena of urban development can be explained without taking into account the very important interactions between the elements described above and some important parts of the environment: the political systems of the nation, the financial organizations of the big production

sectors and of the multinational firms, the cultural systems of the regional and national levels, the ideological systems existing at the national or even at the international levels, the physical environment.

Some of these interactions between parts of the city--considered as a physical object--and its environment are particularly relevant for diachronic analysis of urban development. The definition of the "urban system" as a scientific object must be enlarged by these considerations, and the analysts themselves should give rather high priorities to studies of the relations of such an urban system to its environment, in addition to studies of the internal interactions between elements of the urban system.

At the same time, a critical view of the main control center of the urban system--the municipal government--reveals the limited range of its possibilities. For some of the most important components of the urban development, the monitoring and management powers of the municipal government are very small or even non-existent. For instance, important economic decisions concerning a city are determined by technological requirements, by a certain equilibrium of the market of specific goods, by the strategies of some firms. Important evolutions in consuming habits, in housing requirements, or in standards of living are determined by new ideological trends, by the role played by political, cultural, religious groups, etc.

For many aspects of urban development, it seems more relevant to consider the interactions of different systems inside the urban organization. Each of these systems has its own specific control center and regulating mechanisms, but the relations between these different systems are in many aspects not strictly predetermined by any kind of hierarchy, but, on the contrary, more and more subject to flexibility and heuristic procedures. Many authors have recently described the city as an ecosystem. They emphasize particular aspects of the states of equilibrium of such an ecosystem: limited range of stability, possibility of wide changes between the successive states of equilibrium.

In this conception, much attention is paid both to the display and accurate description of chains of interactions particularly important for the urban development, and moreover, to the consideration of the feedback loops intervening in stability or instability phenomena. For instance, positive feedback loops can be described when examining the cumulative economic growth of a city. And negative feedback loops may be important for the explanation of the decay of some historic town-centers.

3) Independently of expected progress in scientific knowledge, systems analysis applied to the urban development should promote progress in urban planning

At a first stage, systems analysis should allow better understanding of the existing capacities of urban systems:

a) to realize continuous evolution and the long term (in size, in economic growth, in cultural progress), and

b) to regulate in the short term most of the problems and even crises appearing in the course of this evolution, by the intervention of many control-centers flexibly connected to each other.

In a second stage, a better knowledge of the main mechanisms of change and equilibrium of the urban ecosystem should lead to a better view of the role and the expected capacities of urban planning practices. How can urban planning contribute to non-homeostatic changes of the urban ecosystem? How can urban planning improve the reactions of the ecosystem to exogenous demands and especially to innovation? It seems likely that two kinds of answers should be given to these questions:

a) improvements of planning techniques should be introduced in each of the systems composing the urban ecosystem, and

b) the existing interactions between these systems could be voluntarily modified so as to reduce the risk of main instabilities due to uncontrolled positive feedback mechanisms, and to increase the general capacity of the urban ecosystem to realize continuous and controlled development.

Thus the importance of actions to be taken in the field of improving information flows, building of new institutions, design of new communication and decision making procedures, construction of new learning and training capacities, etc., could appear.

4. Progress through the use of systems analysis in the field of urban planning will necessarily induce the same kind of efforts and progress in the field of regional planning. It is a natural consequence of the broad definition of the urban ecosystem which will naturally include the "catchment area" of the classical town.

When interactions between neighbouring towns are strong, it is necessary to consider the whole system composed by the

different towns, this consideration being sometimes emphasized by the existence of a specific political institution. More generally, economic and cultural evolutions seem better analyzed at the regional level (in addition, of course, to the national and international levels). Strong interactions appear in these fields between a certain number of towns of different sizes and their rural peripheries. Strong interactions appear also between these towns and other systems such as the national and regional political systems, the main economic systems, the cultural systems, etc. Coherence is needed for efficient economic or cultural policies and for the development of some public utilities (transportation networks, big hospitals, universities). Coordination has to be organized between the different municipal authorities, the national agencies, and the regional authorities, when they exist.

It is not at all obvious that the empirical answers given to these problems of coherence and coordination are the proper ones. A systems approach to these interactions is necessary: it will probably reveal a high degree of complexity, even if the number of systems considered seems to be smaller than in the urban ecosystem. The balance between the powers of the different control centers involved in regional planning is sometimes in favour of a big town (Rotterdam, in its region, for example) and sometimes rather difficult to characterize (in French regions, for instance). It is likely that the assumption should also be made that the region is an ecosystem.

The same kind of progress could be expected in regional planning as in urban planning: a) better comprehension of the existing mechanisms for acquisitions of new capacities and for regulation of exogenous changes in the different systems, b) improvement of these mechanisms, and c) introduction of new interactions between the different systems.

Some Suggestions for a Systemic Approach to City and Region

Considering the complexity of the urban and regional systems, considering also the "state of art" in systems analysis, it seems impossible to propose any kind of comprehensive and rational plan for the conception and the management of this research program. On the contrary, it seems necessary to take at least at the beginning of the program, a flexible and diversified view of the project. Therefore, a tentative list of specific research proposals has been established, each of them being considered as relevant for a systemic approach to urban and regional problems. The specific interest of each of these heterogeneous works will be greatly increased by the simultaneity of other works and by the possibility of creative interactions between all of them. It must also be considered that most of these research efforts can be and <u>should</u> be under-

taken with a broad international perspective: different towns or regions located in different countries should be selected for information so as to develop comparative studies as much as possible.

The research proposals have been very broadly classified in two groups: A) studies of a rather comprehensive style, dealing with "normal" situations, and B) more specific studies, dealing with "abnormal" situations (i.e. when the systems considered are confronted with strong exogenous demands, or are even in crisis situations).

Studies within group A would include the following:

1) Anatomic Studies of Urban and Regional Systems

- Typology and description of the components of the systems.
- Typology and description of the main internal interactions.
- Main interactions with the environment, leading to typology and description of main environmental systems, in relation with urban and regional systems.

2) Urban and Regional Institutions

- Analysis of urban and regional institutions considered as important components of urban systems or regional systems and as important knots of interactions.
- Analysis of the regulating mechanisms of these institutions, of their tendancies to rigidity, to self-perpetuation, to homeostasis.
- Analysis of their functions in some major aspects of urban development and regional development.

3) Urban Power Structures

- Description and investigation of the different structures of power existing in the city or affecting the urban development, of their interactions and especially of their conflicts.
- Evaluation of their respective influences in some major aspects of urban development, and especially through the decision making processes.
- How are these influences changed when common norms and values are put at issue?

- Similar studies at the regional level.

4) Urban Economic Growth

- Systems analysis applied to the economic growth in the city.
- The major interactions between urbanization and industrialization:
    - external economies or diseconomies of industrial activities
    - balance between local elites and economic powers of national or international dimensions
    - new types of industrial activities associated with new types of urbanization.
- Costs of urbanization and the financing of creating urban space; how are social changes taken into account in the reshaping of towns?
- The urban manpower system:
    - immigration of workers
    - training of manpower
    - interactions between availability and demand for skilled manpower.

5) Regional Economics

- Systems analysis applied to regional economic growth and to regional economic strategies.
- The major interactions between urban development and national economic policies.
- Complementaries and external economies of the regional economic system; the tertiary activities both within and outside the region.
- The strategic role of infrastructures and other heavy equipments.
- The possibilities and limits of regional economic strategies in their relationship to national economic policies and to strategies of firms and financial organizations.

6) Interactions in Urban and Regional Systems

- Investigation of long chains of important interactions in the urban or the regional systems.

- Special attention to loops leading to positive or negative feedback mechanisms; description, quantification, and eventually modelling of these mechanisms.

7) Sectors of Urban Services and Activities

- Systems analysis applied to some important sectors of activity in the city. For instance, to all the problems of production, use, and consequences of use of energy in the town. Energy and the dynamics of urban economy. Energy and urban pollution problems. These studies could have fruitful interactions with the IIASA research program on energy.
- Another important sector of activity in the city is urban transportation: transportation systems are closely related to most of urban activities, and closely reflect the main urban structures and even the distribution of power between various groups or institutions.
- All the problems of production, transportation, use, and disposal of fluids in the city are also to be considered.

8) Failures in Planning

- Analysis of the failures of urban and regional plannings.
- What are the main conceptual difficulties in urban planning? For instance, is the distinction between objectives and means always relevant for municipal government?
- What are the main practical difficulties for the formulation of interrelated plans and programs at the national, regional and local levels? These studies could be considered either from the cognitive or the normative points of view.

9) Techniques for Future Planning

- Prospective studies of urban and regional planning.
- Some aspects or tendencies of the theory and the practice of urban and regional planning may reveal important characteristics of the urban and regional systems and of their evolutions. For instance, the new practice of urban simulation games may help the definition of the different systems interacting with one another and emphasize the role of information

procedures, decision making procedures, flexible training facilities for the different organizations involved in urban or regional development.

We shall now consider studies in group B which would deal with particular "abnormal" aspects or phases of urban or regional development.

1) New Towns

- Planning
  A rich group of studies can be organized around the problems of "new towns." In these new towns, there is a sort of acceleration of the historical process of urban development: conception, planning, realization of large fractions of these towns take place in a short period of time, so that information is more largely and easily available, and problems can be better defined and studied. The intentions of the urban planner can be compared to the practical results of his work.
- Study of Innovations
  In the new towns, many innovations have been tested. New techniques have been applied to urban transportations, urban communications. New types of urban design have been applied to houses, streets, neighbourhoods.
- Construction and Financing
  The large programming problems of the building of new towns have instigated new techniques for the coordination and the financing of these works.
- Abuses and Innovations in Public Administration and Services
  The acceleration and exaggeration of the urban problems have emphasized the tendancies to technocratic abuses such as hyperfunctionalist conceptions of the new towns. Some new towns are interesting to consider from this point of view. But in other new towns, original experiments have been tried, in order to fight back these tendancies: the most interesting efforts in re-designing the conception and distribution of public utilities and in institutional and political experimentation, have been made in new towns.

2) Critical Urban or Regional Situations

Another way of enriching the analysis of urban and regional systems is to apply it to abnormal states of urban or regional development. In critical

situations, the role of some systems or even some components of the systems, the effects of some particular interactions appear to be of major importance. The observations may be of great interest also for the understanding of normal apsects of the systems. For instance, some important feedback loops may be specially visible in the critical situations.

Examples of critical situations are relatively easy to find: strong decay of urban centers, high levels of pollution in towns or in parts of some regions, underdeveloped regions caught in a sort of downwards spiraling, obsolete regional economies faced with the necessity of conversion, etc. In all these cases, the reactions of the people and organizations involved are very strong and somewhat desperate, as there is no easy solution in sight. This strong amplification of the interactions may reveal new innovating capacities of the systems and may suggest a more frequent use of these capacities in normal or subnormal conditions of development.

3) Effects of Exogenous Disturbances

Another way of amplifying some of the normal interactions in urban and regional systems is to study the effects of a strong exogenous pertubation, such as the decision to locate an important airport in some particular region and near certain towns. For big airports, the decision is largely taken inside the national economic system which faces international problems and has little to do with the regional or urban aspects of the decision. In contrast, most of the direct consequences of this airport, either positive (jobs, new revenues, industrial sites) or negative (pollution, congestion of ground transportation facilities) appear in the urban and regional systems.

The history of the decision and its implementation, the different reactions of various urban and regional institutions, the reactions of the people involved, may put in evidence the nature and the limits of the interactions between national systems on one hand, and regional and urban systems on the other.

The conditions in which new equilibria are achieved after realization of the airport may also give precious information on the structure and the functioning of the urban ecosystem and the regional ecosystem.

4) Disturbance of Social Norms

A more typical but limited critical situation occurs when some kind of violence appears in urban or regional systems. It may be interpreted as the outbursts of a strong contradiction by some individuals or some organizations of the role of some institutions, of the application of some rules or regulating procedures, of some commonly shared norms or values. The analysis of the causes of the explosion of violence may be very valuable for the understanding of the regulating mechanisms and their limits in the different systems concerned.

It appears clearly that, in this heterogenous list, many proposals are so connected to one another that some proposals may be considered as specifications or special applications of other more comprehensive proposals. It is therefore important to suggest an appropriate organization of the whole research effort.

Towards a System of Research Programs

The efficiency of the research work in urban and regional planning will depend on two general conditions:

- Most of the work should be conducted very close to real problems, in contact with decision makers in particular towns and regions.
- Numerous and various interactions should be organized between these different applied projects.

The following procedure is thus suggested:

1) A list of possible applications of systems analysis to urban or regional planning should be established, such as the list given above.

2) This list would be communicated to various qualified research organizations in various countries. These organizations would:
   - discuss the general orientations of the whole research effort
   - select some of the proposed approaches and if necessary, propose amendments to these first projects
   - agree to apply these amended projects to the cases of particular towns or regions.

3) After a list of associated organizations and the list of the selected research programs has been compiled a seminar would be organized by IIASA to formulate common assumptions, to find a common language, to define common orientations.

4) The associated organizations would start working on the spot. IIASA would be responsible for the continuous coordination of the projects, and for stimulation of permanent interactions between the different projects by communication of information and specific meetings. IIASA would also conduct by itself applied studies (on Austrian towns, for instance) and more comprehensive studies leading to some kind of theory of systems analysis applied to urban and regional problems.

5) One year after the start of these coordinated research projects, IIASA would organize another seminar to examine interesting project results, to study interesting interactions between the different projects, to discuss elements of theoretical construction, and to decide on a new program of projects for the next year.

6) Some further suggestions:
The proposed organization of research should foster comparative studies by different means:

- large communication of information from one country to another and from one associated organization to another
- simultaneous application of some studies in different countries and in different regions and towns
- critical review by each of the associated organizations of the works done by the others
- exchange of scholars between the different associated organizations.

Of course, IIASA would play an active role in all these activities.

Questionnaire and Survey

on

Directions and Methods for Research

in

Urban and Regional Systems*

This questionnaire seeks to collect information in order to facilitate communication within the conference group. The forms should be completed and returned to the staff by Tuesday morning. Late submittals should not arrive after Tuesday at 5:00 pm.

The answers received will help the conference leaders structure the discussion on the last day of this Conference. Your answers will not -- we repeat, NOT -- be included as part of the Proceedings of this Conference. However, the conference participants might wish to discuss the desirability of asking IIASA's national member organizations to prepare formal answers (for attribution) to this questionnaire and survey -- in this or perhaps a revised form.

Although at this point in time we are seeking only preliminary informal answers (not for attribution), this is still a demanding task, given the time pressures of this Conference. We shall highly appreciate your cooperation on this. Of course, this does not preclude any further suggestions you might like to add to our questionnaire-survey.

Answers can be short; however, we hope they will cover all the questions. The Wednesday session depends upon this effort.

The survey should help to sketch a broad picture of the choices open to the IIASA team on Urban and Regional Research. Hence, it deals with the thorny question of (1) definition of systems analysis. Then it moves to a brief survey of (2) the best urban and regional systems research in each country...in order to delineate (3) proposals for cooperation between research institutes in the member countries and IIASA. This will open the way to a discussion of (4) linkages between the Urban and Regional Projects and other IIASA projects. This is a crucial

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*Prepared by M. Rousselot

topic, since the success of the Vienna venture depends upon the ability of IIASA teams to develop a common frame of reference from both theoretical and methodological points of view. This requires that full attention be given right from the start to overlapping areas of projects. Then the survey proceeds to the most pressing questions of (5) the tentative outline of an in-house research program, as well as (6) the tentative outline of topics that can be the subjects of International Conferences both at IIASA and elsewhere.

All the questions are open questions.

Please feel free to attach sheets of paper if you need more space for one or more questions.

We know that any question introduces a bias, and we need your reactions to our wording as well as your opinion on the whole approach to the task of circumscribing the possibilities for the IIASA project. Therefore, please express your feelings about misplaced emphases, points missing, naivetes, etc.

1. WORKING DESCRIPTIONS OF URBAN AND REGIONAL SYSTEMS ANALYSIS

Please characterize the actual most significant use of urban and regional systems analysis in your country by using the following criteria (amongst others):

(a) Use

e.g.
- decision making (at which level of government?),
- design of decision making instruments,
- design of information systems,
- pursuit of scientific knowledge per se,
- ....

(b) Nature and Scope of the Topics Investigated

e.g.
- regional development,
- urban economics,
- neighborhood planning,
- municipal service delivery,
- national housing policy,
- social change in the urban context,
- design of new towns,
- evaluation of public facilities programs,
- ....

(c) Main References to Scientific Disciplines

e.g.
- mathematical programming,
- optimization techniques,
- stochastic process theory,
- information theory,
- cybernetics,
- general systems theory,
- Monte Carlo and computer simulation techniques,
- structural-functionalist theory,
- human ecology,
- decision theory,
- classical economics,
- political science,
- Marxian methodology,
- ....

If you think that in your country there are different types of works undertaken or planned in systems analysis on urban and regional problems, then give a separate description of each of these types.

2. THE BEST URBAN AND REGIONAL SYSTEMS RESEARCH IN YOUR COUNTRY

Please list a few outstanding research projects as well as the name of the author's institution and the potential users of such projects.

It would be quite valuable to give an account of the characteristics that make this research especially commendable: methodological and conceptual progress alike should be highlighted on the one hand, and actual use in urban situations should be exemplified on the other hand.

3. PROPOSALS FOR COOPERATION BETWEEN RESEARCH INSTITUTES IN YOUR COUNTRY AND IIASA

Please state which organizations in your country would be interested in maintaining close contact with IIASA; whether they would sponsor systems research, or project evaluation task forces; or whether they would call upon IIASA to sponsor conferences, international comparisons, etc.

What kinds of benefits would the national organizations expect from this cooperation?

What would be the benefits to IIASA?

4. LINKAGES BETWEEN THE URBAN AND REGIONAL PROJECTS AND OTHER IIASA PROJECTS

The other projects envisioned are:

(1) Complex use of water resources
(2) Design and management of large organizations
(3) Energy systems
(4) Medical systems
(5) Ecological systems
(6) Computer systems
(7) Control of integrated industrial systems
(8) Optimization and control of complex dynamic systems

It is obviously desirable to call for cooperation between the urban and regional project and one or many others, but this would not be very helpful unless specific ties are sketched out.

For instance, one might propose a field of interest which would overlap several projects or would involve a common methodological interest or a common reference to certain concepts.

It would be very nice if you could make clear whether similar efforts are encouraged in your own country.

5. TENTATIVE OUTLINE OF AN IN-HOUSE RESEARCH PROJECT

Such projects have already been proposed in a IIASA paper of January 9, 1973 and it seems useful to have a full assessment of these proposals by all participants at this conference.

A. Assessment of the January Proposals

A xeroxed copy of this paper entitled "A Preliminary Research Program in Urban and Regional Planning" has been distributed to you already. The suggestions for specific projects are enumerated from page 6 to page 10. Each suggestion can be designated by its alpha-numeric reference (from A1 to B4).

We would like you to make comments about each of these suggestions that seems to you worthwhile investigating at Laxenburg.

For instance:

- appraisal of scientific interest,
- appraisal of usefulness of expected results for your country,
- gross evaluation of the type of research work to be achieved, data sources, and practical hints about personnel, international liaison, etc.,
- interdisciplinary aspects of the research and possible overlap with the IIASA projects,
- cross-cultural aspects of the research.

B. Open List of New Projects

Since many other projects can be envisioned, we would be very happy with new proposals followed by the same type of comments as above.

Actually, one might propose research along two different lines:

(1) genuinely new topics;
(2) review of research already completed or of a research design already realized but not implemented.
(Could you point out specific examples in your own country?)

C. State-of-the-Art Handbook in Urban and Regional Systems

In which domain do you think it is timely to write a state-of-the-art handbook? Would some organization in your country take part in such an effort and how?

6. TENTATIVE OUTLINE OF CONFERENCE TOPICS

It is common knowledge that many conferences on urban and regional problems are organized each year at both the national and international levels. Please state clearly whether you favor organizing new types of conferences? Why, and whom should they concern?

Please give precise examples of conferences to be run:

e.g. Convention of urban political leaders to be made conversant with fire protection management in 1974.

7. AFTER MIDNIGHT COMMENTS AND FURTHER ANGRY REMARKS

An Approach to Urban Systems

Y. Barel

(Note: Mr. Barel made an oral presentation during this Conference. His talk was based upon this paper.)

Introductory Remarks

The following analysis shows the stage of development of our ideas at the time that our institute is about to begin research on urban systems, under the auspices of the French research team of the Ministère de l'Equipement. I would like to make the following remarks:

1) If urban planning and an urban policy are to be worked out and evaluated, it is necessary to know whether and to what extent cities and groups of cities are systems. Factors that are determining or not (and thereby the results of planning) will be different according to whether or not cities have systemic characteristics and what these characteristics are specifically. For example, just as the programs for renewing or building dewellings not only improve housing conditions but also aggravate the poverty level or the unemployment rate, it is possible that these phenomena correspond to a set of feedbacks capable of distorting an urban program, well-intentioned thought it may be. The following remarks will aim at substantiating this argument.

2) Paradoxically (if we take into account the already over-abundant systemic literature on the city), the problem of the existence and identification of urban systems has not yet, as far as I know, been studied seriously. Some of its aspects have merely been touched upon. Some authors are reluctant to speak of a system when they refer to the city. For example, H. Lefebvre[1] says that in the past there may have existed urban systems (in the Ancient World, the Middle Ages, or the Renaissance), but that they were transitory and vulnerable to disruptive forces. It is interesting that Lefebvre's reluctance to use the notion of a system is based on his perception of urban phenomena as contradictory.[2] On the other hand, many other authors do not hesitate to use, and sometimes misuse, the notion of an urban system. Some, like J.P. Lacaze[3] even describe the city as a living organism with its own structure and logic. But W. Ostrowski[4] rejects the idea of the city as an organism since the city does not have the self-regulating capacity characteristic of biological organisms.

However, in a study carried out by the French Planning Commissariat,[5] the city is defined as "a huge object which has the peculiarity of constructing and destroying itself continuously while remaining itself." Additional points of view on the idea of the city as a system could be given, but they all share the characteristic of considering the problem secondary of easily resolved.

I shall here take the opposite point of view and try to show that we should not neglect either the problem or the means of solving it. I hope it will become clear from what I say that the answer is not as obvious as it might appear at first sight and that when it is found it opens up new perspectives to research.

3) There are two ways, almost unrelated, of approaching the problem of the existence and identification of urban systems: one is "decisional"; the other is "cognitive." The decisional approach, to urban systems as well as to other systems, is based on the idea that it is possible to speak of a system as long as its "constructor" has decided that it is a system and has given to what could have been a heterogeneous set a finality and a function which turn it into a system. The hypothesis of the cognitive approach, on the other hand, is that there is a category of socio-cultural sets that no one--that is, no identifiable individual, group or ganization--has "decided" to make a system of but which still has systemic characteristics. In the first case, the system is decided upon from "the outside"; it results from a planning act. In the second case it springs out of the"scientific observer's"theoretical and empirical analysis of the internal processes of the system.

From the decisional point of view, it is then easy to identify a system: it is a simple matter of recording organizational and institutional facts. This point of view is based on an implicit ideology which would take too long to develop here but which cannot be ignored: an ideology based ontthe primacy of human organizations and of the role played by elites, governors, etc... It has less to do with science than with power and the use of power.

If we agree--as I do--that the field of socio-cultural systems is much broader than that in which "visible" organizational and institutional forces act, we arrive at the paradoxical conclusion that from a <u>decisional</u> point of view the cognitive approach is, in the end, more determinant than the so-called decisional approach. If, indeed, socio-cultural systems are created independently--at least partly--of the planning action, it is obvious that any important decision will be influenced by these systems which, from the decisional point of view, do not exist, by definition. This gives rise to endless misunderstandings on the analysis of results of

planning and urban policy. The following analysis is made from the cognitive point of view.

Different types of Urban Systems as Related to Levels

There are many kinds of urban realities which can be analyzed as to whether they are systemic or not. In order to carry out these analyses--which are important to our research work--it is necessary to analyze urban levels as precisely as possible, so that the passage from system to level is always feasible. (In many cases, the urban level at which the analysis is made is not taken into account or is not made explicit; this makes the notion of an urban system sound unreal or imprecise.) I shall here give some examples of levels which need to be studied.

Historical Systems and Service-delivery Systems

What we call historical systems are socio-cultural systems that crystallize processes at a speed which is sometimes very fast and sometimes very slow, and that are both determinant (they express the main tendencies of societies as they grow) and, to a great extent, "clandestine" (they can only be perceived after a great effort of theorization). Service-delivery systems in some way represents the organizational and institutional "superstructures" of historial systems, the emerging part of the iceberg. The distinction between historical systems and service-delivery systems[6] is directly linked to the hierarchy of levels we have taken from Alain Touraine (slightly modifying what he means by each) and which includes: the level of historicity, the level of political decision, and the level of organizational functioning.[7] Historical systems "cover" all three levels; service-delivery systems are to be found at the political level and at the level of organizational functioning.

We shall try to determine whether service-delivery systems are contradictory realities, as we will see is the case for historical systems, or simply what the decisional approach calls functional sets, in which case the word "system" would have two different meanings.

Historical systems and service-delivery systems are partially overlapping, partially distinct. In any case, a service-delivery system never overlaps more than part of an historical system. But it may sit astride several historical systems, or correspond to no historical system, etc... Thus there is no one to one correspondence between these two types of systems. They belong to different levels of social reality, and a set of interactions is progressively woven between them which we should take into account if we are to make theoretical and empirical studies. In urbanism, just as

in other areas of social reality, there are historical and service-delivery systems which we must try to identify. We should try to make a clear distinction between the whole and its parts, the visible and the invisible, the institutionalized and the "unconscious." (We are using a metaphorical vocabulary here which leads us to speak of the city as if it were a human being.)

Urban Systems and General Systems

We use the term urban system to designate either a particular city (e.g. Paris, Grenoble, Vienna) or a set of cities linked geographically (an urban area, or several cities economically related) or theoretically (by abstracting characteristics which are common to several cities but which do not correspond to any one particular city). These are two levels of urban reality, defined by their dimension. What seems capital to me--and is obvious, even though it has been neglected--is that no valid analysis of urban reality can be carried out without a continuous shift from one level to the other. This point is made particularly clear in Alain Medam's study.[8] Medam points out the existence, within the urban system, of a "politico-institutional" subsystem which groups government members, public institutions, organizations of all sorts (urban agencies, chambers of commerce, committees of development) that play an important role in the dynamics of the city. Starting from an analysis of Rouen and Grenoble, he points out an historical tendency of this sub-system to lose its importance, linked to a loss of power of the local middle classes, and a tendency of local organizations and their strategies to become dependent on national or international authorities. Unless a clear distinction is made between these two levels, one could get the false impression that the political and institutional "factor" tends to play a less important part in the dynamics of the city, whereas it might be only a shift in the level on which this "factor" acts. (An example of such a shift in France could be the increased importance of the role played by local representatives of national authorities dealing directly or indirectly with urban development.) Generally speaking, it is obvious--although systemic literature on the subject largely ignores it--that in order to understand what is going on at one level it is necessary to take into account what is going on at other levels. Whatever its level, an urban system never changes independently of the whole. We should rather say that it is the hierarchy of levels to which it belongs that changes at one particular point. We can learn no more about urban systems if we neglect the history and description of particular cities than if we heap up, ad infinitum, monographs of cities.

The Urban Phenomenon and Urban Systems

The city is perennial (relatively) either as an economic social, and cultural phenomenon ("the city" existed thousands of years before Christ) or as a geographical phenomenon (several of the cities of the Ancient World and the European Middle Ages are still urban centers in spite of economic, social, commercial upheavals). But in some cases, we feel intuitively that "we are not talking about the same thing," that it is not the same city, but that specific urban systems have created discontinuities in the history of the city.

One of the main aspects of our research concerns the relationship between the urban phenomenon and urban systems; it is perhaps this relationship which shows the urban specificity as related to other socio-cultural systems. How is it that the fact that Rome is almost 3,000 years old has an influence on the specificity of today's Roman system and on the specification of its economic, social, and cultural inputs?

Criteriology of Levels

Curiously enough, most of the levels which I have mentioned are based on the application of one criterion of hierarchization: that of dimension (spatial, temporal, spatio-temporal). The reason might be that this is the criterion which is easiest to apply. But the distinction between historical systems and service-delivery systems connot be put into terms of dimension alone and makes us notice that there are other criteria for ranking and identifying levels. Besides dimension, there are three other criteria which systemic literature makes use of (implicitly, most of the time): emergency, complexity, and domination.[9] A. Touraine's discussion of levels[10] has led us to a conclusion which we consider very important: these criteria are not independent of one another. Thus we can look for a privileged hierarchy of levels, that which represents the best possible combination of these four criteria acting simultaneously. A. Touraine's hierarchy fulfills this condition It shall have to be discovered whether this research technique can render interesting results as concerns urban levels; and, more generally, the problem of urban levels will have to be studied in "criteriological" terms rather than half intuitively, as seems to have been done in most of the literature on the city.

The Notion of an Urban Eco-system

This notion, of frequent usage, is both rich and ambiguous. It can be understood in at least two important ways:

a) In some cases, what is understood by an urban eco-system is the meeting place of ecological processes (among which is human biology, of course) and economic,

social, cultural processes. If it were shown that this junction does have a meaning and, in particular, that it makes up a system, the notion of an urban eco-system would gain much operational value. In particular, it would help confirm or invalidate the systemic character of the urban phenomenon.

b) In other cases, the expression is used to signify that the city is inserted in a set of cities or in a context of social systems other than urban. This is the sense in which the phrase must be understood in the works of Medam and many others. The notion of an eco-system is thus an interesting way of shifting between the two levels that we spoke of, that of local urban systems and that of general systems.

It is then worthwhile to specify exactly what we mean by an urban eco-system, even if the notion remains providentially flexibile. We should also try to determine the characteristics of urban eco-systems as compared to other, "natural" eco-systems. The following points should be emphasized: 1) the predominance in urban eco-systems of an animal species, the human species; 2) the importance in urban eco-systems of what could be called "populations of objects"; that is to say, human artifacts; and 3) the discontinuous character of urban eco-systems, and, more generally, of human eco-systems--as compared with vegetable or animal eco-systems. The difficult problem of the boundaries between urban eco-systems. The difficult problem of the boundaries between urban eco-systems, often dealt with in the literature on human and urban ecology,[11] is but an aspect of this discontinuity. By going deeper into the study of the notion of urban eco-systems, we can moreover show that the opposition between nature and culture, "natural" and "artificial," is factitious. Just as "the country" has long been made artificial, it is likely that the city is, more than we think, a "natural" phenomenon.

How to Identify an Urban System at a Given Level

1) The study of systemic literature[12] shows that four fundamental criteria are taken into account, either implicitly or explicitly, when systems are to be identified: interaction, totality, finality, and reproducibility. These criteria are presented in order of their "systemacity"; that is, the least "systemic" systems are characterized only be interaction, while the most systemic systems are self-reproducible. There is no need to explain the characteristic of interaction between elements. Totality means that the behaviour of a system cannot be said to be the mere sum of the behaviour of its parts. The notion of totality, which has long been a philosophical notion, sets fascinating problems for science to solve. Finality should here be taken in its cybernetic sense: either as a true finality

or as a quasi-intentional behaviour (in those situations in which a system behaves as though it had a goal). The cybernetic finality is a recurrence of identical results obtained by a system, no matter what intentions and disturbances (within certain limits) are brought in by the actors of that system or of other systems. Reproducibility is not a criterion of current usage in systemic literature but results from the research carried out by our institute. The reproducibility of a system is the capacity of an open system (all socio-cultural systems are open systems) to take advantage of its relationship with the environment (and of the relationship between sub-systems) in order to reproduce itself; that is, to reproduce, to re-create its relative identity, specificity, and authonomy.

It must be noted that these criteria are not independent of one another. We can hardly imagine, for example, the existence of a cybernetic fanality without reproducibility.[13] And, in a number of cases, totality can be analyzed as a quasi-intentionality. One of the most interesting questions (and one on which no research has been done, so far as we know) is whether it is possible to conceive of interactions which do not lead to some sort of totality. I cannot deal with this problem here, but only indicate how important and interesting it is. If, as is often said--and as I believe--the analytic method and the reductionist procedure fail to explain the behaviour of a set in interaction, it would seem[14] that it is because of the simultaneity of interactions. However, although Newton and classical mechanics postulated simultaneous interaction, modern science rejects it. We are faced with a true scientific enigma: if simultaneity is rejected, the analytic method cannot explain everyting; if it is accepted--and the analytic method considered deficient--then the validity of modern science is disputed. Ever since Kuhn, we have been aware that when research is confronted with an enigma, it means that it is on the way to a successful result. Maybe it would be possible to make modern science and the apparent simultaneity of some interactions compatible through Piaget's notion of feedforward. This is a sort of improved feedback, by means of which some systems and organizations can adapt themselves beforehand to foreseen disturbances.

I hope I have not given the impression that it is sufficient to apply these four criteria for an easy, clear, scientifically objective identification of a system. For one thing, a lot of work remains to be done in order to transform these criteria into really operational identification tools; we shall discuss this later in relation to feedbacks. And, above all, the identification of a system is not a non-committed operation. There is an object and a subject who "observes" the object through distorting theoretical and social habits and who is, moreover, often part of the observed reality himself. See Ph. Mallein's analysis concerning this matter.

In any case, in spite of the great methodological progress yet to be accomplished, I am certain that it would be useful to apply these criteria to what are too carelessly called urban systems, and thus to study this field with a bit more precision.

2) From what has been said, it is clear that it is clear that it is impossible to distinguish automatically, once and for all, those socio-cultural sets which are systems from those which are note. A set is more or less systemic. There are few socio-cultural sets which do not have some sort of interaction, and probably few in which totality, finality, and reproducibility are at their full extent. Moreover, a system is never static; it is always making or unmaking itself. The fact that it is impossible to decide, once and for all, what is a system and what is not, brings in a new diachronic or genetic dimension which is essential in systems analysis, linking it to Piaget and Goldmann's genetic structuralism. But, to return to my starting point (the advantage of the cognitive systemic approach for the analysis of the results of urban planning), it is obvious that this advantage is all the greater when we are dealing with a more or less finished system. I propose that the term urban system be conventionally limited to those systems which have the capacity of reproducibility. Urban systems are self-reproducible urban structures.

3) To give an urban system the name of self-reproducible urban structure only makes sense if it helps identify the system. Social reproduction, unlike biological reproduction, cannot be observed; it must be theorized. As for the content of social reproduction (including urban reproduction), I can only refer to our publications. But if there is a content, even if it is not immediately perceptible to the observer, it must give birth to perceptible forms. In relation to urban systems, I shall call these forms regulators or feedbacks. (The work feedback is to be given its scientific meaning and not the bastardized one of elements in interaction which it is often given.) It is evident that at least three of our fundamental criteria (totality, finality, and reproducibility) are partly dependent on the existence of these feedbacks. It would not be possible for a system to reproduce itself--to maintain for a while its relative specificity, unity, and autonomy--if it did not have regulators to enable it, within certain limits, to make the necessary adjustments to internal and external disturbances. This statement is even more valid if the notion of system, reproduction, and feedback is associated with the notion of contradiction, in the Marxist sense of the word. Systems and processes of reproduction cannot be contradictory units without the intervention of regulators. In our approach to social reality, the notions of feedback and of contradiction are necessarily related.

Under these conditions, the identification of urban feed-

backs makes it possible to detect at the same time our four fundamental criteria and is essential to the identification of urban systems.

Superposition, Specific Assimilation, Urban Specificity

Superposition

What we mean by superposition is that socio-cultural systems and processes of reproduction are not placed side by side but are partially superposed: some of the elements, parts, sub-systems of a system are also elements, parts, of another or of other systems. Superposition is then something other and something more than mere interaction. At the same time, we have tried to show that a system never reproduces itself in isolation but as part of a hierarchy of systems. As it reproduces its member-systems. To this process we have given the name "double reproduction."[15]

In urban affairs, the real problem is not bringing to light the superposition of a possible urban system on other socio-cultural systems, but, on the contrary, deciding whether there is anything behind this superposition specific enough to be called an urban system.[16] This gives rise to endless discussions on the existence of urban specificity.

In our opinion--and paradoxically enough--it is by studying this superposition of systems related to the urban system that we shall be able to tackle the problem of urban specificity. I shall refer to A. Medam's relevant remarks on urban self-management.[17] He shows that self-management attempts have failed because popular organizations, like local oligarchies, introduce into their local strategies elements of more global strategies. Urban conflict has thus become one of the manifestations of wider social conflicts. But, developing further Medam's analysis--and it is here that the analysis of superposition gives rise to the problem of urban specificity--we may ask whether the existence of such mediating forms is not precisely a sign of urban specificity. The idea of urban self-management may be a sort of homage to this specificity. The city assimilates social conflicts and turns them into urban conflicts. The formal character of this assimilation (But is it entirely formal? I do not think so) is due to the openness of the hypothetical urban system, that is, to the difference between the urban policy and the urban system policy system policy,[18] where the latter includes the urban aspects of economic, social, political strategies of wider extent. But the form which urban conflict takes creates specificity; for example, by permitting local political alliances unimaginable at the national level, by creating new or specific attitudes among the actors in the urban conflict, by complicating the interplay of the real and apparent finalities of human action, etc.

Specific Assimilation

What I have said should make it clear that while superposition does not show the non-existence of a system but rather the opposite,[19] it can help identify a system only if the system specifically assimilates the phenomena originated by other systems. Specific assimilation, which is the process by which a system unstructures and restructures its inputs, describes what is essential in the phenomenon of reproduction. One of the main aspects of our research will thus be to try to find out whether urban units are really the place for specific assimilation. This would be an important indicator of their systemic character.

For example, Medam's notion of censor-city (op. cit., p. 11) is based on the idea that urban space censures significations, that is, social structures. In Medam this is tantamount to saying that the city "manages" to throw out to the outskirts, in hidden places, the disagreeable sides of urban reality.

We could perhaps go still further in our approach to the problem and ask whether, because of their inevitable passage through the sieve of urban materiality (even "human" materiality), social phenomena do not undergo a transformation, an assimilation, which turns them into urban phenomena. The urban phenomenon would be a social phenomenon, specific and autonomous as compared to the original social phenomenon. For example, the expression of dissatisfaction--violence, revolution, rebellion--seems to be partly conditioned by material structures. Autombile traffic can deeply modify the conditions of collective games (children in the streets, popular celebrations, spaces devoted to ludic activities, such as pavements in front of cafes, etc.). It is even possible that the city creates social phenomena and psycho-social behaviour towards these phenomena. Because of urban spatial and material structures, city-dwellers have a certain life style which is reflected in their dress, leisure activities, transportation, and food. How do men adapt to these structures? What are the main areas of maladjustment? Do there exist feedbacks, the (cybernetic) finality of which would be to preserve a certain human equilibrium at the individual level and possibly at the group level by influencing spatial and material structures on the one hand and socio-urban facts and behaviour on the other? As an example, we could ask if there is not a specifically urban connection between transportation and popular culture. The tediousness and discomfort of urban public transportation cause boredom and fatigue. In order to fight against boredom and promiscuity, men seek refuge in reading, but in a certain kind of reading, of a certain quality, conditioned by public transportation. This is a social phenomenon (the individual struggle against boredom) which passes through a material sieve (public

transportation). It is possible that this hypothetical feedback maintains the human "equilibrium" at the level of mediocrity: reading bad books chloroforms the tediousness of public transportation and prevents its improvement, and the qualitative stagnation of public transportation blocks the aspiration for culture. Moreover, one reads in front of the public, and thereby like the public, which perhaps contributes to the unformizations of culture, etc. Profound modifications in the system of transportation or in the passenger's physiological and nervous equilibrium (which can result from the wear and tear due to the action of the feedback itself in the conditions of mediocrity described above) may render the feedback inoperative. The existence of sequences of feedbacks with the same finality (personal "equilibrium") may have to be identified. Moreover, we have examined public transportation "in itself"; but the "equilibrium" gained from human behaviour during public transportation itself depends on a set of feedbacks which link transportation, work, family life, meals, leisure activities.

All these analyses are of course hypothetical. Their only aim is to indicate the way in which we should like to proceed, in order to detect the existence of a possible specific urban assimilation. The question we ask ourselves is the following: what are the main processes which make it possible to understand how phenomena of all kinds are turned into urban phenomena? Without claiming to be exhaustive, we could perhaps hypothesize two main processes:

a) Socio-cultural phenomena takes place within the framework of spatial and material structures. This idea has already been developed, and we would only like to add that there are two sorts of material structures: human artifacts and natural conditions. In both cases the analysis of specific assimilation ties in with and makes use of the analysis of the city as an urban ecosystem, in one of the meanings this expression was given above.

b) It is also possible that specific urban assimilation is partly based on a particular way of combining socio-cultural structures. We shall presently discuss whether or not this combination represents a factor in urban specificity. For the moment I am only trying to see if the way in which this combination is achieved has itself a specific aspect. One of the hypotheses to be explored would then be the following: one would have to discover if the life-span of urban spatio-material structures and of urban cultures, as compared to that of socio-cultural structrues combined by the city, does not give rise to a difference between rhythms of reproduction of social phenomena and of urbanized social phenomena, which would result in the specificity of their urban way of combining.

What has been said is only an attempt to understand reality and not the result of this understanding.

Urban Specificity

Even if it were assumed that we have managed to show the existence of a specific urban assimilation, no answer would yet be given to the question: what is urban specificity? Bourdieu and Passeron clearly show the specificity of the educational system; educational reproduction changes social and political violence into symbolic violence. I think that in spite of all that has been written on urbanism, the problem of determining what is specific about urban reproduction is far from being solved. We shall have to work in this direction. The problem of urban specificity has two main aspects:

A. This specificity is naturally defined in the first place in opposition to what is "non-urban." But what is non-urban itself groups together phenomena that belong to two different categories: 1) what could be called the "eco-systemic" category, to which, for example, the city-country opposition belongs. The specificity of the urban system then shows up after an analysis of the characteristics of the urban eco-system; and 2) what could be called societal phenomena, thought to undergo a change in order to become urban phenomena, which establish, for example, the distinction between industrial society and urban society.

B. An aspect of urban specificity which has somehow been neglected but which seems essential is that of the existence of specific urban systems which are different from one another. Research on urban specificity is here closely related to research on the continuous-discontinuous nature of urban change.[20]

The idea we start from is that of the city defined as a specific combination of social phenomena. The city has its own way of associating phenomena which, at the level of the society, are combined otherwise. I must refer once more to our work on social reproduction and to our analysis of the concept of social formation, of specific systems and associated systems that make up this formation, of connection-disconnection processes between these systems, explaining how social formations reproduce during a certain period of time and favour at the same time other, future social formations, etc. This should help explain how the elements are combined in a different way at the city level and at the level of social formation (there is a difference either in the elements considered or in the relationships between them). What is urban in a given society is thus distinguished from what is not. Or, the analysis can be carried out at the level of local urban systems (of particular cities), and what is specific to each city, as compared to others, can

be examined from the point of view of its combined elements. These first two aspects could be called synchronic specificity. But we should also deal with diachronic specificity, tnat is: 1) with the difference between general urban systems themselves, which is based on the kinds of elements that are related and the way in which they are related, and 2) with the way in which the passage is made from one system to the other--i.e. the combined process of the dissolution of an old system and the emergence of a new one.

I shall try to explain this further by giving a few examples. According to Castells,[21] the medieval city arose from the combination of what to me is a specific element of feudal social formation (the fortress) and an allied element (the market). We could also mention other types of emergence of medieval cities, e.g. the combination of two allied elements of formation (the monastery of cathedral, and the market, which was sometimes linked to religious pilgrimages). There are, of course, other elements and relationships between elements that belong to feudal social formation besides the fortress, the market, and their relationships. The medieval city is thus a choice among elements and ways of combining these elements, and this choice might be the starting point for the emergence of a feudal urban system which is not the exact reproduction of the feudal social formation. Similarly, if it is the monastery and not the fortress that combines with the market, may be there are two local systems emerging within the same feudal urban system. Urban specificity is thus the particular way in which systemic elements are connected and disconnected within a given social formation.

Our study will be diachronic if we try to explain the passage from one system to another, as from the urbanized fortress city--i.e. from the feudal city to the capitalist city within the feudal social formation. A study carried out by the Cerfi[22] shows that all through the Middle Ages, the urban middle class fought to gain extra-territoriality, a "blank" area in which feudal rights no longer applied. In other words, the capitalist city sought to emerge from the feudal city by disconnecting the "fortress" and the market (for example). In order to achieve this disconnection, the middle class tried to create new connections with other elements of feudal social formation, such as serfs struggling to gain their freedom or royalty attempting to be autonomous and to dominate. The feudal capitalist city is thus a sort of territorial exception to the rule of feudal social formation. It is surprising to note that urban conflict retains the feudal characteristics of a spatial conflict, a struggle for extra-territoriality; it does not abolish the feudal rule, but only suspends it locally, which is another way of accepting it. Nevertheless, Braudel is right in insisting on the importance of this spatial autonomization, which leads to the emergence of the city-state. A

most interesting dialectial process of territorial independence-redependency of the city begins here. The capitalist city first becomes territorially independent by becoming economically independentof the surrounding territory (in particular, of the drain of the economic surplus of this territory) and by creating a discontinuous world-wide territory. Then there is often a new territorialization around a dominant city (the Milanese state, the Tuscan state, etc.). The dialectics between a territorial independence and a new territorialization favours, in its specific urban forms, the passage from feudal monarchy to absolute monarchy, and possibly from a feudal urban system to a system of transition between the form and an industrial urban system.

Another of Castell's ideas that seems interesting (op. cit., p. 26) is that the development of industrial capitalism almost brings about the disappearance of the city as a relatively authonomous social and institutional system, because the city, as a spatial form, is no longer associated with the sphere of social domination of a specific class, the middle class. This relative loss of urban authonomy is in fact the expression, at the urban level, of a more general social phenomenon: the middle class dominates everywhere and not only locally. The struggle of the middle class for power gives rise to two specific urban systems (the neo-fuedal system and the industrial system) and to the progressive emergence of capitalism within feudalism. In his study on Rouen, A. Medam corroborates Castell's remarks: the development of textile manufacturing is accompanied by a "ruralization" of Rouen, an apparent threat that the city is about to disappear which in fact indicates the transition from one urban system to another. (In Rouen's spatio-material structures, this change is expressed by the fact that the old city gradually becomes the centre of the new city, although at a certain point it looked as if it were going to disappear.)

From the diachronic point of view, the specificity of urban systems as compared to the social systems in which they are inserted could be due to the fact that they represent the original combinations of different social formations or of fractions of these social formations.[23] The reproduction of the urban system would be antagonistic to the general reproduction of social formation. Part of urban specificity would result from this antagonism. If Medam's hypothesis[24] were confirmed, we would have a good example of the two-fold and contradictory nature of social reproduction.

Urban Contradictions and Feedbacks

Urban Contradictions and Their Role in Research

I have already said that our approach to socio-cultural

systems makes us consider them reproducible structures while insisting at the same time on the twofold and contradictory nature of social reproduction. If we define social reproduction as a contradictory phenomenon, it means that we consider it a unit of contraries (for example, continuity and discontinuity in change, reproduction of the sub-system and of the meta-system, etc.). It follows that a system is a system--i.e. a reproducible structure--only because it is itself contradictory, a unit of contraries. It is because they are contradictory that we can understand the evolutions of systems (their internal changes in spite of a certain systemic invarience) and the revolutions of systems (when one system is replaced by another). We have also tried to distinguish social contradictions from social conflicts by showing a) that there could be social conflicts which have nothing to do with contradictions (i.e. not dependent on a unique explanatory dynamics applied to a unique system), b) that other conflicts could be the phenomenal and sometimes derived expression of contradictions, and c) that some contradictions could exist for some time without giving rise to visible social conflicts.

The hypothesis on which our work is based is that even if urban reality has systemic manifestations, it is contradictory, and that this contradiction must have specifically urban manifestations. The study of urban contradictions is thus essential to research, since it may help us to discover if urban reality is systemic and to show its dynamism. No research has yet been undertaken as concerns this aspect of the problem. I can only give a few examples of the way in which we intend to proceed, without, for the time being, claiming to be systematic:

1. We shall have to ask ourselves if there are not some necessary contradictions between urban historical systems and urban service-delivery systems. Signs of possible contradictions are to be looked for in three directions: a) in the fact that historical systems and service-delivery systems do not coincide "spatially"--i.e. that service-delivery systems correspond only to a part of historical systems; b) in the fact that they do not coincide "temporarily"--i.e. that a given urban formation generally corresponds to systems belonging to different periods; and c) in the fact that, as has been said, service-delivery systems are often "transversal"--i.e. that in the same strategy or the same institution points of view belonging to different systems, and thereby contradictory, are represented. (For social reproduction, an attempt has been made to show how the contradiction arose from the difference and even the logic of the relationships between sub-systems and meta-systems.)

2. With respect to service-delivery systems, two different approaches are possible. One of them favours the "function-

alism" of the system, its homogeneity around a determined finality or function, and is in keeping with the decisional approach. A service-delivery system would then correspond to what would be an administration or an institution defined according to the sound rules of PPBS; such a system is not "contradictory." But there is another way of conceiving a service-delivery system. We shall give an example, taken from Castells, of American urban institutions.[25] Castells notes that in 1967 there were 228 metropolitan areas in the United States, and 20,745 local governments (an average of 91 per metropolitan area), from which he concludes that there was more integration space than regulation space. The underlying idea is that the area is the space to be regulated and that the local government (the authority qualified to regulate) acts on a much smaller area, resulting in deficiencies in the regulation of the area. Castells advances the interesting idea that this lack of correspondence between the space to be and the regulated space is a socio-political necessity: regulated space (the territory of the local government) correspondsto the territory of the dominant social groups. These groups will dominate only so long as they reproduce social inequality (especially cultural and academic inequality), thus only as long as they distinguish, within the metropolitan area, between privileged areas (from the point of view of public facilities) and those which are less privileged. In other words, it is part of the policy of the local government that the space to be regulated and the regulated space should not coincide. Thus, there is a contradiction (that is, a necessary untiy of contraries) between the reproduction of urban social relationships and the regulation of the area. Since this contradiction could create public disturbances, it is overcome by "welfare projects" drawn up by the Federal government for disadvantaged areas and by the creation of ad hoc organizations of urban planning. These organizations are not intended to regulate the whole but rather to regulate non-regulation--i.e. to regulate the reproduction of political devices of domination and discrimination. So then if we consider that the urban service-delivery system is neither the local government nor the welfare organization but both, we realize that from this point of view--which has the advantage of giving a better explanation of the whole of the institutional situation--the service-delivery system is itself contradictory. In this particular case, we could even ask if this institutional proliferation is not a feedback making it possible to regulate temporarily the urban system by ensuring the "control" of social contradictions and of the urban projections of these contradictions. This control will give rise to the emergence of a new contradiction: that which arises from the unending reproduction of the non-correspondence between space to be regulated and regulated space and which shows up in the "irrational" incoherence of urban planning (which is actually perfectly rational). If this

contradiction is too difficult to assume, that is, if it becomes necessary to define a new institutional space until the political domination of social groups based on old categores is questioned, then the contradiction between regulation and political domination comes to the foreground, the old regulating feedback (institutional proliferation) is upset, and it becomes necessary to mount new feedbacks for the urban system to continue acting "contradictorily."

3. Eric E. Lampard[26] borrows some of Isard's ideas, and by studying the city as an eco-system he implicitly poses the problem of the existence of a contradiction between urban development and social (or historical) development. The contradiction would be that the city--like any other eco-system--changes, and that its evolution is constantly confronted with the constraints and limits of the inherited physical framework of the city. Boulding speaks of the same problem when he says that growth creates the form, but that the form limits growth (op. cit., p. 106).

4. Castells often deals with the problem of urban contradictions. Here we shall give an example, which is, by by the way, somewhat ambiguous or obscure.[27] Referring to Mario Gaviria's investigation of the neighbourhood of Gran San Blas in Madrid, Castells reminds us that this neighbourhood is a product of the urban paternalism of Falangist syndicates. The aim was to build a working class district, socially differentiated in space. This neighbourhood, according to Castells, is a borderline case since it is rare that a residential space is built so directly by an overall social conception. It would express a "specific social relationship." working class dwellings directly dominated by a bureaucratic institution. I would reinterpret this by saying that here part of a service-delivery system tries to dominate part of an historical system. But this domination is not really complete, and it gives rise the a contradiction which opposes a socially coherent residential space to a residential milieu which finds it hard to adjust to the foreseen social appropriation. (I hope I am not distorting Castell's words.) In other words, a pre-existent social structure could never be completely assimilated by the neighbourhood and would give rise to a specific urban contradiction. Its inhabitants would have an "historical" behaviour in contradiction to the institutional behaviour. If Castells is right (and if I have not misunderstood him) an element of both urban specificity and urban contradiction would be that a projection grounded on the values of each social group necessarily goes together with a non-correspondence between the space production system and the value production system.

The Relationship between Urban Contradictions and Feedbacks

When we examined the American "institutional proliferation"

observed by Castells, we saw that this proliferation was perhaps a feedback, but that in any case it was certainly linked to the control of some socio-political contradictions in American cities. I think this relationship between the notion of contradictions in American cities. I think this relationship between the notion of contradiction and that of feedback has a capital importance. If I attach great importance to feedbacks in the procedure of identification of urban systems, it does not mean that I have a functionalist view of the urban system or that I would assimilate this system to a coherent machine. To me, contradiction and feedback are two different ways of expressing the same thing. If the hypothetical urban system changes, adjusts itself to internal and external disturbances, it is because it is contradictory (and is in contradiction to other systems). It is because of this possibility of adaptation that possible feedbacks--i.e. finalized and recurrent mechanisms of adaptation (kinds of programs of adaptation)--are created. Feedback is possible because of contradiction. Conversely, contradiction is possible because of feedback. Contradiction exists only within and through a system, and the existence of a feedback contributes to the reproduction--the perpetuation for a certain period of time--of the system. The feedback expresses the existence of a need for regulation, and this need is itself a consequence of the contradictions in the system. If we are right, we thus arrive at an interesting methodological observation: the existence of contradictions is helpful in discovering possible feedbacks, and vice versa. (Such was the case with the American "institutional proliferation.")

Looking for Urban Feedbacks

We have mentioned only a few possible urban feedbacks. We could mention still more. The diversification of activities within a city, for example, or the specialization of cities as compared to one another might be signs of feedbacks in charge of reproducing an urban system in spite of its internal contradictions or the contradictions which oppose it to or unite it with other systems. Kopp's utopia of nomadic-cities might well be a way of proposing the creation of a feedback made up of an aim, a means, and a socio-ecological determinism set into action. The aim is that there no longer be a difference between center and outskirts, between city and country. The means is the building of light material structures--light, individual nomadic dwellings made in sections, with public facilities reduced to a minimum. The determinism is the correspondence that is thought to exist between these light material structures and the desired change in certain social structures (for example, the disappearance of the family).[28] Perhaps in the urban life around us there are feedbacks of this sort that link the reproduction of urban systems (and of other systems) to such phenomena as: the disappearance of the lunch-time family meal, working women, shops remaining open at lunch time,

the preference to live in a neighborhood other than the one in which one works, etc. In Hawley[29] we find signs of possible feedbacks concerning the demographic dynamism of cities or the number of industrial jobs as compared to the population, etc.

I am giving these examples merely as a hypothesis, since we do not know if we are dealing with authentic feedbacks. Reliable authors tend to belive that there are no urban feedbacks. After having studied the history of Rouen and Grenoble, Medam seems to have come to the conclusion that he has empirically verified the existence of urban systems that are specifically self-reproducible, but not the regulation of systems, the self-regulation by cities of their reproduction. Laborit writes:

> What we have tried to show in this study as concerns the retrospective effect of the urban structure on the socio-economic structure which gives birth to it is that in spite of a few corrections or adjustments, it is no longer a regulated system with a negative retrospective effect on the value of its factors, but a system in tendency that must necessarily end in "evacuation," that is, rupture, if nothing is done to completely change the type of regulation. What we have tried to show is that if the social effector's aim is the maintenance of its structure, the city is one of the ways in which he can reach this aim; but that because he probably does not know the laws of cybernetics, he is not aware, when he has recourse to this means, of its long-term consequences, and that it will probably lead to the disappearance of this structure, that is, the opposite of what he had hoped.[30]

If further studies were to confirm Medam's or Laborit's findings, it would mean that the urban systems observable up to now are incompletely developed, precariously reproducible systems. This is, of course, only one of the possibilities for which we must be prepared. But we do not have, to my knowledge, any serious method for identifying feedbacks for socio-cultural systems, and particularly urban systems. One of the aims of our research should be to advance in this direction. And, in particular, we should consider the meaning of the notion of social feedback. As everyone knows, the notion of feedback was inherited from cybernetics and from the study of material systems to which man has given a finality, or from the study of biological systems. If this notion were carelessly transferred to the social domain, one of the two following extreme solutions would result: either the total lack of social feedback, or its assimilation to some sort of phenomenon of interaction. A social feedback is probably more flexible than the feedback of an automatic machine and

more stringent than a mere interaction. The main thing--and the most difficult--for the identification of a social feedback is certainly the identification of a (cybernetic) finality and of a link between this finality and the interplay of socio-cultural factors which may be substituted for one another. It is difficult not to be arbitrary when identifying the finality in a systemic world where quasi-intentionality is predominant (despite technocratic illusions), or when relating this finality to socio-cultural factors. In the physical or biological domain, the fact that certain values do not change (or change very little) often indicates the existence of feedbacks. This invariability is frequent in the social sciences (in demography, for examples). However, without further study it is not possible to tell whether in this case they indicate the existence of social feedbacks (with the possible exception of the demography of the so-called primitive or archaic societies). Conversely, it would be naive to believe that the absence of such invariability shows that feedbacks do not exist. The regulation of a system may be quantitative and/or qualitative. It is possible that social feedbacks, especially in complex systems, are mainly qualitative (for example, those which have to do with the regulation of personal equilibrium in urban systems). From this point of view, further reflection on social feedback might show us the disadvantages of the classical distinction between positive and negative feedbacks, improperly confused with the distinction between disruptive and regulating feedbacks. Finally, it should not be forgotten that the analysis of an isolated feedback rarely has an explanatory value in the identification and behaviour of a system. Only in analyzing several (or a system of) feedbacks can we speak of an explanatory value.

Notes

1. H. Lefebvre, Du Rural a l'Urbain, Paris, Anthropos, 1970, p. 263.

2. See especially H.Lefebvre, La Pensée Marxiste et la Ville, Paris, Casterman-Poche, 1972, p. 151.

3. J. P. Lacaze, "Une Nouvelle Science Appliquée: L'Urbanisme," La Recherche, No 27, October 1972.

4. W. Ostrowski, L'Urbanisme Contemporain, Tendances Actuelles, Paris, Centre de Recherche d'Urbanisme, 1970.

5. Les Villes, La Société Urbaine, A. Colin, Plan et Prospective, 1970, p. 120.

6. Which is almost equivalent to the difference between the decisional and cognitive approaches.

7. For a discussion of these levels, see my book, La Reproduction Sociale: Systèmes Vivants, Invariance et Changement, Paris, Anthropos, 1973.

8. "Approche Historique des Systèmes Urbains", Ministère de l'Equipement, Mission de la Recherche, Ronéo., Dec. 1972.

9. Refer to my book, La Reproduction Sociale: Systèmes Vivants, Invariance et Changement, for further development of this point.

10. Ibid.

11. The works of Galpin, dating back to 1911, are still relevant to this point, as are the analyses of A.H. Hawley (Human Ecology, A Theory of Community Structure, New York, The Ronald Press Co., 1950, p. 245 ff.)

12. On this point, see Y. Barel, La Reproduction Social: Systèmes Vivants, Invariance et Changement and Prospective et Analyse de Systèmes, La Documentation Française, 1971. Also see Ph. Mallein, "le Problème de l'Identification d'un Système Social", IPEPS-IREP, Roneo, May 1972, p. 50.

13. Neither does reproducibility exist in itself. It is always the reproducibility of something specific, definite, that is, with a final aim.

14. The restrictive nuance is due to the fact that we have not yet seriously studied the problem.

15. The following quotation from the biologist Laborit (L'Homme et la Ville, Paris, Flammarion, 1971, pp. 18-19) illustrates double reproduction in urban affairs very well:

"It would be more exact to consider that the city represents the product of a social group. Using cybernetic language, we can say that the city is "the effect" of an effector and that this "effector" is the social group. But this statement, which seems self-evident, is nevertheless inexact, for an effector, in order to act, must have a goal, an end, a finality. Indeed, it is "programmed" for it. But the finality of a human group is not to construct a city; it is to live, to maintain its structure. In this respect, a human group is no different from a living organism; that is, a cellular group, for which the goal can only be to maintain its organization, its complex structure, in an environment which is less complex. The city is only a means of realizing this end; it cannot be an end in itself. Furthermore, it seems to be an indirect means, because the fundamental means of maintaining the

structure of a middle class society, for example, is, above all, profit. In this specific case, the city will be only a secondary means of achieving this profit, which itself is necessary to maintain the social structure... Thus, considering the city as the product of a living structure, of a social group, leads us to also consider it as a "means" employed by this living organize to preserve its structure. Understood in this way, the city itself becomes an "effector" because it maintains the structure of the human group. This human group thereby becomes the active "factor", or agent, of the city because without a human group to build, live in, and use the city, there would be no city."

16. Regarding service-delivery systems, we see in P.A. Rondinelli ("Adjunctive Planning and Urban Development Policy," Urban Affairs, Vol. 7, No 1, September 1971) that the most important policies in designing a modern American city are "transversal" policies, in the sense that they are structured around problems of urban systems and also other systems. The same observation can be made regarding the organizations which embody these policies.

17. A. Medam, La Ville-Censure, with an introduction by A. Kopp, Anthropos, 1971, p. 165-66.

18. For an explanation of this difference, refer to our research project, "Changement Social et Politique Urbain d'Aménagement du Territoire," pp. 5-7.

19. Multiplying the examples of the intervention of external systems in the city does not preclude the possibility of an urban system. A system can be as open as you like and still exist.

20. An essential aspect of our research will be an attempt to construct a typology of simultaneous and successive urban systems, using the analyses already available on this question (for example, those of Lefebvre, Medam, Castells, etc...).

21. Castells, La Question Urbaine, Paris, Maspero, 1972, p. 25.

22. Cerfi, "Généalogie des Equipements Collectifs, Première Synthèse," Paris, Roneo, December 1972.

23. Castells, op. cit., p. 26: "We could also analyze the evolution of the urban systems of each country in terms of the triangular relationship between the middle class, the nobility, and the royalty. For example, the underdevelopment of commercial Spanish cities, in contrast

to Italian or German cities during the 16th and 17th centuries, can be explained by their primary role of transmission belt between the crown and American commerce, while the Italian and German cities were quite autonomous vis-a-vis the Emperor and the princes, for whom they were only occasional allies."

24. A. Medam, op. cit., p. 32.

25. Castells, op. cit., p. 257-68.

26. Eric E. Lampard, Issues in Urban Economics, p. 105 ff.

27. Castells, op. cit., p. 147.

28. On the other hand, I have recently learned that in Norway, the development of suburban dwellings was accompanied by a sort of "extended family", but in a very different form from the classic extended family.

29. Hawley, op. cit., pp. 374-378.

30. Laborit, op. cit., p. 165.

Urban Systems Analysis in France: Difficulties and Prospects

M. Conan

Systems analysis entails various meanings. It may be used when dealing either with the management of large organizations, or with the use of different scientific works outside the domain where they originated, such as the study of systems of inequations in mathematics, the control theory of informational machines in cybernetics, or the behavior and pathology of organisms in biology.

It would be both tedious and useless to enumerate the various topics in French urban research that verge upon some of these currents of thought. Actually, this would amount to a kaleidoscopic landscape with no clear gradient for future research.

In contrast, it seems appropriate at such an early stage of the IIASA project in municipal systems to deal at some length with the difficulties imbedded within the various approaches, because this may be helpful in drafting the project to be achieved in Vienna. Moreover, an attempt has been made in this paper to define the current prospects for urban systems research in France and to outline very briefly some of the materials upon which a systems approach to urban phenomena may be attempted there.

Difficulties in Urban Systems Analysis in France

Any discussion on the success or failures of social sciences implies some judgement upon the social function that should be served by social research. Positivist philosophers held that better knowledge equates with greater social well-being. Alvin Gouldner [2] has convincingly argued that the welfare state is responsible for some type of development within social research, and it is also clear that the judgement upon the function that social research should serve depends upon the social and political organization within the country.

Without indulging in a detailed account of the French political and administrative set-up during recent years, one may simply state that a large amount of research has been geared at providing short term answers to urban policy problems that faced the government. We shall first deal with the

shortcomings of scholarly attempts under these circumstances. Then, we shall turn to more theoretical problems that appear whatever the purpose of social research when it is made to depend upon two analogies: either using cybernetics as a model for the social sciences, or equating society or the state to an organism.

Expectations and Disillusions about Applied Social Research

On research, the frame of thought in 1966 in the most enlightened circles of the French urban administration was very much akin to what Eugene Meehan [4] has termed a system paradigm of research. The crux of the matter was that an explanation was to be judged according to its potential utility. Any logical sequence of empirical generalization would be a suitable explanation provided it entailed a certain number of levers that could be manipulated by the administration.

Henceforth three types of considerations would determine the most valuable theoretical path to pursue: a) the acknowledgement of a problem area within the government or the administration, b) the monies available, and c) the empirical data gathering and monitoring apparatus available in a consulting office. This led to a large number of studies that produced no scientific knowledge at all and to a few serious attempts at applying mathematical techniques to urban research. (There were a few attempts at modelling: the housing market of metropolitan area, at the aggregate level, the development of central business districts in new towns, and a very ambitious scheme for residential land use control of a metropolitan area at a disaggregate level.)

It turned out that neither the use of duality theorems in non-linear programming nor sophisticated techniques of computer simulation were usually sufficient to keep up with the high expectations that had been put out at the onset of the research effort. Actually one may go along with Douglas Lee [3] and state that these efforts: a) were based on a very shallow knowledge and understanding of the urban phenomenas, b) were far too crude to suit policy makers either at the national or local level, and c) called for such large date collection that maintenance overtime was beyond the financial possibilities of French city halls. Furthermore, one could also say with Lee that the model behavior itself is largely unknown for lack of experimentation and sensitivity analysis to say the least, and that reliance upon the models tends to deter from a close scrutiny of the actual urban situation. Thus, the scientific achievements have been meager and social benefits scarce even though they may have led to some change in consultant's practice when working with city officials on down-to-earth town planning.

One should probably insist, though, on two aspects of the lines of development of research that followed from the use of this paradigm: the danger of taking administratively acknowledged problems at face value, and the dependency upon the systematic empiricist view of science.

On the one hand there is some clear advantage at trying to wrestle with the difficult situations that face any administration either at the national or local level, since an attempt to discover the underlying rationale of any such problem challenges the ability of the scholar. But there are at least three severe limitations to such problems:

1) Since any administrative body has a limited realm of action it tends to restrict the scholar to that aspect of the problem which falls within its control. This makes for a rather parochial type of research.

2) Some problems that crop up within government are taboo and never inspected.

3) The government is not the whole of society and this way of picking problems distracts from many social issues that could be illuminating for an understanding of how cities work or how citizens live.

On the other hand, the usual training of most scholars concerned by those efforts in applied mathematics and statistics had led them to a spontaneous philosophy of science that was self-justifying and, not surprisingly, very close to systematic empiricism as it can be derived from D. Hume, S. Mill, K. Pearson, R.A. Fisher, and others. This entails several difficulties that we should keep in mind: since any empirical category is treated as a concept, it is clear that theoretical endeavers can be paid but lip service, hence no intellectual constraint is put upon the search for empirical generalization or for contingency relationships between variables. It is inescapable then to look for mechanical criteria (e.g. statistical tests of significance, levels of confidence, ...) in order to decide which empirical relationship should be discarded as insignificant and which should be held to stand for "natural laws." The results may depend upon the criteria chosen but the criteria themselves seem void of theoretical significance. All of this is most clearly exemplified in many survey studies that have been conducted about the use of commercial centers or of satisfaction of residents in newly built high-rise apartments. But almost the same criticism can be leveled at more subtle attempts at modelling the urban housing economy with an economical model. The actual intention was to write a model with a theoretical framework, and to work back and forth from theory to observation. But the low specification of the concepts through first hand empirical categories has led to questionable interpretations of the results. Moreover, the analogy with the market economy

which implicitly governed the econometric model may have obscured the issues. But this leads to the problems of metaphor. And systems analysis makes use of the metaphoric language in a way that we ought to reflect upon.

Cybernetics: an Imagination Catching Model

Direct references to cybernetics in French urban research have been scarce until fairly recently. Nevertheless a pervasive influence of cybernetics can be traced in much of what has been said about planning and about information processing at the urban level, or in several attempts to map actual processes into gaming simulations. Actually one of the main efforts [5] in the field of general systems applied to social science does rely extensively on ideas borrowed from cybernetics, but it would be cumbersome to discuss this proposal in detail. Moreover, the attempt at using this frame of reference in a field research has been going for only a few months.

The introduction of feedback seems to promise a renewal of functional analysis based upon more solid ground than ever before. For instance it points to a model of a functional system where information coming from the environment activates a feedback loop that regulates a certain state of the system. There is a clear methodological gain there since on the one hand one cannot any longer conceive a functional system as a purely mechanical whole where perpetual motion would have been achieved despite the second law of thermodynamics, and on the other hand, functional analysis points to the interest of probing into problems of communication, information gathering, information retrieval and information use in social research.

Additionally, a machine such as the homeostat by Ashby points to the fact that it may be useful to try understanding how several feedbacks are related to one another in actual homeostatic systems. This is very important since such a machine is capable of rearranging its feedbacks in order to cope with a traumatic event such as failure of a part without modifying its purposive behavior. In other words this may provide a model to account for structural rearrangement within an organization or, perhaps, within society. Let us for a while take this to be true in order to probe some of its implications for research.

If some social institutions are behaving like a network of feedbacks analoguous to an Ashby machine and exhibiting purposive behavior, any attempt at controlling one of these feedback loops or at rearranging some aspect of the institution without considering the whole system is almost certain to be doomed. And one may expect the institution to go through a trial and error search and then to resume its anterior behavior.

This would call attention to:

a) the fundamental aspect of a system's boundary definition, and

b) the absolute need to gain a thorough understanding of all the feedbacks at work within a system.

In a sense, urban games that have been widely used in France--e.g. the Cornell Land Use Game [9], APEX [8], or Easy Builder [10] and S.I.M. [11]--provide models of interactive feedback loops for a city as a system or for a subsystem within a city. Their use is a very good example of the difficulties and limits of this type of analogy. Actually, the very questions of when a city is to be called a system, or why the chosen model is comprehensive enough to account for the whole working of a city, are eschewed. Moreover no amount of interaction or information flow between the "social actors" in the game will achieve a substantive change in the behavior of the system. If the model is geared to growth there will be no way to simulate a decaying city within a flourishing society. This is to say very simply that the purposive behavior in the Ashby machine or in the urban games has been fixed within the set-up, and that learning behavior invention or modification of behavior are not possible for that type of system. If you want a decaying city in a flourishing society you have to produce a new model. That is to say, a new brain process is necessary to make the model amenable to something that looks like social change. In other words the Ashby analog is a severe reduction of social change processes and provides no way to decide whether some social phenomenon is amenable to a systems representation or not.

In a general sense it seems that cybernetic analogs redirect attention to some important aspects of the mechanical functioning of society. It seems likely that a careful inspection led by this intuition has much to teach us. At the same time, one is compelled to realize that living organisms display features that are not to be found in machines--they convey meaning to information, they communicate through vague ideas, they use symbolic modes of communication--and that some social organizations do actually depend upon exchanges of symbols (prestige, money, name). This is a challenge to communication theory, and it has brought a reviviscence of organismic analogies. The efforts at merging biology and communication theory lead us at times to the brink of metaphoric thought.

The Organismic Metaphor: a Reviviscence

A large part of the urban research program for the VIth Plan in France was placed under a rather vague and pervasive

organismic analogy [7] cast under the general category of open system. Fortunately the research program that ensued had been careful not to propose an a priori definition of the urban system, and most emphasis had been put upon topics that could enable a better understanding of the relationships between social organization and economic activity at the urban level. This has led to a large number of research projects that pay little attention to the initiating analogy but that might still contribute to a systems analysis of urban processes. One notable exception should be made for the research project proposed at the beginning of 1973 by Y. Barel [1].

Y. Barel has made a broad effort to study carefully the concept of reproduction in biology and to discover the actual use of this concept in modern biology. This has led him to propose a specification of the notion of reproduction in the social system. His presentation at the IIASA meeting provides some examples of the insights he proposes.

This is one possible approach to urban systems analysis, and, contrary to many systems approaches, it concentrates on the question of the existence of a system. That is to say, from this point of view it is not enough to write down a set of relationships in order to be entitled to describe a social phenomenon as a system. We are very far from the systematic empiricist point of view. But the empiricist might in turn object to the organismic metaphor that lingers upon the whole approach. This is to be examined with care.

Metaphoric thought has fallen into disrepute in the social sciences, and proponents of organismic analogies usually take care to disguise their thought as skillfully as possible. On the other hand it has been fashionable to dispel an argument on the ground that it was based on some analogy rather than on pure scientific concepts or on abstract methodology.

We shall follow J. Schlanger [6] and take a slightly different position. It is clear that both sociology and political science have borrowed a few of their concepts from biology at some point of their history. But it must be remembered that a few biological concepts such as the struggle for life[1] or the physiological division of labor[2] have been borrowed from social sciences. It is usual in scientific endeavor to invent new concepts that keep some flavor of the metaphor that led to their intuition. The sources of such metaphors change over time and, mostly, the type of use to which a metaphor is put changes through historical periods.

In order to judge a metaphor one has to elicit the function it serves. It is always meant to facilitate the understanding of an idea, to convince the reader of the soundness of an argument through its linkage to an undisputable fact of opinion. It turns out that life or organicity are fascinating

to our minds.

A close inspection of the long historical use of analogies[3] between organisms and societies shows they have main functions:

1. They provide a basis for the specificity of life.

2. They make it possible to conceive the place of the human being in the universe.

3. They allow for a science of man and society that would fit along the natural sciences.

Moreover it is possible to develop: either a methodological analogy or a discursive one. The methodological analogy consists in borrowing from one domain its concepts and methods or scientific attitudes, but not the content of the subject matter. It bears upon thought processes and does away with all the results that are not deemed transferable. In this way the concepts exported into the new field take on new meanings and may prove useful to build new types of relationships.

Unfortunately this type of analogy is hardly convincing unless it borrows more than the concepts. And the temptation always exists to illustrate the concepts in the importing domain with examples reminiscent of their field of origin. Then one step after another one is led into discursive analogy. The effort is then directed towards making the analogy ever more convincing. The result is that it becomes worthless, because instead of providing a new questioning approach of reality it yields ready-made answers that are made to sound like ascertained facts.

Social change through history has challenged the scientific endeavor in such a way that it has led to many organismic analogies. At first sight history appears to be a succession of phenomena both diverse and discontinuous: their disparity through space and time seems to keep history out of the realm of scientific knowledge. The living organisms and their common belonging to species that are constantly reproduced over time seems to provide a model for the solution of the dilemma set by history to social science.

Many analogies have been proposed concerning who makes history. There are two types of answers: according to some authors humanity makes history. It leads them to metaphysical questions the ultimate meaning of which is usually given by their answer to the question of the death of humanity. According to different authors, nations, civilizations, people, or social classes make history, and this raises the question of succession through history. This may lead from our point of view to scientific question.

After this lengthy discussion on the merits and pitfalls of metaphoric thought we ought to make our position clear. We have learnt two things about analogies:

1. They should be restricted to concepts and methodological questions.

2. Concepts should take a specific meaning in the field where they are imported.

This to say that a notion like "open system" is too loose to be really useful in the social sciences. The same thing can be said about feedback homeostasis or morphogenesis. Any effort at showing that these notions can apply directly to a social situation will lead one step ahead towards discursive analogy.

The real challenge is to specify what are the specifics of social systems[4], the characteristics of social feedbacks, the relationship between a social structure and a social system, and the reproduction of a social system. All of this should obviously be done in order to account for any urban situation. But, the other way around, one might try to find how urban specific institutions (such as municipal organizations or local authorities) play a decisive role in social reproduction processes. It is of the utmost interest to understand how new institutions are appearing within the city. Clearly some work has been done on industrial activities and on the emergence of new types of activities but this may be extended to a number of different institutions. In the same way it is quite necessary to have a firm grasp of decaying processes. Housing abandonment has been blatantly acknowledged, but many institutions may affect the urban setting, through their disappearance in a less spatially visible way. At the same time one has to ascertain what are the common logical properties of the concepts of system, feedback, and reproduction, irrespective of their field of application.

This double condition is necessary for systems analysis to be meaningful in the social sciences and so that knowledge can be transferred from other disciplines. This task can be further advanced either through field research or through a sifting of empirical research in a quest for the foundation of concepts that exhibit both transdisciplinary properties and field specific characteristics.

It is quite clear that such an effort will not be able to take advantage of all existing research and is likely to demand a secondary analysis of the pieces of work from which it is elaborated. This is a rather demanding effort similar in many respects to the use of several monographs by Homans in the "Human Group." Such an achievement is far beyond the scope of this paper and we would like to suggest that this could be one

direction of research in Vienna, once some agreement is reached about the most interesting questions to probe and the most fundamental concepts to be defined through a systematic analysis of urban research monographs from various countries.

In the section of these Proceedings entitled "National Research in Urban and Regional Systems" we outline possible questions that it seem worthwhile and possible to put to urban research monographs that have been published, or that are underway in France at present.

Footnotes

[1]The struggle for life was explicitly borrowed from Malthus by Darwin. Darwin was clear about this: he had borrowed a phrase in order to catch the imagination and never meant this to imply that some deity was performing a "natural selection" among earthly species. He would point out that no one objected to the physicist's saying that the planets obey the universal law of gravitation.

[2]Edwards Milne borrowed the idea of division of labor from Adam Smith. The phrase, enriched with its physiological meaning, was to be borrowed later and put to a new use by Emile Durkheim.

[3]Since Menenius Agrippa and the plebes secession in Rome, to the high surge of the 1890 with Spencer, Lilienfeld, Schaeffle, Novicow, Worms, and onto the more cautious authors of modern times such as Bertalanffy.

[4]For instance one way of defining an organism as a living system which satisfies three functions: self-reproduction, self-conservation, and self-regulation.

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[8] "APEX," An urban simulation game by R. Duke et al. at Michigan University.

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[10] "Easy Builder," An urban simulation game by M. Chapoutot, C.S.U., Paris, 1972.

[11] "SIM," An urban simulation game by G. Salmona and D. Vicas, to be published, Fall 1973.

The Lessons of the LOGIMP Experiment: A Collaborative Exercise in the Application of a New Approach to Local Planning Problems

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From the outset, the LOGIMP programme was conceived in terms of a two-way learning process, in which we on the research side might expect to have just as much to learn as the local authority officers with whom we were collaborating. A certain amount of analytical work still remains outstanding, several of the decisions at issue remain to be finalized, and several of the authorities have plans to pursue the application of AIDA further in relation to other decision problems, some of which may offer a better test of its value than the problem originally selected. Our object here is to make a few observations of our own, with special reference to what we learned about the conditions for successful application of the approach, the relative usefulness of different aspects of the method, and the priorities for further research and development work.

One of the main questions which concerned us in launching the experiment was whether we should place our main emphasis on the AIDA technique in particular or on the strategic choice approach in general. Obviously, in a limited exercise of this kind, there was much to be said for concentrating primarily on the testing of specific techniques; but we were also conscious of the risk that there might be some practical problems to which the general philosophy of strategic choice and "management of uncertainty" might be more relevant than the specific methods we had developed for handling related decision areas. In the event, we tried to keep our options open by giving equal emphasis to the two related concepts of AIDA and of strategic choice, and by adapting the neutral code name LOGIMP to refer to the experiment as a whole.

In practice, there were some projects in which AIDA proved directly useful as a technique, in that the relationships between decision areas could be charted with reasonable

confidence and a range of feasible solutions could be thrown up for further examination; but there were other projects where it proved difficult either to reduce the problem to tractable dimensions or to express the relationships between one decision area and another in an analytically useful way. In the replies to our questionnaire, it is perhaps significant that people tended to see the value of AIDA not primarily as a technique but more as an attitude of mind; and in the various project reports there appears to be a consensus that the mere process of attempting to isolate decision areas served as a useful means of focusing attention on what we might call the "dimensions of choice." Through this process, people could start questioning each others' assumption about the choices available in a way which was not in itself related to any particular departmental perspective; and even without explicitly charting the relationships between decision areas, they had an explicit means of defining and re-defining the boundaries of the problem at different stages in their exploration of alternative solutions, asking themselves how far particular elements of the problem were controllable or uncontrollable, urgent or non-urgent, open or committed.

One obvious gap in the methodology which was exposed during the experiment was the lack of an effective means of dealing with the time dimension in decision making, in situations where it is not sufficient to consider merely "urgent" as opposed to "deferable" decisions, but also to consider different degrees of deferment over future time. The idea of "decision time sequencing" emerging from the Teesside project points to a need for further research into the development of the "robustness" concept as a practical aid to decision making under uncertainty.

The experiment did not make a great deal of progress in the testing of evaluative methods. The emphasis here was not so much on the introduction of any fundamentally new variants of cost benefit analysis, as on the explicit consideration of the uncertainties to which such evaluation can give rise. Attempts were made in some projects to compare alternative approaches to evaluation based on the fulfilment of goals and on the identification of impacts on different sectors of community ("impact analysis"). The main conclusion was that these approaches could often converge in the identification of similar sets of practical effect measures; the "impact analysis" approach could provide a useful discipline but could not often be pursued to the extent of direct numerical estimation of impacts on each of the sectors affected.

Much of the evaluation carried out during the experiment was of a fairly rough and ready kind--approximate costings, subjective ratings on points scales, rankings of preferences and "evaluation by constraint," i.e. the process whereby additional option bars are inserted in the problem formulation in accordance with prior judgments on policy. Lack of further

progress in evaluation can partly be attributed to pressures on limited time, and partly to the recognition that the balancing up of different cost-benefit criteria must involve political as well as technical considerations; although there were some projects--such as the London one--which led to the posing of particular questions relating to the valuation of costs and benefits for a policy decision by elected members, the duration and scope of the experiment was not such as to allow a dialogue on such policy issues as an integral part of the programme.

The questionnaire replies indicate a view that the analysis of uncertainties is the one area of the methodology which most requires further development. The mere identification of uncertainties, and classification into the three classes UE, UR, and UV, proved helpful in some projects, and there were one or two cases where a subjective appraisal of alternative actions to reduce uncertainty either cast doubt on the "cost-effectiveness" of certain conventional survey procedures as a means of reaching more confident decisions, or else pointed to the value of outside consultations with other decision making groups. Further progress in handling uncertainties is, we believe, likely not so much to lie in an attempt to derive any objective measurements, as in the use of procedures to reach consensus between different peoples' subjective judgments, and the systematic appraisal of alternative "routings" of issues through the decision making procedures of the local authority or group of authorities concerned. Again, this raises organizational issues which fell somewhat beyond the scope of this first brief experiment.

The experiment served to confirm our general view of planning as a process of strategic choice, from which decisions tend to emerge incrementally and in which the question of what options to leave open is no less important than the question of what decisions to take here and now. The concept of robustness--of selecting a set of immediate actions against a conscious appraisal of the opportunities and constraints that these imply in other areas of future choice--seemed to be highly relevant to all the selected problems, although we were conscious of the need for a good deal of further research to refine the basic concept, in particular in so far as it is necessary to take account of a range of time horizons as opposed to a single indefinite "future," and in so far as the actions selected impinge on the future freedom of action of a variety of different agencies.

At the end of the experiment, several of the participants commented to us that they would have tackled the analysis very differently had they started out with as much experience of AIDA as they had now acquired. Much of the work may have indeed appeared abortive in retrospect, though it was probably an essential part of the mutual learning process in an initial

experiment of this kind. We on the research side had felt hesitant at laying down precise guidelines in advance on the procedure for applying the AIDA approach--and the tentative notes on procedure which we did issue during the first two seminars do not stand up particularly well to the lessons of subsequent experience. It is perhaps doubtful whether the approach could, or should, ever be formulated in terms of precise procedural steps, particularly if AIDA is viewed as an attitude of mind more than a technique; to some extent, drastic revisions in the formulation of a problem may be part of the learning process which must be faced up to every time a new planning situation is encountered. However, the Cheshire project brings up the real practical difficulties of scheduling the planners' work programme where problem situations are complex but time and analytical resources are limited; and in the approach adopted by Cheshire to overcoming these difficulties, another important area of future research is illuminated.

It was encouraging to us that many of the respondents to the questionnaire felt reasonably optimistic about their future ability to apply the AIDA approach without assistance from "experts." However, the development of skills in this direction must take time, and the time needed to grasp some of the basic concepts was clearly a contributory factor in the difficulties experienced in several authorities during the earlier part of the LOGIMP programme. It was also encouraging that most respondents seemed to agree that the AIDA approach was likely to lead to increased confidence when it came to the submission of proposals, and that on balance this gain in confidence would be achieved with little if any increase in the amount of time spent in analytical work. For our part, we would hope that one of the eventual benefits of AIDA would be to bring about a redistribution of analytical effort towards those areas of analysis most likely to contribute to the selection of more discriminating courses of action.

Although the questionnaire replies give a clear impression of increased confidence resulting from the use of AIDA, we feel some caution in interpreting this because of the limited nature of the experiment, in which we could only collaborate directly with a small group of officers from each authority. It would obviously take a very much more extensive process of testing to establish whether or not this increased feeling of confidence could be sustained through other stages and levels of the decision process, and whether it could make a significant impact at the level of the committee decision or the public participation exercise. It is clearly important not only that the planners (using the term in the non-departmental sense) should themselves feel more confident in the results of their work, but also that the departmental heads, the elected members and the public at large should feel more confident that a reasonable range of alternatives had been

explored, that all the assumptions entering into the analysis were open to inspection and modification, and that they could exercise real influence over the decision process without undue disruption of the groundwork that had already been done. Because of this, we see the doubts expressed in the questionnaires about the effectiveness of AIDA in communication with members of the lay public not so much as a deterrent, but rather as a spur to further developmental work.

The problems selected for the LOGIMP exercise were all fairly localized ones, but several of them had broader implications and it was perhaps significant that several of the local uncertainties which arose were associated with the outcomes of regional planning processes. Our experience elsewhere suggests that the philosophy of strategic choice, and the idea of the "management of uncertainty," are also applicable in the regional planning context and in the context of planning the internal development of specific public services such as education and housing; but further work will be necessary to establish the validity of the AIDA approach in contexts such as these, as also to establish its possible relevance to the new physical planning procedures established under the 1968 Town and Country Planning Act.

The LOGIMP experiment itself has pointed clearly towards certain immediate research priorities; among them the treatment of the time dimension in AIDA, the "job planning" problem identified by Cheshire, and the question of how lay people can participate realistically in the review of alternatives, and the examination of the assumptions underlying them. The exercise has also pointed towards the need for further experimentation through more sustained project work in conjunction with individual local authorities; the short and intensive nature of the LOGIMP programme certainly helped to generate a rich variety of practical experience within a limited period of time, but inevitably it left the wider organizational implications of each individual project largely unexplored from the research point of view. Several of the problems selected had complex implications at the inter-departmental and inter-authority level, and the inability to involve all the decision-makers concerned in the experimental situation inevitably made it difficult to test the full potential impact of the AIDA approach. It is the hope of both INLOGOV and I.O.R. that the experimental process started by the LOGIMP experiment will continue, and that the practical usefulness of the AIDA approach can thereby be further developed for the benefit of local government at large.

MATHEMATICAL PROGRAMMING APPLICATIONS IN THE ANALYSIS OF THE DEPLOYMENT AND UTILIZATION OF FIRE-FIGHTING RESOURCES*

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I. INTRODUCTION

Since 1968 The New York City-Rand Institute has been engaged in a joint research program with the New York City Fire Department. Under this research program, we have examined problems relating to fire communications, water delivery systems, fire insurance, and fire prevention in addition to looking at some traditional operations research type problems in the deployment of fire-fighting resources. A general discussion of the research program can be found in [1], and a somewhat detailed presentation of much of the OR work is given in [4]. Here, I will discuss our uses of mathematical programming in the analysis of such questions as:

- How many fire engines should be dispatched to a new alarm?
- Which fire engines should be temporarily relocated when a large fire depletes one part of the city of its fire protection?
- How many fire engines should be permanently assigned to each region of the city, and how should this number vary by time of day?

First, I should say a few words about the motivation of the New York City Fire Department in sponsoring and participating in this research. At first glance, fire would not seem to be one of New York City's most pressing

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problems. But, in the last ten years, while the number of firemen and fire engines has stayed essentially constant, the incidence of fires in structures has doubled, false alarms have increased five times, and the cost of running the Fire Department has more than doubled. That cost is very high--the budget of the New York City Fire Department is well over $250 million, exceeding the entire budget of the City of Boston. With such a scale of operations, even small percentage improvements can result in very significant dollar savings. Further, the finances of the City are so greatly strained that there is great interest in better utilization of the Department's resources.

Other characteristics make analysis of the deployment of fire-fighting resources a fertile research field. Many of the problems encountered involve physical processes (fire incidence, travel times, communications, etc.) which are quite amenable to scientific study. While the basic phenomena are stable enough to be studied successfully, the growth in alarm rates has been so rapid that the existing system has been hard pressed. For example, at the very high alarm rates now current, the old manual system of dispatching is strained to the breaking point, and a key element in our research program has been the design of a computer-based dispatching and information system. Two of the problems discussed below were investigated with the view toward developing computerized algorithms for assisting in making tactical deployment decisions. The traditional method of making these decisions was to reference all fire alarms to the nearest fire alarm box. For each alarm box (about 15,000 in New York City) there is an index card containing the dispatching rules. These advance plans designate which fire engines respond to the initial alarm, which additional units respond if the fire escalates beyond the

capabilities of the companies initially dispatched (a second alarm), and which engines relocate on higher alarms in order to balance protection. These plans presume that all fire-fighting units are available for their assignments. Ten years ago, that presumption was largely true, today it is not and the plans break down since the designated units are often not available. In addition, the plans contained on these alarm assignment cards do not take into account other information such as how the alarm is reported, the time of day, or the season. The proposed computerized system--which is still several years from implementation--will consider the entire system status, that is, all fires in progress, and all fire engine location and availability information, as well as other factors.

In addition to the formulation and solution of mathematical programming problems, many other kinds of analysis have been necessary in the design of this system, including probabilistic modelling, structuring of information flows, and statistical data analysis. In viewing this research effort in perspective, I would say that mathematical programming has played an important, although not a dominant, role.

II. HOW MANY FIRE ENGINES TO DISPATCH

When an alarm is received, it is not known whether it signals a fire at all, let alone whether it signals a serious fire. If such knowledge were available, the dispatcher could match the number of engines sent to the needs at the scene. Acting in the absence of perfect information, we might send too few units with resulting losses of life and property at the fire in question, or we might send more units than are needed, and, if a subsequent alarm is received for a serious fire while these units are needlessly occupied, other losses could be incurred. We view the decision of how many units to dispatch to a particular alarm (in hand) as being dependent on the number and location of available units, the estimated seriousness of the alarm, and the probability that another and more serious alarm will be received in the near future. Arthur Swersey has formulated a finite state semi-Markov decision problem having, as the objective, the minimization of the long-run average of a utility function of the response time to fire alarms. His model explicitly considered the following factors:

(1) The potential seriousness of the alarm. The higher this value, the more units we would tend to dispatch. Such information is often directly available when the alarm is reported by telephone. If the alarm is reported by telegraph box, the probability that it signals a serious fire can be estimated statistically from the history of the alarm box and the immediately surrounding area.

(2) The alarm rate in a region served by several fire engines and surrounding the location of the alarm. The greater the alarm rate, the greater the chance that units dispatched now will be needed in the near future, and so the fewer units one would tend to dispatch.

(3) The availability of fire engines in the surrounding area. The more units available, the more we would tend to dispatch.

(4) The relative utility or value of the response time of the first responding unit to that of the second responding unit. The higher this ratio, the fewer units one would tend to dispatch.

The mathematical programming formulation allows the simultaneous interplay of all the above factors. Empirical data were gathered for one region of New York City, the problem solved using the linear programming representation of the decision process, parametric and sensitivity analysis carried out, and finally, the suggested policies were tested using a detailed simulation of fire-fighting operations.* For the basic reference, see Swersey [8]. Out of this work came a simple rule suggesting control limits on each of the key parameters. This rule and elaborations, which select the particular companies to dispatch, are to be implemented in the computerized control system, but, in advance of that, in November 1972 the Fire Department implemented a city-wide "adaptive response" policy which was based in large part on our analysis.

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*For a discussion of the simulation, see the work of Carter, Ignall and Walker [2], [3].

III. TEMPORARY RELOCATION OF FIRE ENGINES

When one large fire, or several small fires, is being fought in a single area of a city, the fire houses of the working fire units are left empty, resulting in a sharp degradation in the fire protection afforded the surrounding area. It is common practice in many cities to spread out the available companies by relocating some companies into selected empty houses. Existing manual methods to perform relocations use preplanned assignments which are adequate at low alarm rates but which break down at high alarm rates when the companies preassigned to relocate are not available, or when more than one serious fire is in progress at a time.

In New York City relocation problems occur on the average about 10 times a day and, if not solved quickly, can lead to serious situations. For example, a 5th alarm fire in Manhattan could deplete the borough of half of its fire-fighting units.

We have developed a dynamic algorithm which determines when relocations should be made, which empty houses should be filled, and which available companies should be moved. The algorithm has been specifically designed to be implemented in the proposed computerized control system. By using the computer's capability to store and update information about company status and to evaluate alternative plans using mathematical programming formulations--all in real time--the algorithm overcomes the deficiencies of the existing method.

Our aim was to develop a procedure for relocation which would overcome the problems of the existing system, was implementable within the computer time and space constraints we faced, and which produced "good" relocations. It was by no means clear at the outset what "good" meant, and we were concerned with "optimality" only as it was a means of achieving our more modest goals. We discuss at length the motivation behind our formulation in Kolesar and Walker [5]. It should suffice to say here that the Fire Department's objectives, although clear in principle, were never unambiguous enough to lead to a simple objective function, and we wound up with a problem with multiple criteria, which we formulated as the following series of integer optimization problems:

Problem 1. Determination of Empty Houses to Fill

The city was completely partitioned into small regions called response neighborhoods and fire engine responsibilities for covering these neighborhoods defined. Generally, there is one fire engine per fire house and, when some fire houses are left empty (for an extended period of time), the house and perhaps some of its response neighborhoods are left uncovered. For example, if the Fire Department adopts a criterion of having one of the two closest engines available, each response neighborhood would be the region "covered" by two engines. We adopted as our criterion for the determination of empty houses to fill: have every response neighborhood covered but move as few engines as possible. This translates to the integer program known as the set covering problem.

Problem 2. Determination of the Available Companies Which Relocate

Each of the houses designated to be filled in the solution to problem 1 must borrow an engine. We have been able to define a cost c_{ij} of relocating

available engine i in empty house j. These "costs" are the increments in expected response time to future fires if the i to j move is made. Thus, the determination of who moves where becomes an assignment problem with some additional constraints like those of the set covering problem which are due to coverage requirements set by the Fire Department.

Problem 3. Determining Specific Relocation Assignments

The solutions to problem 2 repeatedly yield good selections of relocatees, but we found that the specific assignments could be improved upon. By permuting the assignments, the total distance traveled by the relocating engines could often be greatly reduced with small increases in the expected response time increments. This was a symptom of our multiple criteria problem. Consequently, we use an assignment problem to permute the relocations to achieve minimum total travel distance.

Clearly, the separation of problem 1 and problem 2 is artificial and leads to suboptimal solutions. But, the c_{ij} used in problem 2 depend on the geographic configuration resulting from the solution to problem 1 so that, in practice, we had no recourse save trying to obtain many solutions to problem 1 and using each as an input to problem 2. We have, however, been able to develop an approximate formulation linking both problems and are still testing it.

Heuristics which rapidly solve these problems have been developed and implemented [5], [7]. The algorithm has been extensively tested in simulations, and in the field on a small time-sharing system. Its actual implementation awaits the installation of the Fire Department's "Management

Information and Control" computer system. Meanwhile, the algorithm has been used recently in Denver in a way we never anticipated. It is employed to create for Denver the very alarm assignment cards we set out to replace in New York City, for, at Denver's low alarm rates, the static preplanned deployments still work!

We have also used a variant of the set covering problem in New York City to aid in making decisions about the permanent location of tower ladders and aerial ladders--different but similar types of equipment that the Fire Department wants distributed in a manner which avoids having two units of the same type respond to the same alarm.

IV. ALLOCATING FIRE ENGINES TO REGIONS OF THE CITY

Now we consider a more strategic problem, determination of the number of fire engines to station (permanently) in the various regions of the city. Suppose that the city has been partitioned into regions labeled $i = 1, 2, \ldots, m$, and that we know the utility function, $f_i(n_i)$, of the number of fire engines stationed in the region. Then, a variety of important allocation problems could be formulated. We have had some success along these lines. First, we have shown that, for any region, i, the response distance of the first arriving engine is given approximately by

$$RD_i = C_i \sqrt{\frac{A_i}{n_i - \lambda_i S_i}}$$

where

A_i = physical area in square miles

λ_i = alarm rate (average number of alarms per hour)

S_i = average total time required to service (extinguish, etc.) an alarm

C_i = an empirically determined constant depending on the geometry of the region.

Second, we have determined empirically the relation between response time and response distance. We then formulated and solved a variety of very simple integer optimization problems of the form:

Find integers $n_1, n_2, \ldots, n_m$ to

$$\text{minimize} \sum_{i=1}^{m} a_i f_i(n_i)$$

$$\text{subject to} \sum_{i=1}^{m} n_i = N$$

where the $f_i(n_i)$ are generally expected response times and the a_i are weights taking into account the hazards in the region.

A reference to this work is Kolesar and Blum [6]. Such analysis done for and with the Fire Department was partly instrumental in the decisions implemented by the Department in November 1972 to change the permanent locations of some fire-fighting units and to disband others and reassign their men to units in high hazard areas.

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Human Systems: System Methodology of Social Intervention

Canada

(Note: This paper is a tentative resume of Working Papers 4-10 and 18-20 and of a book being prepared by P. Pergler, W. Buckley, co-authors and consultants. This work represents a team effort conducted in part by the Research Branch of the Ministry of State for Urban Affairs, Canada, and in part by other groups outside the Ministry. The Working Papers are circulating in draft and will be available for wider circulation around the end of 1973.)

The goal of the work is to explore the application of system methodology to selected aspects of social sciences. In the simplest case, system methodology is perceived as a way to explore the relation of 1) the behavior of several objects, 2) the structure of the system, and 3) the behavior of a system whose parts are these objects. As a formalized discipline, system methodology has been developed mainly in interaction with its application to man-made systems. Because of some specific features of social systems, little of the formalized procedures of modern system science seem to be (at least until now) applicable. The fundamentals of system methodology on the conceptual epistemological level however, seem to be general to all systems and, in the opinion of the authors, will have an impact both on social sciences and their practical use. The work is composed of the following parts:

Part 1. Introduction

Part 2. Prerequisites to System Methodology

Part 2 describes first the epistemological channel used for the exploration of the external world, with an accent on social system models. There is a discussion of the interaction of several epistemological levels (the mathematical level, the conceptual level, the common sense level, the experiential level). The latter parts of the book are concerned with the development, and application of the conceptual framework of social system models. In this part there is a discussion of the process of developing a conceptual framework. Conceptual epistemological channels are compared with other channels in examples concerning research and the decision making process. Conceptualization, using operationalized definitions, is performed in such a way that it may be a step toward the development of mathemat-

ical models.

Part 3. Basic Concepts in System Methodology

This part develops a conceptual framework for system analysis and synthesis suitable for several applications, including some aspects of the social sciences. Each concept is defined operationally, using, in most cases, simpler concepts previously defined. The simple concepts are defined in a generalized way suitable for all types of systems; the complicated concepts are defined for living systems only, since relevant man-made systems have not yet been designed. A partial list of defined and applied concepts includes element, structure, system, model, analysis, synthesis, causation, control, goal, strategy, regulation, adaptivity, homeostasis, morphostasis, morphogenesis. For each concept, several classifications (e.g. stochastic and deterministic elements) and auxilliary concepts (e.g. characteristic of an element) are introduced.

Part 4. Human Systems

Some sociological and socio-psychological concepts concerning major social structures and processes, especially decision making and control processes, are defined and discussed. A model of a decision making subsystem is developed and applied to persons and decision channels in the society. Using this model, selected aspects of the dynamic of the social structure, social conflict, and social regulation are discussed.

Part 5. Complex Society

The complex society is perceived as being characterized by clustered social control and a rapid rate of change. The social morphogenesis of the complex society is analyzed (with reference to social conflict, change of values, and participation in decisions), and some relatively concrete proposals are deduced for influencing the morphogenetic process. Even if the proposals may be found unacceptable, they could be a basis for the discussion of the practical applicability of system methodology for society.

Part 6. Elaboration of Complex Policies

This part describes in more detail one of the concrete proposals of Part 5, i.e. a method applicable for elaboration of policies, that integrates several partial policies (e.g. domains of problems; geographical areas; levels of government; short-term and long-term policies). A descriptive outline of

this method follows this resume.)

Part 7. Urban Pollution

Results of an original empirical study are summarized here, as far as they are related to previous hypotheses and models. The results serve as a partial test of some hypotheses and as an applicability check of some models.

Part 8. Statistical Association

One of the basic used concepts is association; it is defined here as a statistical relation of two or more phenomena, with statistical independence as one extreme and a full deterministic relationship as the other. The proposed concepts and procedures are based on the theory of information and are developed for phenomena that can be approximated by a large number of variables (some variables being nominal, some ordinal, and some metric); this is frequently the case in social sciences. Some of Shannon's procedures, and correlation analysis, may be regarded as special cases of association analysis. The concept of association is later used to define other concepts in system methodology. In Part 3, the meaning of association and its interpretation is discussed; the mathematical aspects are elaborated on in Part 8. Some paragraphs of the work describe a problem first in everyday language, using simple examples. By reading only these sections of the book the reader may get an approximate image, which should be enough for general information, though not for professional application. The second parts of some paragraphs contain a more precise elaboration of the problem. Detailed elaboration of some of these problems is given in the appendices.

To cover the subject completely, the work would require a team of experts in several areas; this was not obtainable at the time of writing. Many problems are therefore covered only partially, with the hope that the critical comments and/or future collaboration of experts might lead to the filling of gaps and correcting of possible errors.

A Method for Elaboration of Complex Policies

P. Pergler, Canada

A process called "Method of Alternative Strategies" was suggested for elaboration of policies for which the following assumptions hold:

1. the policy is too complex to be elaborated without any specific method,
2. some components (partial policies) have to be ready relatively quickly,
3. most of the available knowledge and prediction is not quantifiable,
4. part of the available knowledge and part of the prediction exist only on the "gut level" (i.e. experimental epistemological level,
5. the goals are not well-defined and only partially communicable, and
6. the complex policy is a result of integration along several dimensions (geographic areas, professional domains, short range and long range, levels of decision making--e.g. levels of government).

The method is pragmatic and is based on

- experiences in a (limited) number of practical cases (it has not, however, been applied yet as a whole),
- system methodology, and
- selected professional disciplines.

The method includes:

1. a process for elaboration by stochastic prediction of alternatives in the format of a strategy, by a heterogenous team,
2. a process for evaluation of the predictions according

to the criteria of several groups and/or persons,

3. a computerized channel for delivering the elaborated policy alternatives to the decision makers, concurrently with standard formats, and

4. a process for the successive integration of partial policies.

The method is described in Working Papers 18, 19, and 20 by P. Pergler in the Ministry of State for Urban Affairs in Ottawa. External professional comments on the method will be ready by the end of 1973. Its applicability, if any, is probably not limited by the domain of application.

The suggested method is a part of a broader team-prepared work on the application of System Methodology to the study of society, mainly on the dynamics of the decision making structure. A draft of this work should be under discussion by the end of this year.

System Approach to Problems of Forecasting the Development of Urban Regions

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In this paper I would like to report on an application of the systems approach to settlement development problems of Czechoslovakia, in the first place to the development of urban regions. In Czechoslovakia, the concentration of population in towns has not been so fast as in other countries, owing to the national social policy whose proclaimed aim was to ease the difference in the standard of living between the urban and the rural population.

This aim has been achieved and the living standard of the rural population is considerably high, the average housing and environmental standards of villages being now higher than those of the towns. The way of life of the rural population has in many aspects become similar to that of the urban dwellers.

In spite of this fact, in the period between the 1961 and the 1970 national censuses, certain trends towards a rising migration into cities and towards depopulation were observed in most villages. The growing attractivity of towns due to the greater diversity of choice, better job opportunities, and services brings about the concentration of population.

The concentration of population, as a major factor of the development of settlement, has also its rational economic reasons. Until lately, the development of Czechoslovakia's national economy has been characterized by a considerable dispersion of investments into both industries and services. The further economic advance of the country requires new investments to be concentrated fewer places, but disposing of better locational conditions. Such places are available mostly in the proximity of large and medium size towns with more than 50.000 inhabitants, i.e. in urban regions.

In the forecasts of the development of Czechoslovakia's future settlement pattern, which are being made at present by

various government bodies, urban regions are regarded as the main element of the country's future settlement structure. The Department of Urban Research of the VUVA was entrusted to devise a method for forecasting future development trends in the country's various urban regions. The method is supposed to provide prognostic material on the basis of which policies might be adopted warranting the development of urban regions to be guided towards the defined social aims.

These development forecasts are expected also to underlie the urban and regional development plans, and according to the prepared revision of the Town and Country Planning Law, they should be regarded as the first degree of the planning documentation. While the input data for these forecasts are coming from all spheres of social and economic activities, the output data are oriented to the sphere of urban and regional planning. A modified systems analysis--described below--was used with regard to this feature of urban and regional development forecasts.

The systems was defined for a town (urban region) by defining its elements and relationships, structure and boundaries separating it from other systems. A set of all phenomena occurring in a given space (region) and relating to human activity is regarded as a system, which we call a "spatial system."

This spatial system consists of two sub-systems--society and physical structure. Society is the active factor which permanently produces changes in the physical structure, these changes being oriented towards the defined goal. All relationships in the subsystem of physical structure are projections of relationships existing between people, or between people and physical objects. In planning, to forecast the development of an urban region means to forecast the development of its physical structure. Therefore the subsystem of "physical structure" may also be called "urban system." In the following, I shall confine myself to this "urban system."

The urban system of a town, or of a region, is made of a set of all physical elements existing in the town or region and enabling them to fulfill their settlement functions. The relationships between these elements, being a reflection of social relationships, may be classified according to the three following criteria:

- social or socio-cultural
- economic
- physical.

This classification conforms to that usually used for classifying human activities.

In order to simplify the operation with the urban system, we have decomposed its set of relationships according to the three above criteria and obtained three reduced systems: a) socio-cultural, b) economic, and c) physical. The set of elements is the same for each of these reduced systems--it is a set of physical objects located in a given space. The set of relationships is different. Perhaps it might be said that these systems are quite different from the basic system since they are defined in other terms. This orthodox interpretation is possible. By using the term "reduced systems," I want to suggest that they were not formed arbitrarily, but were generated by the reduction of the set of relationships of the basic system, to which we want to come back through reintegration.

This first theoretical conclusion enables us, in this phase of analysis, to classify and to select the data and to find their relationships. For instance, in the physical system, man is a demographic unit; in the economic system, man is a unit of labour or a consumer; in the socio-cultural system, man is a member of a social group. In the same way the relationships, inputs, outputs, behaviour, may be described. This classification allows at the same tim the methods and techniques of the special disciplines to be used in certain phases of work.

Further theoretical reasoning is oriented towards the elaboration of development forecasts. The optimum path, the optimum structure, or even the optimum size of towns often come into question. The optimality may be defined for relatively simple phenomena and processes. Three aspects of optimality have to be taken into account:

- Evaluation of all phenomena in commensurable units
- Selection of optimization criteria
- Selection of the optimum solution.

In such a complex phenomenon as a town, these aspects present serious difficulties. The units of economic benefit are different from those of the social benefit; the criterion of economic effectiveness is often in contradiction to that of optimum social effects. Not even cost-benefit analysis could give the answer to these intricate problems.

In our work, we employ the above decomposition of the system in devising a method for determining a limited development path. We try to find out the innate development

limitations of the individual reduced systems. These limitations result from the needs and possibilities of the society and from the conditions of the given space. Comparing these needs and possibilities we obtain in the individual reduced systems a set of desirable solutions. By integrating these solutions in the basic urban system we obtain a set of acceptable solutions (admissible with regard to the objective or conventional limitations) of the prospective development. This set of solutions represents a potential array of political decision making from which, in individual cases and at a given time, the decision maker may select a solution according to optimization criteria which he may choose for his goals. This set of solutions enables the application of exact methods to be tuned with the intuitive creation of the architect-planner who, respecting the boundaries of the set of admissible solutions, may develop his creative power in forming the spatial structure--i.e. in a field where computer techniques will never be able to replace man's creative invention.

Thus we obtain not one solution but a set of solutions, limited by the postulates of the society and by the physical and technical conditions. This reintegration of decomposed systems, however, is not effectuated in only one iteration. Through a series of feedbacks the limitations in the individual reduced systems are corrected. The reintegration does not include all the data collected in the analysis, but only those which may be confronted in various reduced systems. In this manner, the amount of information needed for forecasts may be reduced and their significance already differentiated in the phase of analysis.

Another contribution of the system approach consists in finding the relationships between the structure and the behaviour of reduced systems. For instance, the towns of Czechoslovakia exhibit a strong relationship between their dynamics of growth and their structure. This, of course, is a feedback relationship, the knowledge of which is of major importance in forecasting future development.

The idea of system approach has found a series of practical applications in the works of the VÚVA. Development studies for the cities of Brno, Olomouc, and Ostrava have been made on the principles of the system approach. A structural analysis based on the principles of the system approach has been employed in constructing a model of the urban infrastructure of the city of Ústí nad Labem. In the departments of our Institute, the system behavior of settlement units is being studied by means of the stochastic Markov chains. In the next year a whole set of methods has to be tested experimentally under the elaboration of the development forecasts for the urban regions of Brno and Gottwaldov.

An Example of Transfer of "Nut and Bolt" Study Between Nations

(A Comment Arising from Mr. Kolesar's Presentation)

A. Hitchcock

In the United Kingdom, the Transport and Road Research Laboratory has recently started work on Dial-a-Bus. Similar work has been carried out in the United States and in Canada. Before starting the UK work, we therefore examined the American situation. We would that a number of the variables (in particular car ownership and telephone ownership) at the UK site were a long way outside the North American range. Further, the evaluation technique we wished to use required data not collected in the other studies.

The results therefore were clearly in no sense transferable. However, detailed contact with the oeprators of the North American experiments has proved extremely valuable, since we have gained information about staff training, types of system failure, methods of data collection, and other important matters which common sense indicates can be transferred, and certainly directs attention along lines which might otherwise have been overlooked. It is perhaps remarkable that very little of the usefully transferable material appears in the official reports.

There may be a lesson for IIASA somewhere.

Comments upon the Notion of Control

G. Palmade

In speaking of the notion of control, we must first note that this notion is ambiguous. One could consider that control is a regulating element of behavior: through control regulation of behavior emerges. But one could also speak of a control which "governs" behavior regulation, thus implying thereafter a dichotomy, a new process more or less opposed to "primary" behavior regulation.

Moreover, one ought to ask if a social organization admits a single system of control, and in what sense one takes this term. Some suggest that a social grouping comprises different systems of behavior and control, with certain conflicts between them. In this perspective, it becomes essential to study these conflicts and the way they are eventually resolved. The study of these conflicts, these contradictions, thus forms a part of the study of control.

The distinction between "behaviors which are controlled" and the processes of control (as described above) would correspond to structural phenomena in the society, and would thus be related to organizational "levels." For example, certain levels are processes of arbitration and censure.

It would be interesting to introduce here the notion of "regression." One would then hypothesize that when an organization has "too many" unresolved problems in a certain level, a more or less complete destruction of this level might occur. The organization thus "regresses" to a "prior" level. This "regression" could have a forecasting value over the long term.

One hypothesizes that one is witnessing, or will witness, "regression" phenomena in the urban system. This is not merely a theoretical subject; in our era it will have great concrete importance.

It is proposed that this subject be studied a) concretely, through examination of "regressive" behaviors which emerge in the urban system, and b) theoretically, as all the proposed concepts pose problems from this viewpoint.

From the organizational viewpoint for this dual approach, it would be possible to constitute a working group which could first deal with work accomplished in different countries, and

then develop its own work in order to produce original proposals.

Additional Comment

G. Palmade

If we consider a social system, we see that in order to clarify and better to control its action, it can elaborate an ensemble of "criteria." The system will tend to develop a certain rationality in its action in order to organize it as a function of these criteria.

One must note secondly that social systems, and particularly "large scale systems," are divided into subsystems. Each subsystem necessarily has, in specifying its functioning, a form of local rationality and its "own criteria."

We could thus say that there is a "disaggregation" of global criteria into local criteria. However, this disaggregation is not simply a division or a distribution. To be operational, it must use new concepts corresponding to specific types of situations. This "disaggregation" is thus in fact a structure which corresponds to the global structure of the system.

One often studies local rationalities, or a general abstract rationality of the organization. To the extent that one does not examine the disaggregation structure defined above, one supposes that it is rational, and that in the organization exists an integration of local criteria into global criteria defined in general terms.

However, one might inquire about the real nature of the disaggregation structures, and ask if the hidden assumption of their rationality is verified. By following this line, a more realistic view of the fundamental systemic structures would likely be introduced.

Comment about Disaster Forecasting

G. Palmade

The notion of "disaster forecasting" seems to me an opportunity to put into opposition--in the strongest sense of that word--two approaches: a strictly rational approach to this problem, and an approach which would take into account human and social reality.

In the first case, one will construct a sufficiently complete model, representing that which it is supposed to represent. In the area it covers, the model will predict certain "disasters." Two problems appear:

a) The model must be sufficiently representative, and must effectively contain a symbolic expression of what will lead to disaster.

b) Those who would have forecast the disaster using the model, must be socially in a position to express themselves and to make themselves heard.

One will observe first that when men are personally threatened by a disaster in the face of which they feel weak, they have a tendancy not to see it, not to "face up to it." Furthermore, and from a sociological viewpoint, responsible organizations in different sectors--particularly those organizations with bureaucratic characteristics--will tend to avoid recognizing that their sectors contain the threat of some disaster.

To simplify greatly, before the threat of a disaster can be disclosed through certain aspects of reality (which permits elaboration of the model), and before this threat can be explicated and heard, the "courage" to see and speak of the threat, and the social capability of doing so, must exist in the society.

Thus we see that mere rationality alone is insufficient. Cultural and educational factors of social communication are also determinants.

Additional Comments about Attitudes toward Risk

G. Palmade

Description and analysis in systems terms should not be solely concerned with quantified data or in such a case the global representation one achieves cuts off reality.

We can give an example, drawn from a French study, of a "system" of cultural behaviors. This stable system plays a determinant role in the situation of which it is a part.

The majority of French people are in a situation of "housing frustration." It has been shown that in many cases they react to this frustration with the following attitudes:

Appeal - In this case, one "appeals" to an exterior power in order to resolve the problem.

Dreaming - One imagines, often in great detail and with the appearance of realism, how one will come to be better housed (often in a detached dwelling).

Magic - Computations, and sometimes behaviors, take on a magical twist--e.g. an impoverished family buys a (used) washing machine for a dwelling lacking electricity.

Reinforcement of Obstacles - One emphasizes insistently that there is no way out of the housing problem. For example, one shows that it is radically difficult to know how to proceed.

Transference - For those who are badly housed, but who pay a relatively low rent, the expenditure which could be used to procure better housing is transferred to other modes of satisfaction: vacations, car, furnishing of the dwelling. This transference is in both an economic and an affective sense.

"Withdrawal" - For some low-income French people, ill-housed and paying a low rent, housing is "withdrawn" from the universe of decision. Housing is considered a sort of tax and is placed outside the realm of possible choices.

Furthermore, certain of these attitudes have been shown to reinforce each other, thus constituting a "complex" of highly determined attitudes. This system depends upon a certain global economic situation. But, in turn, the system determines this

situation. If one considers that the problem as a whole has no economic solution, one can consider the "complex" adaptive. In the contrary case it becomes a disfunctional resistance.