SYSTEMS RESEARCH INSTITUTE
POLISH ACADEMY OF SCIENCES

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS

CONTRACTED STUDY AGREEMENT REG / POL / 1

"CONCEPTS AND TOOLS FOR STRATEGIC REGIONAL SOCIO-ECONOMIC CHANGE POLICY"

STUDY REPORT

PART 1

BACKGROUND METHODOLOGIES

COORDINATOR, IIASA: A. KOCHETKOV
COORDINATOR, SRI PAS: A.STRASZAK

ZTS/ZPZC/ZTSW 1-36/85

WARSAW 1986

SYSTEMS RESEARCH INSTITUTE

POLISH ACADEMY OF SCIENCES

AND

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS

CONTRACTED STUDY AGREEMENT REG/POL/1

"CONCEPTS AND TOOLS FOR STRATEGIC REGIONAL SOCIO-ECONOMIC CHANGE POLICY"

STUDY REPORT

Consisting of 3 Parts

PART 1

BACKGROUND METHODOLOGIES

COORDINATOR, IIASA: A. KOCHETKOV

COORDINATOR, SRI PAS: A. STRASZAK

ZTS/ZPZC/ZTSW 1-36/85

W A R S A W 1986

I. PROSPECTIVE EXPLORATORY ANALYSIS: AN OUTLINE OF APPROACH

by Jan W. Owsiński

This short chapter is meant to introduce the manner in which certain problems related to strategic analysis and planning can be perceived and studied. First, the domain of considerations is outlined and requirements resulting therefrom formulated. Then, a procedure is presented proposed for this domain, which would secure satisfaction of the requirements formulated. Third section provides examples of existing methods and software implementations meant for setting up the general procedure proposed. Finally a number of conclusions are given on both methods and their applications. A list of references follows.

It should be noted that this chapter introduces the themes which will be taken up and further developed in some other portions of the Report, either problem-wise or with regard to methods used, see e.g. Chapters II and III in this part of the Report, Chapter V in part 2, or Chapter I and II in part 3, i.e. in the software appendix.

I.1. The problem

In forecasting and planning, for any kind of social and/or economic entity (a plant, a firm, an urban area,...), it has become quasi-customary to at least develop, if not actually use the so called mathematical and computerized models. These constructs are, generally speaking, meant to perform two crucial tasks:

* <u>representation</u> of the system in question and of its relations with the environment,
* generation of possible alternative development paths (directions) for the system and the <u>choice</u> of best among them,

see Owsiński and von Winterfeldt (1976).

There exist a great variety of such models, representation and/or choice ones, meant for different socio-economic entities, sectors, aspects, and for different time horizons.

It is trivial to state that the narrower the area considered and the shorter the time horizon the more precise the corresponding model can be. An instance of this is provided in the chapter by Ziółkowski, Cichocki and Iwański in Part 3 of this Report. Thus, if an annual financial plan of a firm is being put together a number of essential data can be taken for constant or only very slightly varying, e.g. employment, wages, production profile, market share, technical coefficients of technologies used. Moreover, some of the changes are either predefined or can be effectively planned, e.g. introduction of new technology lines, product changes. Hence, in this case, and in the similar ones, constant parameter models can be developed and used, allowing, enventually, for some random fluctuations and the risk related to such phenomena.

Not so for longer time horizons. Returning to the example of a firm, if a longer time horizon is considered, a number of product, market and technology options have to be taken into account, whose parameters are not very precisely determined. Even if some of these options would have been tried out elsewhere - and when one is looking far into the future many of them might have not - not much of knowledge therefrom would be valid for implementation in the firm considered. Still, however, although parameters must be treated alternatively or through some chance formalism, constant structure models can be applied. It is within the structures adopted that various approaches to problem of parameter values can be used, see e.g. Chapter III in this part of the Report.

When one speaks of strategic analysis and planning, this means reference to deep hypotheticality: it is generally no longer possible to seriously consider continuation or extrapolation of existing tends. Deep analysis of mechanisms behind such trends is necessary. But, if for longer time horizons such analysis is feasible, since assumption of constant structure can be made, its results for strategic purposes could be dubtful. The above phenomena do not only have objective sources. In fact, strategic thinking involves quite a lot of subjectivity: for shorter time horizons one may choose out of a set of pre-given, albeit not too precisely, activities or technologies. In order to choose one may define an own criterion. Usually, for short and medium terms the choice of criterion is quite limited. But in strategic thinking it is not only the criterion, but also the domain and objects of choice that should be defined. For instance, even if certain activity options or technologies, which are in an early stage of development at the moment of analysis, and decision making, do not yet look too promising, an explicit effort made to develop and implement them may entirely change the cost-and-benefit image.

Thus, one is faced with the development and decision situation characterized by:

* lack of direct continuity, and therefore
* unknown parameter values,
* ill-defined causal relationship system, and
* subjectivity,

see e.g. Godet (1985), Ansoff (1965, 1975), Ader (1983).

It is in order to be able to face such situations that the prospective exploration approach outlined in the following section is proposed.

I.2. The approach: prospective exploration

Prospective exploration notion as proposed here is meant to denote the approach which makes is possible to

* delineate the proper area of concern for strategic analysis, and main objects therein,
* indicate the criteria with which to evaluate potential future developmets, from within the system considered, and from outside,
* formulate the indicative events, whose occurrence would be significant for the shape of future developments,
* construct a quasi-model, being perhaps even just a throw--away product, resulting from an assessment of inter-object and/or inter-event relations,
* generate plausible scenarios of future developments,
* indicate the strategic moving forces within the system, assess sensitivities and point out the crucial interrelations.

In doing all that the approach refers to some extent to data, but primarily it relies upon experience and knowledge, acquired by people working or interested in the domain in question. Certainly, such an approach has certain common points with knowledge engineering and expert system construction, but, in particular, the latter is too restrictive and rigid for purposes of the analysis intended.

Now it appears clearer why the notion of "prospective exploration" was used in the context of strategic analysis and planning. Namely, in order to close on any specific strategic path, this specific strategic path always evolving in a definite environment under a set of definite choices, one of necessity has to explore the space of feasible futures: to determine the domain of feasibility, to identify the general features of potential developments, topether with the instruments which could serve to influence the course of these developments and the traps and difficulties therein, i.e. the conditions, instruments and difficulties of implementing a strategy.

The output of the prospective exploration approach, as listed at the beginning of this section, roughly corresponds to the more accurate list of stages which, in general, this approach assumes:

PHASE 1: PROBLEM RECOGNITION

1a. List of problems (issues)
1b. List of criteria (features)
1c. List of objects
1d. List of indicative events (landmarks)

PHASE 2: PROBLEM STRUCTURATION

2a. Inter-entity relations
2b. System of interrelations
2c. Generation of potential scenarios

PHASE 3: PROBLEM ANALYSIS

3a. Roles of factors
3b. Identification of subsystems
3c. Identification of scenario features
3d. Assessment of control capacities
3e. Identification of actor system features.

The stages listed can be carried out via a number of alternative methods. When choosing particular methods to fulfil the jobs enumerated one should, however, remember about securing the smoothess of the whole procedure and its internal consistency. Of special importance is the possibility of performing the analysis in a interactive and flexible manner with one group of experts--analysts in one sitting (say, a two- or three-day session), so that information arising from discussions and presentations is not lost for all the participants. Thus, the methods applied must be, to the extent possible, intuitively easy to grasp and handle by the participants, both on the input and output sides. Anonymous voting schemes, for instance, appropriately broadened and accompanied by a discussion, do satisfy these requirements. One cannot, however, limit the analysis to votings, even if very well organized and run. Of crucial importance is visualisation of the far-off consequences of the assumed cause-and-effect relation system, even if only loosely conceived. It is solely through such an assessment that e.g. the proclaimed a priori importance of objects or events can be confronted with their model-displayed effectiveness in influencing the future course of development. Thereby, not only a deeper insight into the system at hand can be gained, but also certain means of controlling its development established.

I.3. Implementation

Table I.1. contains certain examples of applications of particular known techniques to the stages 1a. through 3e. as listed in the preceding section. Because of the mere introductory nature of this chapter and because many of the more detailed questions were taken up in the literature, whose some positions are given in references, only a couple of comments shall be forwarded here.

Note, first, that the methods proposed for implementation were to a large extent either used in the Polish regional case study reported in Part 2, or at least available within the study team, see e.g. Part 3 of this report. Some of the software available represents only a portion of the know -how existing within a given domain, as it is the case e.g. with structural analysis or cross-impact techniques. This reflects as much the state of work as it corresponds to the actual needs of the work being done.

In fact, a concrete procedure may be based on a definite subset of specific assumptions related on the one hand to the expert--provided knowledge (information), and on the other hand to the system considered. Procedures using the very same set of methods in general, may importantly differ when a different subset of assumptions is used. Thus, in one case it might turn out necessary to secure proper transitive closure of the interrelations system, while in another case this might be of secondary importance.

Furthermore, the methods applied, developed and/or proposed are relatively simple, even if their construction happens to be by no means trivial. It is held that such approaches as strictly formal game theory or control theory - see Chapter IV and onwards in this part of the report - are not only better fit for situations where parameters are more accurately determined, even though their time horizon may be quite long, but also their data requirements and lack of transparency make them less proper for the interactive type of multi-participant analysis.

Thus, this leads to a capacity of running analytic sessions during which prospective exploration would be performed, starting from a basis of, usually scarce, available data, and proceeding through knowledge gathering to an image of potential futures and the margin of controlling them. All that would be done, see Chapter V, Part 2, within a group of experts and analysts aided by appropriate software. In order for the participants to better follow the course of exploration not only simple and/or graspable methods have to be used, but also their microcomputer implementation should allow easy contact and intervention. It should be assumed that software and hardware available do not place more limitations on the course of the session than the control exerted by a human moderator.

In view of the above a session could proceed as exemplified in the Appendix to this chapter.

As regards expert systems and the like constructs, their relation to the presently outlined approach can be best explained by indicating that given sufficient amount of time and appropriate software, an expert system could be created during the session, based upon questions to and responses of the exports, as coinciding mainly with stages 2a. and 2b., and then used afterwards in

Table.I.1. Examples of applications meant to implement the approach of prospective exploration

Method	Stages of application	Remarks, references
1. Simple voting	1a÷d, 3e	Voting on single items or on orderings
2. Delphi (mini-Delphi)	1a÷d, 3e	Within or without convergence; see Chapter II, Part 1 and Chapter V, Part 2, also e.g. Dalkey and Helmer (1963)
3. Aggregation of votes (orderings)	1a÷d,	See Chapter I, Part 3, for three alternative methods
4. Rank correlation	2a, 3a, 3b	Classical methods, see e.g. Kendall (1957)
5. Consensus measurement	1a÷d, 3a, 3e	See Chapter I, Part 3
6. Factor analysis	1d, 2a, 3a, 3b, 3e	Classical methods, see eg. Harman (1967)
7. Clustering	2a,3a,3b,3e,and - less - 1a÷d	See e.g. Owsiński (1984) or Diday et al. (1980)
8. Structural modelling		
8.1. transitive closure	2a, 2b	See e.g. Ganin, Kochetkov and Solomatin (1985) or Solomatin (1982)
8.2. reachability	3a, 3c, 3d	See Chapter II, Part 3
8.3. partition	3b, 3e	See Chapter II, Part 3 and, e.g. Owsiński (1984) or Fisher (1969)
8.4. consistency	2b	See Godet (1985) and references therein
9. Scenario generation	2c, 3c, 3d	Cross-impact: see Barraud and Guigou (1984), Dalkey (1972), Ducos (1979), Turoff (1972), Chapter II, Part 1 of this Report
10. Scenario analysis	3a÷e	As above
11. Control and sensitivity analysis	3a, 3b, 3d	See e.g. Owsiński and Romanowicz (1985), Turoff (1972)

subsequent stages (2c. and 3c., for instance), see Feigenbaum and Barr (1981), Winston and Brown (1979), Bourgine (1983). It may turn out, though, that construction of a proper expert system would put too much strain on the organization of exploratory session, without securing adequate output.

I.4. Concluding remarks

The chapter outlines the course of strategy-oriented analysis, consisting of propective exploration. It refers to the know-how presented in this Report and available within the study team. The emphasis in this outline of the procedure is placed upon its:

* effectiveness
* implementability
* simplicity of operation
* flexibility

while preserving non-triviality of results. Although such complete procedure was not applied in the course of the Polish Case Study (Part 2 of the Report), some of its portions and assumptions were, yielding promising results, both from the technical and substantial points of view.

I.5. References

Ader, E. (1983): L'analyse stratégique et ses outils. Futuribles, No. 72.

Ansoff, H.I. (1965): Corporate strategy. McGraw-Hill.

Ansoff, H.I. (1975): Managing strategic surprise by response to weak signals. Calif. Mgmt. Rev.

Barrand, J. and C. Guigou (1984): Analyse structurelle, impacts croisés: micmac et smic 10 ans aprés. DEA 120, Economie de la production. INSTN - Paris IX Dauphine.

Bourgine, P. (1983): Contribution a la Modélisation Assistée par Ordinateur: Systemographie et Systèmes Experts. These 3·ème cycle. Universite d'Aix-Marseille III.

Dalkey, N. (1972): An elementary cross-impact model. Technological Forecasting and Social Change, 3, No.3.

Dalkey, N. and O. Helmer (1963): An experimental application of the Delphi method to the use of experts. Mgmt. Sci., No.9.

Diday, E. et al. (1980): Optimisation en classification automatique. IRIA.

Ducos, G. (1980). Two complementary cross-impact models: MIP 1 and MIP 2. Futures.

Feigenbaum, E.A. and A. Barr (1981): The Handbook of Artificial Intelligence, Vols. I, II and III. Wlm. Kaufmann.

Fisher, W.D. (1969): Clustering and Aggregation in Economics. John Hopkins Press.

Ganin, I., A. Kochetkov and D. Solomatin (1985): Structural Modelling as a Tool for Strategic Regional Policy. IIASA, WP-85-37.

Godet, M. (1985): Prospective et planification strategique. Economica.

Harman H.H. (1967): Modern Factor Analysis. Chicago University Press.

Kendall, M.G. (1957): A Course in Multivariate Analysis. Griffin.

Owsiński, J.W. (1984): On a quasi-objective global clustering method. In: Data Analysis and Informatics 3, E. Diday et al., eds. INRIA.

Owsiński, J.W. and D.v. Wienterfeldt (1976): Models and decision-making in integrated regional development. In: IIASA Conference '76, IIASA.

Owsiński, J.W. and T. Romanowicz (1985): Sensitivity analysis of an agricultural linear programming model. EJOR, 22, pp. 370-376.

Solomatin, D.P. (1982): Mathematical background and software for an interactive structural modelling system (in Russian). VNIISI, Moscow.

Turoff, M. (1972): An alternative approach to cross-impact analysis. Technological Forecasting and Social Change, 3, No. 3.

Winston, P.H. and R.H. Brown, eds. (1979): Artificial Intelligence: a MIT Perspective. Vols. 1 and 2.

Appendix

An example of the initial course of analysis:

A session with 15 experts, 1 technical and 1 substantial moderator.

1. Gathering of proposals of issues, given by experts.
2. Ordering of issues by experts.
3. Aggregation of orderings, measurement of consensus.
4. Second round of ordering and aggregation.
5. Establishment of the issue list.
6. Gathering of proposals of conditioning assumptions as to the state of systemic environment, given by experts.
7. As 2÷5 above, in relation to conditioning assumptions.
8. Establishment of inter-issue relation structural model by simple majority voting.
9. Votings on issue states in the future, under adopted assumptions.
10. Possible repetition of votings.
11. Adoption of events, i.e. issues with their numerical states given.
12. Votings on event occurrence subject probabilities.

...

The above steps should take approx. 15-20 hours of group work.

STUDY REPORT

PART 1: B

AUTHORS: A
J.
A
J.
K
M
W
J.
A

PART 2: POLISH CASE STUDY REPORT

AUTHORS: J.W. OWSIŃSKI
W. CIECHANOWICZ
J. BABAROWSKI
A. STRASZAK
A. JAKUBOWSKI

PART 3: APPENDIX: SOFTWARE AVAILABLE

AUTHORS: L. KSIĘŻOPOLSKA
S. ZADROŻNY
J.W. OWSIŃSKI
T. ROMANOWICZ
A. ZIÓŁKOWSKI
W. CICHOCKI
C. IWAŃSKI
A. KAŁUSZKO
P. HOLNICKI

ABC — UZP