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METHODOLOGY of system studies and comparative analysis in industrial applications and its implications for developing countries

ABSTRACT

Methodology as the science and practice of methods, denotes "to know". It is aimed at discovering, fact finding, characterizing, organizing and explaining facts, principles of systematic and logical thought.

Advice and Consultation
Education and Further Training
Innovation and Development
Organization and Evolution
Utilization and Assessment

are probably the most important methods and influences behind the forward movement of society, particularly in developing countries.

A method itself is the way of doing anything, especialy according to a regular plan as well as a systematic or orderly arrangement.

For developing countries, in certain respects, advice and consultation is even more important than the other, above-mentioned methods in giving society its forward thrust. The reason is that advise and consultation alone deals with actual "here-and-now"

problems - ones that, if solved or avoided to increase, can make a real difference to real people in the way they live and work.

This study provides a systematic presentation on the methodology of systems studies and comparative analysis in industrial applications its implications for developing countries particularly of the scope of the advise and consultation as well as the other surnamed methods.

Such orderly methods are systems, that means a complex whole of connected things or parts as well as a department of knowledge or belief considered as an organizational whole. The function of a system is always based on information, communication and co-operation.

Systems studies therefore are the gathering, ordering and analysis of information on a systematic basis in accordance with predetermined criteria. Analysis again means the action of taking something apart and examining its components.

Emphasis throughout is on the dynamics of the interaction between consultant for example UNIDO-Experts and client for example their partners in developing countries.

Techniques and methods employed by UNIDO- and IIASA-Experts have been described in each case to the degree necessary for learning something about the particular approach and its why, what, with what and "how to do it" aspects.

A sucessful consultant - client interaction leads to an innovation process. Therefore each major approach to consultation has to be examined from the standpoint of the assumptions underlying it, and in such a way as to demonstrate the relative richness or shallowness of the approach; as well as for comprehending under what conditions each of the many approaches are likely to be appropriate and consequential and where it would be inappropriate to employ a particular approach.

In paragraph 1 an "consultation - (innovation) cube" of 64 cells is introduced which serves as the orienting framework for this study and an additional study an the "Choice of Strategy for the Management of Innovations in an Industrial Enterprise; and its Implications for Developing Countries."

Comparative analysis in industrial applicatios and in innovation management for developing countries may help expressing a higher degree of the quality to resolve innovation- and development management policy, -strategies, -methods and -operations as well as their interconnecting process into its main cells.

Innovation- and development management demands and -tasks are very complex and difficult to fulfil, because innovation is

- the process of finding economic application for the inventions as well as
- the result of an innovation process, that means a change in the technological system that has a particular effect on a given socioeconomic system or subsystem.

If we look at the innovation process from the standpoint or larger social systems, enterprises or other organizations, groups and their individuals, we see that these systems have four main objectives:

- to ensure their own existence and ability to function (continuation)
- to balance the inner and outer relations of the system by relieving bottlenecks (balancing)
- to find enduring means of ensuring effectiveness and efficiency in a changing environment (technological push)
- to solve problems and to avoid new problems in general and to accept and satisfy market demands as well as users or customers needs by new technical and economical solutions (demand pull)

The main point of the so called "demand pull hypnothesis" is that need or demand is the prime source of innovations. In reality, the "pull" of demand and the "push" of technology are interlinked in a specific way. The higher an innovation level, the more it is induced by a push from technology, which is the result of a modifiable random process. The innovation can then be enhanced by a demand pull in the following difussion stage. There is also a complicated interconnection among changes in social needs, cultural approaches and scientific developments. In this sence, science is affected by the real needs of the production system.

Innovation demands are the technical potentials for problem solving (technique) and economic application are covered. The concept of technique includes product and production process methods (e.g. automation). There must be something "new" in at least one area.

1. ADVICE AND CONSULTATION

Advice and consultation in the very innovative "Information Age" needs no longer a specialised group of people skilled in some branch of engineering or specialists in planning and directing more or less innovative operations in technical fields. It requires more and more also economic and social innovators with the ability:

"To do more with less"

"To substitute energy and raw materials by information" and

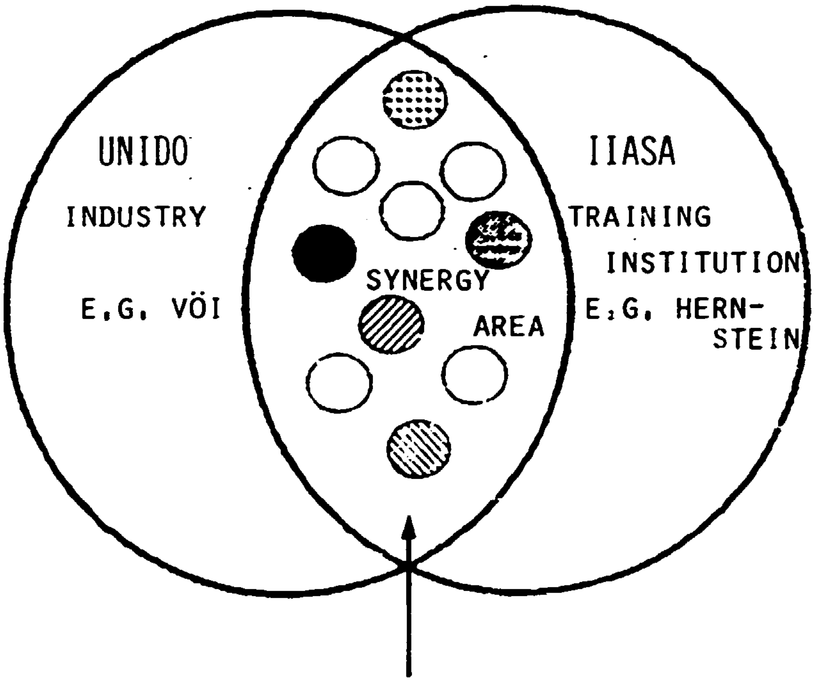
"To create new productive partnerships".

Industrial applications as well as its implications for developing countries call for symbiotic relations between technology and science, east-, west- and third world economics, multilateral cooperations etc.

ADVICE AND CONSULTATION

GOAL: EFFECTIVENESS, PRODUCTIVITY, FLEXIBILITY AND INNOVATION BY "PRODUCTIVE PARTNERSHIP"

FOR EXAMPLE:
- TO DO MORE WITH LESS
- TO SUBSTITUTE ENERGY AND RAW MATERIALS BY INFORMATION AND
- TO CREATE NEW PRODUCTIVE PARTNERSHIPS



COOPERATIVE PROJECTS E.G. IN DEVELOPING COUNTRIES

- EFFECTIVE
- PRODUCTIVE AND
- FLEXIBLE ETC.

INDUSTRIAL APPLICATIONS AS WELL AS ITS IMPLICATIONS FOR DEVELOPING COUNTRIES CALL FOR SYMBIOTIC RELATIONS BETWEEN TECHNOLOGY AND SCIENCE, EAST-, WEST- AND THIRD WORLD ECONOMICS, MULTILATERAL COOPERATIONS ETC.

VÖI = VEREINIGUNG ÖSTERREICHISCHER INDUSTRIELLER

Consultants have to be good prototypes of a learning society.

An effective Management in this field assures not only an enterprises or a larger social systems future, but also its growth rate, with significant influence on the economy and society as a whole.

Strategies for the Management of industrial applications as well as its implications for developing countries must continue the technical-, economical- and social progress during following the markt- or user needs, solving problems and crisis, avoiding new problems and using chances as well as being orientated on values.
That means, e.g.:

1. Firstly, to support the individual, the enterprise, industry economy and society, and to help its development.

2. Secondly, to maintain the high standard of living and pros perity so far achieved by our technical civilization.

3. Thirdly, to help other people which would be impossible without further technical progress, for the industrial countries as well as for the developing countries whose 80 % of the world's population now claim their rights and their shares in the benefits of technical progress.

Behind the front lines of innovative activities new ideas and concepts have to be assessed and tested for their technical application.

2. REQUIREMENTS OF CONSULTATION STRATEGY

Strategies aim at tracking down and utilising the new kinds of chances offered by the future. A strategy in general is the vision as to what an enterprise or a larger social system should be, not how it gets there.

The "why (policy)" and "what (strategy)" must be separated from the "how (methods and operations)". The "how" means operational plans ans activities. Before plans can be made, a directional framework for alternatives is necessary, which dictates the actual content of the activity and the basic direction of the march.

A plan is the result of a (consideration) weighing up of the activity and the alloting of resources. Strategy is the setting for the direction of the alternative measures and allotment of resources.

Before the beginning of any new project therefore answers must be found which are as clear as possible, to the following questions:

1. Why must we operate? "Know why".
   What kind of enterprise or society does the organization or larger social system want to be?
   (Situation analysis ans system studies, effectiveness areas and effecteveness measures, objectives ans goals.)

2. What shall/can we do? "Know what".

   What set of businesses or operations should the organization or larger social system be in;

   (Users and consumers needs, demand pull and driving forces)

3. With what and how can we operate? "Know how".

   What human qualities are needed to steer the organization or larger social system in the wanted direction?

   (Demands and qualification profiles, guidelines......)

Which technologies should be used ans which technological opportunities should be pursued? (Technology push and technology assessment).

These fundamental questions, which continuously require new answers. This is because the conditions, resources, attitudes, and the progress of a society and its larger social units change at a faster rate than ever before in connection with:
new demands, basic innovations, key-technologies, shared values. organizational culture, worldwide competition etc.

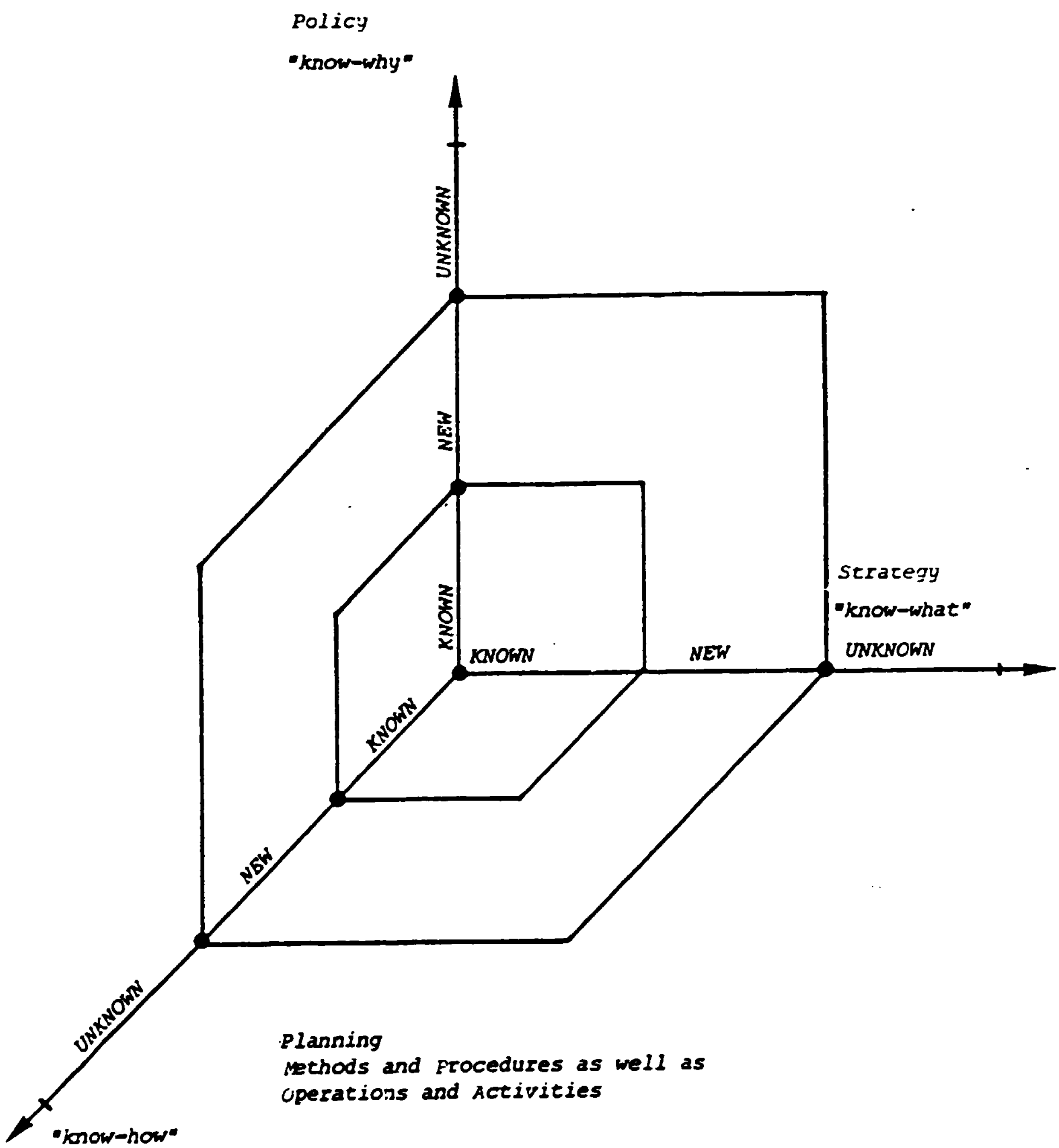


Figure 4: "Know-why", "know-what" and "know-how".

During several IIASA Task Force Meetings on Innovation Management the participants from east and west countries learned to create an METHODOLOGY cube, as shown in the following figure.

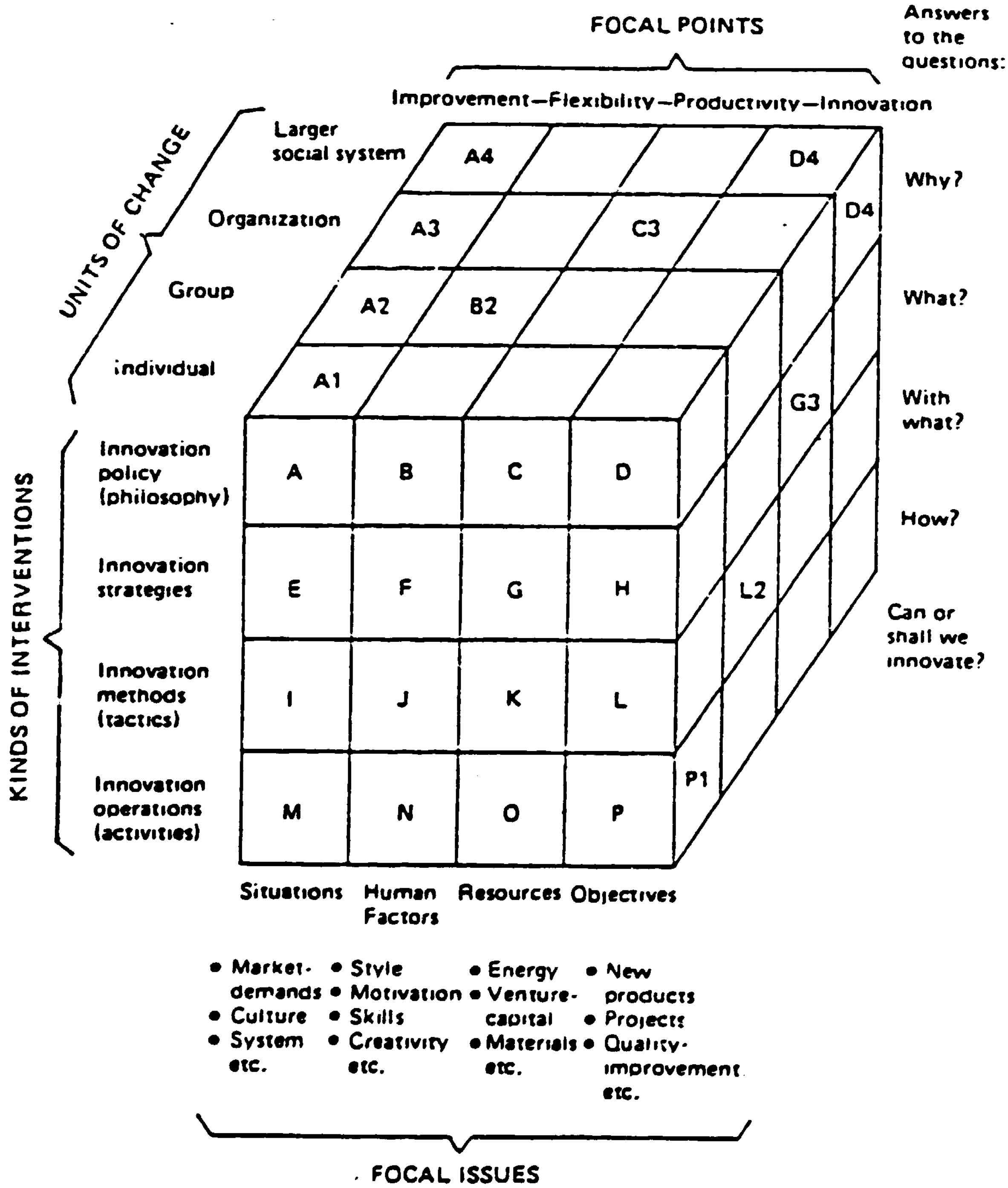


Fig. 5 : Scheme of arrangement in an Methodology cube

Every organization and institution as well as a larger social system must make clear from the first, when considering strategy, hich tasks it is fulfilling and which tasks it should really be fulfilling. They must know what their clients are paying for and their clients consider good value. Management must think carefully about the suitability of their organization's strong points and possible partners in a cooperative venture, and whether on target application will make them effective.

The formulation of a strategy is the process of determining the scope of objectives, within defined effectiveness area of operation and determination of the, for example developing policy, to be adopted to attain those objectives.

Strategy formulation involves selecting objectives and -goals and establishing the character of the task, after delineating the scope of operations, vis-à-vis markets, geographical areas and technology.

K.R.Andrews defines what strategy is with the following sentence: Corporate strategy is the pattern of decisions in an enterprise that determines and reveals its objectives, purposes or goals, produces the principal policies and plans for achieving those goals, and defines the range of business the enterprise is to pursue, the kind of economic and human organization it is or intends to be, and the nature of tne economic and non-economic contribution it intends to make to its shareholders, employees, customers and communities. (The concept of corporate strategy).

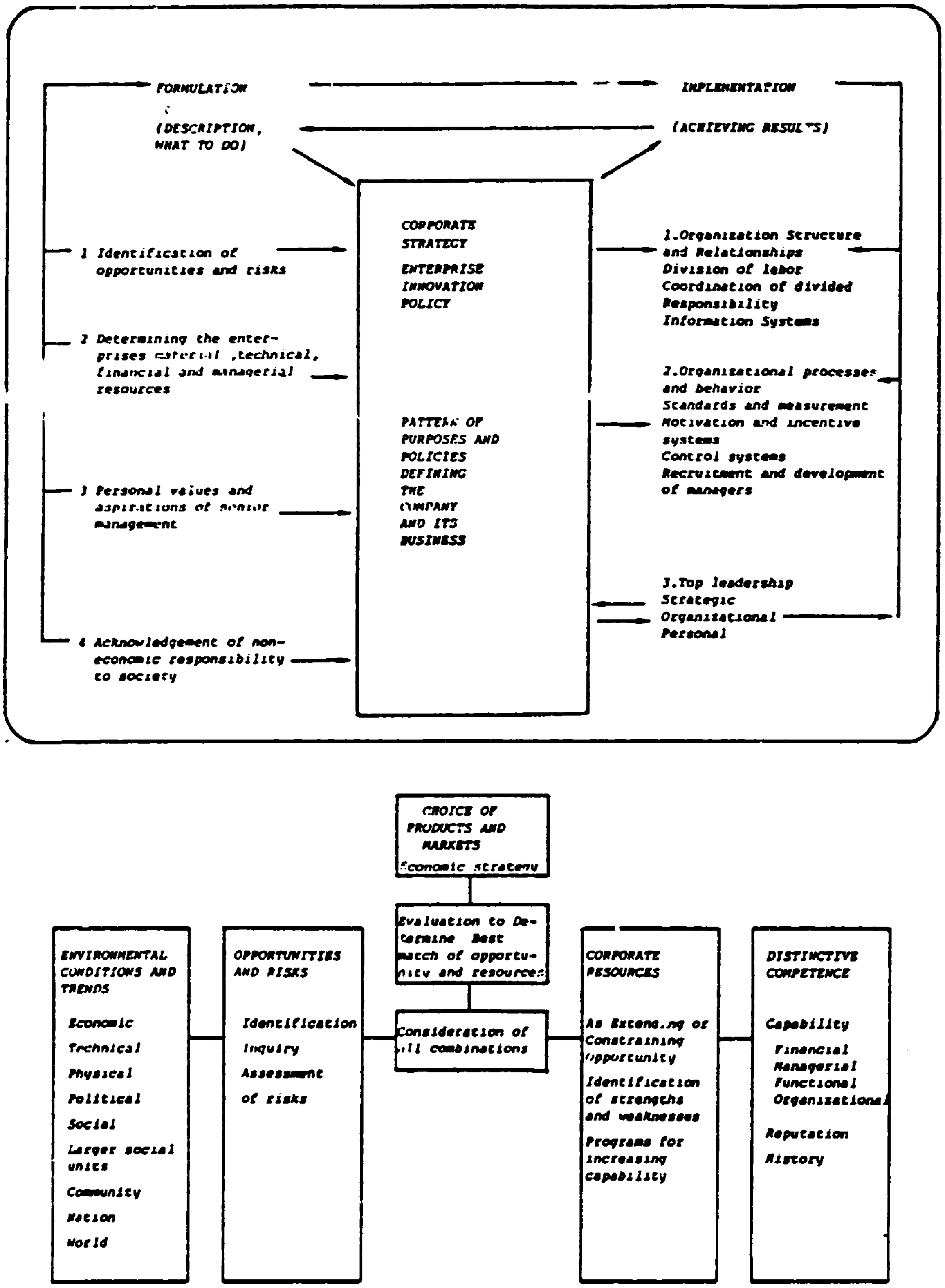


Figure 5: Depictions of the corporate strategy process from the concepts of corporate strategy by K.R.Andrews, Irwin (1980) obtainable from Richard D.Irwin, 1818 Ridge Road, Homewood, Illinois.

Formulating strategy demands:

- recording and consolidating of the framework data for the declaration of strategy
- the devising of a plausible concept including:
    - time framework
    - driving forces (Management which clearly thinks pcsitively and expansively
    - task orientated cooperation on all levels
    - strategic key areas
    - interplay of specialist knowledge present
    - characteristics/range of products/services
    - characteristics/range of techuological attractions
    - financial guidelines
    - task setting for strategic areas of bisiness
    - guidelines for the application of the strategy
    - mehtodical procedures for the development of alternative strategic concepts
    - methodical procedures for strategic decision making.

Choice of strategy for the management of industrial applications and its implications for developing countries calls for systematic study, purposeful technical, economical and social development and continuous training.

Advise and consultation education and further training as well as innovation and development are probably the three most important pairs of influences behind the forward movement of an organization, institution enterprise, larger social system and of society as a whole. In certain respects innovation and development is even more important than advise and consultation or education and further training in giving an organization, an enterprise and society its forward thrust.

3. SYSTEMS STUDIES AND COMPARATIVE ANALYSIS

Studying and analysing of a system means the action of taking something apart and examining its components, the chemist makes an analysis when he discovers the quantity and quality of ingredients in something. The biologist and botanist use analysis to signify the operation of classifying a specimen. The psychiatrist uses the word to mean the treatment or cure of aberrant psychic behaviour. The physician interprets it in terms of what happens in the laboratory of pathology. The mathematician uses the term in a variety of ways; for example:

- he uses it as a technique for proving a theory by assuming the truth of the theory and then searching out the consequences;

- since integral and differential calculae are commonly used in searching out these consequences, he tends to regard any application of calculs as a form of analysis;

- still more loosely, he regards any problem amenable to mathematical solution as "subject to analysis", and most loosely of all;

- analysis becomes the estabishement of - or search for - any kind of quantitative relationship.

In the framework of industrial applications and its implications for developing countries a responsible manager analyses "situation" within systems and -processes. An analysis methodology must be needed for a particular kind of work as well as be useful and enables:

- to deal with systems, processes and situations (tasks) in the same language, which is particulary advantageous at meetings, etc.
- to become more secure in decision making
- to direct spheres of activity better, often without having, yet, to know all technical details
- to arrive at solutions faster and save time as well as human - and material resources.

That means in methodology "to solve the right problems with the right strategies, methods or techniques and operations".

Systems studies and comparative analysis ans project assessment for example is such a methodology. It systematically identifies, analyses ans evaluates technical business and social impacts - both beneficial and detrimental - before a project is implemented.

In many instances large amounts of resources have been needlessly spent on solving the wrong problems. The business community has become sensitized to such wasted efforts and have recently come to look on systems studies and comparative analysis ans project assessment as a means of minimizing this problem.

A1 - Situation (task) analysis within a system and -process. (SA)

A2 - Problem analysis, mainly to detect project barrier causes and/or innovation discrepancy.

A3 - Decision analysis, mainly preparing decision alternativer. (DA)

B - Potential problem analysis, mainly used for the key-assessment. (APP) For example to assess the chances and risks of the integration of key-technologies into new project strategies as shown in figure

What is project assessment?

It is a method on project management which systematically identifies, analyses and evaluates the full range of sultural, social, econonic and environmental impacts - both beneficial and detrimental, which may result from the introduction of a new technology or from changes in the application and utilization of existing technology. In project innovation - as well as in technology assessment, a focus is placrd on secondary and higher-order impacts, i.e., on unplanned and unintentional consequences with an emphasis on consequences that are indirect, unanticipated and delayed.

The following figure 9 summarizes for example critical elements in the process of innovation project assessment

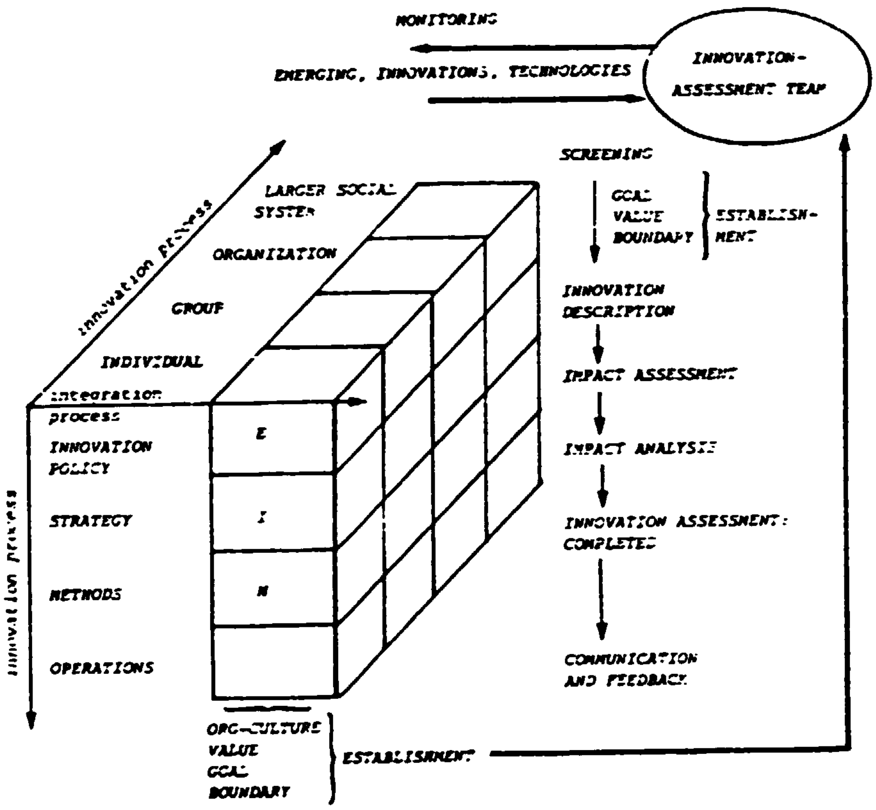


Fig. 9 : CRITICAL ELEMENTS IN THE PROCESSING OF INNOVATION AND TECHNOLOGY ASSESSMENT

There are four main objectives of an innovation assessment:

1) To identify and analyze the relevant economic, social, technological, cultural, legal, psychological, institutional, environmental, and political consequences of an innovation or a projected technological change;

2) To analyze the ability of existing institutions to accommodate innovation and technological change, and the ability of new technologies to accommodate institutional change;

3) To compare the alternative policy and technological choices available to decision makers; and

4) To identify and analyze the reward and risks associated with alternative policy choices.

WHY INNOVATION ASSESSMENT IS NECESSARY?

Today, one of the most powerful forces in the society - and at times by far the most important for many communities including the R & D community - is technology and new applications. They are pervasive factors in modern society.

The notion of assessing key-technology as well as key-innovations was originated from the convergence of two observations:

1. that key-technologies are critical forces in modern society and

2. that key-technologies-based innovation can go awry. Innovation assessment has resulted from concern over these negative effects of key-innovation on the environment and society.

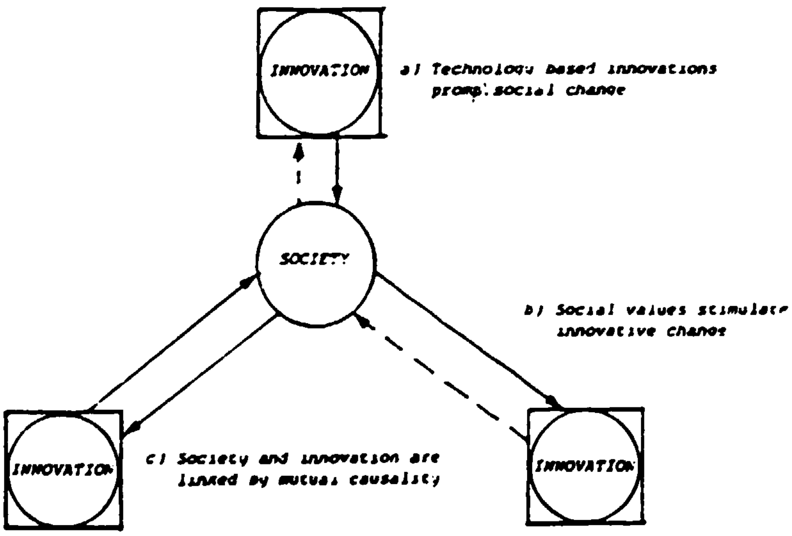
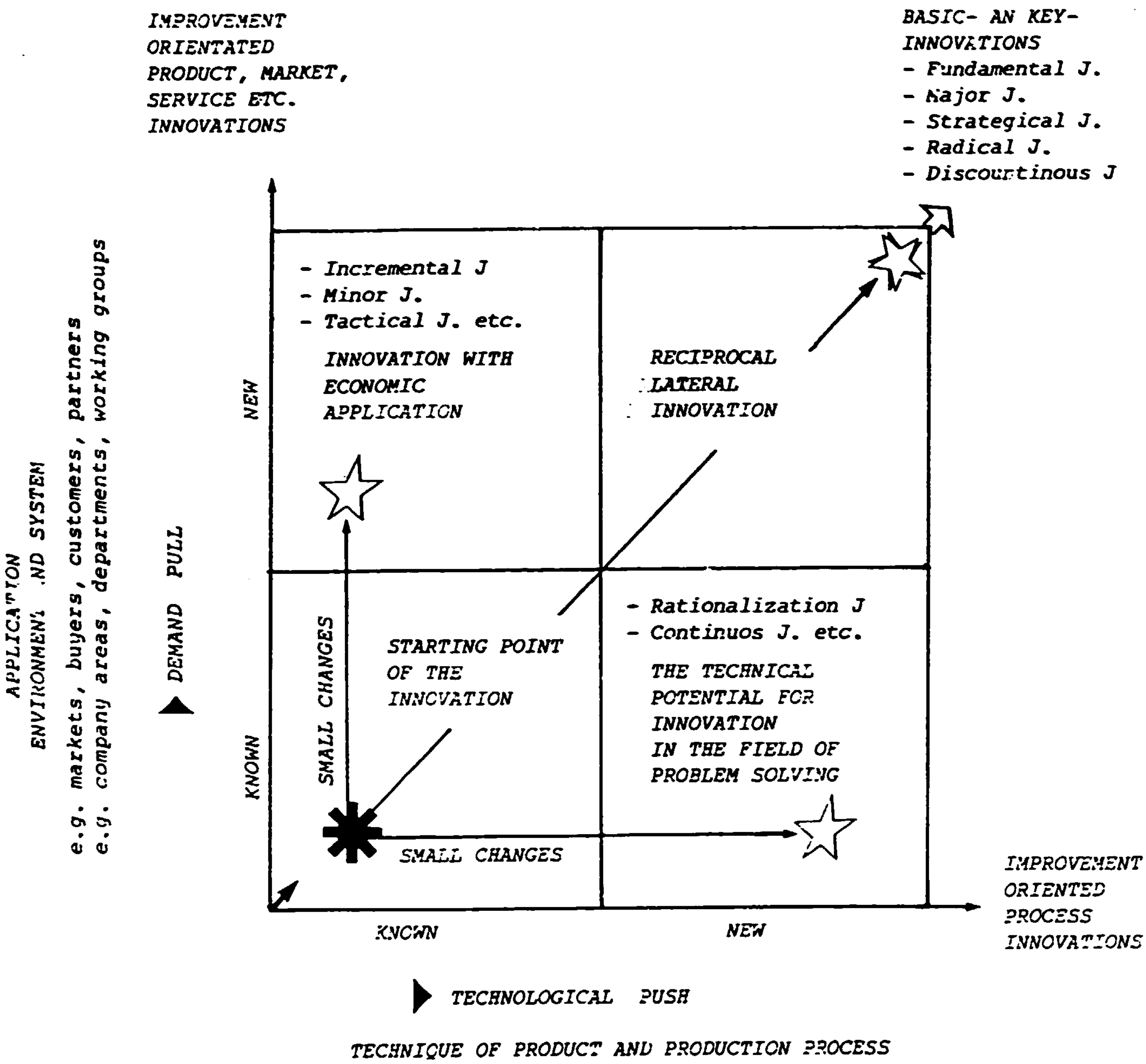


Fig.: 11: Cause-effect relationship between innovation and society



The three functions of Innovation are:

- continuation
- balancong
- push and pull

Fig. Directional matrix of innovation

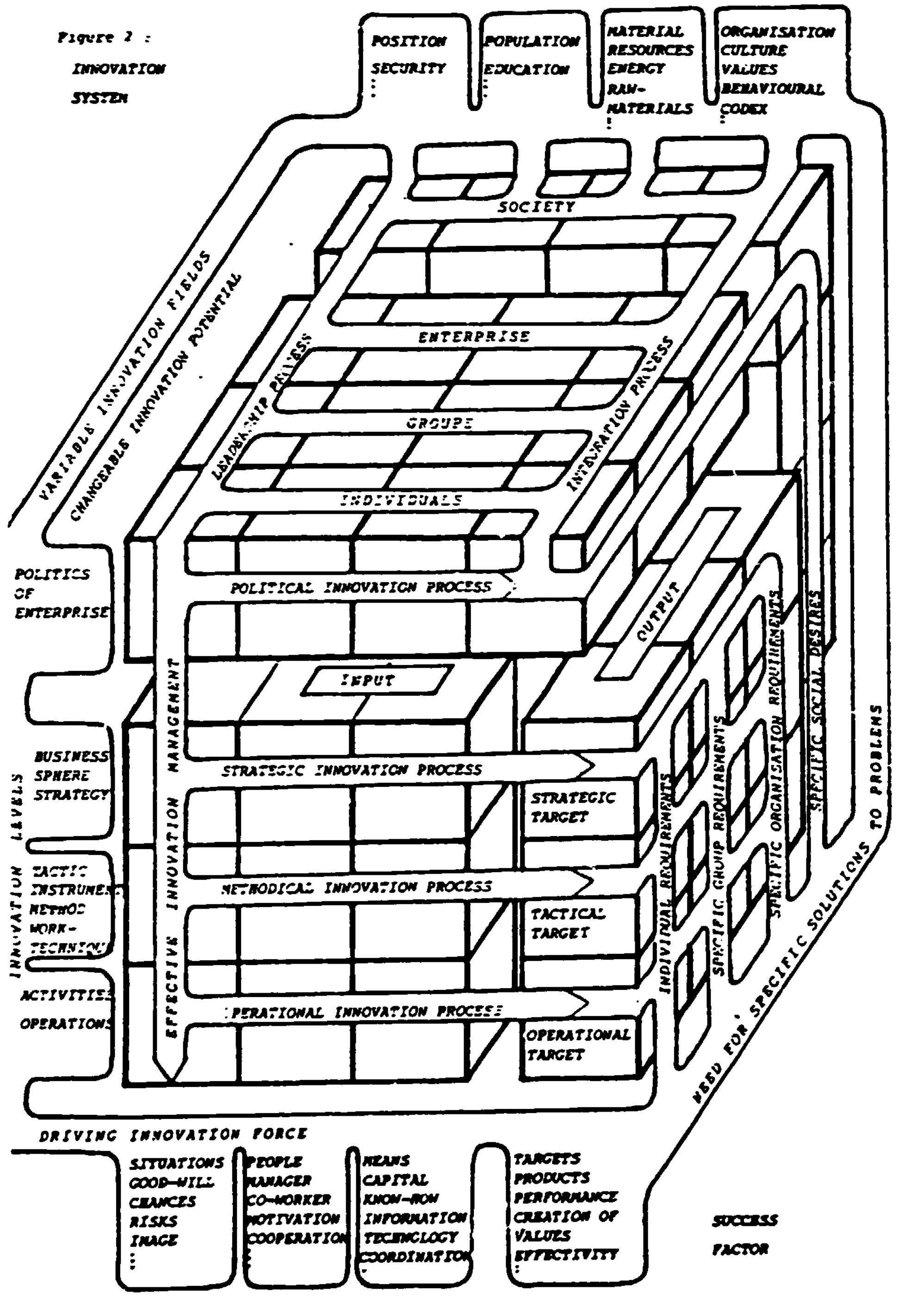


Fig. An innovation system

The expression innovation has several meanings:

J_1 A process (P = Input) that aims at bringing about a strategically and according to plan change with new qualities, where success is not yet assured.

J_2 A first accomplishment and realization of an idea for solving a problem (R = Output) (invention), i.e., changes in design, manufacture, sales and system formation for, e.g., the manufacture of a new product.

J_3 The innovation process itself as well as the realization of a problem solution in a new mode.

J_4 An absolutely successful innovation with regard to its strategically planned implementation, as well as its successful introduction onto the market.

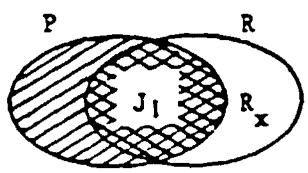
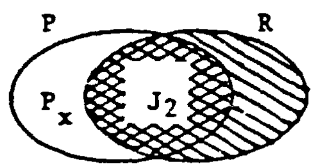
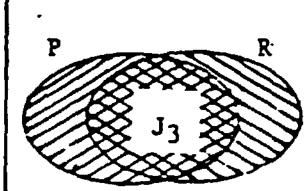
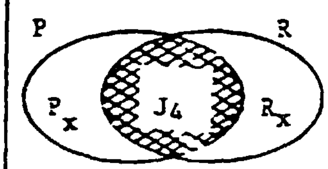
J_1 = P (Process)	J_2 = R (Realization)	$J_3 = P \cup R$	$J_4 = P \cap R$
			
J_1 neglects all (R_x) problem solutions that did not go through the normal process (P) channels E.g.:Innovation that is the process of finding economic application for the inventions.	J_2 neglects all (P_x) endeavours and processes that did not lead to success E.g.:Basic innovation means Fundamental-Strategical-Radical-, Discontinous- and/or Major-Changes	J_3 includes realizations (R) that occured through planned and unplanned endeavours. It also includes all (P) processes whether they were successful or not. All inputs and outputs are summarized	J_4 strictly denotes only those innovations that occured through planned ($P - P_x$) endeavors and which were 100% successful
That occur through proposals or activities of small groups to increase quality	Here it is very difficult to objectively define success	E.g.: Improvement oriented Innovation means incremental-Minor-, Tactical-, Methodical-, Rationalization-Continous- and small changes	Areas of effectiveness, performance standards and innovation goals are clearly identified Innova.-portfolio
CONTINOUS - OR RATIONALIZATION INNOVATIONS	BASIC - OR KEY - INNOVATIONS MUTATIVE CHARACTER	SOMETIMES LEADING TO RECIPROCAL OR LATERAL INNOVATIONS	PLANNED NEW PRODUCTS AND SYSTEMATICALLY DEVELOPED NEW PROCESSES

Fig. The several meanings of "Innovation" as a process (P) and a result (R)

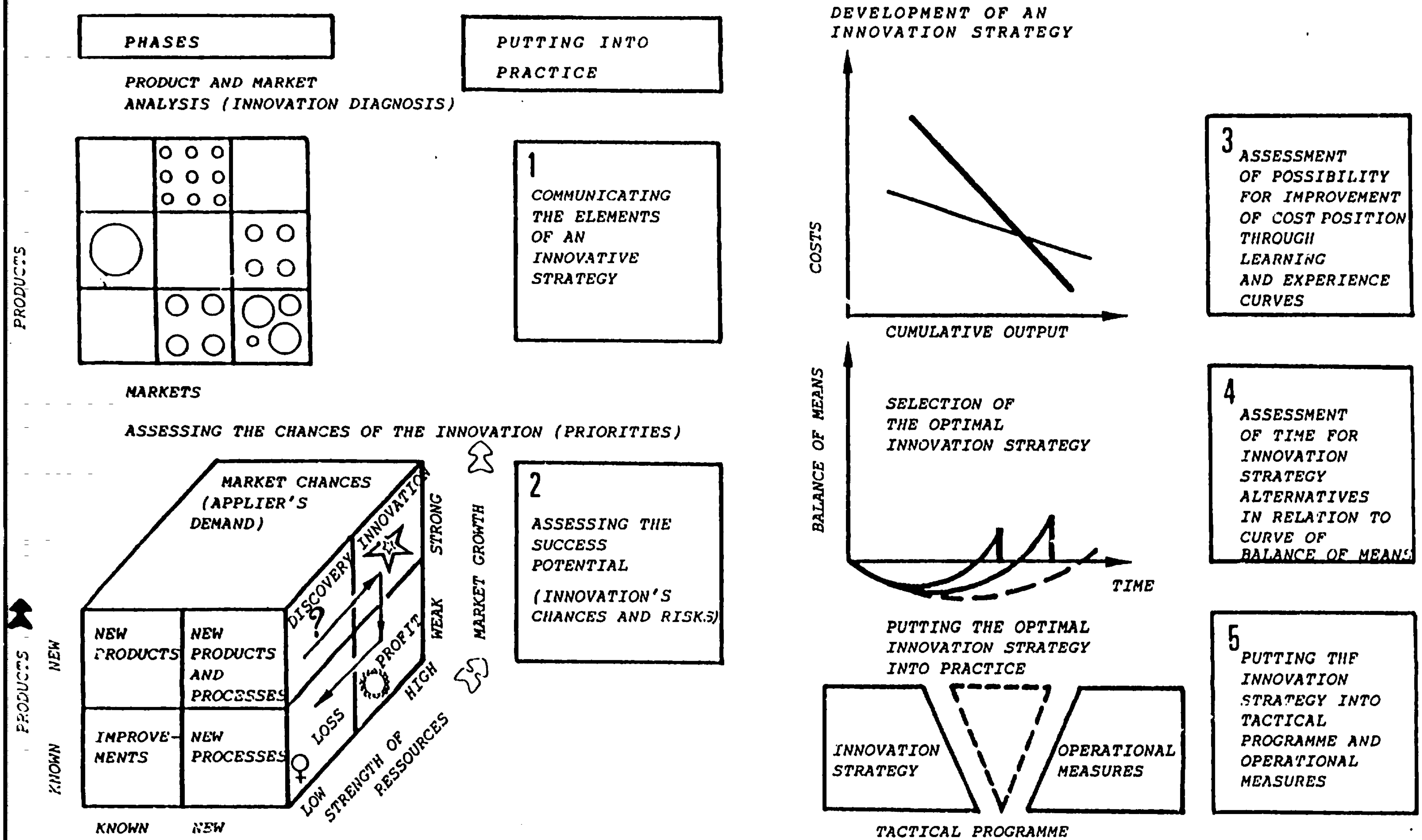


Fig. PHASES AND THE PUTTING INTO PRACTICE OF AN INNOVATION STRATEGY BY "INNOVATION FORCE"

Society intends that key-technology and innovation will be held accountable for its total impact. Therefore, innovation assessment is becoming a requirement of innovation based proposals.

How is Innovation Assessment done?

The methodologies employed in innovation assessment are numerous and diverse. They include a variety of techniques developed in futures research such as:

scenario-building
Delphi techniques
project/trend extrapolation
modelling and simulation
cross-impact analyses
relevance trees/decision trees
probabilistic and heuristical models
morphological analysis
interviewing/survey research
gaming
interpretative structural modelling
public participation techniques
disciplined speculation, etc.

(Arnstein and Christakis, 1975, Ayred, 1969, Watson, 1978)

Table 1: Methodologies in innovation assessment

Determinants / Technique	Problem	Rules	Participants	Mode of implementation	Control	Preparation time	Implementation time	Evaluation time	Result
Brainstorming	defined	few	5-12 persons	centralized	1-2 moderators	depends on procurement of devices	maximum of 30 minutes	medium	many ideas
Method 635	defined	few	usually 6 persons	usually centralized	only initiator, "time control"	short	45 minutes	medium	great number of solution approaches
CNB-Method	problem area known	few	experts	in writing, decentralized	only initiator	1 meeting	1-10 weeks	1 session	solution concept
Morphological Analysis	defined; suitable for morphological analysis	many	5-7 persons	centralized	moderator	not required	1/2-2 hours	long	solutions
Synectics	defined	many	5-7 experienced participants	centralized	moderator	depends on procurement of devices	2-6 hours	evaluation by external parties	unconventional solution approaches

Table 1: Methodologies employed in innovation assessment

A 1 What is Innovation Situation (task) Analysis within an Innovation System or- Process?

It assists innovation management to systematically take stock of the innovation situations and tasks which they are concerned with, to establish priorities and to assign them to the corresponding thought process.

Innovation situation analysis enables innovation management besides, by asking pertinent questions, to break down complex and multi-layer innovations into their component subsituations.

Innovation situations (particular, critical innovation situations) are matters that require action on an innovation managers past. They develop into tasks which he has to perform.

How can an innovation manager probe a critical innovation situation? By asking e.g.:

- *What is troubling the innovation management?*
- *Discussing relevant issues and any major problems.*
- *Establishing the nature and scope (breadth and depth) of inquiry.*
- *Where must something be done?*
- *Indicating the range of social and environmental values involed in the assessment.*
- *What is of particular urgency?*
- *Developing project ground rules.*

- *INNOVATION SITUATION ANALYSIS STARTS WITH A LIST OF INNOVATION SITUATIONS*
  But not every innovation situation is immediately comprehensible or evident to all concerned because it is a complex structure.
  The next step therefore is:

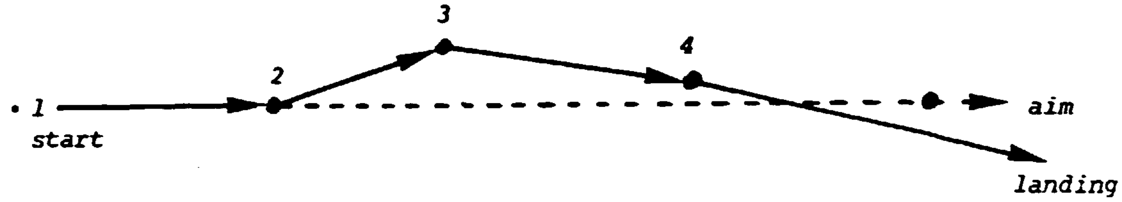
- *DEFINING AND BREAKING DOWN INNOVATION S ITUATIONS AND ESTABLISHING PRIORITIES*

Priority is a product of importance (costs, human- and material resources required) time urgency and the tendency (trends) which has been noted up to now and which will probably continue in the future.

All innovation situations within an innovation system can be divided into the priorities - the trend is already contained in the corresponding factors.

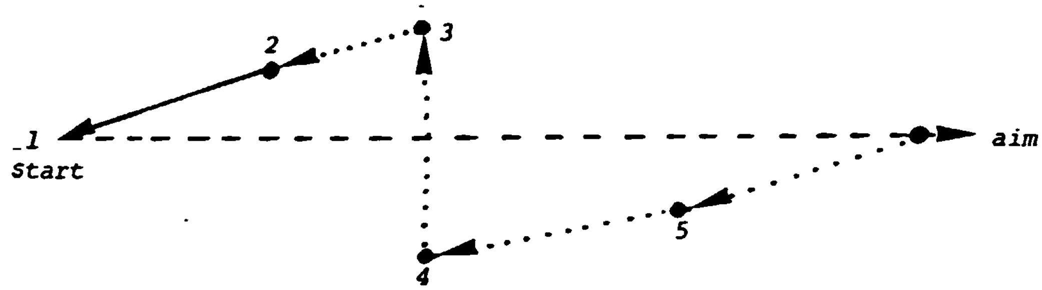
resource factor IMPORTANCE / time factor URGENCY	HIGH	MEDIUM	LOW
HIGH	A	B	B
MEDIUM	B	B	C
LOW	B	C	C

Uncybernetic procedure - determined by occasionally ensuing events:



The conditions needed to reach the desired goal are not known, although it is in sight (dotted line) hence, because of taking the wrong direction, situations which have changed or a lack of preventive measures, one often ends up in a completely differt spot.

Cybernetic procedure - determined by predictable, future events (in the style of net work technology).



The conditions to actually reach the goals are ascertained backwards. The chance to reach the desired goal, with an (innovations) strategy, produced in this way is much greater, encouraging the development of several more useful alternatives as it does. In the pursuit of particular goals, in inverted order (diagram below) the attainment of goals is preprogrammed.

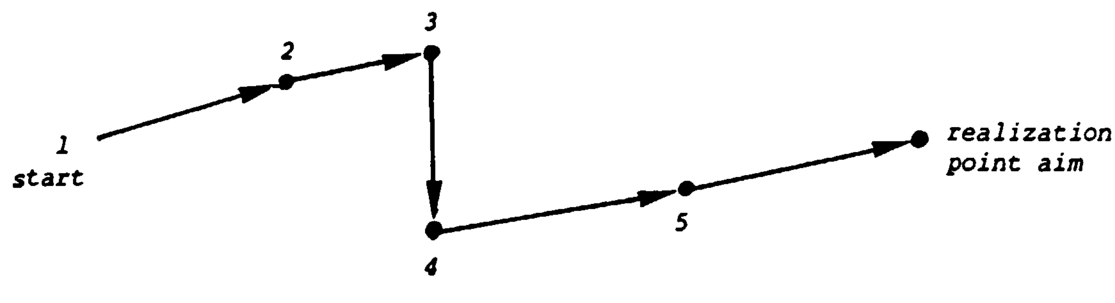


Figure Cybernetic and uncybernetic planning strategy

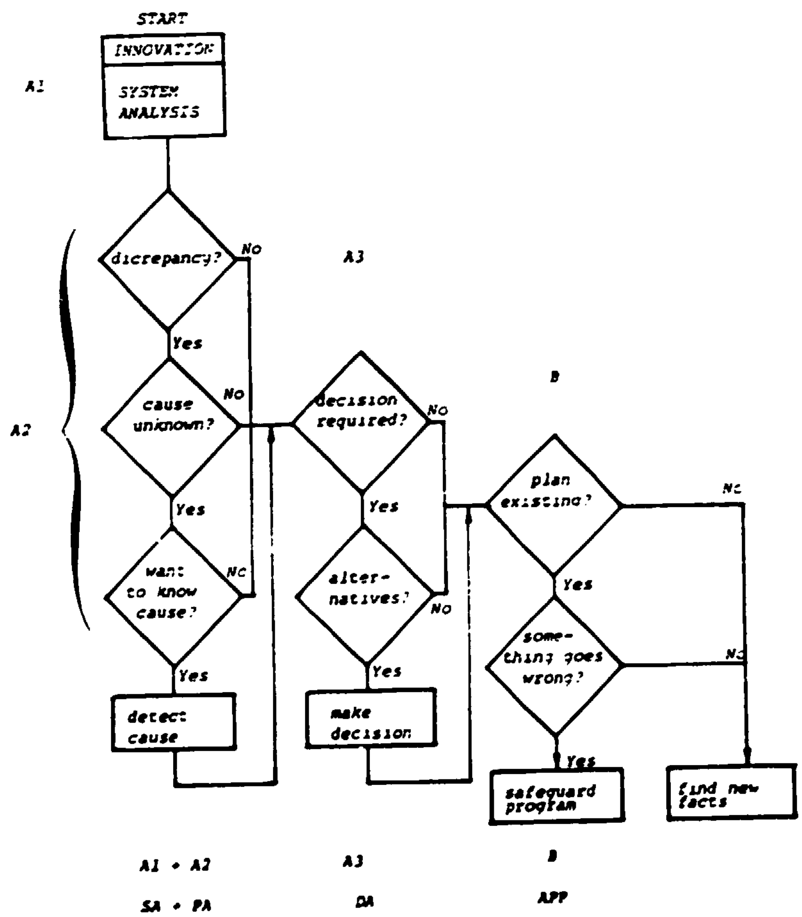
A - Innovation situation: must be dealt with at once or within the next hours

B - Innovation situation: should be dealt with this evening or tomorrow morning

C - Innovation situation: can be left for a few days or weeks

Priorities are valid for the present state of information only. If new points of view are produced or new information is added, priorities must be checked and perhaps altered.

How do I arrive at the approriate thought-process?
(assign a given innovation situation to the right thought-process)



METHOD OF INNOVATION SITUATION ANALYSIS

An Innovation Situation analysis, follows the steps:

1) *Preparation of a list of Innovation situations (tasks)*
   Must IM intervene?
   Must IM act? — *yes*

2) *IM defines and breaks down situations*
   Is the situation unambiguous and clear?
   Subsituations
      What does it mean, exactly?
      Which - how - exactly?

3) *IM establishes priorities*

Importance	}	*H-M-L*	*A*	} *different situations*
Urgency			*B*	
Tendency			*C*	

4) *IM assigns the appropriate thought-process*

Is there a discrepancy?	*yes*	} *PA*
Is the cause unknown?	*yes*	
Do we want to know the cause	*yes*	
Decision required?	*yes*	} *DA*
Have we got a choice, alternative?	*yes*	
Should anything be done, is there a programm?	*yes*	} *PPA*
Can something go wrong?	*yes*	

IM = Innovation Management

SUMMARY

Innovation situations arise when IM has to intervene, to act, to determine the cause of a discrepancy, to prepare and make a decision, or safeguard the implementing of a plan.

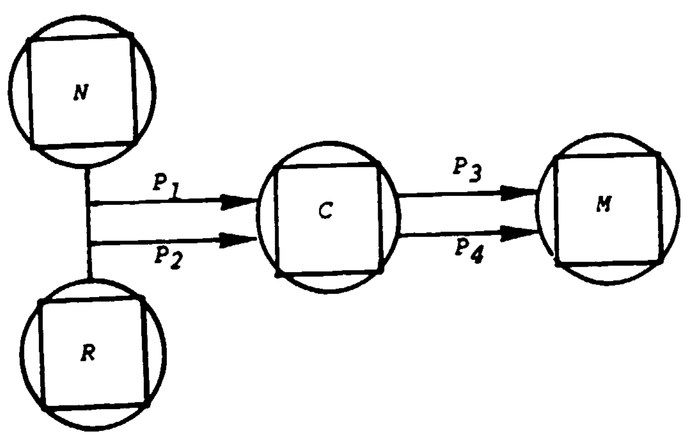
The situations are then:

- *listed*
- *defined and broken down*
- *investigated for priorities*
- *assigned to the appropriate thought-process (localised)*

Since new innovation situations keep arising and information keeps coming in, the four process-components of this analysis must be continuosly checked.

A 2 INNOVATION PROBLEM ANALYSIS

An Innovation problem is e.g.: the discrepancy between an existing and a desired effect or between the present situation and certain objectives, which cannot be closed by using a known algorithm. There exist four problem levels or trade-offs between needs N and resources R, goals G and means M.



P_1 Problems of need assessment and goal definition

P_2 Problems of resource assessment and goal definition

P_3 Search for means under given objectives

P_4 Search for goals under given means

With the aid of innovation problem analysis methodology innovation management will be in a position to detect causes of discrepancies by using a precise technique of questioning to collect critical information.

Discrepancies are the differences between what is supposed to be and what actually is taking place, i.e. between SHOULD and IS.
A discrepancy may be positive or negative.

It is useful firstly to describe thoroughly and accurately the innovation being analysed and assessed.

The description should include identification of the major technical parameters, alternative ways in which these can be implemented, competing technologies, and definition of the pertinent technology delivery system.

The innovation managements e.g.:
-describes supporting technologies,
-provides information on changes over time in technical parameters and in the relative diffusion in the technology.
-identifies key uncertainities, potential breakthroughs, upcoming substitutions of onetechnology for another, likely cost reductions, and new applications.

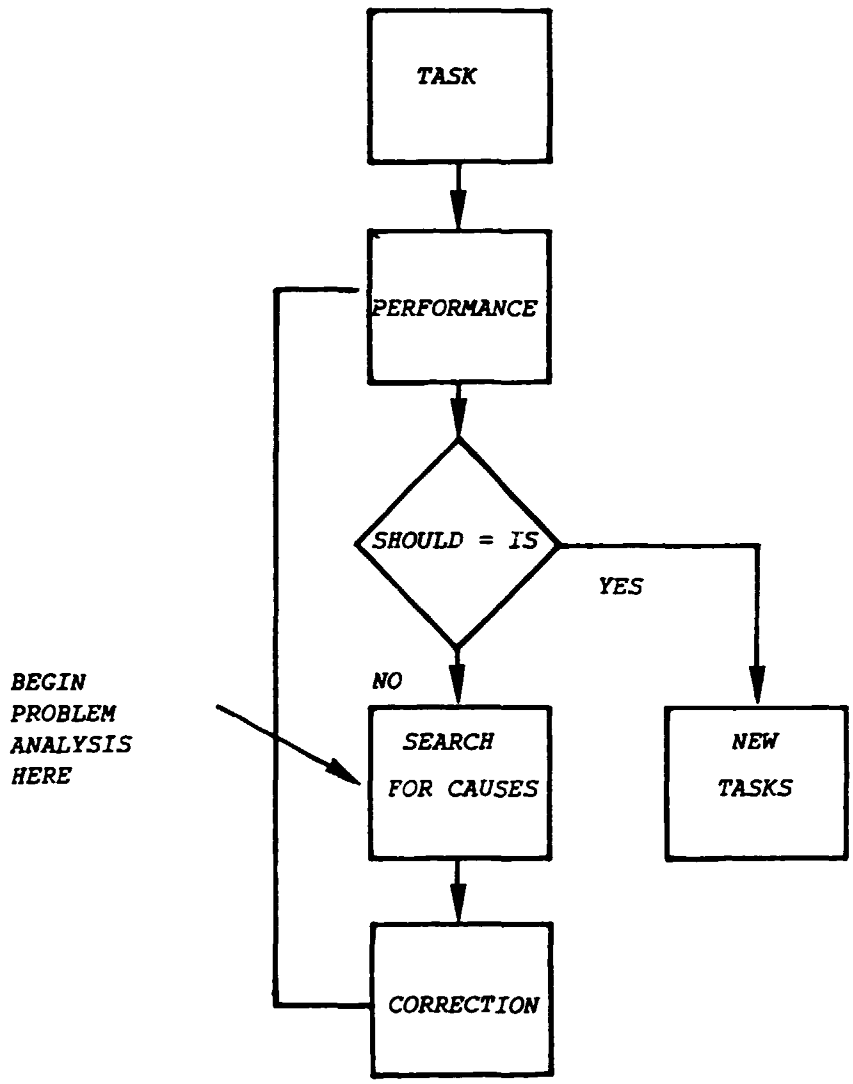
Secondly the discrepancy, now clearly defined, is desribed

-A discrepancy is described by defining WHAT, WHERE, WHEN and HOW MUCH, in order to pin down the fault precisely (is-sphere = innovation-problem-sphere). But in order to properly orientate ones search for possible causes it is necessary to mark off this innovation-problem-sphere as closely as possible by setting up and defining an IS NOT-sphere (BUT COULD BE-sphere).

Questions for defining innovation discrepancy

	IS-sphere	IS-NOT-shere
WHAT	what is the innovation-project?	what object could also have been affected but isn't?
	what is the innovation-discrepancy?	what discrepancy could also have occured but didn't?
	what does the discrepancy consits of?	what could the discrepancy also have consisted of?
	what does the discrepancy look like?	how else could the discrepancy have looked?
WHERE	where is the discrepancy on the object?	where on the article could the discrepancy also have been but wasn't?
	where "geogrpahically", was the discrepancy ascertained?	where "geographically", could the discrepancy have been ascertained but wasn't?
	where was it observed?	where could it have been observed but was not observed?
	where was the discrepancy reported from?	where could the discrepancy have been reported from but was not reported?
WHEN	when did the discrepancy first occur?	when could the discrepancy have first occurred but did not?
	when does the discrepancy occur?	when could the discrepancy also occur but doesn't?
	when was the discrepancy observed?	when could the discrepancy have been observed but wasn't?
	when was the discrepancy reported?	when could the discrepancy also have been reported but wasn't?
HOW MUCH	how much of the object is involved?	how much of the object could have been involved but wasn't?
	how many parts (or units) are involved?	how many parts (or units) could have been involved but weren't?
	what percentage are affected by the discrepancy?	what percentage could have been affected by the discrepancy but weren't?
	what is the trend?	what trend could have been expected but didn't show?

WHERE INNOVATION PROBLEM ANALYSIS BEGINS



<u>Investigating an innovation discrepancy for possible causes</u>

Assuming that a discrepancy does not happen without a reason in a well-functioning innovation process, there is one possibility only, namely that desired or undesired change has happenend, bringing about this discrepancy. With new programs conditions and correlations can be different from those expected.

It is essential, in order to clearly limit the problem area, to search only for changes which apply to the <u>IS-sphere</u> but <u>not</u> to the <u>IS-NOT-sphere.</u>

To this end, the differences between IS and IS NOT are defined. These differences are called innovation DISTINCTIONS.

Innovation DISTINCTIONS can be ascertained by the following questions:

- *which characteristics apply to IS but not to IS NOT ?*
- *in what way does IS differ from IS NOT ?*
- *by what distinctions does IS differ from IS NOT ?*

If discrepancies appear in well running innovation processes, it's the CHANGES in the innovation distinctions that are the cause.

Innovation CHANGES can be determined by the following questions:

- *what changed or was changed in the innovation distinctions ?*
- *what changed or was changed relative to the innovation distinction ?*
- *what changed or was changed within the scope of the innovation distionction ?*

The word "changed" can be substituted by the following terms:
- made new - made more effective or efficient - improved - remodelled - replaced, etc.

It is important to mark the changes with the date of occurrence.

The possible causes are now derived from these innovation changes and - distinctions. Innovation management now has to draw up a statement which could explain how, and in what circumstances, the (innovative) chance, in a particular (innovation) distinction could be the cause of the unexpected (innovation) discrepancy.

The possible causes (hypotheses) can be established by answering the following questions:

- *How can the (innovative) change have brought about the (innovation) discrepancy?*
- *How can the change in a distinction here caused the discrepancy?*
- *How can one change, together with another change, have caused the discrepancy?*

It is useful to set up as many hypotheses as can be derived from the existing facts (i.e. changes).

Now it is necessary to test the hypotheses about possible causes.

If several hypotheses have been set up, it's most likely that only one of the possible causes is the "correct" one.

It would not be very sensible to try and prove all the hypotheses that are put forward.

Certain hypotheses can be eliminated as improbable or not applicable.

A highly probable hypothesis must explain the IS and the IS NOT-facts.

Often assuptions have to be made, since only in expectional cases are all the facts about the discrepancy known at the time if the analyis. If innovation management receive a subjunctive (could, must should, possibly, probably etc.) in reply to their test-questions they mark this in the analysis: (A=P - assumption, still to be proved). The extent of the truth in this infomation must still be checked. But this can then be done very precisely.

To test innovation management asks the following question?

> *Does this hypothesis explain why the discrepancy occured in IS but not in IS NOT ?*

Innovation management goes through all IS and IS NOT lines with this question. The hypothesis "dies" as soon as it leaves a line unexplained.

Table 2: Innovation problem analysis

PROBLEM ANALYSIS (detecting causes)

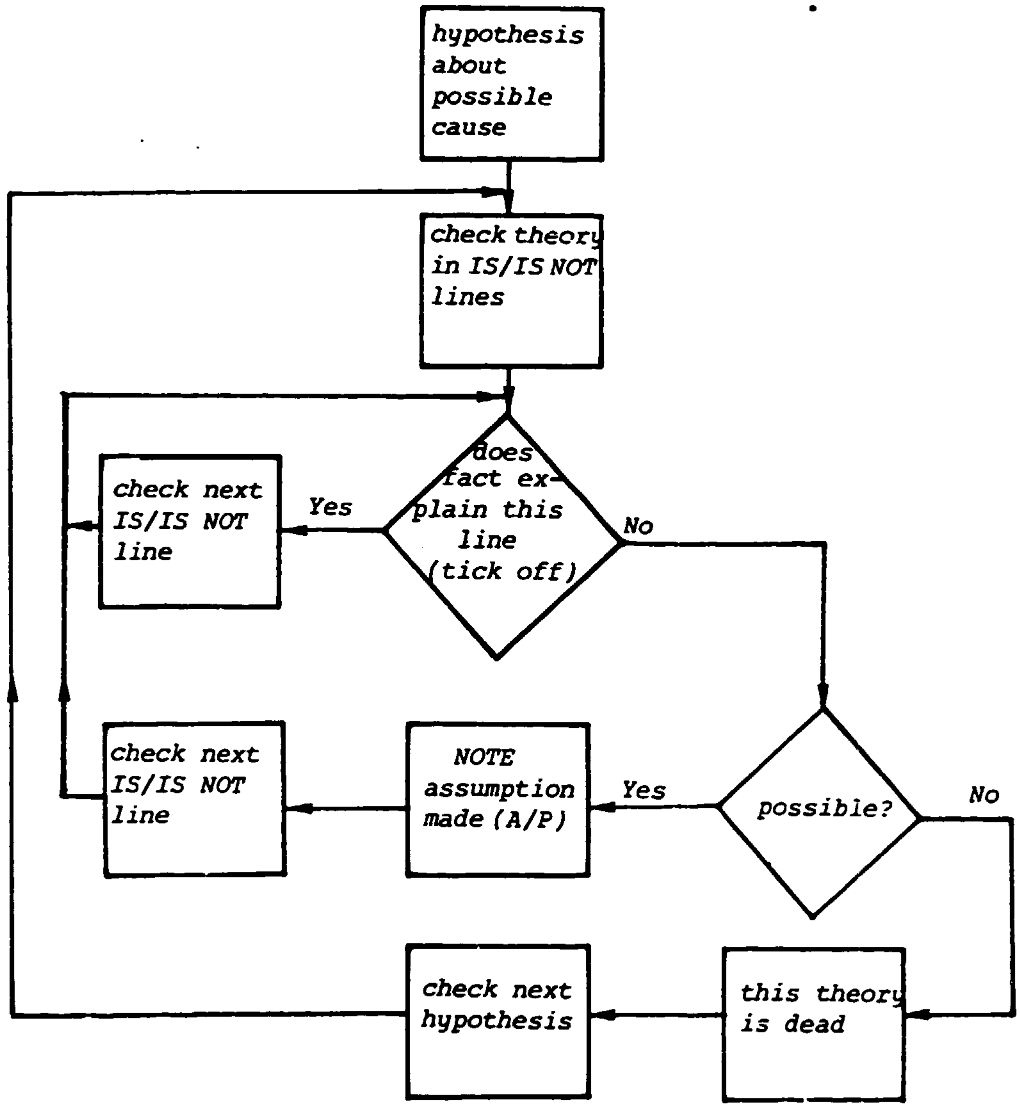
Discrepancy:
(definition of article and fault)

hypotheses:

		DESCRIPTION IS (problem area)	DESCRIPTION IS NOT (could also be the case)	DISTINCTIONS (what distinguishes the IS from the IS NOT?)	CHANGES (how have the distinctions changed?)	date	TESTS 1.	2.	3.	4.	5.	6.	7. PA
what	is the article concerned												
	is the fault			X	X	X							
where	on article												
	geographically observed												
	geographically occurred												
	geographically reported												
when	occurred			→									
	observed			→									
	reported			→									
how much	on article			X	X	X							
	quantity												
	%												
	tendency												

Table 2: INNOVATION PROBLEM ANALYSIS

CHECKING - SEQUENCE OF INNOVATION PROBLEM ANALYSIS (TEST)



At least the most likely cause may have to be "proved".

The methodology of innovation problem analysis is a short description

1. Definition

   What is the innovation object affected?

   What does the discrepancy or fault look like?

2. Description

   What
   Where
   When
   How much

   } IS / IS NOT

DECISION - ANALYSIS

DA 2
(2nd step)

MUST-objectives (conditions/ requirements)	Alternative: Information for must-objectives	Test	Alternative: Information for want-objectives	Test	Alternative: Information for must-objectives	Test
1.						
2.						
3.						
4.						
5.						

WANT-objectives	Weight	Information for want-objectives	W	P	Information for want-objectives	W	P	Information for want-objectives	W	P
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										
11.										
12.										
Total alternatives:										
Total risks:										

3. *Innovation Distinctions*
   By what distinctions does IS differ from IS NOT?

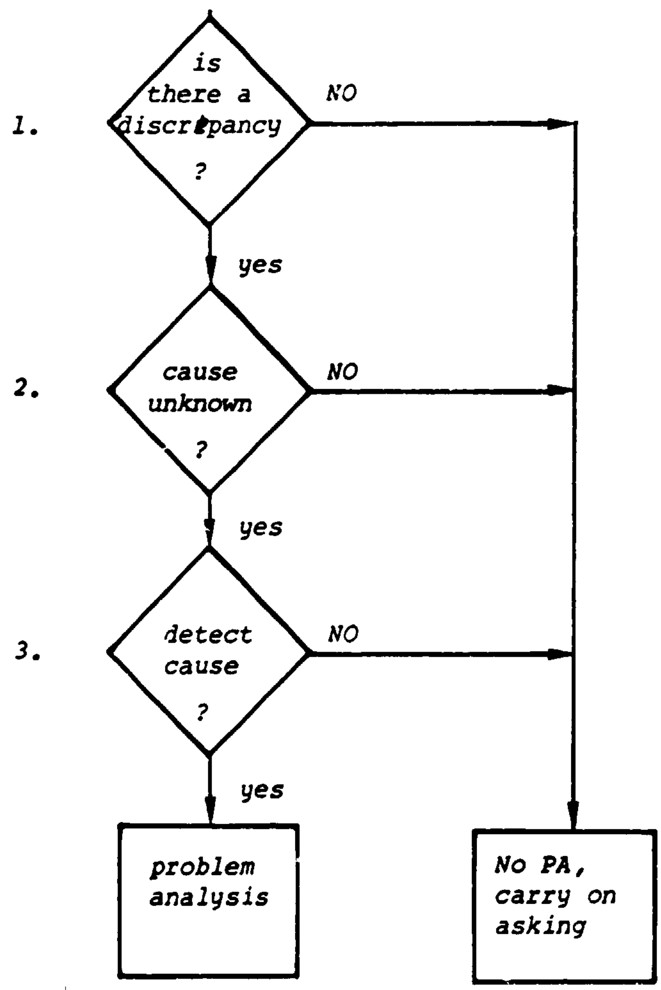
4. *Changes (innovative of not)*
   In what way have the distinctions changed?

5. *Hypotheses*
   How could this change possibly have caused the discrepancy?
   Perhaps in conjunction with distinctions?

6. *Test*
   If this is the cause, does it explain the IS and the IS NOT?
   (perhaps A/P)

7. *Proof*

Tree innovation situation analysis-questions which lead to the innovation problem analysis (PA)



SUMMARY

Deviations from achieved or planned standards, specifications, and what is supposed to happen, are inevitable in a work of innovation process subjected to continuous changes. In the event of trouble the search for a culprit is not important: what is important is the determination of the cause.

If innovation management assume that a discrepancy is caused by a change or a distinction, then these factors must be determined by appropriate questions. The basis to start from is the description of:

WHAT WHERE WHEN HOW MUCH	IS / IS NOT

Using the above description of a discrepancy innovation management contrast the sphere involved (IS) with the sphere not involved (IS NOT) and, working from the distinctions and changes we have drawn up, we establish hypotheses about possible causes.

These hypotheses are then tested for probability against the description of the facts.

This test anly establishes a degree of probability to make a possible cause into an actual cause we need proof.

The Description of the whole range if possible solutions for a given problem in the sequence:

- definition of a problem
- description of all thinkable properties to the problem
- Distinction between variants of properties described in a first morphological table
- Marking the most interesting elements in the morphological table
- Choice of possible solutions by connecting those elements

is also called as a "Morphological analysis".

PURPOSE of PLAN:	PERSON RESPONSIBLE:

A. Plan-step

progr. sect. No	TITLE				
CA	P	I	start	finish	responsible

B. Sub-plan for plan-step

progr. sect. No	sub-pr. No	TITLE			
CA	P	I	start	finish	responsible

C. Action

progr. sect. No	sub-pr. No	act-step No	TITLE		
CA	P	I	start	finish	responsible

A. program-sect.
B. sub-program for pr.sect
C. action step:

Program-section
sub-program section
action step:

Potential problems (possible deviations) — Text: Plan step No. / Sub-plan No. / Action No. / Poss. Dev. No. / Prob / Imp-ort-ance / priority (yes / no)	Conceivable (possible) causes	probability	Action: preventive action (against arising of cause)	Action: contingency-act. (when poss. cause still occurs)	Who triggers conting. action ? from	Who triggers conting. action ? off	Limiting period f. cont. action

In search of objectives/selection criteria in technology- and innovation assessment IM e.g. trys to:

State-of-Society Assumptions

- *Identify and describe major nontechnological factors influencing the application of the relevant technologies.*
- *Use both quantitative and qualitative social descriptors.*

Impact Identification

- *Ascertain social characteristics likely to be most influenced by the application of the assessed technology (e.g., population displacement, cultural disruption, lifestyle change, etc.).*
- *Identify both direct and higher-order impacts.*
- *Categorize impacts by the parties affected.*

Impact Assessment

- *Analyze environmental, sociocultural, and socioeconomic impacts of each technology option. Impact assessment procedures should be clear to the user of the assessment to allow for acceptance or rejection of conclusions drawn.*

Possible Options Identification

- *Lay out and analyze various trade-off/optimization options to obtain maximum advantages.*
- *Study and present probable consequences.*

Conclusions and communication of Results

- *Develop summary and conclusions.*
- *Integrate findings concerning each potentially applicable technology for final decision-making.*
- *Communicate the results to all interested parties.*

One of the early pioneers of technology assessment, Joseph Coates. recommended that each assessment should consist of three iterations of the basic methodology.
The first iteration scopes the study and familiarizes the pasticipants with issues, problems, and the technology itself.

The second iteration involves the largest amount of time and greatest effort as specific techniques are used to carry out the impact assessment.
The third iteration integrates and polishes the result.

A3 INNOVATION DECISION ANALYSIS, MAINLY PREPARING INNOVATION DECISIONS ALTERNATIVES

With the aid of this methodology an effective innovation management will be in a position to prepare and make (innovation) decisions by following a precise procedure when collecting information essential for decision-making.

The process of innovation decision -analysis makes the decision transparent. It shows why this decision was made and not another.

Innovation Objectives and selection-criteria may be determined step by step. Basic innovation policy objektives are laid down first, then general (innovation strategy) objectives and finally exact (innovation operation) objectives and -goals.

The following questions determine the objectives and selection-criteria:

- *what do we (innovation management want to achieve, where, when, to what extent?*
- *what do we want to avoid, where, when, to what extent?*
- *what means are available where, when, to what extent?*

The answers to these questions enable an effective innovation management to clearly and unequivocally define an innovation objective and a selection-criterion.

The categories of significance to determine objectives/selection-criteria with appropriate weighting are:

- *MANAGEMENT* *effectiveness, coordination, responsibility, cooperation etc.*

- . *PEOPLE* attutude, skills, qualification, etc.
- . *MATERIAL* availability, quality, quantity, compatibility, etc.
- . *MONEY* capital, cost, profit, investment, etc.
- . *PLANT* capacity, flexibility, location, size, etc.
- . *PRODUCTION* quality, productivity, quantity, etc.
- . *DISTRIBUTION* products, competitors, customers, needs, markets, etc.

Innovation objectives can be MUST- or WANT-objectives.
MUST-innovation objectives/selection-criteria are demands that must be met without fail (mandatory) if an innovation alternative is to stay in the selection. They must be measurable or have distinct limits. They are maximum or minimumrequirements; maximum requirements in regard to means, and minimum requirements as to results. MUST-objectives must be realistic.

All non-measurable or non-mandatory objectives/selection-criteria are WANT-innovation objectives/selection criteria.

WANT-objectives can be derived form MUST-objectives (MUST-WANT-objectives.) In practice, decisions are frequently made based on WANT-objectives only.

The WANT-objectives are weighted to set their relative values. To obtain the most accurate possible weighting, it is a good idea to use a preference-matrix.

Innovation-decision-analysis is applied to each basic innovation objective (perhaps including risk-assessment), i.e."sub-analysis", whose results go into the overall analysis.

Innovation alternatives are possible avenues to reach an innovation objective. Usualy alternatives emerge form experience or from the experience of others.

To compare and evaluate alternatives innovation management need information that describes the alternatives in the light of the *innovation WANT-objectives. After the innovation alternatives have been compiled, innovation management has to check which of these alternatives meet the innovation MUST-objectives and which do not. This way eliminates the unrealistic and inpracticable alternatives.*

<u>Innovation alternative RISK analysis and -assessment</u>

Every innovation alternative has its risks which impair effectiveness and efficiency. The effects of possible disadvantages must be analysed and assessed.

The most important aspects in any innovation risk analysis and -assessment involves three uncertainities:
(a) market
(b) cost of development and production, and
(c) technical difficulties.

This kind of analysis and assessment is basically an effort or attempt to take specific account to these uncertainties are in the form of subject probability distributions. The outputs of such assessments are probability distributions of quantities such as discounted cash flow return on investment, net present value, net income etc. Thus risk analysis provides the innovation management with answers to questions such as the following. What is the chance of loss an a innovation project and what is the likelihood of achieving a 15 percent return on investment? etc.

A related concept is "engineering risk", which is the degree of probability that a given design of a system, incorporating a number of components, will be effective. The design problem is to find the optimum trade-off between the use of proved components (thus inviting the risk of unreliability) etc.

Every innovation alternative has its risks which impair effectiveness and efficiency. IM must assess the effects of possible disadvantages wich they may have to put up with.

Sources for innovation assessment

- *limits of MUST-innovation-objectives*
- *alternative-evaluation (highly weighted WANTS poorly satisfied)*
- *forgotten objectives*
- *experience by others with the same or a similar alternative*
- *professional discrepancy or fault-finders (here we can put their talent to meaningful use) etc.*

What questions can be asked?

- *is the information at hand well founded?*
- *is the person supplying the information trustworthy?*
- *which adjacent spheres may be impaired?*
- *is there a risk in something NEW and UNFAMILIAR?*
- *what may be changed through outside influence?*
- *where may growth and development be hampered?*
- *where may they, in the circumstances, not adapt and what does this mean for the alternative?*
- *what outside influences will change? etc.*

After all disadvantages and their affects have been determined, probability and implications are calculated.

Final innovation decision

The best decision is the selection of that alternative which satisfies all MUST-objectives, which complies in the best possible way with the WANT-objectives, and has few adverse consequences.

The methodology of innovation

DECISION ANALYSIS

1. *Motive for decision - main innovation objectives (innovation policy)*

2. *Specifiy objectives*

   Clear <u>definition</u> of matter to be decided

   What <u>exactly</u> does the innovation management want to achieve?

   What <u>means</u> are available?

3. *Classify and weight objectives*

   Specify MUST-objectives (mandatory, clear limit, realistic?)

   Weight WANT-objectives (1 - 10)

4. *Develop and evaluate alternatives*

   Measure alternatives for compliance with MUST- and WANT-objectives. If a MUST-objective is not or only partially net, the alternative is eliminated.

   Make <u>provisional decision</u> according to compliance value (C)

5. *Determine adverse affects, risks (R)*

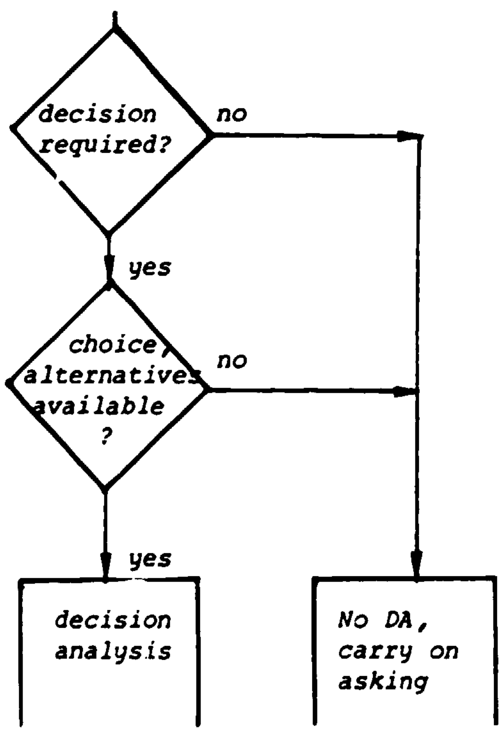
   Evaluate as to probability and importance (1 - 10)

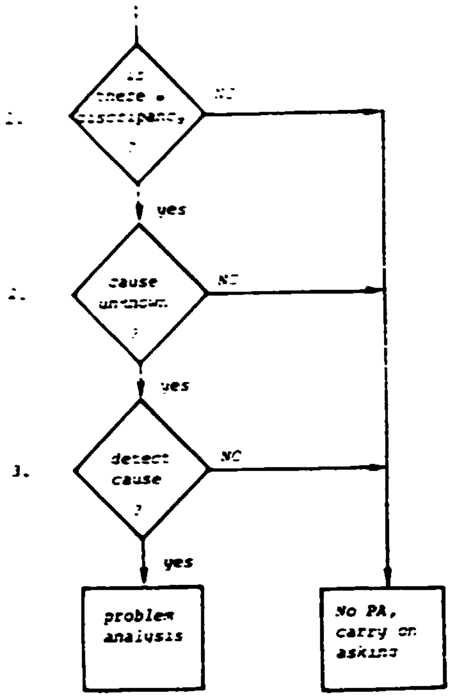
   Wherever possible, evaluate cost of prevention or reduction.

6. *Make final decision*

   To visualize, decision-triangle.

Two innovation situation analysis- questions which lead to the innovation decision analysis (DA)





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If assumed that a discrepancy is caused by a change or a distinction, then these factors must be determined by appropriate questions. The basic to start from is the description of:

WHAT
WHERE
WHEN
HOW MUCH
} IS / IS NOT

Innovation decision-analysis ansures systematic procurement and processing of information. It makes a decision transparent by showing what information led to the decision. It also makes the decision verifiable and storable.

The individual steps of the decision process are:

- establish objectives/selection-criteria, (basic,general, and exact objectives)
- classify into MUST- and WANT-objectives/selection-criteria
- specify and develop alternatives,

- testing of alternatives with regard to MUST-objectives/selection-criteria,
- evaluation of alternatives for WANT-objecitves/selection-criteria
- determine risk-factors and
- calculate probability and implications of these risk-factors,
- make final decision
- to visualize, decision triangle.

APPLICATION OF INNOVATION ASSESSMENT IN ENTERPRISES

1. A new product can be assessed for the extent to which it contributes to satisfying basic consumer needs (i.e., lifestyle, preference rather than acceptance); it can be evaluated with regard to its regulatory impacts; and it can be assessed with respect to its environmental soundness (e.g., a long-term pollution potential). These environmental, economic, social regulatory, and other factors vary from technology to technology, so that the impacts of a particular technology in one setting can differ greatly from those in another.

2. The important problems exposed by this concept invevitably involve conflicts of business interests, values, and goals. While there is no agreed quantitative method by which the costs and benefits of R & D may be precisely evaluated, the assigning of costs and benefits of R & D is fundamentally a managerial decision, and one of the results of a properly conducted Key-innovation assessment is clarification of the managerial choices connected with the implementation of specific technology-based innovations.

3. There is the need for a clear perspective of the anticipated goals of the organization itself. Without this view of the whole, there is a tendency to maximize the importance of special innovation projects often at the expense of other equally important activities elsewhere in the organization. Sensitivity to this cause and effect phenemenon is crucial and can be developed to a degree by cross training or, at least by familiarization of key personnel to the

other parts of the triad.

4. Throughout the process of developing a marketable product, the assessment process must be applied continually in R & D endeavors to eliminate or, at least, minimize costly and unnecessary excursions on the way to the objective. By recognizing the pitfalls and dead ends before they appear, many of them can be avoided altogether, and the appropriate alternatives can be selected with concomitant savings of time and resources. The result would be a highly desirable product in the most cost-effective manner which should lead to quick payback and high returns.

<u>Typical Assessment Questions of Innovation-Assessment</u>

- Are the appropriate available data used?
- Are analyses conducted according to accepted principles, and to sufficient depth?
- Is the study comprehensive in its breadth of coverage so as to incorporate all relevant considerations? Does it integrate the considerations to draw reasonable conclusions?
- Are inferences sound and supported?
- Do projections conform with actual developments? Over what time frame?
- Were the potential study users identified?
- Is it rentable and understandable to those interested in the subject in question?
- Is it credible to various potential users?
- Does it present a balanced point of view, or does it favor a particular viewpoint? In what ways does this affect conclusions drawn?
- Do the parties at interest use the study?
- Is the study influential on user attitudes and behavior? Does it affect decision-making and, if so, in what regard?

- Over what time period does the study retain its usefulness? Is it quickly outdated?
- Is the study worth cost in resources and in time?

B POTENTIAL INNOVATION PROBLEM ANALYSIS, E.G.: USED FOR KEY-TECHNOLOGY- AND INNOVATION ASSESSMENT

With the aid of this methodology, a effective innovation management will be able to safeguard the carrying - out of their (innovation) decision and -projects and ensure that they are completed with minimum risk.

Problems must not be allowed to arise in the first place. For this reason, this methodology is concerned with the events and problems of the future.

An innovation "safeguard-programm" must not be confused with "innovation planning".

Although both are concerned with the future, the differenc: is that an innovation "safeguard-programm" guarantees the success of an "innovation strategy and -plan" i.e. this methodology starts and becomes effective only after a innovation strategy and an innovation plan has been made.

A safeguaru-program comprises 4 phases

1 Specifying the parts of a innovation plan and determining the criterial portions of it

2 Possible devations (potential porblems)

3 Conceivable (possible) causes

4 Preventive measures

An innovation plan aetails all activities which are necessary for the carrying out of a decision. Deadlines are fixed for tne activities and activities are assigned to the persons responsible.

Examples of planning techniques ("program network" or "sequential program") are PERT (program evaluation and review technique), CPM (criteria path method) and "bar-chart".

The more aninnovation plan is broken down into components, the more details it contains , the easier it is to find the weak points and criteria areas.

Three program steps are offered in this methodology for breaking down an innovation plan:

1. Note plan steps

Im makes a list of the approximate steps in the innovation plan (program-sections). Start and completion of these steps are specified and persons are given responsibility.

2. Sub-program for plan steps

If one plan steps is too complex or if responsibility rests with several persons, innovation sub-plans must be formed. Specify start, completion and responsibility for each critical innovation sub-plan.

3. Action

The vario s innovative activities in the innovation plan steps or plan subsections are written down, and the start and completion times are fixed and responsibility is assigned.

The point of finding out the critical steps in a innovation plan is to locate any discrepancies in the most important elements of a plan.

How can IM determine these "critical plan-steps"?

IM asks, e.g.:

- is something new, unfamiliar or difficult being tried?

- are there tight deadlines?

- *must a sequence of events be accurately maintained?*
- *is work being done whicn is difficult to assign clearly?*
- *will there be grave disadvantages if something goes wrong?*
- *is responsibility shared by more than one person?*

If the answer to one of these questions is "yes", then it's a "critical area" (CA).

The critical "innovation plan areas" determined in this manner are then investigated for possible deviations.

Possible deviations are the Potential innovation problems.

Imagination, innovation management experience, logical thinking etc., will help to recognize the conceivable causes of a specific possible deviation.

It's useful to remember the 6 M's:

Man	*- makes a mistake; in the wrong job*
Machine	*- special model, one-off job*
Material	*- not available or wrong*
Method	*- not ordered, unsystematic*
Minute	*- delivery time - too late or too early*
Money	*- too expensive, too cheap*

All conceivable causes of a innovation deviation are written down, without, however, entering into a discussion.

These causes cannot occur all at once; to ensure sensible and economical application of safeguards, IM has to examine how probable it will be for the cause to happen.

The motto "Prevention is better than cure" is particulary valid for safeguard-programs. Preventive action prevents undesiderable events from happening or, at least, reduces their probability of materialising.

IM tries to find being possible in every case, IM has to accept certain risks. This also applies when preventive action is feasible but more expensive than the damage otherwise done.

CONTINGENCY-ACTION must be made available in case preventive action cannot be taken or is insufficient and a risk threatening the success of the project still exists.

Whilst preventive action is aimed at prevention conceivable causes from arising, CONTINGENCY-ACTION is employed when something went wrong in spite of all the prevention. It goes against the effects.

Reporting back:

It is a fact of the matter that contingency-action does not materialize on its own. It needs a trigger. IM has to specify a trigger, (a person or an arrangement) for each contingency-action. IM tells the trigger, when, in what circumstances it must report back, and with what message. IM has to specify the reporting channels.

On the other hand, there is contingency-action which is required for a certain period only which must, for reasons of cost, be stopped as soon as possible. Specify periods for testing of certain tasks, actions or plan-steps.

The methodology of POTENTIAL INNOVATION PROBLEM ANALYSIS

Innovation management has firstly to specify:

Purpose of innovation operations:

What must be done?

Where must it be done?

When must it be done?

How much shall individually be spent?

It has to specify activities (plan-step, sub-plan-step, action).

Then it has to:

1. *Recognise and determine critical areas in the plan*

   What are the critical areas or single activities of a plan which are particulary threatened by potential problems?

2. *Investigate critical areas for potential problems*

   What could go wrong?

   Where, mostly, did it go wrong?

   Evaluate potential porblems

   Probalility P
   H - M - L
   Importance I

3. *Conceivable causes*

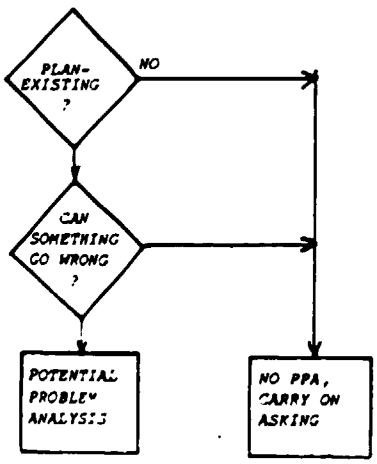
4. *Specify preventive action against causes.*

   Take contingency-action against effects.

5. *Establish alarm- and reporting system*

   How long should the preventive action remain in force?

Two innovation situation analysis - questions which lead to the POTENTIAL INNOVATION PROBLEM ANALYSIS (PPA)



SUMMARY

A safeguard-program will enable an effective innovation management to carry out innovation-projects without big surprises. Unpleasant surprises fail to appear, since you have investigated in depth those points of your program which could cause difficulties. Such difficulties must not be permited to arise.

Working from the innovation plan,

THE CRITICAL PLAN-STEPS

are determined first. Thereafter all critical parts of the plan are investigated for

POSSIBLE DEVIATIONS

for which

POSSIBLE (conceivable) CAUSES

are then established. To safeguard the carrying out of the plan

PREVENTIVE ACTION

is taken and

CONTINGENCY-ACTION

made available.

Since contingency-action must be triggered off,

TRIGGERS

must be provided.

TEST-PERIODS

are introduced to stop preventive action after a specifed period.

5.3. *Tolls for comparative research into the international experience in innovation policy formulation*

All industrial countries in west and east have a wide variety of policies for the stimulation of industrial innovation with many new measures adopted only in the past ten years. This is particularly true of specific direct aid to enterprises and fiscal incentives to enterprises. Remarkable is the extent to which countries, which normally shared an active interventionist role of government policies, have nonetheless recently adopted new policies and started new programs which undoubtedly enhance the role of public policy in relation to industrial innovation. This indicates how crucial the innovations became for the governmental policy and reflect the fact that the management of government more and more recognize the challenge from new resources situation which implied a lot of social problems on the national and global problems to the innovations acitivities. The old emphasis on "science" policy is increasingly related to technology and to industry and more and more countries adopted some measures of direct aid to industry in the field of innovations. They are aware that it is increasingly difficult to permit this strategic variable to be given over to uncontrolled market forces.

But the experience of management of innovations in several countries has also shown that simply to spend more money on R & D cannot in itself ensure success, and may indeed make failure more likely. A whole series of innovation studies have demonstrated that the most common causes of failure are not those associated with lack of finance for development, but those related to a poor understanding of the market, to a gap of information about successful innovation fields and failure to relate technical development to the needs of potential users and coming shortages in the resources situation. This indicates that government policy to stimulate industrial innovation have to have a well conceived combination of procurement policies and innovation subsidy policies. There are a wide variety of measures which government can adopt to improve the capability of firms to innovate. The government policy to try to stimulate one *or other of the innovation stages (invention, prototype and development, technical and commercial feasibility studies, production), or the transition from one to another, within an enterprise. There are:*

- *measures for aiding inventions*
  (whether classified as "specific" measures or as "climate" measures)
- *measures for directly financing innovation in an enterprise with the object of stimulating scientific and technological creativity by supporting projects planned by the enterprise*
- *"major programs"*
- *measures for preparing the most environments of innovations*
- *measures for ensuring the transfer of technology and knowledge from government laboratories to industry or between industries*
- *measures for making certain research capacity available to industry.*

It is not easy to isolate the effectiveness and efficiency of an innovation from the effectiveness and efficiency of the production unit which is introducing the new technology because of the interference between the new technology and the existing funds and skills.

What can be done to solve this problem is only a comparison between an innovation unit and a non-innovating unit. However, in this case it is also not possible to isolate two parts of the innovation effectiveness and efficiency,

- *the result of the interference with the old funds and skills and*
- *the result of the originally new elements.*

It is difficult enough to measure effectiveness and efficiency comparing innovation industries or countries of the same social type, but we run into far more problems if we try to measure efficiency of industries or countries in different social systems. The reason for this is the simple fact that the goals and underlying mechanisms of socio-economic actions are different and so is the reference system for measurement of efficiency.

If we look at the following Table one may find that there are no very important differences between market economies and planned economies. But we must make sure that similar indicators are used for different goals in both systems and that in planned economies they are calculated in a univied and partially obligatory way within the planning process connecting all levels from the plant to the national economy.

Table: Innovation Efficiency measures in market and planned economies

	Level of the firm	*National level*
Market economies	*Growth rates of sales and profits.* *Profit margins (as percent of sales)* *Earnings per share* *Return on book value* *Market share* *Productivity of labor and capital*	*Growth rates of national income* *Labor productivity* *Balance of current account* *Capital coefficient*
Planned economies	*Growth rate of Net product* *Labor productivity* *Capital coefficient (output per unit of funds)* *Return on funds* *Export profitability* *Cost factor* *Material intensity of production*	*Growth rate of national income* *Balance of current account* *Capital coefficient*

A common reference system is needed and this is plausible mainly on two levels:

1. *In fields of cooperative actions (trade, exchange of technologies, measures for solving world problems)* .
2. *At the level of intermediate goals (productivity, technical level and others).*

Some of the innovation indicators have the character of intermediate goals. In the following Table some innovation indicators for various stages and levels of the Innovation process are shown.

Table: Innovation effectiveness indicators for various stages and levels of the Innovation process

	National Economy	Industry	Organization	Process
Research	Number of discoveries Innovation expenditure Share of basic research Structure of research	Innovation expenditure	Number of innovation personnel Innovation expenditure	Degree of complexity
Development	Innovation expenditure Number of patents	Number of patents	Number of patents	Scientific, technological level Range of application Risk factor
Investment	Share of expansionary investment	Share of expansionary investments	Share of equipment in investments	Realization time
Production	Share of leading industries	Number and share of new products and processes	Number and share of new products and processes	Costs Economic benefits
Marketing	Diffusion figures of new technologies	Diffusion figures of new technologies	Share of exports	Market period Parameters of technical level and commercial success
Total	Productivity growth Number of basic innovatis	Productivity growth	Profitability Return on book value	Economic efficiency Speed of innovation Potential of an innovation

Determinants of innovative activities in industrial organizations

Factor analysis of innovations can be made for different purposes. There are many such sources in literature, for example the study by Sumner Myers and Donald G.Marquis (NSD 1969) REFERENCE, THE PROJECT SAPPHO (1973) REFERENCE. "The Flow of the Industrial Innovation Process" on the example of 218 cases by L.Uhlmann (1978) REFERENCE, and others.

The Myers/Marquis gave an overview of factors affecting innovations and their proportions in several branches. Project Sappho was an investigation comparing pairs of successful and unsuccessful innovations. The statistical results indicated that innovations which had achieved commercial success could be distinguished from those which were failures by their superior performance in five major areas:

- the strength of innovation management and characteristics of innovation managers
- understanding of user needs
- efficiency of development
- effectiveness of communications.

The Uhlmann study tried to identify the main types of innovations that can be distinguished by various combinations of factors.

All of these studies were for the specific purposes of planned economies.

Another study by H.D.Haustein used 32 firms in a planned economy. The questions were:

- How strong is the influence of inhibiting factors in the innovation process at the level of state-owned enterprises?
- How strong is the influence of a firm's own ideas and measures in overcoming bottlenecks and barriers in the innovation process?

Twenty-six variables were investigated:

1. insufficient supply from the supplier industry
2. technical difficulties

3. stress from other production tasks
4. insufficient supply of machines and means of rationalization
5. failure to abandon unsuccessful processes
6. inability to master a new process
7. shortage of research and development personnel
8. poor management, insufficient involvement by management
9. overly long coordination time with superior management
10. differences between managers and experts
11. poor preparation for production
12. delays in construction
13. failure to reach planning targets. High costs
14. insufficient technological and qualitative level

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