SCIENCE AS A GROWING SYSTEM

A CYBERNETIC ESSAY

A thesis submitted for the degree of Doctor of Philosophy

by

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ABSTRACT

Direct and significant narrations of the Human's past subsume so complex a multitude of problems (historical, anthropological, psychological, epistemological, etc) that, taking exception for some few areas, no formal, quantified and predictive theory of historical reconstitutions (understood in the classical, paradigmatic, sense of physical, quasi-physical or engineering disciplines) has, so far, been constructed.

A first step towards overcoming this situation is outlined in the essay.

The work is primarily (though not exclusively) devoted to historical/ scientific reconstitutions; special emphasis is laid upon the so called "domain of Natural Science". Throughout it a rather unconventional way of looking upon human's past achievements in that area is proposed, discussed and progressively developed: not as a mere repository of inventions and discoveries (as the usual historical approaches do), not as a simple reproduction of the possible cognitive processes which their authors used (as the logistic reconstitutions seek) but rather as a cybernetic adaptative learning process (in the sense of G. PASK and H. VON FOESTER).

The use of this approach allows, in particular

- to demonstrate that Science may be globally regarded as a (time-"space") growing system

- to give expression to this growth in terms of an evolutionary model binding the approaches of PIAGET, WALLON, FREUD, HARTMANN etc (in which epistemological, contextual (social), psychological (conscious, unconscious) affective and cognitive paradigms are involved)

- to describe this evolution in formal and quantifiable terms (using for it fuzzy "conditioned" automata theories)

- to reproduce it in a special purpose cybernetic device (PASK's THOUGHTSTICKER system)

- to perform historical experimentation (varying the value of the parameters, relationships and constraints by means of which the system is described)

The essay ends with a pratical application: the construction of an entailment-mesh of the First (or Greek) Image of Nature.

INDEX

ANNEXES

PART TWO : THE FORMAL APPROACH

S/0- PRELIMINARIES: AN OVERVIEW ON THE MAIN OBJECTIVES, PROBLEMS AND THEIR POSSIBLE SOLVING PROCEDURES

LIST OF FIGURES

LIST OF TABLES

TABLE ONE presented in addition to the main thesis corresponds to p.143

An application of the theory exposed called "The First Image of Nature" (corresponding to the whole entailment-structure underlying this image) is also part of the main thesis.

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- my parents, for the help they provided to us in critical moments

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PREFACE

The work on which the content of this essay is centered took place over more than a decade. It started in the middle of the seventies when, thanks to my conversations with Prof. GORDON PASK, a lot of still disconnected studies on Cybernetics, General Systems Theory, Epistemology, History of Science, etc., I had already performed were articulated and inserted into a more extended conceptual frame. These studies and GORDON's deep awareness of the problems it involves led him to propose the using of his THOUGHTSTICKER as a means to demonstrate that science (Physics, in special) could be regarded as a growing system.

Since then this topic became the main objective of a research project which, progressively, led me to the examination of some of the most profound (and sometimes rather cumbersome) mechanisms of past and present human minds.

Retrospectively examined the research obeyed so far three main stages. STAGE ONE corresponded to what may (roughly) be named the stage of direct narrations. This meant that my main concerns during that period were essentially devoted to the construction of an immense entailment-mesh by means of which the brute material of the whole European Natural Science could be implemented in GORDON's system. Classical Mechanics since the XVlllth century onwards, its greek and medieval foundations, mechanics of deformable bodies, MAXWELL's (original) electromagnectic theory, their contemporary

transformations etc, were some of the subjects there examined.

The reading of KUHN's (classic) "The Structure of Scientific Revolutions" determined the begining of STAGE TWO, now directed to significant narrations. To it correspond a new way of looking upon the already systematized data not in absolute terms but rather as the outermost, (or externalized) expression of some time-variable mental structures (cognitive and affective) which in all epochs are/were consciously or unconsciously shared by all members of some society.

A lot of questions arose then in my mind. From them all two types were particularly relevant: the interactive mechanism individual-community (" How can some individual contribute to a group change?", " What may happen to the history so far known if these individuals or their group constraints had been different?", etc) and the characteristics of such structures ("How did reason evolute?", "Why religious beliefs, myths, etc., were so influential in the construction and public acceptance of the earlier images of Nature?", "How can these beliefs be related to cognitive explanations?", etc.).

The searching for possible answers to these (still present) interrogations led me to investigate the psychological theories of PIAGET, WALLON, FREUD, and followers as well as the historical and epistemological works of BAUDREL, GOURHANT, KOYRE, MEYERSON, FEYERABEND and POPPER (among others). One overall conclusion might then be extrated from all these readings: that the present day psychological/epistemological panorama is far from being unified.

The reasons underlying this situation are manifold and this is not the occasion to discuss them. Two, however, deserve special attention: the intrinsic dificulties of studying the subject matter under examination, the human mind (either synchronously and/or diachronously examined); and the features of its approaching theories. So far these theories have essentially been concerned with verbal (written) descriptions of mental phenomena; and since some of them cannot be experimentally tested (particularly those concerning past evolutions) then they easily bogg down into interminable (and often sterile) mutual criticisms, contradictions and verbal/written disputes. Above all (and with rare exceptions) they tend to look upon past reconstitutions from particular (and sometimes diverging) viewpoints. The consequence is a situation which, in my opinion, presents deep analogies with the state of natural science in the XVIth and XVIIth centuries before the revolutionary changes introduced by the quantitative approaches of GALILEO, KEPLER and NEWTON.

The progressive awareness of this situation was crucial for the emergence of the third stage (STAGE THREE) of this research: that one in which my attention was devoted to the searching for and construction of a (possible) quantifiable model of scientific evolution in which either the already systematized data or the mental structures previously referred to could not only be suitable inserted but also experimentally tested in PASK's (or any other) computerized system.

Here (again) the problem was rather cumbersome. As a matter of fact neither General System Theory nor Probability Theory may be regarded as appropriate tools to treat historical information. The first (which apparently provides an unified, algebraic, language embracing an extended class of systems) due to its pragmatic and semantic insufficiencies. The second because its axiomatic foundations impose severe restrictions to situations in which true "novelties" (new concepts and theories, etc.) are involved.

Fuzzy Subsets Theory is a recent branch of mathematics in which these questions are able of offer a soluction. Due to its youth its tenets are still being developed; but the results already reached show that either the problem of novelties (new "possibilities"), the question of semantic significances or the use of qualitative expressions (such as "more or less", "reinforcement", "consensus", etc.) frequently used in historians' descriptions admit, undoubtedly a quantified translation. STAGE TREE was then devoted to the aplication of fuzzy mathematics to the results already obtained. With it - and apart from the problems which still have to be solved (the reader must bear in mind that this essay is only a first step towards overcoming the gap between physical-historical disciplines) - not only that endeavoured model was constructed but also a unified formal structure was ascribed to the whole work.

These were, in summary, the main steps on which the erection of this approach was based.

Some of its aspects are in my oppinion rather unconventional. I have in mind, firstly, the way of looking upon historians' reconstitution work in terms of a conversation between two symbolic individuals (or, if you prefer, between two parts of the same mind): a present one (standing for present-day historians) and an "old" one (symbolizing those individuals named THALES, PLATO, NEWTON, etc. who have significantly contributed to mankind's scientific transformation).

Those individuals are (supposed to be) engaged in an imaginary dialogue about Nature; and as far as this dialogue continues the "old one" is progressively acquiring more and more knowledge of it, the whole process running therefore as if it were a true evolutionary system in the sense of VON FOESTER and GORDON PASK.

The premises on which this viewpoint is based obey, obviously the tenets of GORDON's Conversation Theory. This means that such a dialogue can, in fact, be reproduced in his computerized system (CASTE, THOUGHTSTICKER); thus, satisfying part (at least) of the aforementioned "experimental" requirement. This is not all however. As a matter of fact one of the main assumptions of that theory underlies a true philosophical relativistic atitude. This not only agrees with historians's task (the past is always regarded from present eyes) but also avoids the (usual) logistic mistake in which past events are judged in terms of logical veracity and not of historical agreement.

Furthermore: since (past) reproductions are made taking the present day image of Nature as reference then it is possible to regard those descriptions as fuzzy subsets of such a reference - with everything this vision implies in terms of that algebraic theory.

"Relativism" and "historical agreement" underly precisely the second, non-conventional feature of the approach: the explicit use of psychoanalytical assumptions as a means to describe not only socializing processes (all scientists are/were always inserted into societies) but also the influence of affective processes upon the constitution of their images of Nature, the earlier ones in particular.

A great deal of work was then spent in the searching for a global "mechanism" in which contexts, individuals and images of the Nature interact with each other. Two immense entailment-structures one describing the evolution of an imaginary group (from a horde to the stage of an organized society), the other dealing with the real data involved in the construction of the Greek Image) represent in this sense the most concrete results of this research.

These structures have obviously a formal correspondence - they are described in terms of "states" and "transitions" obeying a set of fuzzy equations (a personal modification of ZADEH's theory of human operators). And though their values are not yet estimated (which is a work to be performed in the future) their (potentially developable) relations in GORDON's systems opens new and exciting perspectives to history studies: the possibility of performing historical experimentation understood not only in the sense of

testing past data but also (and above all) of constructing new (possible) histories; consequently new possible/impossible presents and futures.

Whatever these future trends (or present criticisms to the approach) may be I do hope that the reading of this essay contributes significantly to the enrichment of the reader's insight. If this happens then, indeed, we shall both be not simple "observers" but, rather, real participants in the great adventure and challenge which Science is.

FOREWORDS

This essay is mainly devoted to historians, scientific historians in particular. It outlines a rather unconventional way of looking upon human's past achievements in the domain of Natural Science, not as mere repository of inventions and discoveries but rather as a (cybernetic) learning process, "learning" being here understood according to the evolutionary meaning of PASK and VON FOESTER. It is expected that its full implementation (requiring the accomplishment of a true research project which this doctoral dissertation outlines and partially details) converts historical problems into systemic questions capable of description, formalization, quantification and even experimentation through using a special purpose computer (PASK's THOUGHTSTICKER System).

As such, its scope is rather diversified. It involves in fact such distinct areas as, for example, psychology (cognitive and affective), epistemology (dealing either with the genetic and historical/critical trends or with the logistic approaches), historical data as well as some of the most typical cybernetic approaches (for example, deterministic and fuzzy automata theories).

In order to bring to light a coherent and unified picture of all such matters the essay is divided into three main parts(ONE, TWO, THREE):

-PART ONE (named "THE ARGUMENT") contains a concise (we should say "axiomatic") description either of the fundamental question whose solution the essay aims for (the so-called historical/scientific reconstitution problem) or of the (possible) procedures by means of which that solution may be brought to light.

The origins of this question, its importance in the contemporary scientific panorama and the demonstration of its associated solving-procedures [leading ultimately to the construction of an evolutionary model into which (part) of mankind's cultural, social,economic,religious,scientific,etc. tranformations may be suitably inserted and reproduced (through PASK's system)] is left for

-PART TWO (named "THE FORMAL APPROACH").

This part of the essay comprises seven sections (S/0 - S/6) throughout which the question of historical reconstitution is approached according to an unusual "cyclical" strategy.The word cyclical means here that (due to its complexity) the solution of that fundamental problem is searched using successive approximative approaches (similar in some way to a dialogue between two individuals) in which conclusions inferred from some set of initial premises are next used to deepen the scope of their starting standpoints (leading, consequently, to the introduction of new matters);these, will lead,in turn,to deeper conclusions which, next, willdeepenagain the set of initial tenets,etc.

It will be shown in this sense that the conversion of historical problems into systemic (cybernetic) questions deals,ultimately, with three main elements and three fundamental interactions.

As regards these elements they are related to:

i) past observers/participants (briefly OP_k, k being a time variable index) representatives of those men called PLATO, ARISTOTLE, NEWTON etc who, in a way or in another, have significantly contributed to mankind's scientific transformation;

ii) present historians (OP_R) aiming for direct and significant narrations of the information proceeding from their historical past. This information is supposed to be condensed in messages z_k, emmited by past OP_k and expressing in some way their own images of Nature

iii) OP_k's and OP_R's total environment, respectively E_k and E_R

As regards the interactions between these elements, the most important (for us) deal with

iv) the communication(through z_k) between OP_k and OP_R $(OP_k \longrightarrow OP_R)$

v) $OP_k \longleftrightarrow E_k$

vi) $(OP_k \longleftrightarrow E_k) \longleftrightarrow OP_R$

"Elements" and their "interactions" will be supposed to specify a time-variable system S which OP_R "observes" and in which he simultaneously participates; its reproduction is what precisely defines OP_R's main goal. The particular analysis of these elements and the construction of a global and coherent model of S, is what precisely defines the main objective of PART TWO.

It is in order to accomplish it that PART TWO is divided into the seven aforementioned sections.After S/0 (which works as a general introduction to the whole essay) each one of the remaining sections is specifically devoted to a detailed examination of the topics i) to vi) previously referred to; in this sense:

S/1 - deals with items i) and ii), i.e. with the main features by means of which observers/participants may be described

S/2 - with "environments" in general (item iii)

S/3 - with the interaction OP_k E_k(item v) examined from the point of view of OP_k's mental activity (commonsensically called "thinking") and aiming for the simple presentation of the psychological approaches of WALLON, PIAGET and FREUD.

S/4 - is concerned with item iv) and seeks essentially z_k's systematization.A "quantified" and "geometrical" interpretation of these messages in terms of Fuzzy Subsets Theory is also outlined in this section.

S/5 - is,in summary, nothing but an extension either of S/3 or of the fuzzy procedures of S/4 to the specification of past E_k as well as of the dynamical interaction $OP_k \longleftrightarrow E_k$

S/6 - examines item vi) based upon the results brought to light in S/4 and S/5. A possible model of S involving the relative "weight" of OP_k's affective and cognitive structures, of their time-variable influence upon the z_k 's time-variancy etc. In brief, a conjectural and evolutionary model of S (regarded as a learning system) and embodying all the preceeding considerations will be there presented.

Finally in

-PART THREE (named "APPLICATIONS") the tenets of this model are concretely applied to the construction of an entailment-mesh (in PASK's sense) of the first (or Greek) image of Nature.

PART THREE comprises two sections (S/7 and S/8). The first simply introduces significant historical data related to the Greek evolution between 800 B.C. and 200 B.C. (though, in pure scientific terms, its features have remained pratically unchanged until the XVth century). The second presents its systematization

in terms of "states of knowledge" and "transitions" between them (these last reproducing in some way OP_k's thought-processes) as outlined in S/6. PART THREE ends with the presentation of an immense mesh, already able to be transposed to PASK's system. Further extensions to the second or Renaissantist image of Nature are also already prepared.

Though dealing with an enormous amount of information, the subject matters involved in these three parts are simple fractions of a whole, the aforementioned research project, whose development and full implementation is consequently expected to be accomplished in future works. Two final comments, concerning the way according to which the present essay must be globally regarded, are then necessary.

Firstly, the broad public to whom it is addressed (historians, psycholologists, epistemologists, cyberneticians, etc.) has required the inclusion of materials which, more than familiar to some, will surely be considered insufficient by others. In these conditions they will, I hope, remember that being neither a professional historian nor a professional psychologist nor a professional programmer, the essay must be simply regarded as a first step towards overcoming (for example)the traditional gap between history and physical sciences. Secondly, and in consequence, that further developments of its underlying conceptions will necessarily require the future cooperation of experts in so distinct areas as history of

science, of religion, of arts,etc. as well as psychoanalysis, cognitive psychology, epistemology, mathematics (involving at least fuzzy subsets and control theories), computer programmers, etc.; hence the name "essay" assigned to this thesis. It is this cooperation which I precisely hope. And in order to accomplish this expectation nothing is better than the proper interdisciplinarity that the cybernetic perspective has introduced to the present day scientific panorama.

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A GUIDE TO THE READER

From the three parts into which the whole essay is divided ("The Argument", "The Formal Approach", Applications") only the first corresponds to the main thesis document. The remainder (which provide deep supports and answers to the hypotheses proposed in the thesis) must therefore be regarded as Annexes to it.

The structure of the thesis document comprises three main sections (I,II,III) which are respectively named "The Problem","The Model","The Future". Generally speaking Section I introduces and states the problem whose solution is the ultimate objective of the essay; Section II presents the approach used to solve it; Section III states (briefly) the importance of the essay in the present-day historical/epistemological panorama as well as the future work which is still needed to be performed in this area.

Each one of these sections comprises in turn several subsections.

Section II in particular (in which a model of scientific evolution is proposed) has three main principal subsections (II/1, II/2, II/3):

Subsection II/1 presents the overall procedure used to overcome the main problem stated in Section I; Subsection II/2 deals with the two overall modelistic hypotheses which such a procedure involves: one essentiallypsychological (including subsubsections II/2.1, II/2.2, II/2.3) the other formal (subsubsections II/2.4.1, 2.4.2, 2.4.3) in which such psycological analyses are mathematically expressed by means of fuzzy approaches.

The results so obtained are summarily discussed in subsection II/3.

Due to the interdisciplinarity and complexity of the questions involved pratically all the cybernetic, psychological, epistemological, historical and mathematical supports of the main thesis'document were purposively excluded from it. This additional information may be found in the Annexes (Part Two and Three).

Their structure is more carefully analysed in the Forewords; summarily, however, it can be seen that cybernetic procedures are discussed in S/0; Psychology and Epistemology are treated in S/3 and S/6; fuzzy mathematics and its applications to the historical/scientific reconstituition problem deal with S/4 and S/5. And as regards historical data (those concerning the entailment structure of the Greek Image of Nature) they are exhaustively discussed in S/7 and S/8.

A list of symbols and abbreviations used in the approach is presented in a Glossary. With it we hope to render easier the comprehension of the symbology used.

PART ONE:

THE ARGUMENT

"What thou hast inherited from thy fathers, acquire it to make it thine"

(GOETHE, "Faust" Part I)

0- THE GENERAL OBJECTIVE

The aim of this essay is to arouse conviction that cybernetic procedures may overcome the gap between two areas of knowledge which, so far, have been regarded as extraneous: those concerning historical and physical (or quasi-physical) sciences. In this Argument the tenets of such procedures are stated, as they were, dogmatically - in the most concise form and (in so far as possible) in the most unequivocal terms. The number and complexity of the questions involved as well as the peculiar and, shall we say, unconventional characteristics of the essay justify, however, that especial emphasis is laid upon the reasoning used to bind them.

I- THE PROBLEM

I/1- Introduction

The disciplines which seek an intelligent and coherent reconstitution of human's past, have always played a rather peculiar role in the general context of sciences. This has been due to two fundamental types of reasons

- Firstly, the differences (still) existing between historical information in itself and information concerning physical or quasi-physical sciences

- secondly,historians' position before the content of such information

I/1.1- Differences existing between the objectives and methodologies of historical and physical disciplines are manifold; the most significant of them all are the following:

i) Firstly, physical sciences pay attention to processes of <u>events</u> (in the sense that Nature may be regarded as a permanent phenomenon) which, in principle (due to the postulated demarcation "object"-its"environment") are supposed to be <u>reproducible</u> again and again (experimentation). Historical disciplines (in general) are, however, concerned with <u>actions</u> executed by human agents; these actions involve, consequently, not only an <u>external</u> <u>part</u> (their simple "description") but also an <u>internal</u> (and usually <u>private</u>) source, intimately related to the (affective and cognitive) <u>thought-processes</u> of their executing agents. Furthermore: since these actions were executed in the past and depend (in principle) of non-reproducible time-variable "environments" then they are (also in principle) incapable of <u>repetition</u> and <u>experimentation</u> (in the sense of present day physical disciplines.

ii) Secondly, physical disciplines search for <u>laws</u> (the so-called "natural laws") which, once brought about and expressed in terms of a synthetic and formal language, are referred to logically <u>open</u> <u>classes</u>. Historical disciplines are, on the contrary, mainly concerned with <u>judgements</u>, formulated (in a natural language) about logically <u>closed</u> <u>classes</u>. In other words, they usually deal

not with men but, rather, with the men who have executed this or that concrete action.

iii) Physical or quasi-physical disciplines involve the use of standard frames of reference (PASK's classical paradigm) usually based on the use of numerical magnitudes (or formal languages at least) which [together with i) ii) above] ascribe an objective and universal character to such laws. This point of view is (or has been) opposite to that one belonging to historical studies in which subjectivity,singularity and non-formal characteristics, seems to be unavoidable.

iv) Finally, physical disciplines seek a description of natural events which (in consequence of the aforementioned items) may be based on the using of differential or integro-differential equations (or, failling this, on the use of automata theoretical approaches, deterministic or probabilistic). These descriptions allow, therefore predictions (thus, satisfying one of the most primary and primitive wishes of human beings since their most remote past) as well as an enormous reduction of the whole amount of information which Nature is permanently providing to us. This because an already confirmed natural law may be interpreted as expressing a doubly condensed statement:

a) the law is (usually) expressed in a synthetic language and

b) (once it is confirmed) it is implicitly extended to all the members of the open class to which it refers.

None of this last conditions is, obviously, satisfied by historical information.

Hence

I/1.2- The special problems which historians have to face and solve when they seek some intelligent reconstitution of past actions. Two of these problems are (or have been) particularly relevant

i) one (which deals with the so-called direct narrations) involve all the quantitative difficulties related either to the treatment of an enormous amount of informations already accumulated since the beginnings of mankind or, paradoxically, to the immense hiatus which that data presents.

ii) the other (which is now concerned with the so-called significant narrations) brings to light the distinction between the "external" and "internal" parts of historical actions. The reconstitution of such "insides" implies the reproduction of past thought-processes, of hidden intentions, of alien semantic significances which no one can positively assert to be similar to those presently adopted.

I/1.3- In order to overcome both of these problems, two (main) solving trends have (until quite recently) been widely employed in history

- the first has traditionally consisted in the specification of sucessively narrower historical "windows" (as a way of avoiding the excess/lack of information) which restrict either the period of time or the "area" to which historians pay their attention. In the limit this tendency leads, obviously, to the analysis of the individual action, to the biography etc. briefly, to more and more <u>specialized</u> analyses

- the second has prevailed the role played by <u>logistics</u> in past reconstitutions (as a way of avoiding, for example, the aforementioned subjectivity).

Both of these procedures have, however, been submitted to deep transformations in the last three or four decades. The reasons for these changes have proceeded, partially from

- the specialization referred to a moment ago

- the need which historians have felt in order to overcome the fragmentation of their general domain

- the introduction of quantitative techniques in some historical areas (Economy and Demography for example); which consequently led to

- the "discovery" of new and (till recently) unsuspected historical happenings.

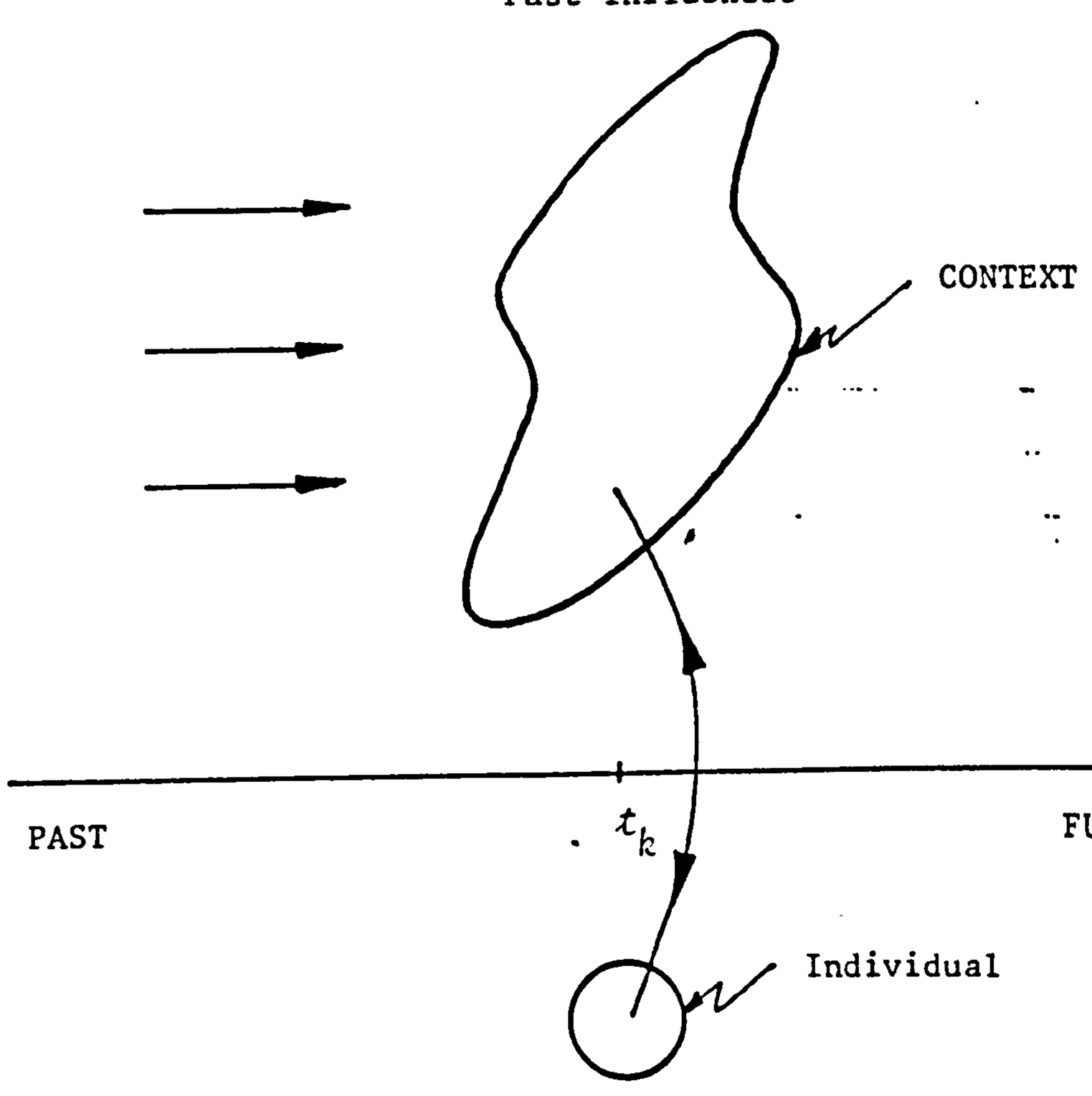
Either individually or collectively regarded these trends have contributed to the emergence of a <u>new way of looking upon mankind's past</u> in which the role played either by the individual event or by the logistic procedures is no longer the same as before. Particularly

important for the reinforcement of such a new vision was the discovery of "short" and "long" time trends and movements (involving decades or even centuries) which explicitly or implicitly (say, consciously or unconsciously) have influenced (and still influence) the individual action. Illustrative examples of these conjunctural and long-time processes are manifold. Some of them are exposed in S/0 (PART TWO); for instance ERNST LABROUSSE's work in Economy, LUCIEN FEBVRE in Sociology and Literature, ALPHONSE DUPRONT in history in general, PIERRE FRANCASTEL and PETTER FULLER in Arts, G. DURAND in past and present mythological influences (to whom K. ABRAHAM, C. JUNG, S. FREUD etc. are related), COLLINGWOOD and T. S. KUHN (among others) in history of Science, J. PIAGET in the so-called genetic epistemology, etc. Other, more concretely related to the objectives of this essay are circumstantially analysed in S/3, S/6, S/7, S/8.

I/2- The discovery of these conjunctural and secular trends, their influence upon individuals (influencing and being simultaneous influenced by them), the conscious and/or unconscious character which these influences take or have taken etc. - all these features have clearly contributed to the reinforcement of the aforementioned distinction between historical and physical (or quasi-physical) studies. On the other hand, however - and this is the crucial point - they also brought to light a rather peculiar vision on mankind's (overall) transformations in which the role played by this or that individual (or group of individuals acting together as a single one) is no longer <u>singly</u> regarded but, rather, in relation to

- the particular synchronous or historically "instantaneous" context into which such an individual is inserted

- the short and long-time trends to the influence of which that context, its individuals and their mutual relationships are, in turn, being submitted (Fig.1)

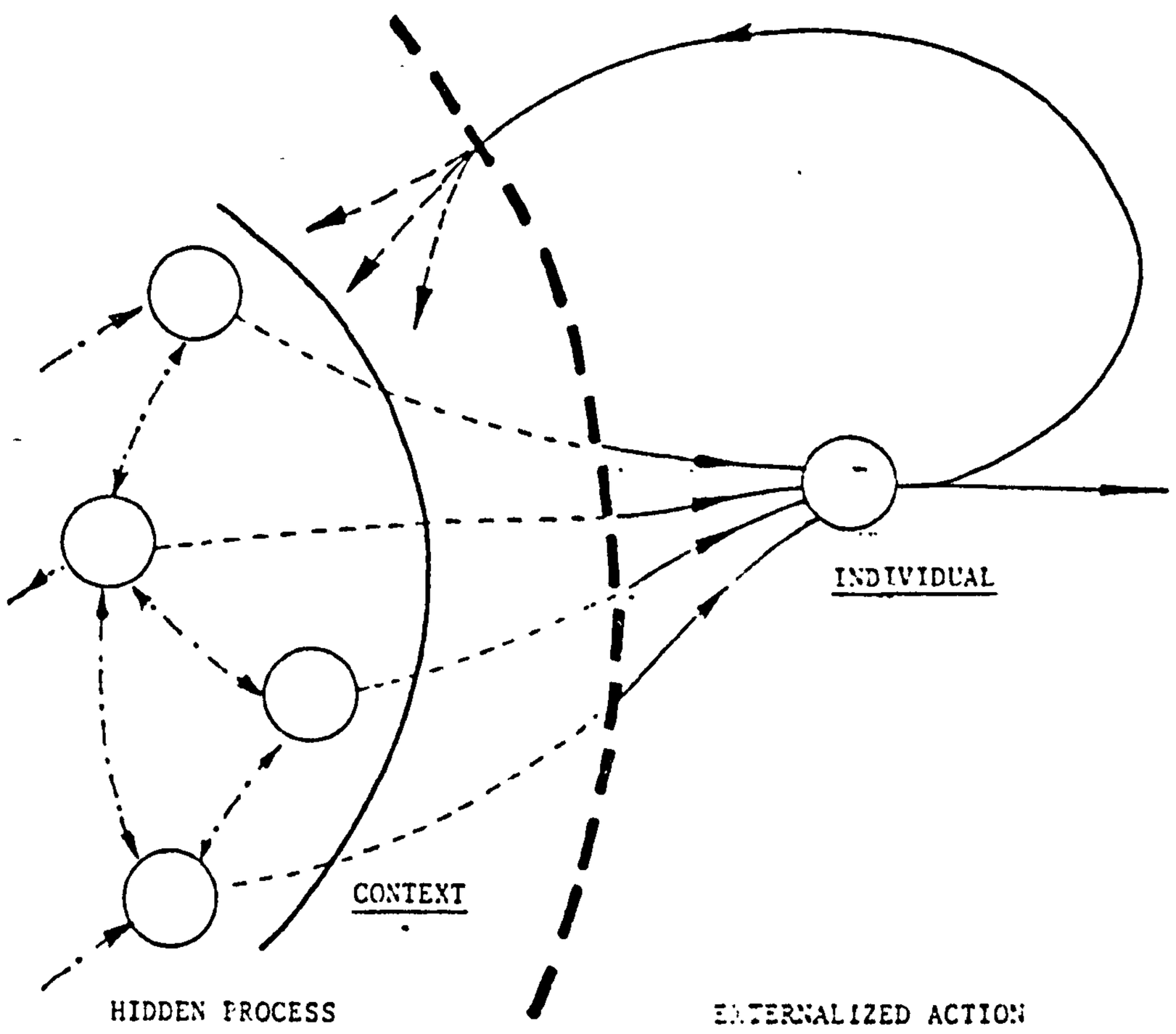


Interaction individual-context

Fig. 1

With the inclusion of these perspectives the personal action (that one upon which traditional historians had foccussed their attention) became simply a part - what we should say to be the outermost superficial or externalized fraction - of a complex and (often) hidden dynamical and interactive process - something which (considering the temporary indefinitiveness of the idea) may be regarded as a reciprocally crossed web of different "influences", "trends",

"movements", etc. [each one of them obeying a particular time-variation (instantaneous, conjuntural, secular)] which sometimes opposes one another, some other times reinforce one another etc. (Fig.2:



Hidden influences in the interaction individual-context
Fig. 2

Due to the extreme complexity of these interactions (as well as to the difficulties previously referred to) the overall picture which present-day historians draw from mankind's past is far from being clarified. There are however, restrict historical areas where (if some simplificative hypothesis are postulated) their framing lines are undoubtedly capable of a more precise deliniation.

One of such areas involves situations in which

i) individual actions are susceptible of being detached from their contexts (i.e. present-day historians are able to demarcate - sometimes in a rather artificial manner - the concrete actions which X, Y or Z past individuals accomplished in the past).

ii) these actions may be regarded as <u>intentional, purposive</u> or directed towards the accomplishment of (more or less) well-defined <u>goals</u>.

iii) the procedures which such individuals used in order to achieve them are (essentially) <u>mental</u> and (in principle) capable of being <u>reproduced</u> or (at least) <u>understood</u> by present day historians.

iv) <u>really</u> achieved goals (intentions) are simply part of a more general (time-invariant) process (usually hidden) which, briefly, may be described in terms of a <u>comparison</u> between two main trends

- one related to a set of (potentially possible) "proposed", "endeavoured" or "desired" (individual) <u>disturbing</u> alterations

- another associated with the <u>constraining</u> (contextual) <u>influences</u> to which, this or that individual is always being submitted, tending in turn, to <u>perpetuate</u> paradigms, internalized or externalized "standards", "frames of mind", etc. inherited from the past.

being from the "result" of this comparison that some proposed action is materialized or not.

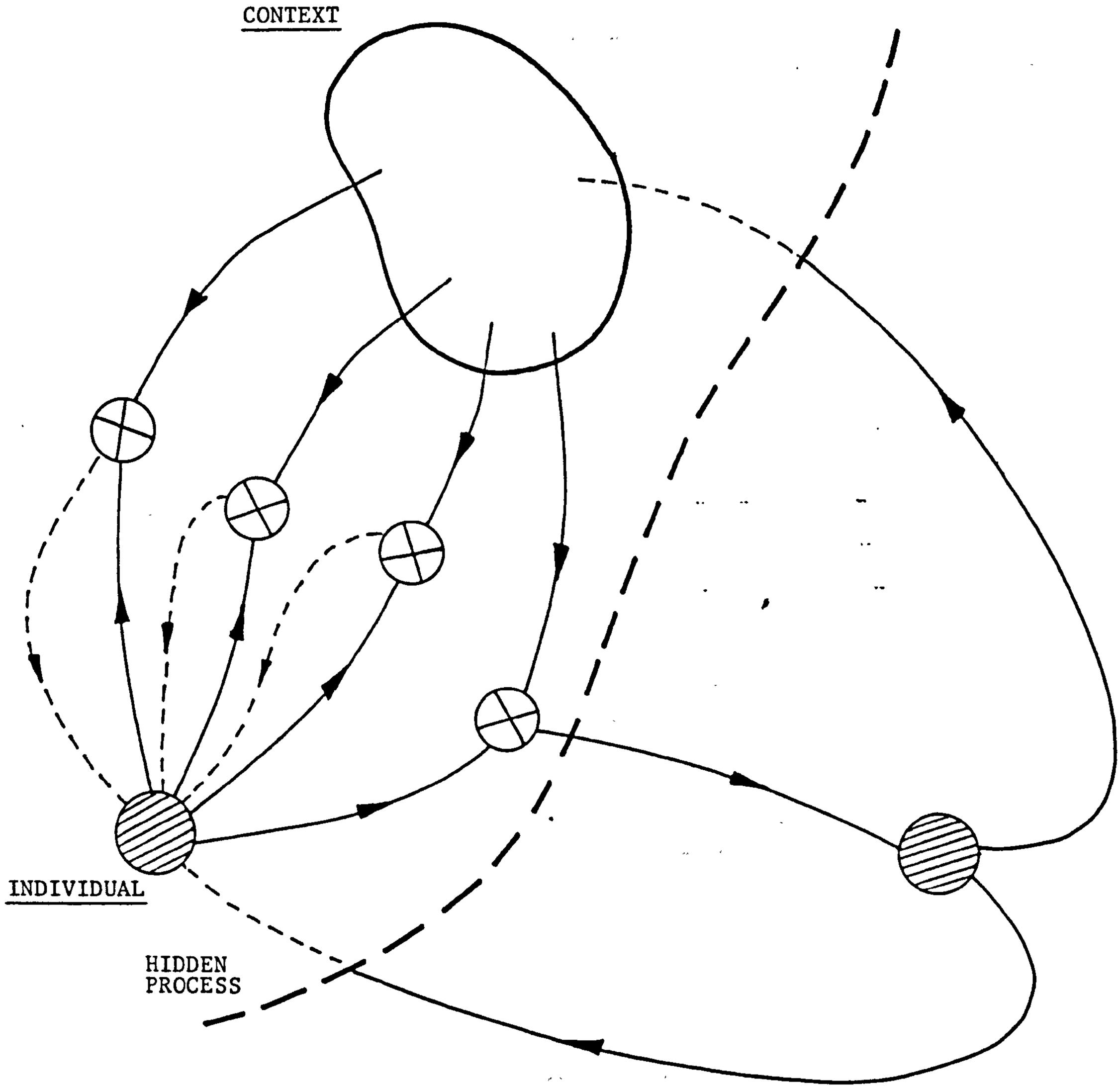
In other, general, words this is equivalent to saying that if a proposed alteration finds expedient or growing contextual conditions - i.e., if the existing constraints "reinforce", "allow" or "accept" the individual disturbance - then a desired (potential) change is converted into a real (actual) one; thus, leading, soon or later, to a change of the proper environmental conditions. If not - i.e. if the overall "weight" of such constraints (in some epoch and in some historical place) "exceeds", "forbides", "prevents", etc. this or that particular action - then no contextual alterations will arise.

v) finally, simply proposed, or effectively accomplished changes [individually or collectively (say, contextually) regarded] are next transmited (through some kind of social "memory" represented by books, documents, oral and written traditions, etc.) to future generations. Thus, becoming henceforth an integral part of the contextual patrimony.

Two (equivalent) symbolic representations of this process are provided in Fig.3 and Fig.4 a, b, c. The first is a simple refinement of Fig.1 and Fig.2.

The second is a simple "bidimensional" (instantaneous) "projection" of some (hidden) interactive process individual-context.

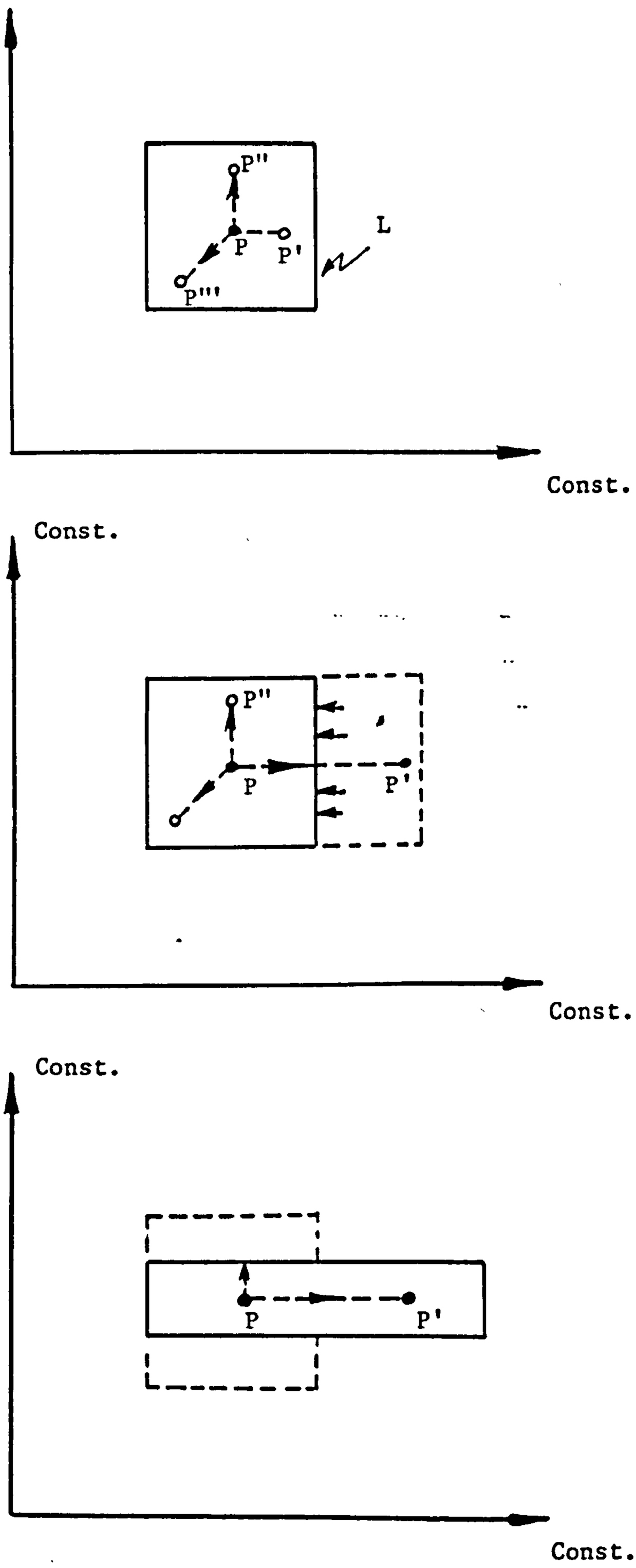
There, the boundary line L encloses a constrained "area" within which the point P (the symbolic representative of some individual) is, in principle, free to move in any direction. Three typical situations are emphasized there. In a) the individual's actions (represented



Externalized individual actions as a result of a control process

Fig. 3

through the point-transformations PP', PP" etc.) are effectively accomplished but they do not contribute to a change of L's "shape". In b) such an accomplishment would probably imply



Interaction individual-context regarded as a control process

Fig. 4

i') that this individual must, at any instant be aware of the "difference" between his ideal objective (roughly a "pattern") and the actions he actually performs in order to "materialize" it - difference which (working as some new "input") will tend, in turn, to bring such actions closer to those given by the pattern;

ii') but (in this case) he must also consider the proper contextual "constraints" which (eventually) and through the using of a "mechanism" similar to that described in i) may also "react" in order to "eliminate" (or, at least, to decrease) the influence of such an individual disturbance (say, to hold some paradigm inherited from its past).

Finally in c) a proposed action similar to that of b) is effectively accomplished without contextual "reaction", since (for some reason meaningless to remark here) L's shape is supposed to have changed; which is tantamount to assert that the proposed individual action has now find expedient "growing" conditions.

Whatever may be the (present) indefinitiveness of these representations, situations satisfying these requirements may be found not only in history but also in many other scientific areas in which - and this is the crucial point - some kind of control "mechanism" plays a prominent part in their understanding. "Control" may exist in case a) (if the individual decides to execute actions which would lead him to the "outside" of the constrained area); it is clearly emphasized in case b); and may also be brought to light in case c) if, in order to avoid contextual reactions, all the individual's actions are performed in the direction PP'. Situations of this kind may be applied to the

description of a wide range of historical actions. Hence, the basic conjecture of this essay:

i) if some types of past actions may be regarded as <u>externalized</u> "results" of (hidden) dynamical processes in which some kind of control "mechanism" is involved;

ii) if, on the other hand, cybernetics is a discipline which precisely seeks the description and explanation of dynamical processes in which some kind of control is present

<u>then</u>:

why not extend the particular procedures and points of view of this discipline to the study of (some at least) of such historical areas and (through this extension) to overcome the gap between them and the physical (or quasi-physical) sciences?

I/3- <u>Effectiveness and Related Problems</u>

A complete answer to such a general question involves such distinct interactions, so many individuals, so many problems that (unless some simplificative hypotheses are introduced) this endeavoured extension would run the risk of being unachieavable. It is in order to avoid this situation that the essay is primarily, though not exclusively, directed to the application of such procedures and points of view to a restricted historical area: the one which deals with the so-called domain of <u>Natural Science</u>, being here implicit the reconstitution of those problems, their solving procedures etc. which throughout mankind's history have led to the emergence of sucessive

transformations of the images of Nature. Two main types of reasons underly this choice.

Firstly, items i) to v) of I/2 are clearly satisfied. As a matter of fact the efforts developed by past observers in the construction (and/or transformation) of such images

i) may be regarded as intentional (or, at least, goal-directed)

ii) they always involve some kind of mental activity as well as a comparison between what (in some epoch) was already known about Nature and what was proposed to change this knowledge

iii) many of these proposed alterations were really confronted with strong contextual reactions

etc.

Secondly it also allows

i') an analysis of past thought-processes (since Natural Science is an area where these processes are or have been particularly emphasized) which, in consequence, inserts this problem into the most recent research objectives;

ii') a possible comparison between past and present mental processes [since both of them deal with a complex "object" whose features are (partially) common to past and present observers] - which, consequently, may ascribe a diachronous and evolutionary "dimension" to that analysis referred to a moment ago;

iii') the application of already existing epistemological, psychological, cybernetic and even mathematical approaches to the historical/scientific reconstitution problem; thus, rendering it capable in principle of

iv') effectiveness

Effectiveness is here cybernetically understood meaning (F.GEORGE, 1973) "the construction of a theory that can be translated in a particular blue-print form, from which an actual hardware model could, if necessary, be constructed".

The trouble is (and this justifies the emphasis laid on the "in principle") that neither such a "theory" nor its associated "hardware model" exist in the case of the historical/scientific reconstitution problem. Each one of the approaches emphasized in iii') above provides obvious answers to it; however, these answers are simply partial i.e. they do not embrace the problem "in toto". The consequence of this is that a possible solution to our conjectural question of I/2 becomes dependent on the previous construction of some overall model capable

- to provide suitable answers either to the historical/scientific problem (already stated) or to the particular questions it involves

- to bind the approaches referred to iii') or any other additional theory regarded as necessary to their clarification

- to be experimentally "tested" having in mind the confirmation (or not) of its underlying assumptions.

This "model" (a true cybernetic <u>theory</u> of historical reconstitutions) is exhaustively analysed throughout sections S/0 to S/6 of PART TWO of this essay. As any formal theory it makes use of some number of (more or less) well supported postulates. Being meaningless in this ARGUMENT to reproduce such supports, the following considerations will therefore be (almost exclusively) directed towards the simple <u>presentation</u> of those assumptions, of <u>some</u> of the questions which they avoid or bring to light etc.

I/3.1- The first and the most general of such postulates (henceforth named HYPOTHESIS ZERO) clarifies the links which (from our point of view) may be established between a particular way of looking upon the historical/scientific information and cybernetics.

In its most concise form it states that:

I/3.1.1- The historical/scientific reconstitution problem (directly and significantly understood) is ultimately reducible to a question of <u>interindividual communication</u>:

i) There are two (symbolic) individuals OP_k and OP_R, [k being an index representing historical dates referred either to an hypothetical (T_h) or real time-scales (T_R) $k = 0, 1, 2, \ldots, R-1$] who are (supposed to be) exchanging information about a previously chosen subject matter.

ii) In the case of this essay this subject matter is primarily (though not exclusively) related to history of science; particularly to the history of Physics (simplif. HYPOTHESIS ONE of S/2), this discipline being here interpreted as providing throughout time more and more correct descriptions of what is commonsensically called "Nature" or "physical world" (*PhW*).

I/3.1.2- In consequence of this, such individuals work

i) The OP_k as a general representative of those men called PLATO, ARISTOTLE, NEWTON etc. who, in a way or in another, have contributed to the <u>transformation</u> of *PhW*'s knowledge (briefly, TSK)

ii) OP_R as a general representative either of present-day scientific historians or of present-day natural scientists (physicists)

I/3.1.3- For metaphysical reasons (simplif. HYPOTHESIS TWO of S/2) *PhW* in itself was supposed to be <u>time-invariant</u> (in the sense of, for example KLIR and KALMANN).

In consequence of this

i) the whole communication OP_k <--> OP_R may be <u>globally</u> and <u>abstractly</u> regarded as though these individuals were engaged in an imaginary <u>conversation</u> <u>scheme</u> (S/0) which (by dint of some hypothetical contract established between its <u>participants</u>) is primarily though not exclusively foccussed upon

- *PhW* 's descriptions.

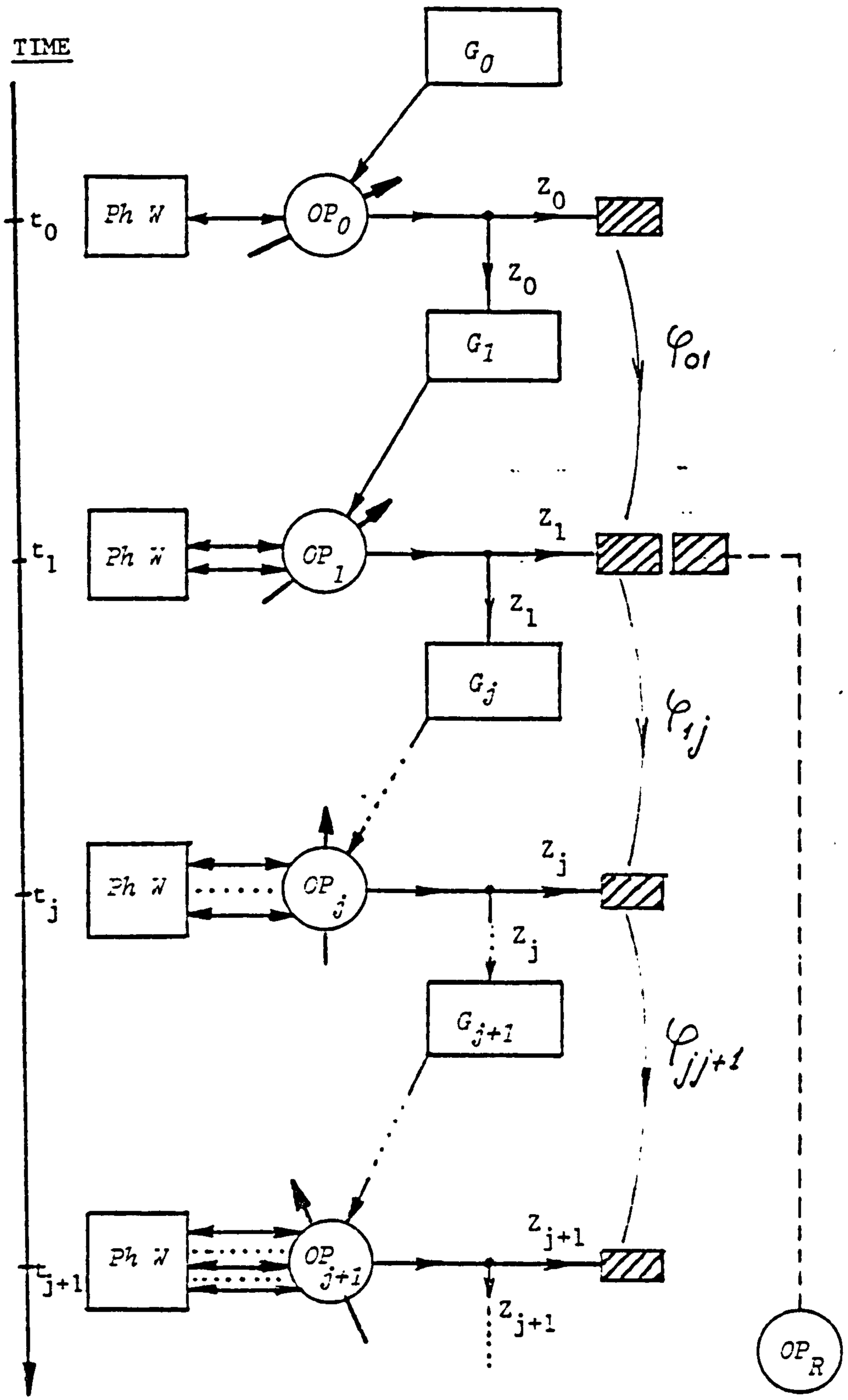
- the reasons of their transformations

ii) all the *OPs* work as members of a trasmission chain by means of which the images which they have obtained and constructed from *PhW* are successively communicated to one another till they reach (Fig. 5).

I/3.1.4- These images are supposed to be contained in messages z_k [a general word including written documents, oral traditions transmited from generation to generation, artifacts, even scientific instrumentation (understood according to a contemporary sense etc.)] which OP_R receives. However, due either to their proper historical vicissitudes, to the characteristics of the information there contained, to their authors' thought-processes (which nobody can assert to be exactly alike to those presently followed), to the peculiar frames of mind according to which they interpreted natural phenomena etc. as well as to OP_k's own limitations (recall I/1) - part (at least) of such images appear to OP_R as having been lost, destroyed or else, leading to mistaken interpretations of z_k .

It follows in consequence that there are two kinds of expectancies and uncertanties which OP_R may have

i) one, as regards changes occured in his present environment part of which (that one involving their decreasing in relation to *PhW*) characterizes OP_R as a natural scientist



Transmission chain past observer/participants - present day historians

Fig. 5

ii) another as regards his historical <u>past</u>.

To decrease (or lower) this last kind of expectancies and uncertanties (through the <u>interpretation, reconstitution</u> and possible <u>explanation</u> of such z_k) determines either OP_R's role as scientific historian or consequently a (first approximative version of) the historical problem he has to solve.

I/3.1.5- Possible solutions to this question may be brought to light from the interdisciplinary area in which cybernetics play a prominent role.

Several arguments support this assertion; the most important of them (fully analysed in S/0) relates the particular way of looking upon the communication OP_k <--> OP_R to PASK's <u>learning/teaching approach</u>. <u>Abstractly</u> regarded the standpoints of this relationship follow from

i) the postulated time invariancy of *PhW* in itself

ii) the <u>two</u> (symbolic) roles assigned to OP_R (as natural scientist and scientific historian)

iii) the proper temporal and "spatial" transformation [1] which z_k's descriptions have undergone.

I/3.1.6- Due to i) above it is possible in fact to look upon the whole conversation OP_k <--> OP_R in terms of a <u>directed</u> and (in some way)

[1] The word "spatial" is connoted here to the attributes and relationships by means of which the *OP*s are described. See II/3 for more details.

restrict dialogue about a complex "object" PhW part of which is described by features potentially common to both of its intervening participants.

Two results may be extracted from this:

a) that OP_R is (in principle at least) able to understand (PASK, S/O) past descriptions of PhW,

b) that OP_R can globally regard the effectively occured time-variancy of these descriptions [item iii) above] as though they were the result of a dynamic process by means of which

- once some image of Nature say z_K is proposed (by some OP_k at $t = t_k$)

- immediatly a new OP_{k+1} criticizes it (due, for example, to some hidden problem which OP_k was unable to detect or to solve completely); next, and

- as soon as this "problem" [understood in the sense of ELSHOUT, PASK, (S/O) DEWEY (S/3)] is solved, a new image z_{k+1} ($k = 0, 1, \ldots, R-1$) is brought to light.

As far as these problems are being solved (a "problem" is ultimately a particular relationship PhW <--> OP_k which these observers/participants have to bring about or satisfy) also these images become closer and closer of the image of Nature z_R which present day OP_R has constructed or is simply obeying [item ii), iii) of I/3.1.5].

I/3.1.7- Under these conditions, the whole dialogue OP_k --> OP_R (k = 0, 1, ..., R-1) may be globally interpreted as though these OP_k were acquiring more and more knowledge of PhW as far as time went on; or which is similar, more and more expectancies and uncertainties about changes occured in PhW are being successively confirmed. This temporal evolution of knowledge (symbolically represented by TSK) satisfies therefore PIAGET's definition of "epistemology" (S/0).

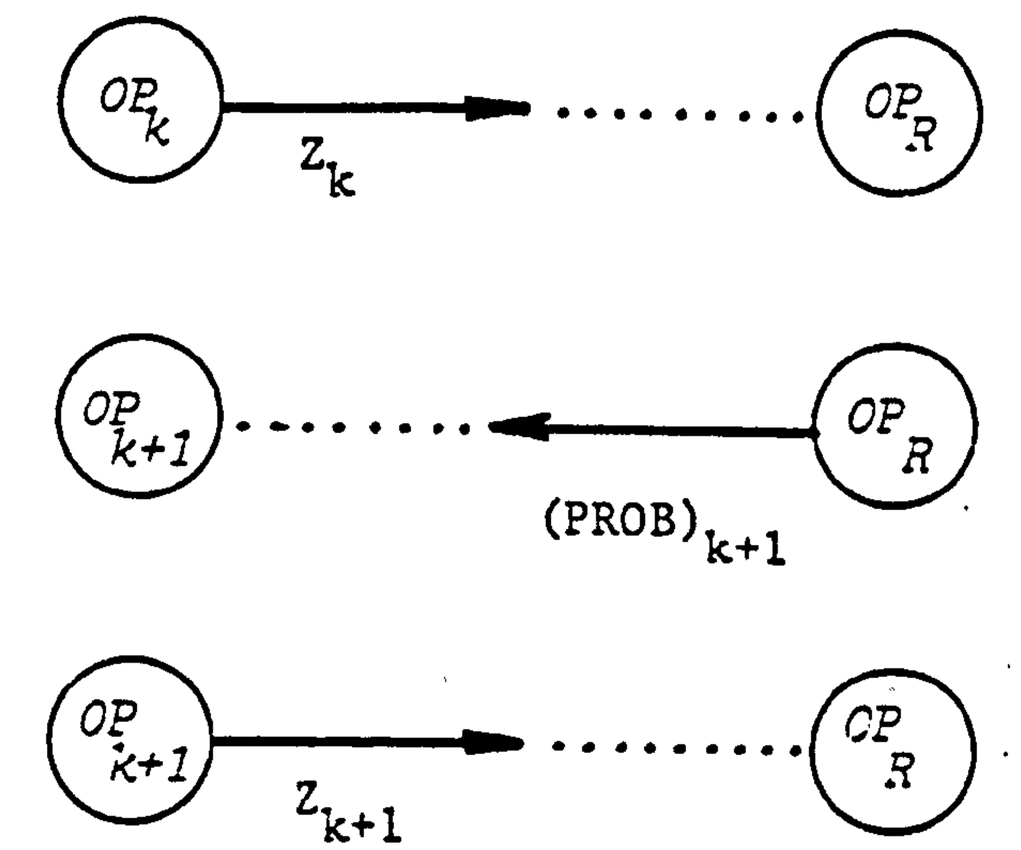
I/3.1.8- It follows from this that the dialogue OP_k <--> OP_R can (globally and abstractly) be interpreted as reproducing the proper evolution of TSK. Hence, also satisfying the interpretations of PASK and VON FOESTER of a <u>learning/teaching adaptative scheme</u>.

Everything works therefore as though the roles played by OP_R and OP_k were similar to those played by

- a (symbolic) "teacher" T ($\equiv$ OP_R)

- a (symbolic) student S ($\equiv$ OP_k) engaged in conversation about PhW. As far as T proposes some image z_k , immediatly S criticizes it (say, poses a new problem to S). Once this new problem is (somehow) solved, a new image z_{k+1} will emerge, new problems will in turn appear etc. till that z_k coincides with z_R (Fig. 6)

<u>Abstractly</u> regarded the interaction S <--> T (and through them - if some precautions are taken - the proper historical/scientific evolution) is therefore capable of being <u>reproduced</u> by means of PASK's THOUGHTSTICKER system. In other words a(n initially regarded) <u>historical</u> question is, by this means, converted to a (cybernetic)



CONDENSED REPRESENTATION

The interaction student - teacher

Fig. 6

learning/teaching problem reproducible in principle (we insist in this expression) through a special purpose (cybernetic) system.

I/3.1.9- The preceding assertions provide a global support to the general reasoning which we have been developing since I/3.1.1. Additional explanations to the aspects already emphasized (particularly to the relationships between history, epistemology, psychology, cybernetics in general and PASK's conversation theory) may be found in S/0.

This being accepted the emphasis laid upon the word "in principle" referred to a moment ago becomes now clearly understandable. As a matter of fact an <u>actual</u> (and not simply abstract) historical/scientific reproducion requires that OP_R has a <u>concrete</u> knowledge

i) either of the z_k <u>effectively</u> occured throughout mankind's history or (at least) throughout some periods of its evolution

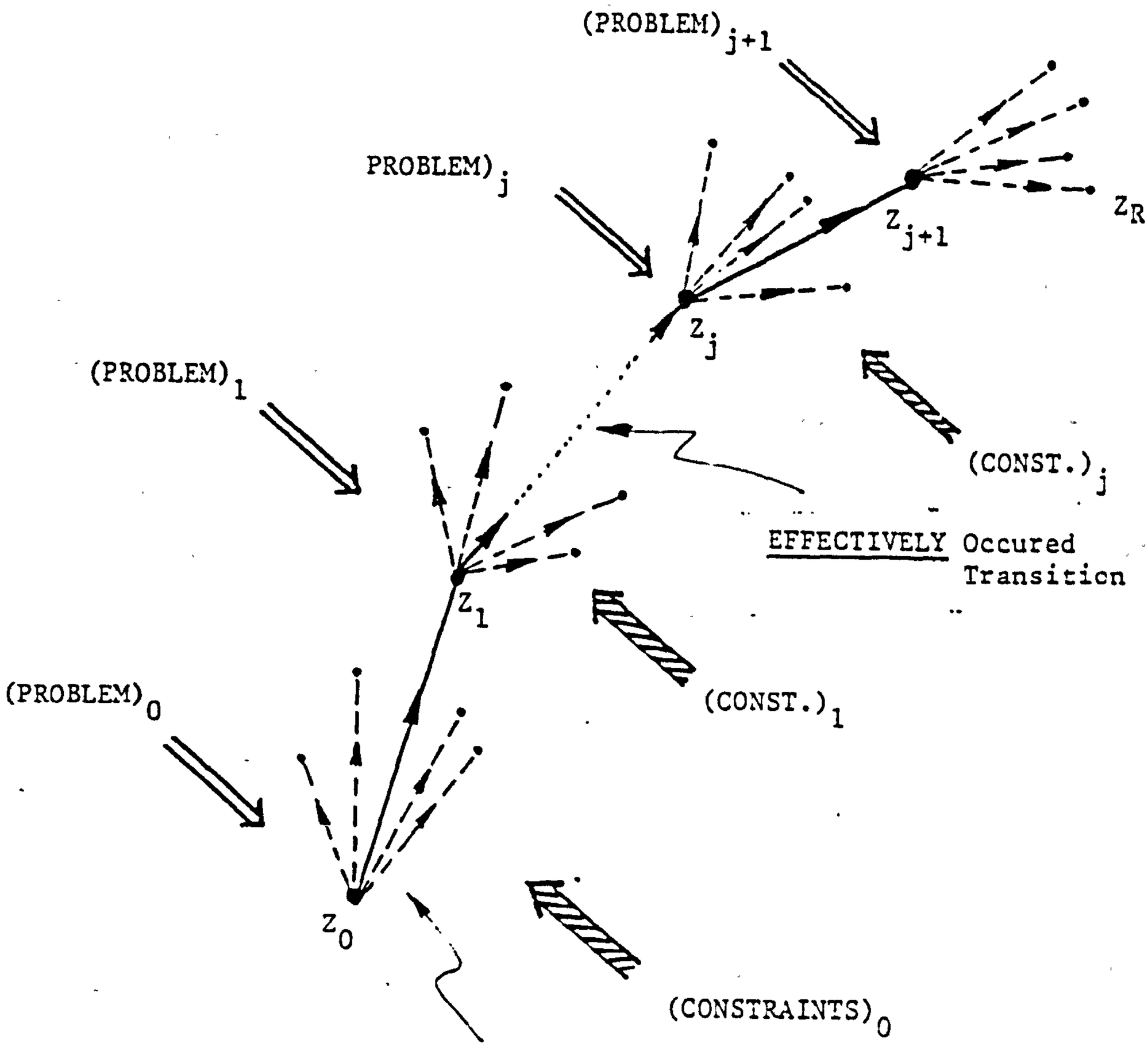
ii) of their <u>changes</u> or <u>transformations</u>(what, according to ASHBY's terminology we may represent by a <u>transition</u> T_{ij})

iii) of the <u>problems</u> which have been in the origin of these T_{ij}.

iv) of their authors' <u>thought-processes</u> (which the T_{ij} "materialize" in some way)

v) of the reasons why this or that proposed solution was or was not accepted at this or that epoch (Fig. 7)

Briefly: it requires the <u>previous</u> construction of some historical/scientific <u>model</u> of TSK by means of which such a transformation of knowledge may be not only suitably inserted into PASK's THOUGHTSTICKER (say, may be <u>described</u> and <u>reproduced</u>) but also



The interaction individual-context -the general representation

Fig. 7

explained; this term is here asscciated with the contextual influences emphasized in I/2.

Obviously, if this model has already been constructed then (by a converse process) its "variables", "parameters", mutual "relationships" etc. would also be capable of some kind of testing; in other words some kind of historical experimentation could be performed through PASK's system.

What this would ultimately mean is that a strong relationship would be established between history,epistemology,psychology,etc.and cybernetics: the former would provide the necessary information to the rest and this, in turn, (through that "experimentation") would be able to clarify many of the vague and nebulous aspects of the former. Briefly,the contemporary gap between those two general areas of knowledge would, in some way, be overcome.

The point - the crucial point indeed is that (as we emphasized in I/3) such an overall model does not exist. Items i) to v) of I/3.1.9 are (or have been) objective of present historical, epistemological, psychological, etc. partial researches but an integrated and unified "construct" into which they can be properly inserted was not yet brought to light.

The construction of such a modellistic approach of TSK [satisfying items i) to v) of I/3.1.9 and the proper characteristics of PASK's system] become therefore a priority goal of this essay.

I/4- The Basic Problem(final version)

I/4.1- Reasons related to the complexity of these questions suggested the decomposition of the aforementioned dialogue OP_k <--> OP_R into two temporally separated phases:

i) one, where this conversation between past and present is supposed to be unilateral, i.e. as though only OP_k were providing to OP_R concrete information about past images of Nature (situation in which OP_R 's role is, in some way, passive)

ii) another, requiring the previous accomplishment of i), in which OP_R 's role is now an active one: OP_R poses concrete problems to a present day student S (similar in some sense to those which past OP_k had to face and solve), being expected that [taking into account a set of constrained influences (mirrored from past contexts)] S is able

- either to reproduce solutions really accomplished in the past

- or to bring to light new answers, never imagined or (although proposed) never achieved in the past.

Only step i) is discussed in the present essay, step ii) being postponed to future works.

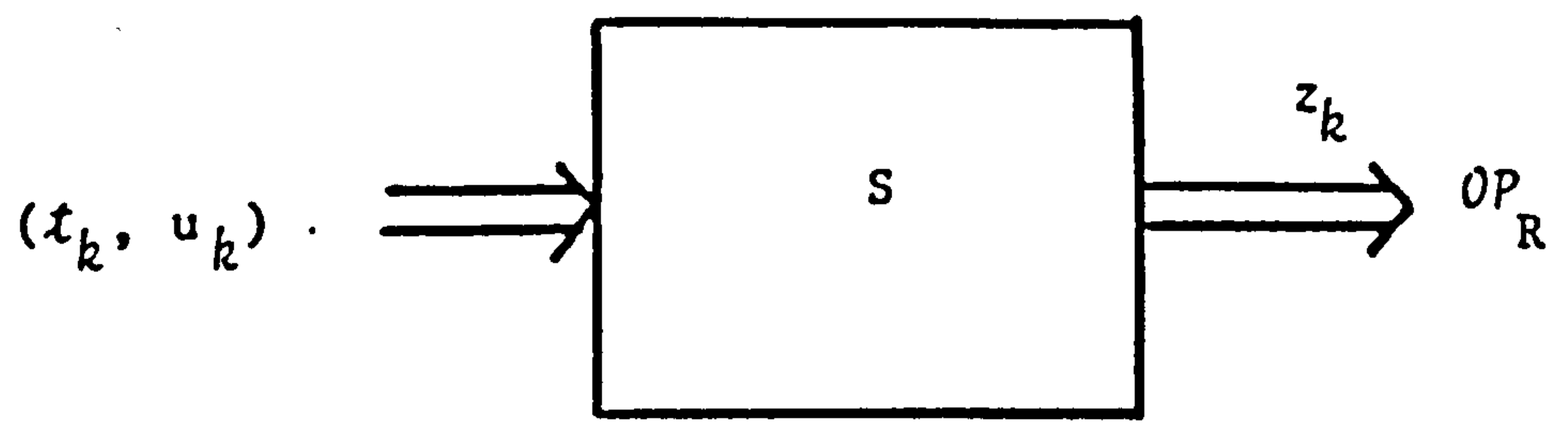
I/4.2- Though apparently restrictive this unilateral way of looking upon the relationship OP_k <--> OP_R allows on the other hand that some well-known systemic procedures (frequently employed in Cybernetics, Control Theory etc.) may be almost integrally transposed to the historical area. This restriction outlines an interpretation

of OP_R's role before the amount of information proceeding from his past quite similar to that played by an <u>active receptor</u> [2] before the information emmited by an hypothetical system S whose

- time-variable "outputs" are those messages z_k previously referred to
- time-variable "inputs" are the aforementioned problems u_k

and whose "inside" can (for the moment) be regarded as unknown.

Under these conditions the historical/scientific reconstitution problem becomes clearly reducible to a question of <u>synthesis</u> (systemically understood) which, briefly, is : what internal structure must be ascribed to S so that z_k's time-variancy may be described as well as explained [in the sense of item v) of I/3.1.9]? (Fig. 8)



The conversion of the historical scientific problem to a systemic problem

Fig. 8

[2] Active Receptor means here that OP_R's attitude must not be confounded with that played by the ("impartial") external observer of physical or quasi-physical sciences (ruled by the classical paradigm) but rather as <u>observer/participant</u> (in the sense of PASK's relativistic paradigms).

I/4.3- It can be demonstrated that this general statement (subsuming an analogue or systemic interpretation of the historical/scientific problem) embraces

- the two usual significances according to which the term "history" is presently regarded (directly and significantly)

- through them, of items i) to v) of I/3.1.9

- finally, a set of difficult and complex historical, psychological, epistemological, etc. questions whose solution is far from being reached.

As a matter of fact:

i) Direct historical narrations correspond to an analysis of S's "outside" i.e. of S's outputs z_j together with their mutual transitions T_{ij} [items i), ii) of I/3.1.9]

ii) significant historical narrations deal with S's "inside" i.e. with

- the relationships $PhW \dashrightarrow OP_k$ [those "problems" u_k referred to item iii)]

- the proper long-time variancy of these processes, of the relationships between their authors and their contexts [item v)]

The point is that this variancy is, still, a pure conjectural matter. No one knows in fact neither what thought-processes our remote ancestors exactly used in the construction of their images of PhW, nor the temporal variation of these processes nor the reason of their

change. About them the most which can be asserted is that

- they appear to us as being different from those presently employed

- based upon their externalized expressions (the proper z_k) some (more or less) well defined (evolutive) phases may be detected.

Due to both of these reasons some additional questions are therefore involved in the construction of S 's inside:

iii) The first is related to what we should say to be an epistemological dilemma .Its condensed statement is as follows:

The understanding of the (hidden) thought-processes of which the z_k s are the externalized expressions, requires the use of some overall conceptual frame (which present-day historians have necessarily to introduce, due to enormous amount of information already accumulated about mankind's past) whose mental rules depend, in turn, of the proper processes whose clarification the frame aims for. In other words: if we seek the understanding of past mental processes (processes which are usually private) then we have to adopt a psychical frame of reference in which these processes have (in some way) to be involved. However, these processes (either those actually employed or those simply proposed) are unknown.

How this situation may be overcome is a matter which will be analysed in II/2.4. For the moment it suffices to point out that such mental rules, whatever they may be, lead to the emergence

iv) of a second type of questions whose scope is now psychological.

Long-time approaches to mankind's evolution are, in fact, nothing but extensional analogues of the theories which contemporary psychologists have constructed about short-time diachronous evolutions; say, more concretely, the genetic approaches to child's development. The point (another crucial point) is that due to their mutual divergences and contradictions, to the particular points of views from which these developments are (or were) analysed etc. the panorama which contemporary psychology offers as regards these aspects is far from being unified.

The consequence is that such divergencies, contradictions etc. are projected upon long-time explanations and such problems as those dealing for example with

v) the so-called conflict "myths-reason" (involving the "weight" of affective workings upon the rational ones)

vi) the distinction between the system of experimental actions (what PIAGET associates with "practical intelligence" and WALLON with the "intelligence of situations") and the system of inference rules on which Reason is (supposed to be) based ("formal" and "representative" intelligences according respectively to these two authors)

vii) the divergence between the followers of the metatemporal or pre- (or a-) logical mental structures

viii) the "weight" of social contexts upon the individual's evolution etc.

are questions which, cannot be neglected in such a long-time variancy.

I/4.4- Some overall conditions - determining either the deepest approach to the historical/scientific reconstitution problem or to its (possible) solving-procedures - may be extracted from the preceding survey. From them it can be stated that a (as complete as possible) solution for that general question must, necessarily, involve.

i) an overall psychological, epistemological and historical hypothesis (dealing with S's inside) where the long-time variation of thinking has (somehow) to be considered and (insofar as possible) "explained". This "explanation" must provide suitable answers to questions iv) to viii) above and must agree with what is historically known [3]. Since this knowledge is ultimately contained in z_k then

ii) a "theory" concerning S's outside is also needed. The conditions which this "theory" must satisfy are, broadly speaking,

- that z_k's presentation must allow that their T_{ij} can, automatically, be brought to light, the word "automatically" implying the use of some computerized device

[3] A condition not always satisfied by contemporary psychologists (see S/6 for more details).

- that (having in mind the proper cybernetic and control significances ascribed to the historical/scientific process) the attributes and relationships by means of which the z_k and their T_{ij} are described, must be capable of <u>formal</u> and (if possible) <u>numerical</u> treatment

iii) finally a <u>strategic solving-procedure</u> by means of which the epistemological dilemma referred to item i) of I/4.2 may be avoided.

The effective accomplishment and corresponding implementation of these requirements is the ultimate goal of

II- <u>THE MODEL</u>

The construction of this conjectural model of S is a task which occupies more than six hundred pages of PART TWO of this essay. Reasons for this deal with the presentation, analysis and clarification of the innumerable questions which such problems and requirements deal with (involving history, cognitive psychology, psychoanalysis, epistemology, cybernetics, systems theory, fuzzy mathematics, etc.) as well as with the inexistence of an overall frame of reference into which all these matters may be suitably inserted.

In order to overcome all these difficulties a peculiar and (insofar as we know) <u>original approach</u> is progressively developed throughout sections S/1 to S/6.

The tenets of this approach respect

- a general (or strategical) way of looking upon the whole amount of historical/scientific information by means of which item iii) of I/4.2 may be superseeded

- an overall modellistic hypothesis embracing item i) of I/4.2

- a formal and numerical description of S in which either the z_k or the T_{ij} may be related to S's internal structure [item ii) of I/4.2]

A condensed presentation of such tenets is given as follows:

II/1- THE OVERALL SOLVING-PROCEDURE

The standpoints of this procedure were outlined in the FOREWORDS. Broadly speaking they consist in the use of a "cyclical" or "more and more" approximative approach to the historical/scientific reconstitution question (similar, in some way, to a dialogue between two individuals who, as far as their conversation is being processed, are also progressively deepening the subject matter of their discussion) in which results obtained from some set of initial premises are next used to depth the proper scope of such premises; this deepening leads to new results (as well as to the introduction of additional supporting matters) which, in turn, will change the (new) initial standpoints, these to other inferences, etc. The number and characteristics of such "cycles" are determined by what henceforth is named a psycho-historical approach to the historical problem (systemically regarded).

In its most concise form it states that a (so complete as) possible understanding of such a problem must necessarily consider three distincts (though interrelated) perspectives (or points of view)

i) a topographical one, in which S's inner elements (for example "OP_k", "PhW", etc.) are chiefly stressed;

ii) a dynamical one, which is ultimately concerned with the relationships which may be established between these elements;

iii) a temporal one, in which these elements and relationships are examined taking into account typical temporal perspectives.

Two of these temporal perspectives are, in the essay, especially relevant

- a synchronous one, corresponding to an instantaneous observation either of S's elements or of their relationships but in which the OPs are regarded as adult human beings

- a diachronous one, further subdivided into two other periods, in which short-time (decades) and long-time (secular) evolutions are considered [4].

Each one of these perspectives can, in turn, be examined according to different "depths" or "levels". Broadly speaking, it may be asserted that as far as this "depth" increases, also more and more elements and/or relationships are involved in S's analysis. A

[4] This classification is based upon that one brought to light by the french historian F. BAUDREL.

simplified "tri-dimensional" representation of this psycho-historical approach to history is given in Fig.9.

Two main conclusions can be extracted from it

i') firstly that the historical/scientific reconstitution question is a matter which deals with the last of the transpositions there emphasized

ii') Secondly that (as pointed out in the FOREWORDS) they also coincide with the three overall cycles into which the approaching structure to the whole essay is divided. As a matter of fact

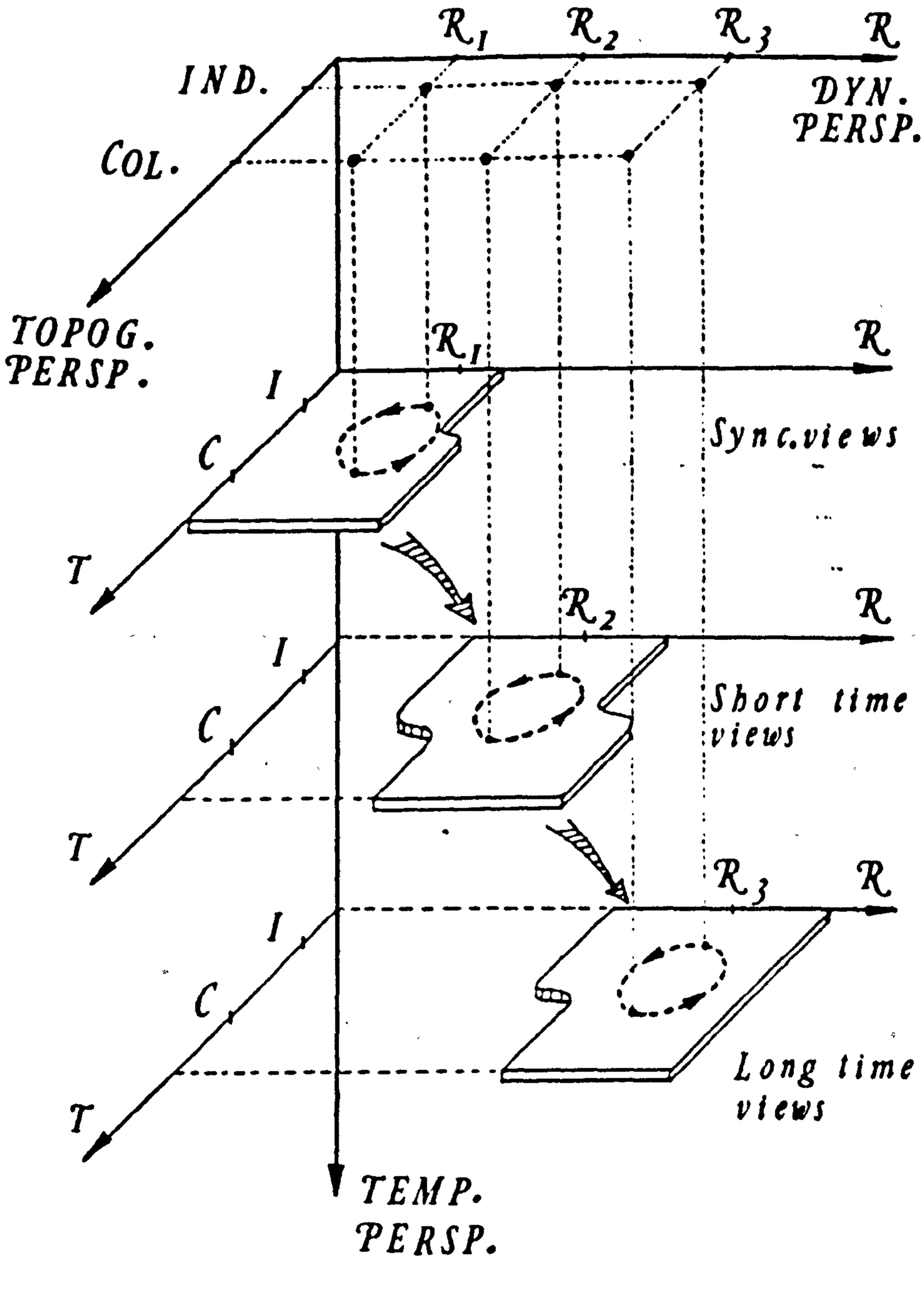
- S/1, S/2 are primarily, though not exclusively, focussed upon an instantaneous vision either of the OP_k or of their general environments

- S/3 correspond to an analysis of the three great theories according to which the short-time (diachronous) psychological evolution of human beings is framed; say PIAGET, WALLON and FREUD (this last also including his immediate and mediate followers HARTMANN, M.KLEIN, SPITZ, etc.)

- S/4, S/5 and S/6 examine (among other things) the problems which the transposition from the short to long-time views involve.

The implementation and progressive development of these cycles underly precisely

THE PSYCHO-HISTORICAL APPROACH



The psycho-historical approach

Fig. 9

II/2- THE OVERALL MODELLISTIC HYPOTHESIS

This hypothesis is ultimately related to the construction of a model of S's "inside" so that z_k's changes do not contradict known historical data and (through them) the epistemological psychological etc. theories there involved. According to the approaching strategy previously referred to, it involves three main steps (corresponding to the three temporal perspectives from which historical data may be regarded); the first of these steps deals with the

II/2.1- THE SYNCHRONOUS PERSPECTIVE

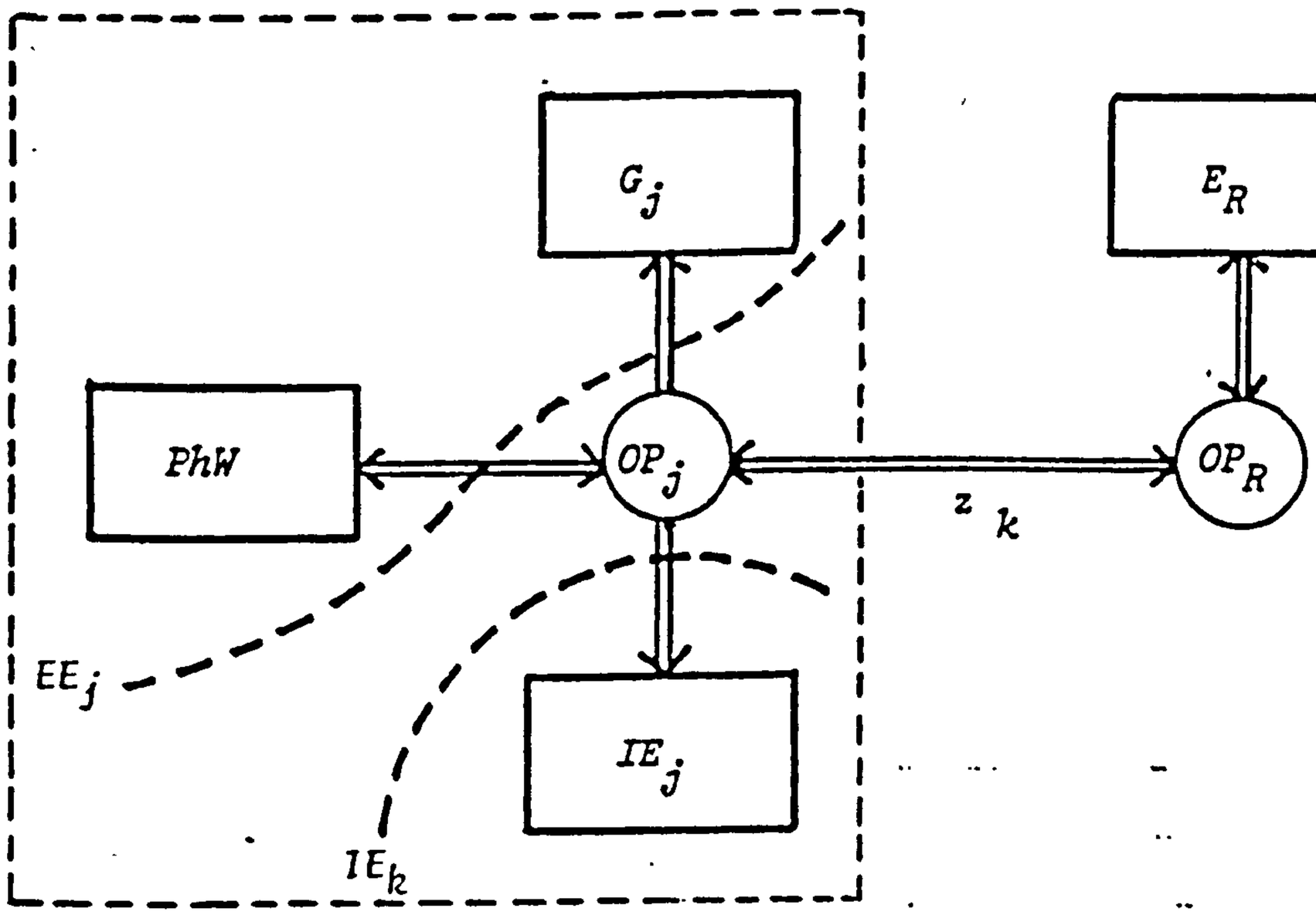
In its most concise form this point of view states that, together with the OP_k, OP_R and PhW already considered, the time-variation of z_k's images can only be explained if OP_k's group environment (briefly G_k) and OP_k's internal environment (symbolically IE_k) are also taken into account (S/2). From a topographic perspective and in terms of their descriptive attributes only this is equivalent to assert that every OP_k interacts with a total environment E_k,

$$E_k = EE_k \cup IE_k$$

in which EE_k (his "external environment") can, in turn, be partitioned into PhW and G_k; briefly

$$EE_k = PhW \cup G_k$$

A simplified representation of these classes are given in Fig.10



The synchronous interactive perspective

Fig. 10

Further (topographical) refinements of these classes will progressively be brought to light as far as deeper analyses of the interactions OP_k <--> E_k are being performed. These analyses lead precisely to the second "cyclic" step of the approaching strategy previously outlined, now essentially concerned with

II/2.2- THE DIACHRONOUS (SHORT-TIME)PERSPECTIVE

This point of view deals now with a (short-time) model of OP_k 's mental apparatus,being PhW, G_k and IE_k simultaneously involved.

As we emphasized beforehand the theories on which this model is based (WALLON, PIAGET and FREUD) are analysed in S/3, S/6 and APPENDIX A to PART TWO of this essay. From their tenets it is possible to lock upon that apparatus (brain and nervous system) as obeying an overall postulate whose ultimate nature is a <u>biological</u> one. This postulate makes use of the concept of <u>purpose</u> (or perhaps of "expediency") and it runs as follows:

i) the nervous system has the function of getting rid the stimuli that reach it, or of reducing them to the lowest possible level; or, if it were feasible, would maintain itself in an altogether unstimulated condition. In other words: as though to the nervous system were assigned a task which (speaking in general terms) consists of <u>mastering</u> stimuli.

ii) these stimuli may arise from without (i.e. from the external world EE_k) or from <u>within</u> (i.e. as though part at least of IE_k were working as an <u>internal</u> source of stimulation)

iii) that, in consequence of i), ii) above, the whole apparatus may be topographically partitioned into three psychical instances which (according to the contemporary psychological research) are respectively named

- the <u>id</u> and the <u>superego</u> [essentially concerned with item ii)]

- the <u>ego</u> [whose main function is related to item i)]

II/2.2.1- ON THE ID

The id is the oldest of such provinces. It contains everything that is inherited, that is present at birth, that is laid down in constitution - above all the instincts which originate from the somatic organization and which find a first psychical expression here (in the id) in forms still unknown to us. What litlle it is known of it, is learnt from the study of the dream-work and of the construction of neurotic symptoms. Generally speaking the processes in the id obey the laws of the so-called primary processes; they are characterized

- by having no negation, no idea of space, no idea of time, being also timeless

- the logical laws of thought do not apply to them, this being specially true as regards the law of contradiction

- by having no judgement of value

Instinctual cathexes seeking discharge is all there is in the id.

II/2.2.2-ON THE EGO

Under the influence of the real external world, one portion of the id has undergone (in the course of phylogenesis and ontogenesis) a special development: from what was originally a cortical layer equiped with the organs for receiving stimuli and with arrangements for acting as a protective shield against stimuli, a special organization has arisen which henceforth acts as an intermediary between the id and the external world. This second (topographic)

agency is named ego.

i) In this essay [and due to i) of II/2.2] the ego is globally regarded as a controller whose main task consists in the searching for an appropriate balance between three particular types of demands:

- those proceeding from without (EE_k)

- those proceeding from within (IE_k). in which are included either the instinctual (or somatic) demands coming from the id or those born from a comparison between some action (planned in order to satisfy for example the id's needs) with a "moral" internalized standard (in which firstly parental's influences and social constraints from G_k later, are dominant)

ii) As a coherent organization of mental processes the ego is (supposed) to possess an overall structure which psychological research has (artificially) particned into two substructures

- one dealing with affective phenomena in general (sensations, feelings, etc.) whose functioning is ultimately associated with the kinesthetic system

- another with cognitive (and in some way impersonal) phenomena related to the diacritical system

The ultimate relationships between these two structures are still to be determined. It is already known however that

- it is on the working of the affective structure that the earliest cognitive developments are based (WALLON, SPITZ, etc.)

- this affective structure never ceases its influence throughout human beings lives

- that, consequently, in the adult's stage the ego's general activities may be regarded as guided by considerations of the tensions produced by these stimuli, whether these tensions are present in it or introduced into it. The raising of such tensions is, in general, felt as unpleasure and their lowering as pleasure. The ego strives pleasure and seeks to avoid unpleasure. An increase in unpleasure that is expected and foreseen is met by a signal of anxiety ("realistic" as regards external world, "moral" as regards the superego, and "neurotic" as regards the needs of the id); the occasion of such an increase, whether it threatens from without or within, is known as a danger.

iii) In order to face these "dangers" there are two additional imperatives which the ego must satisfy:

- an imperative of knowledge (implying a conscious or pre-conscious activity) consisting in distinct types of intellectual activity (in which the cognitive structure plays the most preeminent role)

- an imperative of defence (self-preservation) implying a conscious , preconscious or, usually, unconscious activity and consisting in the use of appropriate defence "mechanisms".

The satisfaction of both of these imperatives in the adult's ego can be clearly understood if attention is d to its outermost superficial part: the perceptual system Pcpt, which works as the sense-organ of the whole apparatus.

iv) Since this system is receptive to excitations arising from <u>outside</u> (what is usually called sense-perceptions) or from <u>inside</u> (memory-traces may become conscious just as perceptions do, especially through their association with residues of speech); since, further, the ego has voluntary movements at its command (in consequence of the pre-established connection between sense-perceptions and muscular actions) - then these imperatives are differently satisfied insofar as they are regarded as coming from without or from within.

In this sense, as regards <u>external stimuli</u> it is supposed that the ego faces them becoming aware of them, storing up experiences about them (in the memory), avoiding excessively strong stimuli (through flight), dealing with moderate stimuli (through adaptation), <u>learning</u> to bring about expedient changes in the external world to its own advantage (through activity).

As regards <u>internal events</u> in relation to the id's somatic demands it is assumed

- that such an imperative of knowledge is obeyed by interpolating between a demand made by an instinct and the action that satisfies it an <u>activity of thought</u> which after taking its bearing in the present and assessing <u>earlier</u> experiences (through mnemic residues) endeavours, by means of experimental actions, to calculate the

consequences of the actions proposed. It is in this way that the ego comes to a decision on whether the attempt to obtain satisfaction is to be carried out or postponed or whether it may be not necessary for the demand of the instinct to be suppressed altogether as being dangerous.

- that imperative of defence is satisfied through the use of special "mechanisms" whose objective is (in general terms) to withdraw from consciousness stimuli regarded as unpleasurable . Since active flight, active adaptation or active changes in their sources are not available, these defence modalities have acquired (throughout phylogenesis and ontogenesis) peculiar characteristics and peculiar forms. Broadly speacking they are all <u>unconscious</u> (the individual uses them but he is not aware of their working) and they all involve a special way of looking upon internal events which (roughly) may be described in terms of "<u>as though</u> ...".

Several mechanisms of this kind are emphasized in S/3, S/6 and APPENDIX A to PART TWO. Due to their importance in the explanation of mankind's earlier conceptions of special emphasis was however laid upon <u>projection</u> <u>introjection,</u> <u>repression</u> and <u>identification</u>.

v) In this essay identification find a more concrete application in

- the genesis and growth of the child's ego

- in the formation of its superego

- in the ultimate explanation of the interrelationships between the elements of a psychological group

- finally in the genesis and development of collective paradigms, shared by the elements of some group environment (in this or that particular epoch).

The first two of these aspects lead to the analysis of the third psychical agency into which the mental apparatus is supposed to be partitioned. What is named

I/2.2.3- THE SUPEREGO

The justification for the inclusion of this agency is supported by two different types of reasons

- one, biological, ir related to the long period of childhood during which the growing human being lives in dependance of its parents (human beings are incessorial animals according to SPITZ's terminology)

- the other, psychological (consequence of the preceding one) is concerned with the emotional ties which such a dependence engenders.

Both of these reasons contribute, since child's earliest times, to the formation of two partial substructures (which according to FREUD and his followers) are respectively named the ego-ideal and the proper superego. Their genesis can more clearly be brought to light considering a (necessarily condensed genetic description) of the interactions between the child and its social "milieu". The

ego-ideal is intimately related to FREUD's concept of narcissism; it works as that portion of the ego where the qualities characteristics, conditions etc. which determine one's self-love are contained. Unrestricted self-love must probably exist in the earliest period of childhood during which the child itself is its own ideal. But this kind of love can no longer subsist since the child takes up into itself (by introjection and internalization) the prohibitions, warnings etc. of its parental environment. From this moment onwards self-love becomes dependent on the conditions which it imagines as being necessary to obtain parents' love (love and solicitude which protect them against the dangers which also threaten them from the external world). They pay for this security by a fear of loss of love. In order to avoid this (say, more concretely, in order to avoid an unpleasurable situation) the child loves itself, judges itself, condemnes itself or punishes itself exactly like its parents, love judge, condemn or punish it. Under these conditions, everything work as though love and condamnation were dependent on the agreement (or disagreement) with a critical (or "moral") internalized image (a standard) which is ultimately nothing but a "copy" of parentals' demands. This standard (henceforth inseparably related to the primitive prohibitions, warmings, punishments, rewardings, etc.) form in one's mind a relatively autonomous system; this system is for FREUD, the proper superego.

ii) Throughout the individual's life the superego receives further contributions from later sucessors and substitutes of his parents (such as teachers, models in public life of admired social ideals etc.) and, through them, of the family, racial and national traditions, etc. Briefly: it works as some kind of internalized image, mirrored from the real social "milieu" into which some individual was (is) inserted, image which prolongs (through usually unconscious mnemic residues) his own parental's relationships.

iii) Due to unconscious influence of this image upon many of the ego's present reactions (say, in other words, of the influence of the past upon the ego's actual and contemporary experiences) the superego becomes the vehicle of tradition and of all the time-resisting judgements of value which have propagated themselves from generation to generation. The past, the tradition of the race and of the people, lives in the ideologies of the superego and yelds only slowly to the influences of the present and to new changes. Briefly: it play an important part in the understanding of the social behaviour of the mankind and (through it) of the relationships between the OP_hs and their group environments G_h.

II/2.2.4- ON THE RELATIONSHIPS BETWEEN THE EGO AND THE EXTERNAL AND INTERNAL REALITIES

What was previously asserted about these psychical instances justifies the reason why the ego was identified with a (psychological) controller whose functioning is determined not only by accidental and contemporary events but also by influences (usually unconscious) proceeding from its past.

- "controller" since it has to bring into harmony with one another the claims and demands proceeding from its external and internal worlds (in which the last includes the id and the superego)

- "determined not only from contemporary but also from past influences" since the ego is submitted to stimuli coming from the id (the influence of heredity) and the actions it intends to execute in order to satisfy them are, at any instant, compared with the moral rules of the superego. If these rules are not obeyed then the proper ego is punished with tense feelings of inferiority and guilt.

Further: since part of the rules of this internalized "standard" are unconscious but their associated feelings not [through the timeless influence of unconscious mnemic residues (FREUD 's theory on the two memory registrations)] then in order to avoid unpleasurable internal situations, the individual's present behaviours can, to a great extent, be conditioned by those proceeding from his own past. In other words: he may react "as before" (often whithout knowing why but usually in accordance with the paradigmatic standards of the society,communityor group into which he is (was) inserted) just in order to avoid unpleasure.

Four main conclusions (underlying a reasoning which will lead us to a deep and, insofar as we know, original insight on the historical/scientific reconstitution problem) may be extracted from these considerations:

II/2.2.4.1- Since IE_k is partially (at least) mirrored from G_k, then the <u>effective</u> emergence and public acceptance of (for example) some new intepretation of *PhW* can in fact, be regarded as the result of a process in which two "censorships" have to be overcome

- one, <u>internal</u>, proceeding from the individual's own "standard"
- another, <u>external</u>, and related to the (paradigmatic) rules of his G_k.

From our point of view this is (probably) the reason why:

i) among so many different people of so many generations, only a relatively small number of OP_k has effectively contributed either to the emergence of new interpretations of *PhW*, to actual changes in their societies or to an increase of mankind's self-knowledge

ii) such tansformations have(usually) been accomplished in societies open to rather distinct types of extraneous influences(i.e. not dominated by a single paradigmatic system of rules or of "ideologies") or (failing this condition) only after deep internal <u>crises</u>,

iii) crises which (in turn) only become explicit when a set of socially <u>accepted</u> rules (say, in other words, a set of rules which "match" with the individual's (inner) working mechanisms) collapses for some reason (for instance, the confrontation with some new society, new "frames of mind", etc)

The importance of these points (which, in some way provide a deeper support to our considerations of I/1 will be fully understood when the long-time approaches of WALLON, PIAGET and FREUD are introduced in this argument. (II/2.3)

I/2.2.4.2. Secondly, that - due the necessary inclusion of IE_k's conscious and unconscious (past) influences - the equation "Perception = External Reality" no longer holds.

Either individually or collectively regarded, it may happen in fact that the "weight" of the internal reality upon the external one [5]

is such that the image which some individual (or group of individuals) constructs from *PhW* becomes in some way "distorted" (if compared with some other image taken as reference, for example the contemporary one).

Situations of this kind are frequent in (some of) the ego's patological states (especially in those which are founded on a cessation or slackening of its relation to the external world, i.e. in which the ego is being hemmed in and hampered by the unconscious demands of the id and the superego).

However - and this is the fundamental point - they can also be found either in:

II/2.2.4.3. the ego's development or in the proper

[5] Recall that the perception system Pcpt is receptive to excitations arising from outside and from inside i.e. that memory - traces may become conscious just as perceptions do.

historical/scientific evolutionary process, (in general). In order to support this crucial assertion (fully analysed in S/3 and S/6 from a point of view which, insofar as we know,is original) if must be pointed out:

i) that the distinction which may be established between what comes from without or from within is, ultimately reducible to a concept of "action" [shared by WALLON's "movements", PIAGET's "actions" (understood as part of the assimilation-accomodation cycle) and FREUD's reality-testing],

ii)that [since such "actions" always involve some kind of voluntary movements and these, in turn, are related to the ego's structure (in consequence of the pre - established connection between sense - perception and muscular action) then a link between consciousness (to which the ego is attached), secondary processes (involving the logical laws of thought and the ego's cognitive structure and external reality (in general) can be brought to light.

iii)that (due to the existance of things of EE_k upon which no action is available) there are two general subclasses into which this "external world" may be partitioned:

- one, named neighbouring world (EE_k^N) which is directly and immediatly related to the aforementioned "action" and [(through ii)] to consciousness, secondary processes, ego's cognitive structure, etc.

- another, called the <u>distant world</u> an expression whose meaning is not only "spatial" (things "near" or "far" from us) but also (and fundamentally) epistemological (EE_k^D) which deals fundamentally with objects (things in general) to which no direct and immediate active (identificative) criteria may be applied. So, incapable of being "manipulated" (WALLON's movements, PIAGET's "actions" or "tested", in the sense of FREUD's reality - testing).

One of the consequences of this failure is that <u>part</u> of the elements of EE_k^D (that one which, according to our present-day terminology, we can say to belong to PhW^D) become scenary of particular throught - processes in which those mental mechanisms described in terms of "as though" will play a crucial role. (A <u>genetic</u> analysis of this partition of EE_k into EE_k^N and EE_k^D and these, in turn, into (PhW^N , G_k^N) and (PhW^D, G_k^D) is provided in S/3 through the application of sucessively more refined identificative criteria).

Among them, identification and projection are specially relevant. Identification (understood in the sense that a <u>partial similarity</u> is taken as a complete equalness) justifies in fact (due to its unconsciousness influence upon the ego's development) the reason why some of the relationships between the elements of PhW^D

i')are (or where) mirrored from those of PhW^N; this, through the using of a general psychological process obeying PIAGET's designation [6]

"extensional analogue" (roughly: "in order to explain unknown things we begin with the use of known procedures till the "explanation" they offer can no longer be sustained; this, in result of the "weight" of active testings)

ii') are (or were) regarded as a reflex of IE_k [since (from I/2.4.1.) both "work" (or were supposed to work) in terms of "as though"]

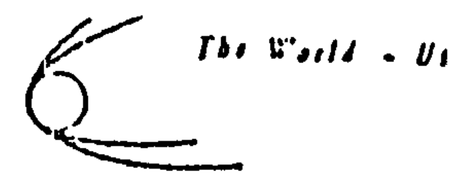
iii') are (or were) interpreted as an image of $G_k{}^N$ [through the relationships between group environments (family, parental's imagos etc) and the progressive construction of IE_k]; and consequently

iv') are (or were) regarded as <u>projections</u> of the individual's (unconscious) inner "realities".

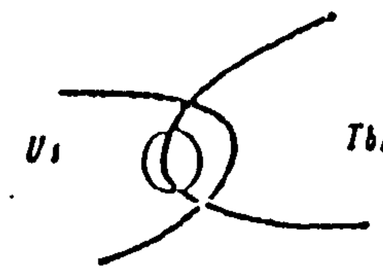
A <u>genetic</u> (symbolic) representation of these results is provided in Fig. 11 a, b, c, d, e, f, g). The last picture shows clearly how to the extensional analogies and (possible) logical laws of thought according to which PhW^D may be "explained", an <u>overall affective structure</u> (based upon "as though") <u>can be superimposed</u>. This result underlies precisely

II/2.2.4.4. - The last of the four main conclusions referred to II/2.2.4

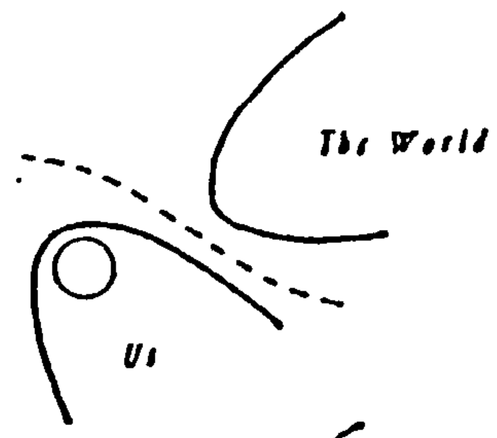
[6] In spite of their terminologic identity it must carefully bear in mind that the reasoning used to bring these "analogies" to light is totally different from that one underlying PIAGET's explanations; this because unconscious affective mechanisms are not considered in his approach. We should say, therefore, that we were led to the same result using a different extensional path, a path which, in turn, establishes a deep link between two theories so far regarded as totally alien: FREUD and PIAGET


The World - U_1

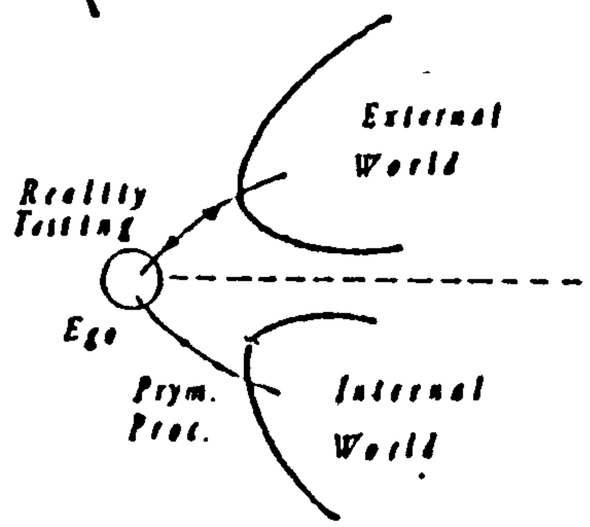
a)


U_1
The World

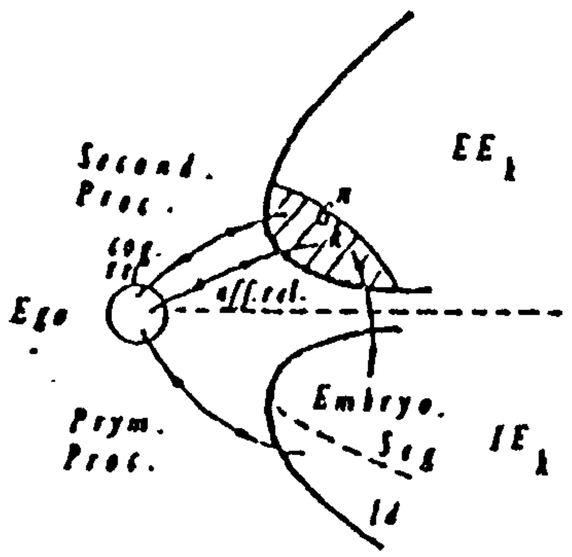
b)


The World
U_1

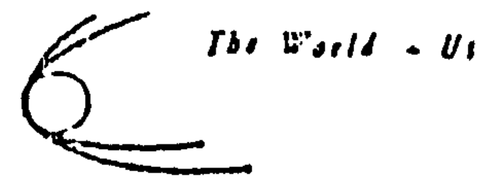
c)


External World
Reality Testing
Ego
Prym. Proc.
Internal World

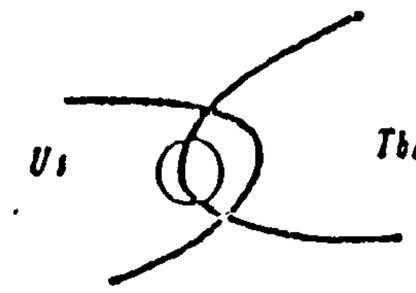
d)


Second. Proc.
EE_k
cog. fct.
aff. ctl.
Ego
Embryo.
Seg
Prym. Proc.
IE_k
Id

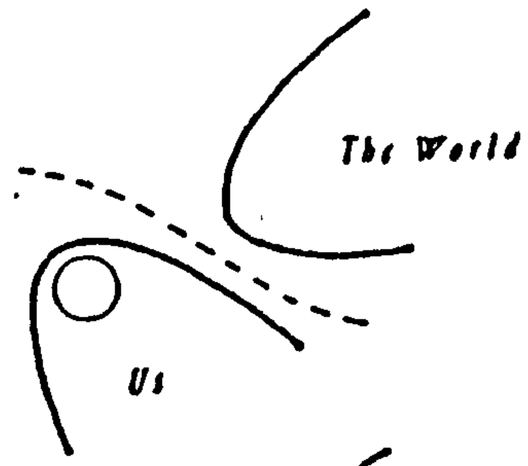
e)


The World - Us

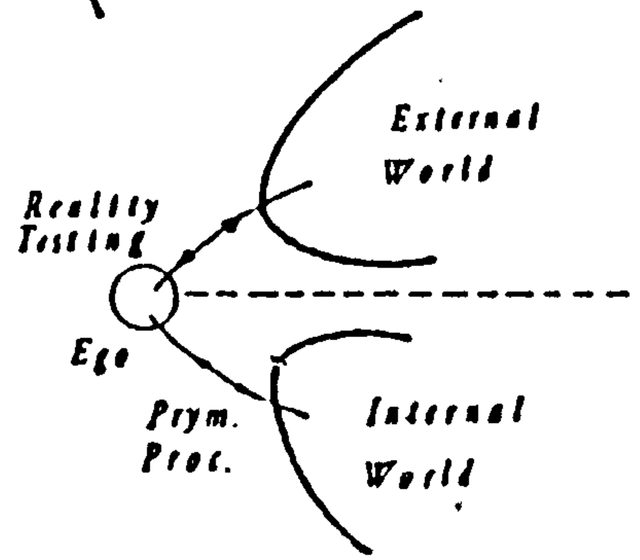
a)


Us
The World

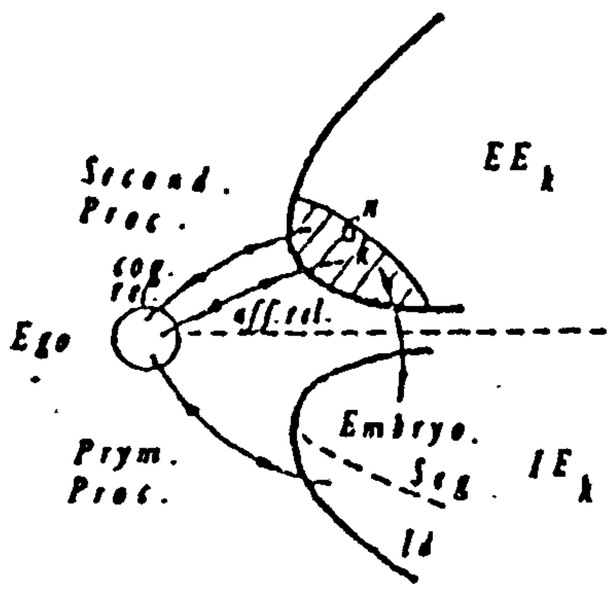
b)


The World
Us

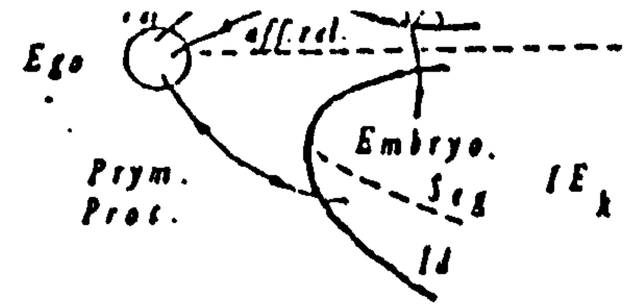
c)


External
World
Reality
Testing
Ego
Prym.
Proc.
Internal
World

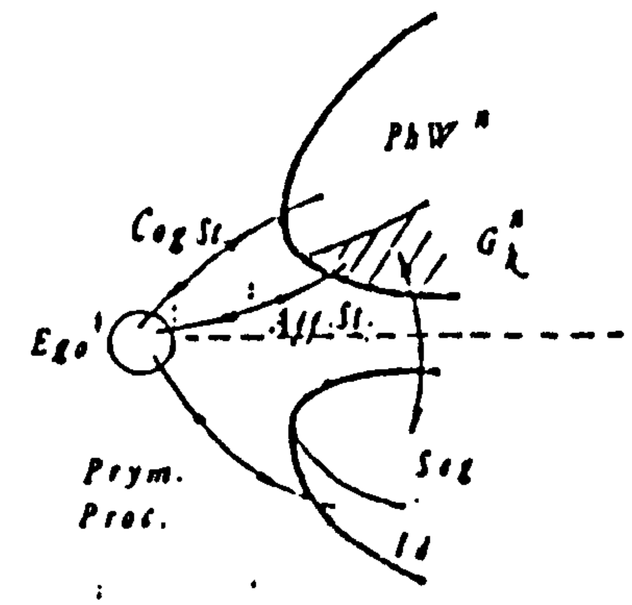
d)


Second.
Proc.
EE k
cog.
fct.
affect.
Ego
Embryo.
Seg.
IE k
Prym.
Proc.
Id

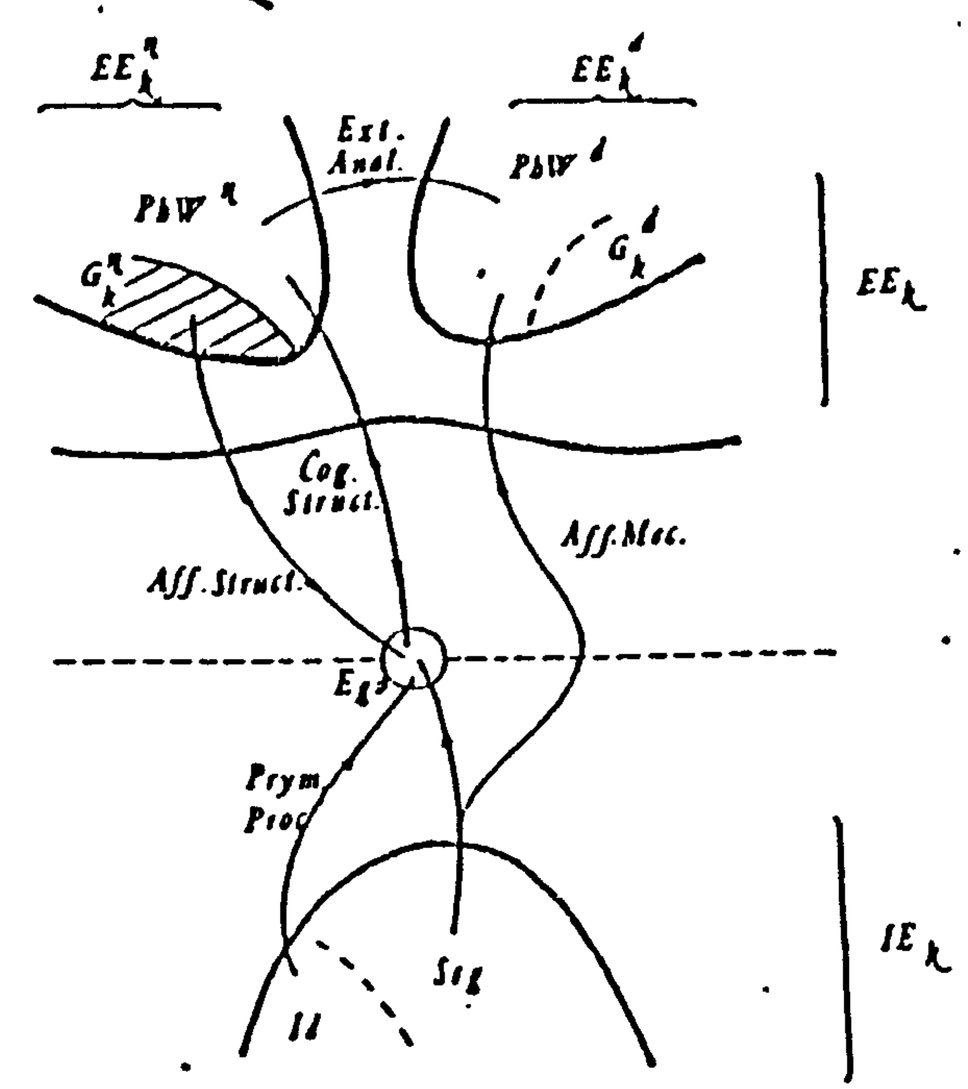
e)



e)

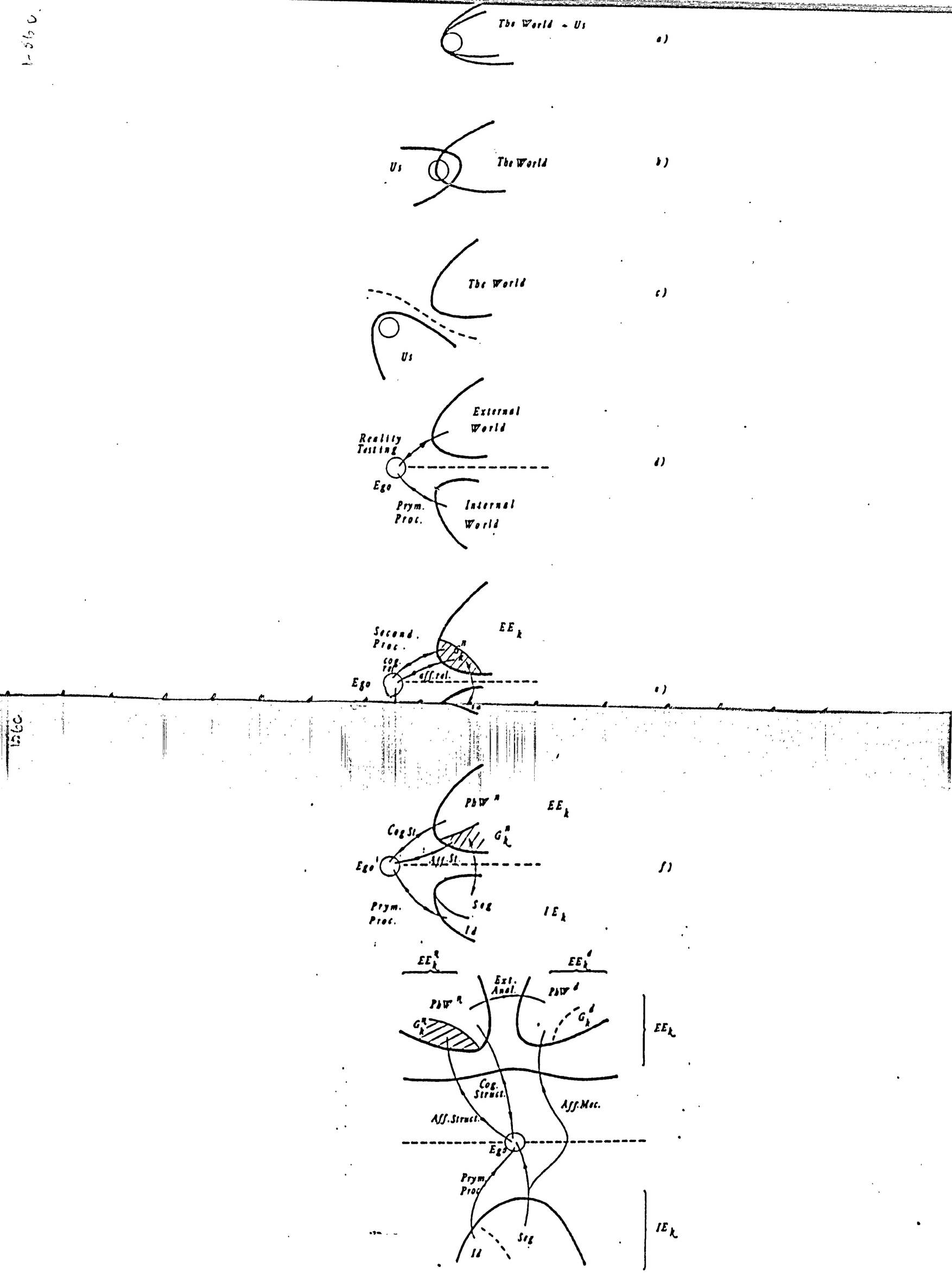


f)



A genetic approach to the construction of a world-embracing image

Fig. 11



A genetic approach to the construction of a world-embracing image

Fig. 11

I/2.2.4, that one which more directly relates these considerations to the historical/scientific problem. It states, summarily:

i) that the "area" corresponding to PhW^N has progressively increased throughout mankind's history (say, more and more things initially regarded as belonging to PhW^D have successively been embraced by PhW^N) (Fig. 12)

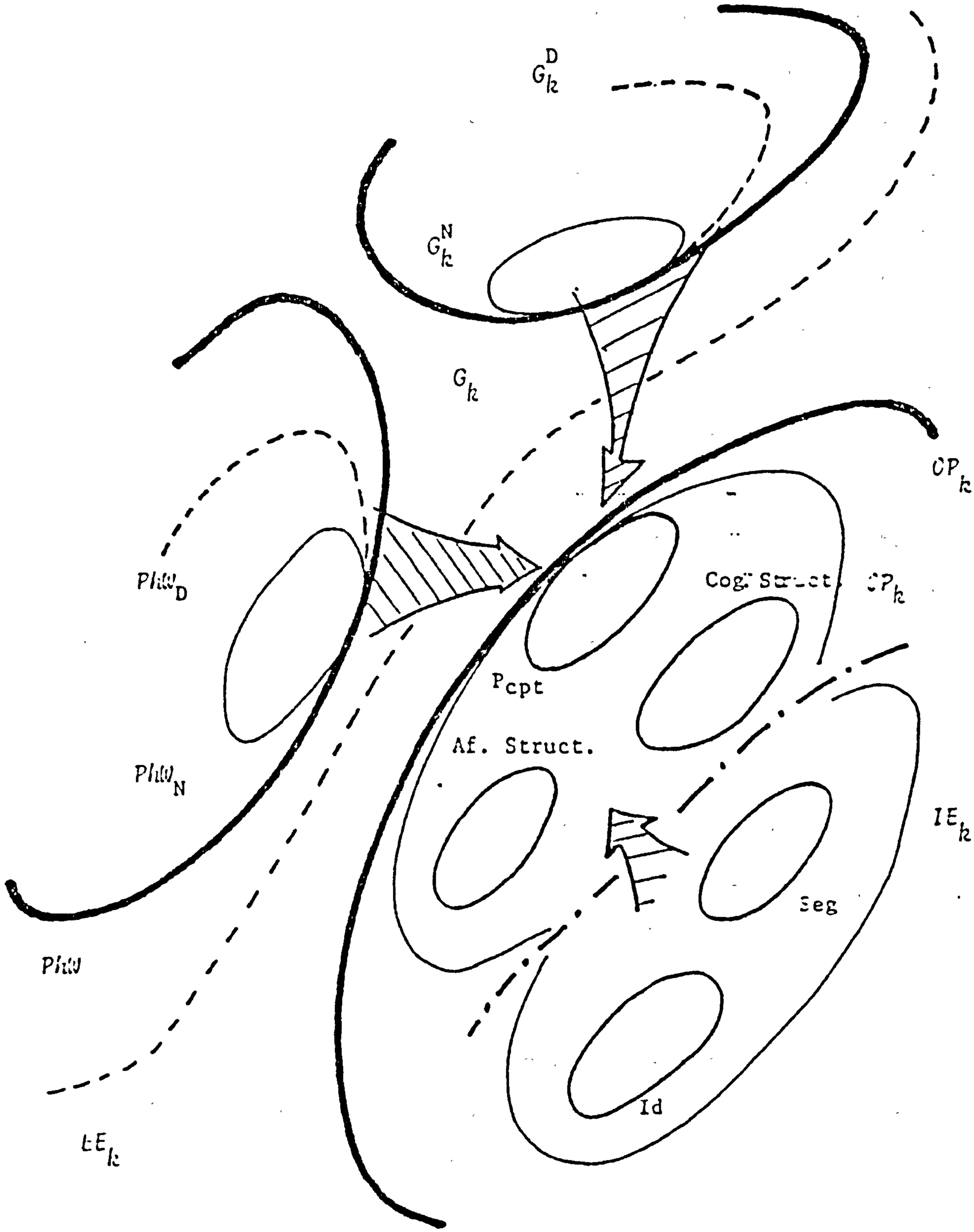
ii)that as far sa this expansional movement of PhW^N has been effectively accomplished (corresponding to a vision of Science as a "growing system) also the influence of "affective explanations upon PhW^D's relationships has progressively decreased,their place being occupied by the cognitive ones.(HYP.FOUR of S/3). Why this happened so is matter whose scope belongs clearly to the

II/2.3 -THE LONG TIME PERSPECTIVE

II/2.3.1. Introduction

As in the case of the short-time (diachronous) analysis this long-time perspective is also the objective of an extended and exhaustive examination, occupying more than three hundred pages of S/6. Reasons for this deal with the problems which such perspective involves; particularly

- the divergences existing between the approaches of PIAGET, WALLON and FREUD to mankind's (long - time) evolution;
- the different viewpoints according to which the contemporary



The short-time interactive perspective

Fig. 12

historical "schools" (idealist, positivist, neo-positivist, etc) look upon past reconstitutions, etc . Briefly: the perspective brings to light those fundamental questions emphasized in I/4.3 and concerning, for example, the so called conflict Myths - Reason [item v)], the distinction between pratical and representative intelligencies [item vi)], the divergences between the followers of the a-(or pre-) logical and metatemporal approaches [item viii)], the "weight" of social contexts upon individual developments [item ix)] etc. As previously asserted all these questions are the objective of detailed analysis in S/6. Particular emphasis is laid in this sense to the application of the (long - time) views of LEVY - BRUHL, BLONDEL, PIAGET, WALLON and FREUD to concrete historical data, showing next the aspects in which new abstract approaches contradict or agree with what is effectively known from our histiorical past;

- to a theory of historical reconstitution (WALSH's coalition pro cess) which, in some way, not only overcomes the divergences between idealists and neopositivists but also agrees with what was stressed in I/2 about actions, contexts, purposiveness, intentions and goals, etc.

Being impossible that such an analysis is reproduced in this ARGUMENT our attention in the next considerations will be simply directed to what in those approaches must be avoided or accepted; this in order to achieve a real adequacy with known historical data. This being done an (insofar as we know) original hypothesis in which many of those questions are overcome (the core of our conjectural model of TSK,indeed) is next introduced, discussed and

applied.

So briefly exposed, conclusions extracted from a comparative analysis of PIAGET, WALLON and FREUD views stress the existence of the following criticizable aspects of the first of these authors:

i) the rigid sequence according to which mankind's developmental stages is supposed to be processed - this in spite of the tremendous simplification which this point of view would bring to the historical/reconstitution problem (at a certain time instant of mankind's history would correspond a typical cognitive structure);

ii) the (assumed) inexistence of "subjective", "affective" or "pre - logical" mechanisms in more advanced stages of mankind's evolution (subsuming an overall view of this evolution quite similar to that defended by BRUHL and BLONDEL);

iii) the exclusion of (possible) long - time alternancies "outwards - inwards", i.e. periods in which the description and explanation of PhW are dominant, followed next by some other intervals in which the human being in itself is the objective of the main concerns;

iv) the non - explicit consideration of social or collective influences upon the acceptance, rejection or simply constancy of the same or of new ideas, conceptions and theories;

v) the (almost integral transposition to mankind's development of the psychological mechanisms which PIAGET has (apparently) brought to light from child's development (susceptible, in consequence, of the same criticism to which the <u>abstract</u> character of his approach has been submited);

vi) finally, the serious historical incorrections to which he is led when examining historical information according to such an initial conceptual frame.

Part of these criticisms is not applicable to the long-term approaches of FREUD and WALLON. In both cases, in fact

vii) social factors are supposed to play an <u>explicit</u> role in individual and collective developments [then contradicting item iv) above] though FREUD's group psychology (involving the unconscious mechanism of identification previously referred to, is undoubtedly deeper than that of WALLON)

viii) "subjective", "irrational" or "affective" influencies upon cognitive developments (individually or collectively) are assumed to be <u>always</u> active even in more advanced stages of those developments (though FREUD's relationship between biology and the unconscious working of the mental apparatus are much more accurate than those which WALLON analysed;for example, no particular significance is ascribed by WALLON to dreams and parapraxes of healthy people, as FREUD did).

If these two aspects are joined together then it is not surprising that a third point, contradicting PIAGET's views [now item iii) above] can also be brought to light. We have in mind

ix) the aforementioned alternancies "inwards-outwards" which both of such approaches consider either <u>explicitly</u> (WALLON) or <u>implicitly</u> (FREUD) though none of their authors had made <u>concrete</u> applications of them to historical situations.

This aspect is important for it emphasizes a (possible) criticism to WALLON which

x) briefly, is that (contrarily to PIAGET) WALLON did not make concrete historical applications of his long-time explanatory system; insofar as we know, in fact, the existence of typical stages in mankind's evolution was, for example, never explicitly brought to light. This situation did not happen with FREUD (for him mankind's evolution obeys three main phases which he named "animist", "religious" and "scientific").

However:

xi) either these phases are supposed to embrace all of mankind's development (i.e. as though it were regarded as a "whole" whose "parts", corresponding to the different cultures and civilizations existing at a certain epoch, are thus looked upon as changing <u>simultaneously</u> - which historically did not happen; or

xii) the reasoning which FREUD used to bring them to light can also be subjected to the same objections which we emphasized as regards PIAGET. As a matter of fact such stages are directly mirrored from those he brought to light about the individual evolution "child towards adult"; thus, implying that children's earlier stages are, in a way, similar to those of primitive cultures - an analogy which contradicts the rather complex social, political or even "technological" level already reached by some of such "primitive" civilizations (recall, for example, the astonishing monuments erected in Egypt, Babylon, Baalbeck in Lebanon etc).

Some general framing conditions follow from this condensed comparative analysis.

On the one hand, and in order to avoid the criticizable points previously emphasized, also avoided must be

A) References to mankind as a "whole" as FREUD does (point xi)

B) References to society as a whole as PIAGET and WALLON do (point xi)

C) Exclusively affective or exclusively cognitive analyses of mankind's evolution as FREUD or PIAGET do (this in order to satisfy either WALSH's coalition procedure or its underlying concept of "action")

D) Identifications between children and "primitive" as well as between adults and the present-day states of our civilization (point xii)

On the other hand, and having now in mind the insertion of really occured historical events into <u>concrete</u> contexts as well as of their <u>real</u> time-evolution, <u>necessarily</u> <u>considered</u> must be

E) The "coincidences" existing between some of the characteristics of child's evolutionary stages and those which (broadly speaking) describe some typical periods of the history of the scientific European Thought (as PIAGET, WALLON and FREUD correctly stress); for example, the primacy of affective explanations in the earlier phases of that history, the systematic use of qualitative descriptions of Nature till, at least, the XVIIIth century etc.

F) The role which society (in general) plays in the acceptance, rejection or simply constancy (say, pure reproduction) of this or that individual development. Or, contrarily, the influence of such individual developments upon the reinforcement, opposition or constancy of this or that collectively accepted ideology [points iv) vii)]; finally

G) The always present influence of affective "mechanisms" upon cognitive explanations (even that such an influence is not consciously felt) and through them, of possible regressions to already superseeded stages, "alternancies", "crises", etc. [points ii),iii) viii)].

It is precisely upon these aspects that our long-time modellistic hypotheses are based.

II/2.3.2 - THE TOPOGRAPHICAL AND COLLECTIVE VIEWPOINT

The first of such conjectural modellistic hypothesis deals essentially with OP_k's <u>contexts</u> (HYP.FIVE of the whole essay).

In its most concise form it states that (from a topographical, collective and long - time perspective) the satisfaction of A) B) and F) above requires that the <u>concrete</u> group environment into which the *OP*s were <u>really</u> inserted must necessarily be taken into account in any historical/scientific reconstitution. The word "concrete" subsumes two additional interpretations of such environments with which those outlining conditions are intimately associated.

i) firstly [from A)], the usual abstract vision on mankind as a whole (as for example FREUD did) must henceforth be avoided. Though certain mental mechanisms (particularly the affective ones) seem to be not only time - invari ant but also common to all human beings, this does not necessarily mean that <u>at the same epoch</u> all mankind's societies are at the same cultural level. The consequence of this is that "mankind" must be regarded as a complex set of civilizations, cultures, dinamically interacting with one another and playing either throughout time or in this or that specific region of the world (its prevailing "influencing area" according to BRAUDEL's terminology) a more or less relevant spatio - temporal role.

ii)Secondly [from B) above], that the way of looking upon each one of these civilizations, cultures or societies, again as an abstract "whole" (as PIAGET or WALLON did) must also be avoided.

Though to these group environments some common characteristics may be ascribed (especially those related to the existence of a common religion, a common language etc) such environments must on the contrary be topographically partitioned into several classes [scientific (Z^*), religious (R^*), political (P^*) etc] mutually interacting and whose importance is (beyond their proper time - variancy) also variable according to OP_R's own goals. From the historical/scientific point of view with which this essay is primarily concerned this importance depends essentially on the influence which R^*, P^* etc may have had upon the "growing", constancy or decreasing of Z^*'s area.

This is equivalent to say that [from the topographical (collective) and long - time viewpoints previously emphasized] the elements of the total group environment of a certain OP_k are susceptible of a partition into three main hierarchical classes

- a class Z^* which plays the most direct influence on the acceptance or rejection of some alterations proposed by OP_k (as regards *PhW*'s descriptions)

- alteration which is next confronted with the (possible) agreement or rejection proceeding from R^*, P^*, T_c^* etc (in a lesser or higher time - variable degree)

- agreement or rejection which, in turn ,(may) depend on extraneous influences coming from civilizations, cultures or societies different from that one into which such an OP_k is (was) inserted.

Briefly, (taking again into account the concept of neighbouring and distant worlds) as though the social or collective influences to which this OP_k is (was) submitted, were regarded as proceeding from three (social) "worlds"

- one (G_k^{NN}) directly related to the scientific community (or group) to which he belongs

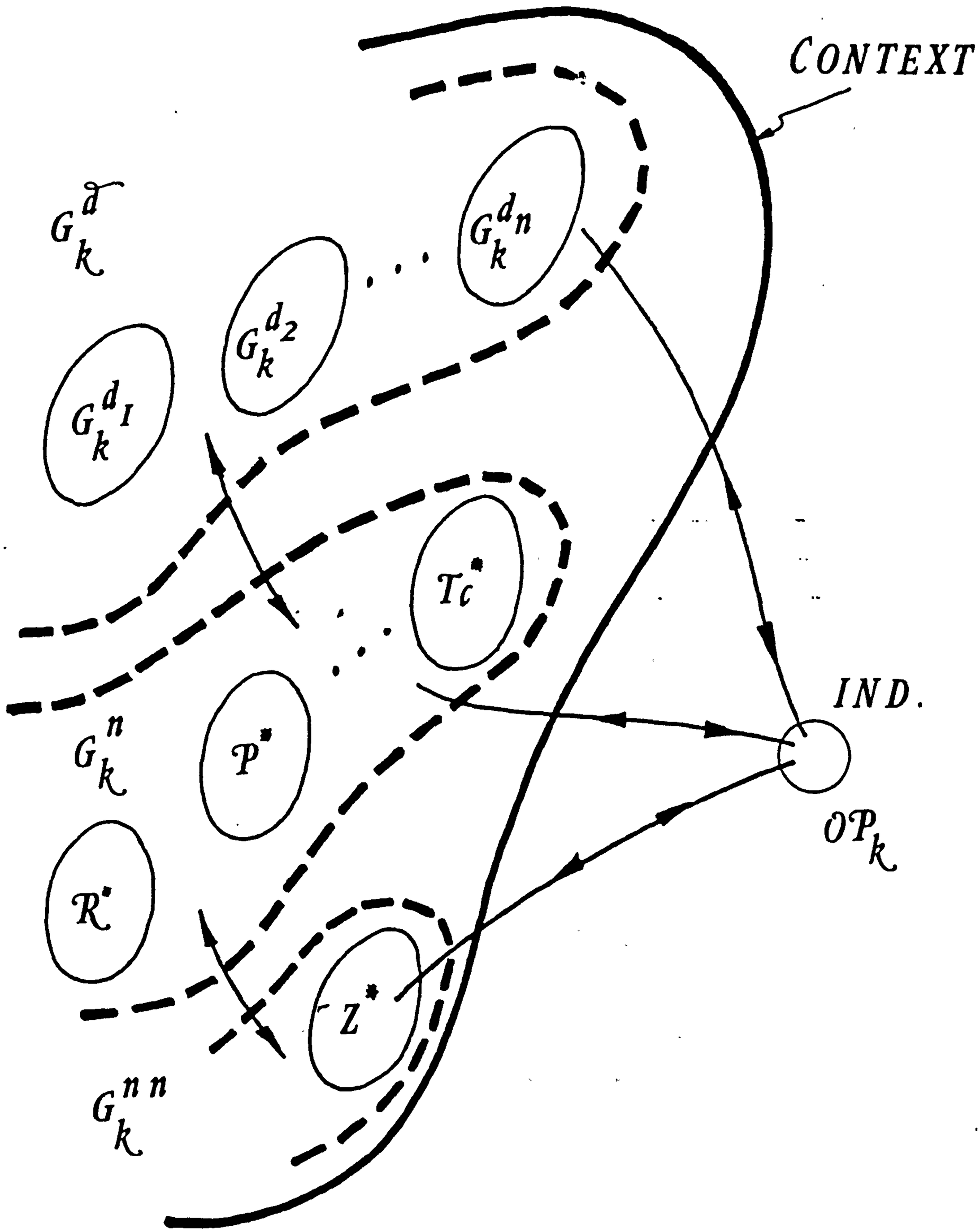
- another (G_k^{N}) in which R^*, P^* , Tc^* etc are included

- finally, a third one (G_k^{D}) associated with other civilizations cultures etc.

A symbolic representation of these "worlds" is given in Fig. 13.

The features, number and relationships between the (topographical) elements of these worlds have, obviously, varied throughout mankind's history. From them all the "weight" of R^* upon Z^* has been particularly relevant, since it has brought to light two types of *PhW*'s explanations, behind which different <u>mental structures</u> have played distinct roles. These structures and their mutual links are now the objective of

II/2.3.3 - THE TOPOGRAPHICAL AND INDIVIDUAL VIEWPOINT



Neighbouring and distanct classes of some context

Fig. 13

This viewpoint deals with HYP VI of the whole essay, that one in which (topographical) individual and long-time perspectives are especially foccussed.

This overall hypothesis is intimately associated with the outlining conditions C), D), E) G) and it includes 8 basic assuptions supposed to be extensible to all human beings, whatever they may be or whatever may be the epoch in which they are being considered.

i) ASSUMPTION 1 lays emphasis upon the concepts of maturation and development when applied to human beings. It implies a particular way of looking upon the new-born baby as a psychologically indifferentiated organism, born with a congenital equipment and some "Anlagen" (or tendencies). Several biological functions, structures, even instinctual impulses will be progressively differentiated in the course of the child's evolution according to the evolutionary laws which that maturation and development obey. Here

- maturation must be understood as dealing with the progressive unfolding of phylogenetically acquired functions (functions which are innate and peculiar to the human species) emerging in the course of the embryonic development, appearing as "Anlagen" after the birth or becoming explicit in posterior stages of child's life.

- development deals with the emergence of forms, functions, behaviours, etc. which are the result of interactions between the organism on the one hand and its internal and external environments on the other.

ii) ASSUMPTION 2 stresses the particular (biological) character of human beings at the occasion of their birth; say, in other words, their altricial, incessorial, immature and defenceless features at that occasion. Under these conditions - being incapable of locomotion, of any goal directed (or volitive) behaviour indispensable for their self-preservation (excepting sucking), etc. - their survival becomes therefore dependent on their parents' cares (as it also happens with other incessorial animals)

iii) ASSUMPTION 3 emphasizes the long period of childhood during which this dependence lasts as well as the psychological ties which it (consequently) engenders between the child and its parents. Particular important are in this sense

- the role played by the (biological) development of the kinesthetic organization (to which the unconscious is related) upon the diacritical one (associated with cognition and consciousness)

- mother's role in the progressive setting up a specific emotional "entourage" which (through successive interactions "action-reaction-action" with the baby) is gradually providing to it means of transforming meaningless in meaningful stimuli; say, in other words, essentially affective links through which it progressively learns to bring about relationships between elements

of its world. [WALLON, FREUD, HARTMANN, LEWIN, ISAKOWER, SPITZ, VON SENDEN etc. as well as condition G) above]

Briefly: as though the growing and development of the child's psychological sector were essentially dependent on the setting up and progressive differentiation of more and more significant objectal relationships i.e of social relationships.

How these primordial relationships affect the child's psychological evolution is a matter of intensive (though, to a great extent, still conjectural) research. Some (possible) clarifying clues may, however, be brought to light if [together with i), ii), iii) above] another assumption is postulated. This new assumption ,now

iv) ASSUMPTION 4, lays emphasis upon a peculiar way of looking upon individuals (whatever they may be or whatever may be the epoch in which they are being considered) not in themselves but, rather, in terms of biological relationships between them and the preservation of the human species to which they belong. Briefly: it looks upon this general individual as a temporary and transient appendage to the quasi immortal germ plasm which is entrusted to him by the process of generation .Which is tantamount to prevail the role played by sexuality (regarded from this biological point of view and not in terms of a simple somatic satisfaction) and, through it, of the relationships between these instinctual stimuli, affectivity and child's (human) evolution in general.

If this ASSUMPTION 4 is related to the preceding ones then one overall (long-time) conclusion underlying

v) ASSUMPTION 5 , can now be brought to light: that the model of the psychical apparatus outlined either in S/3 (item 3.6 in particular) or in APPENDIX A to PART TWO of this essay can (if some precautions are taken) be extended to the individual's (long-time) psychological evolution.

What this concretely implies is, therefore, the acceptance of

- the basic regulator principles which (seem to) govern psychic functioning (say, the principle of constancy, the pleasure-pain principle and the reality-principle)

- the descriptive division of the mind into unconscious and consciousness

- the metapsychological approach to the mental working (involving the so-called topographical, economic and dynamical points of view)

- the structural partition of the mental apparatus into the three (topographical) agencies named "id", "ego" and "superego" as well as their mutual relationships

- the genetic approach which this division underlies (say, that any psychological phenomena, beyond their contemporary and experiencial aspects, may be reconstructed till its psychological source through an ontogenetic process; when referred to development this reconstruction lead us back to the birth; when

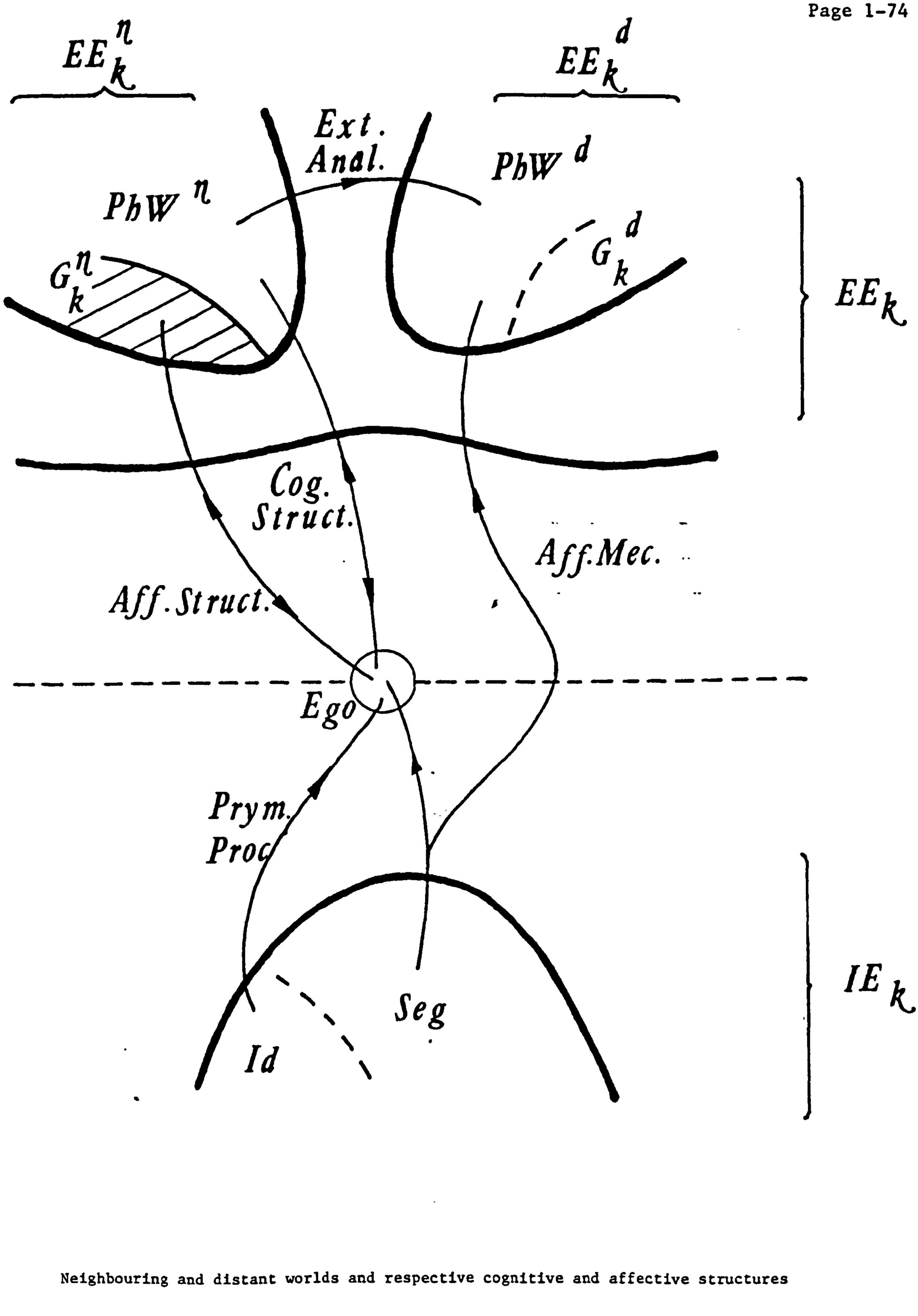
prevailing maturation and associated congenital factors it leads us back to embryology and phylogenesis)

- the <u>adaptative</u> approach [HARTMANN (1939), ERICKSON (1950), SPITZ (1957), RAPAPORT and GIL (1959)] asserting that any psychoanalytical explanation of some psychological phenomena must include propositions dealing with its relationships with the environment

- finally, the concepts of <u>neighbouring</u> and <u>distant</u> <u>worlds</u> previously introduced as well as of their (time-variable) relationships with the internal world, primary and secondary processes, timeless influences of the past upon the ego's contemporary and actual experiences, the theory of the two memory-registrations, ego's affective and cognitive structures, defence and "as though" mechanisms,"actions", reality-testing etc (Fig.14)

One aspect of these relationships is (still) matter of pure conjecture: that one dealing with the (short, and consequently) long-time links between <u>affective</u> and <u>cognitive</u> structures, with their "weight" upon *PhW* explanations etc. Briefly: with the aforementioned conflict "Myths-Reason" [question v) of I/4.3], with the divergencies betwwen the defenders of the <u>a</u> - (or <u>pre</u> -) logical and <u>metatemporal</u> structures [question vii) of I/4.3], with the discrepancy between "practical" and "formal" intelligences [question vi) of I/4.3] etc and (through them) with the outlining conditions C) D) E) and G).

All these questions are the objective of ASSUMPTION 6 and 7.



Neighbouring and distant worlds and respective cognitive and affective structures

Fig. 14

vi) ASSUMPTION 6 lays emphasis upon a particular epistemological and (also cybernetics) relativistic situation in which two generic individuals A and B are somehow communicating (though not necessarily exchanging information) about a previously chosen subject matter.

The premises on which this communication is founded, are that

- this matter deals with *PhW*'s descriptions

- the features by means of which *PhW* is described are partially common to A and B

- A poses pertinent questions to B in order to know what B knows about *PhW* but if B has no answer to them A will not teach B. In other words, A's role in this conversation scheme is restricted to a (somehow) passive examination of B's spontaneous reactions

- initially, B is supposed to be a child (aged 11-12 for example) and A may be a psychologist or an epistemologician (for example).

The situation so described obeys, generally speaking, that one involved either in PIAGET analyses of children's cognitive behaviours or in any child's psychoanalytic examination (as regards its affective reactions). Whatever may be the conclusions which these psychologists may extract from their observations, the point which needs to be stressed - a crucial point of this assumption, indeed - is that, though able to perform this or that action, to solve this on that appropriate problem or to express

this or that affective behaviour, B is not aware neither of the phases according to which its psychological evolution was processed nor of the "rules" or "mechanisms") which its descriptions subsume. Briefly: B works as though the psychological processes there involved were, in some way, unconscious (for him);here unconscious embraces not only FREUD's affective "unconscious" but also the proper development of B's cognitive structures).

Further:

- if B is supposed to be inserted into some "primitive" context (which may be symbolically represented by some other individual C also unware of such phases and rules (but not of his own feelings and emotions)

- if A's position remains passive (or, which is equivalent, if there were no PIAGET or no FREUD able to detect, reveal, convince and teach B and C of what had been "hidden" in such descriptions)

then B would probably grow up and live following C's interpretations of *PhW* (according to the transmission mechanism emphasized in the item I, i.e learning from C what he had already learnt from his contemporaries and ancestors); and till that a new B (or a new C) discord from such interpretations [proposing perhaps new (till then) unsuspected questions, solving them and convincing C (or B) of the validity of such (temporary) solutions] no contextual (or paradigmatic) alterations would arise. In other words: B and C would live, believing that their interpretations

were valid.

It is almost meaningless to remark that the outlining lines according to which this situation has been described so far, can be applied to many of present-day people either adult or still growing human beings, individually or collectively regarded [7].

However, and this determines another step of this reasoning, from our point of view it can also be transposed to our historical past. History teaches us in fact, that (till the ends of the XIXth century, at least) all scientists of all epochs were always convinced of the "strength" of their conceptions about Nature, everything working (for them) as though such interpretations were (in each epoch) supposed to be extensible not only to their past but also to their future; say, in other words, as though they were absolute and not merely relative to a certain data-set and to a certain mental frame. On the other hand, cybernetics (and, in particular, HYP. ZERO) also shows that the communication scheme previously brought to light is susceptible of being converted to a learning/teaching adaptative (and evolutionary) system, since

- A is now supposed to be a scientific historian OP_R,

- C is the symbolic representative of B's (time-variable) environment E_k,

- B himself is regarded as playing the role of an adult

[7] Which in a certain sense may be regarded as a support to HYP. FIVE.

observer/participant OP_k.

It is precisely from these two <u>facts</u> - the similarity between the attributes of A and OP_R before two pasts as well as the fact that the OP_k were <u>adult</u> and not children - that the last step of the reasoning underlying ASSUMPTION 6 starts.

For:

- If the general problem which A and OP_R face is fundamentally the same (to bring to light and explain thought processes and their time-variation) T_{ij}

- If A ($\equiv OP_R$) knows more of PhW than B($\equiv OP_k$) because throughout his life, he became ultimately aware

a) of a set of inference rules, affective mechanisms, processes of thinking (in general) etc. <u>belonging to himself</u> and

b) of their application to the solution of problems, to the discovery of new elements and/or relationships of PhW, etc. [which, in turn, may lead to an enlightenment and deepening of OP_R (≡A)'s own mental processes]

awareness which, in both cases, was <u>detected, revealed, transmited</u> and <u>taught</u> from generation to generation then

-why do not assume also that OP_k's long-time evolution (primarily though not exclusively expressed in terms of PhW's descriptions) was, too,

- dependent on an <u>increase</u> <u>of</u> <u>self-knowledge</u>[8] according to the global ("positive") feedback mechanism [9] of Fig.15 a,b

- increase which, if socially (contextually) accepted, spread one's knowledge to other observers/participants (Fig.16 a,b) (Final version of ASSUMPTION 6)

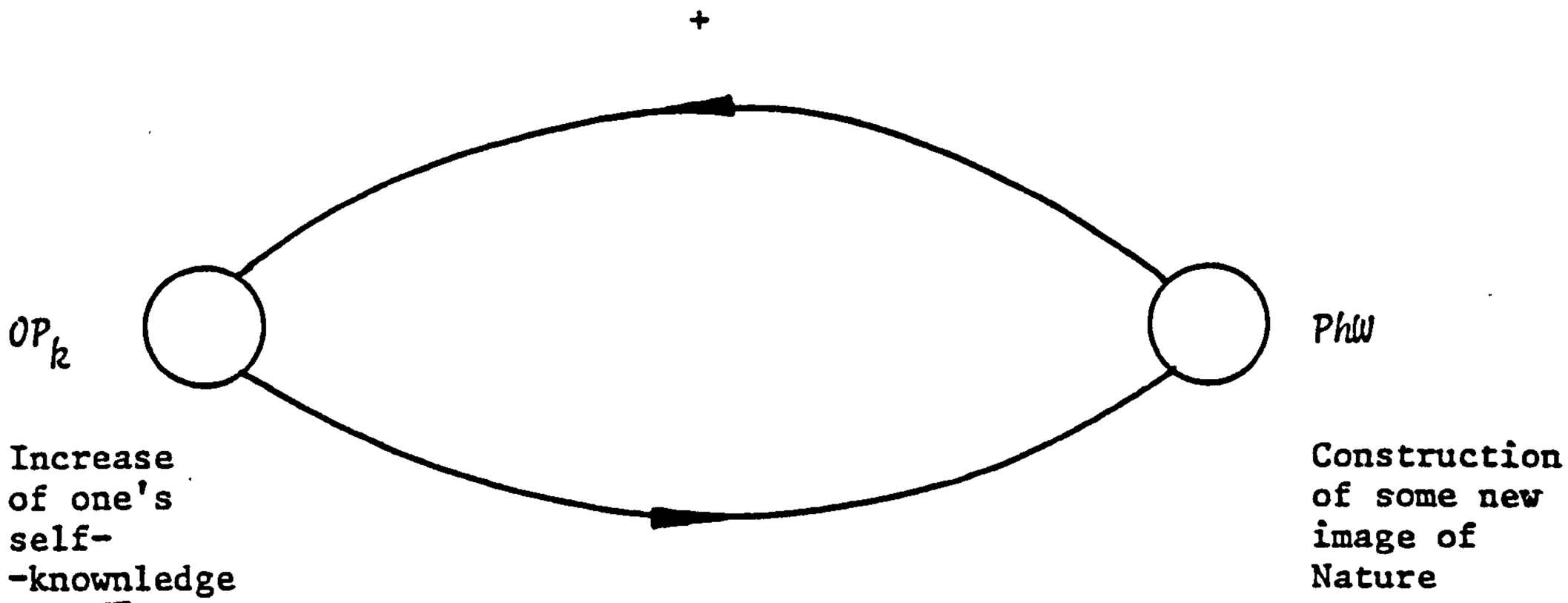
vii) ASSUMPTION 7 asserts that throughout mankind's history this increase of OP_k's self-knowledge was made in such a way that (globally regarded) the "weight" of <u>affective</u> explanations (based upon the "as though" mechanisms previously refered to) upon the <u>cognitive</u> descriptions and explanations of *PhW* [founded on inference (logical) rules experimentally confirmed] has successively decreased.

This decreasing has been followed by an overall <u>expansion</u> of PhW^N's "area" (as regards that one belonging to PhW^D, HYP. FOUR) expansion which, in turn, has <u>always</u> been conditioned by the "positive" or "negative" influences of OP_k's particular contexts G_k.

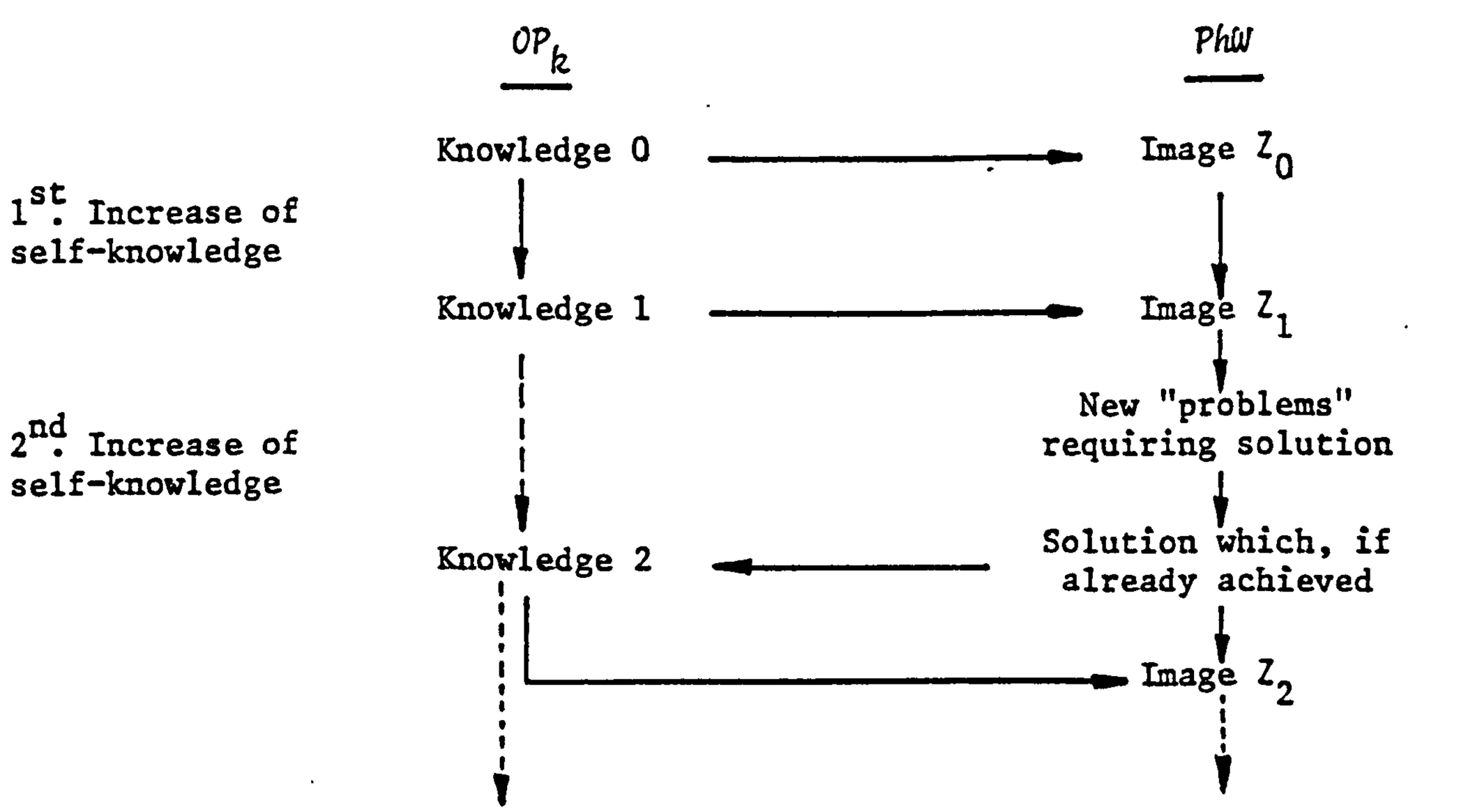
Finally

[8] In the sense of a progressively greater <u>awareness</u> of himself; say, of a progressive discovery of inner (mental) processes which, till some epoch, worked as "unknown", "hidden" or "unconscious" to the consciousness of his possessor.

[9] Not considering contextual influences an increase of one's self-knowledge leads to the construction of a new image of *PhW*; this leads, in turn, to the emergence of new problems, new questions etc. whose solution or answer requires (or leads also to) another increase, this to a new image, etc.



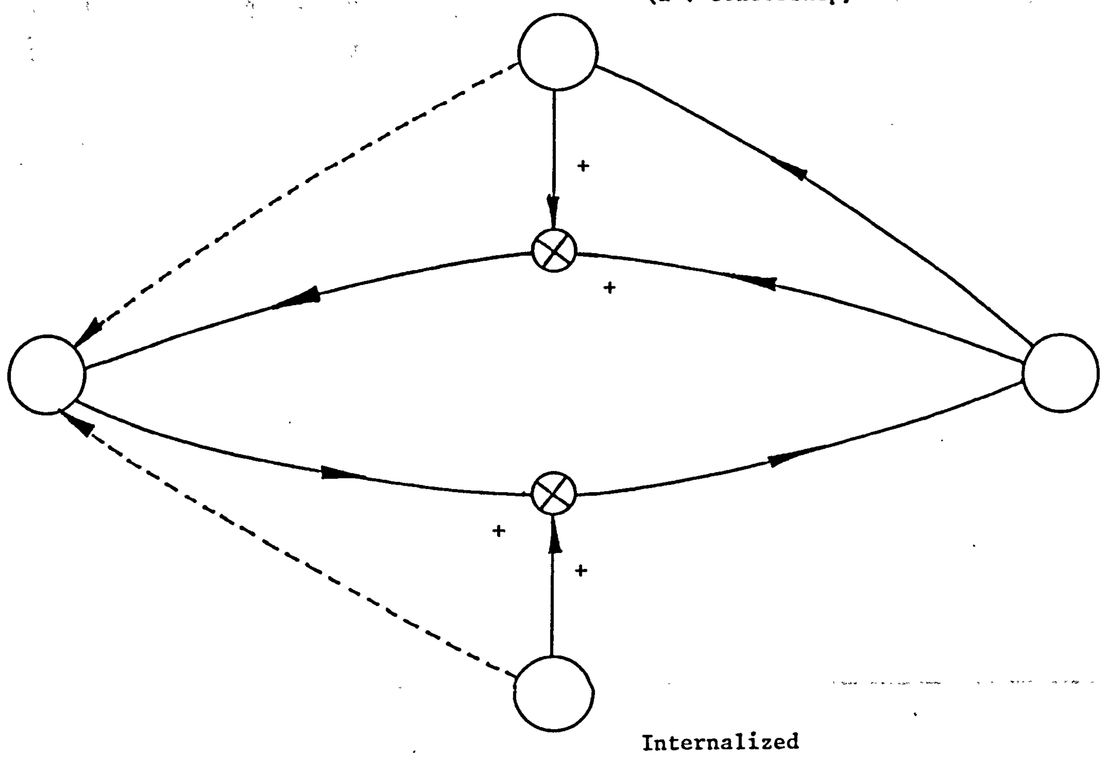
a)



b)

Fig. 15

OP_k's evolution of knowledge. No explicit contextual influences



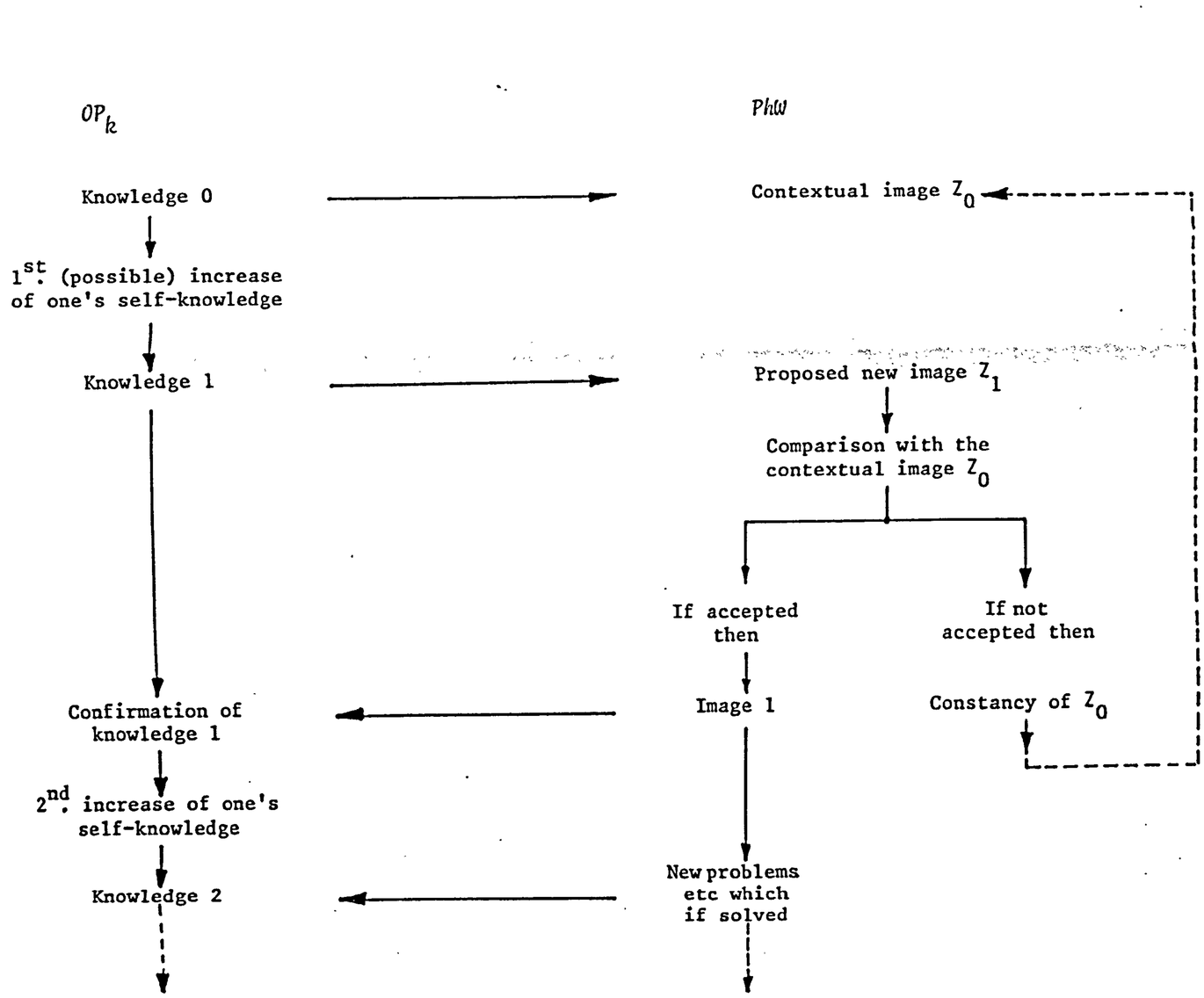


Fig. 16

OP_k's evolution of knowledge. Explicit contextual influences

viii) ASSUMPTION 8 lays emphasis upon the concrete application of the overall mechanism previously stressed to the history of the scientific European Thought. In its most concise form it asserts that (globally examined) the conditioned expansional movement which ASSUMPTION 7 brings to light, led to the emergence of (so far) three progressively growing (typical) images of Nature (three great theoretical and stable long-time "constructs"):

- the first was based upon the Greek Organicist Vision and last until the XVIIIth century (through the influence of the Aristotelian-Scholastic doctrine suitably adapted by the Christian Religion)

- in the second (which corresponds to the so-called Renaissantist Image) God was put aside from Nature and this, in turn, was regarded as a sequential deterministic machine made by God

- the third is still in formation since the ends of the XIXth century but its tenets point already towards an overall vision of Nature as some kind of self-organizing and self-controlled machine (probabilistic and statistically described) in which theological considerations have no influence at all. (Similar in some way to GASSENDI's viewpoint in the XVIIth-XVIIIth centuries).

II/2.3.4- SOME (LONG-TIME) FINAL CONCLUSIONS

Some of these assumptions seem, at a first sight, to be pure truisms. However, suitably interpreted and developed, they provide answers not only to the fundamental questions previously emphasized but also to many other queries which (in so far as we know) have

never been examined (and explained) before. These answers - working as some kind of COROLLARIES of the preceding assumptions - are exposed in the sequel. From the widest to the most particular views on mankind's whole psychological evolution

COROL. 1- respects the double feedback scheme[10] which Fig. 15 a) condenses. It is deduced from ASSUMPTION 6 and it brings to light a (possible) overall explanatory mechanism underlying not only OP_k's long-time psychological evolution (in which contextual influences are included) but also the ultimate reasons for its (long-time) existence.

As a matter of fact

i) Excepting the situation in which the contextual trasmission conditions (represented by libraries, oral or written traditions, etc.) are supposed to be anihilated - once the process leading to one's increasing of self-knowledge has been broken out and socially spread (somewhere in a remote past) then, henceforth - and due to the positive feedback influence - it will no longer be stoped. Globally examined the process may present temporary delays or even retrogresses to already superseeded stages (if the local influence of the "negative" feedback social influences are supposed to dominate the positive ones) but once some (more relatively recent) OP_k

[10] The scheme includes in fact two feedback systems: one "positive", symbolically represented in Fig.15 a); another (usually) "negative" or (stabilizing) working as a systemic expression of that (usually unconscious) tendency to obey past standards and (consequently) to reduce or eliminate any alteration regarded as a disturbance to them.

- has access to the information corresponding to the most advanced gnoseological state existing before the contextual disturbance

- has power to convince his contemporaries of what had already been achieved in the past

then the whole evolutionary process is in conditions of re-starting again[11]. The same "mechanism" justifies also what we can designate by an <u>accelaration</u> of the whole ("positive" feedback) interactive cycle OP_k --> PhW's images. It suffices in fact that, instead of "negative" the contextual influences G_k --> OP_k are now "positive". In other words, instead of tending to hold the patterns and standards inherited from some (relative) past, the context "foments", "helps", "is in accordance with", etc. the alterations which this or that OP_k has proposed as regards PhW's explanations[12]

These results can be directly related to

ii) one of the outlining conditions which any long-time reconstitution must obey [item II/2.3.1]; in this case condition G. Even that the "positive" or "negative" weight of the contextual influences are neglected the scheme of Fig. 15 a) shows in fact

[11] Historical examples supporting this overall view are manifold. We simply recall the emergence of the Renaissantist movement (the prefix "Re" is here particularly significant) or GASSENDI's retrogress to the ancient atomistic conceptions of DEMOCRITUS and LEUCIPUS after the successive failures of the Aristotelian-Christian substantalistic doctrine in the XVIth-XVIIth centuries.

that the growing of the global interactive cycle OP_k <--> PhW's images depend on two <u>factors</u>

- <u>OP_k's possibilities of increasing their self-knowledge</u> (which may be regarded as subsumming a period of mankind's history in which their minds are primarily, though not exclusively, foccussed upon their inner mental working)

- <u>the effective construction of PhW's images</u> (which may be interpreted as corresponding to a period in which people's minds are essentially devoted to the solution of the <u>concrete</u> problems it presents, etc. Briefly: as OP's minds are now turned to the "outside", instead of their inside as it happened in the preceding period.

Under these conditions both of the Figs may therefore be interpreted

[12] As in the preceding section, supporting arguments of this new situation are manifold. Not considering present cases (in which this or that scientific area is developed taking into account, for example, political or defence imperatives) two (past) situations are especially relevant (See S/6); we have in mind

- firstly, the complete reversal of attitude which the Christian Religion had in the XVIIth-XVIIIth centuries as regards experimentation. Primitively forbiden (due to the organicist and theological character which the image of Nature had till there) experimentation became next <u>fomented</u> since Nature was henceforth regarded as a machine made by God; under these new (contextual) conditions, the discovery and confirmation of its hidden mechanisms were no longer a sin but; rather, a means through which His glorification was possible.

- secondly, the astonishing development which <u>any</u> artifact, machine or even conception (pratical or theoretical i.e. leading to an ideology) suffered in <u>any</u> epoch of mankind's history (since its most primitive times) once its social <u>utility</u> has (somehow) been proved or demonstrated.

as containing (implicitly) the two movements <u>inwards-outwards</u> which that outlining condition G determines. The existence of these movements as well as of their conditioning poles "OP_k", "PhW" underly precisely

<u>COROLLARY 2</u>

This corollary is deduced from ASSUMPTIONS 1 and 6 in special, and it provides a first answer to the two structural (mental) approaches which question vii) of item I/4.3 subsume: the <u>metatemporal</u> and the <u>a</u> (or <u>pre</u>) logical theories

As a matter of fact:

- if (by initial dint) past or even present OP_k are supposed to be <u>adult</u> and not children [this implying that their neurological, physiological, biological, etc. systems have already ceased their phylogenetic and ontogenetic maturational development (ASSUMPTION 1)]

- then OP_k's "(long-time) increasing of self-knowledge" postulated in ASSUMPTION 6 can, in fact, be interpreted as the result of an evolutionary process in which affective and cognitive mechanisms <u>already existing</u> in them under <u>a potential form</u> are progressively becoming <u>actual</u> as far as such an increase has been temporally processed.

Everything works therefore as though all OP_k (as well as all their contemporaries) were the possessors of some inborn (affective and cognitive) basic structures, of which till some historical epoch they were not completely aware; they can apply them to the solution of this or that appropriate problem or to the satisfaction of this or that need but, due to that temporally variable unawareness, they do not know what had been "hidden" behind such applications. The arguments which can be presented in order to support this interpretation are innumerable.[13] Part of them - those founded on a(n overall) genetic analysis of that time-variancy are more circunstantially analysed in COROL.3; another part is the objective of an exhaustive examination in PART THREE of this essay.

Four main consequences may be extracted from this interpretation:

i) it clearly prevails the biological role of maturation[14] upon the phylogenetic and ontogenetic development of such basic structures; or, which is similar, it points in principle (we insist in this "in principle") towards the adoption of a metatemporal structural theory (see COROL. 3 for more details).

ii) it allows a partition of the general term "knowledge" into two complementar classes: one, more concretely related to one's self-knowledge in the sense previously described, which (according to BERTRAND RUSSELL's terminology) may be called acquaintance; the other, associated either with what this acquaintance engenders (in terms of application) or with what it is acquired (learnt) from "outside" which (following the same terminology) will henceforth be named knowledge-by-description.

The importance of this classification will be fully understood in II/2.4.

[13] For the moment we simply recall four; two deal with the past, the remainder with the present:

i) The first (which can also be regarded as a support to COROL. 1) proceeds from the british historian COLLINGWOOD, being implicitly contained in his "The Idea of Nature". Speaking about the general evolution of the European Thought he asserts in fact "... In the history of this evolution there were, so far, three typical periods of constructive cosmic mentality: when the idea of Nature was brought to light by thinking, became objective of intensive and extended cogitation (and consequently acquired new features) which, in turn, ascribed new characteristics to the detailed image of Nature to which that remote idea had meanwhile given rise.

ii) The second argument comes (partially) from PIAGET. When examining more attentively what psychologists call "the awareness law" he says: "... We have no immediate awareness of our own mental operations. They work by themselves till that some external obstacle is found. Hence, awareness is centripetal, not centrifugal, i.e. before that its intimate mechanisms are reached, it starts from their external results" (PIAGET, Psychologie et Epistemologie, p.123-124). A concrete (historical) example of this proceeds from the (unconscious) use, which mathematicians and physicists made for centuries of the operations which define an algebraic group;this, until GALOIS was able to reveal and (consequently devélop) this particular structure, integrating a lot of appararently different operations.

The third and fourth supporting arguments [also extensible to the first, long-time, modellistic hypothesis)] deal now with our present:

iii) many (healthy and sick) of present-day people (or cultures) behave, in fact, as our ancestors did <u>before</u> <u>they</u> <u>are</u> <u>(somehow)</u> <u>taught</u> (which agrees with the assumed intemporality of their basic affective and cognitive structures)

iv) finally, we cannot forget that before FREUD or PIAGET have brought such "hidden" structures to light, part at least of the Western Civilization had already reached a high degree of development in terms of 's knowledge.

[14] Thus, agreeing with the points of view of WALLON and FREUD.

iii) It prevails the individual influence of this or that OP_k upon mankind's (general) development as well as of the importance of their social (contextual) transmission conditions [in the spreading (or not) of one's knowledge]

iv) Finally, it provides a diametrally opposite interpretation of PIAGET's "actions" (when applied to mankind's long-time evolution) as well as to the a or pre-logical structural approach (LEVY-BRUHL, BLONDEL, PIAGET, etc.). As a matter of fact instead of saying as such authors did

a) that "primitives" were comparable to children (which contradicts the high developmental level which some of the ancient civilizations attained)

b) that these "primitives" were in a pre- (a) logical (mental) stage because (due to the type of actions they employed) they did not yet acquired the logical structures of more "advanced" civilizations.

what ASSUMPTIONS 1 and 6 allow is, firstly to eliminate the contradiction which a) expresses and secondly, to assert that the actions to which b) is referred, had not yet revealed pre-existing basic structures.[15]

In terms of the interpretation of the external behaviours of "primitive" (adults) the distinction between "revealed" and "acquired" is not important. However, in terms of the understanding

[15] Which partially agrees with WALLON's viewpoint.

of their inner processes, things are completely different. It lays emphasis, in fact, upon the aspect <u>revelation</u> which some gnoseological, epistemological or scientific discoveries [16] and (consequently) upon OP_k's <u>internal world</u>. How this reality may be related to the external one from a long-time perspective is the objective of

<u>COROLLARY 3</u>

This corollary provides a final answer to the fundamental questions which the long-time approaches of PIAGET, WALLON and FREUD aimed for; this, without the inconvenients previously emphasized (item II/2.3.1). It leads in particular to the adoption of a (long-time) structural perspective which, simultaneously, satisfies and rejects the <u>pure</u> metatemporal theory; say, it introduces a <u>new</u> way of looking upon mankind's (general) psychological evolution [COROL.2 and item I/4.3] which (from our viewpoint, of course) provides an <u>unifying psychological basis to the historical/scientific reconstitution problem</u>.

It demonstrates in particular

- that such questions as those concerning the conflict "myths-reason" or the discrepancy between the pratical and representative (or formal) "intelligences" of WALLON and PIAGET [questions v),vi),vii) of that item] arose due to an erroneous (and

[16] One of the most significant historical supports of this assertion is perhaps, that one given by PARMENIDES about his "discovery" of the role which "reason" plays in the understanding of reality. See PART THREE of this essay.

partial) interpretation of the general reconstitution problem;

- that accepting the role which IE_k has played in *PhW*'s (long-time) interpretations, it is possible to bind, coherently, affective and cognitive structures, "actions", neighbouring and distant worlds,etc;

Finally

- that such psychological basis also provides strong clues to the construction of a formal and quantifiable model of TSK, capable, in principle, of reproduction in PASK's system.

The corollary takes into account pratically all the assumptions previously introduced; special relevance is however given to ASSUMPTION 4 [concerning the extension of FREUD-HARTMANN's (short-time) model of the psychical apparatus to mankind's history] already more strongly supported by the results of COROL. 2.

In order to bring to light its main conclusions we shall follow the steps of a progressive reasoning which begins with a conversion of some of the results previously stressed to the peculiar "language" of FREUD-HARTMANN's model. Special emphasis is laid in this sense upon what we have asserted about OP_ks' (long-time) increasing of their self-knowledge.

From this point of view OP_ks' progressive acquaintance can now be differently expressed. Everything works in fact as though (as far as time went on) such *OP*s were more and more conscious of their inner processes (say, of their internal reality or internal world IE_k) or - which is similar - that mental processes which (till some

epoch) were not conscious for their possessors (working consequently as unconscious for them) were progressively brought to consciousness, as far as OP_ks' gnoseological evolution was being effectively accomplished. Briefly: as though the (overall) increasing of OP_ks' acquaintance were similar to a long-time expansion of their consciousness area.

So interpreted this evolutionary (expansional) process obeys clearly what was asserted in ASSUMPTION 6 about the relationships between the individuals A, B (or OP_R, OP_k). In other words, it presents deep analogies either with PIAGET's views on the analysis of child's cognitive development or - more especially - with FREUD's psychological work [17] In both cases, in fact, a present-day individual ($A \equiv OP_R$) is examining mental processes of the individuals ($B \equiv OP_k$) who [unless they are (somehow) taught or unless they are able to discover by themselves how they think] will no longer have consciousness of their (hidden) affective and cognitive structures. Under these conditions (as we previously emphasized) these individuals will (probably) be simply aware of the outermost "results" which such structures produce upon their behaviours [18]; everything lying behind works, therefore, as being unknown. Further: from such "results", the most easily felt (because directly related to the kinesthetic system) are,

[17] We have particularly in mind one of his assertions in which it clearly stated that "... the main objective of psychoanalysis is to bring to consciousness mental areas [primitively belonging to the ego] which so far, are hemmed in and hampered by the demands of the id and of the superego". ["An outline of Psychoanalysis"]

undoubtedly, affects in general; say, sensations, feelings, emotions, etc. It is precisely from these (apparent) truisms that the basic conjecture of COROL. 3 starts. As a matter of fact

> if the "weight" of the pleasure-pain principle upon the command of the ego's activities is taken into account [and through it, of the role which affects in general (love, hate, agressivity, etc.) have played and still play either in the individuals' self-preservation or in the preservation of human species]
>
> then (using the present-day, paradigmatic, image of Nature as reference) it seems plausible to assume
>
> - that in mankind's most remote times (and due to such an affective awareness) the "weight" of affective "explanations" of *PhW* upon the cognitive ones was maximal [implying, consequently, that the "weight of these last upon the first was minimal or, perhaps, even null (temporarily at least)]
>
> - that, since those remote times till now, the historical/scientific evolution which the Western Civilization has undergone, has precisely led to a complete reversal of this situation; say, that the "weight" of cognitive rules upon *PhW*'s explanations are now maximal being that belonging to affective "mechanisms" pratically null

[18] Say, they are in conditions of describing what they observe from the external world, what they feel (fears, pleasures etc.) but they do not know what rules, "mechanisms" etc. these descriptions underlie.

- this obviously, not because such basic cognitive structures did not exist but because, as far as time went on, people have progressively acquired more and more consciousness of them (once again, now in the terminology of ASSUMPTION 6, as though these structures were primitively under a potential form, being progressively actualized in the course of that evolution)

All of these assertions are nothing but rather condensed versions of ASSUMPTION 7. It is from them that the main results which COROL. 3 summarizes may be extracted.

i) The first of these conclusions provides a final answer to question vii) of I/4.3, clarifying simultaneously what was asserted in the beginnings of this COROL. 3 about the "adoption of a (long-time) structural perspective which satisfies and rejects the pure metatemporal theory".

Prevailing the biological (or maturational) aspect of the affective and cognitive organizations previously referred to (ASSUMPTIONS 1,2,3,4,5) we are, as WALLON and FREUD, following the pure metatemporal thesis. However, asserting that throughout mankind's general evolution the relative "weight" of these organizations upon *PhW*'s explanation has varied because past OP_k (inserted into particular conditioning contexts) became progressively conscious of their mental processes (especially of the cognitive ones) [19] we

[19] Recall that logic was "discovered" only 400 years after the beginnings of the Greek evolution; this not considering, for example, 3000 preceding years of the Egyptian or Babilonian civilizations

are also saying that in terms of their externalized expressions (those from which present OP_R have to start in order to understand past interpretations of PhW) everything works as though OP_k's cognitive processes were (for them) either inexistent or (at least) minimally known [20].

Whatever may be the consequences of this fact upon PhW's interpretations (recall what was said about the influence of the "as though" mechanisms etc.) a psychological result can be emphasized: that taking as reference the present-day (cognitive) paradigm of physical sciences, OP_k's past mental processes were not similar to those presently used. From this point of view however, the evolutionary process so briefly described does not obey the pure metatemporal approach.

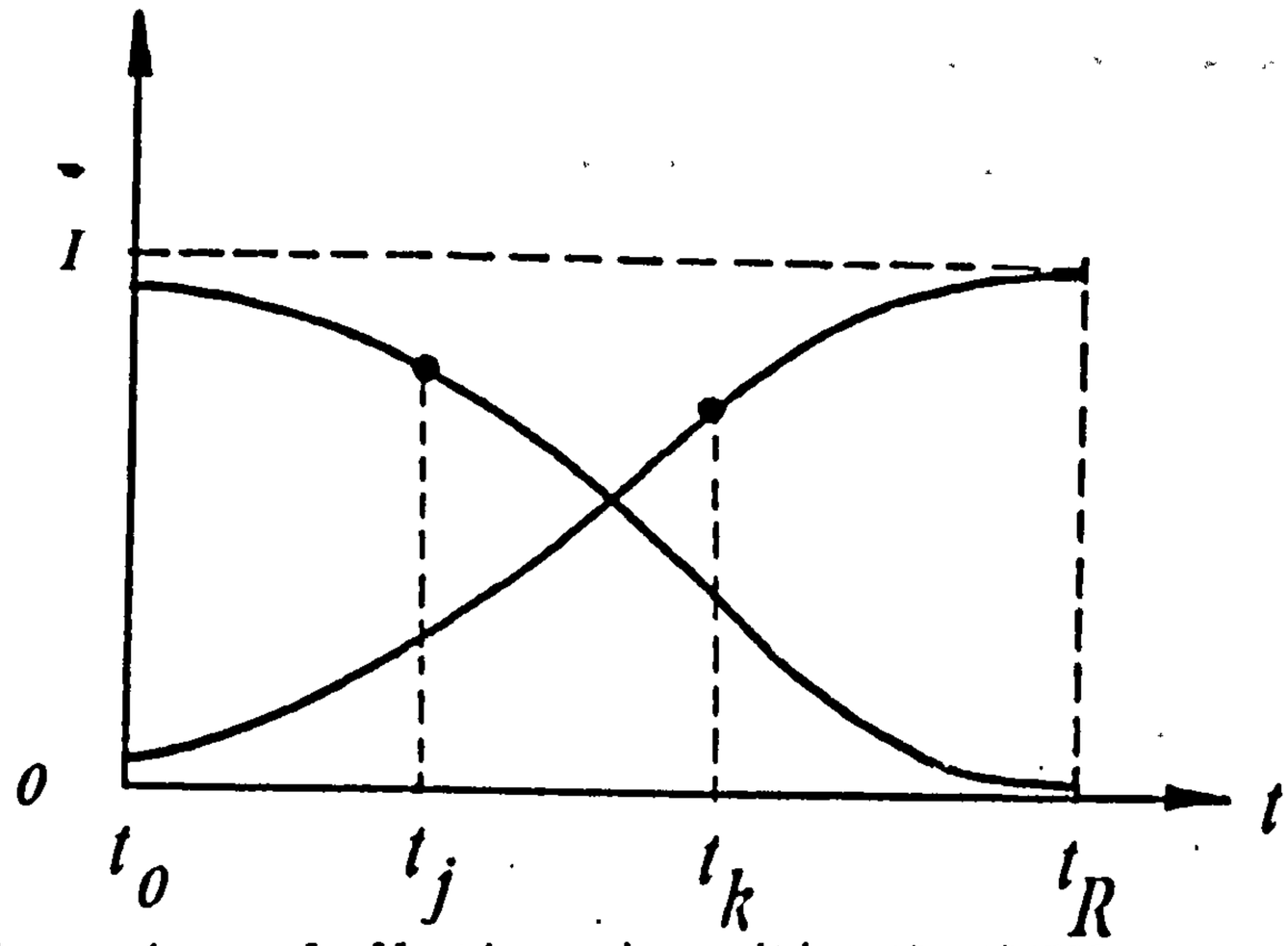
If we assume that the relative influence of the affective and cognitive organizations upon PhW's explanations are quantifiable (by means of some weighting coefficients

$$\alpha_i = \alpha_i(t),\ (i=1,\ 2),\ \alpha_i(t) = [\,0,\ 1\,]$$

then - globally regarded, taking z_R as reference and not considering the particular "acellerating" or "delaying" contextual influences - their "average" time-variancy may be described as shown in Fig 17.

Whatever may be the real curves according to which these variations are described (see II/2.4 of the ARGUMENT) as well as their genetic

[20] Once again, using the preceding terminology, such a structure was potentially there though its intrinsic rules were not yet actualized.



The average time-variancy of affective and cognitive structures
Fig. 17

"mechanism" (See II/2.3.5) the point which needs to be stressed is that, until quite recently (the XIXth century), two different types of *PhW*'s explanations were possible at any time instant of mankind's history. This leads us to

ii) The second overall conclusion which COROL. 3 underlies. The result deals now with the conflict Myths-Reason as well as with the discrepancy between the so-called pratical and representative "intelligences" of PIAGET and WALLON; it also includes what was asserted in the beginnings of this corollary about these questions as false problems whose emergence is due to an erroneous and incomplete interpretation of the general reconstitution problem.

Both of these questions arose in the contemporary panorama from two (supposed valid) premises

- one, essentially psychological, which prevailed the conscious aspect of mental phenomena in detriment of the unconscious ones

- another, fundamentally methodological,which proceeds from a "principle" stated by LEVY-BRUHL as regards his anthropological observations.

In its most condensed form this principle defended the complete and total prohibition of interpreting cultures and civilizations different from the Western one, taking as reference the paradigms, ways of thinking, behaviours etc. according to which our present-day civilization is characterized. In other words, instead of looking upon such cultures using for it our own frames of mind they might, on the contrary, (and since the beginnings of their analyses) be regarded as alien to us.

Though methodologically correct, further developments of this point of view led, however, to misunderstanding interpretations; in particular to the setting up of a radical contrast between our present-day thought-processes and those who (for the sake of simplicity) BRUHL named as "primitives". Everything worked therefore as though

- our present-day intellectual mentality (based upon well-defined logical procedures) were opposed to a mentality in which every existing thing were endowed with supernatural powers, their relationships being justified by means of myths and superstitions

- our present-day reasoning (seeking above all the setting up of logical chains linking some achieved conclusion to its underlying starting premises) were opposed to a pre (or a)-logical mentality which is satisfied with relationships between terms without common denominators

- our present-day factual descriptions (based upon experimentally confirmed relationships) were opposed to a mentality in which causes and effects were essentially regarded in magic and mythical terms; consequently, that their appearance and disappearance may be provoked and avoided by means of prayers, sorceries or through the use of simulacrums, etc.

Briefly, as though an "affective" (and absolute or mutually exclusive) pre-logical mentality were opposed to an "intellectual" (and also absolute or mutually exclusive) way of thinking corresponding to present-day times.

In spite of the attraction which this point of view offered in terms of long-time reconstitutions (leading, for example, PIAGET to compare such primitives with children) the intrinsic difficulties which it underlies are obvious. As a matter of fact it does not justify

- neither the high and complex social, organizational, moral etc. developmental degree which some of such primitives" societies attained

- nor (moving backwards in time) the reason why some their "technological" achievements really worked [21]

- nor also the present-day existence of myths and beliefs (some of which are intrinsically related to the proper scientific development, as emphasized in item I.1).

None of these contradictions arises with the hypothesis previously introduced. As a matter of fact founding TSK's evolution upon OP_k's increasing of his consciousness area (which leads to ascribe real importance to IE_k and consequently to discord from the first of the aforementioned "postulates") we are implicitly assuming that PhW in itself has always been the scenary of two, simultaneous, types of explanation

- one directly related to the ego's voluntary movements, to "actions" (embracing, WALLON's movements, PIAGET's actions and FREUD's reality testing) to secondary processes (and, through them, to the unconscious development of cognitive structures firstly, and secondly to their progressive revelation); briefly, to what we named as neighbouring world (PhW^N).

- another, whose functioning is (was) fundamentally based upon the unconscious "mechanisms" which we described in terms of "as though" (projection, identification, etc.) which are (were) used not only in the structuration of OP_k's internal world but also in the explanation of that part of PhW directly knowable through OP_k's actions;

[21] As PIAGET asserts (See S/6) :" Il est d'abord à noter que si consacreés par un ritualisme mystique et si accompagnées de magie que soient les techniques des "primitifs", elles n'en constituent pas moins, en tant qu'actions, un système d'actes adaptés : leurs huttes résistent aux intempéries, leur cannots tiennent l'eau, et leur flèches atteignent le gibier".

briefly, what we named as distant world (PhW^D).

Under these conditions however, there is no reason at all to oppose a "pre-logical" mentality to an "intellectual" one as though they belong to temporally distinct phases of mankind, as LEVY-BRUHL and PIAGET assert; nor to establish in adult people a distinction between "pratical" and "symbolic" ways of thinking, again as though they were part of temporally distinct evolutionary stages of mankind (as PIAGET claimed).In adult human being (at least) an exclusive affective functioning (uniquely based upon the pleasure principle and, in consequence, totally disclosed from the external reality) is so impossible as an exclusive cognitive working. Identically, to assume that, in adult people, "pratical" actions may be separated from the "symbolic" ones is (among other contradictions) to deny the proper psychological and historical factual evolutions. In both of these situations the minimum which we can assert is that the relative "weight" of the primary (unconscious) processes upon the secondary ones (also primitively unconscious but progressively brought to consciousness) have (somehow) changed throughout mankind's evolution; or, else, that the system of "actions" (through which PhW^N was known) did not allow (looked from our eyes) a true and faithful representation of PhW^D's processes. This is nothing however but the basic statement of this COROL. 3. Hence the reason why we asserted that questions came from an erroneous and (essentially) partial interpretation of the whole reconstitution problem.

iii) Whatever may be the <u>real</u> time variation which such "weights" undergone, it is now clear that the preceding reasoning does not contradict none of the outlining conditions C, D, E, G from which all these considerations have started (item II/2.3.1). As a matter of fact

- Cond. D (which states that the identification between children and "primitives" must be avoided) underlies ASSUMPTION 6, 7 as well as COROL. 2, 3.

- cond. C and G (concerning the simultaneous influence of affective and cognitive processes upon *PhW*'s explanations) are both automatically satisfied through the preceding considerations

- finally, cond. E (which stresses the "coincidences" existing between some of the behaviours of "primitive" people and those of present-day children) follows from what was previously asserted about the expansion of the ego's consciousness area. Unknowing the rules of their intellectual structures (already potentially existing but not yet revealed) the fundamental type of explanations which "primitives" could use, had, essentially, to be based upon what they knew or felt; say, upon their affective processes.

A (possible) long-time justification for such really existing "coincidences" (or psychological evolutionary "parallelisms") can therefore be brought to light: that while in present-day children some of their explanations of physical phenomena are due to a preponderancy of affective processes upon a (still) not completely developed cognitive organization (WALLON's functional preponderancy or alternative "laws") in (adult) "primitives" such explanations

come

- from their unawareness of their cognitive rules

- from their temporal localization as regards a global evolutionary process in which the problems which they have to face (or will progressively face) have not yet been solved (or have not yet been explicitly brought to light)

- from their insertion into particular social contexts (still) incapable of discovering and teaching either such problems or their solving-procedures.

Briefly: as though, throughout their respective evolutions, "primitives" and children were confronted with <u>similar</u> problems:

- in children their solution is not brought about because they (still) have no completely formed cognitive and affective organizations

- in "primitives" because (although such organizations were already completely mature) they were neither aware of their "rules" and "mechanisms" nor inserted into contexts capable of teaching them of what was already learned in more "advanced" societies.

So interpreted the process obeys clearly

- <u>the points of view of FREUD, HARTMANN, and WALLON</u> (though as regards the last one the premisses from which our reasoning started are totally different from those adopted by that psychologist).

- WALSH's coalition theory of historical reconstitutions; this because OP_k's activities may be regarded in terms which are not only teleological or "purposive" (they seek the solution of "problems" suitably related to a certain gnoseological frame of reference) but take also into account either the relative "weight" of their affective and cognitive structures upon PhW's interpretations (structures whose influence on such mental frames is more or less relevant) or the conditioning ("positive" or "negative", COROL. 1) influences of the particular contexts into which such OP_k have been inserted .

- PIAGET's short-time descriptions (we insist in this word "descriptions") of child's development [everything working therefore as though this development (explained either by means of PIAGET's assimilative-accomodative cycle or taking into account for example WALLON's maturation) were common to all children of all epochs; thus, leading them (at 11-12 years) to the construction of what may be roughly named as a common sense image of the world, image on which (if inserted into appropriate contexts) further gnoseological and epistemological achievements can be based. [22]

- finally, what in item I we asserted about PASK's conversational approach [regarding the time-variancy of such achievements in terms of an evolutionary (adaptative) learning/teaching process, reproducible in the THOUGHSTICKER system]. In other words: HYP VI

[22] Either they proceed from what is learned from other individuals or from what they discover in themselves throughout the rest of their lives.

(from which COROL. 1, 2 and 3 were extracted) not only solves the main questions of I/4.3 [23] but provides also a (possible and rather detailed) topographical model to S's inside. [24]

In order to solve <u>completely</u> the fundamental historical/scientific reconstitution problem which this essay seeks, two other questions need, however, to be examined:

- one, associated with the overall approaching strategy outlined in item II/1, brings to light the <u>time-variable</u> relationships which may be established between the elements of S's inside referred to a moment ago.

- the other, deals with the main questions of item I/3.9, i. e., with a (possible) formal and quantifiable description (directly and significantly understood) of such relationships.

The first of these questions is the objective of

II/2.3.5- <u>THE LONG-TIME DYNAMIC PERSPECTIVE</u>

This point of view is outlined in TAB I and it provides an <u>abstract,</u>

[23] Thus, providing a (possible) unifying psychological, epistemological and cybernetic basis either to the long-time theories of WALLON, FREUD and HARTMANN (into which PIAGET's short-time descriptions <u>may</u> be inserted) or to PASK's approach

[24] Since it binds together PhW (neighbouring and distant) group environments G_k, OP_k's ego and his internal world IE_k (in which conscious and unconscious influences are considered)

conjectural and extremely condensed answer to question iv) of I/3.9. In other words: it outlines a psycho-historical and evolutionary model of TSK in which the time-variable relationships $PhW \dashrightarrow OP_k$ are seen to depend not only on OP_k's (possible) personal inventions or discoveries but, rather, on the general social and psychological (paradigmatic) contexts into which they are (have been) inserted.

The model is a direct consequence of the corollaries and assumptions previously emphasized. It synthesizes (and applies) the approaches of FREUD, HARTMANN, BION, BETTELHEIM, M.KLEIN etc as well as many anthropological, historical and historical/scientific data not explicitly expressed but rather there implicitly contained. Briefly: it works as an abstract, "multidimensional" and conceptual frame (some kind of internal scaffold) to which the real amount of historical/scientific information must be referred; thus, rendering easier its present-day interpretation. Globally examined this scaffolding frame is formed by the same perspective or "dimensions" emphasized in II/1; say:

- a temporal one (diachronous or "vertical") comprising 4 (possible) evolutionary phases

- a spatial one (synchronous or "horizontal") subdivided, in turn, into the three main (topographical) elements there referred to, i.e. a group environment G_k (later partioned into G_k^N and G_k^D), a (general) individual OP_k [in which either JE_k or his "ego" (Eg) are considered] and PhW [also including what we named as neighbouring (PhW^N) and distant (PhW^D) worlds] - a third one now relational which stressed the particular set of social and

psychological relationships which the OP_ks use (or to the influence of which they are submitted) in this or that phase of their evolutionary process.

The whole process starts from an abstract, hypothetical and extreme situation: somewhere in the past (in the so called pure colector phase of mankind's proto-history) a certain number of male and female human beings (totally unaware of their mental processes) are supposed to meet together under the pressure of common instinctual needs. Next, and as far as time goes, it is shown how this temporary association leads (progressively) to the formation of an organized society, to the structuration of the internal world of their members, to the emergence of different images of PhW^D, to the expansion of the area of PhW^N etc. Briefly, to the "growing" of OP_k's knowledge either internal or external.

The process is (artificially) interrupted in a (hypothetical) PHASE 4 when cognitive and affective (say "religious") images of PhW are no longer superimposed and Nature itself becomes the ultimate goal of objective (non-anthropomorfic) researches.

TABLE I is exhaustively described in S/6; this in such a way that each one of the condensed assertions it contains appears as a logical consequence of the preceding ones. So understood (and beyond the concrete answer it provides to the aforementioned question iv) of I/3.9) it can also be regarded as satisfying the effectiveness condition referred to I/3. In other words: it works essentially as some kind of general relational [25] data-basis ready to be implemented in (for example) PASK's THOUGHTSTICKER.

Obviously, this does not mean that the historical/scientific problem is already completely solved. Neither history (in general) or history of Science (in particular) are simple relational and abstract disciplines but, on the contrary, sciences dealing with the concrete actions which human beings have executed in the past. A new problem arises, therefore: how to relate this conjectural model of TSK with the real ammount of historical information already accumulated since mankind's beginnings? Or, which is similar: How can such a real ammount be (firstly) systematized and (later) associated with the relational operations previously stressed, so that an as live as possible reconstitution of the past may be achievable?

The answer to this general problem (nothing but another version of the second of the questions brought to light in the ends of II/2.3.4) will lead us to the analysis of the last of the main themes which this essay considers:

II/2.4- THE FORMAL APPROACH

As in the case of TSK's psycho-historical (conjectural) construction the formal (algebraic and quantifiable)systematization of historical data which this part of the essay seeks, is a task which occupies more than four hundred pages (PART TWO). For this reason the following considerations must be regarded as simple and extremely condensed version of the reasoning there exposed.

[25] Since it prevails the relationships (cognitive or affective) existing between its elements.

The whole approach is based upon the implementation of a progressive (formal) procedure, ultimately mirrored from the symbolic representation of Fig 9. What this means is

i) that it begins with a (formal) analysis of the individual relationships OP_k <--> OP_R . Since in historical terms these relationships are expressed by those messages z_k referred to I/3.9 then this analysis will provide an answer to question i),ii),iii) of that item. In other words, it leads not only to the construction of a systematized "theory" of S's outputs (later subjected to a numerical interpretation) but also to their changes (understood in terms of direct historical narrations)

ii) it is followed by a (possible) systematization of OP_k's contexts (their group environments G_k)

iii) it ends with a formal and also quantifiable description and (possible) explanation (significant narration) of the interactions G_k <--> OP_k.

S/4, S/5 and S/6 are the sections where these aspects are more particularly sought. In all of them . General Systems Theory (especially KLIR's UC and ST approaches), Fuzzy Subsets Theory and Automata Theory (classical and fuzzy) are the cybernetic matters more frequently applied. Their insertion into the present context will be progressively understood as far as the approach is being exposed. Due to the characteristics of the ARGUMENT, this presentation is simply restricted

- firstly to (some) of the most important <u>premises</u> on which the formal viewpoint is based

- secondly to the <u>results</u> it leads (or may lead) in terms of the conversion of historical problems to engineering problems.

II/2.4.1- <u>THE PREMISES</u>

These premises (determining an epistemological and historical basis to the whole mathematical treatment of historical information) are mere consequences of the fundamental hypothesis previously postulated; particularly HYP. ZERO [item I/3]

The most important of them deal

A) with the particular way of looking upon the historical/scientific reconstitution question as problem of <u>analysis</u> and <u>synthesis</u> of a system S [item I/4.2]

B) with the difficulties related to the treatment of the information "emmited" by such a system [item I/4.4]

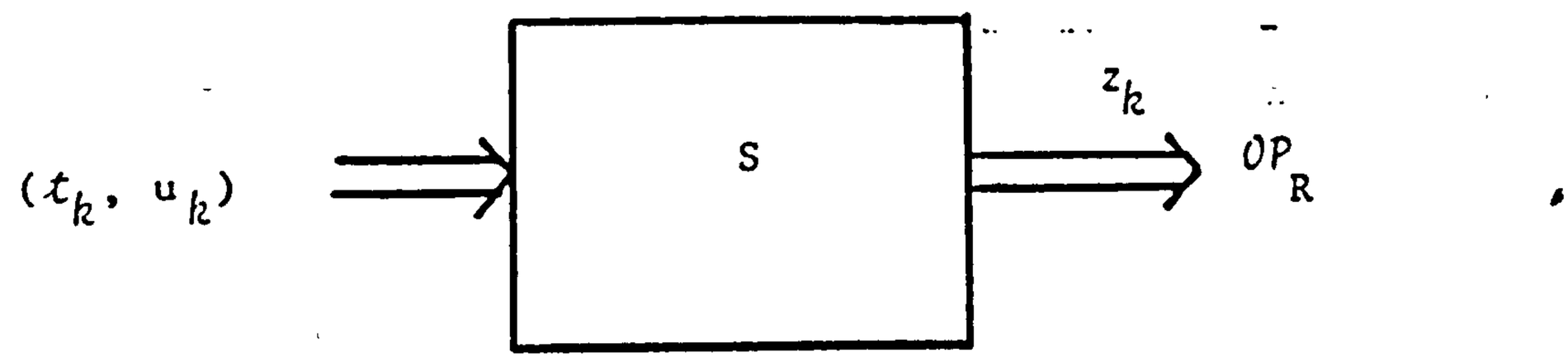
C) with the particular type of knowledge which this information involves: not <u>directly</u> experienciable, observable or controllable by some "observer" OP_R (say, not directly "acquainted by him) but, rather, obeying RUSSEL's classification <u>knowledge - by description</u>

D) with the two roles played by OP_R [as scientific historian and as natural scientist

E) with WALSH's coalition process referred to II/2.3 [regarding historical reconstitutions and historical "explanations" in terms of interactions between some OP_k and the historical "whole" (context) into which he is (was) inserted] as well as with the identification of such "wholes" and/or their time-variation with KLIR's ST approach.

The consequences which may be extracted from these premises are the following:

From Premise A): that S may be regarded as shown in Fig.18.



The historical communication system S

Fig. 18

i.e. as an hypothetical "box" which, sequentially acted by a set of inputs (t_k , u_k) non-specified, but in spite of this supposed to be time-invariant (see HYP I of S/2) "responds" in sucessive instants t_k of the hypothetical time-scale T_l emmiting a set of "messages" z_k (i.e. successive sequences either of generic symbols or of their mutual relationships) whose length and meanings are seen to vary as far as time goes. As a receptor of these sequences OP_R's task seeks the specification of some general methods by means of which the information associated either with their component symbols (words, phrases, expressions, concepts, etc.) or with their relationship may be structured; this in such a way that, given two sequences, say z_i , z_j their related T_{ij} may be

a) firstly, automatically brought to light

b) secondly, objective of numerical quantification and "explained"

Item a) deals with the so-called direct historical narrations; item b) with significant narrations. As regards the first of such narrations it will therefore be assumed that no question involving

1. the eventual connexions between inputs and outputs of the imaginary box of Fig. 18 [a problem concerning the internal "trajectory" followed by the information which every OP_k receives since its reception (sensory organs) until its emergence in terms of ordered and structured image of such a world]

2. the influence of some z_i upon some other z_j (here including either contemporaries observers/participants or temporally distant OP_k 's)

3. the influence of some z_i upon some "memories" eventually existing inside the box

4. the action of some z_i upon some other internal subsystems of S (for example, some complex device representing group environments with or without included memories), etc.

will be taken into account; only the z_ks in themselves will be the objective of analysis.

As regards significant narrations they will be examined after the analysis of E) above.

From Premise B):

that in spite of these restrictions great part of the problems brought to light in § I about historical reconstitutions may be found again in z_k's systematization:

QI) Having, in principle, to take into account all <u>known</u> descriptions of *PhW* throughout the whole history of mankind, the number of the aforementioned symbols and/or their mutual relationships which OP_R has to treat is so great that he necessarily will face the quantitative questions referred to the beginnings of this Argument.

QII) The same can be paradoxically asserted as regards those messages z_j which, due to what we may name as their "temporal noise", are lost, partially destroyed or incomplete - a fact which will render extremely difficult the definition of their corresponding transformations.

QIII) Finally it cannot be forgotten that the previously referred to "symbols" are nothing but words, terms, concepts, etc:

- part of which are no longer used in the present-day descriptions of *PhW*.

- or, if used, are employed with a <u>meaning</u> which not only has varied throughout time but also (and this is especially relevant for the earliest descriptions) is highly ambiguous, vague, fuzzy.

Using the terminology of the conversational approach we should say, summarily, that in consequence of these problems OP_R 's understanding of the language used by the OP_k 's in their descriptions of Nature becomes, in some cases, extremely controversial.

In the aim of the general theory which we are proposing it is obviously meaningless to analyse these particular cases one by one, specifying, for example, the time instants of T_R in which a certain message is missing or the semantic meanings possible to be ascribed to this or that concept; this will be made in PART THREE "Applications". Such a general vision requires, therefore, the introduction of some simplificative hypothesis by means of which the above mentioned questions can, provisionally at least, be superseeded.

i) - The first of these hypothesis deals with I) and II). In order to avoid these difficulties let us then assume that, instead of real observers/participants OP_R, any systematization of z_R is from now on endeavoured by an hypothetical observer OP_F obeying the following characteristics:

1. He lives in OP_R 's futuree
2. He is impartial [in the sense that he is, by no means at all, consciously or unconsciously affected by past or (for us) present group influences]

3. He is fitted with a set of supra-human capabilities (memory, association, etc.) which, among others, enable his visualization of n-dimensional spaces ($n \gg 3$)

4. He is able either of a real moving throughout time (especially to his past) or, in consequence, of being engaged in conversational schemes with every OP_k (k = 1, 2, ... R)

5. He has his attention primarily (though not exclusively) directed to history of Science, particularly to history of Physics, being his fundamental goals

   - to describe (direct narrations)
   - to "explain" (significant narration) part or the totality of TSK since a remote time instant $t = t_0$ until $t = t_R$ (our present).

The usefulness of these postulated features will be progressively brought to light as far as the approach is being developed. We emphasize however, that due to properties 1) and 2) the aforementioned difficulties I) and II) become, henceforth, meaningless.

ii) - The second hypothesis deals with part of III) and, in some sense, is a consequence of premise C) above.

It assumes that the knowledge which OP_F may have of past descriptions of *PhW* can be obtained either by means of written or oral messages. Whatever may be the situation involved - and, for the moment, we shall only pay our attention to written messages - such descriptions obey what was said to correspond to B. RUSSEL's "knowledge-by-description". This means that such messages are nothing but sets of "these" and "those" mutually associated in this

or that way, a particular set of these "these" and "those" being regarded as describing the properties, feature, etc. of some object under OP_k 's examination. For the sake of simplicity - and this is the content of our second hypothesis - a particular set of such "these" and "those" referred to one of those properties (a set which can, however, contain a single element or even none) will henceforth be named attribute. To that which mutually associates elements of these attributes or even attributes themselves belonging to the same message, we shall ascribe the designation internal relation or simply "relation". To what relates messages to one another we shall name external relation, transformation or transition (in ASHBY's sense).

By means of this simplified notation what we have been asserting about messages, historical/scientific happenings or even about their systematization will acquire a more precise significance

- a message becomes a particular (algebraic) set of attributes and inner relationships [first definition of message]

- the occurence of some message at some time-instant of mankind's history becomes nothing but a historical/scientific event i.e. a couple (t_k, z_k)

- and the systematization of messages or of events is converted to a problem of algebraic partitions i.e. a problem in which either the total amount of historical information U '' dealing with WALSH's "wholes" (Premise E) or with that part of U'' say U'

$$U' \subset U''$$

simply related to the history of Natural Science are both divided into equivalence classes. This in such a way that once such partitions are obtained, elements of the same class but belonging to different messages can posteriorily be compared and automatically be brought to light.

It is in the reasoning implicit in this comparison that our third hypothesis will be foccussed. It proceeds

from Premise D)

It stresses what we have asserted about OP_R's roles either as natural scientist or as scientific historian as well as the relativistic position of these observers/participants as regards OP_F.

As we already emphasized, OP_R's role as a natural scientist is devoted to the analysis, description and explanation of his PhW, a partially constructed reality different, in principle, from those already brought to light from his predecessors OP_k. However, contrarily to some of these observers (particularly the earliest) this analysis, description and explanation can no longer be referred to the whole PhW. By virtue of the diversification of TSK throughout time, by its increasing complexity etc., OP_R has in fact to direct his attention simply about parts of PhW i. e. he must use distinct selective criteria by means of which the information directly proceeding from PhW, as well as that indirectly

received from such predecessors. (the teaching process previously referred to) is, in a certain sense, "filtered". This filtering leads to an artificial partition of *PhW* into several equivalence classes, those which in the realm of Physics give rise to Mechanics, Thermodynamics, etc.

Whatever may be the chosen selective criteria (and, in consequence, the point of view from which *PhW* is examined) such partial descriptions of *PhW* obey what we said about attributes and inner relationships. In this sense these "descriptions", while exchanged between two symbolic OP_R, say OP_{R1} and OP_{R2} can therefore be regarded as "messages" by means of which they communicate one another their respective viewpoints.

For the moment we shall not be concerned with the content of these messages; important is, however, to bring about their historical and epistemological meanings.

From the first of these meanings, the idea which we defend is that the role played by these present messages as regards, for example, our future OP_F does not differ from that played by past z_k as regards present OP_R. If this is accepted then an immediate consequence can be brought to light: that the non-redundant totality of this present messages (possible to be perceived by OP_F due to his supra-human characteristics) can henceforth be regarded as an expression of the image of Nature z_R existing at $t = t_R$. It follows from this that, similarly to what we usually assert about those earlier descriptions of Nature (understandable in their

totality by virtue of their simplicity), an imaginary conversation between two OP_F about z_R could then give rise to something like "Look, this is the knowledge which our ancestors had acquire about Nature in the XXth century".

Beyond this there is, however, another interpretation possible to be ascribed to this z_R, now not historical but essentially epistemological. Suppose that, instead of "Look this is the knowledge which the OP_Rs had acquired ...", one of our OP_{Fi} (i= 1,2) says "Look this is the knowledge which the OP_Rs had <u>already</u> acquired...".

The introduction of the adverb "already" changes completely the meaning of OP_F's assertion. As a matter of fact while the first commentary may be regarded as the expression of a simple and absolute appreciation of z_R (an instantaneous "cut" of TSK by $t = t_k$) the second contains an implicit reference to some underlying <u>standard</u> (in the case the hypothetical image of Nature z_F existing at $t = t_F$) as regards to which z_R is being compared.

This underlying thought process is frequently brought to light in the examination of past documents, in special when, due to their unexpected characteristics, they are for us motive of surprise (I can never forgot my astonishment when, for example, I "discovered" that two centuries B.C. the gates of Zeus's temple in Alexandria were controlled by feedback systems).

Our third hypothesis deals precisely with such standards. It postulates, in summary

1. that globally observed by our hypothetical observer OP_F, the interval of time clapsed between t_0 and t_R (and to which corresponds a certain transformation of scientific thought TSK) may be partitioned into several typical epochs.

2. that each one of these epochs is characterizable by means of a particular set of norms, beliefs, myths, logical thought processes, typical problems and typical problem-solving procedures, etc. The totality of these features form, at a given epoch, an <u>epistemological paradigm</u> i.e. a general frame of mind, to the influence of which all OP_k living at that epoch are consciously or unconsciously submited.

3. that part of this paradigm deals with the image of Nature existing at that time. With rare exceptions either this global image (if sufficiently simple to be describable in the whole) or parts of it (if already enoughly diversified) are <u>always</u> used as internal standard in the evaluation of past images.

4. that in the particular case of present OP_Rs their standard z_R or those parts of it which are knowable by each one of them, are supposed to be the most adequate to the description of PhW (though also the most complex and diversified) of all the preceding z_k ($k = 0, 1, 2, \ldots, R-1$).

Reasons supporting 1. and 2. have already been examined (in the psycho historical approach Assumption 8 in special).
As regards 3. and 4., the items which more particularly deal with the systematization of z_k , it is needless to repeat what in S/O was said about the influence of Physics in the present day image of Nature.

For the problems related to such a systematization the importance of 3. and 4. lies in two facts

i') Firstly, if z_R is, on the one hand, regarded as reference in the appreciation of past images and, on the other hand, it is supposed to be the most diversified of all the preceding z_k, then such an image works, in algebraic terms, as a known <u>reference set</u> i.e. a set as regards to which past z_k may be viewed as proper <u>subsets</u>. In these conditions, if z_R is supposed to contain $Z_1, Z_2, \ldots Z_n$ classes of attributes and relationships then some preceding z_i ($i \lll R$) can always be said to be <u>part</u> of this z_R ; i. e. z_i may be identified with $P(z_R)$ the set of all the subsets of z_R . This specification may be accomplished in several ways. One of them referred to S/O, is that in which each of the z_k is associated with a membership function, say $\mu(z_k)$, such that for all the Z_j ($j = 1, 2, \ldots, n$) contained in the reference image

$$\mu(z_k) = 1 \quad \text{if} \quad Z_j \in Z_k$$
$$= 0 \quad \text{if} \quad Z_j \notin Z_k \qquad \text{(II /2.1)}$$

For example, if z_k contains three simple classes say Z_1, Z_2, Z_3 of the n classes of z_R, then z_R may be described as

$$z_k = \left\{ (Z_1 \mid 1), (Z_2 \mid 1), (Z_3 \mid 1), (Z_4 \mid 0) \ldots (Z_n \mid 0) \right\}$$
(II /2.2)

Extensions of this point of view for the case in which the values of M are not $\{0,1\}$ but [0,1] may be accomplished if, instead of classes "per se" (i.e. in which each class works as an element), we consider for example their component attributes and/or relationships. Concretely: if z_1 at $t = t_R$ contains 10 attributes and z_1 at $t = t_k$ is simply described by 3 attributes then z_k may be written as

$$z_k = \{ (z_1 | 0,3), \ldots\ldots\ldots (z_n | 0) \} \qquad (II/2.3)$$

situation in which all the z_k become <u>fuzzy subsets of the reference image</u> z_R.

Future developments of this point of view will be analysed in the course of these considerations.

ii') The second result which may be brought to light from the interpretation of z_R as reference set deals now with Question III, the semantic problem.

Suppose in this sense that the amount of information U' related to the scientific development of mankind is examined by OP_F in such a way that his attention is firstly directed, for example, to the concept of "space" only, next to the concept of "time" only, next to that of "matter" only, etc. Suppose also that, in order to simplify their writtings, each one of these concepts is represented by a letter, say A, indexed with a number i, $i = 1, 2, \ldots, q$, q being the maximum number of concepts which OP_F may found in z_R (the most diversified of all messages); in this sense "space" can for example correspond to A_1, "time" to A_2,

etc. Assume next that while examining the "history" of this A_1, OP_F finds that there are several descriptions which correspond to it; there is, for example, a particular description of "space" in PLATO's epoch, there is another one in ARISTOTLE's epoch, etc. [26]

According to the usual terminology each one of these descriptions can then be regarded as a particular semantic significance ascribed to A_1 at different time instants of T_h.

In order to clarify this point let us however deep our reasoning a little more. Suppose in this sense that (apart from the introduction of these semantic meanings) OP_F's procedure previously referred to is extended to all the remaining $A_2, A_3, \ldots A_q$; assume also, for the sake of simplicity, that each one of the aforementioned descriptions can symbolically expressed by means of an attribute, say a_{ik}, in which "i" is an index which deals with its respective A_i and k corresponds to the message z_k in which such a description was found. In these conditions a rather condensed writting of U' in terms of concepts, messages and attributes can then take the aspect shown in TAB II/0; for the moment, the symbol "0" means here "null" or "not considered" description.

[26] For the sake of simplicity we shall henceforth assume that to every OP_k corresponds one and a single one of these descriptions. It will be demonstrated later that the introduction of a correspondance "one OP_k - several descriptions" does not change the proposed procedure.

TAB II/0

	z_1	z_2	z_3	⋮	z_R
A_1	a_{11}	a_{12}	a_{13}	⋮	a_{1R}
A_2	a_{21}	a_{22}	a_{23}	⋮	a_{2R}
A_3	a_{31}	a_{32}	a_{33}	⋮	a_{3R}
⋮	⋮	⋮	⋮	⋮	⋮
A_q	0	0	0	⋮	a_{qR}

Taking into account what was already said about messages, attributes, concepts, etc. it is clear that each one of the columns of this Table corresponds to a description of a particular message; similarily each one of its lines is a condensed expression of the set of significances ascribed to a particular A_i throughout time. Table II/0 can therefore be regarded as expressing a relationship say G

$$G \subset A \times U' \qquad \text{(II/2.4)}$$

between the elements $A_i \in A$ and the elements $z_k \in U'$, this in such a way that to some (A_j, z_k) corresponds (according to simplificative hypothesis previously referred to) one and a single one attribute a_{jk}.

In order to continue our reasoning let us now assume that OP_F's position coincides with that of present-day OP_R ; in other words, OP_F works as a present scientific historian as well as a present natural scientist. From this last viewpoint all atributes a_{iR} belonging to the column z_R have, for him, a "weight" whose importance cannot be neglected: they are, in fact, elements of his image of Nature, part of the general paradigm into which he is inserted and according to which he consciously and/or unconsciously describes his world.

From the set of all attributes considered in TabII/0 these last can then be interpreted as being for him <u>fully significant</u>; in the same way, elements of this Table to which the symbol 0 was ascribed can be regarded as being <u>no significant</u>.

Supose then, that OP_F has the possibility of relating these attributes to the values of a totally ordered numerical set M

$$M = [0,1] \qquad (II/2.5)$$

in such a way that "fully significances" are always associated with the number 1 and "no significances" with the previously referred to 0 <u>now regarded as a number</u>, not as a symbol. Suppose, finally, that by means of a subjective appreciation, OP_F is able "to measure" the resemblance existing (or not) between some a_{ik} and his fully significant (reference) attribute a_{iR} . This in such a way that,

for example, to an attribute whose resemblance is "great" it is ascribed the value 0,9, to other whose resemblance is lesser 0,6, etc. This hypothetical apreciation could then be subjectively described by means of Table II/1.

TAB II/1

	z_1	z_2	z_3	...	z_R
A_1	0,1	0,3	0,1	...	1
A_2	0,3	0,1	0,2	...	1
A_3	0,8	0,1	0,9	...	1
⋮	⋮	⋮	⋮	⋮	⋮
A_q	0	0	0	...	1

In these conditions, what has been asserted about concepts A_i, messages z_k, attributes a_{ik}, their relationship and numerical values from M can now be precisely defined. According to KAUFMANN, ZADEH, and others [27] it can be asserted, in fact, that

[27] The bibliography related to fuzzy sets and in this particular case to "fuzzy semantics" is practically innumerable. However, for this introductory considerations, we shall have especially used KAUFMANN's "An introduction to Fuzzy Subsets" Vol II, pp 97-108 and ZADEH's "Quantitative Fuzzy Semantics".

- for a (known) universe of discours U' , formed by all z_k ($k = 0, 1, 2, \ldots, R$)

- for a membership set M defined by (II/2.5)

- for every term $A_i \in A$ ($i = 1, 2, \ldots, q$) there exists a membership (characteristic) function $\mu_{A_i}(z_k)$ such that the couple

$$\left| z_k , \mu_{A_i}(z_k) , \forall z_k \in U' \right| \qquad \text{(II/2.6)}$$

defines formally a fuzzy subset of U'.

For a certain $A_j \in A$ this subset specifies its significance or semantic value. For a given $z_j \in U'$ the set of values which $\mu_{A_i}(z_j)$ can take (a column of TABLE II/1 corresponding to this z_j) defines what is called z_j's descriptor. Finally the triplet (U' A,G) specifies what is called a fuzzy semantic language (or parallel-language).

In these introductory considerations we cannot bogged down the innumerable problems (purpose of the most recent researches) which are related to these languages, to the subjectivity implicity in the specification of the $\mu_{A_i}(z_k)$ etc. We shall only emphasize that the previously referred to formal definitions agree with the common sense interpretation ascribed to concepts, messages and attributes; or, which is similar, that the theoretical fuzzy approach seems, in fact, to be adequate to the solution of QUESTION III. In the course of this essay we shall have occasion to present further extensions

of these considerations. For the moment, once our simplificative hypothesis and some of their consequences are already introduced, we are ready to direct our attention to the consequences which may be extracted from

Premise E)

that one concerning the approaches of WALSH and KLIR, as well as the differences existing between the reasoning used in S/4, S/5 and S/6 to describe them formally and that one which will be adopted in the ARGUMENT. In those sections of PART TWO of this essay such an algebraic and quantifiable description was achieved through the using of a progressive procedure. As we previously emphasized we begun with the analysis of the most primary "elements" from which historians can start in order to accomplish their reconstitutions, i.e. the attributes and inner relationships which constitute their messages z_k . These messages were next interpreted as elements of a set H_Z'' called scientific event set and obeying some well known historical, epistemological and algebraic properties. Taking into account the fuzzy "weighting" previously referred to, $H_{Z''}$ was next geometrically interpreted. This allowed the specification of some numerical indexes ["distances", "proximities" as regards some particular message (a "point" in a new space H_Z''), epistemological "velocities of variation", conversion of the relativistic viewpoint to a question of transformation of coordinates etc. etc.]. These results were next

<u>extended</u> in S/5 and S/6. In particular they led

- firstly to the construction of a new "space" H_T'' embracing H_Z'' as well as some other "subspaces" H_{R*}'', H_{P*}'' etc. [dealing with the religions, political, etc. status of some particular group environment G_k (of which the elements $h_k'' \in H_T''$ are the formal images)]

- secondly to a topographical and dynamical interpretation of these G_k as a <u>composite machine</u> (an automaton) hierarchically organized and whose inner relationships obey ZADEH's fuzzy equations together with a <u>threshold condition</u> (the expression of the conditioning constraints to which the elements of such group environment may be submitted). This condition is deduced from a particular interpretation of PERCEPTRON's theory. Based upon these results <u>it can finally be demosntrated that historical questions may be converted to engineering problems capable of quantification and experimentation in (for example) PASK's THOUGHTSTICKER system</u>.

Being impossible in this ARGUMENT to reproduce the aforementioned historical, epistemological, algebraic etc. reasoning, the next considerations will be simply devoted to the presentation of the most important results there achieved. In this sense instead of beginning with the elements of the z_k s and next, by means of successive extensions, to reach the automata description of WALSH's historical "wholes", we shall adopt a different strategy: after the previous introduction of some fundamental definitions concerning for example

- the roles ascribed to the *OPs* (past or present) as <u>observers</u> and participants

- their temporal ordinance

- their interactions with their environments

- their constraints

etc.

the total event "space" H_T'' will be stated in a (shall we say) axiomatic form. Algebraic restrictions to this "space" will lead to the presentation of some of the characteristics of H_Z'' (the most important in the historical/scientific reconstitution problem). This being accomplished, the interpretation of historical/scientific evolutionary process in terms of those fuzzy conditioned composite automata previously emphasized, will end the approach.

II/2.4.2 - <u>THE RESULTS</u>

For the sake of simplicity the presentation and development of the strategy referred to a moment ago is condensed in three great groups of peculiar statements, briefly named <u>PROPOSITIONS</u>. The first of them provides some definitions necessary to clarify the relationships between the *OPs* as well as a condensed systematization of what has already been done in the essay. The second describes formally WALSH's "wholes" i.e. our G_k; the third is concerned with the interactions G_k <--> OP_k examined from the viewpoint of Automata Theory.

PROPOSITION A: ON OBSERVERS/PARTICIPANTS

A/1. Observers/participants (symbolically OP_k) are all human beings who, throughout time, have been giving their contribution to the transformation and expansion of mankind's scientific knowledge (symb. TSK)

A/2. OBSERVERS (synchronous examined)

A/2.1. Every OP_k is supposed to be inserted into a general time-variable environment E'_k (a source of information) with which he interacts

A/2.2. The innate or learned biological, psychological and social characteristics which the OPs possess as human beings (individually or collectively regarded) conditionate in a certain sense the environmental activities and behaviours (KLIR 1975) of which they may be aware or which can understand and explain. These conditioning characteristics can, therefore, be interpreted as constraints [in the sense that if they were (somehow) modified then OP_k's awareness of E'_k (firstly) and his understanding and "explanation" (later)] would necessary be different.

A/2.3. Under these conditions

i) if C_k is the set of such constraints C_k

$$C_k = \{ c_{k1}, c_{k2} \cdots c_{k\alpha} \} \qquad \text{(A/2.1)}$$

$$t_k \in T$$

then it is possible to associate every OP_k with a particular C_k by means of a correspondence Ξ ,

$$\Xi \ : \ C_k \longrightarrow OP_k \qquad \text{(A/2.2)}$$

ii) Ξ is usually <u>one-to-many</u>. Every OP_k is related to one and only one C_k but one C_k may correspond (in some aspects at least) to several OP_k.

This is especially evident for contemporaries or temporally contiguous observers; on the contrary, it does not hold for (temporally) distant OPs . Everything works therefore as though

- OPs belonging to the same generation of some group environment were <u>sharing</u> with each other [28] a great number of <u>common</u> C_k (synchronous examination of these G_k)

- OPs belonging to temporally distant generations (of the same G_k) were presenting in some aspects significant differences (diachronous examination of these G_k)

A/2.4. It follows from A/2.3

i) that every OP_k can never be aware of the whole E'_k <u>in itself</u> but only of a part E_k

$$E_k \subset E'_k \qquad \text{(A/2.3)}$$

of it, that one which his particular C_k allow

[28]Recall what was said about FREUD's social superego

ii) that (due to such C_k) he can only construct a particular <u>image</u> of E_k ;

iii) that if such images are represented by z_k then there exists a homomorphism h_k .

$$h_k : E'_k \longrightarrow z_k \qquad (A/2.4)$$

This homomorphism obeys the simplified diagram of Fig.19a,b.

The picture may be interpreted as though, from the whole environmental behaviours actually describing E_k' ,only <u>some</u> (those represented by E_k) were understood and explained by OP_k, this "explanation" being described in terms of messages z_k for the use of future generations.

A/2.5. Taking these assertions into account the conditions which (from A/1) may be used to define the OPs as <u>observers</u> only are

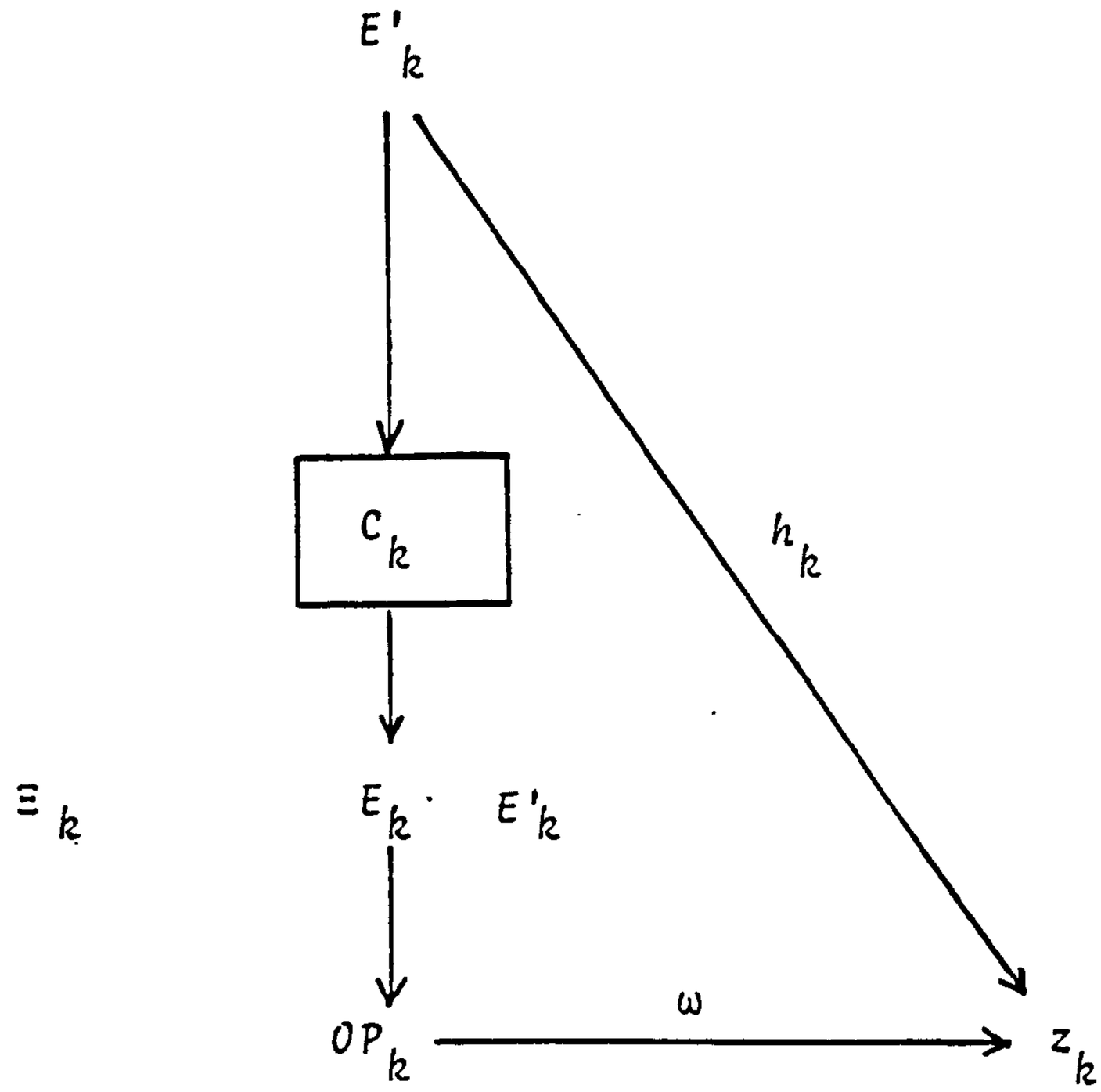
i) that they all present a certain kind of expectancy and uncertanty as regards changes occured in their environments (expectancies and uncertainties which in "affective" terms are translated by anxiety and insecurity)

ii) that they must be aware of them

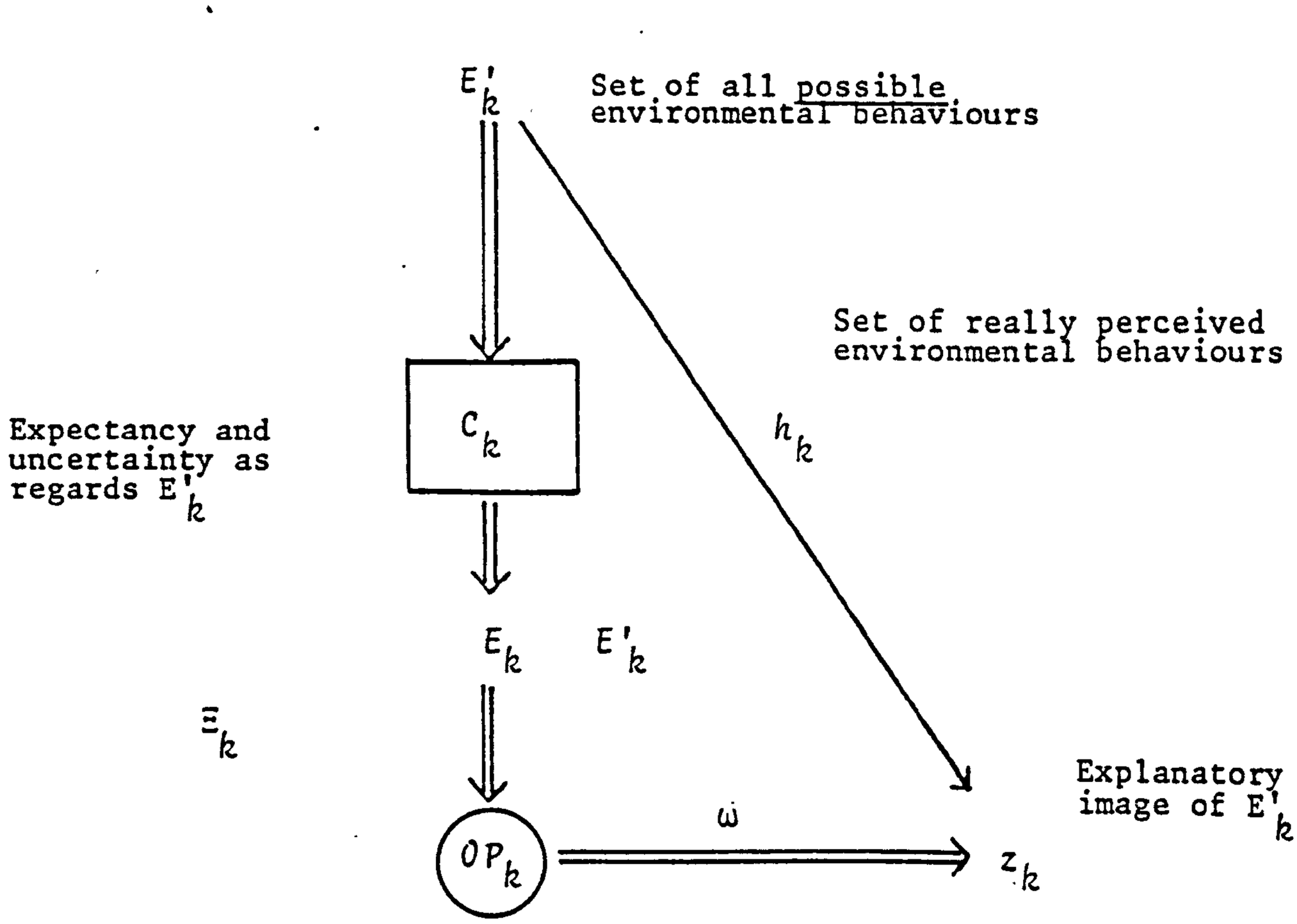
iii) that they must seek their reduction (or lowering) using for it a set of (time-variable) appropriate procedures.

A/3- <u>OBSERVERS</u> <u>(Diachronously examined)</u>

A/3.1 - Observers can be <u>temporally ordered</u>. Let then τ' and τ be



a) Mathematical relationships between E'_k , E_k , OP_k and z_k



b) Systemic relationships between E'_k , E_k , OP_k and z_k

Fig. 19a, b

the correspondences

$$\tau' \ : \ T_R \longrightarrow OP_k$$
$$\tau \ : \ T_h \longrightarrow OP_k \qquad \text{(A/3.1)}$$

so that T_R relates every OP_k to the instants of the <u>real time scale</u> (based upon J.C birthday) and T_h simply expresses their <u>ordinance</u> as regards the remainder OPs (Hypothetically time-scale T_h)

A/3.2- Let also ω_k be mapping

$$\omega_k \ : \ OP_k \longrightarrow z_k \qquad \text{(A/3.2)}$$

called <u>output function</u> and which associates every OP_k with one really achieved (and presently <u>knowable</u>) environmental image z_k.

It follows from (A/3.1) and (A/3.2) that environmental images can be <u>temporally ordered</u>

A/3.3. If (generally speaking) two temporally ordered images say z_i and z_j ($i < j$) are mutually compared then they (usually) present significant differences. In this essay this will be interpreted as meaning that in the interval $[t_i, t_j]$ something has been <u>transformed</u> or <u>changed</u> between them; or which is similar that there exists a <u>transformation</u> T_{ij} (ASHBY, 1972)

$$T_{ij} : z_i \longrightarrow z_j \qquad \text{(A/3.3)}$$

Under these conditions z_j will be named the <u>transformed image of z_i by T_{ij}</u>, this transformation working as some kind of <u>operator</u> which once is <u>applied</u> to an operand z_i produces z_j. <u>Epistemologically</u> these T_{ij} may be regarded as expressing the particular thought-processes which some OP_j used in order to change (to the influence of his G_j) a certain past environmental image z_i..

A/3.4- Given a finite set of temporally ordered observers/participants, say OP_1 , OP_2 ... OP_n included in some previously chosen time-interval $[t_1 , t_n]$ the transformation which links the first of all predecessors to the last of his successors will be named <u>global transformation</u> of the considered set. In particular: if this set contains only two temporally consecutive OPs say OP_i and OP_j (i.e. OP_j is the immediate successor of OP_i) these T_{ij} will be called <u>individual transformation</u>

A/3.5- Global and individual transformations are mutually related. If some historical and formal conditions are verified [29] a global transformation may be regarded as the result of the (algebraic) composition of the intermediate individual transformations T_{12}, T_{23}, ... T_{n-1n} .

$$T_{1n}=T_{n-1n} * T_{n-2n-1} \cdots T_{23} * T_{12} \qquad (A/3.4)$$

in which the operation "*" will be specified in PROP.C.

A/3.6- In the particular case in which the last successor of some remote OP_0 is the proper present-day historian OP_R and OP_1 , OP_2 , . OP_{R-1} deal with all the intermediate observers/participants obeying item I/1 then the global transformation T_{0R} will reproduce TSK. In other words

$$T_{0R} \equiv TSK \qquad (A/3.5)$$

It is as a <u>builder</u> of this trasformation that OP_k's role as participant can be brought to light.

[29] See B/4 for more details.

A/4. PARTICIPANTS

A/4.1. Asserting that OP_1, OP_2, . . . OP_n are participants in we are implicitly saying that beyond their activities as simple observers each one of these individuals shares with the remaining ones (his predecessores or successors) a general entreprise, goal, intention or set of properties common to them all.

i) In the case of this essay this entreprise is the construction of TSK; and

ii) their ultimate goal deals with the presentation of explanatory models of *PhW* (expressed by means of their z_k) through which their expectancies and uncertainties (or anxieties and insecurities in the earliest epochs of mankind) are (somehow) reduced; this according to the particular set of constraints to which they are submitted.

A/4.2- It follows from this that the *OPs* can no longer be regarded as isolated (as their features of simple observers imply) but rather, that they are related to one another

A/4.3- As this relationship is essentially processed throughout time and not in space (except in the case of contemporaries who may be in contact) then the inclusion of something through which some OP_j is capable of communicating his own environmental image z_j to his successors OP_{j+1}, OP_{j+2}, . . . must necessarily to be taken into account. This something is OP_k's group environment G_k.

The consequences which can be extracted from this are that

i) the z_k can, henceforth, be regarded not only as explanatory models of *PhW* but also of <u>messages</u> (in SHANNON's true meaning);

ii) the long-time construction of TSK underlies the existence of some <u>transmission system</u> (a system which is being processed in time and not in space as it happens with the majority of present-day communication systems);

iii) in order that this transmission works, it is required that some OP_{j+1} has <u>learnt</u> what his predecessors had already learnt about *PhW*; which implies the existence of some kind of <u>teaching</u> (PASK, 1975) and consequently

- either the existence of some <u>group</u> of intermediate individuals (scientific community, "schools", etc.) responsible for the simple <u>propagation</u> of past knowledges (what in the language of transformation we can name as <u>identity transformations</u>); thus, working as some kind of (passive) <u>social memory</u> (represented by the libraries, oral or written traditions of some G_k and transmited from generation to generation etc.)

- or the possibility of <u>criticizing</u> and <u>modifying</u> what was already learnt (by introducing new concepts, etc.); thus, giving rise (if the existing constraints allow it) to another individual transformation of TSK.

A/4.4- It follows that

i) when globally regarded TSK may be viewed as a long-time construction in which (broadly speaking) the degree of environmental uncertainty and expectancy related to the first of all predecessors of some OP_R is decreasing as far as time went on. Under these conditions it can be asserted

- that OP_k's knowledge of their environment (PhW in particular) increases; or

- that larger and larger and larger numbers of environmental predictions have been progressively confirmed as far as time went on (PASK 1975).

ii) in consequence, that TSK can also be regarded as the (long-time) result of the activity of some underlying system S the historical communication system.

iii) that when this system is externally or internally examined by some present-day historian OP_R it (globally) works as an adaptative learning system according to the evolutionary meaning of PASK and VON FOESTER.

A/5- PRESENT-DAY OP_R.

A/5.1- Present-day historians (scientific or not) obey the features ascribed to past observers/participants OP_k ($k=0, 1, \ldots R-1$)

This because

i) they also may be regarded as <u>receptors</u> of the information proceeding

- not only from their present environment E_R ,

- but also from their historical past either through the set of messages z_k directly related to the description and explanation of PhW (according to OP_k's own viewpoints) or of some other historical sources which they think to be relevant for z_k's <u>understanding</u>

ii) as human beings they, too, are submitted to the influence of a set of constraints

$$C_R = \{ c_{R1}, c_{R2} \cdots c_{R\beta} \} \qquad (A/5.1)$$

not necessarily identical to those which have affected past OP_k;

iii) partially due to these constraints, partially by virtue of the proper characteristics of the information proceeding either from E_R (particularly PhW) or from past OP_k, they also present expectancies and uncertainties as regards both of these informative sources.

A/5.2- Due to the distinctions existing between such sources the procedures which OP_R may use in order to decrease such expectancies and uncertainties have had (so far) different characteristics

i) as regards for example *PhW* this information may be regarded as directly experienciable, partially or totally observable and controllable (through experimentation), involves logically open classes, it is objective and quantified, leads to predictions etc.

ii) as regards their historical past such an information is not directly experienciable, not controllable (in the sense that historical experimentation has not, so far, been accomplished) deals with logically closed classes, involves actions executed by human agents, etc.;it contains, therefore, an "internal part" associated with OP_k's thought processes, with everything which it implies in terms of subjectivity, singularity, non-objective quantification and (consequently) non-predictability, etc.

A/5.3- It follows from A/5.2 that instead of one (as it happens with the OP_ks) there are in principle two main goals whose achievement OP_R aims for

i) one, related to the construction of some explanatory model z_R of *PhW* - which, in the context of this essay, determines his role as natural scientist

ii) the other, dealing with the possible construction of some explanatory model of TSK - which brings to light his role as scientific historian

A/5.4- Throughout the whole essay it is assumed that A/5.3 i) is already accomplished. Under these conditions the unique problem which OP_R has to face and solve is simply concerned with A/5.3 ii). This question has been called the historical/scientific reconstitution

problem being its possible solution the ultimate and deepest goal of this essay.

A/5.5- Reasons related to the psychological, epistemological, scientific and technological status of our present-day E_R - particularly the widespread use of more and more powerful computerized systems and the interdisciplinary point of view which cybernetics has introduced into the contemporary scientific panorama - suggested two complementar (though simply possible) ways of overcoming this problem.

i) The first of them (pervading explicitly or implicitly the whole essay) comes from A/4.4 above; i.e. from the interpretation assigned to mankind's historical/scientific processes in terms of PASK's learning/teaching evolutionary approach - with everything which this identification implies. (HYP. ZERO)

Particularly important are, in the sense

- the use of his relativistic paradigm

- the peculiar way of looking upon the relationships between past and present (the reconstitution of which historians seek) in terms of a dialogue between a "student" OP_k and a "teacher" OP_R,

- dialogue which (if some conditions are satisfied) may be reproduced in a computerized system (PASK's THOUGHTSTICKER)

- thus, allowing the externalization of normally private thought-processes which (if some conditions are really verified) may lead to the reconstitution of OP_k's past mental processes [either in terms of what they effectively learnt or bringing to light the reasons

(constraints) which in this or that simulated epoch "forbide" or "prevented" that learning]

The abstract analysis of such "conditions" (involving an exhaustive examination of the epistemological and psychological approaches of PIAGET, WALLON FREUD, etc.) culminated with the construction of that integrated (though simply conjectural) psycho-historical model of TSK which TABLE I summarizes: an unifying and (insofar as we know) original approach to part of mankind's evolution in which the sucessive transformations which the images of Nature undergone were closely related not only with the cognitive and affective thought-processes of their authors (say, briefly, with their "internal worlds" IE_k) but also with the (general and abstract) social, political religious, etc. features of their group environments G_k.

ii) In order to overcome the gap between historical and physical or quasi-physical disciplines which A/5.1.1 stressed, another step of this essay needs, however, to be accomplished:

- firstly, because history is not an abstract but rather a concrete science (say, dealing not with Men but with the Men who executed this or that particular action) such a conjectural model of TSK needs to be related to the whole amount of historical information U'' really accumulated since mankind's beginnings

- secondly because such actions were regarded as the simple or outermost superficial part of hidden and complex interactive processes in which some kind of (conscious or unconscious) control is supposed to exist [usually between the actions which some human agent "proposes" or "intends" to execute and his constraining (external or

internal) contextual conditions] then also needed is the specification of OP_k's conditioning constraints, etc.

Two new problems arise therefore

- How to systematize and describe (direct narrations) that <u>total</u> amount of historical information U'' really associated with mankind's evolution (or, at least, that part of U'', say U' more particularly related to history of Science) so that such a systematization and description may be implemented in PASK's system?

- How to "explain" (significant narrations), if possible in <u>quantitative</u> terms, that complex interaction OP_k <--> G_k previously referred to?

iii) The approach used to solve both of these questions proceeds from a (temporary) restriction to the aforementioned dialogue (or bilateral communication) OP_k <--> OP_R: instead of a conversation in which OP_R poses "problems" which OP_k progressively solves, it was assumed in I/4 of this ARGUMENT that OP_R's position before U'' (or U') was similar to that of a simple (though active) <u>receptor</u> of the information emmited by a <u>system</u> S (the historical communication system referred to A/4.4 ii)). In other words, such a dialogue was reduced to a temporary and <u>unilateral</u> data reception. With this restriction the historical problem is converted to a <u>systemic</u> <u>and engineering</u> <u>question</u> to which some known mathematical procedures and techniques are (potentially) appliable.

How this can be use to provide answer to the two problems referred to a moment ago will be the objective of PROPOSITIONS B and C. In order to avoid the quantitative questions referred to II/2.4.1 in both of these Propositions we shall make use of our hypothetical suprahuman OP_F.

PROPOSITION B: ON CONTEXTUAL SYSTEMATIZATIONS (FROM A STATICAL AND DIRECT HISTORICAL VIEW POINT):THE P - SPACE H''_7.

B/1 - ON CONTEXTS IN GENERAL

i) Actions executed by past human agents are historically understandable if they are related to the political, religious, economic, social scientific, etc. environmental influences to which such agents were being submitted (WASH's coalition process).

The totality of these inter-related influences determines a particular organization (a "whole" in WALSH's sense) of the total environment E_k with which some OP_k interacts. This organization is called the group environment of this OP_k.

ii) As a global entity which takes part in the understanding of OP'_ks actions (whatever may be the time - instant considered) group environments can, the refore, be regarded as a (time - invariant) element of the approach. If G is (symbolic) the global representation of this elements then there exists a correspondence θ

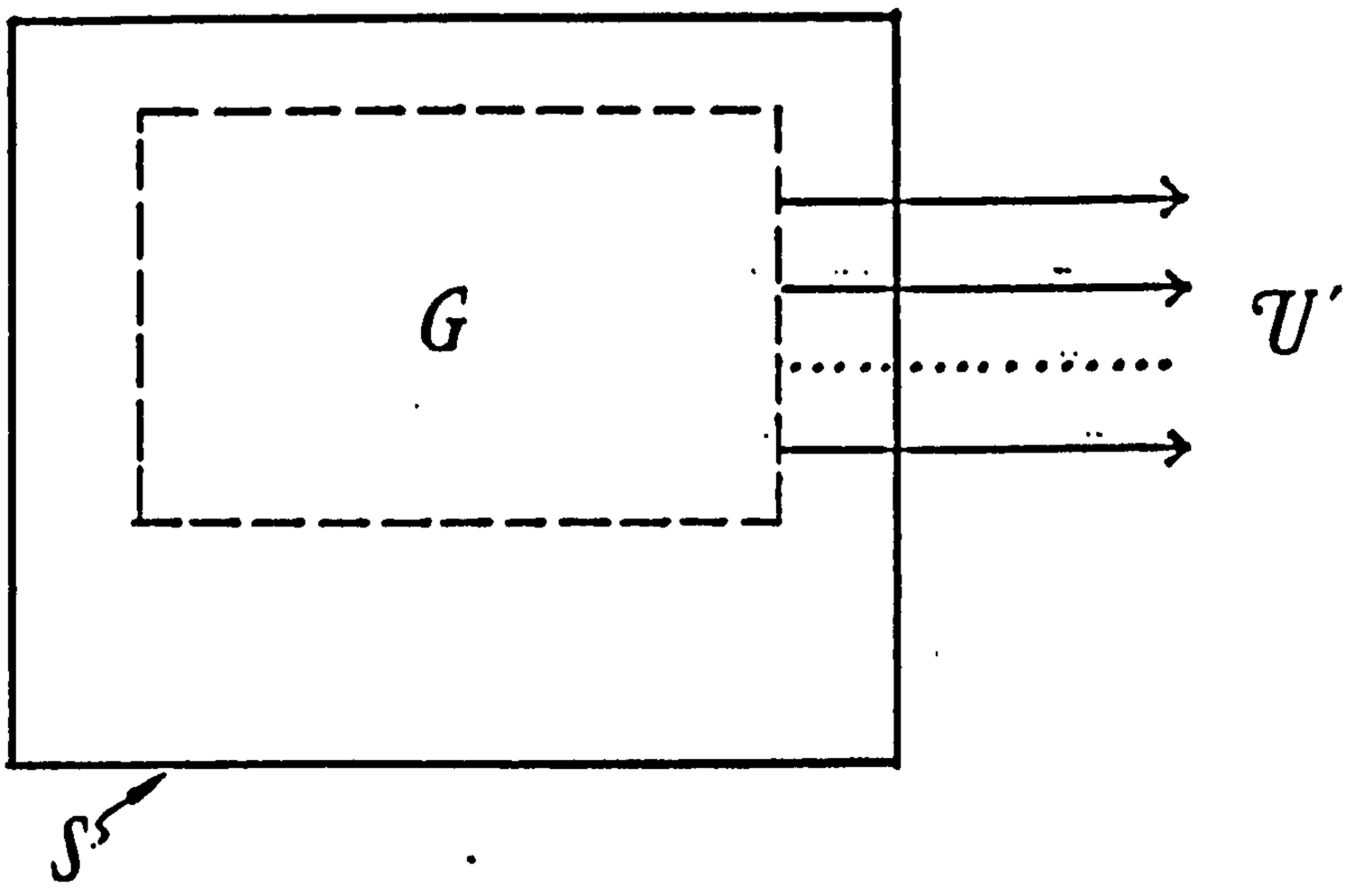
$$\theta : T_R \rightarrow G \qquad \text{(B/1.1)}$$

$$\theta(t_k) = G_k \qquad \text{(B/1.2)}$$

$$k = \emptyset, 1, \ldots R; \; t_R \quad T_h, T_R;$$

G_k is said to be an <u>image</u> of G at a particular time - instant t_k of its history: it represents therefore the global context into which some OP_k is (was) inserted.

B/2 -Let U' be the total amount of information related to <u>all</u> these G_k in some particular region of the globe to which the OP_k belong and to which OP_F has directed his attention (Fig. 20)

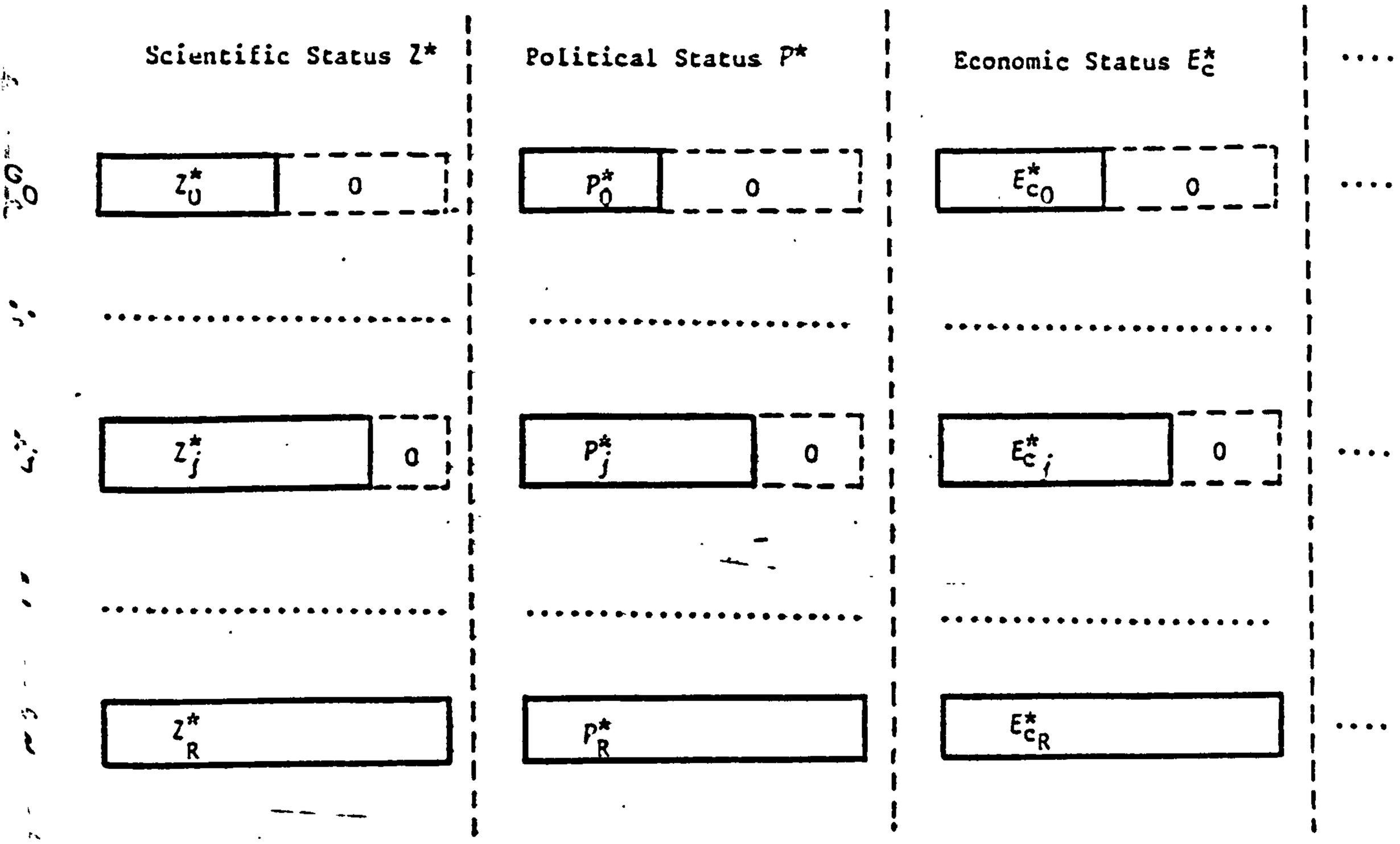


Contextual analysis. The systemic approach (first version)

Fig. 20

i) Suppose for the sake of simplicity that this <u>abstract</u> amount of information is capable of being <u>visualized</u>; say, may be viewed as occupying an extensible "volume" in time and "space" [in which the word "space" is here related to all the attributes and/or relationships by means of which the G_k are knowable (by that supra - human observer OP_F)]

ii) that this "region" can be <u>synchronously</u> and <u>diachronously</u> examined as shown in Fig. 21 a) b). Here "synchronous" means that such a region is examined image by image (i.e. as though it were made of several "stratified" cuts, each cut being made according to particular time instants $t_0, t_1, t_2, \ldots t_R$ of history) and "diachronous" that some attribute and/or relationship of one of these cuts is compared with the remainder elements of the other cuts.



G_k^*s Horizontal Analysis

Fig. 21a

iii) that while accomplishing a synchronous analysis of every G_k ($k = 0, 1, \ldots R$) finds not only that

- part of its designating attributes and relationships are always <u>exclusively</u> concerned with the whole scientific status of G_k, say Z^*

G_k's Vertical Analysis

Fig. 21b

- another part, say R^*, is always <u>exclusively</u> concerned with its religious status

- another one, say P^*, is always <u>exclusively</u> referred to its political situation etc.

but also that when this description deals with the most recent G_R it proves to be the most complex and, diversified of all the remaining G_k. In other words, that if these G_k are compared with G_R (or, which is similar, if G_R is regarded as some kind of reference standard) then part of the attributes and relationships used to describe this present situation prove to be inexistent for $t = t_{k'}$ $t_k \in T_R$. Let 0 be therefore (as we did in S/4) the symbolic representation either of such missing attributes or of its corresponding missing, relationships. In these conditions a condensed tabular representation of OP_F's analysis of every G_k could then take the aspect shown in TAB B./1 in which z^*_k, r^*_k, p^*_k, etc. are supposed to be messages dealing with Z^*, R^*, P^*, etc. at $t = t_k$.

It is by means of these attributes that the G_k are assumed to be historically knowable.

TAB B/1

G_k	Hyp. Time	"Spatial" description of G_k			
		Z^*	R^*	P^*	.....
	G_0	t_0	z_0^*	r_0^*	p_0^*	.....
	G_j	t_j	z_j^*	r_j^*	p_j^*	.....
	G_R	t_R	z_R^*	r_R^*	p_R^*	.....

iv) Suppose next that, while comparing attributes belonging to the same status but now corresponding to distinct time instants t_k, OP_F finds that, in spite of their <u>temporal</u> differences, such attributes may be distributed by some <u>equivalence classes</u> (or conceptual categories), each class being characterized by a certain property or feature <u>common to</u>

.all its elements (and thus time invariant). Let in this sense

$$A_1, A_2, \ldots\ldots A_p$$

be the categories into which Z^* may be partitioned (taking the description of G_R as reference), $A_{p+1} \ldots A_q$ those found necessary to specify R^*, $A_{q+1} \ldots A_s$ those necessary to characterize P^* etc. Let in addition an attribute belonging to a given class A_i but used to describe a certain historical situation at $t = t_k$ be represented by a_{ik} (or "0" if this is the case). Suppose, finally, that these conceptual categories are ranged according to their order of antiquity i.e. that $A_1 \in Z^*$, $A_{p+1} \in R^*$, $A_{q+1} \in P^*$, etc. are classes including the "oldest" attributes, while A_2, A_{p+2}, etc. are those which appeared next, etc..

Based upon this OP_F could then write for the whole attributes used to specify G_R

$$\begin{aligned} A_1 &= \{ 0, a_{10}, a_{11}, \ldots a_{1R} \} \\ A_2 &= \{ 0, a_{20}, a_{21}, \ldots a_{2R} \} \\ &\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ A_R &= \{ 0, a_{r0}, a_{r1}, \ldots a_{rR} \} \end{aligned} \qquad \text{(B/2.1)}$$

or more generally

$$A_i = \{ F_i(t_k) \mid i = 1, 2, \ldots \; k = 0, 1, \ldots R \} \quad (B/2.2)$$

in which

$$F_i : T \longrightarrow A_i \quad (B/2.3)$$

are mappings which associate every time instant $t = t_k$ with a given element $a_{ik} \in A_i$.

Using the terminology of the aforementioned Premise E we can, therefore, say that the $a_{ik} \in A_i$ may work as <u>significances</u> (semantic significances) which A_i successively acquires as far as t varies.

This being accepted a complete diachronous description of the G_ks throughout time can then take the condensed aspect shown in TAB B/2 in which, for the sake of simplicity, we have omitted the relationships R (a_{ik} , a_{ij}) existing between attributes.

TAB B/2 translates therefore a <u>spatio-temporal</u> description of G, the meaning of "spatio" being understood as in B/3 i).

TAB B/2

"Spatial" description of G_k				
Time	Z*	R*	P*	
	$A_1 \cdots A_p$	$A_{p+1} \cdots A_q$	$A_{q+1} \cdots$	
t_0	$a_{10} \cdots 0$	$a_{p+10} \cdots 0$	$a_{q+10} \cdots$	
$\cdots$	$\cdots\cdots\cdots$	$\cdots\cdots\cdots$	$\cdots\cdots\cdots$	
t_j	$a_{1j} \cdots 0$	$a_{p+1j} \cdots 0$	$a_{q+1j} \cdots$	
$\cdots$	$\cdots\cdots\cdots$	$\cdots\cdots\cdots$	$\cdots\cdots\cdots$	
t_R	$a_{1R} \cdots a_{pR}$	$a_{p+1R} \cdots a_{qR}$	$a_{q+1R} \cdots$	
G_k	G_0 $\vdots$ G_j $\vdots$ G_R			

v) under these conditions, taking into account

- the numerical (fuzzy resemblance) interpretation which may be ascribed to these $A_{ik} \in A_i$ [item ii) of PREMISE E]

- KLIR's ST approach

- the properties of n-ary cartesians products and their epistemological significance

- the features of LANCZOS' configuration spaces

- the analogies which may be established between the elements of these products and those belonging to R^n (interpreted as vectorial euclidean space)

it can be asserted that the exists a pseudo-space H'_T (similar to LANCZOS' configuration space)

$$H'_T = T \times Q' \qquad (B/2.4)$$

where the elements of T are time instants of T_h or T_R, Q' is p-state space

$$Q' = Z^* \times R^* \times P^* \ \ldots = \overbrace{\prod_{i=1}^{n} A_i}^{n} \qquad (B/2.5)$$

and the A_i obey (B/2.1).

H'_T is named <u>total event p-space</u> and (B/2.4) is assumed to translate the time-"space" decomposition of G previously referred to.

The usefulness of these (general) contextual description will be fully understood in PROPOSITION C when the <u>relationships</u> between G_k's status will be the objective of numerical interpretation. For the moment - and in order to stress some important, formal historical and epistemological results needed for such an understanding - let us pay attention simply to <u>part</u> of those status: that one more concretely related to the systematization of <u>historical/scientific data</u>, particularily to the construction of OP_k images of Nature. Using the preceding (formal) symbology this data is supposed to be describable by means of p-space H''_Z (named <u>historical scientific event p-space</u>)

$$H''_Z = T \times \prod_{i=1}^{n} \Lambda_i$$

in which $n < p$ since the <u>physical</u> description of Nature is simply part of all the matters presently involved in Z*'s descriptions (Fig. 22). In order to see how H''_Z is constructed we shall begin our considerations not with p-spaces but with <u>sets</u>.

B/3. <u>THE SCIENTIFIC EVENT SET H''_Z</u>

B/3.1. <u>The systematization of historical/scientific data: attributes only</u>

i) let U be the total amount of information related to OP_k's description of Nature. Let z_k be the messages emmited by these observers/participants by means of which OP_F has knowledge of such descriptions.

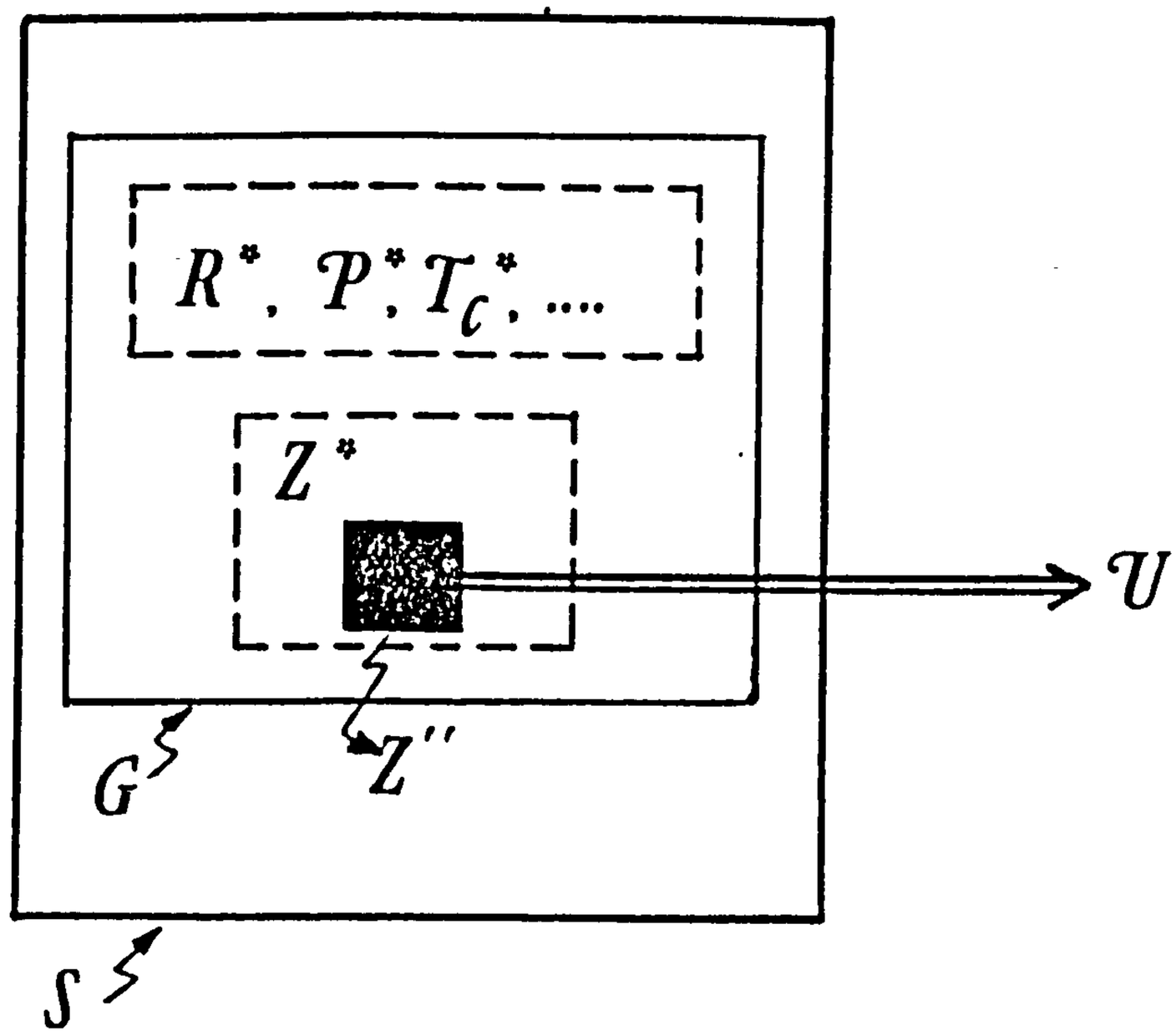


Fig. 22

Contextual Analysis (second version)

ii) Assume [as in B/2 i, ii]

- that this amount may be visualized as an extensible region of time and "space"

- that this region can also be synchronously and diachronously examined

- that in result of these operations (taking the present-day image of Nature z_R as reference)

OP_F is led to a systematization of U as shown in TAB B/3

- in which $Z_1 \ldots Z_q$ are equivalence classes into which z_R may be partitioned (i.e. sets of attributes and relationships obeying a particular group of postulates, properties, features, etc common to them all, for example Mechanics, Thermodynamics, etc)

TAB B/3

T_h	z_k	CLASSES								
		Z_1			...	Z_q				
		A_1	A_2	A_3	...	A_{p-2}	A_{p-1}	A_p		
0	z_0	a_{11}^0	0	0	...	0	0	0		
1	z_1	a_{11}^1	a_{12}^1	0	...	0	0	0		
...	...	.....			...	.....				
R	z_R	a_{11}^R	a_{12}^R	a_{13}^R	...	a_{qp-2}^R	a_{qp-1}^R	a_{qp}^R		

- the A_i (i=1, ... n) are <u>concepts</u> [undertood as representatives of class and not as <u>procedures</u> (in PASK's sense) due to the statical point of view according to which U' or U has been examined so far]

- the a_{ij}^k are the semantic significances which an attribute A_j belonging to some class Z_i takes at $t=t_k$.

In terms of attibutes only (and looking upon U as direct historical narratories) TAB B/3 expresses therefore part of the schematization of that amount [30]. The other part deals with

the relationships therecontained either <u>internal</u> (i.e between attributes) or <u>external</u> (say between messages, what we called transformations)

B/3.2 - <u>The systematization of historical/scientific data: internal relationships</u>

From an exclusive formal viewpoint, relations in themselves work as simple elements of U' whose specification (similarily to what has happened with a^{k}_{ij}) also obeys the aforementioned procedure. In this sense we could assume that our hypothetical OP_F was, for example, able to sweep firstly, all possible horizontal and vertical relationships existing between two particular A_i, say A_1 and A_2, next to extend this analysis to the other remaining A_{i-2}, next to group them into this or that equivalence class etc. until to bring to light some new table (similar to Tab B/3) which,

[30] It must be remarked that TAB B/3 is nothing but TAB I I/ 0 of Premise B though written in a different form. As a matter of fact (and beyond the identity existing between the semantic significances of both TABLES) not only the A_i work as the set of <u>terms</u> previously referred to but also each line of TAB B/3 is, from now on, associated with a <u>description</u> of the message to which it corresponds. Finally the semantic significances taken by the A_i can can, too, be numerically "weighted" [regarding those corresponding to z_R as fully significant ($\mu_{Ai}(z_R) = 1$)].

together with it, would completly specify U's systematization.

Thought possible the procedure would present however several disadvantages; in particular it would require

- firstly a concrete application of Tab B/3 to a specific and real historical window (a fact which is irrelevant from the point of view of the general theory we are proposing)

- secondly, and together with the systematization of all the A_i and their associated mutual relationships, the introduction of six (at least) additional categories of order relations dealing with

a) the ordinance of the Z_j s (j = 1, 2, ..., q) in the reference image z_R, (an ordinance which must be rigidly followed during the analysis of past images)

b) the ordinance of their respective A_i s (which also, must be always the same throughout that analysis)

c) the temporal ordinance of the semantic significances of such A_i s

d) the temporal ordinance of messages z_k

e,f) the order according to which relationships existing between particular attributes are examined (either in every message or from message to message).

Excepting e) and f) all the remaining relations have already been taken into account in the course of the approach; thus, working as some kind of initial assumptions according to which U's systematization has been framed. However the inclusion of e) and f) into the complete specification of classes and/or their

terms either in every message or from message to message would lead to the appearance of expressions as

$$z_j^k = \{ 0\ a_{j1}^k,\ a_{j2}^k \ldots R_i\ (a_{j1}^k,\ a_{j2}^k),\ R_i\ (a_j^k\ ,\ a_{j3}^k)\ \ldots \} \qquad \text{(B/3.1)}$$

extremely difficult to be treated. It is in order to simplify this treatment that OP_F's capabilities previously referred to play here a decisive role. Suppose that, due to such capabilities, OP_F is in fact able to construct the product set

$$H''_Z = T_R \times Z'' \qquad \text{(B/3.2)}$$

in which

$$Z'' = A_1 \times A_2 \times \ldots A_p = \overset{n}{\underset{i=1}{//}} A_i \qquad \text{(B/3.3)}$$

Lets us for the moment direct our attention to Z".

ii) We begin with the analysis of this set by noting that (B/3.2) contains already the first two of the aforementioned order relations: one associated with A_i's "antiquity", the another related to I_j's ordinance. This can be clearly seen in that expression; in fact, if $A_1, A_2, \ldots, A_m$ are assumed to be terms of Z_1, $A_{m+1}, A_{m+2}, \ldots A_s$ terms of Z_2, etc. then (B/3.3) can also be written as

$$Z'' = \underbrace{A_1 \times A_2 \ldots \times A_m}_{Z_1} \times \underbrace{A_{m+1} \times \ldots A}_{Z_2} \times \ldots = \overbrace{//}^{q}_{j=1} Z_j \qquad \text{(B/3.4)}$$

an expression in which the order of these classes is already implicity considered.

Beyond this, the equivalence of (B/3.3) and (B/3.4) is also susceptible of another advantageous interpretation. In historical terms this equivalence shows, in fact, that U's description either in terms of classes or in terms of their respective A_i - an algebraic refinement of these classes - leads in both cases to the same result. But in these conditions, if the most refined of such descriptions is from now on the one adopted, then the index j specifying the class to which some a^k_{jn} belongs, becomes henceforth unnecessary. If this is assumed then the notation which we have followed so far, can too be simplified. We can eliminate this index and, by rotation of the remainder two, also eliminate the supra-index; thus, the semantic value taken by some particular A_j will from now on be represented by a_{jk} , k being the time instant corresponding to its occurence.

iii) According to this condensed notation the semantic significances of each A_i will now be given by

$$A_1 = \{ a_{11}, a_{12}, \ldots a_{1R} \}$$

$$A_2 = \{ 0 \ , a_{21}, \ldots . a_{2R} \} \qquad \text{(B/3.5)}$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$A \ = \{ 0,0, \ldots\ldots . a_{nR} \ \}$$

in which, by (B/3.2) the a_{ik} are already supposed to be ordered according to their emergence in the scientific history of mankind (the <u>first</u> element of A_1 which appeared was a_{11} ; the <u>second</u> element was a_{12} , etc.). This being assumed the elements of the product-set (B/3.3) will now take the aspect

$$(a_{11}, 0, \ldots 0)$$

$$\ldots\ldots\ldots\ldots\ldots$$

$$(a_{11}, a_{21}, 0, \ldots) \qquad \text{(B/3.6)}$$

$$\ldots\ldots\ldots\ldots\ldots\ldots$$

$$(a_{1R}, a_{2R}, \ldots . a_{nR})$$

which are nothing but the expressions of all the possible combinations of the a_{ik} or 0 taken by all the A_i (i = 1, 2, ... n) throughout time.

In order to continue our reasoning we have now to take into account a well known property of such product-sets : concretely that they may be interpreted as another way of expressing the the relationship existing between some $x \in X$ and some $y \in Y$, X and Y being two known sets. [31]

In our case instead of two, we have now p sets A_1 , A_2 , ..., A_n ; thus defining a n-ary relation between them. However - and this is the important point - the property previously referred to still holds for any number of these sets. In these conditions - and this is the convention which we shall adopt henceforth - we shall assume that (B/3.3) contains not only all the possible combinations of 0 and a_{ik} but also all the possible relationships existing between them. Since every element of Z" includes now

- an ordered combination of A_i s

- a particular and also ordered combination of the 0s or a_{ik} s which they have taken throughout time

- the set of possible relationships existing between them

then - and this is the first result which we emphasize from our present analysis - such p-uples can, in fact, be regarded as obeying a second formal definition of message; a definition which has the advantage of avoiding the use of additional sets of order

[31] In brief: to assert that " $x \in X$ is related to $y \in Y$" (symbolically xRy) is equivalent to say that there exists a graph $G \subset X \times Y$ such that $(x,y) \subset G$..

relations . Thus, what so far has been qualitatively asserted about messages ("an assemblage of attributes and relationships between them") becomes henceforth converted into an element of the set Z" specified by (B/3.3) and (B/3.4).

The same may be asserted as regards the elements $h_k \in (t_k, z_k) \subset H''_Z$ which from now on may be regarded as espressions of historical/ /scientific events. Thus, the reason why Z" is named <u>output-set</u> and H''_Z <u>scientific event set</u>

iv) The result which we brought to light in the preceding item will enable us to answer part of the fundamental questions related to the specification of relationships between attributes.

Suppose in fact that after to have constructed this output-set. Z", OP_F was able to compare all its elements (possible messages' with those <u>effectively verified</u> in the scientific history of mankind. This being done, our observer would then be led to the conclusion that Z" could be partitioned into two classes say Z' and $\overline{Z}$' such that

a) into Z' are only included those combinations which coincide with past messages and to which it can, in consequence, be ascribed an <u>actual</u> [32]

[32] In terms of the scientific history of mankind, so as this history is presently known.

b) into its complementar $\overline{Z}'$ are only comprised historical meaningless combinations, i. e., those in which, for example, ARISTOTLE's notion of matter is associated with quantic concepts etc.

According to an algebraic terminology Z' works therefore as a graph of Z" though in reality the later has been generated from the former by means of the product-set (B/3.3). In spite of this in the next considerations we shall adopt the first viewpoint. In other words: oppositely to the process in which we began with the attributes of Z' and next, by means of their product-set, we were led to the construction of Z" we shall assume henceforth

- firstly, that Z" itself is the expression of a possible historical reality

- secondly, that its subset Z', comprising actual or meaningful historical messages is a graph of Z" only because, from the set of possible relationships existing between its elements, only some can effectively be verified at a given time-instant of the scientific history of mankind

In exclusive formal terms these two viewpoints are obviously equivalent; in both cases Z' is a graph of Z" whatever may be the interpretation ascribed to these sets. However, either in terms of inner relationships or even from a general point of view their differences are extremely significant.

As regards such relationships to assert as we did that "only some can effectively be verified at a certain time-instant" is, in fact, equivalent to say that part (at least) of the attributes

specifying the image of Nature at that instant are submitted to the influence of some inner constraints, something which relates a certain a_{ik} to other a_{jk} ; this in such way that if one of them varies the other will vary too.

Why this happens so is obviously outside of the scope of the present PROPOSITION B exclusively concerned with direct and not significant narrations. It must however be emphasized that as regards historical interpretation in general the introduction of the set of possible messages Z" also underlies a deep change in the way according to which history has, so far, been regarded. As a matter of fact, while in the first of the two aforementioned interpretations the whole historical reality is restricted to a statical examination of Z' (Z ' is what it is), in the second Z ' becames one of the possible graphs of Z" - not simply the one "which has really occured" but rather "the one which happened so because their inner and external constraints were as they were; the one which could also be totally distinct if such constraints were also different".

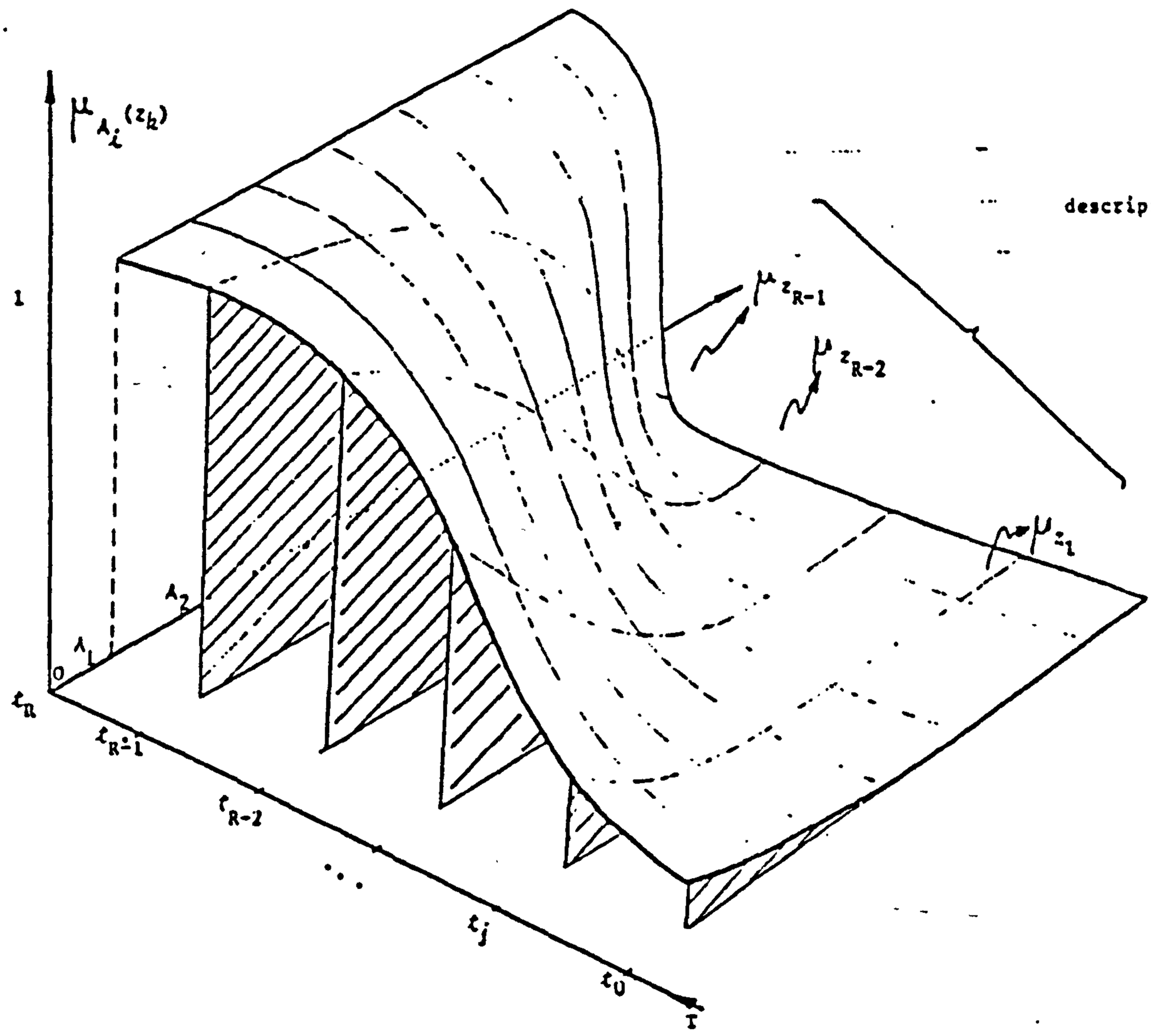
The full development of this dynamical interpretation of history will be more exhaustively analysed in S/5 and S/6. We must however stress that (from our point of view) it opens the way to the construction of several possible coherent models of scientific development, instead of the single one presently followed. This is a change which we compare to the one which happened in Physics with the substitution of the single description of Natural phenomena provided by Classical Mechanics

by G.IBB's Statistical Mechanics. If this vision is accepted we could, in fact, obtain models in which for example Baalbek's batteries and their practical applications would be used two thousand years before VOLTA; or, in which steam machines (already built in the IInd century B.C. by HERON of Alexandria) would be employed in the Roman Empire - both hypothetical situations which, if later developped according to the "normal" evolution of the western thought, would (probably) give rise to a knowledge of Nature totally distinct from that which we presently have. Obviously this vision does not need to be restricted to the past. As previously emphasized "past", "present", or "future", are relative concepts; thus, it can also be extended to our present or even to an "imaginary" or "possible" future as in fact it happens in many areas of knowledge. [33]

v) Let us suppose next that, directing his attention to effectively occured events only, our hypothetical observer OP_F is able to "weight" them in fuzzy terms, i.e., is able to ascribe to each one of the $a_{ik} \in A_i$ ($i = 1, 2, \ldots, p$) some numerical value between 0 and 1 [the membership set M of (II/2.5)] taking the values of z_R as fully significant terms. Suppose also that, by means of some numerical technique unnecessary to be specified (least squares, etc.), it is

[33]See for example "The Global 2000 Report to the President of the United States - Entering the 21st Century".

possible to bring about the curve which more adequatly describes $A_i \ (t), t \in T_R$. In terms of attributes only, and taking into account our hypothesis about their ordinance etc., the time variation of these terms could then take an aspect similar to that shown in the (half) cartesian diagram of Fig. 23.

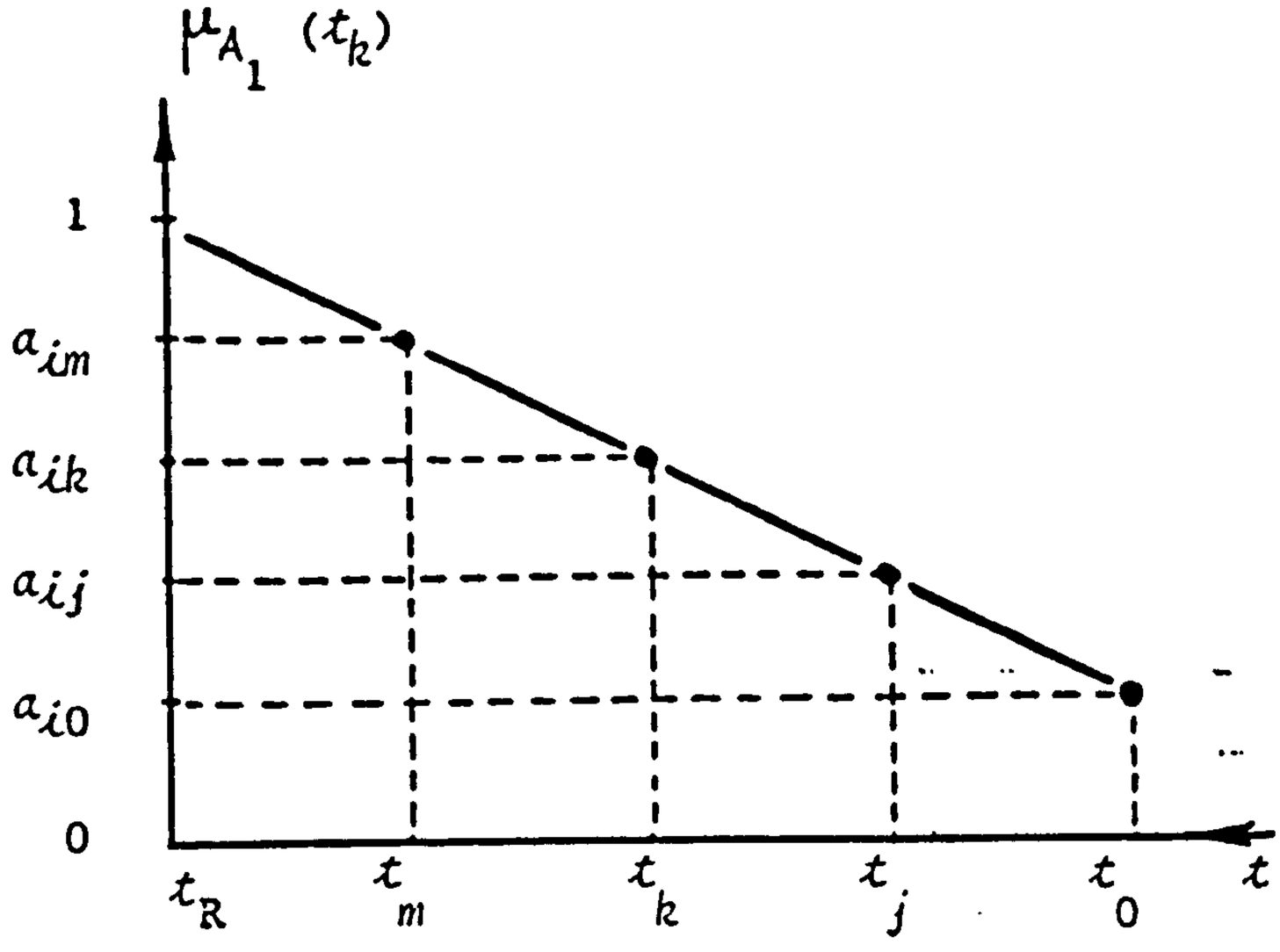


A (possible) three dimensional representation of time-variable messages

Fig. 23

It is easy to see that sections of these curves made according to the elements of T_R ($t = 0$, $t = 1$, ..., $t = t_j$, etc.) will reproduce z_k 's descriptors referred to Prem. D; similarily, sections made according to every A_i will reconstitute the vicissitudes suffered throughout time by their respective semantic significances. Beyond this, however, and this is the aspect which is important to emphasize -the picture translates in fact the possibility of re-telling the past in formal terms: if the mathematical expression of every A_i (t) is known then it suffices to ascribe a certain (integral) numerical value $t = t_k$ to the time variable t in order to obtain the complete description of A_i (z_k) and consequently of z_k .

For the moment, no historical meaning can be ascribed to these expressions, at least for time instants different from those corresponding to effectively occured events. This is due to two fundamental reasons. On the one hand, such intermediate instants are outside the scope of our present considerations, essentially devoted to simple direct narrations. On the other hand, and this is the important point, while the mathematical functions which these expressions translate are continuous, the transformation of some A_i (t_j) into an immediatly consequent A_i (t_k) must essentially be regarded as discontinuous; this because the interval of time which some OP_k has to spend in the creation of that new concept is infinitesimal (if compared with the whole scientific evolution of mankind). This discrepancy is clearly illustrated in Fig. 24.



The discontinuous aspect of historical descriptions

Fig. 24

In spite of these problems (which in a certain way will be overcome in the next item), the identification of these expressions would enormously simplify the treatment of the whole amount of information associated with TSK : instead of k different sets of p numerical values, everything which scientific historians would need would be the knowledge of these expressions, together with some kind of "dictionary" by means of which each one of such values is translated into a complete phrase or word, its semantic description.

This is not all however. For of messages and "events" are now geometrically interpreted taking into account the basic assumptions of B/2v) then it can also be demonstrated

- that these difficulties may be overcome
- that the external relationships (transformations)between messages are susceptible of being formally and epistemologically interpreted
- that the philosophical attitude (which so far has been implicit in the so-called relativistic position) may be mathematically translated
- that, finally, concepts such as those of distances, velocities of variation etc) which (so far) have been excluded from history can, henceforth, be explicitly considered.

B/4 - THE GEOMETRICAL INTERPRETATION OF H''_Z : THE p-SPACE H''_Z

Suppose in this sense that after to have accomplished his vertical analysis of U's, our hypothetical observer OP_F was able to set up a correspondence between the semantic significances taken by the A_i throughout time and the values of the interval [0,1], this interval being now regarded as specifying not the

membership set M of II/2.5) but rather a particular subspace of $\mathcal{R}^n$. Let this correspondence be represented by $\mu_{A_i}(t_k)$ instead of $\mu_{A_i}(z_k)$ as we did so far, the relationship between t_k and z_k being deduced from A/3.2 .

In exclusive formal terms there are obviously no differences between the two interpretations ascribed to [0,1]; the second, however, is the one which precisely underlies the aforementioned geometrical interpretation. As a matter of fact, if we take into account (B/3.5) if the A_i are provisionally assumed as mutually independent then we can see that all elements

$$h_k = (t_k; a_{1k}, a_{2k}, \dots a_{nk}) \qquad \text{(B/4.1)}$$

of H''_Z can, from now, on be interpreted as defining the <u>points of a n+1 - dimensional space as regards to which the preceding items may be applicable</u>. In order to stress the distinction between these two interpretations of H" , the algebraic and the geometrical, we shall however use for the later the symbol $H^{\prime\prime}$; obviously the subsets H'_Z , Z" , Z' , etc. of H''_Z will correspond now to the subspaces H'_Z , Z", Z' etc. Furthermore: because the numerical values ascribed to the a_{ik} are, at the actual stage of historical knowledge, still dependent on a subjective appreciation then, instead of the usual designations "space" or "subspaces", we prefer to name them as <u>pseudo-spaces</u> (briefly p-spaces); this having in mind their difference as regards "normal" vectorial spaces.

In order to see how these p-spaces may work, let us get back to B/1 and, based upon the features ascribed to OP_F, let us assume that this observer is able to visualize n-dimensional. spaces s o e a s i l y as human beings do as regards the 3-dimensional Euclidean space.

Suppose in these sense that, due to this characteristic, OP_F has decided to translate all the algebraic procedure of into geometrical terms. We can see in these conditions (standing our position for that of OP_F) that either the specification of the A_i which determine the conceptual categories of the reference image z_R or the systematization of their respective semantic meanings a_{ik} can now be regarded as <u>two</u> previous operations which such an observer accomplishes in order to define

- the number of independent "axes" (dimensions) which, together with T_R, bound the reference p-space H''_Z

- the time-resolution level according to which the temporal dimension of OP_F's historical window is being examined (in the case the whole TSK) as well as

- the spacial dimensions of this window as well as its space resolution level (wich in OP_F's case will embrace all such dimensions)

This being done (nothing but the usual scalling operations by means of which "normal" reference systems are previously specified) then it can also be seen that

- the product - set by means of which Z'' or H''_Z were built up correspond now to the specification of the totality of possible points of these sets

- once some of these points are shown to coincide with effectively occurred events, then the partition of H'' into H'_Z and $\bar{H}'_Z$ (associated with meaningfull and meaningless events), leads now to a partition of H'_Z into two correspondent regions (p-subspaces), say H'_Z and $\bar{H}'_Z$ such that

  - into H'_Z are only included really occurred events

  - into $\bar{H}'_Z$ happenings either possible (though never effectively occured) or even totally impossible;

These last are due to the epistemological contradictions which they implicitly contain as regards the history which has really happened.

From the point of view of the present geometrical interpretation the most interesting of these results is precisely related to H'_Z or to its derivative set (its algebraic cut by elements $t_k \in T_R$). Since by hypothesis these p-subspaces contain all the A_i as well as their already "weighted" a_{ik} effectively occured in the scientific history of mankind (the principal advantage of OP_F's introduction into these considerations) then

- not only z'_ks descriptors referred to Prem. D (i.e. the membership functions $\mu_{A_i}(z_k)$ by means of which the z_k s are temporally described as regards z_R) are now transformed into the "coordinates" of some point of H'_Z - the geometrical representation of some image of Nature [34]

- but also (if some hypothesis are assumed) to the sequence of time instants elapsed between t_0 and t_R will correspond, from now on, a "curve" [35] in the n-dimensional p-space H''_Z nothing but the geometrical translation of TSK itself between $(t_0; 0, 0, \ldots)$ and $(t_R; 1, 1, \ldots)$

This being assumed it is now easy to see how the preceding difficulties may be superseeded

Suppose in this sense that "t" is now regarded as a parameter. In these conditions, as far as t varies according to a previously chosen time-resolution level (the most accurate of them all, from OP_F's viewpoint), each one of the elements $a_{ik} \in A_i$ will also take numerical values; the time variation of their respective $\mu_{A_i}(t_k)$ will in reality (taking into account Fig. 23) be described by means of a succession of step-functions as shown in Fig. 25

[34] The representation of messages by means of points of n-dimensional spaces may be examined, for example, in KAUFMANN's "Introduction to Fuzzy Subset Theory" Vol II.

[35] Here correctly a "branched" curve whose "branches" correspond, for example, to abandoned tendencies, etc.

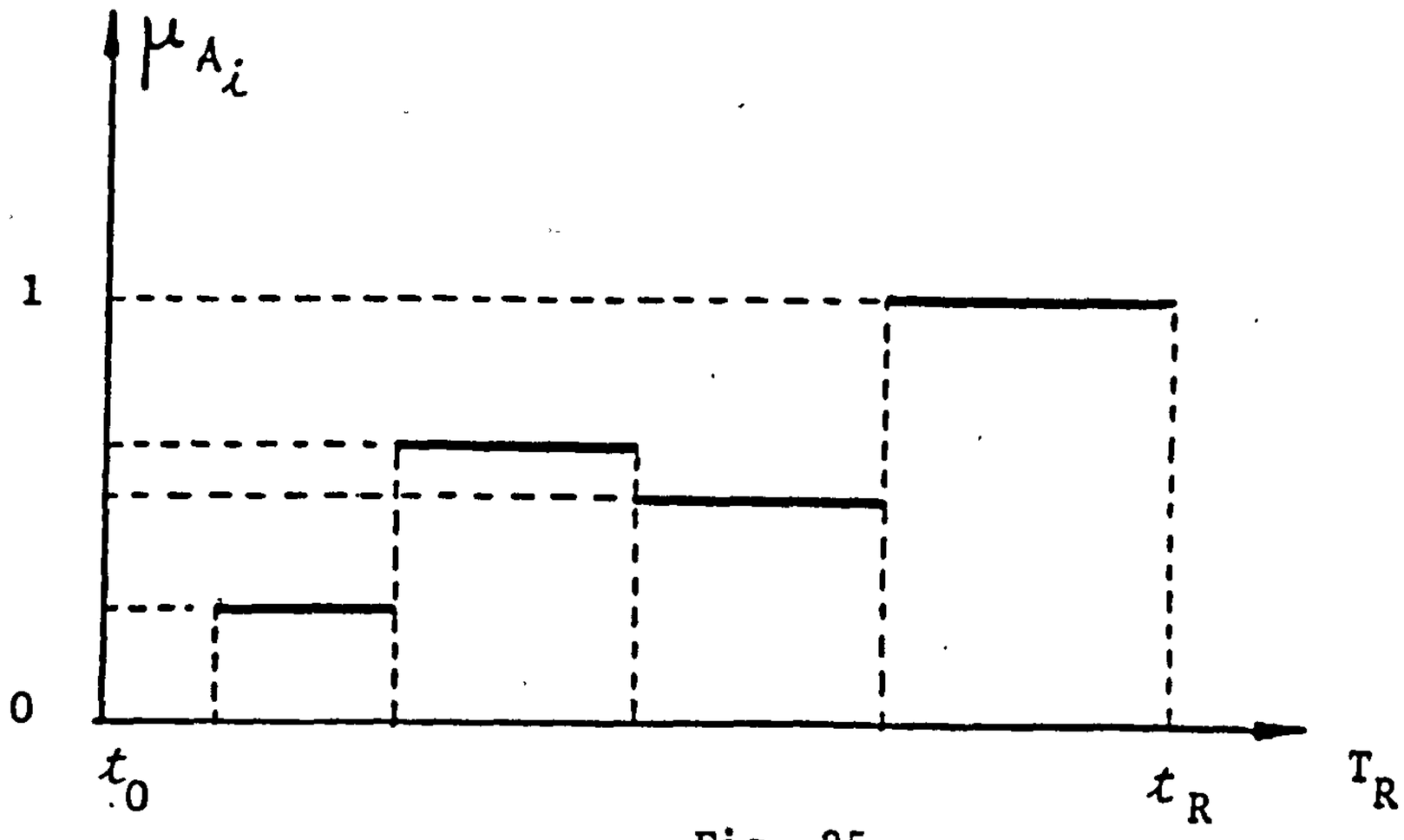


Fig. 25

Historical variations regarded in terms of a sequence of step-functions

in which

- the value 0 is equivalent to a null, non-existing or meaningless attribute

- the value 1 corresponds to a full significant term

- the constancy of some value during some time interval emphasizes a local invariancy

- the discontinuities to the sudden appearance of some new semantic meaning

The picture condenses therefore a (possible) geometrical representation of each one of the vertical histories of the A_i by means of which U' is described.

Suppose also that these p histories are now <u>joined</u> <u>together</u> by means of some procedure similar to that shown in Fig. 26 for A_1, A_2 only. It can then be seen that, due to the discontinuous time-variation of their a_{ik}, the image-points z_k so obtained appear <u>as if</u> they were mutually isolated. [36]

We say "as if" for the z_ks are, in fact, mutually related by means of the transformations T_{ij} referred to P R O P. A. It is precisely here that the preceding geometrical considerations find their most important application.

ii)

To assert that a certain image-point, say P_i (corresponding to z_i), is transformed into another image-point P_j ($\neq z_j$) is equivalent to say that there exists between them a bynary relation T_{ij} such that

$$T_{ij} = (z_i, z_j) \subset Z' \times Z' \qquad (B/4.2)$$

This is obviously nothing but another way of expressing (A/3.3), i. e. both of these expressions are algebraically similar. In geometrical terms (B / 4.2) is however richer than (A/3.3) being possible to deduce from it some important results

[36] We may have a good pictorial representation of this interpretation of Z'' assuming that each one of its points is associated with an imaginary lamp. In these conditions a sequence of really occurred messages (the expression of TSK itself) will correspond to a sequence of lighted lamps separated by dark areas; in terms of direct narration these areas translate, therefore, historian's ignorance about z'_ks mutual transformations.

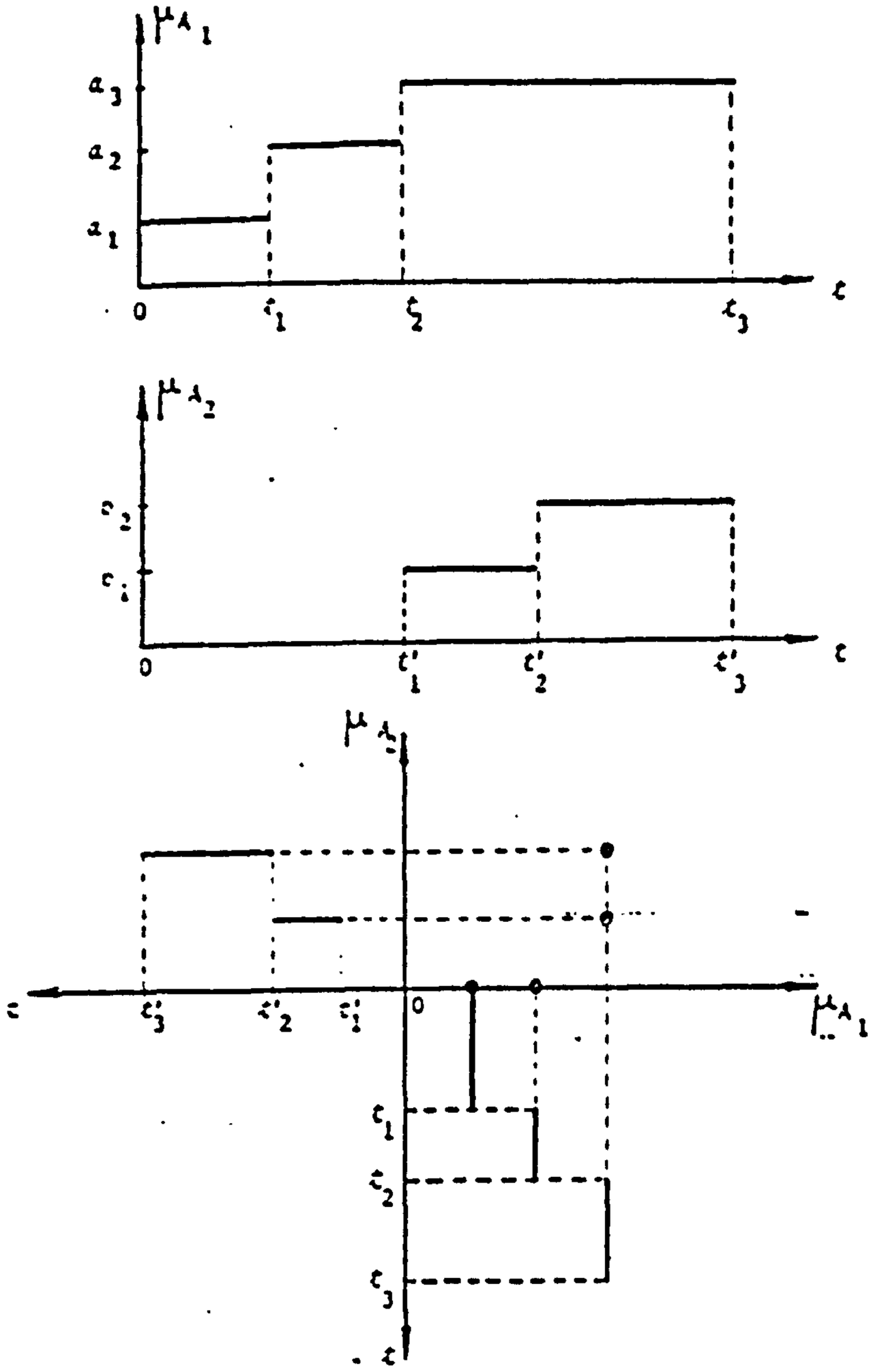


Fig. 26

A historical event regarded as a point of a configuration space

The first of these results deals with the external relationships between messages which henceforth, may be interpreted as (geometrical) point - transformations i. e. as relations which map some image-point P_i into another image-point P_j.

Suppose in fact that z_i and z_j are unambigously described by two membership functions, say μ_{z_i}, μ_{z_j}. In these conditions (A/3.3) can be regarded as a (fuzzy) relationship expressing ZADEH's meta-implication operator "if z_i then z_j by means of T_{ij}", from which (if some formal precautions are taken into account) one at least of the possible T_{ij} accomplishing such a change may be brought to light. For example, if

$$z_i = \begin{bmatrix} a & b & c & d & e \\ 1 & 0.3 & 0.8 & 0 & 0 \end{bmatrix} \qquad (B/4.3)$$

$$z_j = \begin{bmatrix} a & b & c & d & e \\ 1 & 0.4 & 0.8 & 0.1 & 0 \end{bmatrix} \qquad (B/4.4)$$

then

$$T_{ij} = \begin{matrix} a \\ b \\ c \\ d \\ e \end{matrix} \begin{bmatrix} 1 \\ 0.3 \\ 0.8 \\ 0 \\ 0 \end{bmatrix} \times \begin{bmatrix} a & b & c & d & e \\ 1 & 0.4 & 0.8 & 0.1 & 0 \end{bmatrix} = \qquad (B/4.5)$$

$$= \begin{matrix} a \\ b \\ c \\ d \\ e \end{matrix} \begin{bmatrix} a & b & c & d & e \\ 1 & 0.4 & 0.8 & 0.1 & 0 \\ 0.3 & 0.3 & 0.8 & 0 & 0 \\ 0.8 & 0.4 & 0.8 & 0.1 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

the operation "x" corresponding to then (fuzzy) cartesian or direct product [37].

[37] See for example KAUFMANN's "Introduction to Fuzzy Subsets Theory" Vol. II.

The same can obviously be asserted as regards the composition of transformations, a point which has been left in obeyance since PROPOSITION A. In order to insert this problem into the present considerations it is enough to remember that, between the two extreme observers/participants OP_j and OP_R of the preceding item (think of the OP_j as a remote predecessor of OP_R) there is a set of intermediate observers/participants, say OP_{j+1}, OP_{j+2} ... OP_{R-1} such that each one of them has somehow contributed to the global change T_{jR} .

In PROP. A we emphasized that if

$$z_{j+2} = z_{j+1} * T_{j+1,\ j+2}$$

$$z_{j+3} = z_{j+2} * T_{j+2,\ j+3}$$

$$= z_{j+1} * T_{j+1,\ j+2} * T_{j+2,\ j+3}$$

.....

then

$$z_R = z_{j+1} * (T_{j+1,\ j+2} * T_{j+2,\ j+3} * \dots T_{R-1R}) \qquad (B/4.6)$$

in which $T_{j+1,j+2}$ etc are individual transformations and the operation "*" was there, not clearly defined. The interpretation previously ascribed to these transformations allow a clarification of this question: for if the $T_{j+1,j+2}$ are regarded in terms of ZADEH's meta-implication operators "if

z_{j+1} ... then z_{j+2} by $T_{j+1,j+2}$" [38], then (B/4.6) can in fact be looked upon as a sequence of mutually conditioned fuzzy relationships obeying the usual composition rule MAX-MIN. In this sense if we have for example

$$T_{12} = \begin{bmatrix} 1 & .2 & .1 & 0 & 0 \\ .1 & .1 & .1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \qquad \text{(B/4.7)},$$

$$T_{23} = \begin{bmatrix} 1 & .3 & .2 & .1 & 0 \\ .2 & .2 & .2 & .1 & 0 \\ .1 & .1 & .1 & .1 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \qquad \text{(B/4.8)}$$

$$T_{34} = \begin{bmatrix} 1 & .4 & .3 & .1 & 0 \\ .3 & .3 & .3 & .1 & 0 \\ .2 & .2 & .2 & .1 & 0 \\ .1 & .1 & .1 & .1 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \qquad \text{(B/4.9)}$$

[38] Additional conditions can be inserted into this operator

and if z_1 is given by

$$z_1 = \begin{bmatrix} 1 & .1 & 0 & 0 & 0 \end{bmatrix} \qquad (B/4.10)$$

then it is easy to show that

$$z_4 = \begin{bmatrix} 1 & .4 & .3 & .1 & 0 \end{bmatrix} \qquad (B/4.11)$$

$$T_{14} = \begin{bmatrix} .1 & .4 & .3 & .1 & 0 \\ .1 & .1 & .1 & .1 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \qquad (B/4.12)$$

being the intermediate messages z_2, z_3 given by

$$z_2 = \begin{bmatrix} 1 & .2 & .1 & 0 & 0 \end{bmatrix} \qquad (B/4.13)$$

$$z_3 = \begin{bmatrix} 1 & .3 & .2 & .1 & 0 \end{bmatrix} \qquad (B/4.14)$$

Everything works, therefore, as though the use of some thought-process (by means of which $z_i \rightarrow z_j$) were looked from the point of view of a coordinate transformation in which the transformation-matrix is precisely given by the (fuzzy) product-set $\mu_{z_i \times z_j}$. Furthermore, if such coordinates are regarded as elements of z'_ks description, then a true physical meaning can be ascribed not only to these T_{ij} but also to the (philosophical) relativistic attitude which has direct our approach to history.

Suppose in this sense that every OP_k is associated with a particular normative reference system S_k (k = 0, 1, ... R), some kind of "frame of mind" which, in a certain sense, "filters" "conditionates" or, eventually, "distorts" the information proceeding from PhW . S_k summarizes therefore all possible influences endogenous or exogenous (in the sense of "group") which can affect either the analysis of PhW or the solution of some particular "problem" related to it; as we emphasized in S/2 it is due to their influence that PhW's descriptions are time-variable. This time-variancy presents however a curious aspect. Generally speaking when some OP_k has reached what (for

him) is a correct and final description of *PhW* (according to his particular S_k) then the attributes and relationships by means of which such a description is accomplished will immediatly acquire , in terms of that S_k , a fully significant meaning. (We can commonsensically say that this OP_k is "convinced" of the "strenght" of his description). But as soon as a new OP_{k+1} appears, possessing a vision of *PhW* different from that of his predecessor (which implies a "new" S_{k+1}) the former significance looses its fully character and becomes simply converted into something which (in one aspect at least) is only <u>similar</u> to that of the latter description; accordi ng to a (subjective) fuzzy terminology, instead of 1 the new value ascribed to this aspect becomes, for example, .8.

These sucessive variations (expressing the very nature of relativism) can be clearly brought to light if we consider two particular observers participants, say OP_j and OP_R , in which OP_j is, by hypothesis, a remote predecessor of a present OP_R . Suppose in this sense that according to his S_j , OP_j had described *PhW* by means of three simple attributes, say A_1 , A_2 , A_3 ; let this description (referred to S_j) be given for example by

$$(S_j) \qquad \begin{matrix} A_1 & A_2 & A_3 \end{matrix}$$

$$z_j = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} \qquad (B/4.15)$$

Suppose also that when OP_R is working as natural scientist the image of *PhW* which he obtains (taking S_R as frame of reference) is expressed by

$$(S_R) \qquad A_1 \quad A_2 \quad A_3 \quad A_4 \quad A_5.$$
$$z_R = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 \end{bmatrix} \qquad (B/4.16)$$

Assume finally that, using S_R as reference, OP_R (now working as scientific historian) is able to estimate the values of A_1, A_2, A_3 at $t = t_j$ giving rise for example to

$$(S_R) \qquad A_1 \quad A_2 \quad A_3 \quad A_4 \quad A_5$$
$$z_j = \begin{bmatrix} 1 & 0,2 & 0,5 & 0 & 0 \end{bmatrix} \qquad (B/4.17)$$

A comparison between (B/4.15) and (B/4.17) shows therefore that the whole transformation process works as if we have two reference systems, an "ancient" one $S_j = (A_1, A_2, A_3)_j$ and a "present" one $S_R = (A_1, A_2, \ldots, A_5)_R$ which (because referred to the same object *PhW*) are mutually related to. If *PhW* is a simple material point, as it happens for example in Physics, then the transformation of the "old" coordinates into the "new" ones would obey the matricial equation (B/4.18)

in which T_{jR} is the "transformation - matrix" accomplishing such a change. These operations do not obviously hold in our present historical case since T_{jR} is the result of the direct product $\mu_{z_j \times z_R}$ and the "normal" matrix operations "x" "+" are substituted by the usual composition MAX-MIN

$$\begin{bmatrix} x_1^j & x_2^j & x_3^j \end{bmatrix} \underbrace{\begin{bmatrix} \alpha_{11} & \alpha_{21} & \alpha_{31} & \alpha_{41} & \alpha_{51} \\ \alpha_{12} & \alpha_{22} & \alpha_{32} & \alpha_{42} & \alpha_{52} \\ \alpha_{13} & \alpha_{23} & \alpha_{33} & \alpha_{43} & \alpha_{53} \end{bmatrix}}_{T_{jR}} = \begin{bmatrix} x_1^R & x_2^R & x_3^R & x_4^R & x_5^R \end{bmatrix}$$

(B/4.18)

$$x_i^j \in A_i \quad (i = 1, 2, 3)$$

$$x_k^R \in A_k \quad (k = 1, 2, 3, 4, 4, 5)$$

$$\alpha_{11} = \alpha_{21} = \alpha_{31} = 1 \qquad \alpha_{41} = \ldots \alpha_{53} = 0$$

$$\alpha_{21} = \alpha_{22} = \alpha_{32} = 0,2$$

$$\alpha_{31} = \alpha_{32} = \alpha_{33} = 0,5$$

In spite of these differences, however, the role played by T_{jR} is in both cases basically the same : a relationship between an "old" description of *PhW* and a "new" one; or, which is equivalent, something which express the change suffered by *PhW* 's descriptions when regarded either from the point of view of the old system S_j or from the point of view of the new system S_R. It is needless to remark therefore the deep analogies which exist between this interpretation of T_{jR} and the Physical and philosophical attitude underlying the relativistic position.

v) The two distances precedingly referred to are exemplified in Fig. 27 : HAMMING's distance, say d_H

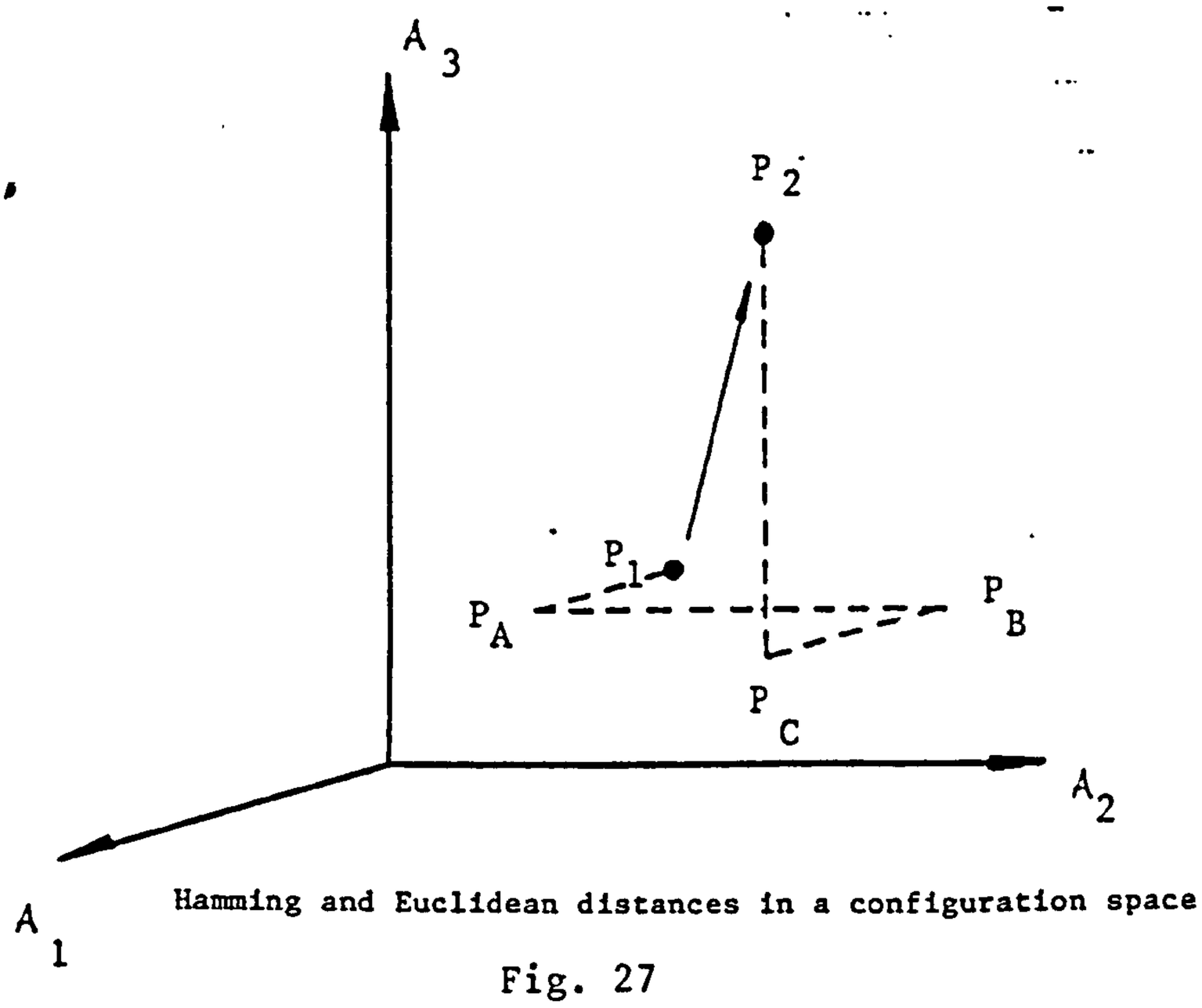
$$d_H\ (1,2) = |P_2-P_c| + |P_c-P_B| + |P_B-P_A| + |P_A-P_1| \qquad (B/4.19)$$

which corresponds to the whole lenght $P_1\ P_2$ measured according to directions parallel to axes A_i ; and the euclidean distance say d_E

$$d_E(1,2) = \sqrt{\sum_{i,j} (\ a_{ij+1} - a_{ij})^2} \qquad (B/4.20)$$

$i,j = 1,2,3$

which gives the lenght $P_1 P_2$ but now measured according to diagonals cr hyper-hypothenuses.



Hamming and Euclidean distances in a configuration space

Fig. 27

a) Suppose in this sense that, given a certain message z_j (specified by some membership function $\mu_{A_i}(z_j)$) we estimate the distance $d_E(j, R)$ between P_j and P_R . For different distances of this kind, a lower or greater value of dE can therefore be interpreted as expressing the epistemological "proximity" of some past image of Nature as regards the one

presently followed. In the case of the example precedingly referred to, we "feel" that the atomistic trend was "nearer" of us than the substantialistic tendences: this subjective feeling becomes henceforth quantifiable by means of $d_E(\ k\ ,\ R\ )$, nothing but another way of expressing the resemblances referred to 4/3.

b) A second (possible) index translates what we may call the (historical) direction of the thought-current globally associated with TSK

Let us consider in this sense any two image points of Z", say P_j , P_{j+1} , mutually linked by means of a ficticious line $P_j \quad P_{j+1}$, the materialization of this T_{jj+1}. Let also $d_E\ (j,j+1)$ be the distance between them and suppose that (similarily to what happens with "normal" euclidean spaces) we define its "i^{th}" director cosine by means of

$$\alpha_i\ (j,j+1) = \frac{d_H\ (\ j\ ,j+1)_i}{d_E\ (\ j,j+1)} =$$

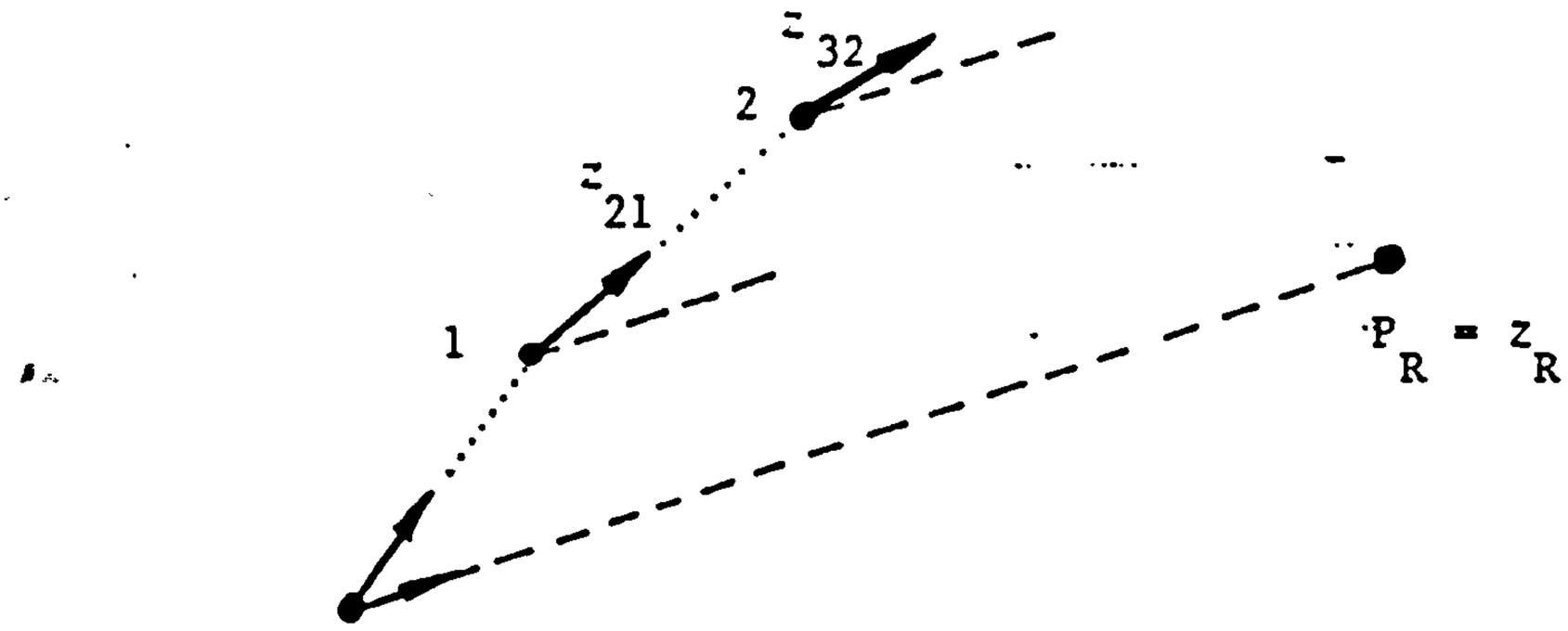
(B/4.21)

$$= \frac{a_{ij+1} - a_{ij}}{d_E\ (j,j+1)}$$

$$a_{ij},\ a_{ij+1} \in A_i$$

in which $\sum_{i=1}^{p} \alpha_i^2 = 1$

If $\beta_{(B/4.20)}$ is applied to the ficticious line which joins z_0 and z_R then we can obtain from it the components of the unitary p-vector, say $\vec{u}_R$ in the direction of that line. A similar reasoning also underlies the specification of a set of p-vectors $\vec{z}_1, \vec{z}_2, \ldots, \vec{z}_n$ corresponding to a sequence of image points $P_1, P_2, \ldots, P_n$, (Fig. 28)



Directions in an epistemological current of thought

Fig. 28

In these conditions, easy vectorial calculations allow the evaluation of the cosine of the angle which each one of these p-vectors makes with u_R these values being given by

$$\beta_{(1,0)_R} = \frac{\vec{z}_1 \cdot \vec{u}_R}{|\vec{z}_1|}$$

$$\beta_{(2,1)_R} = \frac{\vec{z}_{21} \cdot \vec{u}_R}{|\vec{z}_{21}|} \qquad (B/4.22)$$

.....

$$\beta_{(n,n-1)_R} = \frac{\vec{z}_{n\,n-1} \cdot \vec{u}_R}{|\vec{z}_{n\,n-1}|}$$

$\overrightarrow{z}_{n,n-1}$ being the general p-vector wich represents the difference $\overrightarrow{z}_n - \overrightarrow{z}_{n-1}$, n = 1, 2, ... etc.

The knowledge of these values gives an idea of the proximity of the ficticious line which express TSK as it really occurred as regards the "optimized trajectory" $\overline{P_0 P_R}$. High values of the elements of (B/4.22) will correspond therefore to situations in which part of TSK has "diverged" from that trajectory, while low values will indicate the using of some thought- process rather similar to those presently used.

Identical reasoning may be used to describe "points" in which TSK has suffered some kind of inflexion or deviation. As a matter of fact if we have a sequence of image points whose euclidean distance as regards P_R became smaller and smaller (i. e. whose intermediate directions correspond to progressively decreasing angles) and suddenly (from some P_k onwards) $d_E(k, R)$ increases, then this change can be interpreted as if the epistemological orientation broadly associated with the whole TSK has suffered some kind of inflexion at $t = t_k$.

c) This idea of a global change of TSK is related to the third and fourth measuring indexes precedingly referred to, which now stress the "velocity" according to which either messages in themselves (i. e. regarded as wholes) or their components

A_i change throughout time.

In the first of these cases that "velocity" is expressed by

$$v_{k,k+1}(z) = \frac{d_E(P_k, P_{k+1})}{t_{k+1} - t_k} \qquad (B/4.23)$$

while in the second we may write

$$v_{k,k+1}(A_i) = \frac{d_E(a_{ik+1}, a_{ik})}{t_{k+1} - t_k} \qquad (B/4.24)$$

As well as in the aforementioned situations also here the knowledge of these values may be used to provide an idea of the global variation of TSK during some time interval: low values of (B/4.23) will show the existence of what we may call (globally) stables images of Nature [39] while high values will correspond to transition or revolutionary periods, i. e. time intervals during which some image of Nature is submitted to deep transformations.

Examples of these situations can be easily found in the history of the western thought; for instance, the period during which the Aristotelian- Christian image was followed in Europe practically without opposition (i. e. without changes) is a good example of the first case, while the second corresponds to the interval of time elapsed between the failure of this image and its

[39] "Periods of normal science" according to KUHN's terminology.

substitution by that one based upon Newton's "Mechanics".

v) In PROP C we shall see a concrete application of these measuring indexes when real and not supra-human observers will be considered. For the moment - and this summarizes in a certain sense all the theoretical considerations of this section - we only stress that, with them, the interpretation of the whole trajectory $z_0 \longrightarrow z_R$ may be converted into a question of Dynamics understood according to a(n almost) true physical meaning. [40]

Everything works, in fact, as though there were a "point" (the representation of a certain image or images of Nature at $t = t_h$) which under the "pressure" of some kind of need (a "problem", here playing the role of a symbolic force) changes its "position" in the p-space Z'', this displacement being made according to a certain "velocity" and "direction". From the viewpoint of pure direct narration (statical interpretation of history) this "motion", i.e. the trajectory which this motion symbolizes, is unique and determinated (from OP_F's supra-human point of view).

According however to the dynamical interpretation suggested in B/3.2 iv) this uniqueness is simply the visual expression of a more complex process: here again everything works as if, when submitted to some "problem", every OP_k has before him a set of possible options (the transformations T_{ij} preceding referred to, some of which already learned from his predecessors) being the

[40] If some obvious precautions due to the particular characteristics of his historical information are taken into account.

selection of one of them dependent on a set of external or internal conditionating constraints. The trajectory followed (i. e. the solution of the proposed problem) is therefore the one which such constraints allow (at the time instant in which this or that particular problem appears).

The process is summarily represented in Fig. 29 a mere reproduction of Fig. 7.

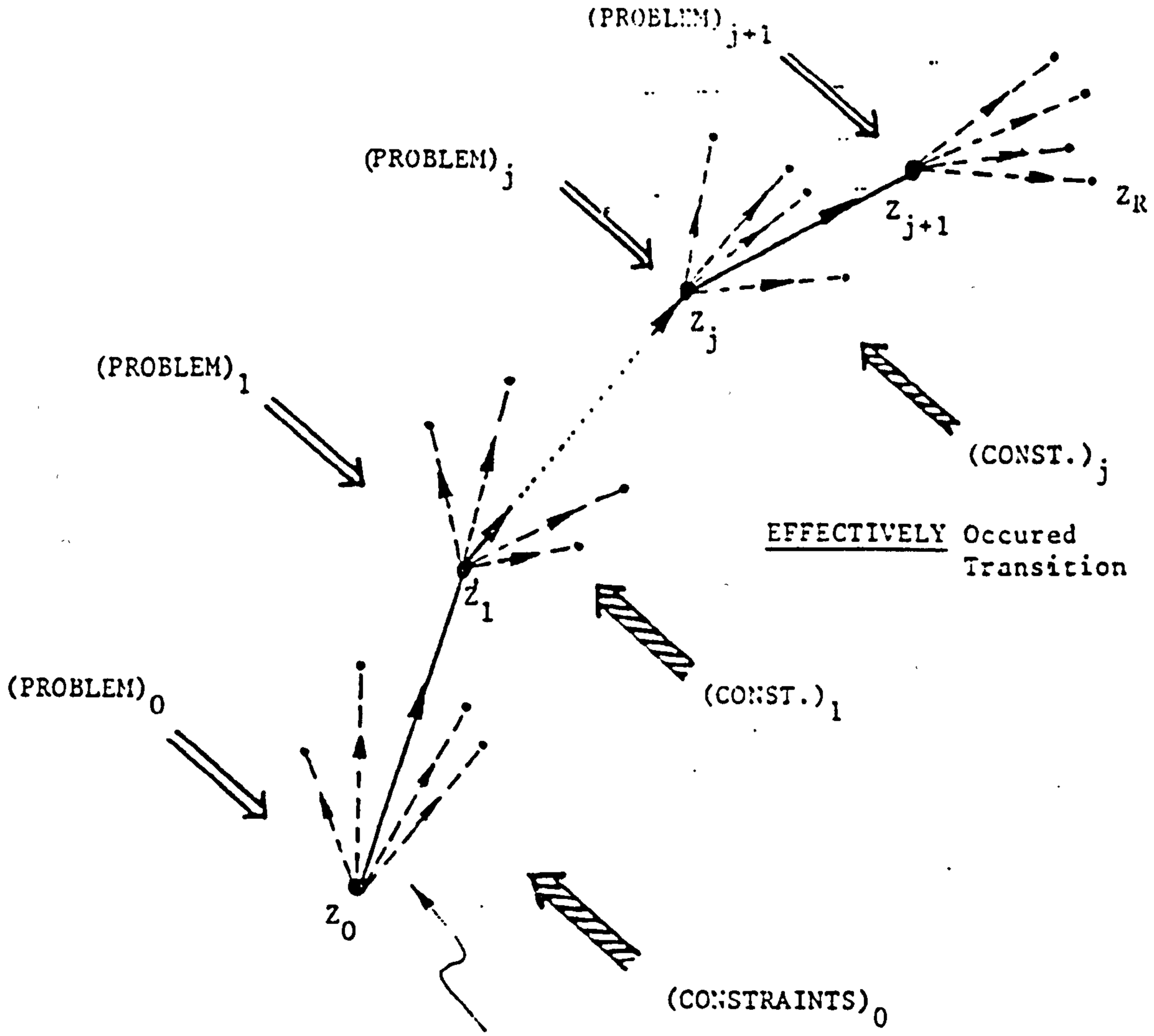


Fig. 29

Interactions individual-context. The general representation

Similarily to what happens in Physics the reconstitution of the whole n+1 dimensional path $z_0 \longrightarrow z_R$ requires therefore the knowledge either of the particular "problem" or of the (time-variable) set of constraints which at some past time instant $t = t_k$ (k= 0, 1, ..., R-1) act upon every OP_k . The analysis of these constraints, the way according to which they can be "composed" etc. will lead us again to the p-space H'_T left in obeyance since B/2 as well as to its relationships with H''_Z . This would be the objective of

PROPOSITION C: ON THE INTERACTIONS $OP_k \leftrightarrow$ CONTEXT FROM A DYNAMIC AND SIGNIFICANT VIEWPOINT)

C/1 - The p-space H'_T: review of some (statical) properties

It was shown in PROP. B (items B/1 and B/2) that the attributes and inner relationships describing the images G_k (k = Ø, 1 ... R) which some group environmental G took at different time-instants t_k of its history may be partitioned into several equivalence classes dealing, for example, with its scientific (Z^*), religious (R^*), political (P^*) etc status

i.) Assuming that there are $A_1 \ldots A_p$ conceptual (atributive) categories describing Z^*, $A_{p+1} \ldots A_q$ describing R^*, $A_{p+1} \ldots A_s$ describing P^* etc and that each one of these categories obeys

$$\begin{aligned} A_1 &= \{ a_{11}, a_{12} \cdots a_{1R} \} \\ A_2 &= \{ 0, a_{21} \cdots a_{2R} \} \\ A_s &= \{ \emptyset, \cdots a_{11}, \cdots a_{sR} \} \end{aligned} \qquad (C/1.1)$$

then (from OP_F 's deterministic viewpoint) every G_j G could be unambiguously described by expressions similar to

$$G_j = \{\ t_j\ ;\ a_{ij}\ \ldots\ 0\ ;\ R\ (a_{ij}\ ,\ a_{ij+1})\ \ldots;$$

$$a_{p+1}\ \ldots\ 0;\ R\ (a_{p+1j}\ ,\ a_{p+2j})\ \ldots; \qquad \text{(C/1.2)}$$

$$a_{q+1}\ \ldots\ 0;\ R\ (a_{q+1j}\ ,\ a_{q+2j})\ \ldots\ \}$$

Thus, obeying what we have previously asserted about R U S S E L 's "Knowledge-by-description".

ii) This description of G_k in terms of (C/1.2) is subjected to the same formal inconvenients as those pointed out in (B/3.1) as regards the descriptive attributes of the $z_k \in Z$. In brief, the necessary inclusion of several order relations which, <u>once and for all</u>, allow the ordinance either of the $a_{ij} \in A_i$ or of their related internal relationships.

.In order to avoid the systematic use of such relations the preceding considerations must be slightly modified. Suppose in this sense that the aforementioned OP_F's spatio-temporal decomposition is <u>initially</u> made not in the terms previously referred to but assuming, on the contrary,

a) that the conceptual categories A_1, A_2, ... A_r into which the G_k's may be partitioned are mutually independent

b) that there are (yet) no explicit temporal relationships F_i (i = 1, 2, ... R) between attributes a_{ij} belonging to the same conceptual category A_i.

Both of these assumptions are, in summary, nothing but a first arrangement of the historical information contained in the documents referred to G_k. Everything works therefore as though OP_F, knowing in advance (by virtue of his supposed experience) the possible $A_1, A_2, \ldots A_p, A_{p+1} \ldots, A_q, A_{q+1}, \ldots A_s, \ldots$ according to which these environments may be globally described were examining such documents firstly, from the point of view of A_1 <u>only</u> (i.e. bringing to light all the a_{1j} (j = 0, ...R) related to it), secondly from the point of view of A_2 <u>only</u>, etc. till all the semantic values taken by all the A_r are swept out.

In "spatial" terms the result of these vertical and horizontal analysis of G_k would not be different from that expressed either by TAB B/1, B/2, B/3 - this last assuming (at least) that the temporal index of the a_{ij} there referred to is concerned with their order of appearance and not with a precise time instant.

This being done suppose now that OP_F (by virtue of his supra-human capacities) is able to <u>combine</u> all the time instants elapsed between t_0 and t_R with all the values taken by all the A_j belonging to a certain status [41] (equivalence classes) Z^*, R^*, P^*, etc. The process used in order to accomplish such combinations is similar to that presented in PROP. B about Z' only; i.e. assuming that the A_j are already ranged according to their order of antiquity, then a certain time instant t_k, A_1 is <u>always</u> combined with a certain attribute belonging to A_{p+1} (or to A_{q+1} or to A_{r+1}) etc. For all these equivalence classes the result of these operations would, therefore, correspond to the n-uples

$$(t_k, z_j^*) = (t_k, (a_{1j}, a_{2j} \dots a_{pj})) \in H'_Z$$

$$(t_k, r_j^*) = (t_k, (a_{p+1j}, a_{p+2j} \dots a_{qj})) \in H'_P$$

$$(t_k, p_j^*) = (t_k, (a_{q+1j}, a_{q+2j} \dots a_{sj}) \in H'_E \qquad (C/1.3)$$

.....

$k = 0, 1, 2, \dots R; \quad j = 1, 2, \dots n$

[41] According to some previously chosen highly accurate time-resolution level.

According to PROP. B each one of these t-uples represents a (possible) historical event; under these conditions the sets H'_{Z^*}, H'_{R^*}, H'_{P^*}, etc. may be called event-sets (respectively "scientific", "religious", "political", etc. event-sets). Also (taking into account the aforementioned spatio-temporal decomposition) H'_{Z^*}, H'_{R^*}, H'_{P^*} .... may be written as

$$H'_{Z^*} = T \times Z^*$$
$$H'_{R^*} = T \times R^* \qquad (C/1.4)$$
$$H'_{P^*} = T \times P^*$$
$$\ldots\ldots\ldots\ldots$$

in which

$$Z^* = A_1 \times A_2 \times \ldots \times A_p$$
$$R^* = A_{p+1} \times A_{p+2} \times \ldots A_q \qquad (C/1.5)$$
$$P^* = A_{q+1} \times A_{q+2} \times \ldots A_{s'}$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

and the A_i ($i = 1, 2, \ldots\ldots$ R) are assumed to obey (B/3.5).

Since the components t_k, a_{ij} (or 0) or (C/1.3), (C/1.4) or (C/1.5) are already intrinsically ordered; since (by virtue of the algebraic properties of those cartesian products) such combinations contain in themselves all the possible relationships existing between those components - then these expressions can in fact be regarded as translating, in purely formal terms, possible partial descriptions of (possible) G_k

without the inconvenients related to in (C/1.2).

iii) This formal results must be interpreted in <u>historical</u> terms. From this point of view it is clear that, from the totality of possible combinations (t_k , z^*_j), (t_k , r^*_j), etc. of (C/1.4) and (C/1.5) only <u>some</u> - those effectively verified in the history of mankind (insofar as this history is presently known) - are historically <u>meaningful</u>. These actual events ("right messages z^*_j , r^*_j , p^*_j , etc. occuring at right times", according to the terminology of S/4) are precisely those which OP_F brought to light in TAB B/1 and B/2. If such meaningful events are supposed to constitute some <u>real</u> event-sets H_{Z^*} , H_{R^*} , H_{P^*} , etc., then it is possible to write[42]

$$H_{Z^*} \subset H'_{Z^*}$$

$$H_{R^*} \subset H'_{R^*} \qquad \text{(C/1.6)}$$

$$H_{P^*} \subset H'_{P^*}$$

The historical interpretations which may be assigned to (C/1.6) is similar to that presented in Pr.B. Asserting in fact that, for example, H_{Z^*} is a particular subset of H'_{Z^*} we are implicitly assuming that, together with the real history of science which

[42] By initial assumption H'_{Z^*} , H'_{R^*} , H'_{P^*} , etc. contain <u>all</u> the possible combinations of t_k , a_{ij} , 0! therefore they must also contain H_{Z^*} , H_{R^*} , H_{P^*} etc.

. H_Z* expresses, there could have also existed some other possible "histories" (either spatially identical or occuring at different times or even spatially and temporarily distinct from that known so far) which in reality did not occur but (potentially at least) are contained in H'_Z*.

In Pr. B we pointed out that this interpretation of history could, if accepted, transform its quasi-statical character into a dynamic one. This point of view can now be advantageously profited in the clarification of the aforementioned relationships between H_{Z^*}, H'_{Z^*}, H_{R^*}, H'_{R^*}, etc. historical "wholes" and the state-space approach in itself - one of the ultimate goals of this section. Suppose in fact that, as historian of science, OP_F assumes that the transformation or constancy of some scientific message z_k emitted by a certain OP_k at $t = t_k$ (i.e. of a scientific event $(t_k, z_k) \in H_Z$) is somehow dependent on the group enviroment existing at that time. How this action is concretely exerted does not concern us for the moment; the point which must here be stressed is that, from OP_F's viewpoint, such G_k works as some kind of organized whole as regards OP_k; consequently that Z_k*, T_k*, P_k* are mutually related at that time instant t_k. In these conditions (adopting the same convention as that settled in PROP. B about the formal expression of these relationships it is possible to look upon that G_k as an element

$$(t_k, (Z_k^*, T_k^*, P_k^* \ldots\ldots)) \qquad (C/1.7)$$

of some new set

$$H'_T = T \times (Z^* \times R^* \times P^* \ldots.) \qquad (C/1.8)$$

including in it all the partial events H_Z^* , H_R^* , H_P^*, etc. really occured as well as the remaining (potentially) possible histories. If now Z^* , R^* , P^* etc, are substituted by their complete expressions given by (C/1.5) with the A_i obeying (C/1.1), then (C/1.8) will be expressed by

$$H'_T = T \times \underbrace{A_1 \times A_2 \times \ldots \times A_p}_{Z^*} \times \underbrace{A_{p+1} \times \ldots A_q \times \ldots}_{R^*}$$

$$= T \times \sum_{i=1}^{r} A_i \qquad (C/1.9)$$

which if compared with KLIR's ST approach shows, finally, that the whole "spatial" description of (C/1.9) may be identified with the proper algebraic definition of the state-set Q' aforementioned.

We shall name H'_T total event set and it will be regarded as describing G_k .

vi) Taking into account the "geometrical" hypotehsis previously postulated it is now easy to see

a) that the event-sets H'_T , H'_{Z^*}, H'_{R^*}, H'_{P^*}, etc.,may be regarded as the underlying sets of some p-spaces H'_T* , H'_Z* , H'_R* , H'_P* etc., respectively, the <u>total event p-space</u>, the <u>scientific event p-space</u> etc.

b) that in these conditions H'_{Z^*}, H'_{R^*} , H'_{P^*} etc. work as particular <u>projections</u> of H'_T upon the "axes" with which they deal (i.e. T and A_1, A_2 , ... A_p as regards H'_Z* ; T and A_{p+1} , A_{p+2} , ... A_q as regards H'_Z* , etc.); then, that they can be viewed as <u>restricted</u> p-spaces of the s+1 dimensional p-space H'_T

c) that, (from b) above), a complete state say $q'_j \in C(H'_T)$. may be seen as a <u>point</u> (state point) of Q', obtained by means of an algebraic cut of H'_T by $t = t_j$.

d) that (in consequence) every significant point of the partial p-spaces H'_Z*, H'_R* , H'_P* etc. (event point or state-point by cut) may be regarded as a particular <u>projection</u> of a single significant point of H'_T (or of Q')

e) that there exists a family of mappings

$$\begin{aligned} \eta_{Z^*} &: H'_T \xrightarrow[\text{onto}]{} H'_{Z^*} \\ \eta_{R^*} &\quad H'_T \xrightarrow[\text{onto}]{} H'_{R^*} \\ \eta_{P^*} &\quad H'_T \xrightarrow[\text{onto}]{} H_{P^*} \\ &\cdots\cdots\cdots\cdots\cdots\cdots \end{aligned} \qquad \text{(C / 1.10)}$$

which precisely translate the formal expression of those projections referred to in d)

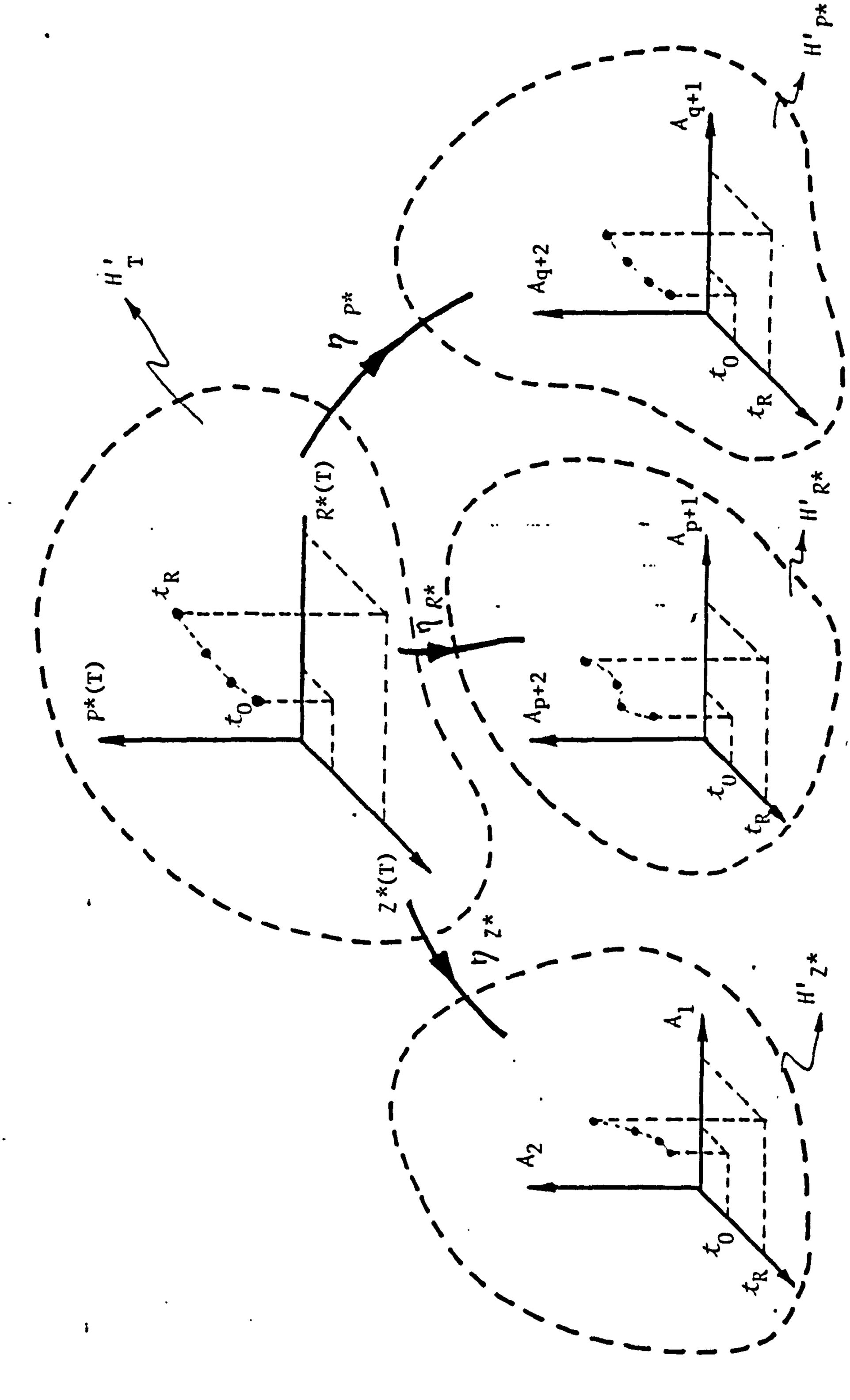
f) that the time sequence of real event-points H'_Z* , H'_R* , H'_P* etc., may therefore be interpreted as projections (by η_{Z*} , η_{R*} etc.) of a corresponding time sequence of real event-points $H_T \in H'_T$, the geometrical expression of the successive images G_k taken throughout time by some group environment

g) that if any two state points of H'_T , say P_i and P_j are assumed to be linked by means of some ficticious path (the geometrical interpretation of their state-transition ψ_G^{ij}) then what was asserted in PROP A and B about transformations, point-transformation (elementary, individual, global etc.) "distances", "velocities" constraints etc. may also be transposed either to H'_T or to its p-subspaces H'_Z* , H'_R* ... etc.

All these geometrical results are condensed in Fig. 30 , a simplified tri-dimensional representation of the p+1, q+1, ... r+1 dimensional p-spaces H_Z* , H_R*..... H'_T .

C/2 - THE p-SPACE H'_T: RELATIONSHIPS BETWEEN G_K's STATUS (EXAMINED FROM THE POINT OF VIEW OF THE CLASSICAL AUTOMATA THEORY

For the sake of simplicity no attention was paid in C/1 to the relationships between G_k status. This descriptive restriction will be overcome in the following considerations



Relations between H'_T and the p-spaces H'_{Z^*}, H'_{R^*}, H'_{P^*} etc

Fig. 30

i) Suppose in this sense that taking into account the meaning ascribe to G_k as organized "whole " (C/1 iv) we assume that this "Whole" may be <u>topographically</u> divided into a set of <u>subsystems</u> $G_k^i \in G_k$ each G_k^i representing a particular "status" of G_k .

Let G_k^1 be from now on the representation of Z* (G_k's scientific status) and let G_k^2 be the symbolic representation of G_k's remainder subsystems.

ii) Assume next that

-(from OP_k's deterministic viewpoint) precedingly referred to, either G_k^1 or G_k^2 may both be described by means of the following 7-uples[FIG. 31 a) b)]

$$G_k^1 = \{ W_1, Q_1, z, c_{12}, \gamma_1, \delta_1, \omega_1 \}$$
$$G_k^2 = \{ W_2, Q_2, v, c_{21}, \gamma_2, \delta_2, \omega_2 \} \qquad (C/2.1)$$

Let a, b, c, ..., a = 1, 2, ...p; b = 1, 2, ...q; c = 1, 2, ...m, etc. be a finite set of numbers. Let also

$q_{1a}(t)$ be the variables which define Q^1's internal states

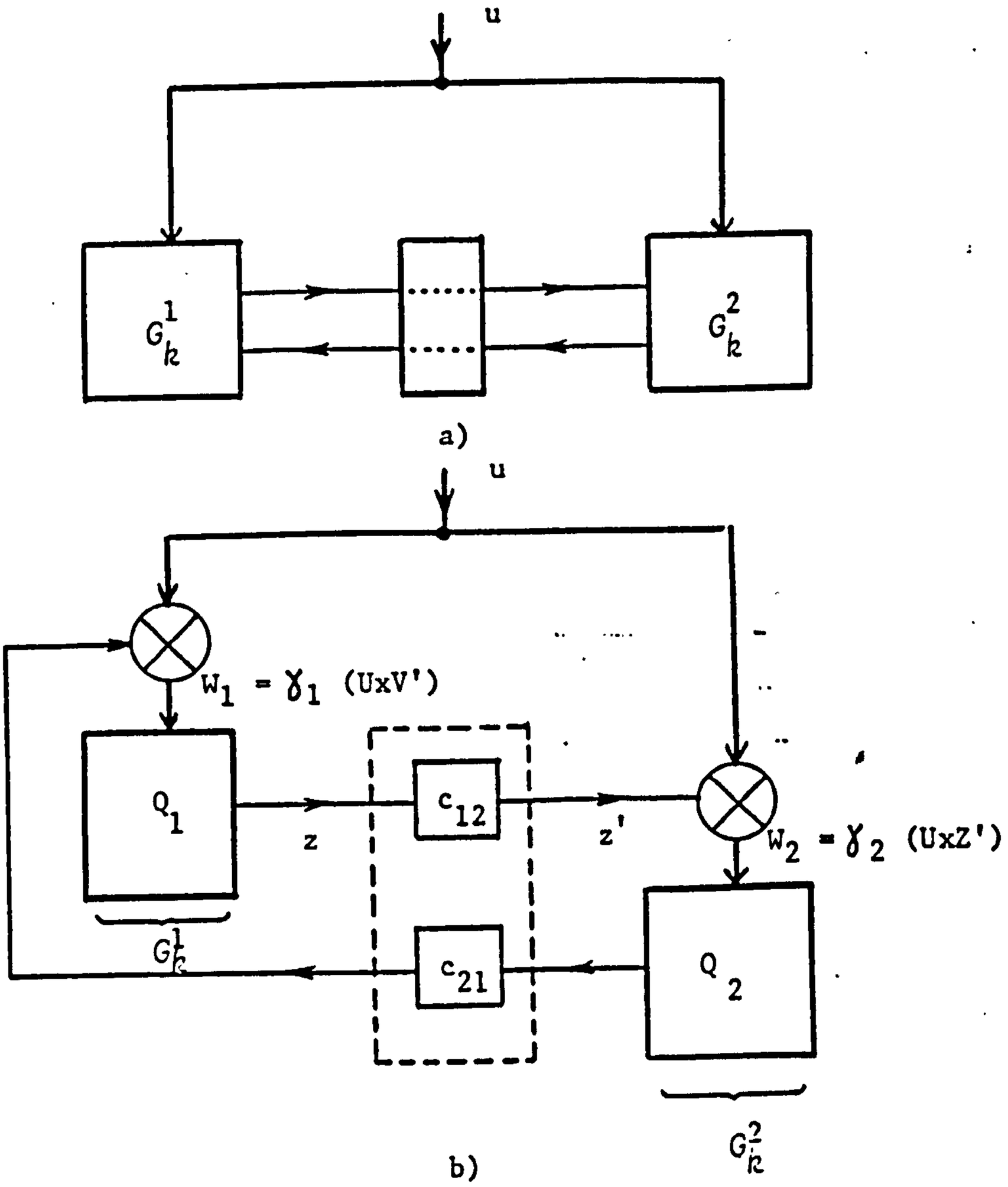
$u_b(t)$ be the variables specifying some input to G_k^1 and G_k^2 proceding from other subsystem

$w_c(t)$ be the variables which specify the inputs directly acting upon $G1_k$, G_k^2

$v_d(t)$ be those variables expressing G_k^2's outputs

$z_e(t)$ be the variables describing G_k^1's outputs

$q_{2f}(t)$ be the variables defining G_k^2's internal states



The automata approach to G_k's topographical analysis
Fig. 31

Suppose that each $q_{1a}(t)$, $u_b(t)$, $v_d(t)$ etc. is respectively related to a time invariant set, say Q_{1a}, U_b, W_c, V_d, Z_e, Q_{2f}, the set of values (not necessarily magnitudes) which each one of those variables can take throughout time. Under these conditions we shall define

- G_k^1 's <u>state</u> as an element

$$q_1(t) = (q_{11}(t), q_{12}(t) \ldots q_{1p}(t)) \qquad (C/2.2)$$

of

$$Q_1 = Q_{11} \times Q_{12} \times \ldots Q_{1p} \qquad (C/2.3)$$

- An <u>input action</u> upon G_k^1 and/or G_k^2 as an element

$$u(t) = (u_1(t), u_2(t) \ldots u_q(t)) \qquad (C/2.4)$$

of

$$U = U_1 \times U_2 \times \ldots \times U_q$$

This input may be regarded as some kind of general disturbance to G_k^1 and G_k^2 proceeding from other subsystems of G_k .

- G_k^1 's <u>output</u> as an element

$$z(t) = (z_1(t), z_2(t), \ldots z_m(t)) \qquad (C/2.5)$$

of

$$Z = Z_1 \times Z_2 \times \ldots \times Z_m \qquad (C/2.6)$$

Due to the existence of the coupling element $c_{12}(t)$ not all this output $z(t)$ is applied to G_k^2 but only (if this is the case) part of it; this means, for the moment, that this coupling-matrix must be regarded as boolean (in the sense discussed beforehand) i.e. is allows (1) or not (0) the existence of this or that action upon G_k^2.

- G_k^2 's <u>output</u> as an element

$$v(t) = (v_1(t), v_2(t), \ldots v_n(t)) \qquad (C/2.7)$$

of

$$V = V_1 \times V_2 \times \ldots \times V_n \qquad (C/2.8)$$

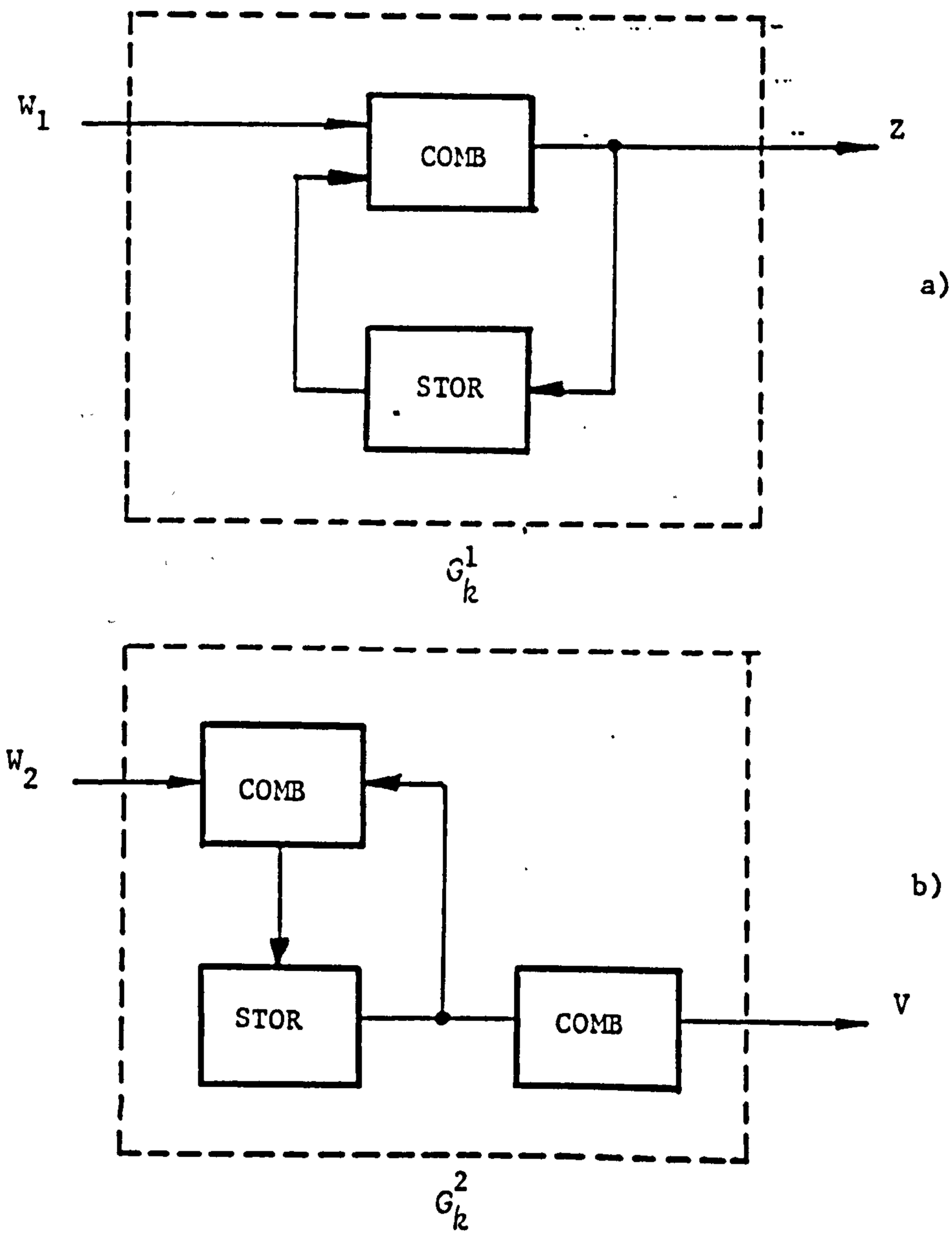
As in the case of G^1_k also here only part of V may (eventually) be applied to this subsystem; this by virtue of the coupling-matrix c_{21} whose features are similar to those of c_{12}

Suppose now that what in G^1_k and G^2_k are representatives of their past histories (libraries, written or oral traditions, religious dogmas, etc.) can here be symbolically expressed by means of existence of some <u>storage</u> devices. What these devices concretely are, is a matter which does not concern us; it is enough to look upon them as something which <u>if so desired</u> is able to <u>reproduce</u> some past state of G^1_k and G^2_k (thus, working as some kind of "memory" in PASK's sense) or "to weight" that reproduction. However, in the present discussion - and for the sake of simplicity - we shall simply assume that the influence of this memory at some time-instant t_k is only restricted to t_{k-1} ; in other words, if $q_1(t_{k-1})$ is G^1_k's internal state at $t = t_{k-1}$ and if $w_1(t_k) \in W_1$ is the input to this subsystem, then its action upon Q_1 will be expressed by means of a state transition $q_1(t_{k-1}) \longleftrightarrow q_1(t_k)$ and not $q_1(t_{k-1}) \longleftrightarrow q_1(t_{k-2}), q_1(t_{k-3})$ etc.

Later we shall examine more attentively what may happen to these "memories" if remote influences have also to be considered; for the moment we simply stress that, in terms of their <u>internal structure</u> (and this is the fundamental point of our present reasoning) each one of these subsystems works as if it were composed either by such "memories" or of some

combination network i.e. devices able to acomplish not only the product-set of their component state variables but also of the transitions "some present input acting upon some present (stored) state ---> new state".

Taking into acount these combination networks and storage elements the representation of G_k and G_k internal structures may therefore be supposed to obey that given in Fig. 32 a,b)



MEALY and MOORE models of automata interactions

Fig. 32

Based upon this representations let now δ_1, δ_2, ω_1, ω_2, γ_1, γ_2 be the mappings

- $\delta_1 : Q_1 \times W_1 \longrightarrow Q_1$
- $\delta_2 : Q_2 \times W_2 \longrightarrow Q_2$
- $\omega_1 : Q_1 \times W_1 \longrightarrow Z$
- $\omega_2 : Q_2 \longrightarrow V$ (C/2.9)
- $\gamma_1 : U \times V' \longrightarrow W_1$
- $\gamma_2 : U \times Z' \longrightarrow W_2$

representing respectively

- δ_i ($i = 1, 2$), G_k^i's <u>next-state</u> functions

$$q_i (t+1) = \delta_i (q_i (t), W_i (t)) \qquad \text{(C/2.10)}$$

which generally speaking, are time-variable; in the present discussion however, and unless some particular comment about it is made, we shall assume that δ_1 and δ_2 are both time-invariant.

- ω_i ($i = 1, 2$), G_k^i's <u>output functions</u>

$$z (t) = \omega_1 (q_1 (t), W_1 (t)) \qquad \text{(C/2.11)}$$

$$v (t+1) = \omega_2 (q_2 (t+1)) \qquad \text{(C/2.12)}$$

As well as in the case of the coupling-matrices c_{12} or c_{21} these output functions will also be regarded as (eventual) algebraic restrictions to the whole set of variables and relationships which define $G\frac{1}{k}$'s internal states; which means in concrete terms that if (for the sake of simplicity) the W_i's are supposed to be identity transformations then the geometrical representations of Fig. 3 0 can also be integrally extended to outputs

- γ_i (i = 1,2) two mappings by means of which the inputs U, V' to G_k^1 or U, Z' to G_k^2 are combined, giving rise to

$$W_1 = \gamma_1 (U \times V') \qquad (C/2.13)$$

$$W_2 = \gamma_2 (U \times Z')$$

We shall say in these conditions that, from OP_F's <u>deterministic</u> <u>point</u> of view, the set of equations (C/2.1) - (C/2.13) specifies unambiguously the interaction $G\frac{1}{k} \longleftrightarrow G_k^2$.

iv) In order to see how these equations work let us consider a concrete example. Suppose in this sense that

- $\delta_i, \omega_i, \gamma_i (i = 1,2), c_{12}, c_{21}$

are given and for the sake of simplicity are also time-invariant

- the initial states of G_k^1 and G_k^2, say $q_1(0)$ and $q_2(0)$, as well as the input sequences u(0), u(1) ..... u(2) for t = 0, 1, ... 2 are known.

It follows from this that the interaction $G_k^1 \longleftrightarrow G_k^2$ will be described by means of the four algebraic equations.

$$q_1(t+1) = \delta_1(q_1(t), W_1(t)) = \quad \text{(C/2.14)}$$
$$= \delta_1\{q_1(t), \gamma_1[u(t), c_{21}\omega_2(q_2(t))]\}$$

$$z(t) = \omega_1(q_1(t), W_1(t)) = \quad \text{(C/2.15)}$$
$$= \omega_1\{q_1(t), \gamma_1[u(t), c_{21} v(t)]\}$$

$$q_2(t+1) = \delta_2(q_2(t), W_2(t)) = \quad \text{(C/2.16)}$$
$$= \delta_2\{q_2(t), \gamma_2[u(t), c_{12} v(t)]\}$$

$$v(t+1) = \omega_2(q_2(t+1) = \quad \text{(C/2.17)}$$
$$= \omega_2\{\delta_2[q_2(t), \gamma_2[u(t), c_{12} z(t)]\}$$

An application of these equations to a simplified situation in which $c_{12} = c_{21} = 1$, $z(t)$ is directly applied to G_k^2, $v(t)$ is directly applied to G_k^1 and U effects simultaneously both of these subsystems is given in a program shown in S/5.

v) What was said as regards "normal" state variables and "normal" relationships can obviously be extended to fuzzy situations.

Suppose in this sense that, taking the general interactive scheme of Fig. 30 as a basis, we introduce the following fuzzy relations[43]

$$\begin{aligned} \underset{\sim}{\delta}_1 (t) &\subset Q_1 \times U \times V' \times Q_1 \\ \underset{\sim}{\omega}_1 (t) &\subset Q_2 \times U \times V' \times Z \\ \underset{\sim}{\delta}_2 (t) &\subset Q_2 \times U \times Z' \times Q_2 \\ \underset{\sim}{\omega}_2 (t) &\subset Q_2 \times U \times Z' \times V \end{aligned} \qquad (C/2.18)$$

in which, according to KAUFMAN's symbology " ~ " is associated with fuzzy sets and/or fuzzy relationships.

We shall have therefore

$$\mu_{\delta_1(t)} \left[q_1(t+1) \,\|\, q_1(t),\ u(t),\ v'(t) \right] \in [0,1]$$

$$\mu_{\omega_1(t)} \left[z(t) \,\|\, q_1(t),\ u(t),\ v'(t) \right] \in [0,1] \qquad (C/2.19)$$

$$\mu_{\delta_2(t)} \left[q_2(t+1) \,\|\, q_2(t),\ u(t),\ z'(t) \right] \in [0,1]$$

$$\mu_{\omega_2(t)} \left[v(t+1) \,\|\, q_2(t),\ u(t),\ z'(t) \right] \in [0,1]$$

[43] See ZADEH's - a System-theoretic View of Behaviour Modifications - Center for the Study of Democratic Institutions. Santa Monica Cal. Proc. Conf. on the Social and the Philosophical Implications of Behaviour Modifications.Jan 1972.E.R.L. Report M320.Univ. of California, Berkeley.Febr. 1972

the symbol "||" meaning that the occurence of some $q_i\ (t+1)$, $z\ (t)$ or $v\ (t+1)$ is (fuzzy) <u>conditioned</u> by the remainder terms lying within brackets.

Let also

$$\underset{\sim}{A}\ (t) \subset\ Q_1, \mu_{\underset{\sim}{A}(t)}(q_1(t)) \in [0,1]$$

$$\underset{\sim}{B}\ (t) \subset\ Z, \mu_{\underset{\sim}{B}(t)}(z\ (t)) \in [0,1]$$

$$\underset{\sim}{C}\ (t) \subset\ Q_2, \mu_{\underset{\sim}{C}(t)}\ (q_2(t)) \in [0,1] \qquad \text{(C/2.20)}$$

$$\underset{\sim}{D}\ (t) \subset\ V, \mu_{\underset{\sim}{D}(t)}\ (v\ (t)) \in [0,1]$$

$$F_k \subset U,\quad k = 0, 1, 2, \ldots \zeta \in T$$

be fuzzy subsets of Q_1, Z_1, Q_2, V, U for a given time sequence), 0 ,1.... .

The system of algebraic equations

$$\mu_{\underset{\sim}{A}(+1)}\left[q_1(t+1)\right] = \underset{q_1(t)}{\text{MAX}}\Big\{\mu_{\underset{\sim}{A}(t)}(q_1(t))\ \text{MIN}\mu_{\delta_1(t)}[\,q_1(t+1)\,\|\,q_1(t),\ u(t),\ v'(t)]\Big\}$$

$$\mu_{\underset{\sim}{B}(t)}\left[Z(t)\right] = \underset{q_1(t)}{\text{MAX}}\Big\{\mu_{\underset{\sim}{A}(t)}\ (q_1(t))\ \ \text{MIN}\ \mu_{\omega_1(t)}[\,Z(t)\,\|\,q_1(t),\ u(t),\ v'\ (t)]\Big\}$$

$$\mu_{\underset{\sim}{C}(t)}\left[q_2(t+1)\right] = \underset{q_2(t)}{\text{MAX}}\Big\{\mu_{\underset{\sim}{C}(t)}(q_2(t))\ \ \text{MIN}\mu_{\delta_2(t)}[\,q_2(t+1)\,\|\,q_2(t),\ u(t),\ Z'(t)\,]\Big\}$$

$$\mu_{\underset{\sim}{D}(t)}\left[v\ (t+1)\right] = \underset{q_2(t)}{\text{MAX}}\Big\{\mu_{\underset{\sim}{C}(t)}(q_2(t))\ \ \text{MIN}\mu_{\omega_2(t)}[\,v(t+1)\,\|\,q_2(t),\ u(t),\ Z'(t)\,]\Big\}$$

(C/2.21)

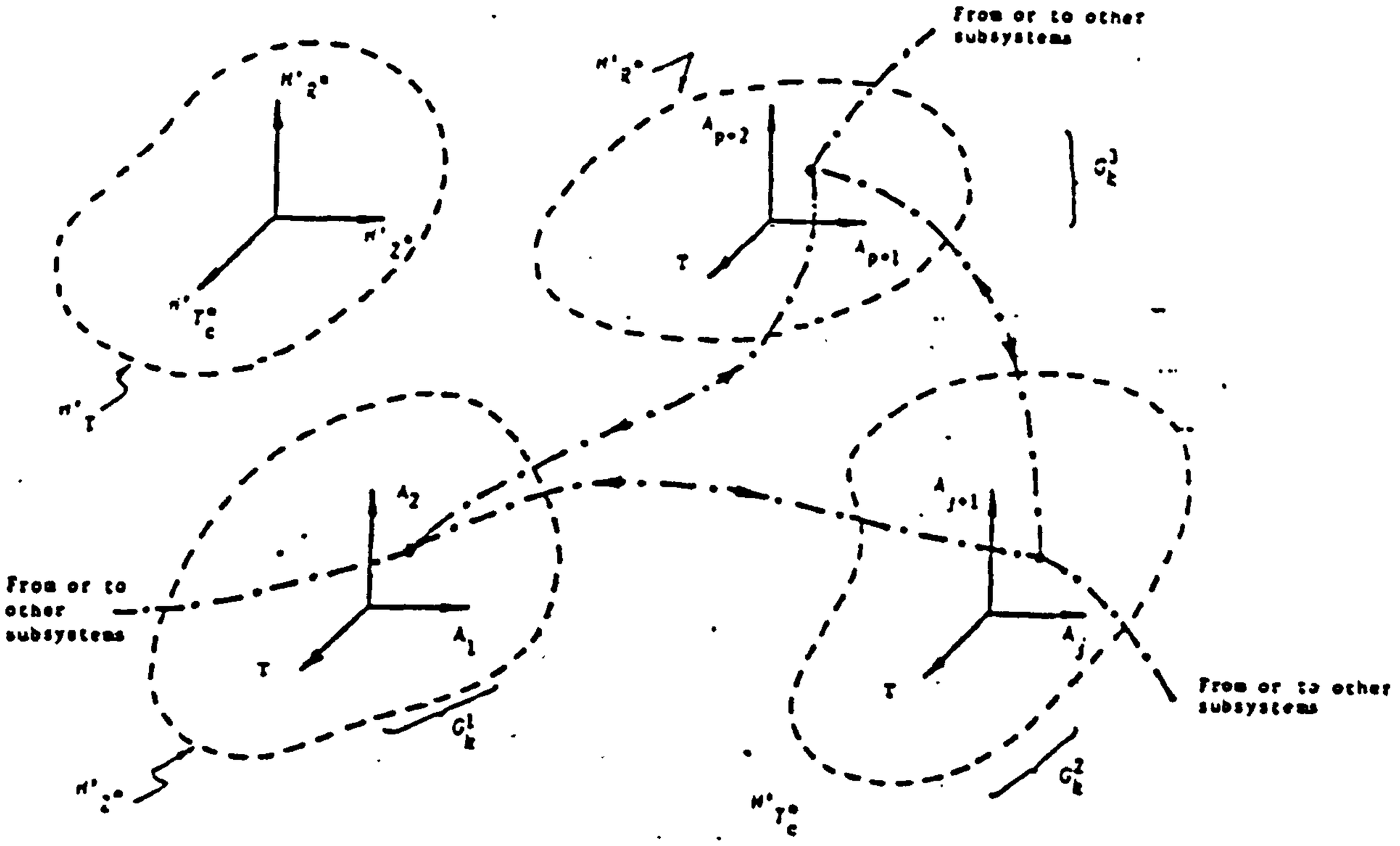
.together with the knowledge of (C/2.18), (C/2.19) the initial values $\mu_{\underline{A}}(0)(q_1(0))$, $\mu_{\underline{C}}(0)(q_2(0))$, $\mu_{\underline{D}}(0)(v(0))$ will therefore play a role quite similar to that of equations (C/2.14) - (C/2.17) for "normal" state-variables and relationships

A program exemplifying an application of such fuzzy-equations to an hypothetical fuzzy interaction $G_k^1 <--> G_k^2$ is also .given in S/5 of PART TWO of this essay

C/3 - The description of historical processes as fuzzy conditioned (growing) automata

The set of "normal" or fuzzy interactive equations precedingly brought to light can be extended to all the couples $(G_k^j, G_k^m) \in G_k$ since some formal precautions, due to the special characteristics of the models describing their inner structures, are taken into account.

This being accepted the simplified diagram of Fig. 30 can therefore take the more correct aspect shown in Fig. 33 in which the links between the event-points of H'_T, H'_{Z*}, H'_{R*} etc. work as symbolic expressions of G_k^i's mutual dependence referred to the beginnings of C/2v). This dependence is implicitly contained in the interactive equations previously emphasized either "normal" or fuzzy examined; for example, from the fundamental deterministic set



Interactions Z , R , P etc regarded from the viewpoint of Automata Theory

Fig. 33

(C/2.14) - (C/2.17) it can be seen that the state-transition $q_1(t) \leftrightarrow q_1(t+1)$ depends not only on the particular $u(t)$ applied to G_k^1 but also (through ω_2, C_{21}, γ_2 on $q_2(t) \in G_k^2$. Similar reasoning holds for $z(t)$ and $v(t)$, $q_2(t+1)$ and $q_1(t)$, $v(t+1)$ and $z(t)$. So interpreted such equations (or the picture which represents them) may be used to provide a vision of G_k not only topographical as we did so far but also dynamical this term being

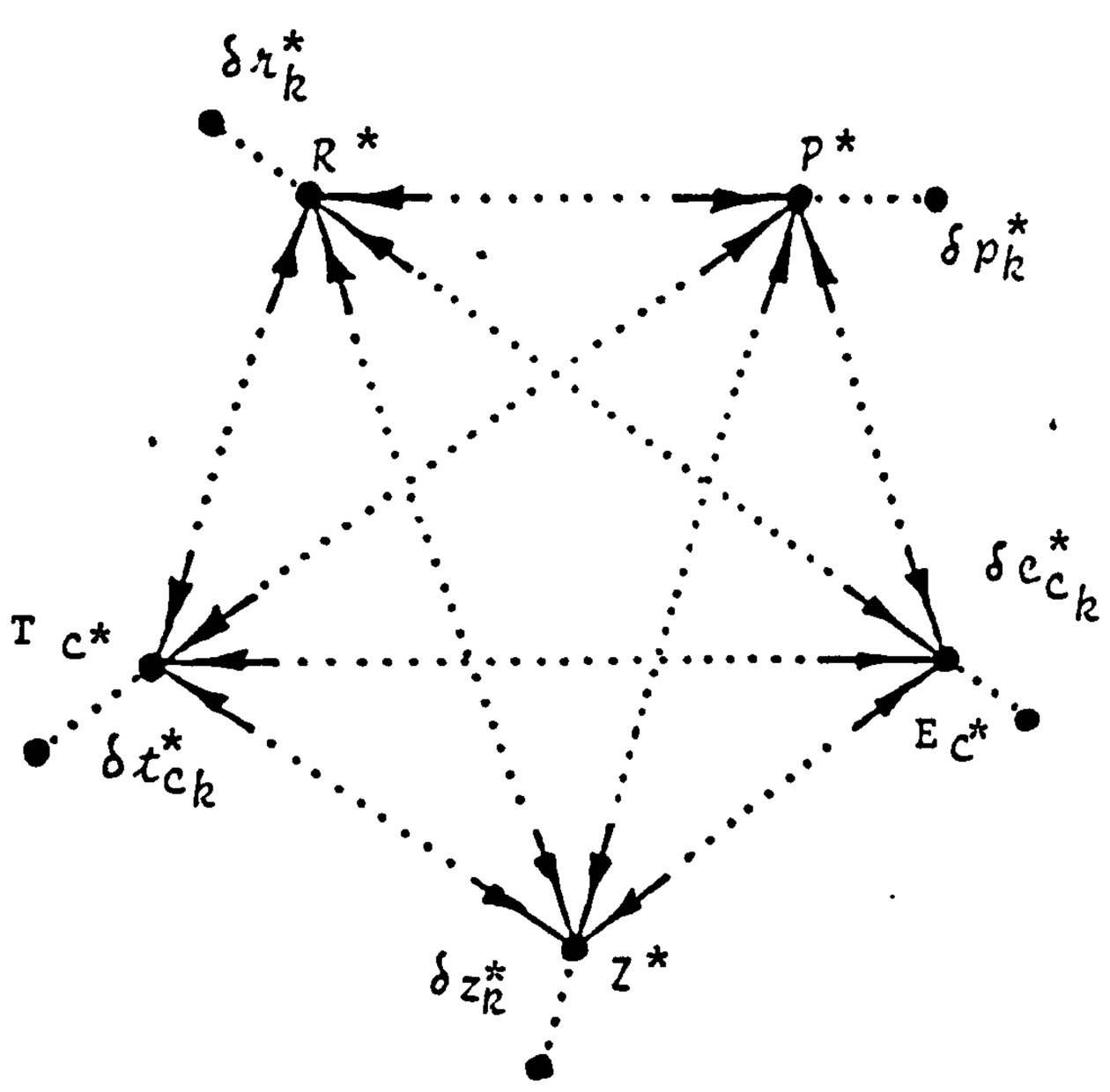
used according to a quasi-physcial meaning: i.e. as if every $G_k^i \in G_k$ were being submitted throughout time to

- a set of "influences", "disturbances", "tendencies" etc.

- which some times "reinforces" one another, some other times "opposes" one another

- whose "total value" may be "greater" or "lower"

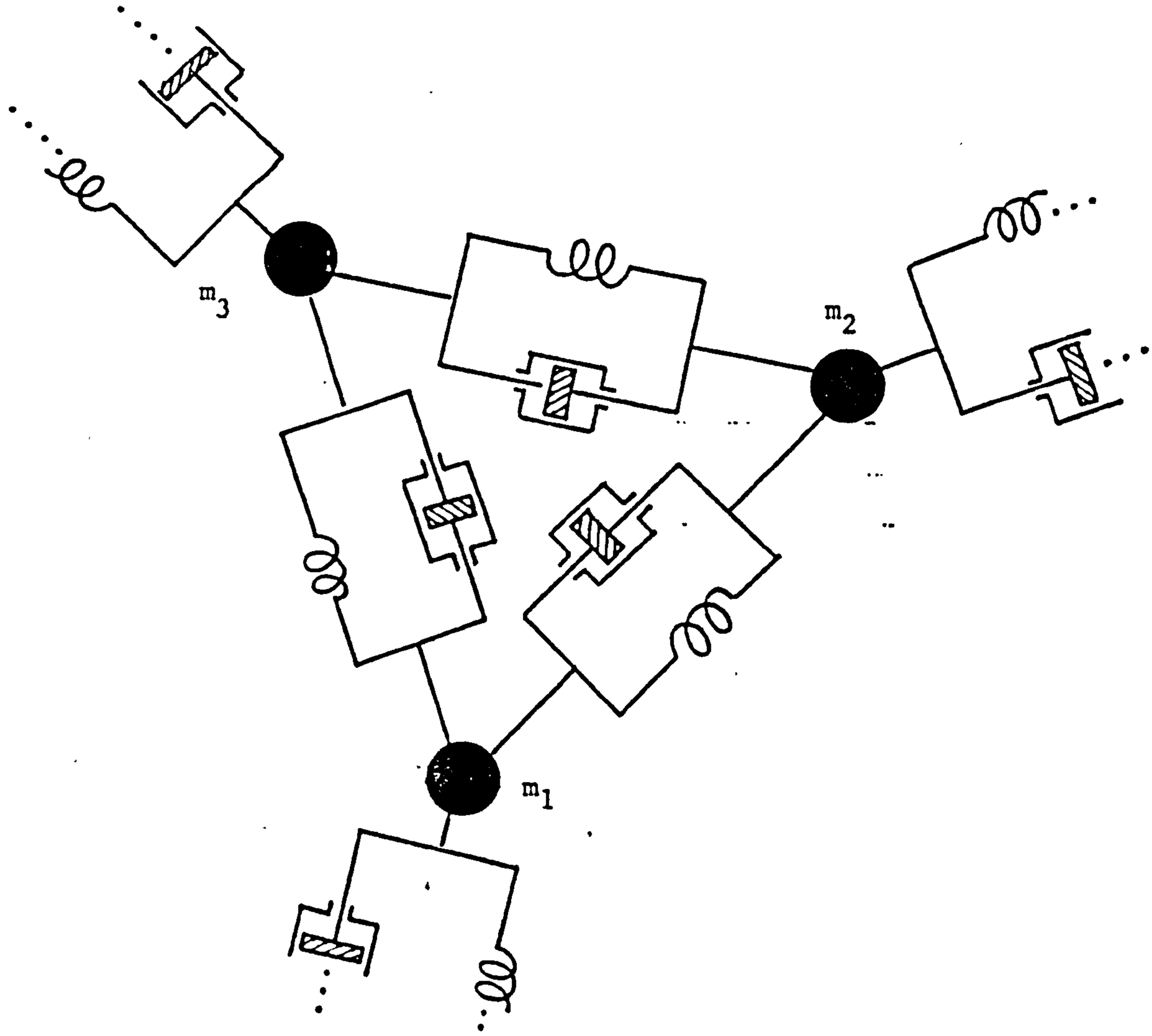
- leading *ultimately* to "greater" or "lower" changes of their internal states; say in the terminology of *PROP. B* to "displacements" of their representative state or event points. (Fig. 34).



Interaction T^*, R^*, P^* etc regarded in terms of displacements of event points

Fig. 34

Once examined from this point of view G_k's dynamical vision is not too different from that offered for example by the mechanical system of Fig. 35 in which



A mechanical analogy to automata interactions

Fig. 35

- the position of the material points m_1 , m_2 , m_3 etc. (as regards some coordinate reference system) is similar to that of the event points of $H'_{T_C^*}$, H'_{Z^*} , H_{R^*} etc. as regards the whole reference H'_T

.- the relationships existing between m_1 , m_2 etc. are here materialized by means either of the spring coils or of the imaginary dampers (not necessarily symmetrical) there shown

- each of the masses of the whole mechanical system is submited to a set of forces under the influence of which they tend to stay in the same or to move to another constrained position, this mechanical displacement being (in some sense) equivalent to a partial state-transition in the p-spaces $H'_{T_c}{}^{*}$, $H'_{Z}{}^{*}$ etc. Obviously neither group systems are mechanical systems nor social "forces" (whatever this may be) are real mechanical forces. In spite of this the basic <u>idea</u> which underlies the dynamics of this analogue (i.e. a system of forces whose magnitude varies in time, whose vectorial resultant once is applied to every mass tends to move it to this or that new position or, contrarily, tends to hold it at the same equilibrium position etc.) is widely, spread in historian's <u>current language</u>. It is almost needless to remark how often such terms as those previously referred to ("influences", "tendencies", "greater" or "lower" etc.) have been used to describe this or that historical situation; unnecessary is also to emphasize how important would be (for the formal description and understanding of human societies in general) the search for some procedure by means of which the problems related to the vagueness of these terms may be superseeded.

.Part of these problems (especially those associated with the formalization of situations involving subjective relationships, for example "greater than" or "lower than" etc) is already clarified in present-day research, taking into account the fuzzy subsets approach[44].

Another part however (insofar as we know) has not yet found adequate solution. Here we have concretely in mind the proper group dynamics previously referred to, - the ultimate core of the question of significant narrations - which even ZADEH's sets of interactive equations previously brought about are in themselves (i.e. so as presented beforehand) unable to accomplish. Two main objections can, in fact, be brought to light from such sets, especially when they are applied to the description of the mental behaviour of human beings:

a) firstly there is a distinction between a message in itself (in the case, of the output $z(t)$ or $v(t)$ of G_k^1 or G_k^2 and its proper influence upon the minds of G_k^1 's ,and G_k^2 's members. One thing is a "message", the "external" symbolic means through which some individual A communicates something to another individual B; another thing is its possible effect upon B 's mind; if, for example , B is indifferent to A 's communication then this influence will be null, everything working as though B were silent. Thus the second objection:

[44] i.e. "vagueness" has given place to "fuzzyness".

b) it may happen that $z(t_k)$, $v(t_k)$ or some sequence of $z(t)$, $v(t)$ did not lead to changes of G_k^1's, G_k^2's internal states as such equations imply.

Using a terminology similar to that of §I/1 we should therefore say that, by itself, some message $z(t_k)$ can only be influent upon B's mind,(B being here the representative of for example G_k^2's members) iff the constraints to which B is submitted "allow" that such an influence be felt.

Which summarily requires that a theoretical model of the "inner" working of such constraints has to be established (or, if already existing, appropriately converted to historical terms) and next added to ZADEH's interactive equations precedingly brought about; this, in order that the dynamical description of group environments may be achieved.

C/3.2 - The formal model: final version

The model which we propose for the accomplishment of this goal takes into account not only some of the hypothesis already outlined but also (and fundamentally) the theoretical background or perceptrons' theory[45]

i) group environments G_k may be topographically partitioned into a set of subsystems G_k^i , $i = 1, 2, \ldots n$, in which G_k^1 stands for the scientific status (class) Z^* of G_k, G_k^2 for its technological status T_c^* , G_k^3 for its religious status R^*, G_k^4 for its political status, P^*, G_k^5 for its economical status E_c^* etc

[45] Let a parallel machine, say C (KAUFMANN 1975) be defined by means of the 3-uple

$$C = (F, \phi , \Omega)$$

in which

i) F is a set of configurations or graphs G which C is able to accept

ii) ϕ is the family of elementar predicates

$$\phi = \left\{ \varphi_1(G), \varphi_2(G) \ldots \varphi_N(G) \right\}$$

in which the $\varphi_r(G) = 1$ if G possesses some property P_R being 0 if not.

iii) $\Omega(\phi) = \Psi(G)$ is the global predicate

$\Psi(G) = 1$ if G possesses some global property P

$= 0$ if not

(cont)

ii) Each one of these G_k^i is assumed to obey the usual automata description (normal on fuzzy)

$$G_k^i = \{ W_i, Q_i, Z_i, \delta_i, \omega_i \} \qquad (C/3.1)$$

the role played by the symbols W_i, Q_i, Z_i, δ_i, ω_i being the same as that referred to in C/2.

iii) These G_k^i are (broadly speaking) not mutually independent but, on the contrary, related to one another (at least in the sense that each one of them may "influence" and in turn may be "influenced" by the remainder subsystems of G_k) In these conditions if C_{ij} ($ij = 1,2 .....$) is the symbol of the relationship $G_k^i \dashrightarrow G_k^j$ then

---

(cont)

Let also $\{ \alpha_1, \alpha_2, ... \alpha_N \}$ be a set of numbers $\alpha_i \in R$ related to φ_r by means of the linear pseudo-boolean constraint equation

$$\alpha_1 \varphi_1 + \alpha_2 \varphi_2 + \dots \alpha_N \varphi_N > \theta$$

A parallel machine for which

$$\Psi(G) = 1 \text{ iff } \alpha_1 \varphi_1 + \alpha_2 \varphi_2 + \dots + \alpha_N \varphi_N > \theta$$

$$\alpha_r \in R$$

$$\varphi_r \in \{ 0,1 \}$$

$$r = 1, 2, \dots N$$

is therefore called a <u>perceptron</u>, the numbers α_r being named the "weights" or "coefficients" of the elementar predicates φ_r and θ designating the perceptron's threshold.

$$
\begin{array}{c|cccc|}
 & G_k^1 & G_k^2 & G_k^3 & \\
G_k^1 & c_{11}\ (t_k) & c_{12}\ (t_k) & c_{13}\ (t_k) & \cdots \\
G_k^2 & c_{21}\ (t_k) & c_{22}\ (t_k) & c_{23}\ (t_k) & \cdots \\
G_k^3 & c_{31}\ (t_k) & c_{32}\ (t_k) & c_{33}\ (t_k) & \cdots \\
\cdots & \cdots & \cdots & \cdots & \cdots
\end{array}
\qquad (C/3.2)
$$

will specify G_k 's structural relationship matrix at $t = t_k$.

iv) By analogy with what for example happens with mechanical systems, these mutual influences are, in the current language, usually described as "forces": social "forces", economical "forces", political "forces" etc. Since to them no real physical meaning can however be ascribed, the point of view from which they will henceforth be regarded prevails not "influences" or "forces" in themselves (whatever this may be) but on the contrary their effects, change or displacement of the representative point G_k^i in the p-space H'_i which it deals with. In these conditions the vague statement "G_k^1 influences" for example G_k^2 " is substituted by the more precise assertion " G_k^1 " is able to promote or, contrarily, to prevent, changes of G_k^2 's internal states

(i.e. displacements of the event points H'_2 at $t = t_k$); such influences work therefore as <u>constraints</u> acting upon every G_k

"Transition", "changes" and "displacements" obey obviously what was said about them in PROP A and PROP B.

v) Since these $C_{ij}(t)$ can on the one hand "exist" or "not exist" and, on the other hand, "promote" or contrarily "prevent", "more" or "less", eventual changes of some G^i_k then it will be assumed from now on that each one of them may be given the product

$$c_{ij}(t_k) = \alpha_{ij}(t_k) \cdot \varphi_{ij}(t_k) \qquad \text{(C/3.3)}$$

$$\varphi_{ij}(t_k) \in \{ 0,1 \} \qquad \text{(C/3.4)}$$

$$\alpha_{ij}(t_k) \in [-1,+1]$$

$$i,j = 1,2, \ldots\ldots\ldots\ldots$$

in which $\varphi_{ij}(t_k)$ is a boolean variable meaning "existing or not existing constraint at $t = t_k$ " and each one of the $\alpha_{ij}(t_k)$ represents its "weight" or "magnetitude". Negative

values of these $\alpha_{ij}(t_k)$ (i.e. $-1 < \alpha_{ij} < 0$) may be interpreted as "favouring", "promoting" etc. some displacement, positive values ($0 < \alpha_{ij} < +1$) as "preventing", "forbidding" etc. it, the value 0 corresponding to a null or "neutral" effect.

vi) For every $G_k^j \in G_k$ the <u>total</u> influence of the set of <u>external</u> (elementar) constraints upon it is supposed to be given by the linear pseudo-boolean equation

$$C_{EC}^j(t) = \sum_{i=1}^{n} \alpha_{ij}(t) \cdot \varphi_{ij}(t) \qquad (C/3.5)$$

in which $C_{EC}^j(t)$, $\alpha_{ij}(t)$ and $\varphi_{ij}(t)$ obey (C/3.) It follows from this that, for an observer similar to our hypothetical OP_F able to know all the $C_{ij}(t_k)$ at all time instants t_k of mankind's history (i.e. able to define unambiguously the structural relationship matrix (C/3.2) the value of $C_{EC}^j(t_k)$ will consequently be <u>deterministically</u> specified

vii)However, for the sake of simplicity, it will be assumed that this OP_F has his attention simply directed to G_k', i.e. to the scientific status Z^* of G_k; obviously, this does not exclude all other external influences which, in a way

or in another, may affect Z^*'s proper development (HYP. II of S/2). Thus in brief, OP_F works primarily, though not exclusively, as a <u>scientific historian</u>.

From this point of view OP_F has therefore not only to describe OP_k's messages (direct narration) but also to explain the reasons as to why this or that transformation has (or not) occured at this or that time instant t_k (significant narration).

In order to accomplish this last goal let us then assume that G_k^1 may be <u>structurally</u> partitioned into two other subsystems

- one responsible for what was named as a "memory" (M_k^1)

- the other for what was called a "combinator" (C_k^1) the relationships between these subsystems obeying (generally speaking) the models previously referred to.

viii) Assume also (as we did beforehand) that M_k^1 is able not only to reproduce all the messages and respective transformations already occured until $t = t_k$ (t_R included) but also to "weight" them according to the values of some time-variable coefficient $\alpha_{11}(t) \in [-1, +1]$ playing the same role as the α_{ij}; referred to v).

Suppose too, for the sake of simplicity, that during some extended interval of time $[t_j, t_k]$ preceding t_k the individual transformations $T_{ij+1}, \ldots T_{k-1k}$ which have constituted some global T_{jk} did not appear randomly; on the contrary, they have followed some well-defined research-direction. In other words (and according to the terminology of PROP.B that the particular "segment" T_{jk} of TSK comprised within the limits $t = t_j$ and $t = t_k$ of the p-space H'_{Z*} presents no sudden inflexions.

So exposed M_k^1 can therefore be regarded as the general representative of the whole direct or in direct scientific influences to which some OP_k is being submitted Briefly: to his scientific context either remote (but kept in the group memory through its libraries, traditions, etc.) or present, this term being here referred to his teachers (say rather teaching system) to the particular set of rules, beliefs etc. directing the scientific community on "school" to which he belongs etc.

According to v) and vi) above, all these influences upon OP_k can therefore be interpreted as constraints, internal constraints in this case, which too may "promote" or "prevent" more or "less" this or that proposed change. If C_{IC}^1 is its symbolic representation then

$$C_{IC}^1 (t_k) = \alpha_{11} (t_k) . \varphi_{jk} (t_k) \qquad (C/3.6)$$

Taking this into account (C/3.5) can now be written in a different way; as a matter of fact if $C^{1}_{TG}(t_k)$ is a relation expressing the influence of the whole constraints upon OP_k, (external and internal) then

$$C^{1}_{TC}(t_k) = C^{1}_{IC}(t_k) + C^{1}_{EC}(t_k) =$$

$$= \alpha_{11}(t_k)\,\varphi_{jk}(t_k) + \alpha_{21}(t_k)\cdot\varphi_{21}(t_k) +$$

$$+ \ldots\ldots\ldots + \alpha_{n1}(t_k)\,\varphi_{n1}(t_k) =$$

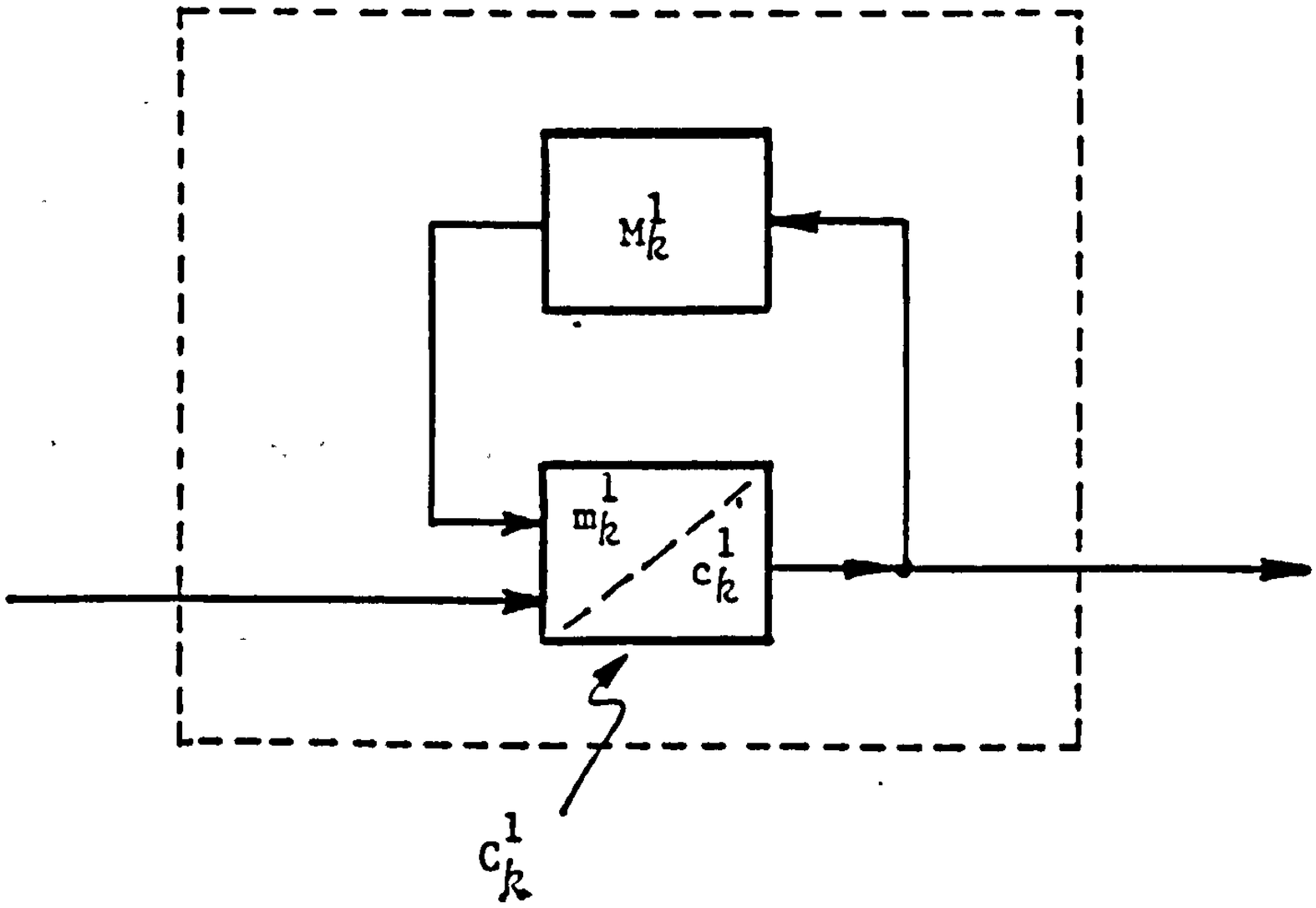
$$= \sum_{m=1}^{n} \alpha_{m1}(t_k)\cdot\varphi_{m1}(t_k) \qquad \text{(C/3.7)}$$

ix) In order to include those changes in the model which we are outlining, the role played by the combinator C^{1}_{k} has to be substantially enlarged. In this sense, instead of looking upon it as a simple passive device whose task is simply restricted to the pure combination of these or those state variables, let us preferentially regard it as some kind of (symbolic) active network playing part of OP_k's own task.

How this network concretely functions does not interest us for the moment; in the present exposition it is enough to assume that it also contains a particular memory (m^{1}_{k}) which at $t = t_k$ reproduces part on the totality of the last stored state $q_k(t_k)$ of G^{1}_{k}'s group memory as well as what we may call a "creator" (c^{1}_{k}). The role of this (symbolic) device is in some sense similar to the simple combination network referred to in C/2 iii); in this case however to the pure combination of

already occured state variables we shall add another property: concretely the possibility of introducing either new variables and/or new relationships between them, always that they are required for the solution of some "problem". Thus briefly c_k^1 works as though it were responsible for OP_k's autonomous responses in all they have of new as regards some previously acepted knowledge of PhW.

Taking these assumptions into account G_k's inner structure can therefore be represented as in Fig. 36 not too different from that shown for example in Fig. 32.



MOORE's model of the interaction individual-context
Fig. 36

Quite different indeed is the way according to which the interaction M_k^1 <--> C_k^1 may be globally regarded, either

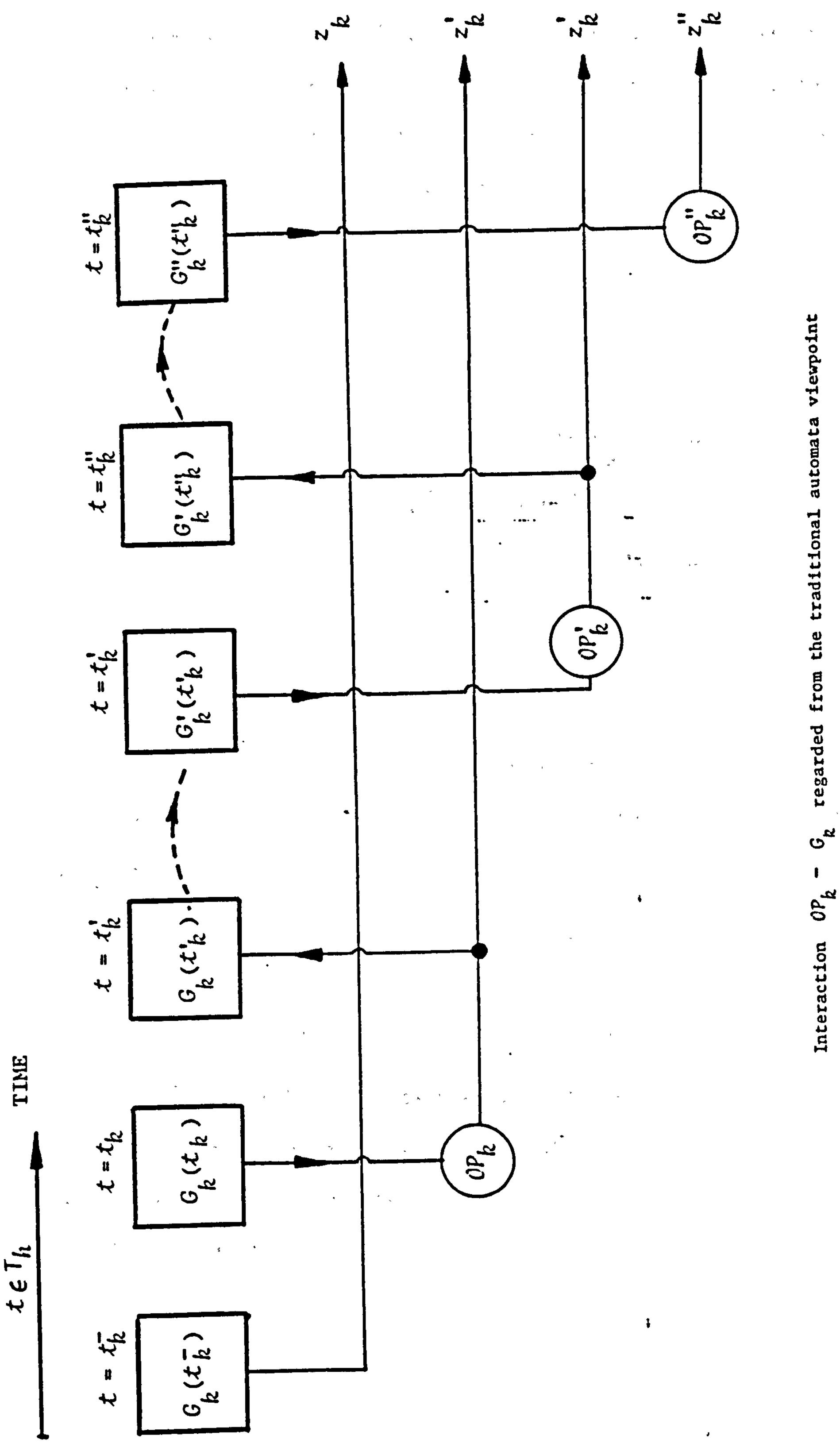
from ZADEH's or from the dynamical points of view previously referred to.

x) Suppose in this sense that OP_k (here partially identified with C_k^1) is able to detect a "problem" implicitly involved in the last group description z_k (t_k) of *PhW* and not yet solved by means of the procedure already known until $t = t_k$.

From ZADEH's point of view once some "solution", say z'_k (t'_k), is found, then it leads to a change of G_k^1's internal state (the next state function or transition $\delta: q_k(t_k) \dashrightarrow q'_k(t_k)$ and consequently to some new (group) image of Nature z'_k (t_k). This image will in turn influence future OP'_k etc., the whole process running according to the simplified <u>sequential</u> scheme of Fig. 37 (a pictorial representation of the set of interactive equations (C/2.14) - - (C/2.17) or (C/2.18) (C/2.21)

From the dynamic viewpoint previously suggested, things cannot however be so easily described; in reality they do only work so <u>unless the proposed solution z'_k (t_k) has already been previously accepted by G_k's group environment</u>

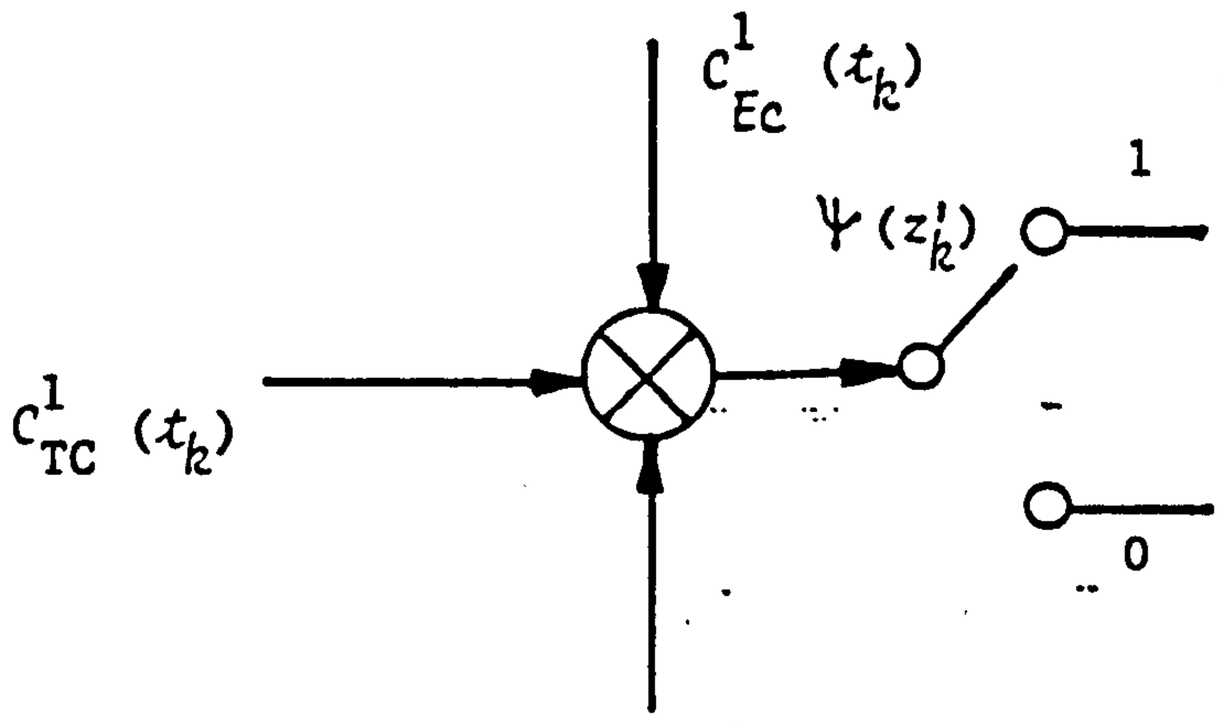
It is in the formal translation of these conditions "acceptance", "not acceptance" that what was asserted either about constraints or about perceptron's theory plays here it's most relevant role. Suppose in this sense that instead of prevailing the influence of z'_k (t'_k) <u>in itself</u> (i.e. of OP_k's own <u>message</u>) we prefer rather, to pay attention to the <u>change</u> which it implicitly underlies



Interaction OP_k - G_k regarded from the traditional automata viewpoint

Fig. 37

Let it be represented by $C'_{OP_k}(t'_k)$ and let us also assume that the group memory M'_k is able to decide whether or not it can be accepted; this by means of a comparison with the totality of constraints $C'_{Tc}(t'_k)$ to which it is being submited at $t = t'_k$ (Fig. 38)



A threshold comparator

Fig. 38

Let $\Psi(z'_k)$ be then a boolean function playing a role similar to that of the total predicate $\Psi(G)$ of perceptron's theory and let us finally postulate the condition

$$\Psi(z'_k) = 1 \quad \text{iff} \quad C^1_{OP_k}(t'_k) - C^1_{TC}(t'_k) > 0$$

$$\Psi(z'_k) = 0 \quad \text{iff} \quad C^1_{OP_k}(t'_k) - C^1_{TC}(t'_k) \leqslant 0 \qquad \text{(C/3.8)}$$

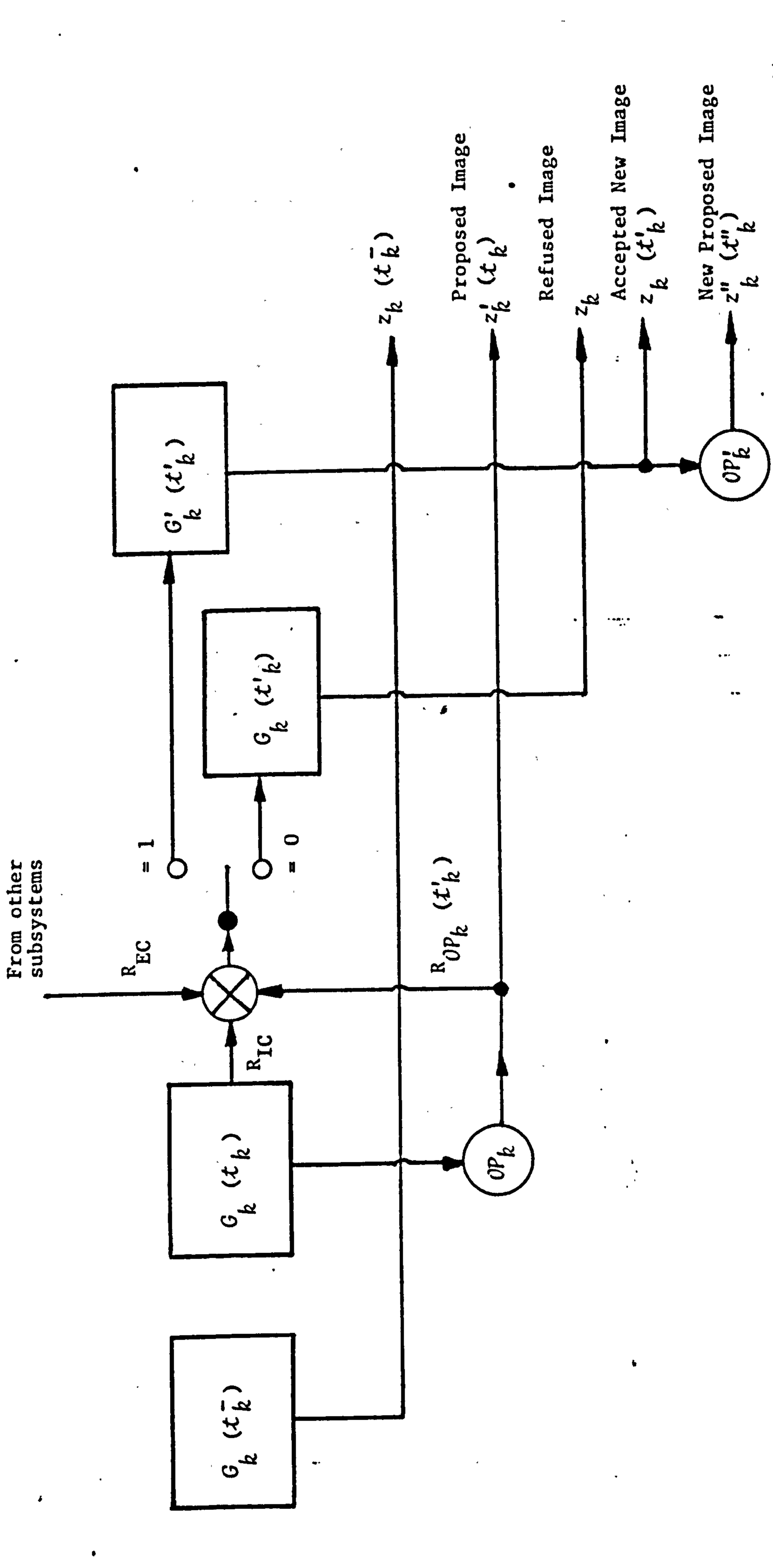
in which $\Psi(z'_k) = 1$ condenses the (current language statement) "the proposed change $C^1_{OP}(t'_k)$ was accepted by a group environment G^1_k , submitted to the influence of a set of total constraints $C^1_{TC}(t'_k)$".

From this point of view ZADEH's interactive equations previously referred to may only be employed iff (C/3.8) is verified; which means in other words that OP_k's proposed change is really converted in ZADEH's next state function $\delta(t)$ when and only when (C/ 3.8) holds.

The set (C/ 2.18) - (C/2.21) together with this condition summarizes therefore the dynamic interaction G_k's ⟷ OP_k's or (if this is the case) any other interaction.

xi) The inclusion of (C/3.8) into ZADEH's equations leads to a correction of the dynamic scheme of Fig. 37 by that shown in Fig. 39 which is more general than the first.

This is due to two main reasons. On the one hand because G_k's inner dynamics can henceforth be formally described in terms of a "growing" conditioned fuzzy automata" in which the term "growing" is referred to the increasing number of non-zero semantic attributes and "conditioned" is here employed as synonymous of "parallel machine". On the other hand because this (unusual) description seems to embody practically all the classical situations which history of Science deals with, this extension depending on the values which the $\alpha_{ij}(t)$ or their respective $\varphi_{ij}(t)$ have really taken throughout time.



Interaction OP_k - G_k regarded from perceptron's theory

Fig. 39

.Here again perceptron's theory provides a good way of visualizing how these constraints may <u>globally</u> influence the acceptance (or rejection) of some proposed new image. To have knowledge of the time-variation of all the relationships existing either between Tc^*, R^*, P^*, Ec^* etc. and Z^* ; of Z^* with itself (this including it's "schools") or between this class and some OP_k (as our supra-human observer OP_F has) is in fact equivalent to the specification of a <u>satisfaction domain</u>) i.e. of a 6-dimensional[46] region) whose limits of constraint precisely bound that global acceptance. If for example the equation (C/3.8) takes the values

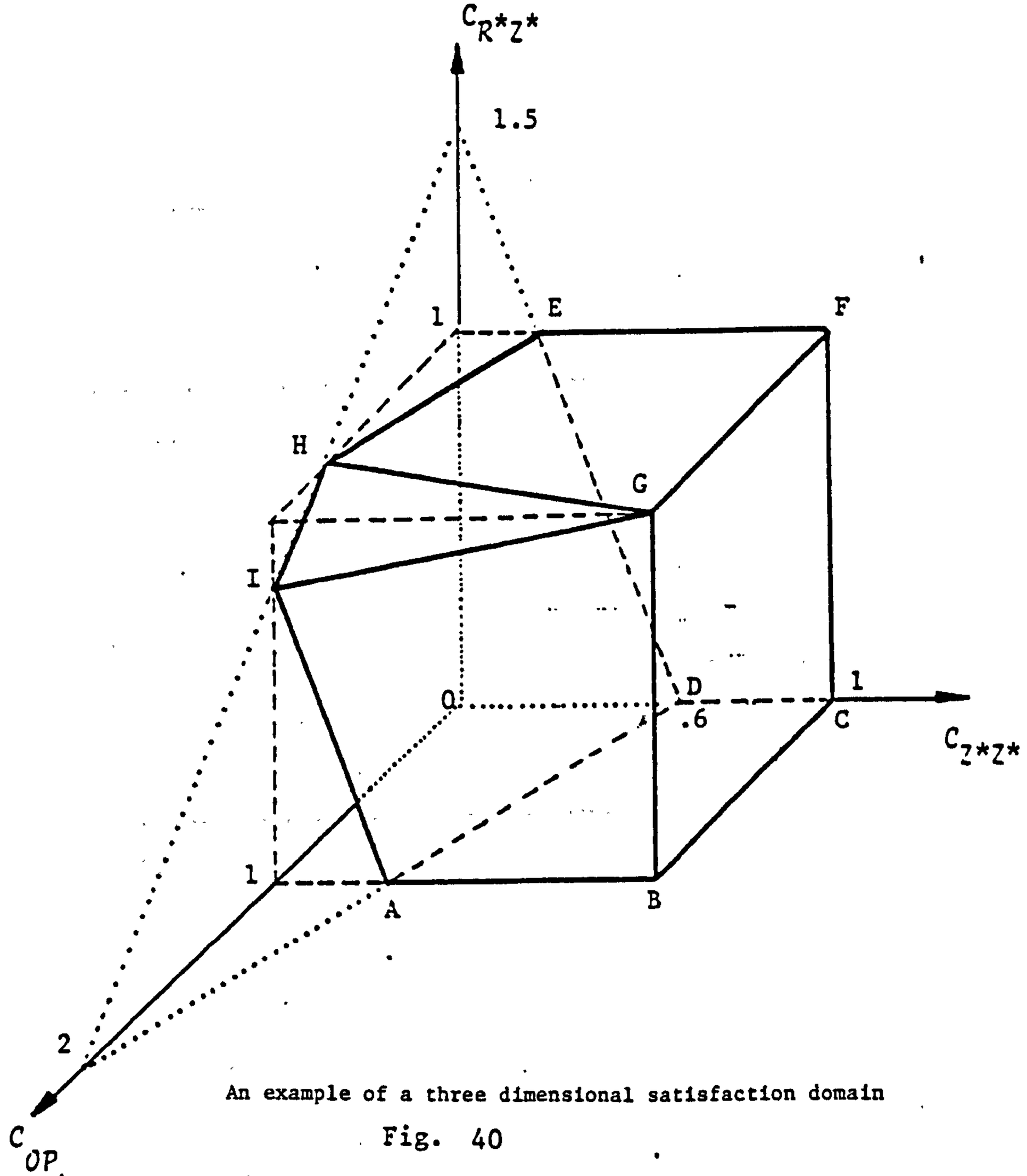
$$0,3\ \varphi_{OP_k} + 1\ \varphi_{Z^*Z^*} + 0,4\ \varphi_{R^*Z^*} > 0,6 \qquad \text{(C/3.9)}$$

(meaning that $R_{Z^*\ Z^*}$ is totally in accordance with the proposed change and $R_{R^*\ Z^*}$ only partially in accordance with it) then it is easy to see that such a region will correspond to the polyhedron ABCDEFGHI shown in Fig. 40

Identical results can obviously be brought to light if instead of these n-dimensional representations we simply consider their bi-dimensional projections. In this sense Fig. 41 shows what happens with the equation

$$0,3\ \varphi_{OP_k} + 0,75\ \varphi_{Z^*\ Z^*} > 0,6 \qquad \text{(C/3.10)}$$

[46]Because in this case we have 6 possible relationships $R_{T^*\ Z^*}$, $R_{R^*Z^*}$, $R_{P^*Z^*}$, $R_{E^*Z^*}$, $R_{Z^*Z^*}$, R_{OP^*}.



An example of a three dimensional satisfaction domain

Fig. 40

- when the attitude of the group environment before some proposed change becomes progressively lesser supporting, or

- (holding the initial value of $C_{Z^*\,Z^*}$) the remainder constraints increase their opposition ,or

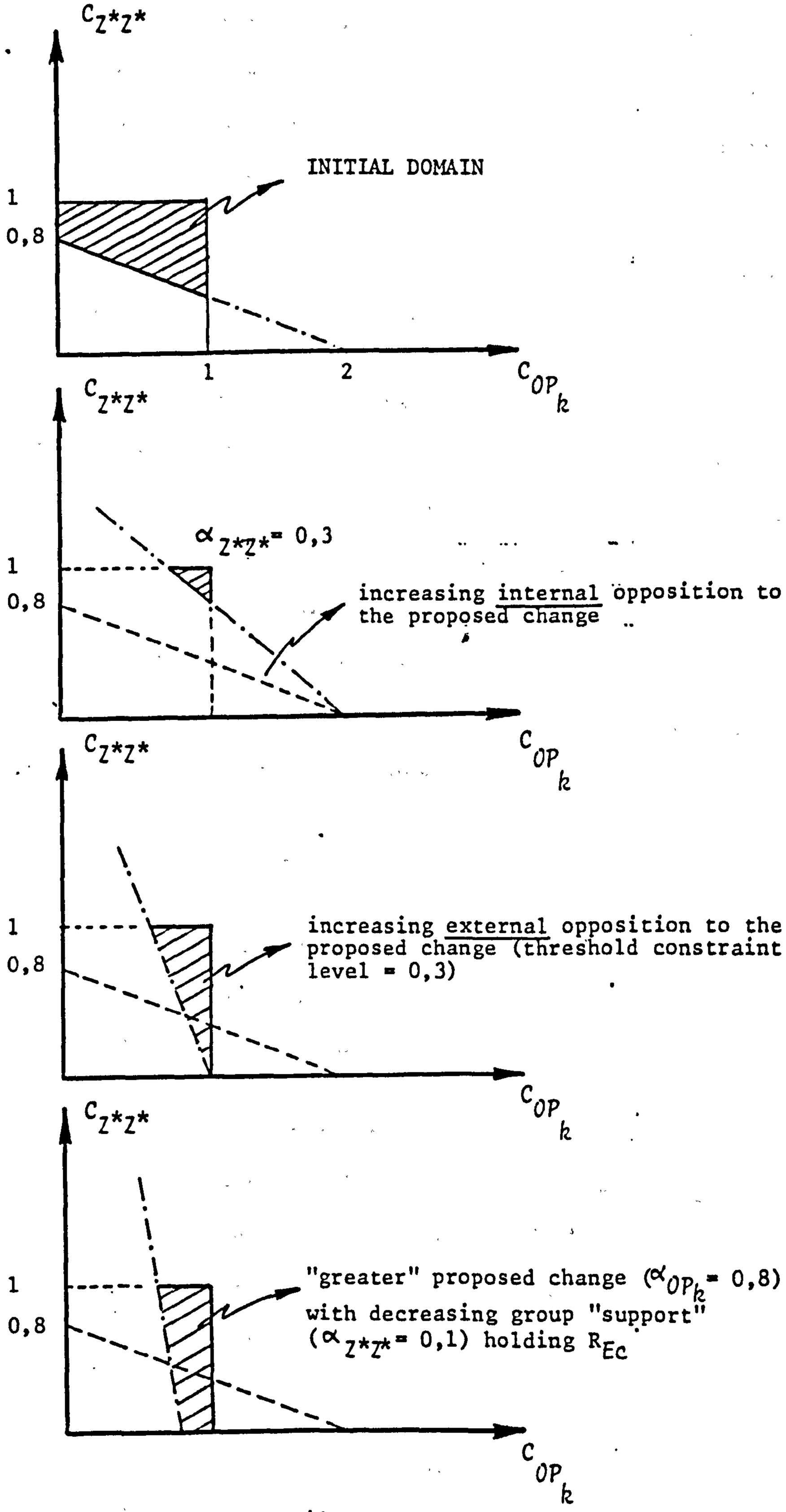


Fig. 41

An application of the theory of satisfaction domains to the interaction

- (holding the initial value of C_{Ec}) C_{OP_k} and $C_{Z^*Z^*}$ vary both oppositely: instead of "small", OP_k 's proposal is now concerned with a "great" change $\alpha_{OP} = 0,8$ the group support being practically null ($\alpha_{Z^*Z^*} = 0,1$)

In all cases there is an evident reduction of the acceptance area and consequently of the proposed changes.

The reasoning can also be extended to other situations: for if we postulate the <u>constancy</u> of that initial area (the relative "value" of such an acceptation) then it can be seen that the substitution of a "small" proposed change by a "greater" one implies a reduction of the supporting level. Which seems to be in accordance with the (common sense) idea asserting that "small" changes are "more easily" accepted by group environments than greater ones.

II/3 - <u>THE MODEL: AN OVERALL VIEW</u>

The standpoints of the model previously outlined are already enough to provide a condensed and integrated vision of the whole formal approach so far presented. Everything has worked, in fact, as though

i) in PROP. B we had simply paid attention to an abstract procedure by means of which that part of OP_k's group environment exclusively concerned with z_k's messages (directly narrated) were systematized and uniformly described; this in such a way that their individual transformations may automatically be brought to light

ii) next in PROP. C

- this procedure were (abstractly) extended to all the remainder (topographical) organizations of G_k,

- to it a true formal support (KLIR's ST approach) had been ascribed

- by means of which such organizations became describable in the language of "states" and "transitions"

- states and transitions which (abstractly) relate $Z' \subset Z^*$ on the one hand to the remainder subsystems of G_k and, on the other, to the OP_k s.

If these OP_k s are now regarded as the ultimate "cause" of Z^* s' changes, then

- the relationships between G_k's topographical organizations, Z^* (and through it) Z' and such OP_k may be interpreted as <u>constraints</u>

- which may "promote" or "prevent", "more" or "less" OP_k's <u>proposed</u> changes

- this dynamical (though still abstract) interaction OP_k - general context obeying the sets (C/2.14)-(C.2.17) or (C/2.18)-(C/2.21)

together with the threshold equation (C/3.8)

From OP_F' <u>deterministic viewpoint</u> the <u>application</u> of these (abstract) results to the direct and significant descriptions of historical processes require

- the specification of all the <u>state variables</u> which define the image of Nature z_R at $t = t_R$; this image (the last stored state of $M_k^{z'}$) will work as a reference image as regards which the whole amount of historical/scientific information proceeding from OP_F's past will henceforth be compared, systematized and later semantically "weighted" (through the fuzzy resemblance emphasized in PREMISE D). This will allow

- the formal and numerical specification of $M_k^{z'}$ state <u>values</u> (as regards the fully semantic significance 1 of z_R's terms), of their individual transitions (those effectively occured in mankind's history) as well as of their composition operations. The knowledge of all these values has therefore worked as though $M_k^{z'}$ were a mere reproduction of TSK in terms of simple <u>direct</u> <u>narrations</u>.

OP_F's position as regards $M_k^{z'}$ outputs was therefore equivalent to that of a (supra-human) observer before the occurence of some kind of "natural" happenings whose simple description (firstly) and explanation (later) he was seeking to accomplish.

From the first of these viewpoints such outputs - now historical/scientific events (t_k , z_k) - were next related to a p-space H''_Z,

$$H''_Z = T \times \overbrace{\prod_{i=1}^{n}}^{n} A_i$$

whose "points" are geometrical reproductions of meaningful or meaningless couples (t_k , z_k). The whole sequence of <u>really</u> <u>occured</u> events (a significant sequence of points mutually related by means of point transformations T_{ij}) determines a (ficticious) <u>path</u> in H''_Z nothing but a geometrical interpretation of TSK. Which consequently allowed

- the evaluation of "distances" either between image-points or between some image-point P_i ($\cong z_i$) and P_R ($\cong z_R$) (specifying a greater or lesser epistemological "proximity" as regards the present-day image of Nature)

- the specification of this or that research direction (followed during this or that period of mankind's history)

- the evaluation of global or particular velocities of variation; the field of these velocities ascribes therefore to the common sense expression "current of thought" a true physical meaning [i.e. as though TSK in itself were regarded as some kind of hidrodynamical current]

- the conversion of the philosophical relativistic attitude (according to which mankind's past has been examined in this essay) to a problem of coordinate transformation capable of formal and quantifiable treatment.

All these results (brought to light either in PROB. B of this ARGUMENT or in S/4 of PART TWO of this essay) may be summarily expressed asserting that the historical/scientific reconstitution question (directly narrated) appears as a problem of Dynamics (physically understood) : everything works as though z_k's representative image-point were following some n+1-dimensional "trajectory" which OP_F (due to his supra-human characteristics) is able to visualize.

As scientific historian OP_F's task is however not simply restricted to the description of such a path but also to its "explanation". In brief: he must also know why (in this or that time-instant of mankind's history) that trajectory has suffered this or that inflexion, why the velocity of variation of that representative image-point was sometimes higher than others, etc. This new question (involving historical significant narrations) is potentially implicit

in the interpretation ascribed to H''_Z : not only a simple and statical reconstitution of what <u>effectively</u> <u>occured</u> in that history but rather (and fundamentally) of the possible histories which <u>could</u> <u>have</u> <u>occured</u> <u>if</u> <u>the</u> <u>constraints</u> to which every OP_k were submitted (at $t = t_k$) were also diferent. Or, which is similar, as though the trajectory effectively followed were as it were because such constraints did not allow different historical evolutions. The specification of these constraints (PROP. C of this ARGUMENT and S/5, S/6 of PART TWO of the essay) led to the introduction of a new extended p-space H'_T,

$$H'_T = T \times \sum_{i=1}^{s} A_i \qquad \text{(II/3.2)}$$

assumed to describe OP_k's <u>context</u>.

The topographical and dynamical interpretation of this context as a hierarchical composite machine (automaton) in which one of its submachines (corresponding to that part of OP_k's group environment exclusively related to his scientific status) was submitted to the influence of the remaining ones, brought to light as a (possible) description of the interactions OP_k <--> context in terms of a theory of <u>fuzzy</u> <u>conditioned</u> <u>growing</u> <u>automata</u>.

<u>Abstractly</u> regarded this meant (essentially)

- the (possible) application to history of ZADEH's (classical or fuzzy) interactive equations (C/2.14) - (C/2.17) or (C/2.18) - (C/2.21) together with the threshold equation (C/ 3.8)

- the specification of OP_k's satisfaction domain i.e. a p-dimensional region within which the representative points of OP_k's proposed changes ("displacements") are free to move or whose boundary limits have (eventually) to be altered (so, implying contextual modifications) if he wants that some "exceeding" alteration is (contextually) accepted.

In this sense the progressive increasing of the "area" corresponding to PhW's cognitive descriptions (what in the psycho-historical approach we define as an expansion of PhW^N as regards the "as though" or affective explanations of OP_k's physical world) may therefore be globally interpreted

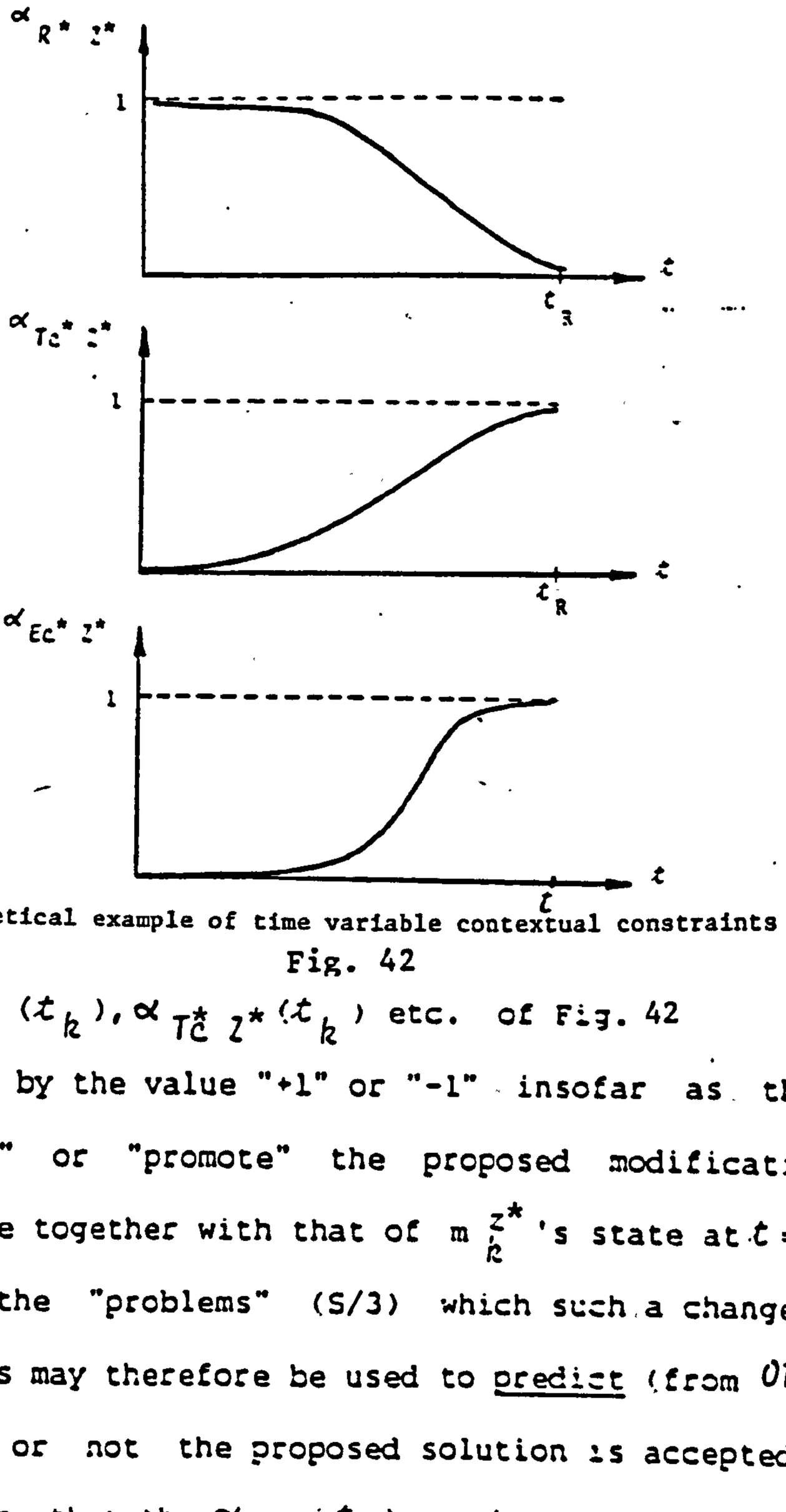
- firstly, as a decline (decreasing influence) of religious explanations upon PhW's cognitive analyses

- secondly, as a growing process in which the number of non-zero semantic attibutes and relationships describing the successive z_k throughout time (taking z_R as reference) is progressively increasing [or, which is similar the number of zeros (meaningless or non-existing attributes/relationships) decreases as far as time went on]

- thirdly, now in terms of PASK's conversational approach, as an (evolutionary) learning-teaching process in which the dynamical operating region of some "student" OP_k is being sucessively transformed (controlled) and enlarged as far as the problems he faces (or are proposed by a "teacher" OP_R) are being progressively solved.

So regarded the historical/scientific problem does not structurally differ from for example a (p-dimensional control) question of pursuit and compensatory tracking (see S/0 of PART TWO of this essay).

From OP_F's supra-human viewpoint the specification of such operating region requires obviously the knowledge of all the curves



A theoretical example of time variable contextual constraints

Fig. 42

$\alpha_{R^*Z^*}(t_k)$, $\alpha_{Tc^*Z^*}(t_k)$ etc. of Fig. 42 affected by the value "+1" or "-1" insofar as these values "prevent" or "promote" the proposed modification. Their knowledge together with that of $m_k^{Z^*}$'s state at $t = t_k$ as well as of the "problems" (S/3) which such a change ultimately underlies may therefore be used to predict (from OP_F's view) whether or not the proposed solution is accepted. It is in this sense that the $\alpha_{ij}(t_k)$ may be regarded as some kind of (historical) "secondary" causes of TSK 's individual transitions.

The knowledge of these curves does not however provide a total and complete answer to the question of significant narrations. This because OP_k position as regards his group environment has essentially been restricted to that of a simple disturbing element of $Z'' \subset Z^*$. In other words: nothing has been asserted (in this formal approach) about the reasons as to why OP_k was led to this or that original solution, to the particular thought-processes he used to accomplish it, to the "weight" of the external constraints as regards what he proposed as creator etc: briefly to OP_k inner dynamics, this word being related to the (posible) conflict between his own autonomous responses and the (external and internal) constraints to which he is being submitted. Two distinct (though complementar) questions are here implicitly involved

- the first deals with the formal description of such a dynamics (i.e. with the difficulties which historians and psychologists may found in its mathematical description)

- the second is concerned with the distinction which exist between such real historians OP_R and the imaginary (supra human) observer OP_F used so far.

i) From the abstract viewpoint of that imaginary OP_F, the automata description of such dynamics does not substantialy differ from that presented in PROP.C. As a matter of fact if OP_F knowledge of OP_k is supposed to be describable in the language of the ST approach (i.e. by means of some internal state-variables and internal relationships) then some new procedure which OP_k proposes or uses in order to solve some "problem" (leading consequently to an increase

of OP_k knowledge of PhW and, retrospectively, to OP_F knowledge of OP_k) may also be regarded as a <u>transition</u>, something which changes or transforms either OP_k state of knowledge (at $t=t_k$) or OP_F knowledge of TSK (in general). The (hidden) process which the selection of this transition underlies is, obviously, not simple. Broadly speaking , it begins not with a <u>single</u> proposed change but with a set of <u>possible</u> modifications which, next, will be internally compared with OP_k's internal constraints (part of which are reflexes or images of those already existing in his group environment and part are due to his past experience (either affective or cognitive).

This comparison may lead to different results: if for example OP_k's own satisfaction domain is supposed to be extremely restrict ("heavy" internal opposite constraints) it may happen therefore that no proposed solution is (internally) regarded as acceptable; everything works,therefore, as though OP_k's own creativity were totally anihilated. This extreme situation was not considered in the course of the approach: since PROP.A that (by definition) the OPs have, in a way or in another, contributed to TSK, "constructing" or giving rise to something "new" as regards what people knew in their epochs. In terms of the aforementioned dynamics this is equivalent to say that there was one (at least) proposed transition which , firstly, is internally accepted and next <u>externalized</u>: this produces a (historial) message z_k which, in turn,will be subjected to another judgment - that one proceeding now from OP_k's group environment. If immediatly acceptd then it will lead to a group change which, next, will be transmited (taught) to future OP_{k+1} etc.

Whatever may be the way according to which this transmission is accomplished (i.e. the teaching-learning process it underlies) the point which needs to be stressed is that (from OP_F viewpoint) the mathematical description of OP_k's inner dynamics obeys (broadly speaking) the same structural set of equations to which we were led examining the interaction $OP_k \leftrightarrow G_k$; OP_k's role as disturbing element of G_k being here (i.e. "internally") played by his own creativity. The problem - the crucial problem indeed - is that one thing is the abstract knowledge of such equations another is their concrete application to historical reconstitutions. This because (even from OP_F's deterministic viewpoint) it would require not only an exact and complete knowledge either of all the $\alpha_i(t)$ or of all the (internal) state variables of all the OPs but also (and fundamentally) of their mental processes; above all of those dealing with their own creativity.

It is here that the psycho-historical model previously outlined becomes relevant. If (and we lay emphasis on this "if") this or that real OP_k is suitably inserted into some of the fundamental phases there brought to light then [knowing eiher what OP_k's group environment knew in his epoch, the "weight" of their affective processes upon the cognitive ones (what we may call his irrational beliefs, taking z_R as reference image) or the constraints to which he is being submitted] the relationships between this knowledge and OP_k's creativity may, in fact, be capable of formal and numerical treatment.

Two of these processes (involving either fuzzy approaches or the use of computers) are described, for example, in KAUFMANN's "Introduction to Fuzzy Subsets Theory", Vol IV (pag. 261 and followings); both are based upon F. ZWICKY's morphologic analyses of human creative procedures. For their importance in the further development of this essay their fundamental contents are given as follows:

A) suppose that some object of thinking Θ_j (for example a pen) is <u>describable</u> by means of an <u>assemblage</u> $p_j \in P$ constructed in a specific way from sets A, B , ...

$$A = \{ a_1, a_2, \ldots\ldots a_n \}$$
$$B = \{ b_1, b_2, \ldots\ldots b_m \} \qquad \text{(II/3.3)}$$
$$C = \{ c_1, c_2, \ldots\ldots c_p \}$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

named <u>forming sets</u>. Let

$$M = \{ A, B, C \ldots\ldots \} \qquad \text{(II/3.4)}$$

be called a <u>morphology</u> and let

$$P = A \times B \times C \times \ldots \qquad \text{(II/3.5)}$$

be the set containing all its possible combinations. One of this combinations containing for example r elements will, therefore, be named an <u>r-assemblage</u> and, in principle, it may describe some Θ_j. It is on the analysis of these possibilities that the first of the aforementioned processes is foccused. Suppose in this sense

- that the forming sets of a certin object of thinking are already completely specified

- that some human operator has knowledge of one of the r-assemblages previously referred to (obtained in a computer by some random procedure)

- that he is able to associate with all the couples of this assemblage an index I specifying the degree of coherence existing between the elements of the couple. This degree is fuzzy "weighted" according to the values of a scale in which, for example

1 corresponds to total coherence

.75 corresponds to great coherence

.50 corresponds to small coherence

.25 corresponds to great incoherence

0 corresponds to total incoherence

When these values are ascribed to all the elements of the r-assemblage they will define a (fuzzy) resemblance relationship R (since R is reflexive and symetric). If, for example, the forming sets are

$$
\begin{aligned}
A &= \{ a_1, a_2, a_3, a_4, a_5, a_6, a_7 \} \\
B &= \{ b_1, b_2, b_3, b_4 \} \\
C &= \{ c_1, c_2, c_3, c_4, c_5 \} \\
D &= \{ d_1, d_2, d_3, d_4 \} \\
E &= \{ e_1, e_2, e_3, e_4, e_5, e_6 \} \\
F &= \{ f_1, f_2, f_3 \}
\end{aligned}
\qquad \text{(II/3.6)}
$$

and the random 6-asemblage under examination is (a_2, b_4, c_1, d_3, e_6, f_1) then R may take the aspect

	a_2	b_4	c_1	d_3	e_6	f_1
a_2	1	1	0.75	0.25	0.75	0
b_4	1	1	0.75	0.75	0.50	0
c_1	0.75	0.75	1	0.25	0.75	0
d_3	0.25	0.75	0.25	1	0.50	1
e_6	0.75	0.50	0.75	0.50	1	0.50
f_1	0	0	0	1	0.50	1

(II/3.7)

This resemblance relation is next partitioned into the maximal similitude subrelations which it contains according to the values of I. For example, for I = 1 it will imply a decomposition like

	a_2	b_4	c_1	d_3	e_6	f_1
a_2	1	1	0	0	0	0
b_4	1	1	0	0	0	0
c_1	0	0	1	0	0	0
d_3	0	0	0	1	0	1
e_6	0	0	0	0	1	0
f_1	0	0	0	1	0	1

(II.3.8)

For I = .75

	a_2	b_4	c_1	d_3	e_6	f_1
a_2	1	1	1	0	1	0
b_4	1	1	1	1	0	0
c_1	1	1	1	0	1	0
d_3	0	1	0	1	0	1
e_6	1	0	1	0	1	0
f_1	0	0	0	1	0	1

(II/3.9)

etc.

In practice the human operator receives from the computer firstly, all the subrelationships obeying I = 1 being next asked to him what concepts he may associate with them. This being done the procedure is repeated for I =.75,.50, etc. Whatever may be the steps followed, the point which needs to be stressed is that when the machine is asking for a new procedure, it is also stimulating the operator's creativity. This can be clearly seen in the program STIM 5 [47] part of which is reproduced as follows

```
!RUN STIM 6
QUEL FICHIER MORFO UTILISEZ-VOUS ? - CINE
VOICI LE R-ASSEMBLAGE

1 MILIEU      : SOLIDE
2 RESISTANCE  : REACTION
3 ENERGIE     : POTENTIELLE
4 MOUVEMENT   : UNIF. ACCELERE
5 FORME       : PYRAMIDE
6 FORCE       : PRESSION
7 TRAJECTOIRE : RECTILIGNE

POUR CHAQUE PAIRE D'ELEMENTS DONNER LE DEGRE DE COHERENCE A
PARTIR DE L'ECHELLE SUIVANTE :

A PARFAITEMENT COHERENT
B ASSEZ COHERENT
C PEU COHERENT
D ASSEZ INCOHERENT
E ABSOLUMENT INCOHERENT

VOICI LA PRESENTATION DES PAIRES

1  2  SOLIDE          REACTION        !A
1  3  SOLIDE          POTENTIELLE     !A
1  4  SOLIDE          UNIF. ACCELERE  !A
1  5  SOLIDE          PYRAMIDE        !A
1  6  SOLIDE          PRESSION        !B
1  7  SOLIDE          RECTILIGNE      !A
2  3  REACTION        POTENTIELLE     !E
2  4  REACTION        UNIF. ACCELERE  !E
2  5  REACTION        PYRAMIDE        !D
2  6  REACTION        PRESSION        !E
2  7  REACTION        RECTILIGNE      !E
3  4  POTENTIELLE     UNIF. ACCELERE  !E
3  5  POTENTIELLE     PYRAMIDE        !A
3  6  POTENTIELLE     PRESSION        !E
3  7  POTENTIELLE     RECTILIGNE      !A
4  5  UNIF. ACCELERE  PYRAMIDE        !A
4  6  UNIF. ACCELERE  PRESSION        !E
4  7  UNIF. ACCELERE  RECTILIGNE      !A
5  6  PYRAMIDE        PRESSION        !A
5  7  PYRAMIDE        RECTILIGNE      !B
6  7  PRESSION        RECTILIGNE      !E

VOICI LES CLASSES  D'ELEMENTS AYANT UN DEGRE DE COHERENCE DE 1.00

1  2
1  3  7
1  4  7
1  3  5
1  4  5
5  6

VOICI LA CLASSE 1

1 MILIEU      : SOLIDE
2 RESISTANCE  : REACTION
POUVEZ-VOUS ASSOCIER UN CONCEPT A CETTE CLASSE ? ! OUI
DECRIVEZ-LE ... ! RESISTANCE DES MATERIAUX.

VOICI LA CLASSE 2

1 MILIEU      : SOLIDE
3 ENERGIE     : POTENTIELLE
7 TRAJECTOIRE : RECTILIGNE
POUVEZ-VOUS ASSOCIER UN CONCEPT A CETTE CLASSE ? ! OUI
DECRIVEZ-LE ... ! ENERGIE POTENTIELLE DE TOUT CE QUI +
! TOMBE SUIVANT UNE TRAJECTOIRE RECTILIGNE.

VOICI LA CLASSE 3

1 MILIEU      : SOLIDE
4 MOUVEMENT   : UNIF. ACCELERE
7 TRAJECTOIRE : RECTILIGNE
POUVEZ-VOUS ASSOCIER UN CONCEPT A CETTE CLASSE ? ! OUI
DECRIVEZ-LE ... ! MOUVEMENT D'UNE VOITURE.

VOICI LA CLASSE 4

1 MILIEU      : SOLIDE
3 ENERGIE     : POTENTIELLE
5 FORME       : PYRAMIDE
POUVEZ-VOUS ASSOCIER UN CONCEPT A CETTE CLASSE ? ! OUI
DECRIVEZ-LE ... ! CHUTE D'UN OBJET DE FORME PYRAMIDALE.

VOICI LA CLASSE 5

1 MILIEU      : SOLIDE
4 MOUVEMENT   : UNIF. ACCELERE
5 FORME       : PYRAMIDE
POUVEZ-VOUS ASSOCIER UN CONCEPT A CETTE CLASSE ? ! OUI
DECRIVEZ-LE ... ! CHUTE OBJET PYRAMIDAL

VOICI LA CLASSE 6

5 FORME       : PYRAMIDE
6 FORCE       : PRESSION
POUVEZ-VOUS ASSOCIER UN CONCEPT A CETTE CLASSE ? ! OUI
DECRIVEZ-LE ... ! PRESSION SUR SOL D'UNE PYRAMIDE.
VOULEZ VOUS ESSAYER UN DEGRE DE COHERENCE PLUS FAIBLE ? ! OUI
VOICI LES CLASSES D'ELEMENTS AYANT UN DEGRE DE COHERENCE DE 0.75

1  2
1  3  5  7
1  4  5  7
1  5  6
```

In spite of the (sketch of) dialogue which is established between the machine and its operator, the (eventual) application of this process to the reproduction of historical/scientific creation presents (among others) two obvious disadvantages

[47] KAUFMANN's ibid p. 265

- the time spent in the analysis of all the possible r- assemblages, particularly in the case of too great r.

- the statical character ascribed to the fuzzy "weighting" of I, time variable from epoch to epoch.

Both of them (especially the first one) are, in a certain way, overcome in the second procedure previously referred to .

B) The theoretical standpoints of this process are, in all of its aspects, similar to those emphasized beforehand. Once again a morphology, some forming sets, their elements etc must be taken into account. Two main differences exist, however, as regards the first procedure: there is a problem to be solved and the search for its solution implies the use of (fuzzy) dynamic programming methods; concretely, the selection of the (fuzzy) optimal path satisfying the proposed problem.

Suppose in this sense that the data which we have at our disposal must (in order to solve some problem) involve 5 forming sets

$$A = \{ x_1, x_2, x_3, x_4, x_5 \}$$

$$B = \{ y_1, y_2, y_3, y_4, y_5 \}$$

$$C = \{ z_1, z_2, z_3, z_4 \} \qquad \text{(II/3.10)}$$

$$D = \{ u_1, u_2, u_3 \}$$

$$E = \{ v_1, v_2, v_3, v_4 \}$$

This morphology comprises 5 x 4 x 4 x 3 x 4 = 960 5-assemblages their examination case by case being consequently excluded. In order to overcome this question the method [48] begins with an arbitrary selection of one of these forming sets (for example) A whose elements are next fuzzy "weighted" according to their better or worst adequacy to the proposed problem. The result of this operation is a fuzzy subset $\underset{\sim}{a} \subset A$ something as, for example

$$\underset{\sim}{a} = \begin{bmatrix} x_1 & x_2 & x_3 & x_4 & x_5 \\ 0.6 & 0.5 & 0.2 & 0.3 & 0.9 \end{bmatrix} \qquad \text{(II/3.11)}$$

This being done attention is next paid to all the couples obtained by means of the cartesian product of A with one of the remainder forming sets of the morphology, say B. These couples are once again fuzzy "weighted" (thus, defining a fuzzy relationship $\underset{\sim}{R}_1$ $A \times B$), this "weight" corresponding now to progressive increasing "distances" as regards the proposed problem. Suppose in this sense that R is given by

	y_1	y_2	y_3	y_4
x_1	0.4	0.2	0.4	0.2
x_2	0.7	0.4	0.6	0.8
x_3	0.1	0.5	0.2	0.9
x_4	0.9	0.1	1	0.9
x_5	0.7	0	0.6	0.1

(II/3.12)

[48] Its authors are HENRY-LABORDÈRE and DE BACKER

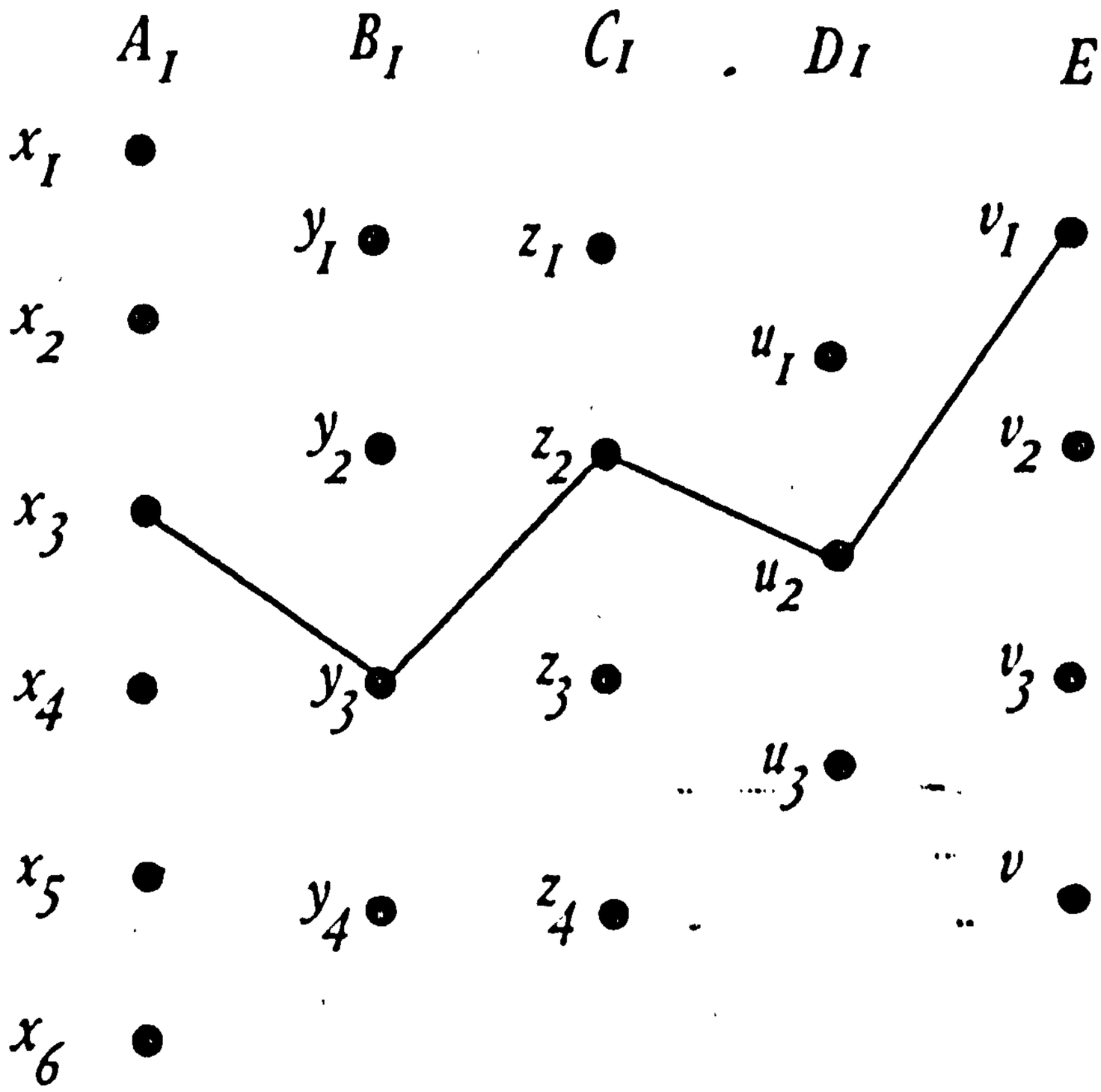
Through the MAX-MIN composition of $\underset{\sim}{a}$ and $\underset{\sim}{R}_1$ it is now possible to obtain a fuzzy subset $\underset{\sim}{b} \subset B$

$$\underset{\sim}{b} = \begin{bmatrix} y_I & y_2 & y_3 & y_4 \\ 0,7 & 0,4 & 0,6 & 0,5 \end{bmatrix} \qquad \text{(II/3.13)}$$

This fuzy subset is now composed with another of the remainder forming sets of M, say C. In other words, employing the same "distance" criterion as used beforehand, a new fuzzy relationship between B and C is now brought to light which, composed with $\underset{\sim}{b}$, produces a new $\underset{\sim}{c} \subset C$, etc. The process is repeated again and again till that all the forming sets are weighted and "swept". In formal terms this is equivalent to search for a fuzzy optimal path (for the MAX-MIN operation) in a sequential graph. Several algorithms exist which provide solutions for this question, being meaningless to reproduce them here. The result is of this concrete problem is shown in Fig. 43 corresponding to a solution (x_3, y_3, z_2, u_2, v_1)

C) compared with the first process this second one presents, therefore, several advantages; the most important of them deal, however, with the possibility of its conversion to the historical/scientific reconstitution problem:

- firstly because the solutions it provides can in fact be interpreted as expressing some new explanation (or new "association") which a certain OP_k constructs in order to solve some problem implicit in z_{k-1}. So exposed the process obys clearly WALSH's teleological or half-teleological reconstitution procedures



A (fuzzy) optimal path corresponding to the Prob. of pag 254

Fig. 43

- secondly because the (fuzzy) optimal path there brought to light is nothing but the translation of what we named an <u>individual transition</u> T_{ij} i.e. a <u>relation</u> (mapping or point-tranformation) which is regarded as satisfying some proposed problem. So understood the process also obeys what PASK, ELSHOUT and DEWEY assert about what a "problem" is.

- finally because, suitably modified, the process can take into account the relative weight either of OP_k's creativity, the internal and external paradigms to which he is being submitted or those (internal or external) constraints promoting (or preventing) the acceptance (or not) of some proposed solution (at this or that epoch of mankind's history). Briefly, it may provide a possible solution to the first question previously referred to.

In order to see how this can be concretely accomplished [49] let us begin with the translation of some o the aforementioned definitions into the language of this essay. Suppose in this sense

- that ZWICKY's "morphology" corresponds now to the vocabulary which a certain OP_k knows at some epoch of mankind's history; i.e. a particular set of attributes (words, terms, etc). This vocabulary comprises several forming sets A, B , C ... whose elements are nothing but particular attributes, somehow related to the labels "A" "B" etc. In other words A, B, C and etc. may be regarded as equivalence classes of the morphology (although one or several attributes may belong simultaneously to distinct classes)

- that the elements of this vocabulary can be mutually related. A particular combination of these elements (what was previously defined as a r-assemblage $p_j \in P = A \times B \times C \times \ldots$) corresponds now to the spatial description of the p-space H_T' ; i.e. to Q' of

[49]Insofar as we know the proces there implicit is original. It was not tested so far but its potentialities justify its inclusion in this ARGUMENT.

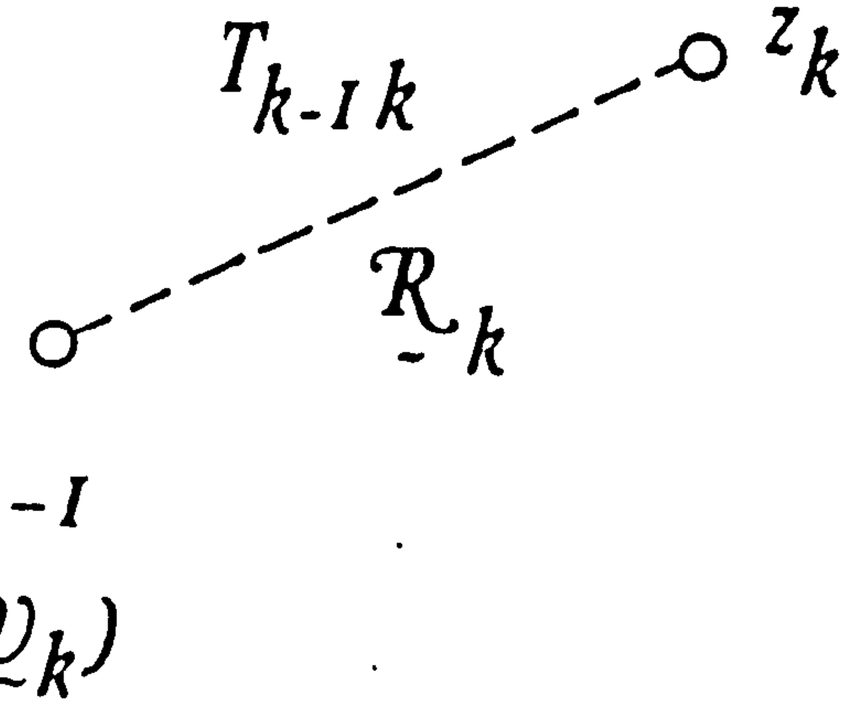
(B/2.5)

$$Q' = \sum_{i=1}^{s} A_i$$

in which the A_i obey (B/2.1). A particular (effectively occured) gnoseological state $q_k \in Q'$ of mankind's history will express therefore not only OP_k's possible knowledge at $t = t_k$ but also the total vocabulary (attributes and relationships) he may use to describe either the physical world, the elements and relationships of his group environment or his internal world. Let now V_k a line vector representing OP_k's vocabulary (attributes) at $t = t_k$ and let $\underset{\sim}{v}_k \subset V_k$ a boolean subset of V_k containing the elements he regards as necessary to solve some problem. In the terminology of PASK, ELSHOUT and DEWEY this solution is a relation which needs to be satisfied or brought about; let then $\underset{\sim}{R}_k$ be this relation. Under these conditions if $\underset{\sim}{v}_k \subset V_k$ is for example (1 x n) then $\underset{\sim}{R}_k$ will be a matrix (n x m) in which every column contains (in the maximum) one value 1. For a given $\underset{\sim}{v}_k$ and a certain $\underset{\sim}{R}_k$ the (matricial) composition $\underset{\sim}{v}_k \times \underset{\sim}{R}_k$ will therefore produce an output z_k which (if some solving conditions are verified) will be nothing but a historical messages z_k, i.e. a new description of PhW in which some problem implicit in z_{k-1} was (supposed to be) already solved (Fig. 44) [50]

According to the dynamic and interactive interpretation emphasized

[50] According to the terminology of b) above this relationships may be obtained by a (fuzzy) direct composition of P= A x B x C x D x E and $[x_3, y_3, z_2, u_2, v_1]$



Fuzzy transitions underlying creative processes

Fig. 44

in II/2.4 this global result is, however, the simple outermost externalized part of a hidden and sometimes rather complex process in which the set of possible solutions which OP_k proposes (consequence of his own criativity) is compared either with his own standards (internal or external paradigms) or with the social and internalized constraints ("censorships") to which he is consciously or unconsciously being submitted. Part of these "censorships" are obviously related to the logical rules of which he may be aware (particularly non-contradiction); which allows that self-contradictory "solutions" are clearly swept out. Let $\varphi_1, \varphi_2, \varphi_3$ be therefore boolean matrices [51] representing respectively OP_k's creativity, his internal and external censorships

[51] For the sake of simplicity internal and external standards and/or censorships are assumed to be confounded in the same matrix

and the (internal and external) paradigmatic standards which he (consciously or unconsciously) obeys.

As previously emphasized the product $\underset{\sim}{v}_k$ by φ_i (i=1,2,3) may be interpreted as providing a particular <u>association</u> (psychologically understood) among some of the terms of UP_k vocabulary. So regarded

$-\underset{\sim}{v}_k \cdot \varphi_3$ will mean that a particular set of relationships is <u>always prevailed</u> (as though the subject were always reacting in the same way)

$-\underset{\sim}{v}_k \cdot \varphi_2$ will mean that part of his associations are always anihilated (if compared with the set of associations he is <u>potentially</u> able to bring to light)

$-\underset{\sim}{v}_k \cdot \varphi_1$ lays emphasis upon OP_k's imagination, creativity or fantasy.

What this means in the present context is OP_ks capability of associating terms in a (shall we say) <u>random</u> way.

Suppose in this sense that part on the totality of the elements of φ_1 say c_{ij} are related to an index X

$$X = RDN \left[0,1\right] \qquad \text{(II/3.14)}$$

obeying the threshold condition

$$\begin{aligned} &\text{if} \quad X \geqslant 1-\beta \quad \text{then } C_{ij} = 1 \\ &\text{if} \quad X < 1-\beta \quad \text{then } C_{ij} = 0 \end{aligned} \qquad \text{(II/3.15)}$$

β being a number varying between 0 and 1. The consequence of this is that as greater β as greater the number of 1s appearing in φ_1 is thus, of terms associated in OP_k's "creative" outputs. In a certain sense $\bar{\beta}=(1-\beta)$ "measures" or "weigths" therefore OP_k's "imagination" degree: great values of β will correspond to small $\bar{\beta}$ and consequently to a great of 1s etc.[52]

Suppose next that each one of these φ_i is multiplied by a (fuzzy) coefficient $\alpha_i(t)$ representing respectively

$\alpha_1(t)$ the "weight" of OP_k creativity (as regards paradigms and constraints)

$\alpha_2(t)$ the "weight" of OP_k internal and external censorships (as regards fantasy and standards)

$\alpha_3(t)$ the "weight" of OP_k internal or external standards (as regards imagination and constraints)

Under these conditions (and assuming for the sake of simplicity that the $\alpha_i(t)$ are mutually independent) the total (fuzzy) relationship $\underset{\sim}{R}_k$ which once is applied to $\underset{\sim}{v}_k$ produces a particular output z_k can now take the more complex aspect

$$R_k = \alpha_1(t)\ \varphi_1 + \left[(1-\alpha_2)\ \varphi_2 \vdots \alpha_3(t)\ \varphi_3\right] \qquad \text{(II/3.16)}$$

[52] Since this process is capable of being translated into a computer program an additional condition concerning the number of 1s in every column of φ is also needed. However, for the sake of simplicity, this condition will not be presented in the present considerations.

in which "+" means fuzzy union and "$\dot{+}$" fuzzy intersection i.e.

$$R_k = \text{MAX}\left\{\alpha_1(t).\varphi_1,\ \text{MIN}\left[(1-\alpha_2).\varphi_2,\ \alpha_3.\varphi_3\right]\right\} \qquad \text{(II/3.17)}$$

Synchronously examined (II/3.17) is nothing but another way of expressing (C/3.8) taking now into account OP_k's inner dynamics. Thus, providing answer to the aforementioned question. It must be remarked in this sense that, if for example

$\alpha_2(t)=0$ (implying no censorships) and $\alpha_3 < \alpha_1$ then $\underset{\sim}{R}_k(t)$ will prevail OP_k fantasy

$\alpha_2(t)=0$ and $\alpha_3 > \alpha_1$ then, in spite of this fantasy, it is the internal or external paradigm which will prevail

$\alpha_2(t)\neq 0$ and to great, then it may happen that only part or even none of OP_k's proposed "solutions" is effectively externalized

etc.

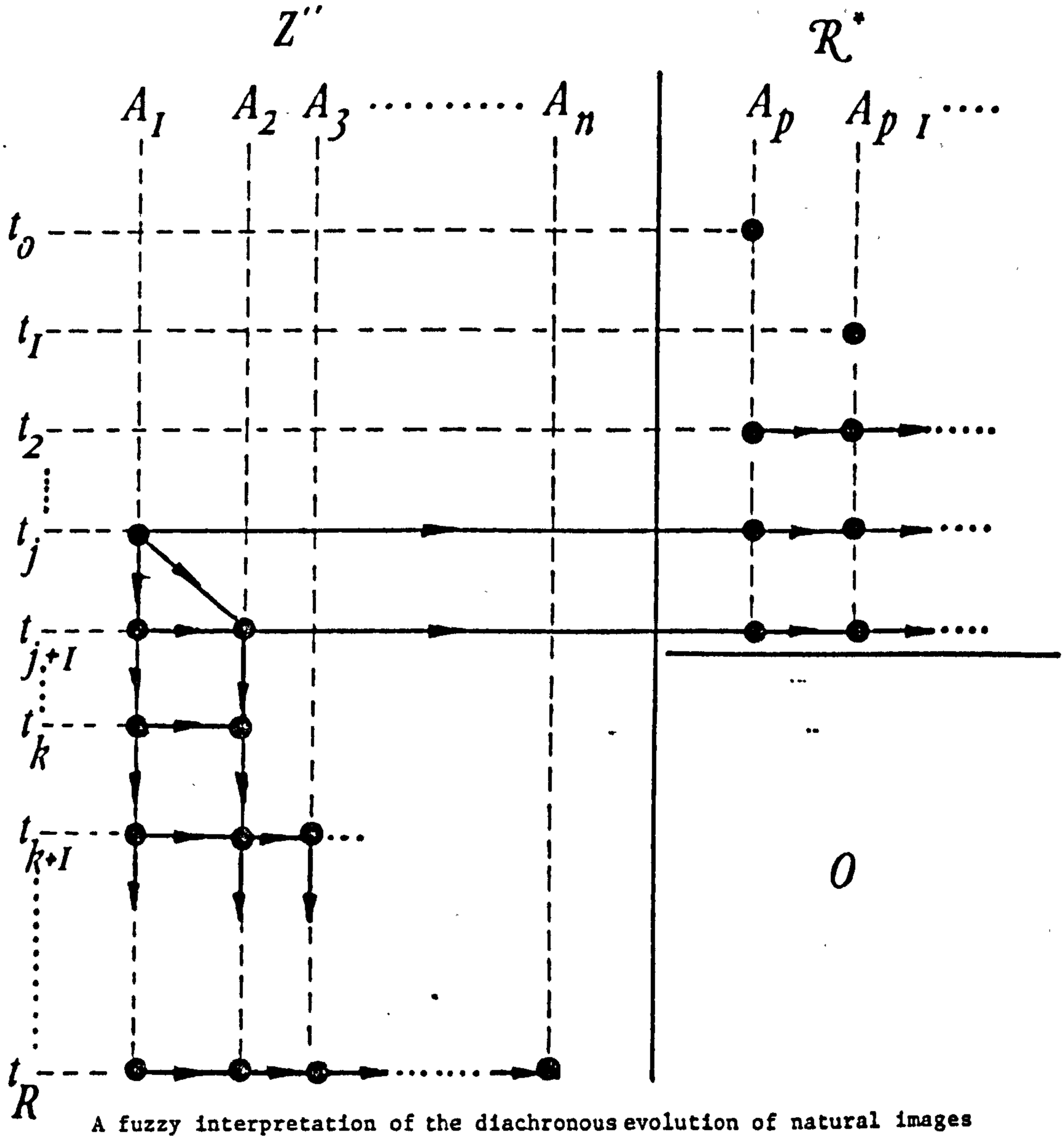
Furthermore: if at any time instant of mankind's history the "distance" between the socially (or internally) accepted standard and OP_k's (proposed) solution is assumed to exceed some previously defined value (an n-dimensional sphere surrounding a particular event point in the p- space H'_T) then it may also happen that OP_k's group environment (or his superego) reacts against the "solution" proposed either in terms of real actions (for example threating OP_k, preventing the publishing of his writings, etc) or according to tense feelings of inferiority and guilt. If such a

limit is not exceeded then, conversely, OP'_ks proposed solution may be internally and externally accepted; thus, leading (eventually) to a change of G'_ks standards and, through it, of the vision of future OPs. These examples suffice to show the potentialities and results which may be extracted from (II/3.16) not only in historical areas but also in many other domains (as psychiatry, psychoanalysis, classical psychology, etc) [53]

In the scope of this essay the most interesting of such results is precisely related to the <u>diachronous</u> interpretation globally ascribed to TSK as an evolutionary learning system. For if the present-day image of Nature z_R is regarded as a complex description involving a certain number of (experimentally confirmed) associations (relationships) then TSK in itself may also be looked as sequence of (fuzzy) optimal paths obtained from <u>growing scientific</u> "vocabularies" and whose "distances" as regards z_R are progressively decreasing as far as time went on (Fig. 45)

This is nothing but another way of interpreting the viewpoints previously outlined. Whatever may be the process solving the historical scientific reconstitution problem it is however clear that they all imply the use of computers; particularly those in which a <u>true</u> dialogue between them and their human operators can be effectively estalished. This will lead us to the second aspect

[53] The relationships between cognitive and affective systems may also be explicitly described by (II/3.16): some affects (cathexis) may prevent or promote this or that group of associations etc.



A fuzzy interpretation of the diachronous evolution of natural images

Fig. 45

previously stressed: the role played by PASK's THOUGHSTICKER.

ii) As we asserted in the beginnings of this ARGUMENT the use of PASK's system as a means to retell TSK requires the concrete knowledge of what effectively happened throughout mankind's evolution. In a more precise terminology this implies the knowledge either of the state variables and relationships specifying CP_k's descriptions of Nature (their messages z_k), their specific

contexts or the particular interactions $OP_k \leftrightarrow G_k$. From historians side (and insofar as we know) no such matters have however been interpreted according to the points of view previously proposed. Everything, or almost everything is therefore to be done in this area not in terms of theoretical background but rather (and essentially) in terms of the concrete application of the conjectural and formal models previously constructed to what is historically known. Not at once, of course (since the inclusion of all such state-variables, relationships, time-variable thought-processes, affective influences upon the cognitive ones, etc is a task almost inpraticable by one single researcher) but acording to a progressive strategy. A detailed presentation of this strategy (involving a true research project for the whole of a life) is obviously meaningless in this essay. We believe, however, that it must include four (at least) main steps.

a) dealing the first with a "simple" total or partial reconstitution of TSK only

b) next (and through the cooperation with experts in several historical areas) this reconstitution may be extended to OP_k's contexts

c) next the results already achieved may be numerically "weighted", this "weighting" being related not only to the state variables, relationships mental processes etc but also to the constraints to which every OP_k was really submitted (the curves $\alpha_i(t)$ previously stressed) - which now involves a cooperation between historians, mathematicians, cyberneticists, psychologists etc

d) finally the last step will be concerned not only with what really happened but also - and fundamentally - with what could have happened [or may futurely happen, since past present or future are pure relative concepts); this by means of a variation of the "values" which such constraints took (take or will possibly take)

All of this can in fact be actually accomplished. Not at once as we stressed but progressively. And in order to demonstrate the effectiveness of this project, in PART THREE of this essay the first period of the (scientific) history of the European thought during which a systematic and organized image of Nature was progressively constructed, is effectively converted to an immense entailment-mesh ready to be reproduced in PASK's THOUGHSTICKER (see a reproduction of this mesh in the ends of the essay).

Compared with everything that the project involves this reconstitution (containing, however, more than four hundred pages of historical, epistemological and psychological data) must, therefore be regarded as a first (and rather restrict) steps towards overcoming the gap between history and physical or quasi-physical sciences - the fundamental problem of this essay.

In spite of such a restrictive aspect we do believe that the solutions proposed as well as the potentialities they contain are already enough to provide solid foundations to the bridge through which those two areas of knowledge can, futurely, be linked.

III- THE FUTURE

The peculiar way of lccking upon human past achievements in the domain of Natural Science (in terms of a conversation between two symbolic participants OP_k and OP_R obeying PASK's relativistic paradigm) which we proposed, outlined and developed in the preceding considerations sought, fundamentally, to provide answers to five main types of questions which, briefly, are:

i) "What does OP_k know of PhW at some time-instant $t = t_k$ ($k = 0, 1, 2, \ldots R-1$)?"

ii) "What does he make with such a knowledge at that time?"

iii)"What could he have done (or made) with it in his epoch?" this implying "Why did not he actually achieve his goals or intentions?"

iv) "What particular problems (DEWEY, ELSHOUT, PASK) does he face at $t = t_k$?" and "How does he overcome (or not) them?"

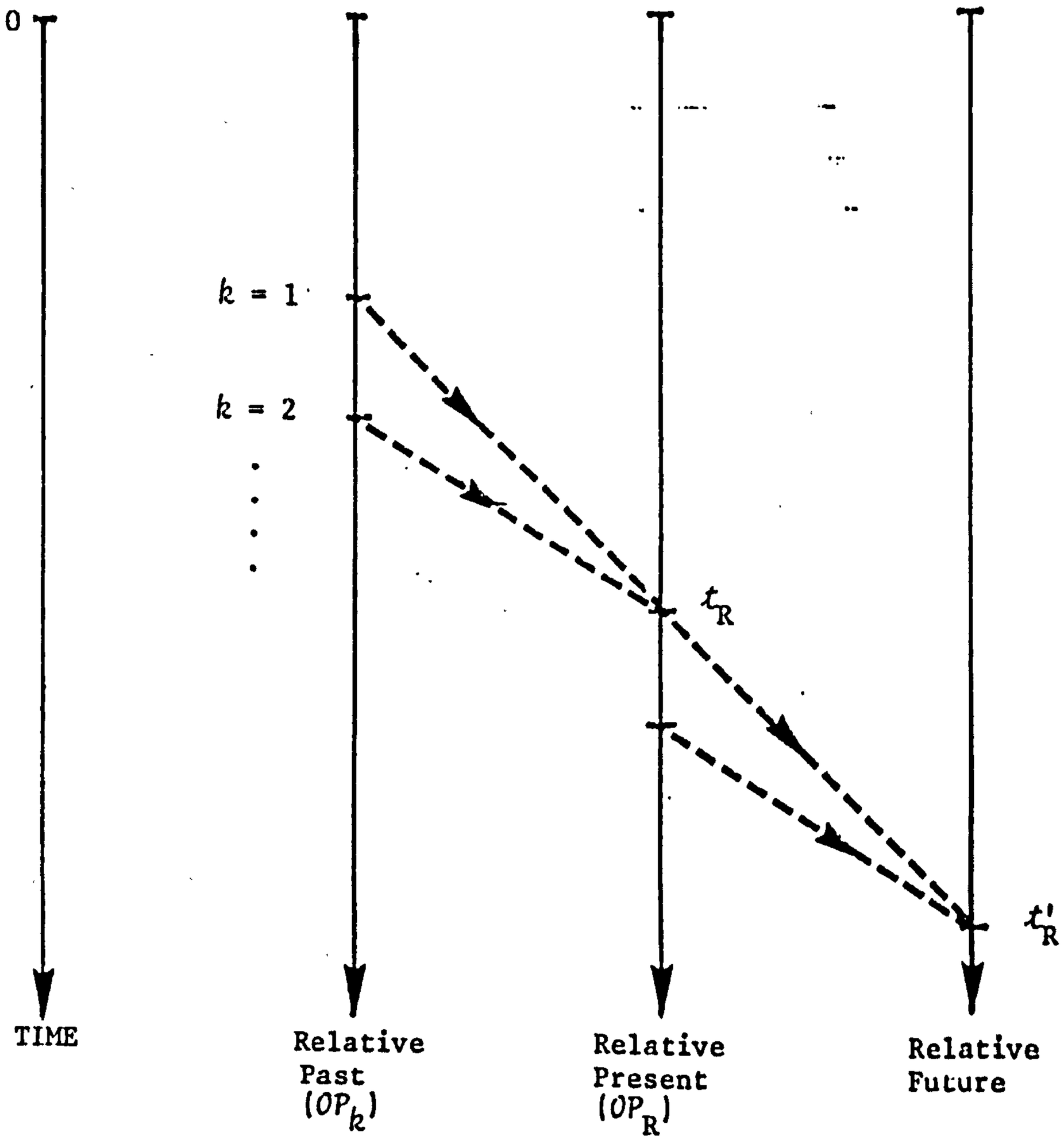
v) How can present-day scientific historians OP_R retell and implement (in some computorized cybernetic device) either OP_k's knowledges, their time-variation or the problems which gave rise to them?

If the time-instant t_R (corresponding to contemporary historians is taken as temporal basis and if all the t_k previously considered obey the condition

$$t_k < t_R$$

the answers to such questions fall clearly into the realm of the historical/scientific reconstitution problem to which our attention

was primarily directed in this essay. However - and this is the crucial aspect which that relativistic paradigm underlies - if t_R is now supposed to be some future reference ($t_R = t'_R$, Fig.46) then the scope of this essay will no longer be exclusively dealt with the reconstitution of mankind's past but, rather, with the relationships between our present and some possible future.



The relativistic approach

Fig. 46

In other words these questions will work henceforth as though they were <u>intemporal</u>; their answers will reflect, therefore, not only the particular concernings, interrogations, doubts, beliefs, certainties or insecurities which our ancestors had about *PhW*, about the social contexts G_k into which they were inserted or about their internal worlds IE_k but also mankind's <u>present</u> preocupations and problems as regards its <u>future</u> evolution.

It is precisely in the analysis of this future - say, more correctly, set of <u>potentially</u> <u>possible</u> futures (not hegelian as PIAGET defends but, rather, wallonian) - that the inter-relational and unifying viewpoint which this essay has outlined may be more interesting. For - in spite of everything which (part of) mankind has already acquired in terms of *PhW* 's knowledge, in the control of natural forces to its own benefit, in the substitution of leaderships based upon the "brute forces" of some individual by the collective power of communities founded on "right" freely accepted, in the increasing knowledge of Man's internal world (cognitive and affective) etc. - the same irrational forces which, since our most remote beginnings, have led men not only to construct a civilization but also to destroy civilizations and cultures, are still active today; and this from the most elementar levels (those dealing with the interindividual relationships) to the most complex ones (opposite intercontinental ideologies) passing by the relationships between groups, communities and countries.

To know in advance which one of these major tendencies will prevail (whether the organizing one proceeding from Eros and Ananke or that one leading to an increase of disorder and chaos) and control the destructive trend would be, therefore, the main objective of some global theory of short and long-time historical prediction (in the sense of physical or quasi-physical sciences). However, insofar as we know, such a theory was not yet coherently erected. As we emphasized in §I/1 part of the reasons justifying this proceeded from the point of view according to which traditional historians had looked (till quite recently) to the matter of their studies; essentially, in terms of more and more specialized (logistic) reconstitutions of the individual, temporally localized, event. Another part had its source in the tacit, paradigmatic and, shall we say, uncriticizable dogma that historical and physical or quasi-physical disciplines belong to separated, non-overlapping, bodies of knowledge.

The first great alteration to this closed panorama arose when the conjunctural and secular movements pointed out in item I were, by the first time, brought to light in the contemporary history. With them, extrapolations from present to some immediate or mediate future become no longer a matter of (more or less) equiprobable combinations of present-day data (which is no prediction at all) but something which we may regard in terms of a set of possible plays (belonging to some complex world-game) part of which, due to such hidden, long-time, trends is "falsified". [54] Hence the importance which this essay has

[54] As though the players of such a game were using preferential strategies of which they are unware.

conceaded to them. The second possible group of alterations may arise from the several research lines which this essay involves. Particularly important are, in this sense

i) the conversion of the historical/scientific problem to a cybernetic question; say, in other words, the substitution of the traditional and unilateral way of looking upon the relationships between past and present in terms of PASK's conversation theory - with everything which this vision can from now on [55] imply either through the systematic use of cybernetic and computerized machines capable to store and treat large amounts of numerical and non-numerical information or through the historical experimentation previously referred to;

ii) the application of ASHBY's concept of change to the description (direct narrations) of historical processes - allowing the translation of these processes into the language of the ST approach "states" and "transitions"), later subjected to the Fuzzy Semantic interpretation previously stressed;

iii) the substitution of the usual and statical vision of the past by a dynamical one - in which "what happened" is no longer regarded in

[55] Recall that the first and most primordial condition for the using of such machines, for example PASK's THOUGHTSTICKER, required the previous construction of some model of TSK in which its "growing" were somehow explicate. This was precisely the main goal of this work.

absolute terms (what happened, happened) but simply as the final or, shall we say, outermost superficial part of hidden, complex, processes [underlying comparisons between a set of potentially possible proposed actions and the set of particular (internal and external) constraints to which the authors of such (proposed) actions were being submitted in some epoch];

iv) the (possible) numerical specification either of such constraints or of OP_k s' (multidimensional) satisfaction domains - in which the interactions previously referred to between some and his group or internal environments are reducible to a question of Fuzzy Conditioned Automata obeying ZADEH's equations and our own threshold condition.

The discussion of these (potential) research lines is obviously meaningless in this essay, a simple first step towards overcoming the aforementioned gap between historical and physical or quasi-physical disciplines. We simply remark, however, that if these items are effectively implemented then many historical reconstitutions problems may be converted to engineering problems - which would be nothing but the desired (and insofar as we know not yet reached) goal which the neo-positivist historical school has always aimed for [56].

The emphasis laid on the "if" above becomes now clearly understandable. From now on everything which can be related to the future development of the essay is no longer matter of its author but rather of a group of cooperating experts;experts in

[56] See S/6 for more details.

- Computation,History and History of Science (particularly in the construction of systematized data-bases) so that "messages", their transitions, the relationships between the topographical elements of G_k and their conditioning influence upon the OP_k s can not only be automatically be brought to light but also numerically weighted

- Psychoanalysis and Genetic Psychology [(specially Child's Psychology) in the analysis either of the unconscious mechanisms previously referred to or, due to the similarity existing between some of mankind's past problems and those which children face and solve) of their overall psychological evolution (not simply cognitive)]

-Fuzzy Subsets, Fuzzy Topology, Fuzzy Control and Fuzzy Automata Theories and their application to the description of human behaviours.

Finally, experts in cybernetics - either in the (eventual) construction of new cybernetic machines possessing not only "cognitive" structures but also internal environments capable of reproducing the "as though" operators so often emphasized in the preceding considerations or in the interdisciplinary coordination between the several elements of this group.

It is the need for such a cooperation which I precisely hope to have brought to light with the essay. And nothing is better to accomplish it then the cybernetic perspective introduced to present day scientific panorama.

GLOSSARY

List of fundamental symbols

A_i - Conceptual categories into which the present-day image of Nature may be partitioned

a_{ij} - Semantic significances (attributes) of some (at a certain historical time instant $t=t_k$))

$C\frac{1}{k}$ - Combinator (part of MOORE's model of automata representation)

$C\frac{1}{TC}$ - Set of total constraints.

$C\frac{1}{IC}$ - Set of internal constraints.

$C\frac{1}{EC}$ - Set of external constraints.

Eg - Ego

E - Total environment of some observer/participant

E^*_C - Economic status of some group environment

EE - External environment of some observer/participant

EE_k - External environment (at $t=t_k$))

G - Group environment

G_k - Group environment (at $t=t_k$))

G_k^N - Neighbouring group environment

G_k^D - Distant group environment

H''_Z - Scientific event-set

H'_Z - A subset of H''_Z dealing with real or historically meaningful scientific events

h_k - A historical event (at $t=t_k$))

H'_T - The pseudo-space of total historical events in some group environment

H''_Z - The pseudo-space of scientific events

H''_{R^*} - The pseudo-space of religious events

H''_{P^*} - The pseudo-space of political events

IE - Internal environment

IE_k - Internal environment of some observer/participant (at $t=t_k$))

Id - "Id" (a partition of FREUD's model of the psychical apparatus)

M - Storage (memory, reproductible) network

M_k - State of M (at $t=t_k$))

OP - Observer/participant

OP_R - Present-day historians

OP_k - Past observer/participant

PhW - Physical world

PhW^N - Neighbouring physical world

PhW^D - Distant physical world

P^* - Political status (of some G))

Q - The set of states of an automaton

q - A particular state of Q

R^* - Religious status (of some G))

Sg - Superego

T_{ij} - Transition, transformation

T_h - Hypothetical Time Scale

T_R - Real Time Scale

TSK - Transformation of scientific knowledge

Z_i - Equivalence classes of mutually related attributes

Z'' - Scientific (output) set

Z^* - Scientific status of some group environment

z_k - Past images of Nature

z_R - Present day image of Nature

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