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"AN ESSAY ON THE KINETICS OF LANGUAGE, BEHAVIOUR AND THOUGHT"

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Abstract

Recent developments in conversation theory lead to an inelegant but, nevertheless, powerful protologic, Lp, at the root of any conversational language able to accommodate contemplated action and a reasonably general type of thought. This paper provides a description of one minimal implementation of Lp and a general discussion.

1. Introduction

One physical basis for the Protologic Lp, is an epistemological laboratory, called the THOUGHTSTICKER system, (Fig. 1). It is a sizeable, richly interfaced, computer regulated system for use by individuals and teams of theorists, authors, planners, in order to spell out theories, hypotheses, tutorial material, plans for action, design, or organisation. CASTE (54, 65) the acronym for "Course Assembly System and Tutorial Environment" is a subsystem of THOUGHTSTICKER, that regulates a symbolic but non verbal conversation between participants, who are learning from an already delineated representation of an exposition, or plan. Historically, CASTE was developed first, and THOUGHTSTICKER is a significant generalisation of it. The criteria of Conversation Theory (53-58, 60) as modelled in CASTE, determine what may and may not be laid out as a component, or "topic" and how topics may be related together.

Fig 1

These systems provoke, as well as receive, statements from theorists, authors, or planners. In these roles, the systems are one implementation of a coarse grained, primitive, logic (or, depending upon the exact usage, language) Lp. The crucial point is that Lp is an active entity, modulated by users, not simply a tool at the disposal of users.

2. Preliminaries

This paper places Lp in context, as a vehicle for embodying conversation theory (henceforward, CT) and, it is anticipated, for general interpretation. For expository convenience, the main focus is THOUGHT-STICKER as an epistemological laboratory (EL) in which plans, expositions, etc., are spelled out as Lp expressions which are checked for legality and represented in a canonical graphic form, the entailment mesh (EM). The EM is an interface between participants (authors, planners, curriculum designers or learners). Emphasis on computers is only a convenience, and may be misleading, (a) because Lp and CT are machine independent (epistemological, social, psychological) constructions of considerable generality; (b) because, insofar as generality is achieved, Lp and CT provide a theory of general intellectual operations, whether carried out by human beings or not, which surely includes intelligent other-than-human, or other-than biological systems. However, the computing machines able to embody such operations are concurrent with many independent loci of control (their implementations resemble a group, or population, of devices), and have little in common with serial processors, or the operations usually associated with "artificial intelligence".

An interpretation (semantic) of Lp expressions consists, invariably, of many "universes", a priori independent, but rendered locally dependent by analogy; each "universe" consisting in a process (not, for example, a set). Refer to this collection of universes, non-commitally, as the "computing-medium", whether they are brains, or machines, or organisations in society (urban structure, information search, communication, transportation). The command and question component of Lp (in one sense, its pragmatics) may be regarded as a CT dialogue between loci of control, each involving one or several kinetic universes; stable processes, called participants.

It is expedient to think of participants as people. People are participants but so, also, are many other coherent entities. For example, one person will often adopt a perspective or point of view; and perspectives count as participants, as do schools of thought, systems of belief to which people subscribe from time to time (for instance, a scientific theory in Lakatos' sense, a "Programme of Scientific Research, 36). Clearly, however, there is no one to one mapping, one person may subscribe to many schools of thought, simultaneously or not; conversely nearly all schools of thought grow amongst large numbers of people.

A graphic notation is employed to outline some essentials of the Lp "syntax" (continually checked by the EL) but Lp is itself, a kinetic semiotic system, however primitive.

A conversational language will be designated "L", throughout. L is either natural language or a system of symbolic behaviours rich enough to have many properties of a natural language. In contrast Lp is a "protologic" (or "protolanguage"). Recently it has been argued that the entailment structures (EM) which stand for L agreements, are legitimately regarded as Lp expressions; and still more recently, that Lp is a system able to generate a significant part of any chosen L.

3. Conversation Theory

The EL is an embodiment of conversation theory.

In its first published version (51, 52,53,63,66),Conversation Theory (CT) is an attempt to identify sharp valued conceptual events, in contrast, for example, to sharp valued behaviours which may or may not have cognitive specificity. Excellent independent accounts are provided by Daniel (12), Entwistle (16,17) and others. Sharp valued events are identified with certain agreements between participants, A and B, in a conversation, using a language, L (for example, a Piagetian interview, or the type of investigation currently carried out by Gilbert (26), Hounsell (18), or Laurillard (37)).

Some A,B agreements signify the sharing of a common concept which is retained as stable or memorable, and these agreements are known as understandings. If L is natural language, there is a valuable evidence of understanding; if A and B can explain something, T, and can also justify their explanations of T (explain why they presented the particular explanations they did). When L is a symbolic, but non verbal, language, as it is if the EL is used as an interface between A and B, then understandings can be, and are, mechanically interpretable and agreement has a coherence truth value (Rescher, 77, comparable also with Gaines'(22) and Zadeh's (90, 91) meaning of possibilistic fuzzy truth).

Serious criteria for agreement and understanding are provided by refining and reviving notions enunciated by Bartlett (5). Wertheimer (88), Duncker (13), amongst others. Concepts (alias, skills, usually intellectual skills),are processes, resulting from the execution of a cluster of procedures where, in turn, a procedure is defined as the compilation of a program in a computing medium; either a human brain, or an artifact (Appendix 1).

In line with the older ideas, stable (alias, memorised) concepts are "productive and reproduced". Participants, A,B.. knowing stable concepts $Con_A(T)$, $Con_B(T)$, ... are credited with a repertoire of operations; concepts that act upon concepts to produce, and reproduce , them. A's repertoire and B's repertoire are not identical; but they both contain operations that are generative, and that also preserve specificity.

Given these definitions,it was possible to make various inferences, most of which have been tested and found to hold; for example, fixity effects, the stability of understood concepts, the existence of conceptual style, as manifest in the preponderence of different types of cognitive operation (notably, description building, procedure building, extrapolation),and their entrenchment, under certain circumstances, as learning strategies, due to a mechanism comparable with Festinger's (19) "Dissonance". Much of the experimental work is described in Pask (53,56) and Entwistle (16,17).

The definitions are recursive and permit an independent characterisation of participants A,B,... and the perspectives they adopt which can be specified in the same way as stable concepts. Hence, A and B need not (though they may) represent different people. A and B may also stand for perspectives (points of view), entertained by one person (the proposer/critic in Minsky's (A.I.) paradigm, teacher/recipient, for someone learning alone).

Sharp valued understandings are observable if the A,B, dialogue, whether "internal" or "external" to a brain, is exteriorised through an interface such as the EL. Since computer regulated interfaces are used extensively, conversation theory is quite largely concerned with the interaction between participants (people or perspectives) through machines but not, as it stands, with machines.

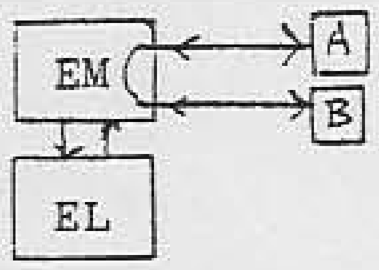


Fig 2 Interface Layout

The coherent, or agreed, part of concepts shared by participants A,B,... appear as L understandings and, for each one, it is legitimate to inscribe a topic that represents whatever is understood by A,B,... . Topics are denoted by nodes in the entailment mesh, EM, shown at the interface in Fig 2. The entailment mesh is a growing structure which depicts relations (appropriate to planning, learning, exposition, etc) between topics, represented as nodes. The construction rules of EMs are set out in Fig 3, onwards.

4. Developments of CT Information and Closure

Developments of CT, anticipated in Pask, Kallikourdis and Scott (66), and in Pask (53), emphasise the critical role of analogy construction and its relation to abductive modes of cognition. (These notions are, in turn, anticipated by McCulloch (42) in stressing abduction, Pierce's specialisation of induction, as a component in "Redundancy of Potential Command").

(a) The conceptual stability of Section 3 may be replaced by the autonomy (and, as a special case, stability) criterion of organisational closure (20,21,30,81, 82,83,89). Explicit free production schemes are shown, and minimally annotated, in Appendix 1; detailed in (58,59). The system of Appendix 1 is, in a narrow sense, "informationally open" as well as "organisationally closed"; the productions give rise to various combinations that are not reproduced in the original system but may be in any system coupled to it. Also, provided a distinction has been established between A and B, it is possible to represent the appearance of coherent A,B, interaction, or agreement.

The EM shorthand for a stable concept, T, is a working model Mod T of Fig 3; the EM shorthand for organisational closure (alias agreement, alias coherence) is the local cyclicity condition of Fig 3, and it is required of all other-than-analogical constructions.

(b) Let several, initially independent, Mod T interact. The potential conflict between Models may be resolved by constructing an analogy (an abduction), which is also representable in EM, (the constructions of Fig 4).

Here, and throughout, "analogy" has a specific meaning. It is a relation, (if unqualified, an isomorphism) between part or all of one universe (X), and another universe (Y), that are distinghished. Unless qualified, the distinction is complete, a-priori-independence.

Both the distinction and the similarity exist in a further, analogical, universe ZG. Some examples are shown in Fig 5.

This usage of analogy tallies with Hesse (34), Klein (35) and Melitis (43). Analogy construction is clearly a different matter from analogy recognition, which need not involve abduction and may, in most "analogy tests", for example, be reduced to pattern matching.

As a special case, the basic event in CT, "agreement over an understanding", constructs an analogy between participants A and B. To the participants, an agreement has a coherence, or even consensual, truth. To an outside observer the statement "A and B agree" is factually true or false, but is an analogy in which the observer distinguishes A,B, as perspectives or people, and sees the content of their agreement as a similarity.

(c) It has been shown, for example, by Nicolis (48,49) that even if a production system is simulated (which is quite distinct from realising it), then bifurcations (essential singularities, "catastrophes", in the sense of Thom or Zeeman), occur; as a result of which systems are distinguished. A comparable result emerges from Aleksander's (1) work with array processors.

The same comment applies to organisationally closed production schemes (as in the Appendices) which are thus rendered informationally open. As such a production system becomes increasingly stable, due to the construction of fresh reproduction paths (in EM, fresh derivation paths), so it necessarily splits into autonomous stable units which can enter into "conversation" and reach "agreement". The overall system is self organising (with the meaning of Von Foerster's, Nicolis', or myself) and it is rescued from rigidity by creating distinctions across which agreements can take place. These are seen by an external observer as analogies (abductions, innovations).

5. Construction rules and operations upon entailment meshes.

With this background the construction rules of entailment meshes EM (set out in Fig 3, Fig 4, Fig 5, Fig 6) can be given life and meaning. For example, Fig 3 shows the structure of a formal (ie. an other-than-analogical) topic which could be instated in an EM (and checked for rule obedience by the EL) by an author expounding an hypothesis, or by a planner contemplating certain actions. In each construction there is a prescriptive (plan, command, imperative) interpretation, and a descriptive interpretation (which would probably be emphasised by the author, in describing his hypothesis).

Apart from the fact that all nodes in an EM, denote a working model, (like Mods T in Fig 3), there is a collective and a distributive form of connection. Essentially, for formal topics, the EL checks that any structure is locally cyclic, thus satisfying the closure criterion noted in Section 3. Next, the author or planner can adopt a point of view or perspective. If so, the EL provides a pruning or a selective pruning (the first operations shown in Fig 4). It is worth noting that this can be quite

Formal Topics (Collective and Distributive Derivations)

Nodes standing for topics (any node is uniquely named, P, Q, ... T ....)

A node in a marked directed graph, the EM, represents a topic, T. The topic named T is a class of coherent working models, Mods T which, on execution (or indefinite iteration) in a computing medium, produce a description of the topic, T. Candidate "media" are human brains and artifacts such as the Appendices). (Throughout, Mods (T), suppressed in the notation, is assumed to exist)

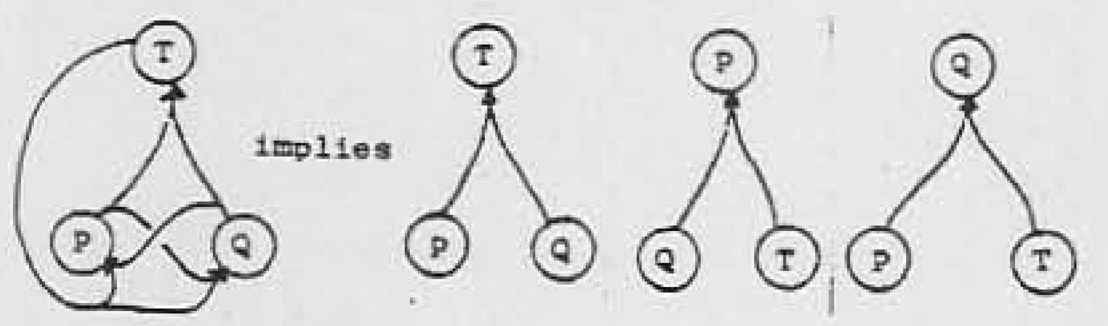
Node "T"

Ex (Mods (T)) $\Longrightarrow$ T

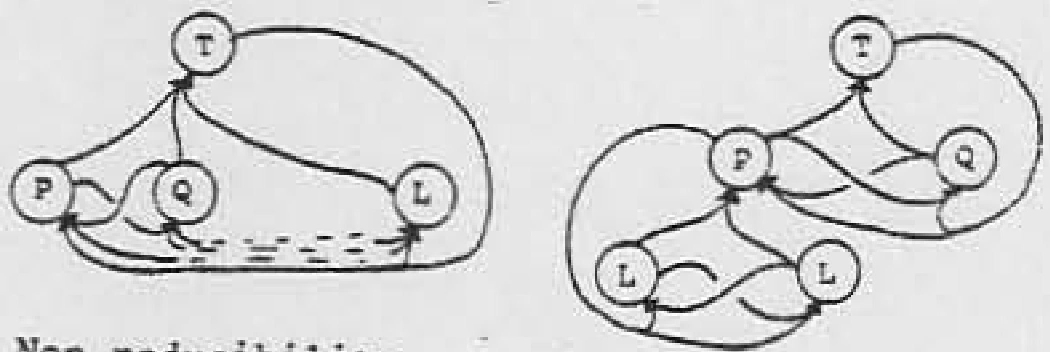
Entailment Derivations (for any other-than analogical topic, any derivation is at-least-locally cyclic). If T(P,Q), then P(Q,T) and Q(T,P).

Collective Derivation
(a) Knowing P and also Q you may learn T, in which case, P is derivable from Q,T; and Q from P,T (Descriptive). For example, T = circle, P = compass of arbitrary diameter and origin, Q = Plane surface.

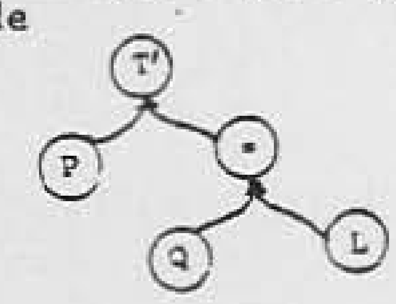
(b) To do T, call collectively for the execution of P and also of Q (Prescriptive).



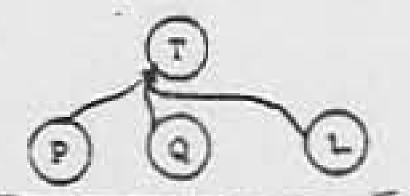
Its prunings for which the list notation is T(P,Q) P(T,Q) Q(T,P). General collective forms are



Non reducibility
The binary coding, $T^{\prime}$, of T(P,Q,L) with * a dummy node

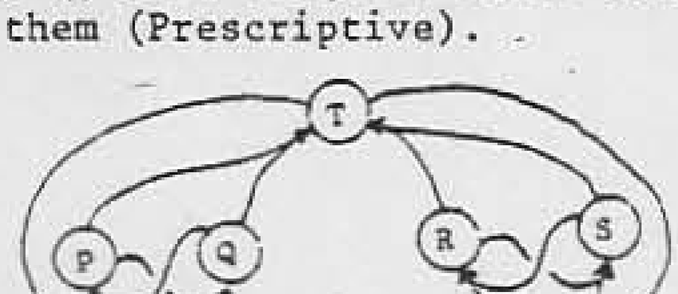


is not equivalent to



Distributive Derivations
(a) Knowing P and also Q, or knowing R and also S, you may know, T, in which case, either P is derivable given Q, and Q given P, or R is derivable given S, and S given R, or both (Descriptive). For example, T,P,Q as before, R = cylinder of arbitrary diameter S = slice at right angles to axis.

(b) To do T, call distributively upon P and also Q, or R and also S, or call upon all of them (Prescriptive).



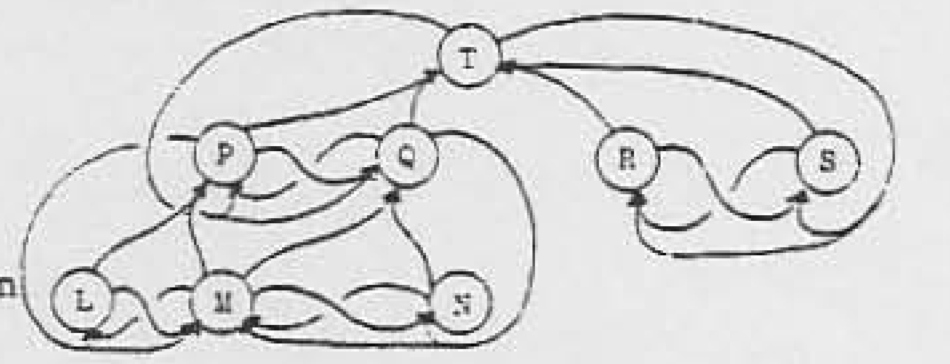
In list notation T((P,Q)(R,S)) implies P(Q,T);Q(P,T);R(S,T);S(R,T).

Fig 3

Pruning. The unfoldment of EM an entailment mesh Ω under a node T (equivalently, in common terms, the activation under T of process attached to other nodes).

If

then



$\underline{\text{Prune}}(T(\Omega)) = T((P,(L,M)\ Q(M,N)),(R,S))$

Selective Pruning: z is an index, 1, 2, ...

$\underline{\text{Selprune}}$, 1, $T(\Omega) = T(P,(L,M)\ Q(M,N))$

$\underline{\text{Selprune}}$, 2, $T(\Omega) = T\ (R,S)$

Superimposition. Call T(P,Q) a kernel of T. Consider meshes Ω_α, Ω_β, then SP $(\Omega_\alpha . \Omega_\beta)$= overlay, kernel by kernel, of all nodes in and in $\Omega_\alpha . \Omega_\beta$ (if these meshes are disjoint the SP$(\Omega_\alpha . \Omega_\beta)$ is void)

Condensation of a mesh Ω^o of order 0 with topics P^o, Q^o ... T^o

$$\underline{\text{Cond}}\ T^o(\Omega^o) \triangleq \underline{\text{Prune}}\ T^o(\Omega^o) \equiv T^1 \text{ in } \Omega^1 \text{ a mesh } \underline{\text{at order}}\ 1$$

$$\underline{\text{Cond}}\ (T^o \ldots P^o) \triangleq (\underline{\text{Prune}}\ T^o(\Omega^o) \ldots \underline{\text{Prune}}\ P^o(\Omega^o);\ SP(\underline{\text{Prune}}\ T^o(\Omega^o) \ldots \underline{\text{Prune}}\ P^o(\Omega^o)) \equiv \langle T^1 \ldots P^1 \rangle \sim \Omega$$

Expansion of a mesh Ω^1 is one or more meshes Ω^o.

The expansion to some finite limit, of Ω^o, is the class of models (such as Mods (T)) of nodes in Ω^o; usually belonging to distinct universes.

Condensation Ordinance. (Tentative). If any topic T^o in Ω^o has an other than locally cyclic derivation, then its condensation exists as a copy; that is :

$$T^o(\Omega^o) \Rightarrow T^o(\Omega^o),\ T^1(\Omega^1)$$

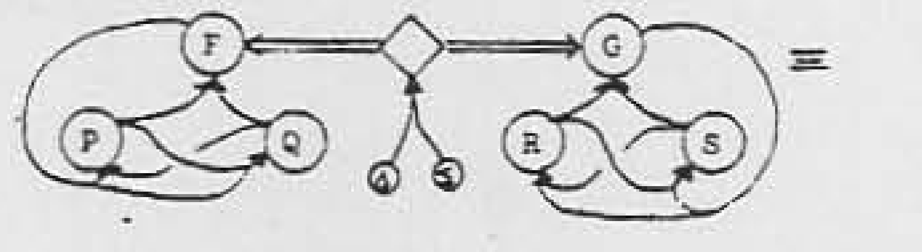
Expansion Ordinance. (Tentative). If pruning takes place, then the mesh is expanded until such moment as a process which can be executed is picked up, (some Mod) or, failing that, information input is required from the user (further kernels must be added to one or more of the nodes).

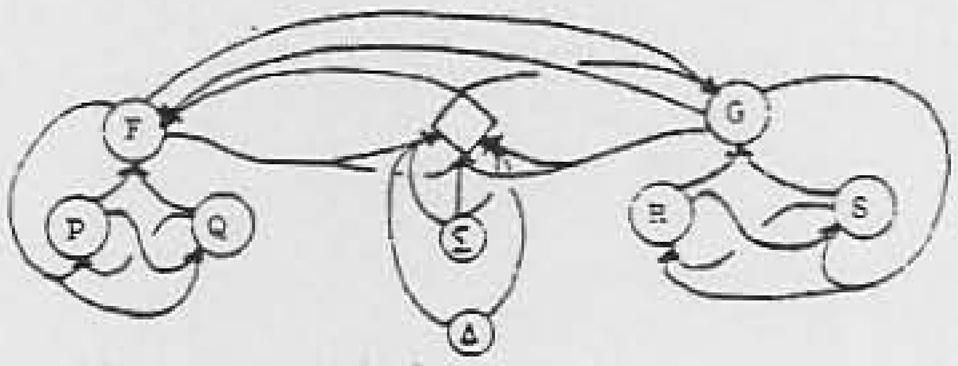
Saturation given a connected, but assymetric structure and derivations to yield a symetric structure provided the exclusion rule (Fig 6) is not contravened. For example, given A is connected to form B, then saturation yields C.

Analogical Derivations in EM

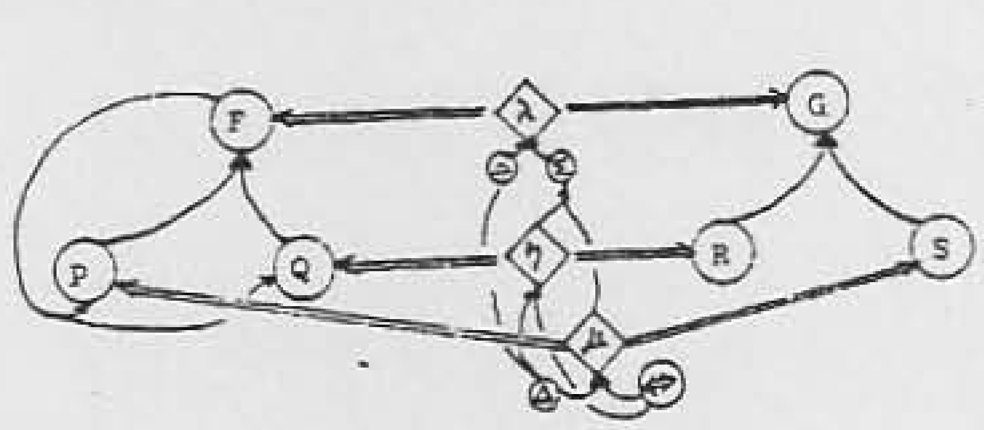
An analogy is represented as a "Psuedo node". If the universe(s) of an EM are X,Y,... then the analogy exists in an analogical universe $\mathcal{U}$. A "psuedo node" is supported by a distinction Δ, and a similarity, Σ. Unless qualified, Δ is independence and Σ is isomorphism, $\Leftrightarrow$. Both Σ and Δ belong to $\mathcal{U}$.

Simplest form





Complex Form



For example, F = Heat Engine
G = Refrigerator

or F = Linear Electrical Oscillator
G = Linear Mechanical Oscillator
Σ = Linear Oscillation

Isomorphic Inference. Given simple form infer one of several complex forms.

Fig 5

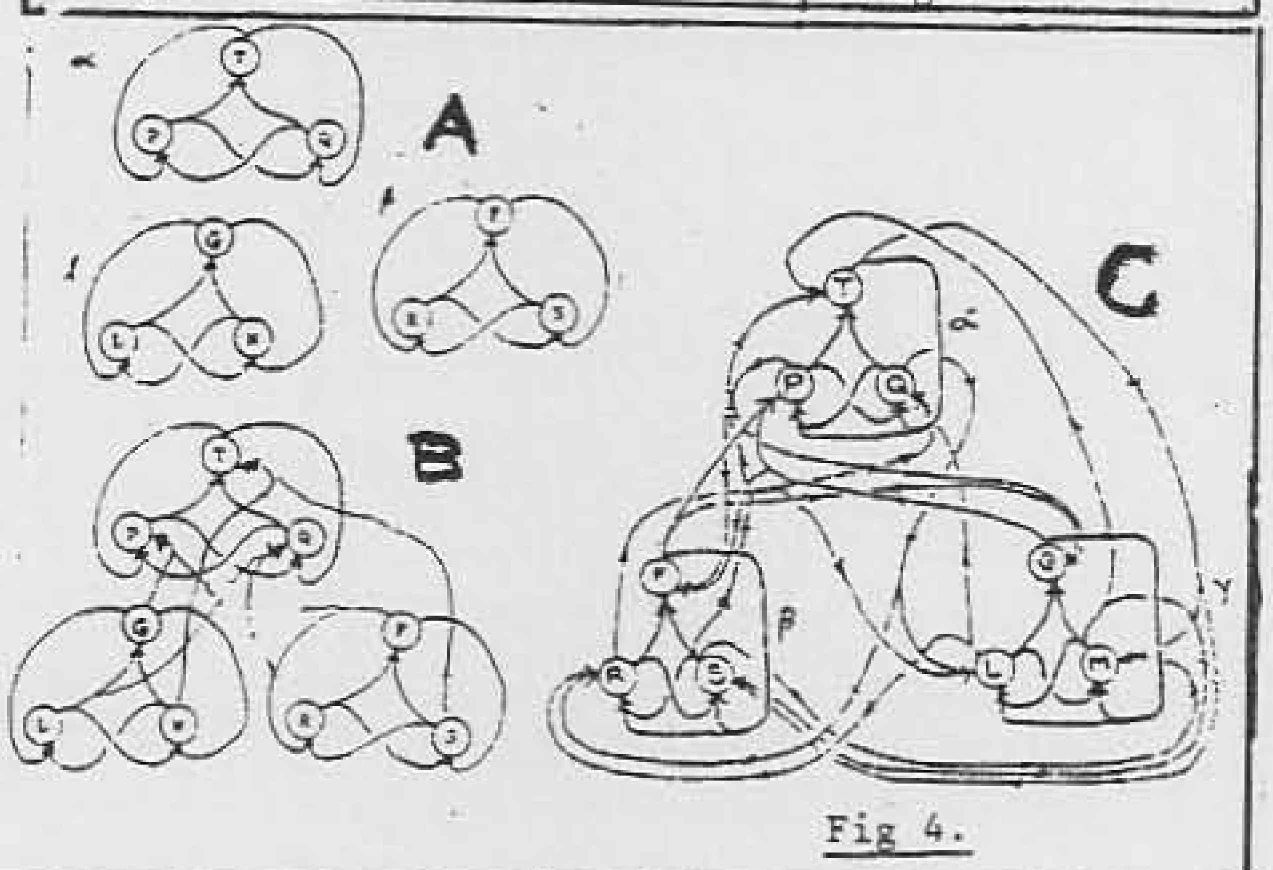
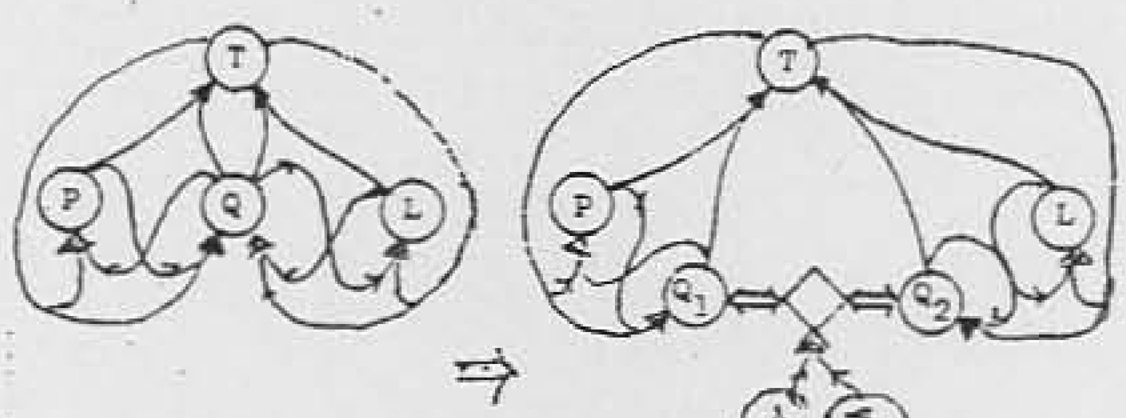


Fig 4.

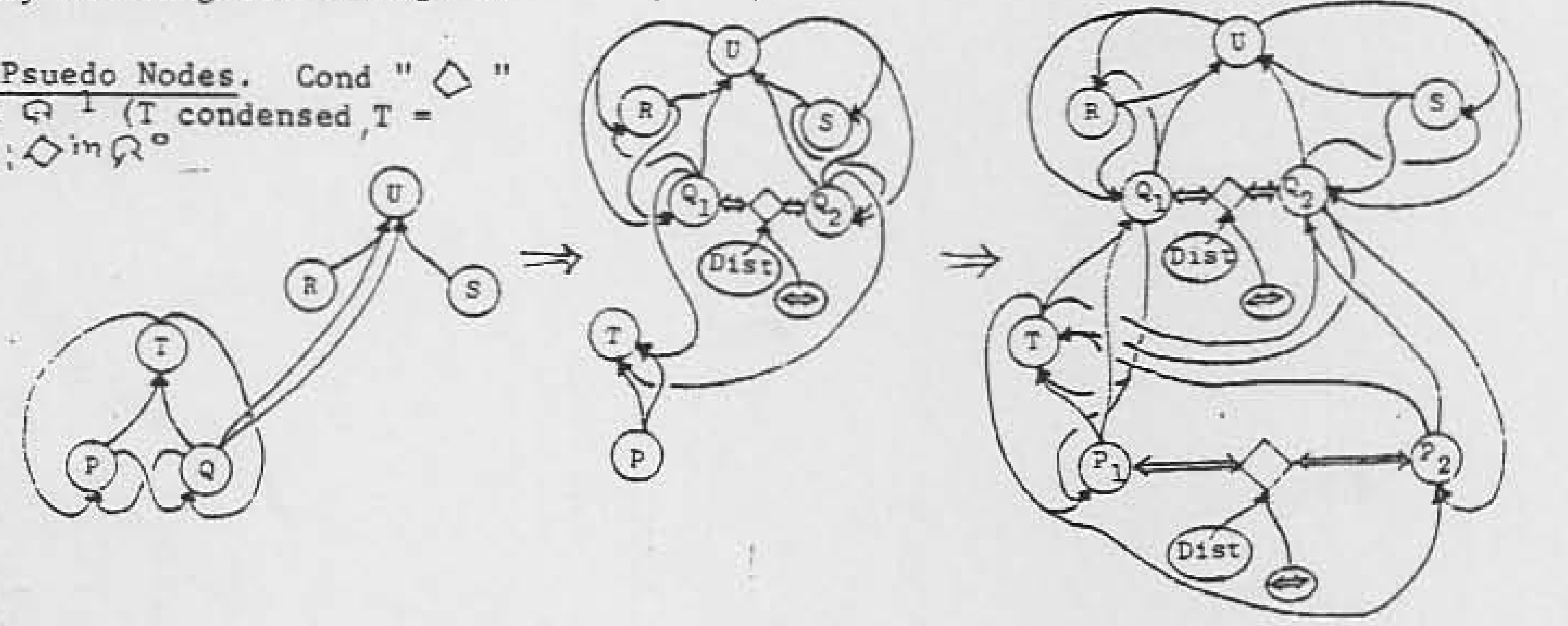
Exclusion Rule (Midoro)

Differently named nodes may not, under local cyclicity, have the same derivation. For example (Prescriptive Case), P as in Fig 4, Q as in Fig 4, L construction of circle by increasing sides of a polygon to a limit. Distinct (somehow independent) planes Q_1 and Q_2 are needed. (Prescriptive Case). Two independent vehicles are needed to obey "turn right" and "turn left" simultaneously.

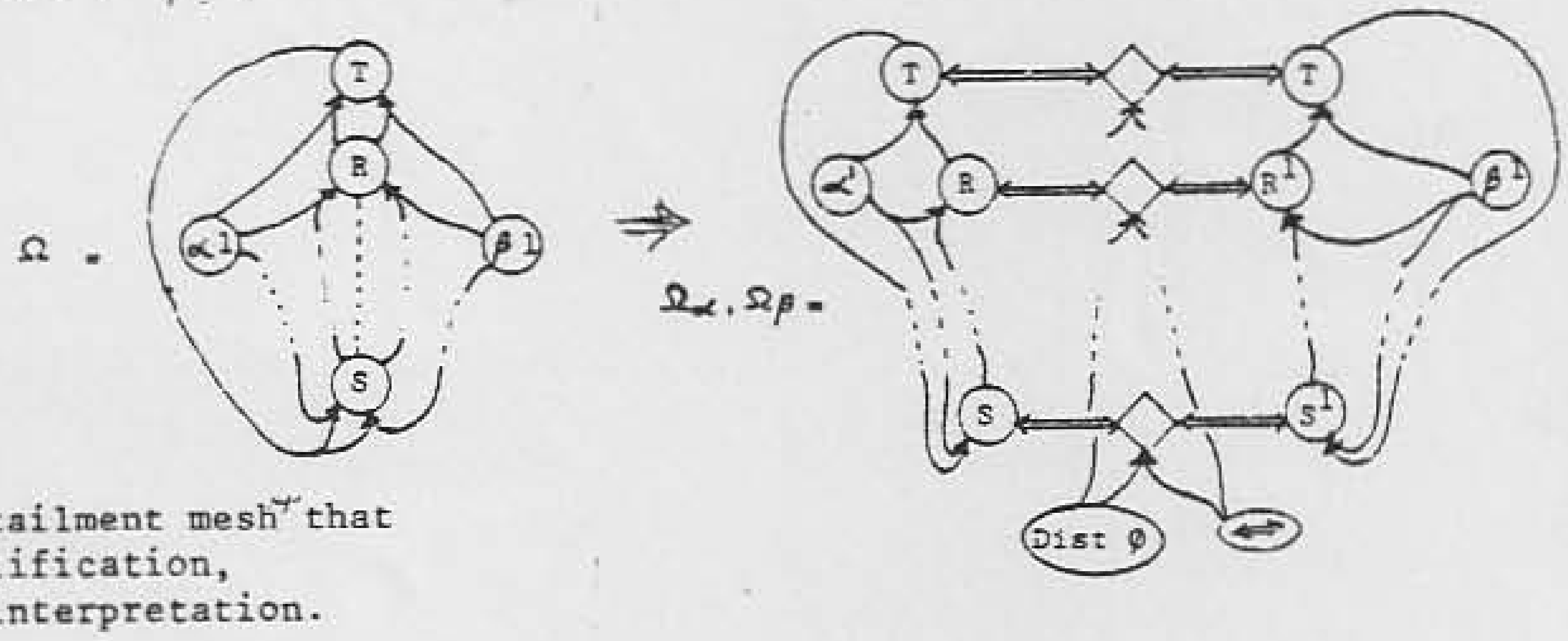


Condensation of a psuedo node (in Ω^0) $\triangleq$ node in Ω^1. But for any order of mesh, 0,1, ... the mesh must be locally cyclic (trivially, or by deriving the analogical topics).

Propogation of Psuedo Nodes. Cond " $\Diamond$ " = "0" a node in Ω^1 (T condensed, T = $\langle T^0, T^1 \rangle$); $\Diamond$ in Ω^0



Replication of Psuedo Nodes (α^1, β^1, condensed).



which creates disjoint entailment mesh that have, without further qualification, independent universes of interpretation.

Fig 6

Rule of Genoa (exclusion in Fig 6)
Hybrids and resonant structures:
$T \neq T^*$, $R \neq R^*$

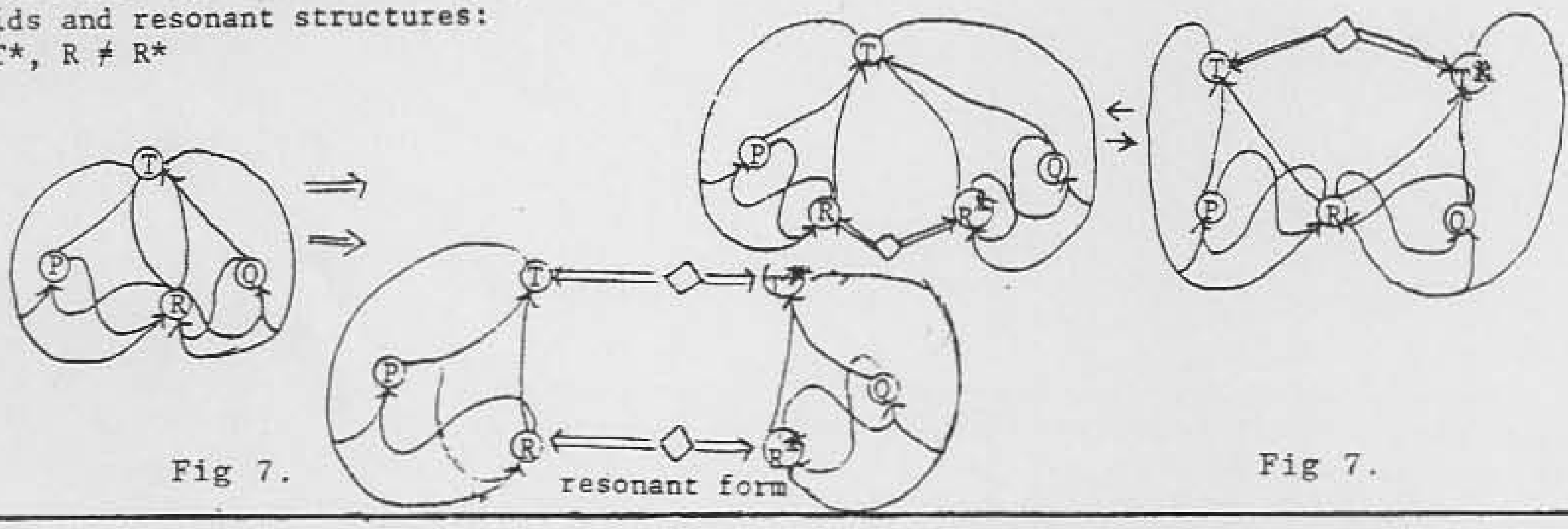


Fig 7.

Fig 7.

complex and that any knowledge (whether prescriptive like a plan, or descriptive, like an hypothesis), can be seen from many points of view. The EM is much more than "an hierarchy of topics". Each pruning is the union of many hierarchies that are specific to a perspective (the selective prunings). For example, the simple EM in Fig 8a (which represents an author's theory of how young children learn about "balance") provides the prunings of Fig 8a (there are as many prunings as there are topics).

The remaining operations, shown in Fig 4, can be initiated by a user and are specified in outline.

Only saturation requires special comment. If the notion of a stable concept is taken seriously, then saturation yields the most stable configuration in an EM (there are as many ways as possible of reconstructing a concept for this topic, which also preserves its specificity, or distinction, in the EM). Peter Clark has recently pointed out that fully saturated organisations are Steiner systems, and is exploring the class of all fully saturated as well as some incompletely saturated, structures.

Fig 5 shows the constructions and operations that are proper to an analogy of the kind discussed in Section 4. The crucial and innovative act is the juxtaposition of at least two different perspectives (and prunings) and the subsequent abductive resolution of these perspectives. Notably, an analogy is not fully cyclic, since an indefinite number of distinctions support the similarity; at least, that is so in the order 0 mesh, so far discussed (Ω^0 of "Condensation" in Fig 4). It becomes a node in a condensed EM, namely, the order 1 mesh Ω^1, as indicated in Fig 5 on the last line. The trick involved is that the simplest distinction is complete independence, later refined by specific predication (of the type exemplified).

6. Exclusion principle, hybrid forms and resonance

The first part of Fig 6 shows an exclusion-principle, which builds a psuedo-node out of an allegedly formal derivation.

Such an indeterminancy of identification (insufficient distinctions are made to support a specific topic) either is or may be reduced to an indeterminancy of "variables" not just an "incommensurability" of values of a variable. Hence, there is, as shown, an essential bifurcation in the EM (it loses neighbourhood topology). Some of the larger and more interesting consequences are shown further on in Fig 6 but real configurations are more complex as a result of the non-uniqueness-property sketched in Fig 7.

A cyclic mesh, like A, in Fig 7, may, unless stabilised (for example, by condensation), exist in "tautomeric" forms, B, C, and there is always a possibility that an intermediary "resonant" form, like D, in Fig 7 is more stable than any of the tautomeric hybrids.

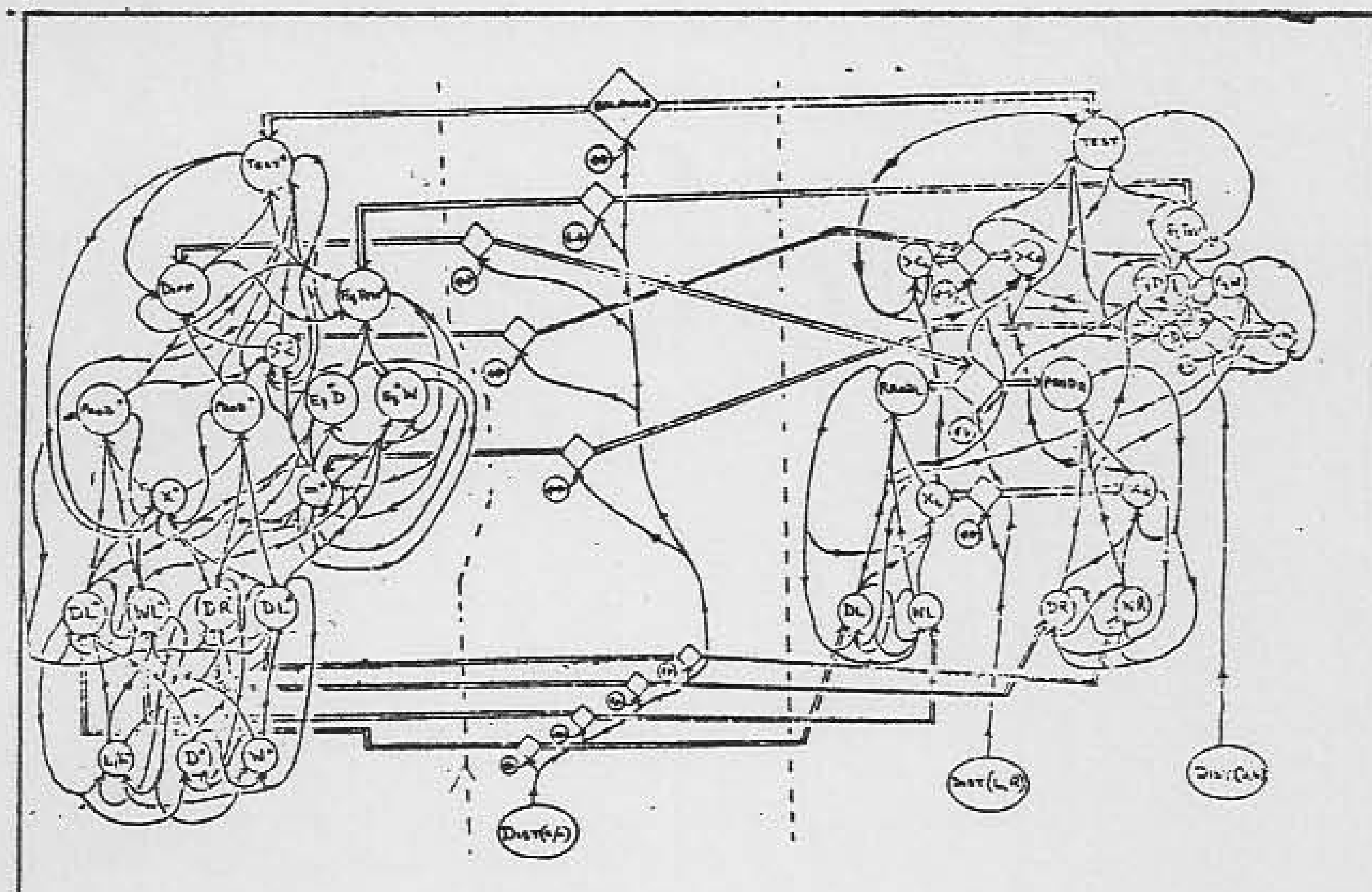


Fig 8 (a)

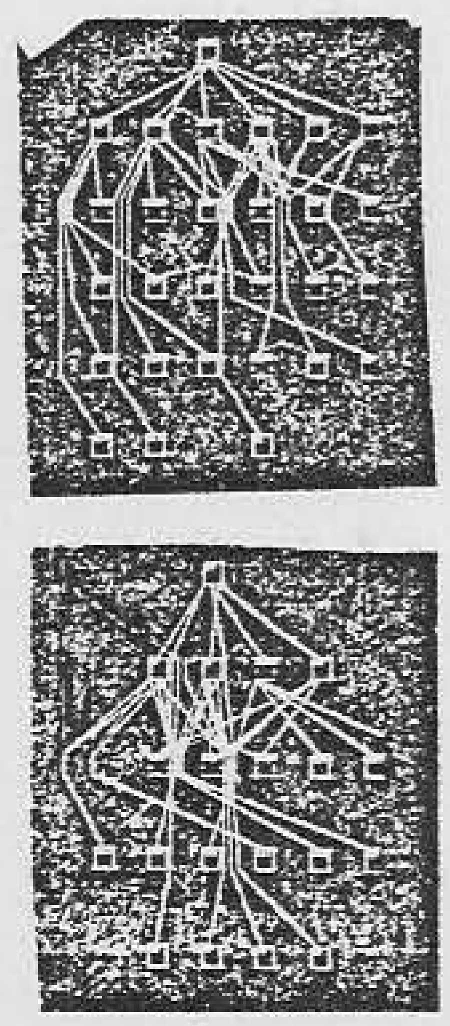


Fig 8(b)

Stability is judged by saturation (Fig 4) of the structures attached to each node and it is ordained that saturation is an ongoing process. One finding is as follows. If further internal kernels are added to a fully saturated structure, it is catastrophically split into components. Conversely, the addition of external kernels, rooted in some other structure, will tend to stabilise the entire system. The most stable structures are just one step from catastrophic decay; they are saved by interacting with others, through the mechanism of agreement, which may be modelled (Appendix 1, Appendix 2). Looking back on some early work (84), this principle applies not only to the field of epistemology, but also to coalitions and social structures where the point is, perhaps, intuitively evident.

7. The Character of Lp

The CT model for agreement (for example, the constructions shown in Appendix 1 and Appendix 2) are very imperfectly implemented in hardware other than brains (no doubt brains are the most beautiful and versatile organs for this purpose but do not, in this respect, have any specially reserved status).

Given EL and some initial EM (which already contain production ordinances and the bifurcations underlying abduction), the addition of agreement between distinct perspectives radically changes the quality of dialogue. The EL is no longer a static system, used by a person or group to spell out hypotheses and plans, as legitimate entailment meshes; rather, it is a dynamic system, modulated by users who communicate through it. This modulation shapes the system; which I call a protologic, Lp, and claim it to be an adequate model for CT in any L that might be employed. The Lp calculus is so unrestrictive (though still sufficient to sustain evolution), that Lp might be transformed by its users, to any L, without obvious limits.

The following salient/interesting hypotheses/conclusions are general in scope.

(a) By hypothesis, language is not only a means of communication. It is also an active system; a protologic, modulated by language users.

(b) Derivation is deliberately not a specific inference rule (only the notions of order and direction are involved). People do reason, but there are no grounds for assuming, in general, that different people use the same rules of thinking or learning.

(c) Derivation is distinct from analogy. An analogy is independence, (a distinction of universes), together with a similarity of process.

(d) Pruning is the activation of an entailment mesh from one (or, generally, more than one), perspective. There is no absolute hierarchy of knowledge. Hierarchies appear relative to one or more perspectives, necessarily adopted for acting, learning, or thinking.

(e) Selective pruning is the nearest approximation to an exclusive disjunction. Complements exist in the domain of action; namely, in selecting one (or more) pruning from the set of topics (and given a pruning the complements of a subset of selective prunings with respect to that pruning. The "alternatives" for "choice" are thus actions, or plans, or derivation paths).

(f) Basic Lp operations are saturation and isomorphic inference between otherwise independent universes (the former, in homogeneous entailment meshes, and at order 0, the latter in many sorted meshes, or at order > 0).

(g) The distinctions between disjoint meshes can arise from mesh operations; it is possible to generate distinctions that propogate, and some that replicate the mesh by producing essential bifurcations.

(h) Derivations which are, at-least-locally, cyclic, represent organisationally closed and informationally open concepts, and are stable. Fully saturated structures are maximally stable (partially saturated structures also exist, the current series accounts for psychological constructions such as Memory, Fixity, Rigidity, Gestalt, Universal. In particular, there is no absolute grain or detail of knowledge. A plan or exposition is at whatever grain its author can apply local cyclicity in derivation. Further, all knowledge is personalised as your thesis, or mine, or ours.

(i) Maximally stable organisationally closed systems occur at the boundary of a bifurcation. However large, one further derivation from within the system would demolish it. It is stabilised, as autonomous, by reference to derivations "from outside the system", or to "others".

(j) Agreement, or coherence, is represented by an analogy. If EM, EL, is augmented by agreement, the system is self organising; as agreements are produced, more distinctions arise from (i), which opens up the possibility of further agreements.

(k) Information transfer, in the Petri sense, takes place across a distinction in reaching an agreement. Other papers have explored the sense in which this information is more than a correlate of conscious experience.

(l) It is also maintained, on firmer

ground, that CT, modelled in Lp, is a relativistic and reflexive theory of knowing.

8. Other Research

This concluding section is an attempt to respect the courtesies, and acknowledge the obligations, which might have been brought into the body of the text. Many people are carrying on research and development in this, or closely related, fields; this work depends upon their ideas as well as mutual criticism which gives me, at any rate, some confidence in the soundness of the scheme.

Much of the original work was carried out with Von Foerster, (84), Lewis (38), Kallikourdis and Scott (63-66). It is paralleled by the work of Braten (6), (with Herbst (33)), and, at the theoretical level, Buber (9) and Moscovici (47). The psychological base of CT is often in the tradition of Bartlett (5), Duncker (13), Wertheimer (88), or generally Vygotsky (85). The more interesting neurophysiological results refer to Popper (76) and Eccles (14), Jason Brown (7), Easterbrook (15) and the pioneering work of Grey Walter (86).

CT, and through it, Lp, is closely related to Glanville's theory of objects and models (for example, Glanville, (27, 28), Glanville and Jackson (29)). Pedretti (73, 74), has a complementary formalism which is more intimately connected to literature and natural language dialogue. In contrast, there are category theoretic and many-sorted-model-theoretic schemes (Bykhovsky (10), Gergely with Szots, Vershinin, Markusz, Andreka and Nemetti (1a, 23-25, 40), Goguen, Thatcher and Wright (31) Milne and Milner (45)) Nowakowska (49a, 49b); candidates for L, linked to computation and mathematical logic.

Much of Lp hinges upon Maturana and Varela's (82), "organisational closure"; in turn, upon Varela and Goguen's (81) "arithmetic of closure", and Spenser Brown's (80) Logic of Distinction. The development of Lp is in harmony with the work of Flores and Winograd (21), who have initiated a programme of epistemology concerned with society; cognition and the artifacts of computer science related to the linguistics of Austin and Searle (3) and the hermaneutic tradition of Habermass (32).

Vittorio Midoro is responsible for the "Rule of Genoa". He has contributed appreciably to the formulation, and is currently cooperating in the implementation of one version of THOUGHTSTICKER, Gardner and his colleagues in another. F. Dowlatshai and Peter Clark are pursuing theoretical studies and Robin McKinnon Wood is responsible for the microprocessor and software organisation, (much of the original LISP structure is due to Derek Richards, who studied some forms of analogy in that idiom). Circumstances have disallowed close contact, for several years, with Dionysious Kallikourdis; but I suspect he has invented a more elegant isomorph of Lp. It also looks as though Lp is a reinvention of something akin to Meredith's Epistemics, though my own ideas were not sufficiently developed for proper discussion during his lifetime. Finally, several indirect contributors, (for example, Atkin (2), Gaines (22), Wermus (87), and Zadeh (90, 91) are scarcely mentioned in the text, though they should be.

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June, 1979

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Appendix 1

Some organisationally closed production systems (Figs 1,2,3,4). Letters A and B stand for participants, $\underline{\mathrm{Con}}_A(T)$ is A's concept of T such that the execution, $\underline{\mathrm{Ex}}$ of $\underline{\mathrm{Con}}_A(T) \rightarrow T_A$; A's description of T or an overt behaviour. $\underline{\mathrm{DB}}_A$ are description building operations of any kind in A's cognitive repertoire (for example, they could be modelled by relational operators, Codd (9)) and $\underline{\mathrm{PB}}_A$ is any procedure building operation in A's repertoire. It could, for example, be (quite differently) modelled by Chang and Lee's A algorithm, or by certain configurations in a tesselation plane. Similar comments apply to B.*

Throughout, the double arrow, " $\Rightarrow$ ", signifies a production, the ordinary arrows " $\longrightarrow$ " stands for paths by which products are returned, to form the arguments of productions.

The relation, "in $\underline{\mathrm{Con}}$" is determined in stages. Let a procedure be the compilation in a processing medium (brain, computer, or whatever) of an L program, $\underline{\mathrm{Prog}}$. A compilation, by $\underline{A}$, is written $\underline{\mathrm{Inter}}_A$ (interpretation for $\underline{A}$), a procedure, $\underline{\mathrm{Proc}}_A$ is

$$\underline{\mathrm{Proc}}_A(T) \triangleq \langle \underline{\mathrm{Prog}}_A(T), \underline{\mathrm{Inter}}_A \rangle$$

In general, there are many Procedures that achieve the same result ($\underline{\mathrm{Proc}}_A{}^i(T)$, $i = 1,2..$). Let "$[\ ]$" stand for a coherently compiled set of procedures (it is always attainable, by compiling each $\underline{\mathrm{Prog}}_A{}^i(T)$ in an independent part of the computing medium, though, usually, this condition is too stringent, and improvident). Let "$\{\ \}$" stand for an unordered collection of procedures. Postulate a mechanism, operating upon $\underline{\mathrm{Inter}}$ of $\underline{\mathrm{Proc}}$ such that incoherent or unordered procedures become coherent upon execution, ie. $\underline{\mathrm{Con}}_A T$ is a coherent, or nearly coherent, cluster of processes.

$$\underline{\mathrm{Con}}_A(T) \triangleq \underline{\mathrm{Proc}}_A(T) \text{ or } \left[\underline{\mathrm{Proc}}_A(T)\right] \text{ or } \left\{\left\{\underline{\mathrm{Proc}}_A(T)\right\}, \left[\underline{\mathrm{Proc}}_A(T)\right]\right\}$$

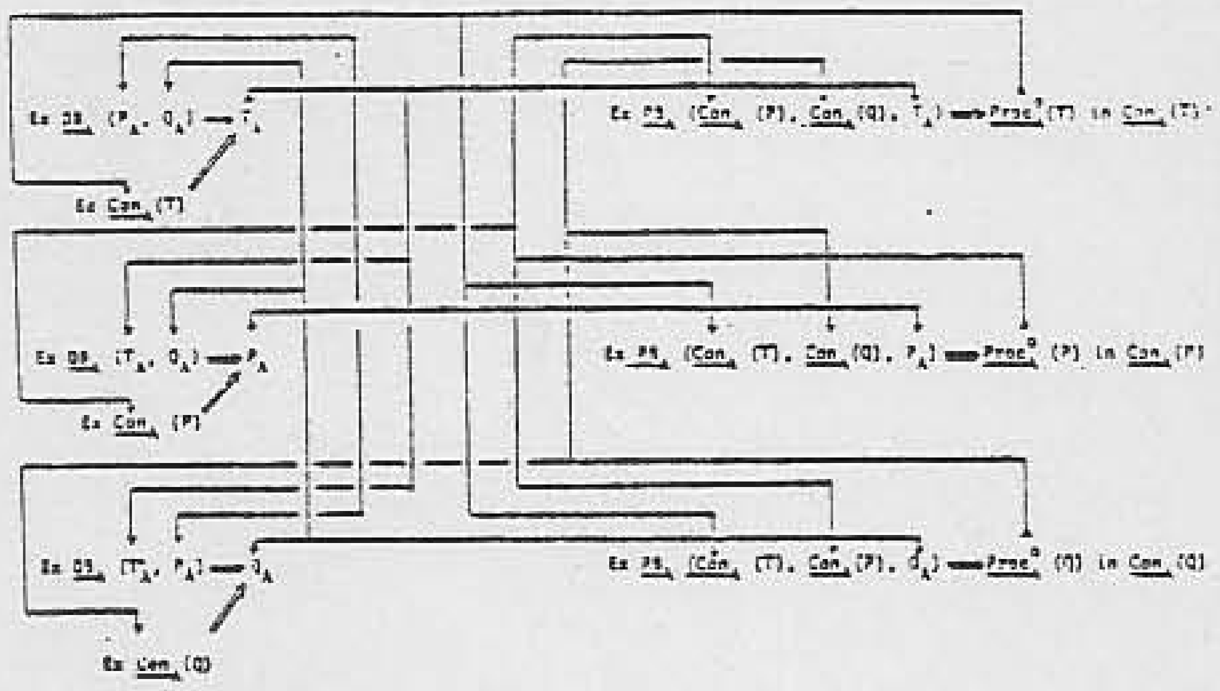


Fig 1: A's stable concept of T (derived from P and Q).

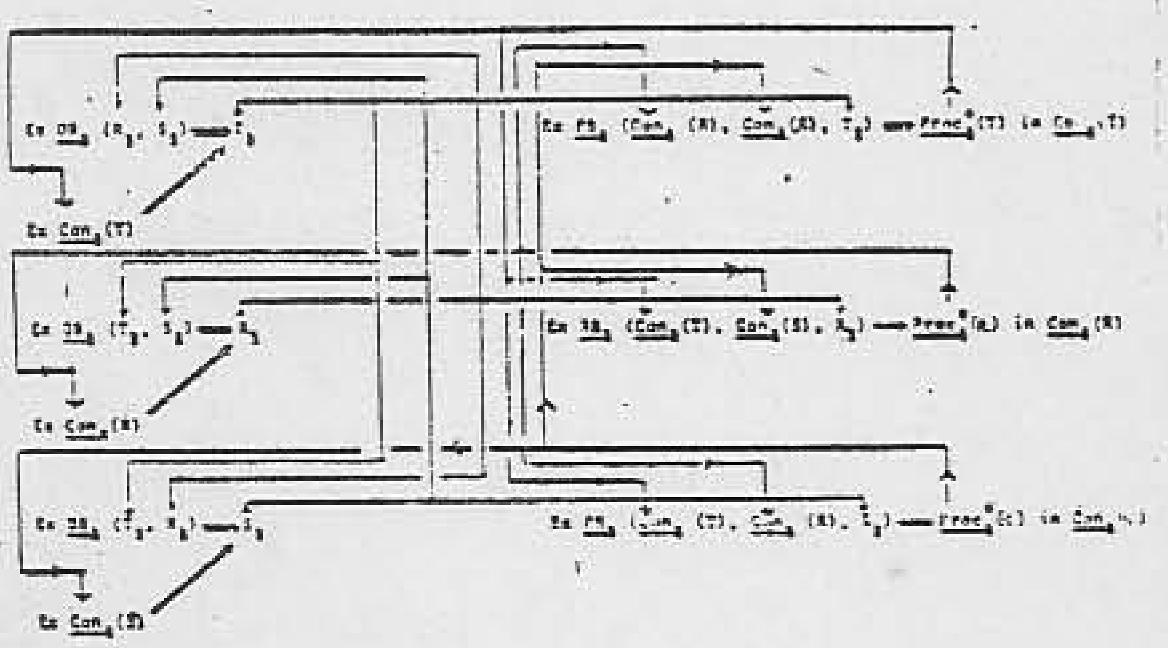


Fig 2: B's stable concept of T (derived from R and S).

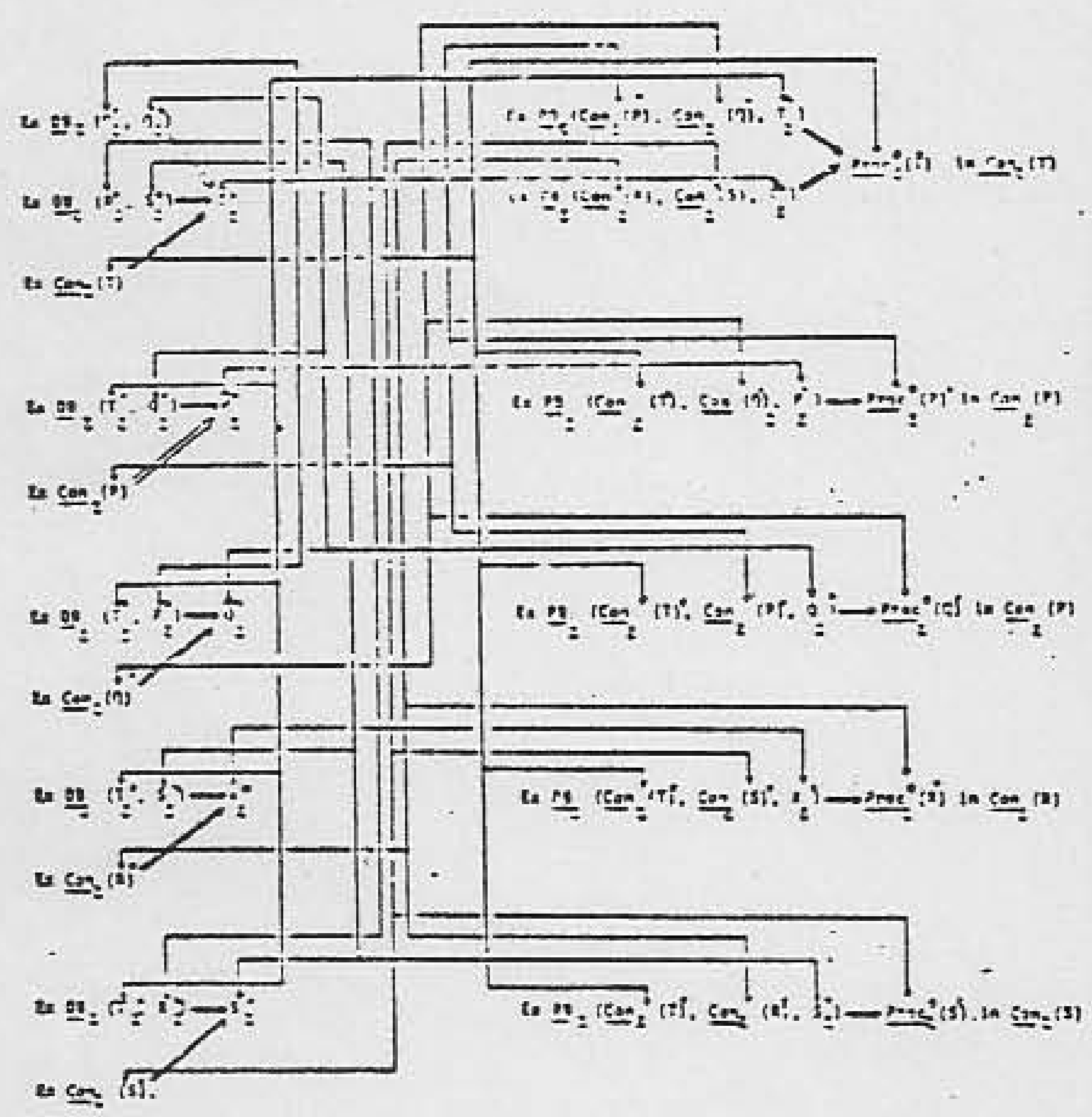


Fig 4: Common concept obtained by A and B agreement. Z is a variable indexing participants, here Z = A, or Z = B.

The productive and reproductive schemes, of Fig 1 and Fig 2, stand for stable concepts $\underline{Con_A}T$ *and* $\underline{Con_B}T$*, the minimal process required to approach coherence (using, "in* $\underline{Con}$*"). The productions of Fig 3 are a minimal agreement over an understanding between A and B who, in the least tractable case, have quite different derivations of T. Fig 4 is the shared concept scheme, obtaining after an A, B, interaction.*

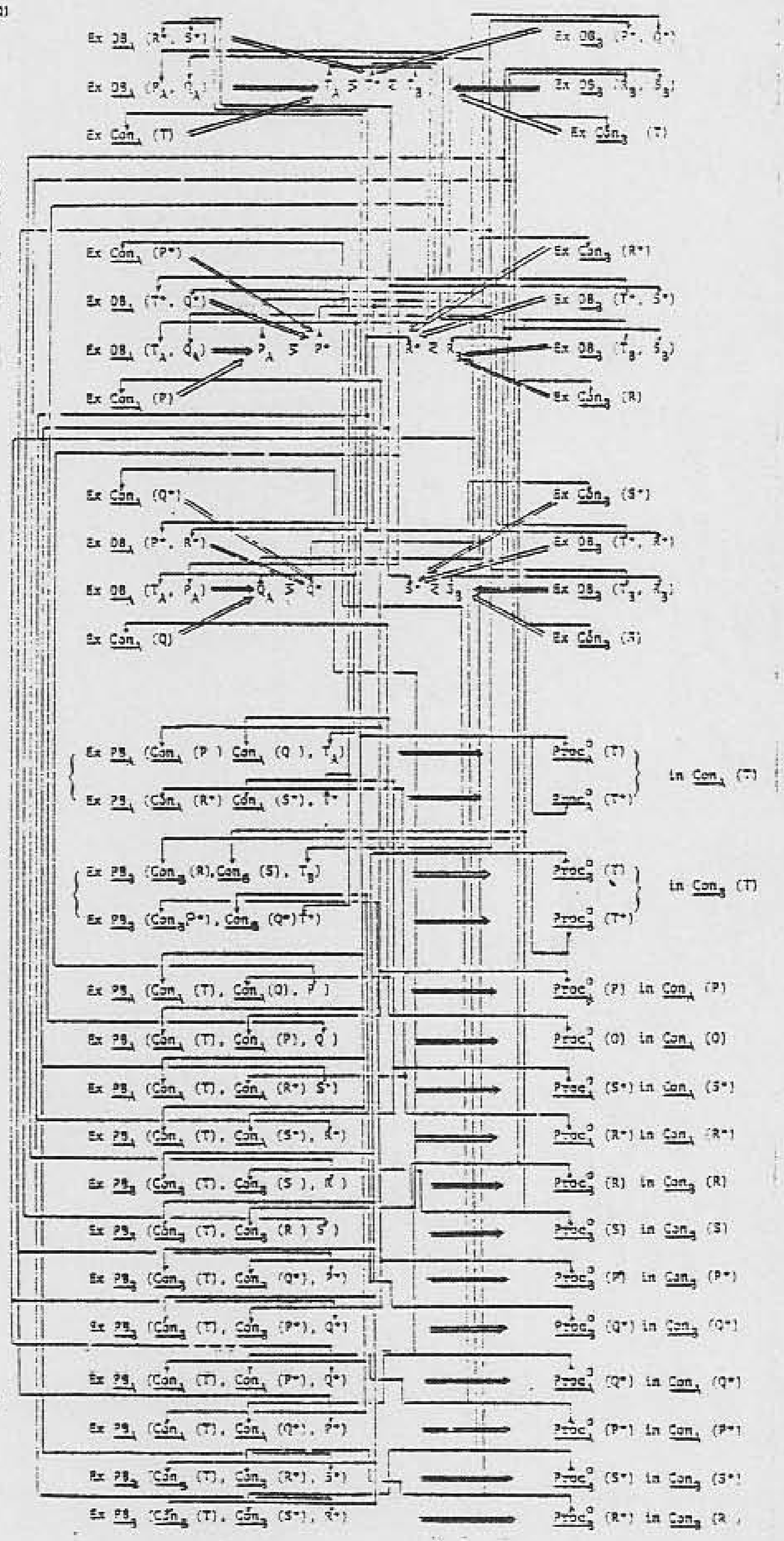


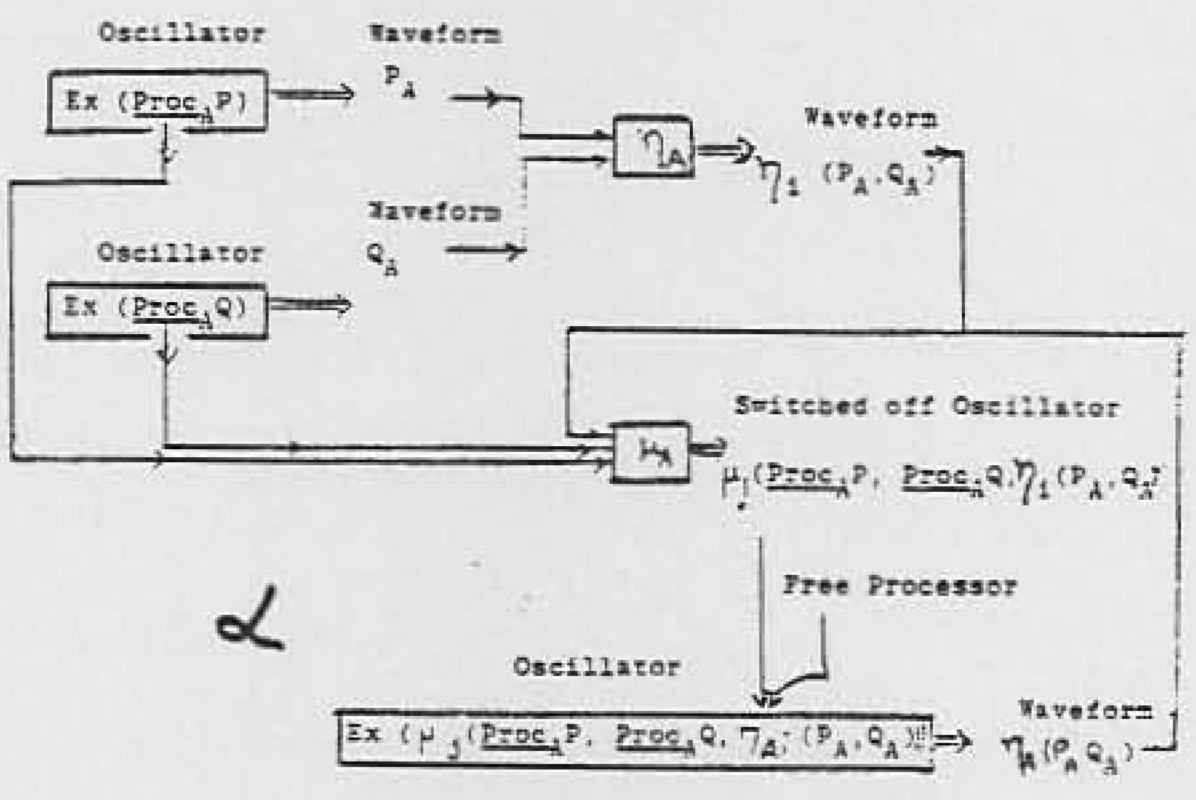
Fig 3: A,B agreement coherence over understanding and obtained by common concept of T*,P*,Q*,R*,S*.

Appendix 2

An alternative construction for the concurrent production scheme in Appendix 1. Only one stable concept (constructed from P and Q is modelled, which after the event, is known as $\underline{\text{Con}}_A T$).

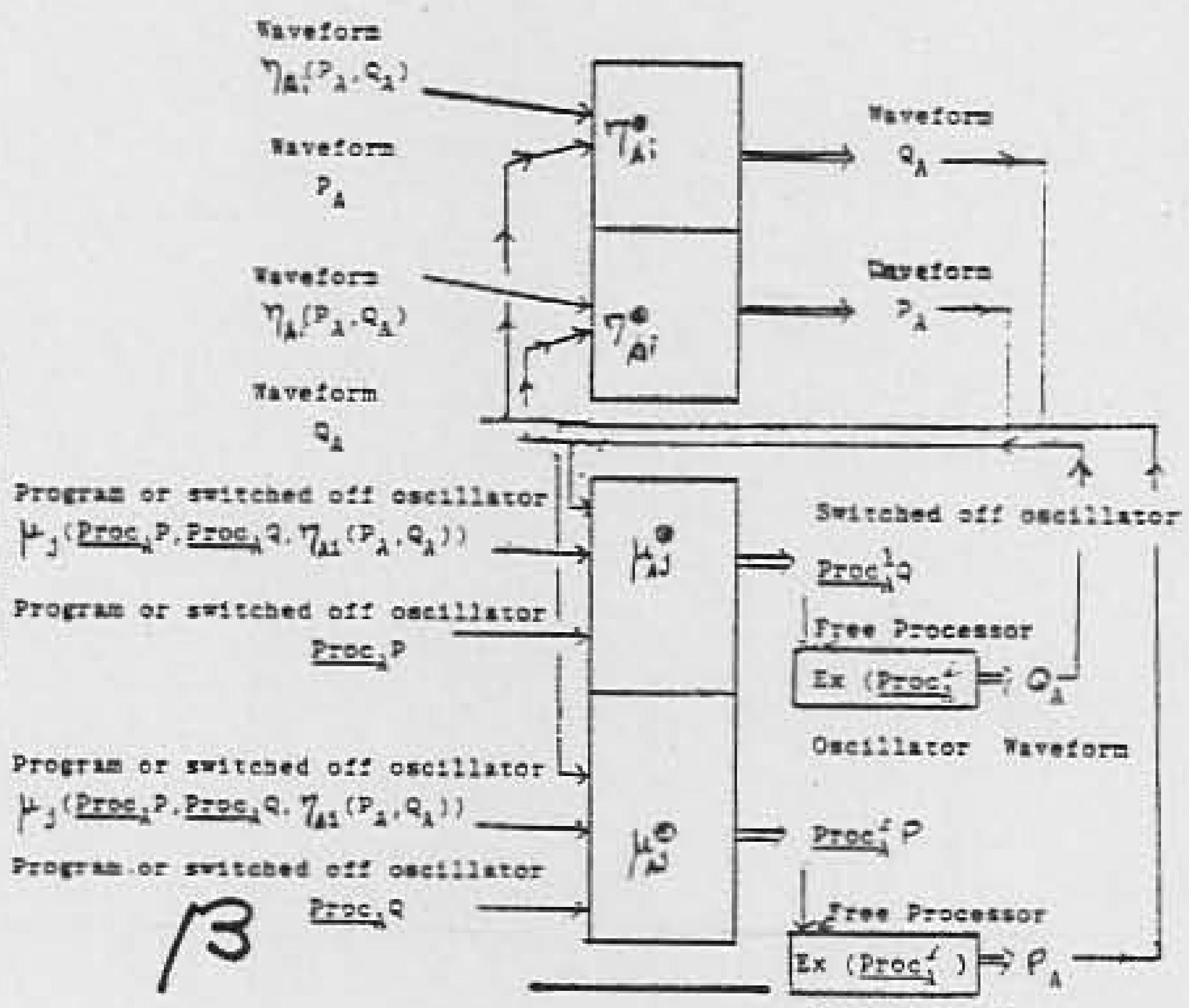
It is assumed, initially, that oscillators (corresponding to the indefinite iteration of $\underline{\text{Proc}}_A P$ and $\underline{\text{Proc}}_A Q$ in distinct processors) exist, and are turned on, to emit waveforms P_A and Q_A (the descriptions computed by $\underline{\text{Proc}}_A P$ and $\underline{\text{Proc}}_A Q$). If used as input to the device η_A, with parameter i, the waveforms are combined and form, for some value of i, the waveform $\eta_{Ai}(P_A, Q_A)$. A further device μ_A, with parameter j, accepts as input $\underline{\text{Proc}}_A P$, $\underline{\text{Proc}}_A Q$, and the combined waveform $\eta_{Ai}(P_A, Q_A)$, such that, for some value of i, there is created, or programmed in a free independent processor, an independent oscillator emitting the waveform $\eta_{Ai}(P_A, Q_A)$.

α



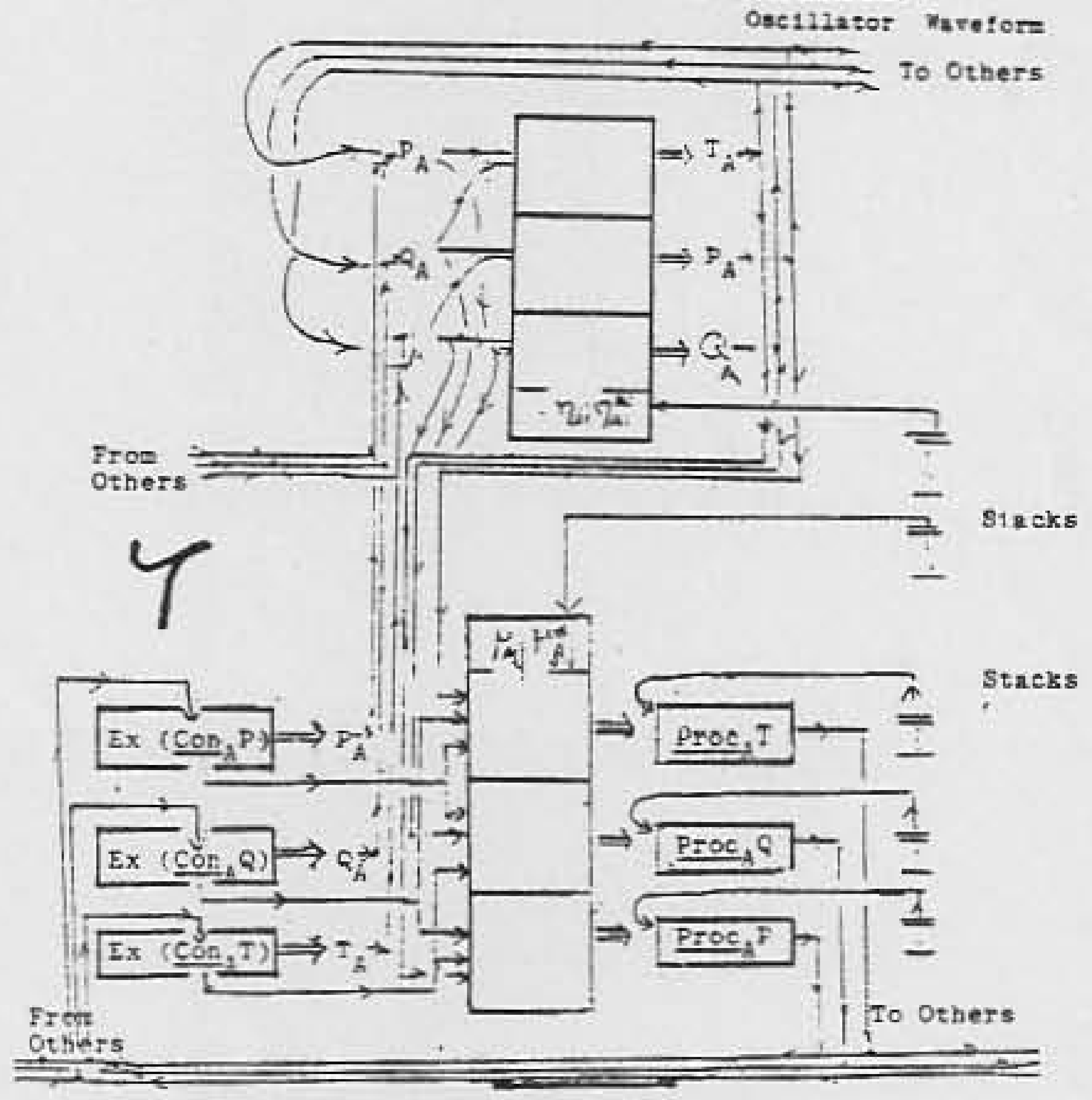
If, for some values of parameters i and j, the independent $\eta_A^{\circledcirc}$, $\mu_{Aj}^{\circledcirc}$, are converse transformations (together with the further pair of free processors), and able to satisfy the stipulated conditions $\eta_{Ai}(P_A, Q_A)$ is known as T_A, and $\mu_{Aj}(\underline{\text{Proc}}_A P, \underline{\text{Proc}}_A Q, \eta_{Ai}(P_A, Q_A))$ is known as $\underline{\text{Proc}}_A T$. If these requirements are satisfied, then the originally assumed $\underline{\text{Proc}}_A P$ and $\underline{\text{Proc}}_A Q$ have been constructed as $\underline{\text{Proc}}_A / P$ and $\underline{\text{Proc}}_A / Q$. Further, there are, already, converse transformations which yield a $\underline{\text{Proc}}_A T$, such that Ex $(\underline{\text{Proc}}_A T) \Rightarrow T_A$. Under these circumstances the device pair $\eta_A \cdot \eta^{\circledcirc}_A$ forms a $\underline{\text{DB}}_A$

β



System of oscillators for a stable concept, which is one implementation of production scheme as realised by partly synchronised collection of machines, such as an array processor, with initially asynchronous modules. The system is informationally open, as well as organisationally closed, insofar as the lines shown as "from others" and "to others" exist; that P_A, Q_A, T_A; $\underline{\text{Proc}}_A P$, $\underline{\text{Proc}}_A Q$, $\underline{\text{Proc}}_A T$ may be constructed in other organisationally closed systems, and the products of *__this__* *system be more coherent with* *__other__* *systems.*

γ



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