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Some reflections on Rosen's conception of semantics and finality

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Summary.
The present contribution departs from Rosen's idea that the semantics of a natural language cannot be fully reduced to syntactical rules. In the first place, this surplus value can be found in the relational organization of living beings as well all in intuitive observational descriptions of them. Second, in order to recognize meaning and to ascribe sense and intentionality to a living being, we observers take recourse to the notion of finality, which is considered here as the upshot of a bifurcation between logical levels of processes. Finally, a particular class of geometrical constructions is proposed as a domain in which the origination of such bifurcations can be visualized.

1. The living organization

Rosen's most impressive achievement is his description of the living organization as one in which all relations of effficient causation are produced internally. Unlike a machine, there is no way to decompose an organism into disjoint physical parts that match with the system's functional units. Rather, in a living system there is an entanglement of processes and processes that regulate other processes, such that a single physical process may function at various logical levels simultaneously.

Such entanglement, when described in formal terms, boils down to an impredicativity: there is eventually no way to keep a distinct track of logical levels. That is: any hierarchical relation between these levels is merely local. More globally seen, these logical levels are not arranged hierarchically but circularly. Thus, an arrangement is envisaged between component parts, yielding a closed loop of mutual specifications«**1**».

1. The idea of merely local hierarchy has been visualized by M.C. Escher's drawing of infinite staircases, entitled: 'Ascending, descending'. The idea of mutual specification can be found in Escher's image 'Drawing hands', in which two drawn hands can be seen each to hold a pencil with which the other hand is being drawn concurrently.

Rosen describes these circular arrangements by means of category theory, a branch of mathematics in which "there is nothing (...) that mandates [an] absolute distinction between sets and mappings [of sets]" (1991, p. 135). In this way, a particular mapping can be the outcome of another mapping, and so in a circular way.

Rosen's (1991) "diagram 10C6" presents such 'closure to efficient causation' in terms of a particular arrangement of relations between mappings, which together is said to make up the crux of the living organization.

The important thing here is that two different types of mapping relations are distinguished. Rosen prefers to address these two types in terms of aristotelian causes: the set-set mappings

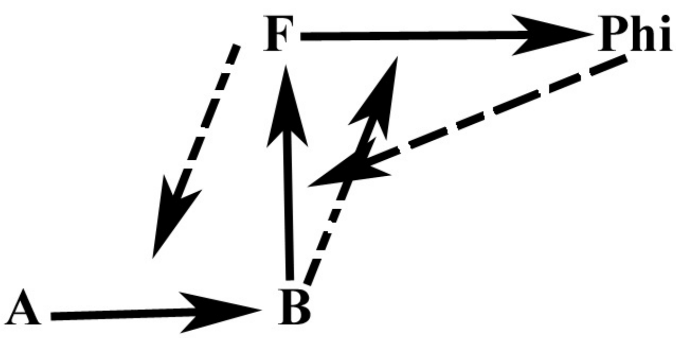

Figure 1 *Adapted from Rosen's (1991) famous "diagram 10C6". Solid arrows denote mappings between sets, dotted arrows denote mappings between sets and mappings*

are considered to encode for 'material causation', which corresponds to the regular metabolic processes within an organism. The set-mapping mappings are considered to encode for functional relations, or 'efficient causation', which corresponds to enzymatic activities that select, steer and modulate the metabolic processes. Accordingly, in the diagram of figure **1** a closed loop of efficient causation is represented between the sets Phi, F and B, each of which is considered to be an efficient cause of a metabolic process that produces one of the others.

Thus, a particular set can simultaneously act in two or more different causal 'roles'. How is this possible?

2. Finality: in the eye of the beholder?

It is due to its enzymatic activities that an organism can be said to act according to final causes. This is to say: the organism's behaviors can be seen to be directed toward particular ends. The myriad of physiological processes taking place internally, as well as of macroscopic behaviors externally observable can be said and be seen to be *functional, goal-directed*. The immediate question, of course is: seen by whom? said by whom? It is, indeed, an external observer who is supposed to be present in order to utter these formulations. That is to say: it takes an external observer, gifted with natural language, to express the goal-directedness or *intentionality* of the observed behaviors.

But is this observed intentionality a mere fantasy of the observer, a subjective, perhaps 'intuitive' construct, or does such observation correspond to something real that also exists beyond the beholder's eye?

Rosen's idea is that finality does exist. It can be put, qua formal systems, in terms of relations between mappings, such that particular mapping relations have a 'function', viz. to enable particular other mappings. In terms of natural (living) systems: such processes cause particular metabolic processes to take place.

3. The concept of semantics

It is the impossibility to describe such a circular organization in terms of mechanisms and machines (that is: to describe it in terms of a strict syntax), that brings Rosen to propose a comparison with natural language:

> "In fact, it is not too far wrong to say that an organism (...) is itself like a little natural language, possessing semantic modes of entailment not present in any formal piece of it that we pull out and study syntactically." (1991, p. 248)

Rosen is claiming here that an organism contains coherences that cannot be expressed in terms of syntactical structures. Thus, Rosen's quote suggests that the semantics of natural language can be a *metaphor* for the closed network of functional relations in an organism, because this closure cannot be described in terms of a syntax.

For such a syntax would necessarily demand the strict stratification of all its terms into a thorough hierarchical arrangement. Due to the entanglement of logical levels something crucial escapes from attempts at syntactical description, and it is this escaping aspect that Rosen compares to the semantics of natural language. Thus, Rosen introduces meaning (semantics) into the description of the living organization; not by claiming that meaning exists in a distinct part of the organism«**2**», but instead by presenting meaning as the organism's unformalizable surplus. The explicit source of inspiration here is Gödel's work on

2. nor in a dualist metaphysical construct such as the 'soul'

the undecidability of true self-referential sentences, the truth of which could not be demonstrated within the axiomatic system they were pertaining to.

Likewise, it is of major importance to define, in as strict a language as possible, that what is missing in any mechanist description of a living organization. Moreover, it is important to show how a non-mechanist, syntactically undescribable, system is possible and how this ungraspable aspect can come into existence.

4. The use of semantics

If, as Rosen has it, the semantics of natural language, qua phenomenon, can be a metaphor for the non-formalizable circularity between the functional relations in a living organism, then it is a small step to *use* such semantics for the actual description of living behavior, i.e., to make meaningful descriptions. This is not what Rosen says, but it is a plausible step.

For the semantics of natural language enables us to formulate a coherence, or gestalt, that we as observers are able to recognize in the functioning of living beings. We can ascribe this coherence to them through our command of natural language, long before we are able only to think of a critical formulation of our observations, let alone a formalized description of them.

This is especially of interest for the observation of goal-directed activities in other living beings. Such recognition is not possible by means of an algorithmic computation.We use natural language, without any awareness of complex problems, as an instrument for the expression of things that are extremely hard, if not impossible, to formalize, such as hunger«**3**».

5. A reappreciation of informal judgment

Thus, we find in Rosen's work an unexpected support for what is usually called 'intuition' or 'subjectivity'. In those disciplines where life is being studied in its various appearances, it is the primacy and irreducibility of a semantic description that is implied by Rosen's position, whereas, to the opposite effect, many behavioral scientists tend to 'purify' their their work and eliminate all elements that cannot be objectified, if only for the sake of being taken serious by their fellow objectivist researchers.

However, instead of discarding and dropping the 'intuitive' descriptions, it might be more fruitful to investigate them in terms of their surplus value in comparison with more formalized behavioral descriptions. Thus we may envisage of a type of investigation in which informal natural language utterings come to the fore as manifestations of *a sense* in the observer; a sense assigned to the studied object, a sense that cannot be reduced to more

3. For what would 'hunger' look like, when expressed in syntactical terms (cf. Pask, 1978)?

elementary and 'objective' units without annihilating it. Indeed, this sense in the observer, like the living organization, can be compared to the semantics of a natural language. Sense, thus understood, is our ultimate tool for the recognition and description of phenomena that are 'so easy to look at, so hard to define'**«4»**! This holds especially for the recognition of sense and finality in the behaviors of other living beings**«5»**. But this does not mean that these phenomena are only accessible as intuitively perceived entities?

Finality is a property assigned by a living observer to the behaviors of a living being. It has been impossible thus far to create operational definitions of it, such that an objective measurement procedure for it could be made. In other words: thus far 'finality' successfully resisted attempts at formalizing it in terms of (a summation of) clearly and distinctly observable behaviors.

Rosen's ideas on the goal-directedness of enzymatic processes emphasize that their finality is not a merely subjective intuition, ascribed to it by a far too naive observer; instead, it is to be understood as a relation between processes within an organism, such that one process steers and selects a second one. But this relation is not a summation of more elementary processes. In that respect it can be compared to the semantics of natural language. Can we better understand what makes up this semantic surplus? In particular: *how is it possible that one process relates to another one such as to specify and steer it?*

6. Construction versus computation in geometry

Rosen (2000, p. 74ff.) extensively argues that a geometrical construction cannot be equated to the computation of its values. This, par excellence, holds for Pythagoras' major finding: the theorem on the length of a right triangle's hypotenusa. For instance, in the case of an isosceles right triangle the ratio of this length to the length of a side is an irrational value ($\sqrt{2}$), and hence not computable nor measurable.

More generally, a natural system can be adequately simulated by computations only in the non-generic case that it is a simple system, i.e. its model is a summation Σ of elementary constituents. On the other hand, a system is called 'complex' as soon as there does not exist such a summative model. This is the case for systems that can only be modeled as a product Π of constituents. Here adequate simulation fails; what remains possible is incomplete simulation, with the explicit risk of computational errors which lead to fatally incorrect outcomes.

4. with due respect to Bob Dylan's "Sara" (1976)

5. Accordingly, it does not surprise us that this unformalizable semantic quality of sense can be investigated in terms of its intrinsic self-referentiality. This plays a dominant part in the field of psychotherapy, where the major tool to bring patients into contact with their own intentionality consists of the establishment of a self-referential discourse (Goudsmit, 1998).

It is obvious that in many non-trivial geometrical constructions a process is realized in which two or more parts together constitute entities that have dimensions of irrational values (such as length and orientation) which cannot be reduced to a summation of rational values. Hence they cannot be measured, nor simulated adequately. Generically, a geometrical construction can only be modeled as a product space**«6»**.

Therefore, it seems legitimate to wonder if we can learn from geometrical constructions something about the mentioned semantic surplus that cannot be covered by syntax. *In particular, can geometry contribute to our understanding of final causation and functional relations? Can we use geometrical constructions in order to visualize and stimulate our imagination on the origination of this functionality?* To this question a preliminary answer may be given.

Let us remember that the origination itself of the difference between material and efficient causation is not explained by Rosen's relational diagrams. How is it possible that a particular physical process obtains more than one role, such as to perform both a metabolic and an enzymatic act simultaneously? If we take the enzymatic 'repair' function to be of a higher logical level than the metabolic process steered by it, then how did a split between these logical levels ever come into existence? Can we search for a type of bifurcation, where a single logical level splits into two?

I will take the opportunity to present a small selection from my work with Joachim Mowitz on impredicative geometrical relations. I will focus on a particular type of bifurcation that can be seen to take place both between circles and between triangles. It is in this bifurcation that an ongoing process can be seen to split into two processes, one of which develops into a rule or principle for the development of future constructions.

7. A bifurcation between logical levels in a domain of geometrical constructions

Let us assume circles that originate at their center point and are all characterized by a centrifugal parallel expansion of constant velocity. Likewise, let us assume triangles that originate at a single point and expand by parallel expansion of their sides (figure **2**). Then such triangles (figure **3**) and circles (figure **4**) can be seen to encounter and to coalesce along their bisector lines.

6. Rosen has claimed that the distinction between construction and computation has been underestimated by Von Neumann, and he seems to make a compelling argument. On the other hand, H.H. Pattee, in a discussion list message of april 2, 2004 (see e.g. www.panmere.com/rosen/mhout/msg01268.html) maintained that von Neumann was much more aware of this distinction than Rosen believed (Pattee refers o.a. to Von Neumann, 1966, pp. 101ff.)

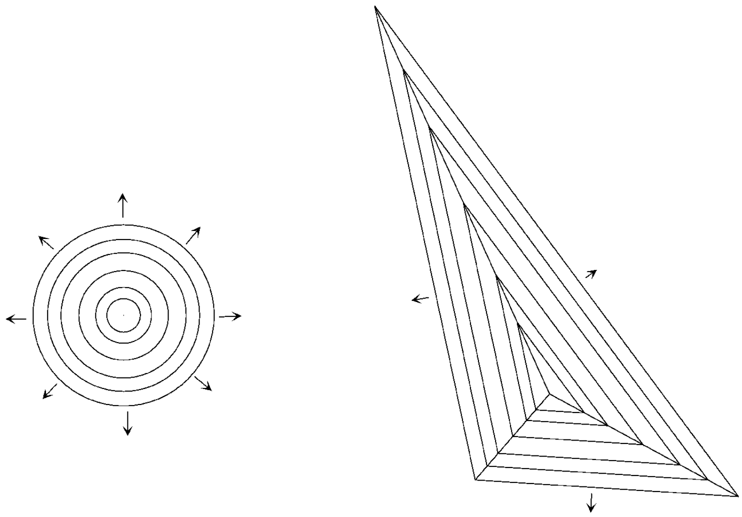

Figure 2 *Circle expansion and triangle expansion. Both expand with equal, and constant, velocity from a single point of inception.*

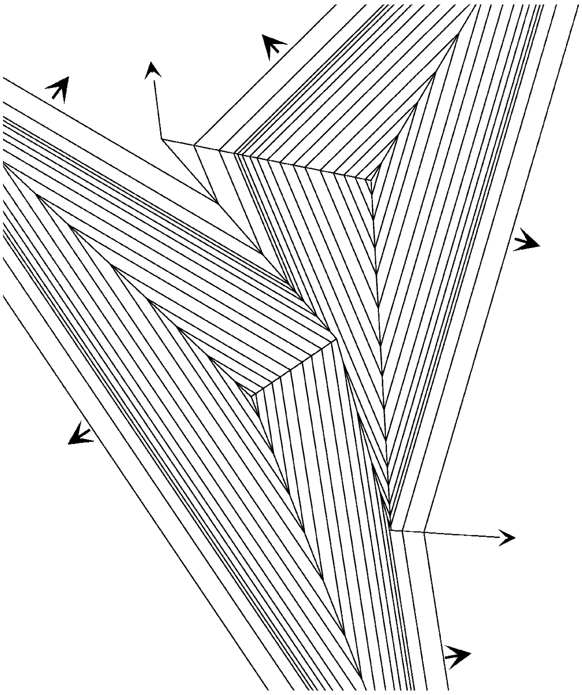

Figure 3 *Expanding triangles specify their bisectors.*

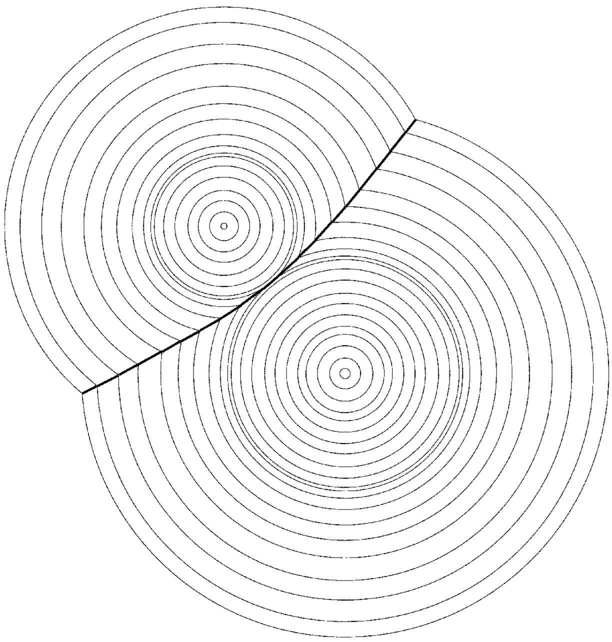

Figure 4 *Two coalescing circles specify their bisector.*

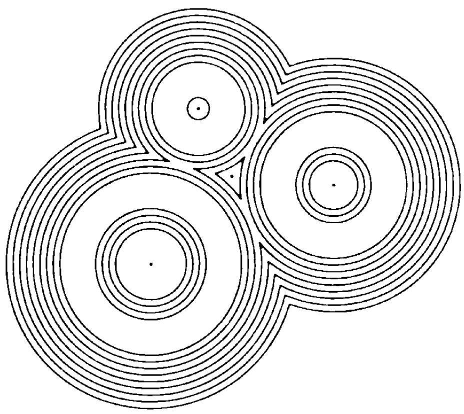

Figure 5 *After self-connection the expansion process bifurcates into an outer and an inner trajectory. Three circles enclose a deltoid which shrinks towards a final point where the three bisectors meet, thus specifying three final radial lines.*

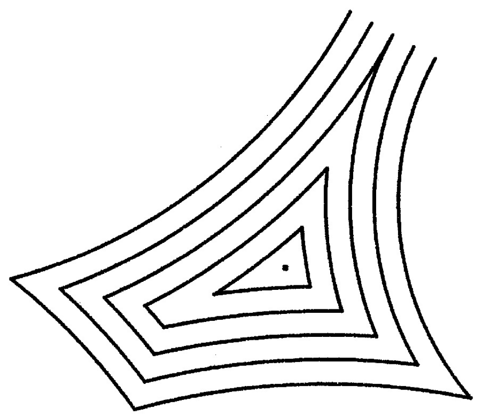

Figure 6 *Shrinking deltoid enclosure of 4 coalescing expanding circles.*

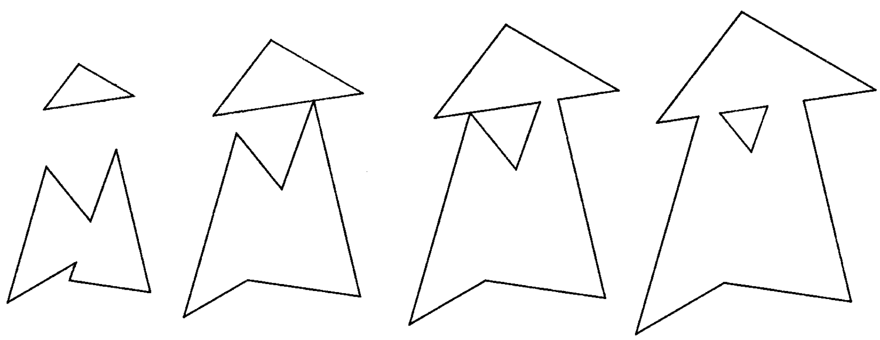

Figure 7 *Self-enclosure in a configuration of expanding triangles. Three triangles enclose a triangle which shrinks towards a final point where its three bisectors meet. At self-connection the expansion process bifurcates.*

The bisectors, both in triangles and in circles, are the outcome of construction processes. Their irrational values cannot be computed exactly. Minor computational errors may lead to radically different outcomes.

Thus, within certain constraints, expanding circles build up cloudlike configurations that connect to themselves (figure **5**)! It is at those moments of self-connection that a shrinking deltoid shaped enclosure occurs, as in figure **6**. Similarly, expanding triangles self-connect and enclose a shrinking triangle (figure **7**). At self-connection the expansion processes bifurcate: the outer expansion process continues its way; the inner one converges and generates a rule for subsequent expansion processes.

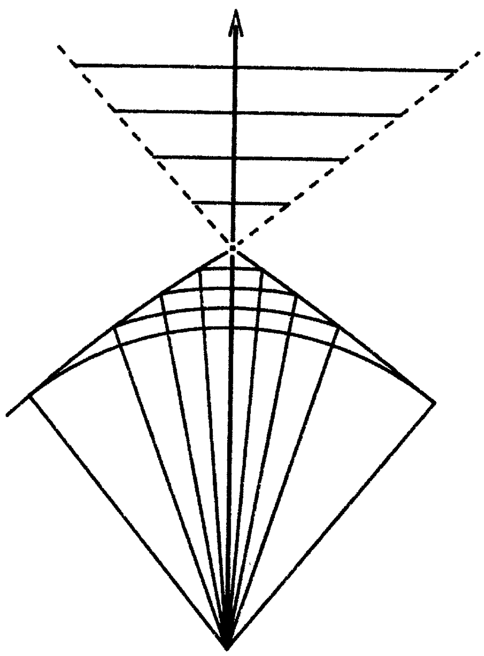

Figure 8 *One single sector of a shrinking enclosed deltoid passes the termination point. Three of such finally selected orientations transmute into a new triple expansion rule for triangle expansion.*

The shrinking path of the deltoid within the circle enclosure can be studied in more detail. Figure **8** shows one side of the shrinking deltoid. It is clear that the final termination point of the deltoid is obtained as the three constituting circles continue their expansions. As this termination point is approximated, each of the constituting circles ends up in a final single radial line. Three of these final radial lines make up the three directions according to which a new triangle may then incept and expand.

Similarly, when a shrinking triangle, as in figure **7**, attains its termination point, it specifies a new point from which a new circle then incepts its expansion.

Thus, shrinking enclosures made up by circles specify where triangles incept, and in which directions they expand; likewise, shrinking triangle enclosures specify where new circles arise and expand. Accordingly, it has been possible to describe coalescing geometrical forms and demonstrate their non-simulability. An extensive documentation of these geometrical processes can be found in Mowitz & Goudsmit (1988; 1989; 2004«**7**»).

What is of our interest here is that it is at the moment of self-connection (of a circle configuration or of a triangle configuration) *that an ongoing expansion process splits into two distinct expansion processes, one of which develops into a new rule for a future expansion process*.

Thus processes of expanding geometric configurations are a domain in which we find the bifurcation of logical levels illustrated. At one level there are simply expansions of configurations. At another level rules are being prepared according to which subsequent expansion processes will take place. These rules are comparable to the enzymes that regulate metabolic processes.

It is by offering this comparison that I would like to commemorate Robert Rosen.

8. References

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7. Mowitz and Goudsmit claim to have been earlier with the specification of these phenomena than Aichholzer et al. (1995)

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