Appendix II

On self-reflexive and self-organizing systems[1]

At the outset let us highlight and distinguish two processes:
a) the representation of an object as a system and
b) the construction of an object according to a plan.

1. Representation of an object as a system. In order to solve certain cognitive problems we have to picture an object as divided into its elements. The picture must indicate the ties and relations which turn this "segmentation" into "wholeness". The elements, ties, and relations may be chosen differently according to the 'standards' which a researcher uses to reflect the object and which determine its structure.

Let us take a set of dots that have to be counted.

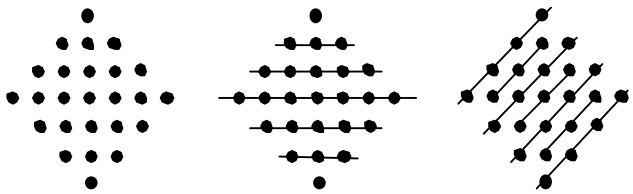

Fig. 1

Depending on the mathematical tools available to the researcher, the object can be represented as a system of either horizontal or inclined lines. It is obvious that these representations of the system are different, and yet it makes no sense to ask which one represents the object more precisely.

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[1]SYSTEMS AND STRUCTURES RESEARCH PROBLEMS, Conference Proceedings, Moscow, 1965 (in Russian)

2. Constructing an object as a system. In solving practical problems, special objects are constructed from a set of parts according to a particular "plan-image" which guides a "designer" in transferring the "image" to another sphere. He realizes the plan in a different medium. The object obtained possesses a structure by virtue of its being created.

3. Analysis of the constructed object. The researcher may be faced with a special problem: determining an object's inherent structure. The object, however, as an object of study, takes on the structure of its image (because "to see the structure of an object means to represent that object"). Therefore, it is necessary to choose a system representation for the object that reflects precisely the structure obtained by it. This suggests a natural principle for the researcher: to borrow the "plan" that guided the designer and use it in a new function - as a means for representing the system.

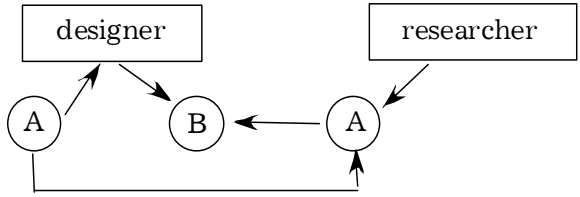

Fig.2

Let us take an ancient text, which initially looks like a random conglomeration of lines and dots:

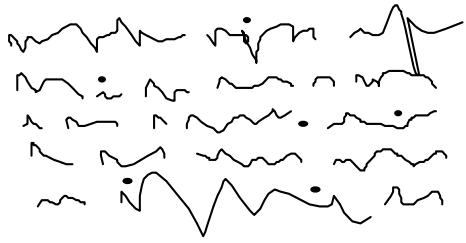

Fig. 3

The task is to decipher it. A linguist would divide the text into distinct elements based on the objective writing standards of an ancient people. The linguist must reconstruct the standards and, from that point of view, represent the conglomeration of lines and dots as a system. A wrong initial representation would condemn all subsequent work to failure, and only one representation will allow the task to be solved correctly.

4. Distinguishing between organization and systemicity. Must a "designer" be a Man (or something created by man)? We have no reason to insist that this be so. Any mechanism that carries out a "plan" by giving structure to material can be regarded as a "designer." This leads us to concepts of organization and of an organizing system that is comparable to a human researcher in its "perfection". A system consisting of two elements A and B and a special determining mechanism which structures element B according to project A will be called an *organizing system*.

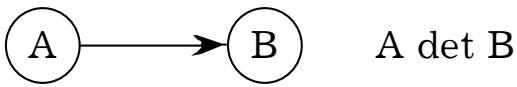

Fig. 4

The structure acquired by element B in this system will be called its *organization*, as opposed to the structure given the element by a human researcher, which will be called its *systemicity*. Such a scheme enables us to introduce the concept of "organization" as characterizing an element of a system but not the whole. To define this concept for the latter we must introduce the concept of a *self-organizing system*.

5. Self-organizing system. A system in which one element functions as the plan for the whole and a particular mechanism structures the whole according to the "plan" will be called a *self-organizing system*. The organization of the whole is that structure

which is generated by the realization of the plan.

A *det* B
A ∈ B

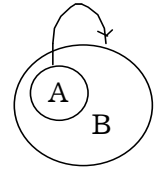

Fig. 5

6. Principle of borrowing. A self-organizing system can be studied just like any other object. In this case, the choice of how the system should be represented is completely up to the researcher. But if we seek to study a self-organizing system *qua* self-organizing, the choice is determined by the system itself. The researcher must extract the system's design from the system, include it (usually with some modification) in the set of his *means for system representation*, and examine the system as if from the point of view of the system itself. The principle of representing a system using means extracted from the system itself will be called the *principle of borrowing*.

7. Degree of organization. The deviation of the system's structure from its plan (system dissonance) can be taken as a measure of the system's organization. The greater the deviation, the less the organization. This allows us to introduce a concept of *degree of organization* without relying on an absolute universal measure, whose function is often assigned to entropy.

8. Systems - configuroids. Consider the process of constructing an electronic device. Omitting insignificant details, we can describe this process in Figure 6. Two different structures are materialized in an electronic device; it has two organizations, both embedded in it. Systems which involve such "symbiosis" of different structures will be called *configuroids*. A special class is constituted by configuroids with antagonistic structures. To represent a configuroid,

it is necessary to construct a system of system representations, that is, a *configurator*.

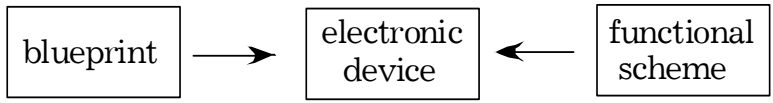

Fig. 6

9. Self-reflexive system. A system, one element of which functions as a representation of the whole, will be called a *reflexive* system. A system which is both reflexive and self-organizing will be called *self-reflexive*. Reflecting the whole in one of its elements will be called *reflexion*.

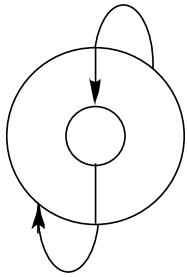

Fig. 7

10. A group as a self-reflexive system. The concept of a self-reflexive system makes it possible to explain some aspects of the functioning and evolution of groups of primitive people. In particular, it makes it possible to construct a mechanism for the origin of individual reflexion. Let us construct a model of a primitive group.

We distinguish between the "leader" and an "ordinary member" of the group. The leader acts as a "designer" of group situational structures. This is his one and only function. Every ordinary member possesses a number of working procedures not internally connected with one another; they can be connected into a

sequence only by the leader's agency.

All the members of the group deal with reality, but the leader deals with a special kind of reality - that of the group itself. The leader is apart from the group and stands above it. He can fulfill the function of a designer if he assimilates this reality by mapping it onto a special tablet, transforms that representation into a plan, and then executes this plan.

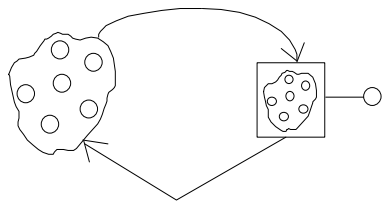

Fig. 8

The tablet must represent ordinary members of the group, the object assimilated by them, and special notations of the procedures performed by these members.

Thus, there are two types of activity:

1) work operations performed by ordinary members, and

2) special operations related to a particular object, a group, and performed by a leader using a special semiotic means, that is, a tablet.

It would seem that a "herd" turns into a group at the moment when it becomes self-reflexive, that is, when semiotic means appear for planning the activity of a group as a whole.

11. Small groups. Let us limit the number of ordinary members in a group and leave the number of necessary working procedures unchanged. In a small group the leader must perform some ordinary functions in addition to his functions as leader. Thus, while solving certain problems the leader must map himself onto the tablet as a special material substitute for the self, together with the

other ordinary group members (for example, in allocation problems). From this point a new phenomenon arises. Both ordinary operations and specific organizational activity are conflated in the person of the leader.

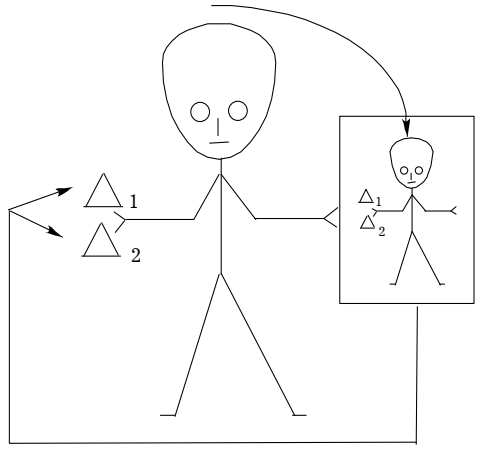

Fig. 9

For the first time, individual activity becomes *organized*. Now the mechanism that previously functioned within the framework of a group is transferred to individual activity. The leader turns into a *self-reflexive system*.

In the beginning, the system for controlling the group (signals) has to be a component of the leader's individual activity. But since there are no spatial distances needing to be overcome in this system, the signals in individual activity become irrelevant, and a direct connection between the tablet and the leader's working procedures is established.

Apparently, the connection of two different types of activity through the creature's mapping itself onto a tablet is the moment when individual reflexion appears. The "self" appears as an external material substitute for the leader. Initially, the loss of the material substitute is a loss of reflexion (self-consciousness). Only later, when the object-substitute comes to be reflected physiologically, does it

evolve into a "head."

Individual consciousness cannot appear in the "head." To explain its appearance, one must study the structure of group activity and the evolution of symbolic systems. The problem of the origin of man, as well as that of the origin of primitive society, are essentially semiotic problems.