A MODEL OF LIBRARY NETWORKS EVOLUTION

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ABSTRACT. The paper discusses a model explaining the appearance and character of phenomena taking place in research libraries after World War II. Two dominating phenomena are discussed - integration of library networks and computerization. The described model is based on the assumption that the evolution of libraries (occurrence of the said phenomena) is caused by the loss of equilibrium in the system and the effort to recover it. The factors which have led to inequilibrium in libraries and how it occurred is briefly discussed. Then a certain rule of recovering equilibrium by the system is shown. It says the system in order to recover equilibrium changes groups of certain quantities which describe the so-called substates (e.g. size, or organizational structure). It is not done at random, however, but always a certain, peculiar to the system, hierarchy of substates is preserved.

INTRODUCTION

When I started to work on the behavior of large information systems the thing which made my life miserable was the lack of a good theory capable of explaining the changes taking place in them.

Statements, rules and hypotheses available in literature were usually very general and had relatively small explanatory power. I must stress here that it was necessary to employ here an explanatory procedure for both cognitive and practical reasons. In order to manage effectively large information systems one must understand their behavior - to the highest possible degree. The situation is similar when new systems are designed or old ones are modernized. A good theory explaining the behavior of systems is invaluable in such situations. Many failure which occurred during the building of the national scientific and technological information system in Poland were due to the lack of knowledge on the above mentioned subject.

My research was concerned in particular with the network of research libraries and dealt with a certain aspect of their behavior, namely their evolution. The development of research libraries after World War II has been characterized by two phenomena, the so-called...
integration and computerization. Integration means here all the forms of library cooperation - cooperation in acquisition, interlibrary loans, storage, processing and cataloging, microfilming, and binding. It has been accompanied by similar, large-scale ventures - plans to coordinate library collection acquisition on a regional, national or even international basis (the Farmington Plan, Scandia Plan, etc.). Starting from the sixties, a specific form of cooperation has been rapidly growing - I am referring to library networks which have been created in a number of countries and which link from several to several thousand libraries. Very often located on different continents. Computerization, the other phenomenon already mentioned, was introduced into the libraries in the sixties and popularized in the seventies. After I had collected and organized some relevant factual material I knew what was going on, but did not know the most important thing - why it was going on?

I have formulated two questions: Why did the phenomena, I observed, take place at all? Why did they proceed in this very way?

I have started with the search for the causes of the studied phenomena. But soon I got lost in factors which not only caused those phenomena, but also interacted with each other. An appropriate model, if not a theory, was needed which could give not trivial, but useful answers to the two questions.

DESCRIPTION OF THE APPLIED THEORY-MODEL

Assumption 1. Assumption 1. A system always strives to achieve equilibrium. 1)

Definition 1. Equilibrium is a state in which no external or internal forces act on the system, or the action of such forces is mutually balanced, or the system does not feel the action of these forces.

Assumption 2. Assistance 2. The state of the system consists of a number of substates remaining in respect to one another in a hierarchical relationship which is peculiar to a given system.

Definition 2. The state of a system is a set of actual values of all the quantities of the system.

Definition 3. A subset of a system is a certain subset of the set of all the quantities of the system.

Statement 1. A system tries to achieve equilibrium by changing the substate which is the lowest in hierarchy. If its change does not result in equilibrium the next substate in hierarchy will change.

Statement 2. If a change of a given substate involves a change of a substate standing higher in hierarchy the substates standing in between them will also change... If these changes are not effective the change of the higher substate is accepted.

Statement 3. A change of any of the substates and the resulting loss of equilibrium caused by a direct action of external factors will make the system try to recover equilibrium by changing substates starting with the lowest in hierarchy.

Statement 4. If a system exhausts all the possibilities of change (i.e. even the change of a substate occupying the highest position in the hierarchy does not result in equilibrium), the system dies.

The theory-model in systems of the organism equilibrium may be a characteristic of certain hierarchy of system. In other words, it is to save others. There is all, it was said earlier achieve equilibrium.

THE PROCEDURE OF EXPLORATORY LIBRARIES AFTER WORLD

Integration has ship throughout the world it took the form of a degree it entailed a Using the model here answer the following occurred in the library the equilibrium?

In the studied period -
- a more rapid increase in war period,
- a more rapid increase in war period,
- a more rapid increase in war period,
- an increase of the organizational and type,
- an increase of the organizational and type,
- a change of formal and non-formal changes, a change in financial institutions.

Changes within the in of certain elements of the financial systems forces the libraries (if it has app...
The theory-model presented here describes the mechanism of change in systems of the organization-institution type. It says that the lost equilibrium may be recovered by the change of internal quantities characteristic of the system. It assumes, however, that there is a certain hierarchy of importance of these quantities, peculiar to every system. In other words, a system will sacrifice certain quantities to save others. There is an apparent contradiction in this sentence. After all, it was said earlier that a system, in the first place, strives to achieve equilibrium. True, but maintaining certain order—a hierarchy of quantities characteristic of it. Of course, this model does not tell how a particular hierarchy of substates looks like. It must be determined by a researcher. In my research I have decided to treat as substates the sets of quantities characterizing: the size of a system, used technology, organization, efficiency and system status (position among other similar systems). Thus if we adopt the above model we must accept that the evolution of a certain type of systems (information systems) takes place exclusively in the way of continuous search for equilibrium. To put it differently, a system in equilibrium will not evolve.

The Procedure of Explaining the Phenomena Taking Place in Research Libraries After World War II

Integration has been one of the dominating phenomena in librarianship throughout the whole post-war period. As it was mentioned earlier it took the form of extensive cooperation of libraries. To a certain degree it entailed a limitation of the autonomy of these institutions. Using the model presented above to explain this phenomenon we must answer the following questions: has the loss of equilibrium really occurred in the library systems? How did these systems manage to recover the equilibrium?

In the studied period we can observe:
- a more rapid increase of the number of publications than in the interwar period,
- a more rapid increase of the prices of publications than in the interwar period,
- a more rapid increase of maintenance costs than in the interwar period,
- organizational and technological changes in other systems of the same type,
- an increase of the number of users of a system,
- a change of formal (official) tasks of institutions,
- a change in financial status and social prestige of employees of other institutions.

Changes within the institution: a continuous increase of size (at least of certain elements of institutions).

The effect of the variables listed here causes the system to lose its equilibrium in the following way: 1/ an increase in the number of publications forces the library to store an increasing number of library materials (if it has appropriate funds at its disposal) — as a consequence, library staff become overworked; if, on the other hand, the number
of stored publications does not increase, it leads to growing discontentment of users and superior institutions, which may result in the library being punished. 2/ rising prices of publications cause the library to reduce the number of library materials stored, which creates discontentment on the part of users and superior institutions and produces disproportionate demand on different departments (dissatisfaction of some of the staff); equilibrium is preserved if the budget is increased.

3/ rising maintenance costs causes the library to either increase its budget or reduce its expenditures (e.g. through staff reductions). 4/ organizational and technological changes in other, similar systems (administration, banking, etc.) change the expectations of the library users who begin to expect the same type of service and librarians meet on a daily basis these new methods of service in banks and offices; new library employees get professional training in line with new organization and technology trends. Therefore, they tend to follow this model of service. It is also a situation of lack of equilibrium; the stress it produces vanishes once they have adopted the acquired or generally practiced behavior. 5/ the introduction of organizational and technological changes in the other systems of the same type may lead the library staff to perceive their prestige as lowered as long as the new solutions are not introduced into their library (it applies, in particular, to management and administration).

6/ an increase in the number of information users increases the system load or, if it ignored, results in the dissatisfaction of the users. 7/ a change in the formal (official) functions of the library causes the loss of equilibrium of the whole system. 8/ an increase in the financial status and social prestige of the employees of other institutions is seen by the library workers as a decrease in their material status and social position, which is of course a situation of un-equilibrium. 9/ an increasing size of the library (increase in the collection) causes an increasing demand on some of the departments.

The factors listed here influence the library with different intensity and simultaneously (which, of course, complicates research work and directly causes the system approach to be used).

Our model also takes into account the degree of interrelations between the library and user and between the library and superior institution or sponsor (university authorities, ministries, etc.). If this interrelationship is weak (e.g. the user cannot "punish" the library for inadequate service) the influence of some factors is rather small (an increase in the number of publications, users and in book prices). Factors modifying the course of evolution include: the level of technology available for the system (library), its organizational structure and functioning hitherto, availability of funds and professional training of staff.

In American library networks and to a similar degree in some countries of Western Europe (U.K., West Germany and Scandinavian countries) the following hierarchy of substates is prevailing (determined by me):


For many years the increase of amount of library materials has been compensated by the libraries by the change of their size. In 1850 an average
German research library had a collection of 128,000 volumes, and an American library of 16,000 volumes. In 1920 an average size of holdings of German libraries was 486,000 volumes, and of American libraries 300,000 volumes. In 1960 an average size of holdings in the largest American libraries was 1,794,000 volumes. In West Germany this parameter amounted, in that time, to 837,000 volumes (a result of the war and the division of Germany).

A further increase of the size was limited by the amount of available funds, besides from a certain moment the size had an adverse effect on library operation effectiveness. In this way a new equilibrium was created. The changes of the substrate "technology" did not bring about any results because there were no technological means that could radically solve the accumulated problems in the 40's and 50's. Changes on the level of "organization" led to dynamic equilibrium (eliminating one of the types of serious tensions, i.e. inadequate financial means and at the same time maintaining efficiency on a satisfactory level, understood as a ratio of outlay to effects).

In some countries (also in Poland) the factors affecting the system were of the same type as in the case discussed above, but they were ordered differently in the hierarchy of substrates. It looked as follows:


Changes on the level of "efficiency" (decrease of efficiency) do not cause equilibrium in this case. It is caused in the first place by the lack of dependence of the system on the user. A significant role is played also by the mentality of the society which is used to a low standard of services. Of course, very low efficiency will cause changes on higher levels, but we do not have to do here with such a situation. The second phenomenon I would like to mention here is computerization. This phenomenon differs from integration in the fact that integration is a process peculiar to libraries and computerization is a feature of the civilization for at least 30 years. It may seem that computerization entered the libraries in a way analogous to the changes of organizational structures. The lost equilibrium of a library network cannot be recovered through the change of size, therefore new technological devices are introduced (change on the level of "technology"). This mechanism is of course true, but the causes of equilibrium are entirely different. Financial difficulties of libraries are solved sufficiently well on the level of organization. Probably, the loss of equilibrium is, in this case, a result of the differences in the technological equipment of the library and similar systems (banks, offices, agencies, etc.). It results in the fact that the library personnel senses this situation as a decrease of their prestige, is upset realizing that there are devices available to the library which might make their work easier. Users are also dissatisfied because they are already used to different technological equipment. To put it briefly, the library and other similar institutions form a peculiar system of connected vessels. The use of computer technology in these institutions and not using it in libraries causes equilibrium (similarly to unequal in connected vessels). This mechanism can be clearly seen in Poland. In the 70's, despite the efforts of many librarians, computerization did not reach the libraries here. At present, computerization (precisely speak-
ing microcomputerization) is introduced to libraries automatically, so to speak. The computerization of libraries is always in constant proportion to the computerization of other spheres of life. It reflects the state of computerization of the whole economy.

CONCLUSIONS

The model presented here is not, of course, a final version, free from contradictions. To keep my line of argumentation clear I have left out many specific considerations. In particular, it is important in specific research to determine precisely what is understood by a given substate. For example, one may encounter different types of efficiency - e.g. in the sense of effectiveness (expediency, relevancy, service time), and in the sense of economic efficiency. It might be possible to isolate in the substates further subsets of quantities, ordered hierarchically. Next, there are certain doubts in respect to the form of Statement 1. In fact, it is formulated in such a way as to suggest that the system protects the immutability of its substates, sacrificing those occupying the lowest position. Maybe in this way it tries to survive - a special case of equilibrium. If a change of size causes the decrease of efficiency - it is a loss of equilibrium, but if the efficiency increases? Undoubtedly there has been a change, but does the system feel it as a loss of equilibrium? Besides, I do not discuss here the effect of modifying factors on the scope of changes.

I should also mention here that the global evolution of the whole library network is also furthered by the appearance of new libraries with new technologies already built-in. One cannot ignore a certain role played by infiltration - penetration of innovations into the system through the replacement of used equipment (used equipment is usually replaced by technologically more advanced equipment) and the replacement of personnel (old employees are retired and new ones bring with them new types of thinking and professional proficiency). It seems, however, that changes through infiltration can also lead to the loss of equilibrium and trigger the same mechanisms of its recovery as already described.

To sum up I must admit that despite its many deficiencies and empirico-intuitive character this model has already proven very useful to me. On the one hand as an research instrument and on the other as a tool which surprising accuracy anticipated certain phenomena in real information systems.

REFERENCES

1. I believe that this view is widely accepted by systems research scholars. I want to quote here a fragment from the work by W. Ross Ashby: 'Principles of the Self-Organizing System' in Modern Systems Research for the Behavioral Scientist, ed. by Walter Buckley, Chicago 1968 p.115 "We start with the fact that systems in general go to equilibrium".

The system group.

2. Remember that, as a de-
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of matter tal-
L. von Bertalan-
1953 p.11-12
This definit-
tried to def-
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sions (actio-
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3. See Robert A
Trends in Ge-
p.213 (In Po-
See also Ana-
in General S-
op. cit. p.5-
"If variable-
edefined as a-

4. A substate c-
structure, o-

5. See J. Peria-
of German an-
The systems analyzed by me belong of course to the self-organizing group.

2. Remember that for Bertalanffy dynamic equilibrium was an independent of time state of open system in which all macroscopic quantities remain constant, although microscopic processes of exchange of matter take place continuously.


This definition, however, did not meet my needs. Finally, I have tried to define equilibrium for open self-organizing systems as a state in which the system does not feel subjectively any tensions (action of any forces). I believe that in the systems in which man is one of the elements this subjectivity of feeling the influence of particular forces is very important. By the way, systems research has a lot of trouble with the definition of equilibrium, although the term itself is used rather easily and frequently.


"If variable are elements of the system the state of the system is defined as a set of values of all the variables in a certain moment"

4. A subset can be a subset of quantities defining organizational structure, or the size of a system, or its efficiency.