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 unequilibrium 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 sys-
tems 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 proce-
dure 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 scien-
tific 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

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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 inter-
national 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
I 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. A system always strives to achieve equilibrium. [1]

Definition 1. Equilibrium is a state in which no external or inter-
nal 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. [2]
Assumption 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. [3]
Definition 3. A substate of a system is a certain subset of the set of
actual values of all the quantities of the system. [4]
Statement 1. A system tries to achieve equilibrium by changing the sub-
state 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 sub-
state 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.

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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 deter- mined by a researcher. In my research I have decided to treat as sub- states 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 librarian- ship 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 inter- war period,
- a more rapid increase of the prices of publications than in the inter- war 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 publi- cations forces the library to store an increasing number of library ma- terials (if it has appropriate funds at its disposal) - as a consequen- ce, library staff become overworked; if, on the other hand, the number

of stored publications does not increase, it leads to growing discon-
tentment of users and superior institutions, which may result in the
library being punished. 2/ rising prices of publications cause the li-
brary to reduce the number of library materials stored,which creates
discontentment on the part of users and superior institutions and produ-
ces 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 bu-
dget or reduce its spendings(e.g. through staff reductions) 4/organiza-
tional and technological changes in other, similar systems(administra-
tion, 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
and technology trends. Therefore, they tend to follow this model of ser-
vice. It is also a situation of lack of equilibrium;the stress it produ-
ces vanish 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 per-
ceive their prestige as lowered as long as the new solutions are not in-
troduced 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, of it ignored, results in the dissatis-
faction 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 in-
crease 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
unequilibrium 9/ an increasing size of the library (increase in the col-
lection) 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 dir-
ectly causes the system approach to be used).
        Our model also takes into account the degree of interrelations bet-
ween the library and user and between the library and superior institu-
tion or sponsor (university authorities, ministries, etc.). If this in-
terrelationship 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). Fac-
tors 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 coun-
tries of Western Europe (U.K., West Germany and Scandinavian countries)
the following hierarchy of substates is prevailing (determined by me):
1. Prestige 2. Efficiency 3. Organizational structure and mode of ope-
ration 4. Technology 5.Size.
For many years the increase of amount of library materials has been com-
pensated by the libraries by the change of their size. In 1850 an average

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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 parame-
ter amounted, in that time, to 837,000 volumes (a result of the war and
the division of Germany).[5]

A further increase of the size was limited by the amount of avai-
lable funds, besides from a certain moment the size had an adverse ef-
fect on library operation effectiveness. In this way a new unequili-
brium was created. The changes of the substate "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 (eli-
minating one of the types of serious tensions, i.e. inadequate finan-
cial means and at the same time maintaining efficiency on a satisfacto-
ry level, understood as a ratio of outlay to effects).

In some countries (also in Poland) the factors affecting the sys-
tem were of the same type as in the case discussed above, but they were
ordered differently in the hierarchy of substates. It looked as follows:
1. Prestige 2. Organization 3. Technology 4. Efficiency 5. Size.

Changes on the level of "efficiency" (decrease of efficiency) do
not cause unequilibrium 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 computeriza-
tion entered the libraries in a way analogous to the changes of orga-
nizational structures. The lost equilibrium of a library network can-
not be recovered through the change of size, therefore new technologi-
cal devices are introduced (change on the level of "technology"). This
mechanism is of course true, but the causes of unequilibrium are enti-
rely different. Financial difficulties of libraries are solved suffi-
ciently well on the level of organization. Probably, the loss of equi-
librium is, in this case, a result of the differences in the technolo-
gical equipment of the library and similar systems (banks, officies,
agencies, etc.). It results in the fact that the library personnel re-
sents this situation as a decrease of their prestige, is upset reali-
zing 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 lib-
rary 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 unequlibrium (similarly to unequal in con-
nected 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 pro-
portion 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, relevantness, service
time), and in the sense of economic efficiency. It might be possible to
isolate in the substates further subsets of quantities, ordered hierar-
chically.Next, there are certain doubts in respect to the form of State-
ment 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 in-
creases? 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 sys-
tem through the replacement of used equipment (used equipment is usu-
ally replaced by technologically more advanced equipment) and the re-
placement 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 em-
pirico-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, Chica-
   go 1968 p.115 "We start with the fact that systems in general go to
   equilibrium".

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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.
    L. von Bertalanffy: Biophysik des Fließgleichgewichts. Braunschweig 1953 p.11-12.
    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.

3. See Robert A.Orchard: 'An Approach to General System Theory' in Trends in General Systems Theory, ed. by G.J.Klir, Warszawa 1976, p.213 (in Polish translation).
    See also Anatol Rapoport: 'Application of Mathematical Isomorphism in General System Theory' in Trends in General Systems Theory... op. cit. p.54
    "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 substate can be a subset of quantities defining organizational structure, or the size of a system, or its efficiency.

5. See J. Periam Danton: Book Selection and Collections: A Comparison of German and American University Libraries, New York 1963.

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