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Co-operation and Network Flexibility in Scientific Research

Sorin Ionescu*, Gheorghe Militaru*, Ileana Ghiţă*, Dan Diulescu**

* University Politehnica of Bucharest, Splaiul Independenţei 313, Bucureşti
e-mail: scion@amcsit.ro, ghmilitaru@gmail.com

** Pforzheim University, Tiefenbronner Str. 65, D-75175 Pforzheim, Germany
e-mail: aaa@hs-pforzheim.de

Abstract

Research programs developed within the European Union encourage the creation of partnerships to ensure competitiveness. At the same time, the industry policy in the European Union sets as a goal increasing producer's flexibility. The producers create both investment and consumer goods, but also knowledge. The research policy represents a part of the industry policy and promotes:

- *minimizing research efforts;*
- *creating top-range knowledge.*

Key words: *research network, scientific research, flexibility*

Introduction

The producer's need for flexibility is connected to environment uncertainty [5]. Scientific cooperation takes place in a turbulent background. Diminishing the risks and creating synergy leads to elaborating scientific research networks. As a consequence, that generates an economy of goal which provides advantages if the network is flexible. The flexibility in the research network involves passing rapidly from a theme to another, quick creation of partnerships - all being subordinated to the quality of solutions that resolve the contract themes. The network's performance can be characterized by parameters such as: research capacity, quality level, profitableness.

Environment of Research

In 1980, John Naisbitt identified 20 mega trends that have recently appeared in the research environment: transformation of industrial society to informational society, spreading of high-tech technologies instead of mechanical ones, global economy birth and transition from national to transnational projects, firms use long term predictions, the trend translates from centralization to decentralization, autonomy of individuals, trying to act by their own means, participative democracy, network structures instead of hierarchical ones, general displacement of production facilities toward South, existence of multiple options for each activity, market globalization, arts re-birth, market socialization, similar life style around the world, privatization of public

services, development of Pacific area, woman ascension to top staff positions, biology development, religious re-birth, individuality triumph.

The main characteristics of current environment are uncertainty and dynamism:

*Uncertainty***.** Uncertainty can be analysed in relationship to changes in dynamics and environment complexity. (Figure 1). The following degrees can be identified:

- Low uncertainty – Food industry;
- Moderate uncertainty – Inssurance companies;
- Raised uncertainty – Women clothes;
- Large uncertainty – Scientific research.

The degree of uncertainty is needed to establish the next status of the environment.

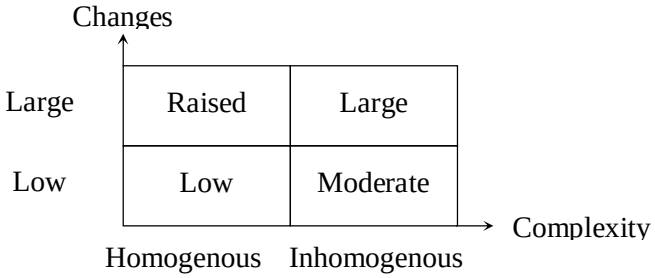

Fig. 1. Uncertainty types

Dynamism – the rhythm of changes is growing. Environmental changes can be described as: growth of economic race, expansion of communications, diversification of customer demands, globalization and global competition, high communication speed and low cost, privatization, settlements relaxation, mergings, aquisitions, alliances, technologies discontinuity, larger production volumes, reduction of company size, change in customer expectances, home activities instead of office activities, limitation of raw materials and energy, introduction of ecological restrictions.

Manager's reaction to change is different (J. Thompson):

- adaptive: passive (they build buffer stock) or reactive (anticipative: they make previsions);
- innovative: they try to modify the environment (through public relations, negociations);
- activity retirement, domain modification.

The frequency of the changes that appear in the industrial environment is considerably different in each industrial branch, area or country.

Three types of environment can be mentioned, as J. Stolker (1961) suggestively named them: steady, variable and turbulent.

The steady environment allows unchanged frame of industrial unit to be maintained for a long period of time, focusing on strict specialization of employees, on compelling definition of attributions and respect for authority lanes.

The variable environment allows appreciable relaxation of those demands and changes them at large time intervals.

The turbulent environment imposes the adoption of a slender frame and leadership manners of announced or already in progress changes. The firm operating in turbulent environment is not focused on a rigorous definition of employee attributions, but on its capacity to solve large

variety of problems generated continuously and unpredictably by the environment itself. Technological breakages are common in turbulent environment and it is difficult or impossible to anticipate them due to disorderly behaviour of environmental factors.

The *influences* between research unit and external environment are mutual (Figure 2). On the one side the research unit influences the environment by the provided products and services, by core specialised personnel which helps create a professionally spread culture, by the work places required by the employees, with their social cultural activities, with their taxes and financial contributions, by information dissemination, all these being responsible for the growth of the living standard.

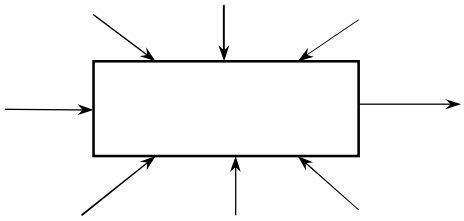

Fig. 2. The influence between research unit and environment

On the other side, the environment affects the research unit and its activities by available information (regarding market demands, production factors demand, existing trends), available resources, demand for organizational frame endorsement and leadership methods suitable to request frequency, the need for opening contact points between the unit and the economic or financial partners working in the same field.

The multiple connections between the research unit and environment are dynamic (in continuous change), adaptive (adapting work structures and methods) and active (influencing the environment by innovative products and services).

The influence of the research unit upon the environment depends also on its size, own financial results or affiliation to different multi-national groups.

The *effects* may be:

- Positive effects: founding new work places, income distribution, local enterprises conveniences, entrapment effect, regional development, local taxes.
- Negative effects: compete with other local enterprises, raise of land price, security issues (explosive or toxic products), surroundings' bio-damage.

The analysis of research unit relations with the environment can be completed in a few different ways:

- Seeing the research unit as an integrated environment system by its input (raw materials, energy, facilities, capitals, work force, informations) and output (products, services, informations);
- Considering the research unit as operating in a frame of political, social and economical opportunities and restrictions;
- Considering the research unit under normal incidence imposed by customers, suppliers, shareholders, governamental and local organizations, employees, citizens, etc.

The influence of environment over management can be explained by two modern theories whose result was the modification of leadership in the past years: the contingency theory (P. Lawrence si J. Lorsch - 1968) and restrictions theory (E. Goldratt -1985).

The contingency theory shows that the environment deeply influences the behaviour of the research unit personnel, organizational structures and applied methods.

- Clear information available about developed activities
- Random character of an activity.
- Confirmation time for the acknowledgement of the activities to be accomplished.

The possibility to predict the work environment depends on the following (Figure 3):

- Industrial sector in which research unit is operating;
- Technological position of research unit within sector;
- Individual activities within research unit (research, production, sale).

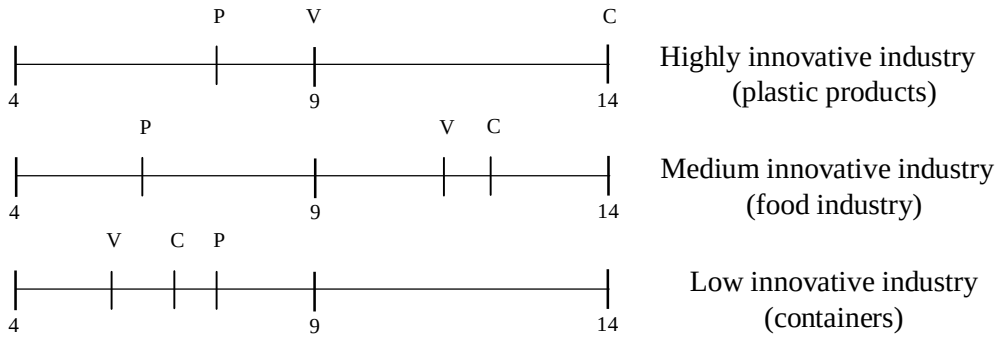

Fig. 3. Easy previsions

The difference between different environments generates differences in personal behaviour, in organizational frame, in innovation orientation, in managers' emotional reaction. So, the differences that appear can be as shown below:

- Activity formation;
- Inter-personal relations;
- Time horizon (short or long) to which the research unit is guided.

If provision spell is shorter, there will be less formal organizational structures, less hierarchical levels and a distribution of decisional centers to intermediate levels. In highly predictable environments, rigid frames are more efficient.

Thus, there are no absolute optimal structures and no absolute efficient methods and each organization should re-adapt to the industrial sector environment.

Restrictions theory states that a system should be analysed related to its own imposed restrictions. Restrictions appear due to traditional naturalized rules (culture), adopted policy (conceded facilities), methods used and available resources (human, equipment). Some restrictions are difficult to identify. Most restrictions can be outclassed by system improvement and not by their elimination.

To be able to lead the organization in a restrictive environment it is necessary:

1. To identify restrictions;
2. To analyse restrictions (not all of them are principled);
3. To adjust the system components in order to make it efficient for existing conditions. But in this case it is possible that some present restrictions which are passive will be transgressed.

4. To dismiss useless restrictions;
5. System control – no solution is permanent.

When the environment is changing a solution is less depreciating if its self modification is in accordance with the changes. Most restrictions exist because of obsolete internal politics. Politics makes the rules regarding the way in which to accomplish activities. Acting accordingly more solutions and ways of analysis are closed.

To be able to apply restriction theory concepts the following must be emphasized:

- System global optimisation (without underoptimisation);
- Process identification – they are interconnected and should be represented in a Business System Mapping (BSM);
- Performance measurement (local decision effects are measured in research unit results by income, stored, expenses).

Research Cooperation

After 1975 research units did not limit their own development to national level. Some markets attract increased number of firms than others. That expansion is achieved by export or industrial units' implementation.

In 1965 Marshal Mc Luhan said that Earth had become a "global village" considering that specialized stock exchanges had appeared world wide as the global television network.

The word national economy shows now only the activities within a country, but the economic system tends to become total because economic processes have become transnational. Powerful firms are interested in business globalization while the small ones are content with local markets and try to preserve them. This is the reason why antiglobalization movement has appeared. But inefficient economic processes can not help local firms, although it is true that powerful firms want to create monopoly.

Through its effects globalization is compared with industrial revolution (which also was boycotted). Globalization succeeds in bringing foreign managers in firms that seem to be national and the industrial units assign abroad activities that are more efficient in another environment and offer better quality.

The impulse towards globalization is given by:

- *New technologies* which are making efficiency possible, even for a small amount of products;
- *Research costs* – research has become increasingly expensive. For example, for a new car model, research cost has increased from 500 to 1500 million dollars, for medicine from 50 to 300 millions, for computers from 600 to 2000 millions. Many enterprises did not succeed in paying off their expenses with their national market share and extended their activity world wide, by acquisitions, licences, joint-ventures or being absorbed by more powerful competitors.
- *Raw materials concentration* in some under-developed countries carried to internationalization of some western enterprises;
- *Innovation acceleration* – the classic process of launching new products consists in a first presentation down the national market and then on other markets. This allowed some products to be copied. Today, due to shorten product cycle, (5 years for a car, 6 months for

a hi-fi stereo) the pay-off should be faster and the product is launched on many markets simultaneously.

- *Competition typology* – in the past, enterprises were more integrated, directly managing all fabrication stages for a certain product. McKinsey advise to build a business system composed by many compartments extremely competitive, even if they belong to different firms.
- *Free markets* – until recently, few firms have tried globalization, but penetration of their national market by foreign firms forced them to look for a global dimension. Some theories suggest that a market has space only for three-four competitors, so concentration is inevitable. But, fortunately, a product is formed with many components, so there is space for more operators, world wide leader parts or stages being continuously searched.
- Globalization occurs also due to the apparition of *universal products.* After 1970, increase number of products has become universal and this number tends to augment. In this category different products are included: food (hamburger, chips), clothes (blue jeans, furs), electronics (watches, computers and video cams), automobiles, services (holiday clubs) and publications. Some have high technological intensity (computers, medicines and telematics) and others have appeared because of their science based standardization. Also in this category we can include goods that are seen as symbols of modernisation. Sometimes, even products representing the national brand become global (French wines, Italian fashion, Japanese motorcycles).

Japanese electronic enterprises are able to manufacture universal products because their chief designers are annually sent abroad to understand market tendencies and competitor's technological advance. Some universal products are obtained through joint-venture of more national enterprises. For example, CD is a standard product obtained from co-operation between Philips, which released it, with Sony and Matsushita. Other universal products are obtained due to the impact of world unique publicity spots; such are the products from Texas Instruments. Thus, a compact and coherent image of an enterprise on different markets is achieved.

Networks Flexibility

Flexibility is the network capacity to easily adapt to environment variations. This directly influences research costs.

Classic theories states that cost reduction can be achieved either through flexibility or projects quality reduction. Now, cost reduction is achieved simultaneously through flexibility and quality development.

Network flexibility is resulting both from its own structure (intrinsic flexibility) and coordination manner (managerial flexibility) [3]. Network will include only organizations with accepted values of *transactional costs*. Transactional costs explain why in certain countries research units integrate many activities (rarely all) and in other countries almost every function is completed by different firms, having contractual connections between them. For adaptation of themselves research units tried to define some *internal markets* where only internal providers and customers can interact. For example to a Brazilian firm tasks are posted up and anyone can stand as a candidate for them. This makes department innovation to become so strong.

To some other firms resources are distributed judging by performance and departments are competing with each other. Motorola's autonomous units are competing with each other to realize a product. Sometimes firms allow SBU's to auto-administer their own businesses in their relationship with competitors. Philips's units are not forced to buy supplies from others units in the concern. Mitsubishi allows his units to choose their partners from internal market, resulting strong departments competitions.

Transactional costs include:

- provider's requested price for the services;
- provider's identification and evaluation cost;
- contract cost;
- litigation quash costs;
- firm vulnerability coverage costs confronting with providers' behavior.

Market imperfections are arguments for activity integration. But the apparition of specialized research units in a secondary activity can develop a market and then can build up a network.

Because networks are operating in a turbulent environment, flexibility has become a strategic matter. Flexibility is the capacity to adapt easily to environmental variability.

I. Ansoff (1975) developed the subject, but still since 1939 G. Stigler had spoken about equipment's flexibility and J. Marsclak in 1962 about decisions flexibility (making it true for a long period of time). Today we can talk both of management system flexibility and operation system flexibility.

Flexibility achievements hypothesis are:

- objectives remain true as time goes on;
- network is a partial controllable system (the results are not depending only on internal decision but also on external factors too);
- management process is done in uncertainty conditions (information is incomplete).

Initially network flexibility was obtained using modulated themes, complementary technologies, flexible structure, multi-qualified people, multiple information sources, briefly being based on division of labor. Today network flexibility is obtained by flexible research units, by network management, investments guidance, and environment adaptation.

Flexibility Types for a Research Network

These types are as follows:

- effective – constant adaptation degree;
- potential – defined trough designed network way;
- approved – wanted adaptation level.

Network flexibility results from its own structure but also from coordination possibilities. There are two ways to describe flexibility:

1. Capacity to assume a wider range of tasks for the same structure (utilization flexibility).
2. Capacity to adapt the structure at transformation change type with minimal effort (adaptation flexibility).

Adaptation is required by the product life span, rapid changes of market, competitive growth, and different requirements of customers. Industrial flexibility is a consequence of individual and groups flexibility. Flexibility should be visible both at operational and managerial levels.

Managerial Flexibility

This flexibility assumes changes easy to adapt leadership. This can be achieved by *activities* such as:

- Marketing – personalized products ;
- Sliding review planning;
- Strategy – insure decision unity ;
- Multivalent trained personnel ;
- Research based on programs and projects;
- Constructive concept –modulated, typical;
- Commercial – alternative supply sources for interchangeable materials ;
- Financial –capacity to take short term loans;
- Logistic – based on robot-transports and storehouses automation.

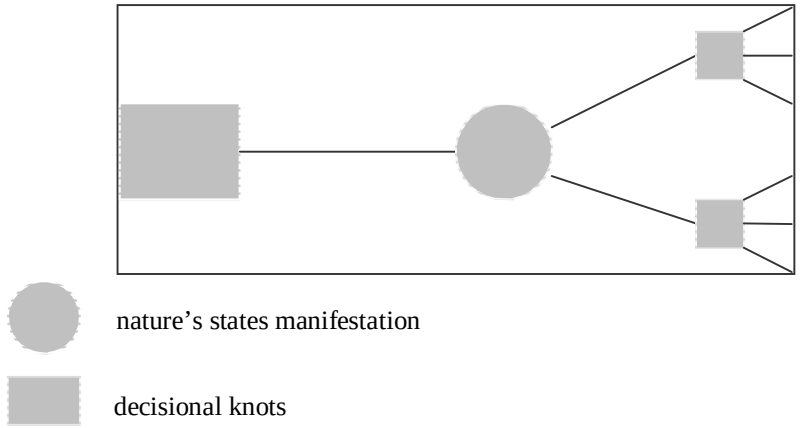

Fig. 4. Decisional Tree

Operational Flexibility

Formally flexibility can be expressed by following relation:

$$F = \frac{V_c}{V_s} \tag{1}$$

V_c - value of common used installations;

V_s - value of specific installations for a certain theme.

This formula doesn't consider timesaving appearing with implementation of new products:

$$F(S) = f(C_f, C_e) \tag{2}$$

where:

S – task;
F – flexibility;
Cf -fixed costs;

Ce - production costs.

$$\frac{dF}{dt} = \frac{dF}{dS} * \frac{dS}{dt} \tag{3}$$

A X% modification of task induce an Y% variation for C_f and Z % variation for C_e

$$F(S + X) = f(C_f + Y; C_e + Z) \tag{4}$$

If $\frac{dF}{dt} = 0 \rightarrow$ then relation with Y and Z is obtained.

A system becomes optimal if costs are considered only for adaptation of production and management systems.

Research unit flexibility is achieved using adaptive structures such as research projects and lattice. Research units should reduce hierarchical levels, should establish horizontal contacts between researchers and research units, to call for services within research network [1]. Network coordinators should attract new research units into the network or eliminate non efficient ones. Research methods and evaluation, control and monitoring procedures must be implemented.

The achievement of flexibility should start from research customer orientation. Strategic flexibility is required, which assumes the existence of a set of strategic options created by the network, options that can be applied in accordance with environment changes [4] and more persons should be attracted in strategy elaboration.

Resources' flexibility is also required. For example, supply flexibility should exist on all supply chain parts. Human resources flexibility can be achieved through empowerment, as Moss Kanter and T. Peters said. Researchers should be encouraged to take decisions and research units should create opportunities for people to get involved, providing training and reducing control. From here, management flexibility can be obtained, meaning its change when situations changes. But usually, managers identify themselves with a certain leadership style, so many years are required to adopt a new attitude. Change appears if managers have previous successes and they are experienced (even if sometimes success is an obstacle for adaptation).

Flexibility Effects

A high degree of flexibility influence research risks, intellectual work performance, research cost.

For example, in order to analyze the influence of flexibility over performance, two situations can be discussed:

- complex network structure, low productivity, maxim flexibility;
- simple structure, maxim productivity, rigidity to change.

Relation between the two examples is given by the rapport between research cost and network flexibility, low cost for rigid solution and high cost for flexible solution [2]. The following indicators can be described:

- *usage flexibility degree*:

$$G1 = nt / nT \tag{5}$$

where:

nt – achieved themes number;
nT – possibly started themes.

- *adaptation flexibility degree:*

$$G2 = Tc/ Tc + Tr \quad (6)$$

where:

Tc - project implementation time;
Tr - network re-organization time.

- *total flexibility degree:*

$$G3 = G2* (1- 1/nt) \quad (7)$$

The design of a high flexibility network depends on values of certain coefficients.

k1 - continuity coefficien:t k1 = n1/ 12;
n1 – number of month in which work is planned;
k2 average specialization coefficient k2 = n2/n3;
n2 – number of projects started;
n3 - network staff teams;
*k3 number of staff projects k3 = Fd/Q*T;*
Fd - time content available;
Q - number of completed projects;
T - planned period for a project.

Conclusions

Research networks should be designed not only to achieve tasks available at the moment of their birth, but also considering future developments. Therefore, a strategy must be defined to cover transaction costs. The accuracy of the network project can be estimated by certain coefficients. At present, it is still necessary to conduct investigations to determine usual values for these coefficients.

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Cooperarea şi flexibilitatea rețelelor în cercetarea ştiințifică

Rezumat

Programele de cercetare promovate de Uniunea Europeană încurajează formarea de parteneriate care să asigure competitivitatea. În acelaşi timp, în Uniunea Europeană politica industrială îşi propune creşterea flexibilității producătorilor. Producătorii realizează atât bunuri de investiții şi de consum cât şi cunoştințe. Politica cercetării este o parte din politica industrială şi promovează:
- *minimizarea eforturilor de cercetare;*
- *crearea de cunoştințe de vârf.*