Possible Approaches to Commercializing Applied University Research: a Russian Case Study

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***Abstract*—This paper discusses the environment around universities in Russia and possible approaches to analyzing and choosing the method for applied research results commercialization as well as selecting promising applied research areas in that environment. Conceptual foundations for decision making during the commercialization and roadmap/action plan creation processes are outlined. These can be useful to both universities for planning their activities as well as for organizations that plan to cooperate with universities or that are interested in university generated research. This being said, obtained models and used evaluation parameters may be unique and may depend upon the particular project, university, region, and personal preferences of decision makers. Thus, consideration of these parameters and characteristics only has merit when making decisions in the dynamics of change of these parameters. For this purpose statistical information is needed that characterizes the competencies of the research organization (university) in question, needs of partner organizations, governmental and societal requirements, and science and technology prospects. After determining the promising research areas it's time to look at particular projects, which in turn are also characterized by various parameters dependent upon their objectives. Considering the values of these parameters in their dynamics allows control of project parameters in the course of its execution. This in turn allows prediction of negative situations and alleviation of such by setting the target values of parameters and using best practices and standardization of management processes to achieve those values.**

***Keywords:* innovation, infrastructure, commercialization, strategy.**

I. Introduction

New research results suitable for use in products constitute a resource, the existence of which is a strategic advantage. Implementation of such results in the form of innovations requires key competencies, which the developers usually lack. Creating innovations in market economy conditions is one of the factors of accelerated and sustainable development. The process of creating and managing innovations has in itself become an innovation [3], which indicates insufficient development of innovation creation and implementation methods.

Development of innovations management theory and practice focused on solving local problems due to difficulties of managing innovations as a system [4], which created a deficit of formal methods for management and foundation [5] for implementing innovations as a system. As a result, regardless of all the advantages of comprehensive innovations management there are no systematic models for implementing innovations as complex systems in previous research, which doesn't allow to effectively solve innovations management, expertise, and validation problems.

New developments are created in R&D organizations. This creates new opportunities for analysis of methods of their commercialization, promising research avenues, and production and economy systems based on statistical bibliographical data, patent data, and data of statistical analysis of joint science and industry projects and their common requirements.

II. Description of Environment and Conditions in Which Innovation Projects Based on Research Results Appear

Results of scientific research in the form of innovation projects are implemented in open systems, creating a lot of uncertainties in the form of links to external systems. Under conditions of uncertainty the effectiveness of projects depends on the effectiveness of resolving these uncertainties and consequently on information expenses. Information expenses as well as lost profit depend on time. Time plays a special role in innovation projects because innovation projects' lifetime has a tendency to shorten, while the number of product modifications increases. The amount of uncertainty and the complexity of the management problem are also high due to the increasing number of components and subsystems of the production and economic system that are involved in product implementation. Structure of economic relations has a direct influence on production [1] (industrial production index) and added value created when implementing scientific development into an innovation project.

Appearance of such projects is impossible without considering the environment in which they are created and implemented. Projects originate in scientific and educational institutions that exist in the environment represented schematically in fig. 1.

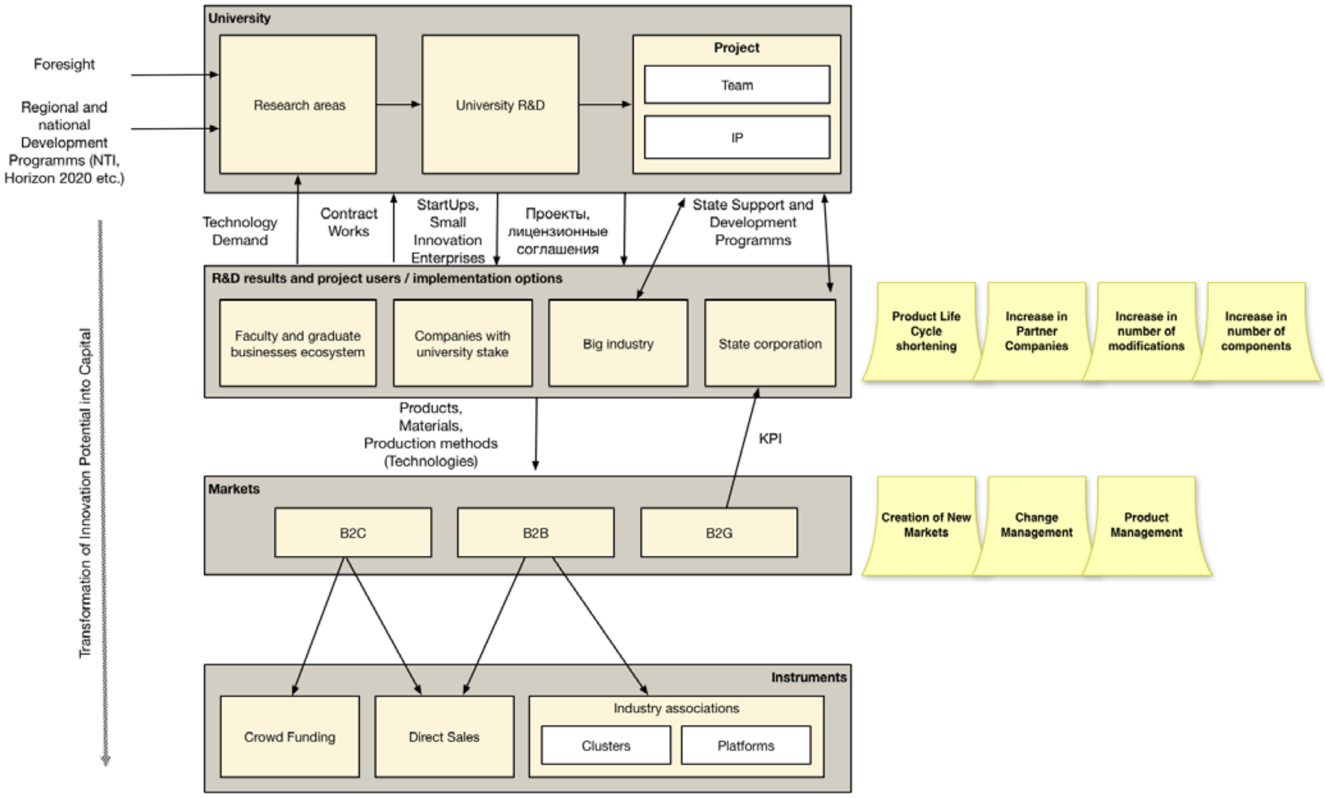

Fig. 1. Innovation commercialization structure in Russian universities.

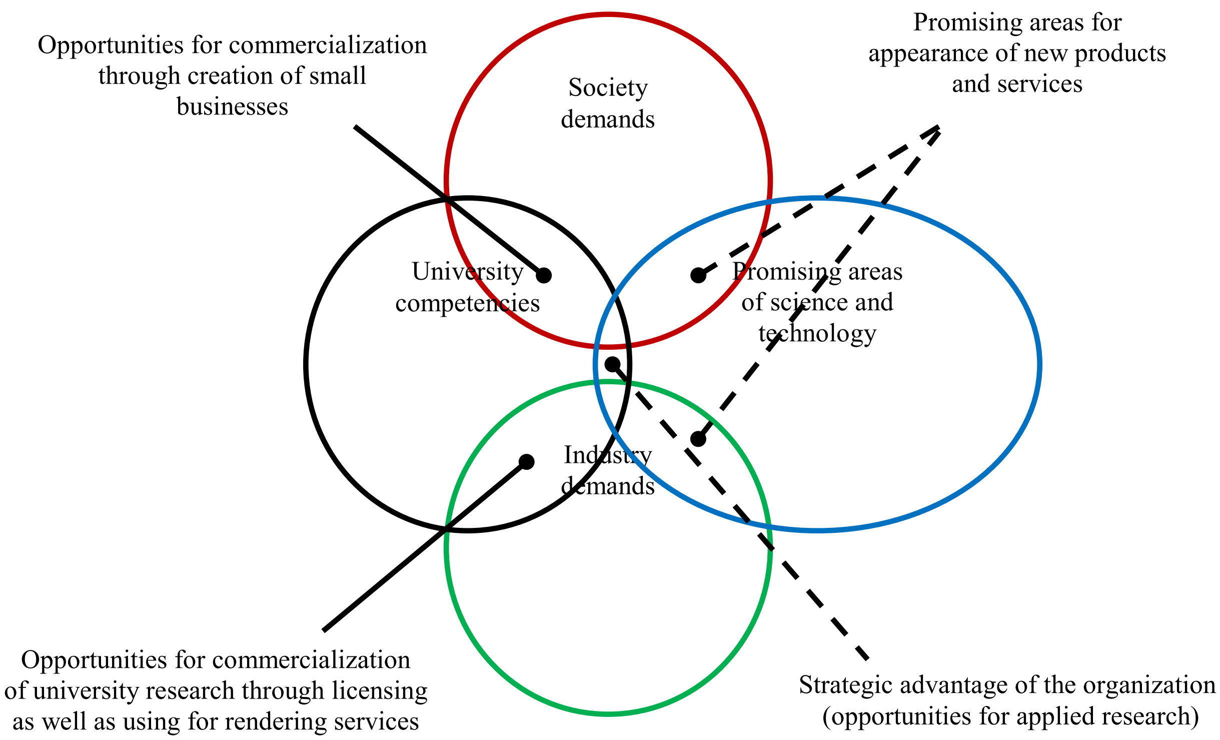

Fig. 2. Opportunities and promising areas for development in university research.

III. Determining Promising Commercialization Avenues for University Environment

Choosing the best method for implementing research results depends on project specifics, which can be determined based on information about the project and statistical data about the environment in which the project originated (see fig.2) considered in their dynamics at the moment of appearance of the underlying research results.

To determine university competencies and promising science and technology areas citation dynamics in citation databases and received patent dynamics can be used. Industry demands can be determined by studying the dynamics of requests submitted to research organizations as well as topics of joint research with industry (actual figures can be seen in Table 1).

Analysis of publication activity dynamics and that of the topics of industry demands will be described by the innovations curve. Thus, it is possible to determine the development stage of a technology or scientific area as well as its future growth potential.

These data are measurable and can therefore be forecast [2] using trends in the form of functional descriptions. Technology lifetime, its scientific and economic potential can be evaluated.

Description of the situation around research organizations allows targeted data collection and comparison. Comparison of these data allows determining promising areas of science and technology for appearance of new products (see Table 2, for example).

Regardless of limited statistics it can be concluded that university competencies lie in the areas of material science, mechanical engineering, and information technology, while the demands besides these areas lie in management systems and life sciences. This indicates that commercializing university's own research results through small innovation enterprises in robotics (mechanical engineering and IT), performing contract work in management systems for the industry, and interdisciplinary research in cooperation with specialized organizations in life sciences can be effective for the university.

When developing a commercialization strategy for a university or research organization it must be considered that not every university possesses competencies in all areas. As a rule, each organization has a specialization. This is supported by development programs, which determine the specialization. Thus, when evaluating commercialization opportunities and choosing research areas one should consider research organization's specialties and associated areas as priorities. Associated areas are chosen based on product requirements. This approach allows construction of new products using existing technologies and according to demands based on morphosythesis (morphology machine) or Koller operations.

TABLE 1
FACTORS AND INDICATORS FOR DETERMINING PROMISING AVENUES FOR INNOVATION PROJECTS IN CERTAIN AREAS

Factor	Indicator
1.Research organization (university) competencies	1.1. Patents and software licenses as well as databases for a certain research area belonging to the research organization in question.
	1.2. Number of small companies with university stake in a certain area of science and technology.
	1.3. Number of independent R&D performed for big industry.
	1.4. Supported applications within the university's strartup support programs (for example START program).
2. Demands of industry partners	2.1. Number of joint applications for government programs in a certain area.
	2.2. Number of independent requests from industry for contractual R&D work in a certain area of science and technology.
3. Government and society demands	3.1. Promising areas determined by foresight.
	3.2. Promising avenues for development of science and technology by industry (national technology initiative).
	3.3. Amount of innovation goods and services (Rosstat).
4. Promising areas of science and technology	4.1. Number of publications in a certain area of science (in one of the international citation databases) with a geographical filter.
	4.2. Number of publications in a certain area in industry journals (in one of the international citation databases, given in percentage of total number of publications or percentage of leader's publications) with a geographical filter
	4.3. Number of patents with a geographical filter

When analyzing specific projects one must consider macroeconomic parameters of the region in which the project is to be implemented and the specifics of the particular form of implementation. To this end one must consider such statistical data as new business density dynamics for 1K population (World Bank data), business survival and development rate, (entrepreneurship support foundations data, for instance START program data for 2nd and 3rd round participants), data about the research organization that initiated project implementation (number of staff in small innovation enterprises with university stake that are already operating, their working capital, number of such companies, total attracted investments), data about similar projects (product price and sales dynamics) etc.

To evaluate dynamics one should determine the rate and acceleration of the rate of change of curve values at a given moment (value of the first and second derivatives). If the acceleration rate is positive, a market creating technology can be expected to appear. At zero acceleration and positive rate of change positive innovations can be expected. At the same time it can be a signal to the fact that a new technological solution is necessary to solve the problem as the existing one has exhausted itself[1].

For detailed analysis of the project with a large volume of statistical data on similar projects (in cases when statistics about the project is inaccessible, similar project data can be used) other data can be used that has the greatest impact on project evaluation with regards to its objectives. These parameters can be chosen based on algorithms of the SlopOne family using all the collectible data.

Considering the values of parameters in their dynamics allows managing project parameters in the process of project implementation, thereby predicting negative situations as they occur and alleviation them by setting the target values of parameters and using best practices and standardization of management processes to achieve those values. These methods are connected with training and use of information systems and are aimed at detecting conflicts when implementing projects and choosing the most adequate technical and managerial solutions.

TABLE 2
EXAMPLE OF STATISTICAL INFORMATION FOR DETERMINING PROMISING AREAS OF SCIENCE AND TECHNOLOGY AND OPPORTUNITIES FOR COMMERCIALIZATION OF R&D RESULTS (PERM NATIONAL RESEARCH POLYTECHNIC UNIVERSITY (RUSSIA) 2013-2015)

	Factor according to Table 1.	**New materials**	**Mechanical engineering, materials processing**	**Information technology (development and use)**	**Energy and resource saving, ecology, recycling**	**Robotics, mechatronics**	**Technological chemistry**	**Management systems**	**Consulting**	**Electrical power generation and**	**Life sciences**	**Nanotechnologies**	**Electronics**
1.Organization competencies	**1.1.**	**40**	**80**	**134**	**1**	**5**	**6**	**2**	**3**	**12**	**9**	**56**	**2**
	1.2.	**1**	**4**	**2**	**2**	**-**	**-**	**2**	**2**	**1**	**-**	**3**	**-**
	1.3.	**4**	**32**	**15**	**4**	**3**	**1**	**2**	-	-	-	-	-
	2013	-	-	8	1	1	-	1	-	-	-	-	-
	2014	2	21	6	-	-	-	1	-	-	-	-	-
	2015	2	11	1	3	2	1	-	-	-	-	-	-
	1.4.	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
2. Industry partner demands	**2.1. (поддержано)**	**-**	**6**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**
	Подготовлено	1	11	-	2	-	1	-	1	-	-	-	1
	2.2.	**7**	**8**	**9**	**9**	**3**		**10**		**1**	**5**	**1**	**-**
3. Government and society demands	**3.1.**	+			+	+					+	+	
	3.2.	**1**	**1**	**1**	**1**	**1**	**-**	**2**	**-**	**1**	**2**	**1**	**-**
	FoodNet	-	-	-	-	-	-	-	-	-	+	-	-
	EnergyNet	-	-	+	-	-	-	+	-	+	-	-	-
	AeroNet	+	+	-	+	+	-	+	-	-	-	+	-
	NeuroNet	-	-	-	-	-	-	-	-	-	+	-	-
	3.3. for 2014	n/d	1062025,8	336863,3	n/d	n/d	1591816,2	n/d	n/d	n/d	n/d	n/d	313132,2

[1] A filament light bulb can serve as an example, where in order to achieve more brightness temperature of the filament must be increased. However increasing temperature leads to melting of the filament. The solution is to use alternative technologies based on inert gases or LEDs.

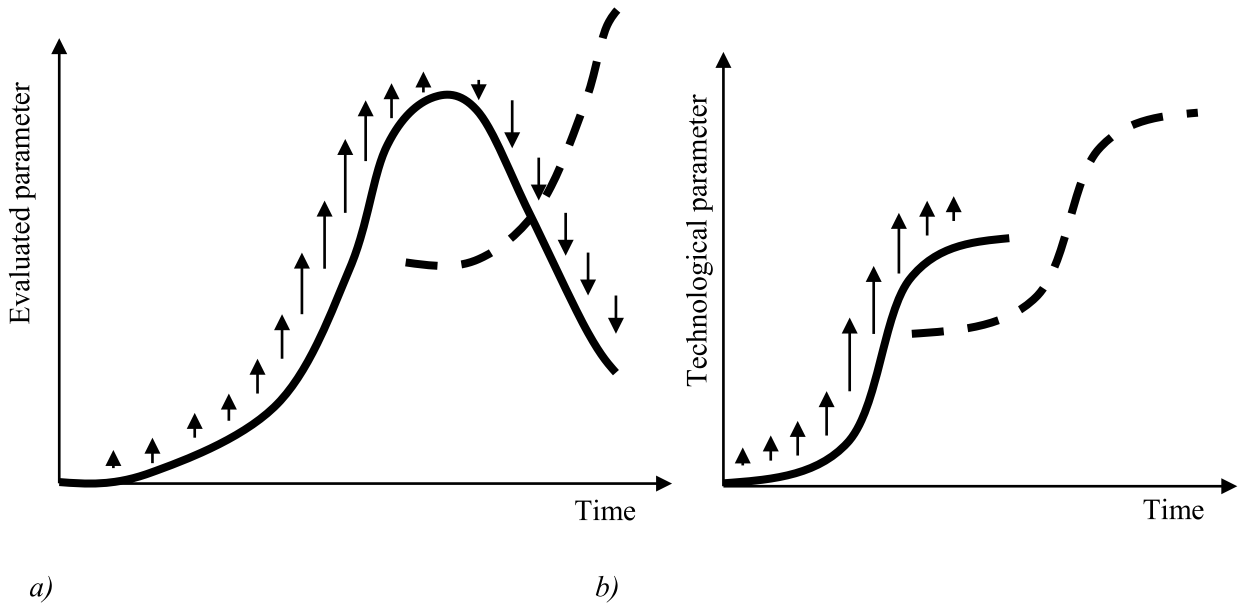

Fig. 3. Conceptual representation of innovation curve *a)* and S-shaped curve *b)* with indicated rate of change values (first derivative).

IV. Conclusion

In the process of choosing projects one must work with various parameters. The solution to the problem, which will allow making managerial decisions when managing the chosen projects, is to create a model that establishes a connection between the parameters that characterize the project and the environment in which the project is being implemented. This solution will allow to take the process from a formal sequence of actions to obtaining numerical indicators, as well as to consideration of an inverse problem of search for the parameter values that describe the project and based on those values the problem of search of a suitable environment for project implementation (in which desirable values of the target project function are obtainable (revenue, for instance)).

Research results implemented into products and technologies as a rule are inbuilt into product chains or production processes of big industry or complement products orientated towards future development of material existence, determined by the plans of corporations or governments using the foresight technology. Determining the form and direction of project implementation is only possible in cooperation between developers, big industry representatives, and forecasting experts.

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