STRATEGY

OF INNOVATIONS DEVELOPMENT IN UKRAINE

INTRODUCTION

INNOVATIONS DEVELOPMENT PLATFORM

Dmytro SHESTAKOV
Oleksiy POLIARUSH

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FOREWORD

80% of developments in the USSR defense industry were carried out in Ukraine. Thanks to such a big school of scientists and developers, Ukraine remains among the world leaders in the field of development and production of military and dual-use products.

Today the state practically does not finance the new developments in this area, since the bulk of financing is spent on maintaining the combat capability of existing weapons and equipment of the Ukrainian Armed Forces. Therefore this traditional state monopoly was handed over to private investors, opening doors for local and foreign businesses to step into this typically closed, highly marginal market.

Moreover, there has never existed a mechanism in Ukraine that in a short time would allow developing an innovative idea into the prototype, and then — launching a serial production and its passing to the army.

The most appropriate alternative under such conditions is to attract funds from Ukrainian and foreign investors for development and production of promising defense products. But it needs to be implemented within a transparent mechanism that has proved its effectiveness in the global best practices.

Today such a mechanism is open platforms — project offices which ensure the development and production of innovative products for specific market objectives and standards: DARPA in the USA, MAFAT and the Office of the chief scientist in Israel, DRDC in Canada, DSTO in Australia.

Considering the experience of developing innovations by Ukrainian specialists commissioned by foreign customers, Ukrainian technologies compare favorably in creativity and cost-effectiveness among foreign analogues and are competitive in international markets.

1 PROBLEMS OF INNOVATIONS DEVELOPMENT IN UKRAINE

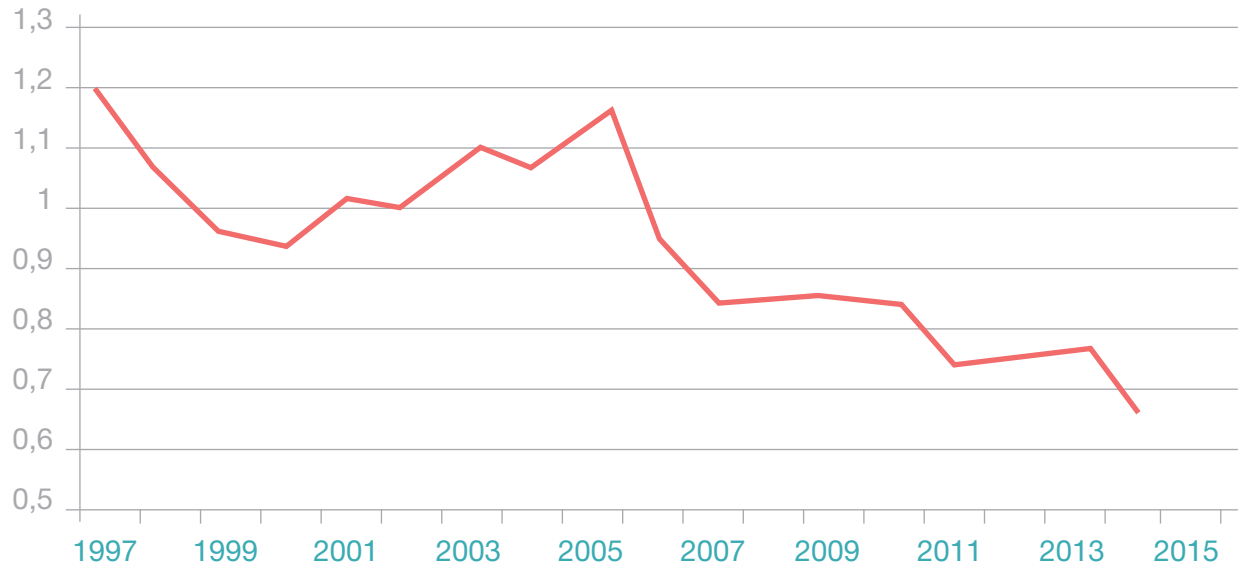
1.1. Development Dynamics and Current Situation

The Ukrainian Act of Innovation Activities defines innovations as new or improved competitive technologies, products or services, and management solutions of production related, administrative, commercial or other nature that improve considerably the structure and quality of production and social aspects. It means that nearly all novelties contributing to improvement of products, separate elements of company's operation or government's policy may be referred to as innovations. The key word here is 'competitive' technologies, i.e. technologies that may compete with the time-proven and reliable development tools. Everything needs improvement, which implies innovations. The aforesaid Act also defines innovation activities as the activities aimed at the use and commercialisation of research & development results and driving market launch of new competitive goods and services.

In point of fact, innovations development in a state is based on the progress and financial support of research & development (hereinafter also referred to as «R&D»). The R&D gross domestic expenditure (both current and capital) is made by manufacturing entities, research institutes, universities, state laboratories, etc. Figure 1.1 shows the dynamics of the GDP percentage spent on R&D in Ukraine.

Figure. 1.1

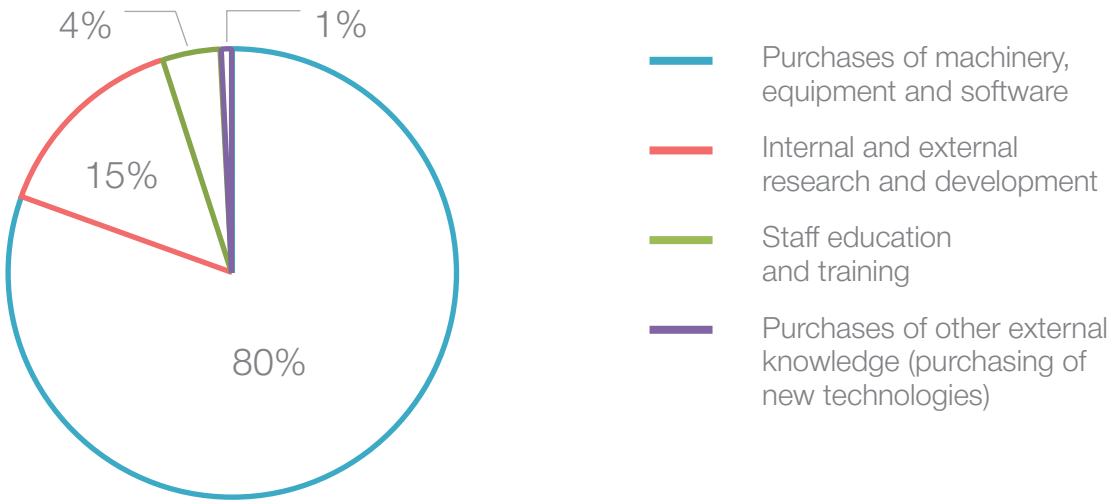
R&D Expenditure in Ukraine, % of the GDP



In 2015, Ukrainian companies spent UAH 13.8 billion on innovations, including: UAH 11.1 billion spent on purchases of machinery, equipment and software; UAH 2.0 billion spent on internal and external research and development; UAH 0.1 billion spent on purchases of other external knowledge (purchasing of new technologies); and UAH 0.6 billion spent on staff education and training to develop and implement new or considerably improved products and processes, market launch of innovations and other efforts related to innovations development and implementation (Figure 1.2).

Figure. 1.2

Structure of Ukrainian Companies' Innovation Expenditure in 2015



As a matter of fact, when talking about 'innovations', a domestic manufacturer usually implies (hypothetically) a 'purchase of new equipment'. The dynamics of the domestic companies' research & development expenditure may be represented on a graph (Figure 1.3)

When expressed in the absolute UAH equivalent, the R&D expenditure tends to grow, however, taking into account devaluation of the national currency (in particular, substantial volatility in 2008 and 2015), in the absolute USD equivalent it is, actually, a downtrend.

The following chart displays the dynamics of the R&D gross expenditure in Ukraine compared with EU countries, Israel, as the country of highest technology development, South Korea, as the country with the highest innovations development rate based on the relative R&D expenditure, the USA, as the country with the highest innovations expenditure, and Poland, as the country having the development patterns most closely resembling those of Ukraine (Figure 1.4).

Figure. 1.3

Dynamics of Ukrainian Companies' R&D Expenditure, UAH million

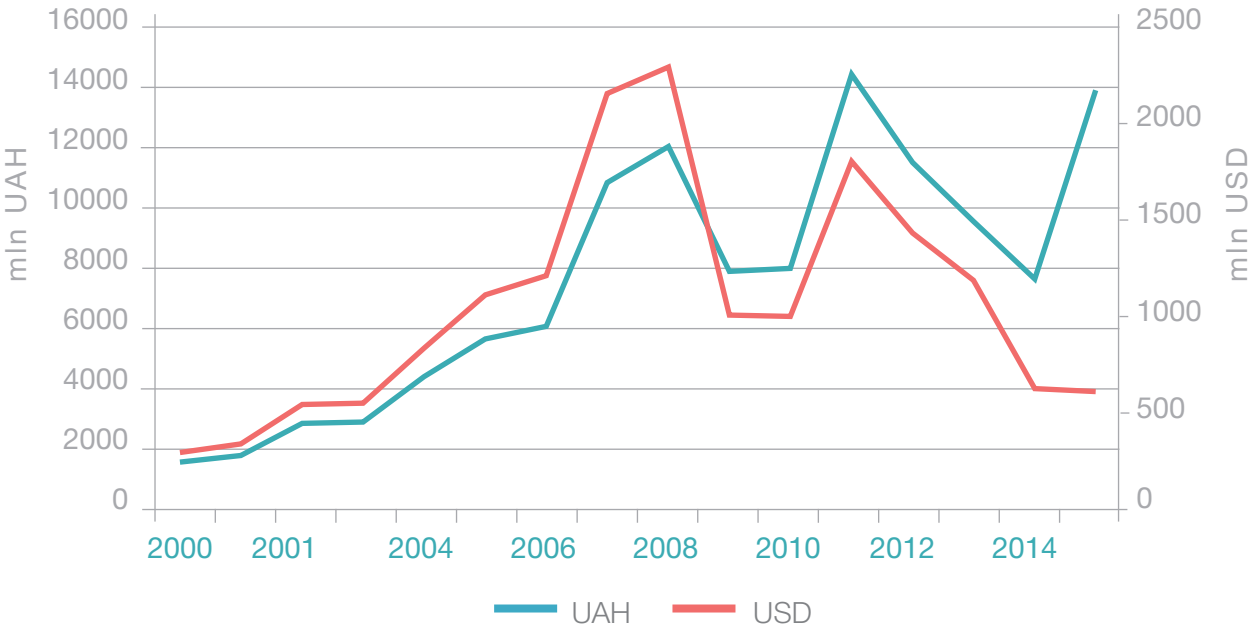
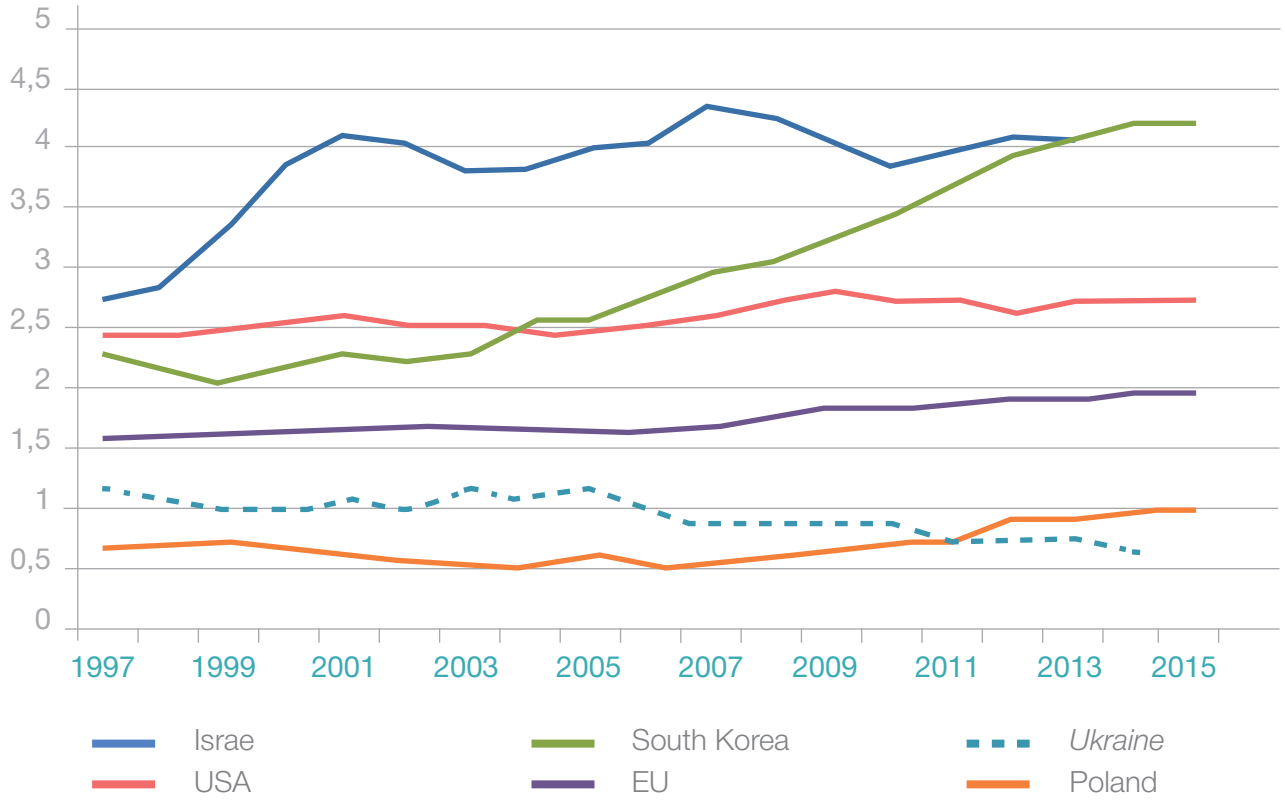


Figure. 1.4

Dynamics of Ukrainian Companies' Gross R&D Expenditure Compared with Other Countries, % of the GDP



According to the data of the Ukrainian State Statistics Service, 972 entities and institutions were involved in research & development in Ukraine during 2016, including 453 entities of the public sector of economy, 366 entities of the business sector, and 153 higher educational institutions (Figure 1.5).

The companies and institutions involved in R&D had 96.5 thousand persons engaged in R&D activities as of June 2016 (Table 1.1).

Figure. 1.5

Breakdown of Ukrainian Organisations Engaged in R&D in 2016

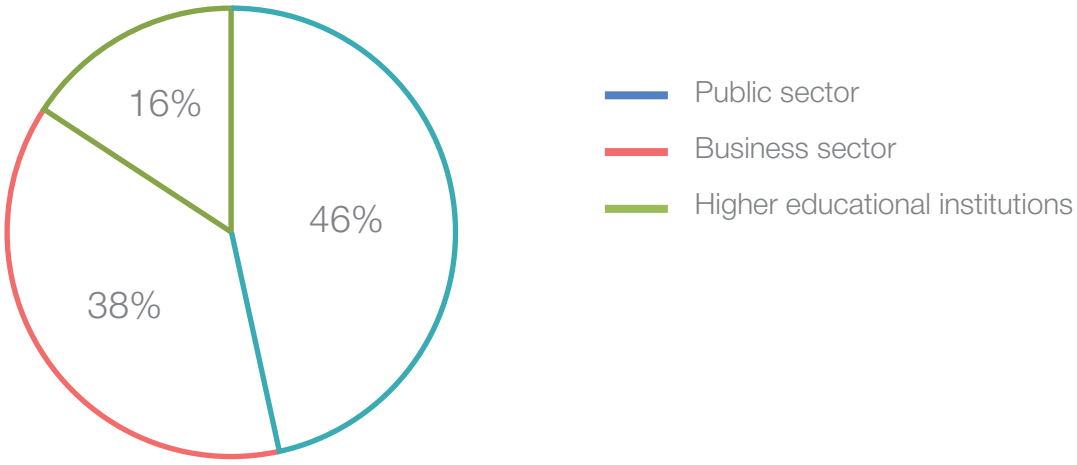


Table 1.1

Employees Involved in R&D Broken Down by Staff Categories

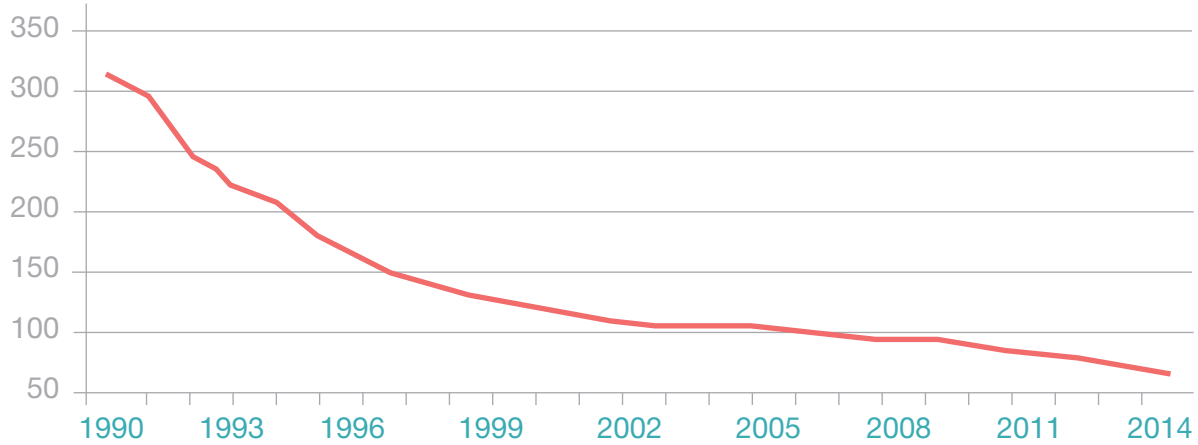
	Number of Employees	
	2015	**2016***
Researchers	53835	51512
Technicians	10029	9109
Auxiliary Personnel	19057	18303
Doctors of Science	4124	4123
Candidates of Science	13929	13471
Total	**100974**	**96518**

* — first six months

The number of scientific research workers has been constantly decreasing since Ukraine gained independence (Figure 1.6). The outflow of scientists is explained by the lack of the R&D attractiveness of Ukraine, lack of development of the innovations business environment and culture, unavailability of financing for business start-ups and innovation ideas on the regional and local levels. From the financial viewpoint, there is a low probability of profit gaining from innovation activities in Ukraine. Therefore, scientists, as the driver of development and improvement, seek for opportunities in more developed countries.

Figure 1.6

Dynamics of Scientific Research Workers in Ukraine, thousands of persons



1.2. Inefficient Use of Treasury Funds

Inefficient use of budgeted funds is common in the budgeting process.

In the circumstances of the total deficit of budgeted funds on the governmental and local levels, the emphasis is placed on their efficient use and deriving of the best possible results. This task is aggravated by a number of objective and subjective problems.

Excessive social orientation of the budget expenditure (which, virtually, prevents investments in the economic development of the regions).

It affects the trends of social and economic development of the regions, in general, and impairs the economic efficiency of the budget expenditure. A high specific weight of the social-oriented expenditure is good for the communities as it enables solving of the social and economic development issues and bringing about of favourable trends in the communities in future, however, provided that the investment-related expenditure (that is, the development-related expenditure) prevail in the social expenditure structure. Presently, the social-oriented expenditure in Ukraine is narrowly aimed at financing of consumer needs, in particular, raising of social benefits, such as retirement pays, child birth payments, etc. and gradual raising of the minimum wage.

Imperfection of the system of budget programs performance assessment. It should be noted that, currently, the Budget Code and other Ukrainian laws provide for no clear values and criteria of assessment of budget resources use efficiency, nor any proven assessment methodology deserving trust due to reliable results.

Planning is a significant element of budget policy implementation both, for the key managers of budgeted funds, and for such lower-level managers. Despite the statutory declared implementation of critical elements of the 'western' model of budget planning and forecasting in Ukraine, such elements are, in practice, distorted. The 3-year plan values (used in budgetary applications) are often purely formal – due to the unavailability of a uniform methodology of midterm expenditure planning, forecasts are presented as analytical materials (i.e. have no legal effect) and, consequently, are not binding. A budget resolution usually diverges from the prepared budget, rather than serves a concept document providing for the priorities of budget planning. As a consequence, themidterm and long-term planning are not the directions of the budget policy, both on the countrywide and regional level.

The researches made prove that bribery and administrative influence based corrupt governance system (in particular, the flaws related to personnel selection and distribution for the key public administration offices) are a significant reason of inefficient use of budgeted funds. Such system contributes to adverse human factors, such as negligence, carelessness and lack of professional competency of the administrative personnel. As we know, the Government relies on public officers' timely, high-quality and justified administrative decisions; however, the audit results and low social and economic development of the country show that the success in achieving of positive results is insignificant. In our opinion, such administrative decisions stem from inefficient HR policy burdening heavily the treasury and Ukrainian taxpayers.

1.3. Unavailability of Investments

Research and development and commercialisation of innovations may be financed by both, private and state institutions. Institutional practices of innovations financing, such as development of financial institutions of banking and non-banking sectors (i.e. special banks and non-banking financial and loaning institutions; innovation, investment and venture funds, etc.) have not been developed in Ukraine. In Member States of the Organization for Economic Cooperation and Development (OECD) uniting 34 most developed states of the world, the state institution predominantly applies indirect methods of innovations motivation. It means that tax remissions, accelerated depreciation permits, tax credits, etc. are practiced in stead of direct financing of innovation projects from the state treasury. As a matter of fact, highly developed countries mainly motivate development of innovation businesses by moderating their financial liabilities before the state rather than through allotment of treasury funds for certain projects. Thus, it's

no wonder that private investments have the highest specific weight in the total innovation investments in developed countries.

The investment process in Ukraine does not contribute to modernisation of production facilities based on innovations expected to reform the domestic economy towards production with long-term innovation-based competitive advantages. What does it all mean? A potential investor has to balance between profits maximisation and risk minimisation. In view of its outdated technologies, failing laws, global loans, financial and investment risks, Ukraine yet fails to catch much interest of investors.

1.4. Unavailability of Organisational Infrastructure

Implementation of innovations requires the appropriate infrastructure. Innovation originators in Ukraine include entities of the National Academy of Sciences of Ukraine, universities and other high schools, field research institutes (RI), innovations and technologies centres, and major industrial companies (Table 1.2).

Table 1.2

Innovation Originators in Ukraine

Organisation Type	Basic Operation Description	Strengths	Limitations and Weaknesses	Best Application
Entities of the National Academy of Sciences of Ukraine	Fundamental and applied researches in topical technology and research directions to get new scientific knowledge and use such knowledge in practice	Efficient fundamental researches	Conservative infrastructure which is not perceptive to innovations	Creation of theoretical tools for further transformation of research results into innovations
Universities and high schools	Educational, scientific and technology & research activities; training of scientists, researchers and teachers	The treasury funds allotted by the Ministry of Education and Science to support university research parks are, in most cases, justified (i.e. financing of the innovations development basis)	Organisational restriction of supported innovations, dictating of the conditions, no flexibility of the educational process, poor professional competency of teachers, enrolment of students having very low interest in studies (spending of treasury funds in vain)	Innovation activities based on development of technology and research training at high schools implemented in university research parks
Field research institutes (RI)	Applied researches, developments and innovations	Technology infrastructure suitable for innovation activities	Unavailability of funds to maintain the technology infrastructure due to financial problems resulting in the inability to ensure a stable innovations cycle	Innovation activities based on own facilities and capacities

Organisation Type	Basic Operation Description	Strengths	Limitations and Weaknesses	Best Application
Innovations and technologies centres	Support of innovation activities	Most suitable conditions to support operation of small companies	Dependency on financing sources (funds)	Unions of independent small companies. Intensive marketing of hi-tech products in pursuit of big companies' interests
Major industrial companies	Production in stable stocking conditions	Opportunity to adopt innovations due to the variety of manufacturing sites, power capacity and staff qualification	Required considerable capital investments in technology preparation of the production process	Batch production of innovative products in case of mass demand
Consulting companies	Providing of services to innovation originators	Prompt and flexible responses to customer requests	The scope and quality of the services are not always sufficient	Use of service providers having the highest potential
Small research and technology companies	Innovation activities	Technically competent staff. High motivation, flexibility, sensitivity to market demands	Tax pressure, balancing on the bring of survival, unavailability of resources, poor technology infrastructure	Innovation activities are not related to solving of fundamental problems

Technology Transfer. It's commonly recognised that successful innovation-oriented countries make use of technology transfer intensively to link science and industry, commercialise technologies and manufacture modernised products. They take efforts to ensure the appropriate conditions, both, in terms of laws and organisation, for the use of the scientific and research potential in the private sector of economy, and in the SME segment. The global experience allows determining of the key institutional factors of the technology transfer infrastructure, in particular, in terms of formation and support by the government of technology transfer centres and networks, research parks and technology parks, business incubators, development of regional and industry clusters, etc.

As a rule, technology transfer centres and networks are created, domestically or internationally, on the non-business basis and operate due to the governmental support. For instance, the European centres (such as the European Space Agency, the United Research Centre, different European organisations (e.g. the European Business and Innovation Centre Network), domestic organisations in Germany, France, Portugal, Spain and organisation representing business interests of the European Union outside its territory) are financed by the

EU; the US technology transfer network of NASA (National Aeronautics and Space Administration) is financed from the US treasury, and the UNIDO Exchange Network is financed by the UNIDO (United Nations Industrial Development Organization). Major industrial corporations create their own technology transfer centres, predominantly, on the non-business basis. By way of example, the Enterprise Europe Network (EEN) may be mentioned here. This Network enables exchange of technologies related information among all other similar European innovation centres. The key directions of technology transfer centres' operation include:

- analysis of technologies market conditions;
- taking of steps and measures aimed at applying of innovation technologies in practice within the framework of scientific and production cooperation and investment collaboration;
- intellectual property management and development of technology commercialisation strategies;
- technology audits of companies and provision of consultancy services;
- preparation of draft international collaboration treaties related to technology transfer and innovation activities;
- monitoring of new technology and research inventions and achievements in various countries;
- ensuring of domestic companies' participation in international exhibitions and trade shows of hi-tech products; and
- enhancement of skills of innovation professionals and technology transfer managers, etc.

Summary. The key problems restraining development of innovation processes in Ukraine include:

- unavailability of the scientific and methodology basis for innovations system formation;
- lack of consistency in the governmental efforts aimed at the use of the innovation potential of the national economy;
- governmental innovations management without a clearly stated strategy of science, technology and innovations development, and without a consistent and well-thought external and internal economic policy;
- unavailability of the efficient system of priorities in science and technology development (the priorities of innovations development have been declared formally, however, no mechanisms of their implementation have been worked out);
- the governmental administration is not ready for the consistent and substantive efforts towards innovations based development of the economy;
- lack of coordination in acts of innovation originators; and
- insufficient financial resources to procure scientific researches and implementation of innovations (despite some progress in macroeconomic stabilising, yet, there have been no meaningful results in ensuring of favourable conditions for innovation activities of domestic manufacturers, which is clearly seen, in particular, in the figures of exportation of innovative products).

For the years of Ukraine's independence, the innovations sector of our country has not yet become actually attractive for domestic and foreign investors. Ukraine has no well-established environment and natural cycle of innovations development. Such situation is largely due to the state's restricted ability to stream financial flows into the innovations based development of the economy, and insufficient governmental motivation of innovation activities. As a consequence, poor development of the organisational infrastructure, brain drain and no political will, prompt our paying attention to the experience of the countries that have managed to achieve considerable success in innovations development, such as Israel,USA and EU countries.

2 BENCHMARKING

2.1. Israel Model

After becoming independent in 1948, suffering from permanent hostilities, having the population of nearly 8.5 million and ranking 147th in terms of area size, Israel has developed as an innovations super-state that coins new technologies and contributes to the global economic prosperity. The first, and, probably, the most important, conclusion one can make based on the experience of Israel is that a state should support new inventions rather than tie the hands of researchers. 60 years ago, Israel exported mainly citrus fruits, whereas now hi-tech products represent 11% of the GDP in Israel and stand behind more than a half of the exports volume amounting to $70 billion. Over 4 thousand start-up businesses (i.e. nearly the same number as in the USA) are operating in the country. It is called the 'Israel's miracle', and it is a result of the right innovation policy.

The Office of the Chief Scientist. The quintessence of the Israel's innovation policy is the objective comprehensive assistance to hi-tech sector businesses. In most cases, such approach is implemented through direct subsidising of scientific researches and developments. For instance, the Office of the Chief Scientist (OCS) formed by the Israel Government in 1968 implements the governmental policy aimed at support of industrial researches and developments, and allots nearly USD 300 million of R&D grants and scholarships annually. The Ministry of Industry and Trade allots about USD 200-300 million as percentage deduction compensations (subject to successful implementation of products). The Office of the Chief Scientist implements, at all stages, R&D agreements supplementing the package of Israel's free trade treaties with the USA, Canada, the EU, the European Free Trade Association (EFTA) and a number of other countries. The topical programs of the Office of the Chief Scientist may be broken down by the following several types: Pre-Competitive and Long-Term R&D Programs, Pre-Seed and Seed Programs, Industrial R&D Programs, Domestic R&D Programs, and International Programs.

Pre-Competitive and Long-Term R&D Programs. Pre-Competitive and Long-Term R&D Programs are aimed at researches held at the initial stages of scientific ideas without the prospect of commercial development in the nearest future. One of such programs is Magnet Instruments, which is a package of general R&D programs motivating collaboration between industrial companies and researchers from academic institutions based on several instruments at a time. In this package, Magnet Consortia is the key program that intends the support of consortiums formed from industrial companies and academic institutions in order to jointly develop general pre-competitive technologies. This program enables links between the academic and industrial environments for the purpose of joint scientific activities, which makes it favourable and beneficial for both parties involved. Among Magnet Instruments, attention should be also paid to Nofar Program (aimed at making scientific research projects ready for cooperation with a business partner) and Kamin Program (designated to transfer scientific research achievements into the sector of technology interests in the industry).

Telem Forum is another Pre-Competitive and Long-Term R&D Program of the Israeli Government which provides for voluntary partnership between several Ministries in Israel. Telem covers several subprograms purporting the countrywide R&D infrastructure in the industries and fields of joint interest of forum members.

Between 2005 and 2012, 6 academic scientific research centres in the field of nanotechnologies were created and launched resulting in development of the

program primarily aimed at formation of the powerful nanotechnologies industry by way of technologies transferring from the scientific environment to the industry and creating of a pool of highly qualified scientists in the field of nanotechnologies.

Other competitive programs include launching of theNational Biobank resulting in the extended basis for biomedical researches; and establishment of theNational Institute for Biotechnology in the Negev that purports more efficient interdisciplinary links between fundamental and applied researches.

Pre-Seed and Seed Programs. These programs are aimed at projects and researches at the initial investment stages. The examples of such programs include Tnufa Fund, Heznek-Seed Fund and the Technological Incubators Program.

Tnufa Fund is designated to offer financial support of start-ups, inventors and businessmen so that their ideas and suggestions could evolve into technology projects. The Program provides for money allowances and various consultancy, career guidance and briefing services. Such services include granting of the USD 50 thousand allowance for a project of prototype creation, patent registration, business plan preparation, etc (with cost coverage threshold of 85%); technological and business analysis of ideas; patent examination and searching for technological information; assistance in finding of strategic partners; assistance in raising of the opening capital for beginning businessmen, etc.

Heznek-Seed Fund makes investments in companies' capital with the private investor's option to repurchase the Government's interest within 5 years at the initial price plus the interest income. Such investors include venture and industrial companies making investments in similar fields and having the ability and resources to develop projects expected to bring profits from their future commercialisation.

The Technological IncubatorsProgram plays a significant role in origination, development and support of innovations in Israel. Managers of such initiatives handle all formalities and organisational issues while inventors are able to work exclusively on inventions and developments. An incubator company has all infrastructure elements that may be required for a new business, i.e. laboratories, servers, etc, and a favourable scientific environment. Consequently, businessmen may focus on development of their competitive products, which is most important. On the average, each incubator develops 10 start-ups at a time. A new company is developed in the incubator for 2-3 years, and then let 'to float freely'. If a project is successful, the businessman repays the invested money from royalties (as a rule, 3-4% of the sale price). If a project fails (which is a rare case), the businessman is not held liable by the state. Therefore, all applications are subject to careful screening.

As their key objective, technological incubators transform innovative technical ideas (being too much risky for private investments) into viable start-up companies which, after the 'incubation period', would be able to engage investments from the private sector and operate independently.

Industrial R&D Programs. Such programs are designated for industry projects. The key program of the Office of the Chief Scientist is the R&D fund supporting research and development projects of Israeli companies by offering of conditional grants in the amount of up to 50% of the approved R&D expenditure. If a project is commercially successful, the company shall repay the grant by way of royalty payment. Such payments are, as a rule, a certain percentage of the total annual income received from sales of the relevant products. Royalties are further used to finance future grants for industrial R&D activities.

In order to retain and enhance state's cyber security, the Israeli Government passed, in 2011, the Resolution aimed at improvement of the national potential in cyber security. After this Resolution was passed, the Office of the Chief Scientist and the Israel National Cyber Bureau developed the program with the joint allotment of nearly USD 20 million to support

new advanced cyber security solutions, and to create the cyber security knowledge centre. This program is called KIDMA; it is a response to increased cyber threats and intends development of appropriate protection systems. Nowadays, Israel holds meaningful positions on the global cyber protection market.

Grand Challenges Israel (GCI) is another industrial program aimed at solving of problems encountered by emerging markets, such as immunisation, availability of medical services, sanitary issues, parasitic diseases, postnatal and prenatal care, mental health, medical equipment, etc., and related aspects, such as quality of foods, wastewater treatment, advanced agricultural practices, irrigation in deserts, environmental protection, etc. Often, solutions that help emerging markets have, additionally, a great commercial potential on the global market. Industrial R&D programs enable Israel industry's links with the international network of companies, scientific research institutions and other healthcare initiatives.

Domestic R&D Programs. These programs are designated to support projects improving the domestic environment in Israel, and include the Fund of Life Science, and innovation projects related to alternative fuels for transport facilities.

The objective of the Fund of Life Science is to motivate and accelerate growing, in Israel, of biotechnologies – the industry where the country has numerous competitive advantages. This Fund is also another example of investments in the Israel's priority industries, i.e. biotechnologies and healthcare.

Supported by the Israeli Government, a national program was developed to support new technologies aimed at lower global consumption of oil-based fuels and motivate development of technology-intensive alternative fuels for transport facilities. Passing of the relevant Government's Decree in 2011 resulted in launching of programs purporting encouragement of investments in Israeli companies professionally engaged in development and implementation of pertinent technologies.

International R&D Collaboration. Israel has a host of programs specifically developed to cooperate with other countries in terms of R&D. Through the Office of the Chief Scientist, and its two branches – MATIMOP and ISERD, the Israeli Government collaborates with governments of other countries, local authorities and organisations, and actively supports and encourages industrial R&D between Israel and foreign partners. Presently, there are more than 40 multinational R&D cooperation agreements between Israel and other countries from all over the world.

MATIMOP (The Israeli Industry Center for R&D) is a governmental non-commercial organisation contributing to development of advanced technologies in Israel and establishing of beneficial international partnership through cooperation in production and development of joint ventures. MATIMOP acts on behalf of the Office of the Chief Scientist as the national authority responsible for encouragement and helping Israeli companies in the framework of international bipartite or multipartite programs aimed at industrial R&D cooperation.

ISERD (The Israel-Europe R&D Directorate) is an inter-sector organisation of the Ministry of Economy, the Ministry of Science and Technologies, the Ministry of Foreign Affairs, the Ministry of Finance, the Planning and Budgeting Committee and the Israel Council for Higher Education. ISERD acts through the Office of the Chief Scientist, and it is designated to promote joint Israeli and European R&D and innovations development.

Venture Capital Funds. The Israeli Government constantly sends impulses to develop relations with other countries in the field of technologies development. The Government helped much in venture capital formation. In 1991, the Israeli Government opened the State Venture Capital Fund that has considerably accelerated development of high technologies in the country.

Gina Heng, the Chair of the Business Development Department in the Yozma Group, Asia, says that 'The Fund was established with the goal to create a venture capital market in Is-

rael. Pre-conditions were set to entice private sector and foreign investors to set up new venture capital funds, to participate as a partner in these venture capital funds, and secure the obligation of these new venture capital funds to invest in start-up companies in Israel.'

Currently, Yozma has fulfilled its key role by enhancing the number of venture capital funds in Israel to nearly a hundred, and delegated own functions to them, thereby diversifying the financing of innovative technologies in Israel. At the stage of R&D development, the Government took lead in financing thereof, however, later, it was followed by private financing which now amounts to 3.6 – 3.8% of the Israel's GDP (the highest value globally) and, together with the governmental financing, brings about the R&D investments in Israel as high as almost 4.5% of the GDP (Figure 1.2).

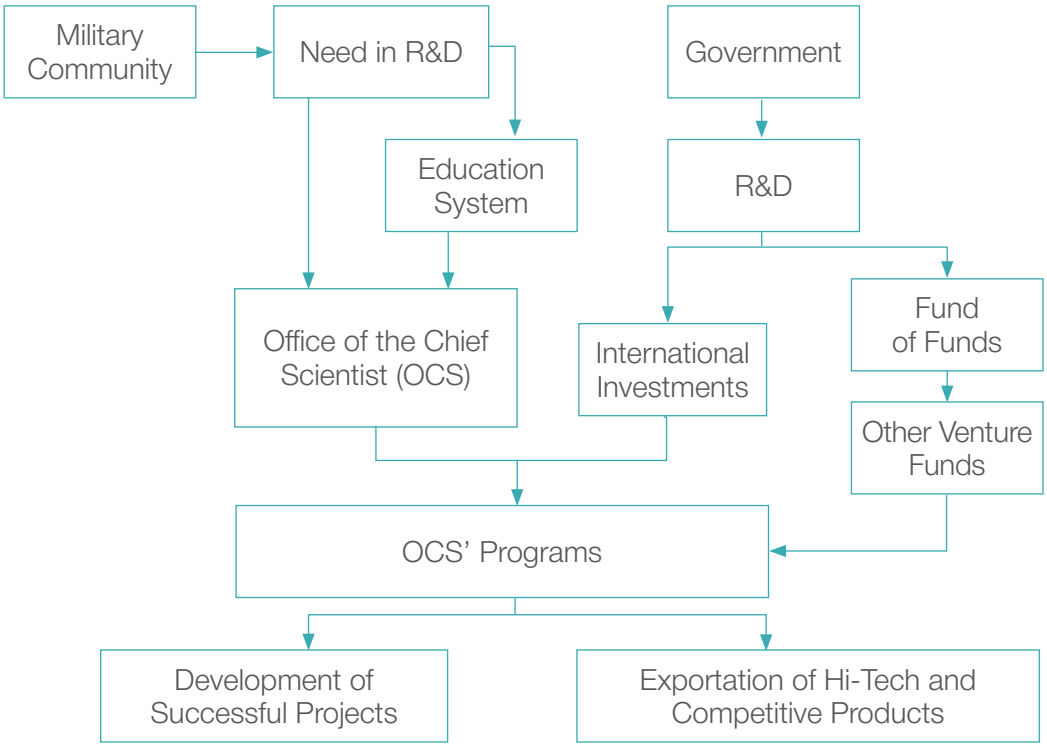
Summary. The Israel's practice of creation of the environment combining science, education, industry and tools for pre-competitive technologies and projects at early stages designated to promote R&D both, in international companies, and in separate fields (narrowly targeted programs), enables the support of innovation projects in different phases of development. At the same time, the constant military threat prevents Israel from stoppage, making the innovations cycle running incessantly in the environment, and instigating progress in innovations development.

Summing up, it's worth saying that the Israel model is a sophisticated and efficient mechanism with each element – the Government adopting required laws; the demand fuelled by hostilities; the Office of the Chief Scientist promoting a wide range of support and cooperation programs; the system of education that intends training of highly qualified professionals, and the venture funds – aimed at development and progress. All these factors, along with the permanent adopting of other countries' experience, make Israel the present-day global leader in terms of R&D attractiveness for multinational corporations, start-ups, and scientists from all over the world.

Figure 2.1 hereafter represents the simplified scheme of the above-listed elements of R&D and modern innovations environment in Israel.

Figure 2.1

Simplified Scheme of Israel's Innovation System



2.2. US Model

The United States of America is one of the most innovative countries in the world. 29 out of the top 50 (i.e. 58%) innovation companies around the globe are the companies from the US (according to the data of The Boston Consulting Group as of 2015). The USA accounts for the one third of the added value in global information and communication technologies. Every fourth employee from the top 250 IT companies in the world works for a US company. What stands behind the USA's success? Firstly, the USA makes considerable governmental R&D allotments – the absolute gross expenditure amounted to 2.79% of the GDP (about $503 billion) in 2015, which is the highest figure in the world. Secondly, this expenditure is closely interlaced with the extensively developed and, supposedly, the best higher education basis. US universities can have commercial proceeds out of R&D, even if R&D is financed from the federal budget. Thirdly, the federal financing is not the only driver of innovations, since private companies spend much on research & development (Table 2.1). 13 out of the top 20 global R&D expenditure leaders are the companies from the USA.

Table 2.1

Top 20 R&D Expenditure Leaders in 2016

Rank	Company	Country	Industry / Field	R&D Expenditure (in USD million)
1	Volkswagen	Germany	Automotive industry	13200
2	Samsung	South Korea	Computing equipment and electronics	12700
3	**Amazon**	**USA**	**Software and Internet**	**12500**
4	**Alphabet**	**USA**	**Software and Internet**	**12300**
5	**Intel Co**	**USA**	**Computing equipment and electronics**	**12100**
6	**Microsoft**	**USA**	**Software and Internet**	**12000**
7	Roche	Switzerland	Healthcare	10000
8	Novartis	Switzerland	Healthcare	9500
9	**Johnson & Johnson**	**USA**	**Healthcare**	**9000**
10	Toyota	Japan	Automotive industry	8800
11	**Apple**	**USA**	**Computing equipment and electronics**	**8100**
12	**Pfizer**	**USA**	**Healthcare**	**7700**
13	**General Motors**	**USA**	**Automotive industry**	**7500**
14	**Merck**	**USA**	**Healthcare**	**6700**
15	**Ford**	**USA**	**Automotive industry**	**6700**
16	Daimler	Germany	Automotive industry	6600
17	**Cisco**	**USA**	**Computing equipment and electronics**	**6200**

Rank	Company	Country	Industry / Field	R&D Expenditure (in USD million)
18	AstraZeneca	Great Britain	Healthcare	6000
19	**Bristol-Myers Squibb**	**USA**	**Healthcare**	**5900**
20	**Oracle**	**USA**	**Software and Internet**	**5800**

Figure 2.2

Breakdown of Private Sector R&D Expenditure by Countries, 2016

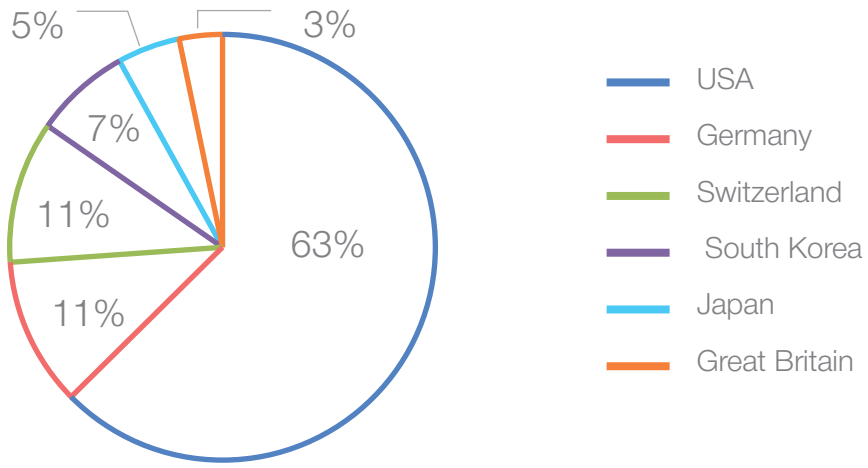
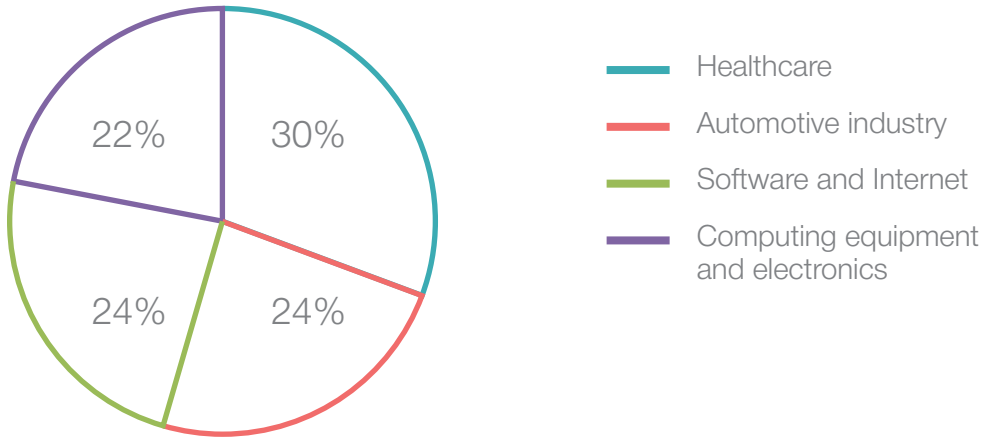


Figure 2.3

Breakdown of Private Sector R&D Expenditure by Industries, 2016



Fourthly, partnership between venture capital holders and businessmen in such sites, as Silicon Valley encourages new innovations, changes and development of business and extension of technology boundaries. Fifthly, the perfect competition in the commodity market, flexibility of the labour market, and skilled management amplifies the R&D expenditure payoff greatly.

DARPA. In 1958, the Defense Advanced Research Projects Agency (DARPA) was formed after the Soviet Union successfully launched the first artificial satellite on October 1, 1957. DARPA was preceded by ARPA committed to prevention of unexpected for the USA military technologies (which is a current topical issue). Later, the word 'Defense' was added to emphasise the agency's connection

with the US Department of Defense. In addition, DARPA has the mission to maintain technology advantages of the US Armed Forces, support advanced researches with the potential of a leap forward in military and other technologies, and use the products of fundamental researches primarily in the defence industry.

According to its model of operation, DARPA implements its own administrative approach to process of new projects development. Such approach means that the Agency, through program managers, determines the top priority problems and technology & research targets, selects implementers and ensures project financing and support. Researches are directly accomplished by implementers in universities, research teams, small companies or big corporations. It is an example of the organisational infrastructure resulting in intensive development of innovative products. Such approach shifts the focus of target setting from the applicant to the Government which, acting through DARPA, ensures development and implementation of new technologies at all stages – from target determining until gaining of the final result in the form of a ready product.

DARPA has directly supported the development and implementation of a considerable number of technology innovations currently used by the US Armed Forces, such as modern precision weapons, the stealth technology, various surveillance and intelligence facilities. Furthermore, DARPA's developments underly the directions and products presently used in every household, including production of integrated circuits and semiconductor devices, Internet, PC graphical interface, cloud technologies, GPS systems, etc.

Silicon Valley. 'Instead of controlling innovations, a favourable environment for their growing should be created', - Mr. Alec Ross, the former Secretary of State's Senior Adviser for Innovation, once said. This is the motto of the world-known Silicon Valley. Silicon Valley is the place of concentration of the unique experience of development and promotion of hi-tech, knowledge-intensive start-up, and the best site in the world where venture capital investors, developers, startupers and representatives of the world leading technology companies have been successfully cooperating for over 50 years. Silicon Valley is one of the top 3 technology centres in the USA (along with the similar centres in New York and Washington).

The intellectual heart of Silicon Valley is Stanford University, a private research university which is one of the most prestigious universities in the world. Stanford University enrols nearly 7,000 students and 8,000 postgraduates annually. Many graduates later become new residents of Silicon Valley as employees of local companies, or, sometimes, their chairs, or initiators of their own projects and start-ups, with some of them evolving into successful companies and (the most successful ones) global businesses. In the vicinity, there are also San Jose State University (with about 30,000 students and 130 curricula), Santa Clara University (the oldest private university in the State), and California University in Santa Cruz (one of the 10 united public California universities).

Currently, about 3,000 companies have their headquarters, representative offices and development or production centres in Silicon Valley, with over three hundred companies dealing with computer manufacturing and over a thousand of companies engaged in software development.

The key factors of Silicon Valley's success include:

1. The high level of cooperation and collaboration (alongside with the high competition level).
2. Development of communications.
3. Openness, democracy, focus on horizontal links, and no vertical management.
4. The spirit of innovations and creativity.
5. Companies' access to scientific resources, technologies and developments due to the concentration of universities and research centres in Silicon Valley.

6. The streamlined technology of start-ups promotion from the initial stage, venture and interim financing, and up to the IPO stage of the most successful companies.
7. Focus on globalmarkets, new, breakthrough and potentially successful technologies.
8. Minimum governmental control and efficient laws.

In 2010, the former US President, Mr. Barack Obama, gave, in his speech, a very precise description of the current development trends in modern economy: 'The first step in winning the future is encouraging American innovation. None of us can predict with certainty what the next big industry will be or where the new jobs will come from. Thirty years ago, we couldn't know that something called the Internet would lead to an economic revolution. What we can do — what America does better than anyone else — is spark the creativity and imagination of our people.'

The USA often pioneers in many fields and areas. Implementation and development of innovations for the US economy is no exception here. Nowadays, the USA is the recognised leader in science and R&D, and the historically established successful higher education system, with the extended network of research universities and centres, resulting, altogether, in the powerful technology and research potential; and existence of sites like Silicon Valley is the consequence of the Government's right innovation policy.

2.3. EU Practice

The European Union implements a number of projects appertaining to the assessment of science and technologies development and efficiency of the key technology-related directions. In particular, the meaningful experience in prioritising of the scientific and technology development was gained in the course of preparation and accomplishment of a series of framework program of scientific researches, technological development and demonstrations. The European Technology Watch program was launched for the purpose of early identifying of new technologies and analysis of their impact on the key markets. Within the framework of this program, potentially significant technologies and services are monitored, and the steps and measures required to encourage their development in the EU Member States are identified.

The European Commission implements programs devoted to the analysis of global technologies that may influence the future economic development and the society, in order to give recommendations to the EU Parliament in respect of the science and technology policy. For nearly a decade, ERAWATCH Program has been the source of information concerning the science and innovations policy in the EU countries and in the associate and partner states. Since Horizon 2020 program was launched, the new source, i.e. the Research and Innovation Observatory (RIO), Horizon 2020 Policy Support Facility, has been used. It can be used to retrieve the true and updated information in respect of the applied mechanisms, organisations and programs on the European, domestic and regional levels, thereby contributing to the improved coordination of technology and research activities.

In EU practice, choosing of the science and technologies priorities is viewed in the context of a long-term strategy of sustainable development, and it is aimed at solutions to the key social and economic targets on the domestic or international levels.

The modern innovation policy of the EU is based on EUROPE 2020 – the EU strategy of the social and economic development for the period until 2020 (full name: 'Europe 2020: a European Strategy for Smart, Sustainable and Inclusive Growth') adopted by the European Council in spring 2010; and development of the statutory provisions purporting innovations and business support.

Framework programs have been the key tool of implementation of the EU innovation policy. In the European policy, a great emphasis is made on the efficient use of intellectual results, in particular, meaning the 'Europe wide trend in the innovation policy – implementation of the mechanism of technology rights transfer to research institutions and contributing to technology transfer'.

Horizon 2020. The EU is implementing Horizon 2020, a scientific research and innovations program covering the period of 2014 – 2020 that provides for considerable expected financing and the following three priorities: generation of advanced knowledge, achievement of the industrial leadership by the EU, and solving of social problems. The infrastructure support of innovation activities in the EU is primarily aimed at results. It is encouraged by the extensive system of international business innovation centres offering the full variety of innovation project support services, and the network of international science and hi-tech centres coordinating innovation projects.

Horizon 2020 is the key tool of implementation of the flagship initiative of the Innovation Union to meet the obligations assumed by this initiative in pursuance of the European Council's Opinion dated February 4, 2011 and the European Parliament's Decree in respect of the Innovation Union dated May 12, 2011.

Horizon 2020 unites all existing EU programs related to financing of researches and innovations, including the Research Framework Programme and the Competitiveness and Innovation Framework Programme, and operation of the European Institute of Innovation and Technology.

Innovation Union. One of the priority directions of the EU's operation aimed at the promptest development and achieving of the set goals in terms of innovations development is the initiative called theInnovation Union launched to improve the conditions and possibilities of R&D financing to secure implementation of innovative ideas in goods and services that will contribute to the economic growth and new jobs.

This initiative is designated to reorient researches, developments and innovations towards the current pressing issues in our society, such as the clime change, alternative energy sources, demographic problems and healthcare issues. For the purpose of the Innovation Union initiative implementation on the EU level, the European Commission will work in the directions listed hereafter:

- Completion of the European Research and Innovation Space;
- Development of the strategic plan of researches in energy saving, transportation, climate change, optimal use of resources, healthcare, etc;
- Enhancement of cooperation with the Member States and EU regions;
- Improvement of the basic conditions for business and innovations (formation of the EU Unitary Patent Office, special Patent Court, updating of the general statutory provisions applicable to copyright and trademarks, enhancement of the opportunities of intellectual property rights protection for small and medium businesses);
- Launching of European Innovation Partnerships between the EU and the EU Member States to accelerate development and transfer of technologies required for achievement of the goals and targets set. It includes 'creation of the 2020 bio-economic environment', 'engagement of technologies to build the European industrial future', and 'technologies enabling pensioners' independent existence and active involvement in the life of the community';
- Strengthening and further development of the EU policy instruments to support development and innovations (through structural funds, funds of development support, framework research and development program), including close cooperation with the European Investment Bank and simplified administrative procedures of financing obtaining, in particular, for medium-sized and small innovation companies;

- Promotion of scientific partnership and enhancement of the links between the educational system, business sector, researches and innovations; and support of newly setup companies engaged in development of innovation technologies.

On the nationwide level, the EU Member States are expected to follow the directions listed hereafter:

- Reforming of the national and regional systems of researches, developments and innovations; implementation of joint development of programs and enhancement of cooperation with other EU countries in financing issues; and procuring of technologies spreading all around the EU;
- Ensuring of the sufficient support for graduates of scientific, mathematical and technical departments, modification of the school curriculum following the principles of creative abilities, innovations and business development; and
- Priority placement on scientific knowledge development using tax leverages and other financial tools to increase investments for researches, developments and innovations.

Taking into account the multiple EU Member States, the research community of Europe has specific economic structure and national interests, while the centralised financial and administrative mechanisms enable coordination of public researches in the scope comparable to that in the USA. In addition, such similarity exists in the priorities of researches (for instance, the focus on basic fundamental researches) and their efficiency. According to the summary data of investments in industrial researches and developments in 2016, the top 2,500 EU companies invested in R&D EUR 696 billion, which is the 6.6% increase over the previous year. The expenditure growth rate for EU companies is higher than the global and US figures of the R&D expenditure growth rate.

Priority Setting Process. On the policy level, the priorities of science, technology and innovations development are set in the EU based on consultations with the European Commission, the European Parliament and the European Council involving a wide range of stakeholders representing all of the EU member States.

The European Commission, being the EU executive authority, plays the key role in formation of the priorities system. Input offers are prepared by the Directorate General for Research and Innovation.

The following aspects are taken into account when industry-specific priorities are set:

- the contribution to achievement of the EU goals, such as the sustainable economic growth, dynamic and competitive knowledge-backed economy;
- consistency with perspective scientific researches having a high potential of results use in the social and economic sector; and
- deriving of the added value on the European level.

Priority setting often relies on the results of foresight researches ordered by the European Commission. Input offers for the priorities system are sent to the European Parliament and European Council for comprehensive discussion (in several rounds) at special events and in the expert teams representing all European institutions. Simultaneously, the European Commission provides active consultancy in discussing of submitted offers with other stakeholders of the European research space, i.e. national and regional science and innovation authorities, and science, business and community representatives.

Once the discussed priorities are approved, the relevant materials are sent to the European Parliament for final endorsement and prepared for acceptance by the European Council. The general policy priorities are further detailed by program committees on the level of annual steering programs underlying bids announced for scientific research projects. Since members of program committees are the representatives of the EU Member States, the interests of such Member States are minded in the Europe-wide program.

3 INNOVATION DEVELOPMENT LAWS

Stages of Laws Development in Ukraine. The laws concerning innovation activities and, in general, the innovation direction of the economy in mature markets are viewed as the tools of implementation of policy documents, strategies, and plans of science and innovation development. In Ukraine, the more typical practice implies attempts to pass laws purporting impulse of innovation development. However, taking into account the lack of policy documents in respect of the long-term innovation development of economy and the lack of political will, laws initiated by the science community are declined when given consideration or, if passed, suffer from later revocations of their critical provisions.

The following three stages of development of the Ukrainian laws governing technology and research issues and innovations:

- *The first stage (1991–1998)* witnessed passing, on December 13, 1991, of the first (among other CIS countries) basic law related to technology & research and innovation activities (i.e. the Ukrainian Act of Scientific and Technology & Research Activities), introduction of tax benefits for technology & research activities, launching of the Ukrainian State Innovations Fund with its structure and targeted financing (separated from the general budget expenditure) represented (at that time) the new model of the financial support of innovations combining support of innovation projects on the regional, central and industry levels.
- *The second stage (1999–2007)* saw cancellation of tax benefits, liquidation of the State Innovations Fund, shifting of the focus from programs of structural changes in industry onto foreign loan borrowings. Despite passing of the Ukrainian Act of Innovation Activities (2002) and the Ukrainian Act of Governmental Control of Technology Transfer (2006), the provisions of these Acts applicable to the financial support of innovations and technology transfer were revoked by further laws.
- *The third stage (2008 – until now)*, in spite of numerous approved concepts and programs related to science and innovation development, intensive parliamentary discussions of problems appertaining to innovation and technology & research activities, has encountered the following problems: the resolutions passed are not implemented in launching of financial, credit, tax and customs mechanisms of innovation development; draft documents related to financing, tax benefits and loans in respect of innovations are not approved by the competent financial authorities, and technology & research issues and innovations are not treated as significant by executive authorities. Moreover, we can now witness the situation when it's quite clear that draft amendments to tax and budgetary laws related to innovation activities will not be supported by the executive authorities, whereas they tend to adopt the provisions that, on the contrary, slow down scientific activities and implementation of research results in the Ukrainian economy.

Ukrainian Act of Scientific and Technology & Research Activities. The Ukrainian Act of Scientific and Technology & Research Activities (passed in 2016 and revised on 01.01.2017) is, currently, the key law for the implementation of the scientific, research and innovation policy in Ukraine. The Act intends modernisation of the basic statutory provisions applicable to scientific and technology & research activities in Ukraine, solving of disputable issues related to scientific and technology & research activities including, in particular, development of new approaches to management and financing in science, ensuring of efficient

and transparent R&D and R&D financing, better cooperation between the scientific community, executive authorities and the real sector of economy in development and implementation of the uniform governmental policy in respect of scientific and technology & research activities, and procuring of the legal basis for commercialisation of the results of fundamental scientific researches, applied scientific researches and technology and research (experimental) developments by public scientific institutions.

Other Laws Related to Innovation Development. In addition to the Ukrainian Act of Scientific and Technology & Research Activities, the following acts and statutory provisions applicable to researches and innovations are effective in Ukraine:

1. The Ukrainian Act of Technology & Research Information. The Act provides for the governmental policy in respect of technology & research information, terms and conditions of its collection and use to promote the technology & research, economic and social progress in the country. The Act is aimed at development, in Ukraine, of the legal basis for obtaining and use of technology & research information.
2. The Ukrainian Act of Scientific and Technology & Research Expert Practice. The Act stipulates the legal, organisational and financial provisions in respect of the technology & research expert practice, and the general framework and principles of public governance in organisation and implementation of scientific and technology & research expert analysis and evaluations to secure the scientifically-based structure and contents of the priority directions of technology and research development, scientific, technology & research, social, economic and environmental programs and projects, determine the directions of technology & research activities, and analyse and assess efficiency of the use of the technology & research potential and results of researches.
3. The Ukrainian Act of Priority Technology and research development Directions. This Act contemplates the legal and organisational principles of the integral system of setting and implementation of the priority technology and research development directions in Ukraine.
4. The Ukrainian Act of KYIV POLYTECHNICS Science Park. This Act governs the legal, economic and organisational relations appertaining to formation and operation of KYIV POLYTECHNICS Science Park, and purports intensification of development, manufacturing and implementation of hi-tech products in the internal and external markets, and higher payments to the state and local budgets due to combining of education, science and production to accelerate innovation-oriented development of the economy in Ukraine.
5. The Ukrainian Act of Special Provisions for Innovation Activities of Technology Parks. This Act provides for the legal and economic bases of special provisions applicable to innovation activities of the following technology parks: 'Semiconductor Technologies and Materials, Optoelectronics and Sensor Devices' (Kyiv), 'Y. O. Paton Institute of Electric Welding' (Kyiv), 'Institute of Mono-Crystals' (Kharkiv), 'Kyiv Polytechnics' (Kyiv), 'Intellectual Information Technologies' (Kyiv) and other technology parks (including, in total, 16 currently operating research parks) in Ukraine.
6. The Ukrainian Act of Priority Directions of Innovation Activities in Ukraine. This Act stipulates the legal, economic and organisational principles of the integral system of the priority directions of innovation activities and their implementation in Ukraine. The Act is aimed at the innovation-based model of economy development by focusing

of the governmental resources on the priority directions of technology & research modernisation of production, higher competitiveness of domestic products in the internal and external markets.

7. The Ukrainian Act of Governmental Control of Technology Transfer. This Act provides for the legal, economic, organisational and financial principles of the governmental control of technology transfer activities and purports ensuring of the efficient use of technology & research and intellectual potential of Ukraine, efficient technology-based manufacturing of products, protection of property rights to domestic technologies and / or their components in other countries where such rights and / or their components are expected to be used, and extending of the international technology & research collaboration in this direction.
8. The Decree of the Ukrainian Cabinet of Ministers on *Approval of the Concept of National Innovations System Development*. This Decree is intended to determine the key principles of development and implementation of the balanced governmental policy in respect of the national innovations system aimed at ensuring of higher competitiveness of the national economy.

Pressing Problems in Ukrainian Laws. *Innovative Ukraine 2020* National Report of the Ukrainian National Academy of Sciences (2015) outlined the problems related to the regulatory enforcement of laws appertaining to technology & research and innovation development in Ukraine, including the following key pressing issues:

1. Non-compliance with the current statutory provisions, primarily, by executive authorities and, also, by other parties (as determined by the relevant laws) that directly influence the innovation development of the state.
2. No long-term programs of national economy development based on innovations, with their implementation requiring approvals in certain technology & research related acts.
3. Lack of consistency in laws. The laws applicable to scientific and technology & research activities, innovation activities and technology transfer are poorly interlaced. Technology & research programs on various (i.e. horizontal and industry) levels are passed in different times, and no provisions are made for their alignment.
4. No mechanisms of the priority implementation of technology & research and innovation activities.
5. Project screening, analysis and financing are oriented on executive authorities known for a complicated and time-consuming decision making process and unavailability of efficient corruption fighting mechanisms.
6. No consistent and integrated applying of governmental impact mechanisms (i.e. financial, credit, taxation mechanisms, etc) to follow and achieve certain priority goals.
7. Lack of well-coordinated operation of executive authorities aimed at the innovation development of the country.

The situation in respect of the laws and governmental authorities' innovation performance has been repeatedly analysed in parliamentary sessions, meetings of the Science and Education Committee of the Ukrainian Parliament, and meetings of the Ukrainian Council for National Security and Defence. Each such session or meeting resulted in resolutions providing for the executive authorities' commitment to take the steps and measures in order to change the situation and develop the relevant draft acts. However, such resolutions, mainly, have not been complied with, and the statutory provisions related to financing, loans, tax benefits and remissions were either defaulted or cancelled later.

Innovation Development Recommendations of the European Commission. Taking into account the list of problems related to regulatory enforcement of the laws applicable to technology & research and innovation development in Ukraine, in addition to the aforementioned pressing issues, the European Commission determined the following recommendations for Ukrainian governmental authorities:

1. Regular assessments of the national innovations system.
2. Development of the uniform comprehensive national innovation strategy of Ukraine based on a consistent and integral approach to the priorities policy.
3. Formation of the National Innovations Board contributing to improvement of national innovations system management.
4. Policy improvement in terms of financial resources provision for start-ups.
5. Alignment of the future development policy of Ukraine with the innovation progress.
6. Private sector engagement in public technology programs through consultations or public-private partnership (PPP) so that venture capital owners could be better informed concerning opportunities available (and, as a consequence, make more intensive investments in achievable projects).

Alongside with *Horizon 2020* Innovations Program, Ukraine may also benefit from the experience of Israel (please refer to Section 2 for the description of development of government's cooperation with businesses, funds and institutions). However, it requires good understanding and, which is most important, willingness to work in alignment for the sake of the clearly defined objective.

4 COOPERATION AND INTEGRATED INFRASTRUCTURE MODEL

Triple Helix Model. The complementary cooperation between the market (arising out of labour division and implementing private interests) and the government (arising out of the community nature of labour and implementing interest of the society) is the mechanism procuring harmony in the variety of human activities and their products. Under any circumstances, innovations are the product of the community divided labour, being, at the same time, the result of human creativity and societal development. And this is a methodological approach to division of the results of innovation activities, rather than pure theory.

Switching from the 'linear model' of innovation cycle management to the 'cooperative model' called the 'triple helix' has become one of the key global trends in innovations development for the recent decades. Such transformation has radically changed the role, forms and methods of science, education and business cooperation in the innovation process.

According to the 'linear model', separate institutions operate, in certain sequence, to accomplish assignments at different stages of the innovation cycle. Such administrative model has the problem of required ensuring of technology transfer, i.e. transfer of the results obtained at each stage, following the chain step by step. The key problem in this model arises when the work completed at one stage are not taken into account in further stages, thereby failing to accomplish development up to the final result – commercialisation, i.e. making of innovations out of raw materials.

When the innovation cycle was sufficiently extended in time, technology transfer agents managed to mitigate gaps between the stages and somehow procured completion of the innovation cycle. Now, with the considerably increased dynamics of all economic processes, and with the globalisation triggering the unprecedented growth of transnational competition, the long-time nature of the linear innovation cycle prevents its successful completion within a relatively short period and in line with the actual demand that has also tended to vary dynamically for the recent decades. The searches for optimizing of relations between the parties to the innovation cycle have brought about the 'triple helix' concept of the innovation cycle institutionally based on the organic cooperation of the three innovation origination parties – governmental authorities (both, central and local), business structures and universities. In this model, universities play the key role in making the entire innovation cycle efficient.

In the USA, every professor of a business university assumes joint responsibility for financing of his / her research projects. Therefore, the business incline had become typical for US scientists long before the options of knowledge commercialisation appeared, and universities are now increasingly engaged in academic business skills. In Europe, business skills are implemented in high schools, mainly, through training students to set up businesses in stead of waiting for the teacher's initiative. Commercialisation of researches is usually treated as the Government's assignment for high schools in European countries. Insufficient business engagement of the high school teaching staff and students in these countries not only constrains development and progressing of high schools, but also slows down the scientific, social and economic development of communities.

Collaboration between Universities and Industry. Leading universities in the world are rapidly transformed to become 'business universities'. They have grown to powerful academic centres producing new knowledge and practical technology developments, and may enter the market and earn profits

directed to further university development. They become focused on technology transfer and commercialisation of the results of their research activities accomplished in close cooperation with businesses and governmental institutions ordering such developments. Furthermore, in mature markets, universities not only cooperate with technology companies, but also have the opportunity to set up their own small innovation companies (i.e. spin-off and spin-out businesses). As a rule, such companies are setup by universities to generate income that can be used for their further development. However, there have been some examples of the great commercial success, with Google Inc., a well-known spin-off business of Stanford University, being the brightest example here.

In the leading world universities, the well-developed system of support encourages new successful projects. In Ukrainian high schools, such system is only being established: special departments or even separate entities affiliated to universities and ensuring comprehensive support of new projects are formed. These include technology transfer centres, innovations and technologies centres, business practice centres, business incubators, etc.

Innovations related collaboration between universities and businesses is represented in countries' competitiveness ranks in the annual analytical reports on global competitiveness prepared by the research team of the World Economic Forum in Davos. Section 12 (Innovations) of such Report sets out the figures of University-Industry Collaboration in R&D. Such figures are derived as the average expert evaluation at the scale ranging from 1 to 7 (1 = no research collaboration; 7 = widely practiced and extensive collaboration). Table 4.1 hereafter shows the leaders and the rank of Ukraine (for comparison) in such rating.

Table 4.1

2016 Countries' Rating of University-Industry Collaboration in R&D

Rank	Country	Scale Value
1	Switzerland	5,8
2	Finland	5,7
3	Israel	5,6
4	The USA	5,6
5	The Netherlands	5,5
6	The UK	5,5
7	Singapore	5,5
8	Germany	5,4
9	Belgium	5,3
10	Qatar	5,2
11	Malaysia	5,2
12	Sweden	5,2
13	Ireland	5,1
14	Denmark	4,8
15	Austria	4,8

Rank	Country	Scale Value
16	Iceland	4,8
17	Taiwan, the PRC	4,8
18	Japan	4,8
19	New Zealand	4,8
20	Norway	4,7
21	Luxemburg	4,7
22	Hong Kong	4,6
23	Canada	4,6
24	India	4,5
…	…	…
57	Ukraine	3,5

Global Practice. When commercialising the results of technology & research activities, the key objective of universities and leading technology transfer centres is to contribute to implementation of projects, from the stage of a scientific idea to the stage of a new mature company, with a university being interested in the maximum benefits from commercialisation of its technologies. The global practice has proven that the highest profit is generated through:

- holding, as a venture capital investor, of an interest in a company; and
- selling of licences for patented developments.

The analysis of the global practice showed that the institutional support of the scientific component in the 'helix model' may take different forms, as a rule, through research departments or special structures or entities in universities, such as science parks, research parks, business incubators, and also through separate institutions, such as research institutes, laboratories and centres. Such structures and institutions should support close cooperation and form combined institutional units. The legal status of such structures is quite different depending on countries and separate regions. They may exist as technology transfer centres, business incubators, research parks, etc. However, irrespective of the legal form, all such structures are focused on achievement of the single cooperative objective – the innovation progress of the university initiating implementation of its scientific research results in the economy, while partnering with the government and business contributes to formation of new innovation companies (start-ups).

Ukraine's Practice. In Ukraine, universities (in particular technical ones) have established, historically, close links with the companies for which they train future employees. However, firstly, such collaboration is mainly reduced to the aforementioned linear model of the innovation cycle, and, secondly, the stage of commercial implementation of scientific developments has always been the weakness of the Ukrainian national innovations system. A great number of completed scientific research works have not usually had their commercial follow-up. In contrast to venture capital investor's holding of the interest in the innovation, Ukraine has widely adopted another practice – accomplishment of the scientific and research work by order of governmental and business structures.

The analytical database in the Global Competitiveness Report enables a more

detailed analysis of the Ukraine's global competitive position based on efficiency assessment of the final stage of the innovation cycle, i.e. commercialisation of the innovation and technology related knowledge. The traditional linear model of the innovation cycle, implying separate management of various cycle stages (i.e. education – research and development – technologies – production – implementation), is now justifiably criticised for its focusing on the research and development stage, rather than on the final result – commercial implementation of innovations. Development in separate stages does not warrant achievement of the desired final result, i.e. making of an economic growth driver out of the knowledge available.

Summary. It may be concluded that we need organic links between all stages of the innovation cycle, when all parties involved consistently work to achieve the final innovation result based on permanent feedback between the stages.

The 'triple helix model' may be expediently applied in the Ukrainian environment with powerful research universities, other high schools, academic and industry research institutes, industrial facilities and scientific and production synergies. Business research high schools are also a significant component of the 'triple helix model'. Efficient implementation of the 'triple helix model' requires governmental support and reorganisation of universities, institutes, academies, etc. to business-oriented high schools.

Consequently, Ukraine urgently needs improvement of the current governmental innovation policy through development of cooperative links between universities, the Government and business sector, adopting the innovation cycle based on the 'triple helix model'. Such approach would contribute to generation of innovative high technologies through the organic synergy of the educational and scientific potential of universities and market interests and resources of the business sector.

5 FINANCING AND INVESTMENTS

Existing Global Risks. The system of financial support innovations shall take account of various possible (macroeconomic, political, etc) factors, including the state and type of the financial system in a certain country. High investment risks of invested capital loss barrier private investments in innovations. A considerably high risk level and the need in substantial financial costs attributable to innovation activities restrict the number of companies able to properly implement innovation development programs in Ukraine. The macroeconomic risks impairing R&D financing include the financial volatility and weakness of the financial sector restricting the access to external financing sources and resulting in excessive costs. These reasons have necessitated development of the concept principles of innovations financial support in Ukraine. The financial risks related to innovations implementation may be overcome through, firstly, capital concentration and diversification of the innovation projects portfolio (i.e. through special innovation funds, development banks); and, secondly, transferring of the innovation risks to a party having the sufficient financial firmness potential (i.e. governmental programs of innovation financial support, powerful companies, transnational corporations).

Innovations Development Platform. To mitigate the existing risks related to financing of innovation projects, SPETSTECHNOEKSPORT State-Run Foreign Trade Company supported by UKROBORONPROM State-Run Concern and coordinated by the experts of Kyiv Mohyla Business School initiated and developed the concept of the Innovation Development Platform (hereinafter also referred to as «the Platform») in 2016. A private-public partnership based on the model of the Office of the Chief Scientist (please, refer to Section 2) and the real options model was chosen as the Agency format. At initial stages, the Agency is expected to be financed by domestic and foreign investment funds and business angels. The Platform is designed to combine the efforts of various teams of developers, experts and investors, and enable their systemic and commercially transparent development of innovative products. Assuming the support from the Government, development of R&D laws, adopting of the experience of innovative countries and development of research parks, we may enter upon the way of innovations and manufacturing of competitive products through formation of the advanced infrastructure.

In the market economy, the innovation process should rely on the competitive market environment, and the Government should procure protection and financial support of the companies initiating innovations development. The key objective of the governmental policy in respect of financing shall be mitigation of the investment risks and ensuring for parties involved in innovation of additional motivations (here, reference may be made to the experience of Israel) on the condition of their own money contributions into financing of initiated projects.

It should be mentioned that the risks related to financing of innovation start-ups are much higher than those attributable to big companies (including transnational corporations), which results in the complicated access to financing and high capital cost for start-ups. In the initial stages of the innovation process small and medium-sized companies are not able to generate cash flows sufficient for debt repayment, which makes the access to loan considerably complicated for them. It would be expedient to grant loans for such companies from the public funds of innovation support through targeted governmental programs (e.g. SBIR Program in the USA, CIP in the EU, etc.), or by transferring of the innovation financing functions to the specially formed public institutions (for instance, the programs of the European Investment Bank and of the European Investment Fund in the EU countries).

The form and mechanisms of innovation financing should be selected taking into account the financial risk level attributable to each stage (including the initial stage, i.e. scientific and technology & research activities, the basic stage, i.e. preparation and launching of batch production, and the final stage, i.e. achievement of the planned production scope (amount) and exportation of innovative competitive products) and the legal form of the entity involved.

TRL Model. The analysis of the global practice shows that the Model of Technology Readiness Level (TRL) is a quite efficient tool that can ensure impartial assessments of technology development. According to the TRL Model, a technology shall pass through the following nine readiness levels in the course of its development:

1. Approval and publication of the technology basic principles.
2. Definition of the technology concept and assessment of technology application.
3. Researches and developments commencement; confirmation of the characteristics.
4. Verification of the basic technology components in the laboratory environment.
5. Verification of the basic technology components in the relevant environment.
6. Model or prototype testing in the relevant environment.
7. Prototype (prototype sample) demonstration in the operational environment.
8. Completion of system development and testing in the operational environment.
9. Demonstration of the technology in its final form through actual testing of the sample.

The key objective of TRL Model applying is to help the management decide on financing of development and transfer of technologies onto a new level. It should be taken as one of several tools required for research and development control in the framework of innovative product creation.

The TRL Model may be used as the basis for the step-by-step approach to researches and developments, thereby enabling distribution of the functions and responsibilities of a research institution and a customer. Transferring to every next technology readiness level requires expert evaluation of the achieved results, and assessment of the key characteristics of the technology developed based on the chosen technical perfection parameters.

Applying of the TRL Model enables lower probability of excessive expenses for final product development programs due to lower risks and elimination of technology uncertainty. The lack of required technologies results in a considerable increase of costs and extended time of sample development. The use of the TRL system allows management of technology development, i.e. evaluation of technologies, monitoring of their readiness, and control of efficient spending of the financial (primarily, budgetary) resources.

Financing Types at Different Innovation Development Stages. The first stage (i.e. the seed stage) provides for the research & development activity characterised by excessive investment risks due to the high probability of unsuccessful scientific research. At this stage, the financing amount is relatively modest. The key source of scientific research financing in the OECD countries is the companies' own funds covering 40-80% of the total related expenses incurred in the course of a research. Private savings may be also used. If no financing is available, certain potentially successful innovation projects may not be implemented. As a matter of fact, the first stage requires the financial support of the Government, primarily, in the priority directions of science and technology development. The governmental financial support at the initial stage is the second largest financing source covering 10-50% of the total research and development expenses in the OECD countries.

The basic stage provides for the implementation of scientific developments in a new or improved product. At this stage,

financial risks are still high, and the amount of financing to cover the cost of technology implementation, production of innovative product samples and innovative product promotion is considerably higher comparing with the first stage. Existing companies may use their own funds (i.e. unallocated profits and depreciation) as the source of innovations development financing at this stage. In the OECD countries, companies spend on such financing up to 8% of the implementation expenditure in conventional industries, and up to 15% of the implementation expenditure in hi-tech directions.

At the stage of production implementation of technology & research developments, innovations in small companies and start-ups may be justifiably financed through special investment and venture funds. In the recent years, innovation start-ups financed by venture funds have tended to make IPOs sooner than other innovation companies.

At the final stages of innovation activities (i.e. organisation and batch manufacturing of competitive products), such forms of financial support as tax incentives and a bank loan gain significance along with self-financing. Tax incentives have proven to be an efficient tool of the indirect governmental support of innovations development at the final stage, when batch manufacturing of innovative products and profit generation commence. Granting of tax incentives enables lower average weighed cost of capital (due to tax payment savings). A bank loan is the relevant financing form at the final stage, when a project begins generation of favourable cash flows from operations. In practice, the higher percentage of a bank loan in financing of innovation activities proves to be expedient at the stages of batch manufacturing and expansion of a created product.

Innovations Development Investment Fund. The Innovation Development Investment Fund (IDIF) is the initiative of the Innovations Development Platform – the first domestic agency engaged in incubation, financing and implementation of innovation projects in the field of defence technologies. The Fund makes investments in potentially successful projects at the 4-7th technology development level according to the TRL Model, when the concept of a new technology is experimentally proven.

Governmental Innovation Financial Institution. The Governmental Innovation Financial Institution (GIFI) was set up in line with Decree No. 654 passed by the Ukrainian Cabinet of Ministers on April 13, 2000 as the legal successor of the property rights and obligations (including those under innovation loan agreements) of the State Innovations Fund and its local branches. The Governmental Innovation Financial Institution is designated to organise competitive selection innovation and investment projects and programs for further financial support thereof. The financial support of the Governmental Innovation Financial Institution is implied by its key targets listed hereafter:

- financing, from own and engaged moneys, of technology & science and marketing researches, technology development and other project work, technology & science researches, and, subject to the approval by the Ukrainian Cabinet of Ministers, innovation and investment projects and programs aimed at production implementation of advanced technology & research developments and technologies;
- financing of the events and measures related to innovation development infrastructure;
- financing of innovation and investment projects and programs approved by the Ukrainian Cabinet of Ministers from the Treasury (State Budget) based on the priorities of innovation and investment development of the national economy;
- engagement of finance, including foreign finance, issuance of security guarantees for financing of technology & science and marketing researches, technology

development and other project work, technology & science researches, and innovation and investment projects and programs;

- development and accomplishment of pre-investment steps and measures;
- follow-up of innovation and investment projects and programs, control of their efficient implementation and authorised use of GIFI's moneys by parties to innovation activities;
- collaboration with international financial organisations, governmental and non-governmental foreign organisations in the issues related to engagement of financial resources in the Ukrainian economy and implementation of joint innovation and investment projects and programs; and
- participation in development and implementation of comprehensive organisational, financial, economic and law measures in order to ensure business development, and support of technology & research and innovation activities of small and medium-sized businesses.

Summary. Development of innovations expects establishing of links between universities, the Government and the business sector. Even though each such party has its own targets and objectives, – if we assume combining of their efforts for the sake of innovative Ukraine, gradual progress of technology parks, incubators, development programs, and permanent adopting of the experience of other highly developed countries – launching and acceleration of innovation development mechanisms in Ukraine are quite attainable.

However, we should take account of the objective complexity of Ukraine's switching to the innovations-based model of economic development due to the lack of investment resources and high macroeconomic investment risks. In the midterm (until 2020), the market forms of innovation financing in Ukraine are expected to remain in the bud for objective reasons, and, therefore, a proactive governmental innovation policy is welcomed. Ukraine should take considerable political and economic efforts to build a favourable institutional, regulatory, economic and motivation environment contributing to acceleration of innovation processes and development of innovative technologies.

Consequently, to instigate the processes of innovations development in Ukraine, the following Action Plan issuggested:

1. Holding of a strategic meeting devoted to formation of the Innovation Development Board in Ukraine.
2. Formation of the Innovation Development Board.
3. Holding of the kick-off meeting of the Innovation Development Board.
4. Development and approval of the Plan of Innovations Development in Ukraine
5. Audits of the legal framework, innovation and investment infrastructure.
6. Development and approval of the comprehensive model of cooperation between stakeholders and the innovation and investment synergy.
7. Development and approval of the new legal framework to be further adopted.
8. Implementation of the relevant legislative and organisational reforms in the public and private sectors.

INNOVATIONS
DEVELOPMENT
PLATFORM

AGENCY ON INCUBATION AND IMPLEMENTATION OF INNOVATIVE PROJECTS
IN THE AREA OF DEFENCE TECHNOLOGIES

Contacts: 1, Dorogozytska Str., 1, UNIT City, office 204,
Kyiv, Ukraine, 04119
тел. +380 44 333 60 63

www.ukrinnovate.com
info@ukrinnovate.com

www.ukrinnovate.com