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**BARRIERS INTECHNOLOGY TRANSFER OF ADVANCED
DUAL-USE MATERIALS IN UKRAINE**

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This effort is an attempt to assess the underpin premises of technology transfer appeared after 1991 when the Ukraine gained the independence and to highlight and evaluate the potential barriersfaced between technology supplier and recipient. After the Soviet Union has fallen apart, there was a strong increase in a number of participants in foreign economic activity. For many of them, commercial interests were much more attractive, important and understandable than the national, economic and political security of Ukraine. Under the umbrella of disappearance of many administrative mechanisms, this brought to elevation of physical volume of sales of strategic goods and advanced technologies abroad, which may pose a threat to national security, regional and global stability, and a competitiveness of domestic economy. Thus, this is the set of factors that strongly affect an efficient and proper functioning and optimization of the process of transfer of intangible materials science technologies. Consequently, a technology transfer is a process that under its umbrella involves not only a technology transfer itself but a dissemination of specific technological knowledge; acts as a rather complicated communication between supplier and recipient; stimulates a creation of new consumer values and may be repeated time after time. Thus, when implementing the process of technology transfer, specific situations may appear that depend on characteristics of the activities of transfer subjects involved, and if given that an object of transfer is a new technology each time, thus it is fair to conclude that a specific and unique approach in the process of technology transfer may not be offered, and that is precisely why an implementation of each stage of transfer requires well-founded and grounded solutions.

Key words: dual use materials, technology transfer, export control.

1.1. Problem definition

Traditionally, Ukraine has been a leader in development of new progressive materials for the needs of leading high-tech industries. After Ukraine has gained an independence in 1991, its technical and scientific potential turned out to be of a little demand sincethe country could not sufficiently finance scientific efforts and thus a development of advanced technologies that had been patronized within the Soviet Union. Fundamental and applied research, powerful materials science schools, developed industry, advanced educational system and a highly educated population with good scientific and technical background became good prerequisites for becoming a successful European country. It was expected that after a certain period of experience, Ukraine would move forward rather fast and successfully compete not only on the world market of ideas and new technologies, but also in the field of research and innovation as well.

It is well known that any developed economy is based on a solid background of science and knowledge. New technologies for production of high-tech products are the main driving force of country's progress, and a success of their implementation in the basic industries allows us to increase national welfare and take a stable high place in the world rankings [1]. However, for 27 years of independence, a business in Ukraine has never become a civilized one. Every year, a rather large number of

students graduate from Ukrainian technical institutes and universities, but there are no longer those industrial R&D institutes and industrial enterprises that previously could employ this annual huge flow of young specialists and attracted those to a development of high technologies. All this leads to dramatic outflow of talented young people from the Ukrainian scientific community, industrial and engineering sector. It also brought materials science to crisis, which further resulted in a decrease of a level of high-tech industry, which is based on advanced materials. However, the highest scientific level of knowledge had been accumulated by the Ukrainian material science experts, gives us a hope and a good chance to revive these enterprises by attracting both knowledge and investments. Nevertheless, the more knowledgeable and experienced in the field of technology transfer, the persons who hold this knowledge would be able to work with more experienced and powerful investors and the easier would be for them to tackle the problem and enter the world market. It is obvious that a training of specialists and creation of national system of advanced training of scientists in the field of technology transfer management and trade control system that meets international requirements is one of the main tasks that need to be resolved in the near future if Ukraine moves to a market economy and wants to meet the international standards.

If to analyze a foreign experience in this area, then we will see that institutions start to be involved in commercialization of their R&D results, so-called technology transfer offices (TTO), are established almost at every university or R&D institute [2]. And this is natural, since the main scientific research in Europe, USA, Singapore, Japan, etc. are conducted by scientists in the laboratories of institutes and universities, and the product for further commercialization is either technology, or material, or a specific article made from this material. However, TTO mainly does consulting, helps to attract investment, and conducts thematic trainings and seminars on industrial R&D and export control of strategic goods. All this helps scientists to acquire the necessary knowledge for successful and safe implementation of their inventions and developments. However, if those offices are not necessarily aware of trade control constraints that might raise the risks of a misuse and WMD proliferation.

For Ukraine, a history of advancement of scientific developments and technologies that implement those (especially dual-use products) [3] to a consumer market is almost zero. The socialist state (the former Soviet Union) usually divided a financial support of science and transferring R&D results to industry. And if the financing as a whole, had a consistently moderate and controllable level throughout the country, the financial support of technology transfer to industry had a significantly higher priority but was geographically clustered in nature and was concentrated mainly in the environs of Moscow and Leningrad. An exception was a direction of development of new advanced materials for military complex, aerospace, electronics and other high-tech industries. The Academy of Sciences of Ukraine was the recognized leader (and it was documented at the highest state level at those time). However again, this may not be referred to most researchers but was also of a clustered nature and singled out certain groups of scientists who carried out targeted research and development programs fixed by the government decrees with specially allocated funding. One of such programs was a development of powder metallurgy. Scientists of Frantsevich Institute for Problems of Materials Science of National Academy of Sciences of Ukraine created a new industry - powder metallurgy by commissioning four powder metallurgy plants and more than 50 workshops of this specialization at existing plants.

After the collapse of the Soviet Union, the practice of government patronage of works on transfer of scientific developments to industry was almost curtailed for all

countries of the former Soviet Union except Russia, since all specialized innovative institutions remained on its territory and under the authority of its government.

A paradoxical situation has appeared – the carriers of knowledge in development of new materials remained “homeless” in own country. From the one hand they possessed a great value in hands, but simply do not know how to offer it to the world market and had no experience how to resolve this serious and important issue. And in case of dual-use technologies, there still exists a danger of violation of the Law on State Secrets, which has not been ever canceled and is still in force [4].

1.2. Historical and other premises

Nowadays, the Ukrainian materials science institutes, recognizing and understanding the world level of their developments, understand that their R&D results (both current and those left from the Soviet times) may not be easily brought to a format perceived by the global market (a problem of certification, etc.) and to bring those to this market without any efforts applied. Thus, the biggest problem comes here - scientists simply do not know how to competently and professionally do this! In the era of the USSR, 1) none of them even cared and 2) nobody taught them and even at present this system of education does not exist, despite being of extremely important. The same educational activities on innovation, trade control and technology transfer, which are conducted by international foundations are ineffective and not that systematic. To study this abroad is a very problematic, as both for financial reasons and language barrier as well. In addition, such training does not account for peculiarities of a mentality of scientists from former Soviet Union and national regulatory framework.

In addition to these general problems, there naturally exist some technical problems of a technology transfer itself and especially a transfer of dual-use technologies. Intangible (dual-use) technology, is a technology having its commercial (civil) and military and/or defense applications, has been always a controversial subject [5] in Ukraine, the EU and all over the world. For Ukraine, at present, all these problems should be considered accounting for the fact that this is a two-way road. On the one hand, Ukraine, having a military conflict in the east, needs to modernize the existing weapon systems and an influx of new dual-use technologies. On the other hand, having a “goldenstock” of materials science developments, Ukraine is extremely interested in export of those to elevate a level of its economy. Because of the technical problems, first, it should be noted that virtually every exported technology is not that new to the state which want to buy it. The developed countries never transfer the most advanced technologies not to create competitors and potential threats to State’s national security. Therefore, for Ukraine, which imports these technologies in a time-critical position, their qualified expertise for the presence of Ukrainian counterparts is extremely important. A technical problem is also the fact that the technologies involved in transfer process often need to be modernized and/or improved and adapted, for example, to domestic raw material base and existing equipment. One of the problems that can be encountered in technology transfer is technical problems. The transfer and implementation of a new technology often involves a radical and/or partial change of the existing process.

It is obvious that less transformations required by the available technology are, the easier is to perform a transfer process, therefore, when looking for a potential future consumer, minimizing any “*additional*” costs and changes should be of the highest priority. Technical problems are mostly dictated by the content of

technology and therefore it is necessary to have thoughtful solutions to those problems that may pop up in the process of technology transfer. The more difficult problem faced is so-called historical and mental problem. Each company has its own history and employs a team with a certain level of knowledge and experience thus mastering a new (especially Ukrainian) production technology of any advanced materials requires acquiring new knowledge under the guidance of one of technology developers. To put it into the other words a new technology has to be escorted. Often these technologies use non-standard equipment, which is also of a problem and needs an additional training for a staff. Thus, a transition to a new technology requires quite a lot: new raw materials base, components, equipment, etc.; administrative management and control difficulties, which bring the entire previously stable supply system to a quite slight and/or complete change. The commercial risks of this restructuring grow up significantly, and sometimes they simply become critical and lead to a question of advisability of buying a new technology. One of the most important is a question of future sales. An appropriate market search, future demand prognosis, sale network formation—all these activities should be constantly in a view of company's management, which is to acquire a technology. Let's consider the existing premises and the Catch-22: 1) *technical*: a technology must be both new and "slightly outdated"—to minimize the need of radical changes; 2) *historical and mental*: company's team must be both highly experienced and ready to master new knowledge and skills— an escort of new technology being transferred and team training has to be of administrative prime priority and managed; 3) *administrative*: the management has to be effective and ready to face new challenges; 4) *economic*: innovation should facilitate a quick profit and be reliable for a long time - advanced materials science technologies (especially dual-use solves this problem through a duality —and a quick profit through a good product and a long-term perspective through manufacturing responsible aimed articles; 5) *political*: the need to export advanced technologies to financially support internal activities and at the same time constraints imposed by a risk of WMD proliferation and a misuse that might restrain potential transfers.

The main difficulties faced in transfer and implementation of technologies in this bilateral movement mostly could be related to: a) insufficient amount of available own funds of companies importing technologies and science exporting those; b) small budget and extrabudgetary funding of National Academy of Science institutions; c) drastic production fall; d) difficulties in opening credit lines due to the high interest rate; e) limited level of risky financial assets; f) low wages of scientists and developers of new technologies; g) outflow of highly qualified specialists abroad and in other sectors of national economy often due to that companies and State do not demand scientific research.

1.3. The Ukrainian case

The identified problems of transfer of production technologies of new advanced dual-use materials in Ukraine, an analysis of their complexity and a vision of solutions described above brought us to the following:

- Ukraine needs to import such technologies and has a significant potential for their export;
- for imported technologies, a thorough examination is needed for the existing Ukrainian analogues;
- for an effective technologies export and import, it is necessary to establish a solid national system for training of specialists of the highest level in the field of technology transfer and an efficient trade control system;

- for a civilized withdrawal of technologies to the world market and reliable operation of imported technologies by their consumers, it is necessary to create a network of international certification centers;
- to maintain the potential of Ukrainian exports as production technologies of advanced materials, and high-tech products from them, a significant increase in R&D budget and State's patronage and an umbrella under the transfer of R&D results to industry (for both state-owned companies and private ones) are required.

For the time being, discussions on intangible technologies lack creativity; political and diplomatic initiatives are as well. Thus, this is the set of factors that strongly affect an efficient and proper functioning and optimization of the process of transfer of intangible materials science technologies. Consequently, a technology transfer is a process that under its umbrella involves not only a technology transfer itself but dissemination of specific technological knowledge; acts as a rather complicated communication between supplier and recipient; stimulates a creation of new consumer values and may be repeated time after time. Thus, when implementing the process of technology transfer, specific situations may pop up that depend on characteristics of the activities of transfer subjects involved, and if given that an object of transfer is a new technology each time, thus it is fair to conclude that a specific and unique approach in the process of technology transfer may not be offered, and that is precisely why an implementation of each stage of transfer requires well-founded and grounded solutions.

CONCLUSION

There should be a clear agreement to establish a transparent dialogue between technology supplier/recipient countries, to enable mutual political objectives to be complemented by compliance and enforcement procedures. Central to the debate would be a discussion of fundamental and practical questions associated with transfer of dual-use technologies. Thus, a good question comes: is it appropriate to undertake multilateral negotiations? Then if so, in what form and what type they should be?

Ця стаття є спробою оцінити основні передумови трансферу технологій, що з'явилися після 1991 року, коли Україна здобула незалежність та висвітлити й оцінити потенційні бар'єри, які можуть з'являтися між постачальником та отримувачем технологій. Після розпаду Радянського Союзу число учасників зовнішньоекономічної діяльності різко зросло. Для багатьох з них комерційні інтереси були набагато привабливіше, важливіше і зрозуміліше, ніж національна, економічна і політична безпека України. Під егідою зникнення багатьох адміністративних механізмів це призвело до збільшення фізичного обсягу продажів стратегічних товарів і передових технологій за кордон, що може становити загрозу національній безпеці, регіональній та глобальній стабільності і конкурентоспроможності вітчизняної економіки. Існує сукупність таких чинників, які сильно впливають на ефективне і правильне функціонування та оптимізацію процесу передачі нематеріальних матеріалознавчих технологій. Трансфер технологій - це процес, який в своїй основі містить не тільки передачу технологій, а й поширення конкретних технологічних знань; є досить складним взаємовідношенням між постачальником і одержувачем, а також стимулює створення нових споживчих цінностей і може повторюватися не один раз. Таким чином, при реалізації процесу передачі технологій можуть виникати конкретні ситуації, які залежать від характеристик діяльності беруть участь суб'єктів передачі, і, якщо врахувати, що об'єкт передачі кожен раз є новою технологією, буде справедливо зробити висновок, що не існує якогось одного специфічного і унікального підходу в процесі передачі технологій, і саме тому реалізація кожного етапу передачі вимагає ситуативних і добре обгрунтованих рішень.

Ключові слова: матеріали подвійного використання, трансфер технологій, експортний контроль

Эта статья – попытка оценить основные предпосылки передачи технологии, появившиеся после 1991 года, когда Украина получила независимость, а также выявить и оценить потенциальные барьеры, которые могут возникнуть между поставщиком и получателем технологии. После распада Советского Союза число участников внешнеэкономической деятельности резко возросло. Для многих из них коммерческие интересы были гораздо привлекательнее, важнее и понятнее, чем национальная, экономическая и политическая безопасность Украины. Под эгидой исчезновения многих административных механизмов это привело к увеличению физического объема продаж стратегических товаров и передовых технологий за рубежом, что может представлять угрозу национальной безопасности, региональной и глобальной стабильности и конкурентоспособности отечественной экономики. Таким образом, существует совокупность таких факторов, которые сильно влияют на эффективное и правильное функционирование и оптимизацию процесса передачи нематериальных материаловедческих технологий. Трансфер технологий – это процесс, который в своей основе включает в себя не только передачу технологии, но и распространение конкретных технологических знаний; является довольно сложным взаимоотношением между поставщиком и получателем, а также стимулирует создание новых потребительских ценностей и может повторяться не один раз. Таким образом, при реализации процесса передачи технологии могут возникать конкретные ситуации, которые зависят от характеристик деятельности участвующих субъектов передачи, и, если учесть, что объект передачи каждый раз является новой технологией, будет справедливо сделать вывод, что не существует какого-то одного специфического и уникального подхода в процессе передачи технологии, и именно поэтому реализация каждого этапа передачи требует ситуативных и хорошо обоснованных решений.

Ключевые слова: материалы двойного назначения, трансфер технологий, экспортный контроль

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