

Zagorodny, A.G.

Presidium of the National Academy of Sciences of Ukraine, Kyiv

SCIENTIFIC AND TECHNICAL COOPERATION BETWEEN THE NATIONAL ACADEMY OF SCIENCES OF UKRAINE AND THE KYIV CITY PUBLIC ADMINISTRATION: CAUTIOUS OPTIMISM



The experience of scientific and technical cooperation between the National Academy of Sciences of Ukraine and the Kyiv City Public Administration has been summarized. The approved innovative projects based on R&D works of NASU institutions to be implemented in 2015 in the urban economy has been briefly described.

Keywords: National Academy of Sciences of Ukraine, Kyiv City Public Administration, public transportation, energy saving, and hydrological monitoring studies.



Anatolii ZAGORODNY

The National Academy of Sciences of Ukraine has always paid great attention to the cooperation with the Kyiv City Public Administration

(KCPA). The relations with KCPA have greatly progressed since 1998, when the Cooperation Agreement was signed between the parties (in 2006, the Agreement was revised). The implementation of this Agreement and the Cooperation Program has brought tangible fruits in solving the problems of urban transport, preservation and improvement of the city green space, energy saving, healthcare, etc. In particular, a set of advanced technologies for restoring the worn parts of public transport facilities has been developed and a significant amount of works on diagnosing the condition of bridges and estimating their residual life has been done. Thanks to numerous R&D projects, the pharmacies and medical institutions of the city have received new effective drugs and therapeutic agents produced by Kyiv pharmaceuticals. Many archaeological and hydrological monitoring studies in the Kyiv historic areas have contributed to the preservation and restoration of cultural heritage.

As a result of the cooperation between the National Academy of Sciences of Ukraine and the

Kyiv City Public Administration, the research centers and the city administration departments have established sustainable relations and contacts. The research institutions of NAS of Ukraine have formed groups of researchers whose activities largely focus on the addressing the problems of the city.

However, starting with 2007, the cooperation has dramatically shortened and is taking place under conditions of almost total absence of funding from the KCPA. In 2012, the National Academy of Sciences of Ukraine submitted to the KCPA about 80 proposals on joint projects, many of which were approved by the KCPA competent departments and recommended to be included into the cooperation program in accordance with Agreement on Cooperation between the National Academy of Sciences of Ukraine and Kyiv City State Administration in the field of science and technology made in December 2011. However, none of the projects have received funding from the city budget, as stated in the Agreement. Notwithstanding this, some projects agreed by the KCPA have been implemented by institutions of NAS of Ukraine at the expense of NASU funds. In particular, the Institute of Bioorganic Chemistry and Petrochemistry of Ukraine has designed, manufactured, and successfully tested in operating environment a pilot plant for dewatering wastewater sludge at the Bortnichy WWTP. The implementation of results would reduce the sediment and costs of their pumping, significantly decrease the load on the station sludge pits, and prevent possible man-made disasters due to lowering the table of sludge drying beds. However, this project, as well as a number of other projects has remained non-commercialized because of the lack of funding from the KCPA.

The institutions of NAS of Ukraine have performed some R&D works for the sake of the city under contracts with direct customers. For instance, the Institute of Demography and Social Studies of NAS of Ukraine has completed the study on comprehensive analysis and forecast of demographic development of Kyiv till 2026. The results of this work underlaid the Master Plan

Development of the Kyiv city and its suburbs. The M.M. Grishko National Botanical Garden of the National Academy of Sciences of Ukraine has elaborated the section «Recreational Areas and Landscaping of the Kyiv City» as part of the Master Plan of Kyiv and its Suburbs till 2025. The experts have made a comprehensive survey of green spaces, assessed their condition and worked out recommendations for its improvement. Also, they have developed a concept of recreational areas and landscaping in Kyiv.

The E.O. Paton Institute of Electric Welding has developed a portable mobile hardware for butt welding of steel reinforcing rods directly on site. In particular, the hardware has been used for mounting the upper tier of spectator stands at the *Olympiiskyyi* National Sports Complex. Its use for the construction of industrial and residential buildings, bridges, viaducts, and other facilities has been being expanded. A welding technique for mounting steel structures of transport interchanges has been designed and implemented for the flyover in Moskovski District and the road junction of Darnytsky Bridge and the Dnieper Embankment. The experts of the Institute have exercised supervision over the welding of sections of the arch bridge over the Dnieper River in Podil District. They have polished a technique for welding the arch sections weighing up to 700 tons, developed a technique for welding the flyover beams of the right bank approaches to Podil bridge, provided research and engineering support for the beam manufacture and installation. A set of effective technologies for repairing the rolling stock of city public transport has been introduced. Among them, there are a technique for deposit welding of worn surfaces of tram wheel tires and a technique for mechanized deposit flux cored wire welding of clamps coupling the subway cars, which can be used not only for recovering the geometric dimensions of clamp working surfaces, but also for extending their service life 2–3 times.

The R&D works done by the institutions of NAS of Ukraine within the framework of government program for the development and imple-

mentation of energy efficient LED lights and lighting systems based on them have been actively implemented for the sake of the Kyiv City. Pilot projects on the use of developed LED lighting have been implemented on Kyiv subway stations, roads, and housing facilities of the city and showed a significant capacity in terms of energy savings with a payback from 9 to 30 months.

The Institute of Mathematical Machines and Systems has created and is implementing a system for LED lighting of subway cars, which reduces electricity consumption 4 times, with the illumination of cars increasing 1.5 times. Fifty cars have been already refurbished; now, it is planned to refurbish all 400 Kyiv subway cars that will give annual savings of more than UAH 500 thousand. The system of controlling engineering equipment of buildings designed by this Institute has been widely used in the construction industry. Energy savings from the introduction of these systems range from 15 to 30%.

The Institute of Engineering Thermophysics of the NAS of Ukraine was involved in revising the regional program of municipal power engineering system of Ukraine and the heat supply system of Kyiv in 2011–2015 and district heating schemes of Kyiv for the period till 2015.

The Institute of Archaeology of the NAS of Ukraine has been doing, on regular basis, archaeological monitoring of construction in historic areas of the city of Kyiv to preserve the archaeological sites. The organization has contributed to designing the museum tours and tourist routes in Kyiv.

The Institute for Problems of Information Recording of the NAS of Ukraine in cooperation with specialists from *Eye Microsurgery Center* of Kyiv City Clinical Ophthalmologic Hospital and the P.L. Shupyk National Medical Academy of Postgraduate Education has developed a technique and organized the mass production of optical elements with micro-prism structure effectively used by the eye care clinics of Kyiv. This work has been awarded with the State Prize of the Cabinet of Ministers of Ukraine for the development and implementation of innovative technologies in 2013.

The above examples illustrate the fruitfulness of cooperation between the National Academy of Sciences of Ukraine and the Kyiv City Public Administration in solving a wide range of issues of the urban economy. However, the cooperation capacity are not utilized in full manner because of the lack of funding of joint projects from the city budget. Prospects for their development opportunities depend on the municipal budget and the appetency of KCPA new leadership.

In June 2014, the National Academy of Sciences of Ukraine submitted to the KCPA proposals for cooperation in 2015 comprising 230 projects. The proposed projects focus particularly on energy efficiency. They include methods and techniques for control and minimization of heat losses, heat recovery, energy efficient electric heating systems, a technique for the use of combustible waste in thermal power plants, measures for broad implementation of energy saving lighting systems, including those with wide use of LEDs and supercapacitors. Large part of the proposal relates to addressing resource saving problems through applying new techniques for corrosion prevention and control, wear-resistant coatings, and for waste management.

Many projects concern improving the environmental situation in the city, prevention of disasters, and improvement of the quality of health care and drinking water.

The implementation of developments designed to improve reliability and to increase operating life and rolling stock of public transport and infrastructure elements, including bridges and overpasses are expected to yield good fruits.

On October 7, 2014, a meeting on the resumption of cooperation under the Agreement of 15 December 2011 between the Kyiv City Council and the National Academy of Sciences of Ukraine was held at the KCPA, for ensuring the use of developments of NASU institutions on urgent problems of urban economy. The meeting was attended by representatives of the KCPA, leadership of the National Academy of Sciences of Ukraine, the board of directors of enterprises, institutions, and

organizations of the city of Kyiv, the Associations of Employers of the Kyiv City, the Ukrainian Chamber of Commerce, and the Kyiv Chamber of Commerce. The participants had an opportunity to get acquainted with the R&D works of institutions of NAS of Ukraine, which can be effectively used to raise the engineering level of the urban economy at the exhibition «*The institutions of the National Academy of Ukraine for the Kyiv City*». Before the exhibition, the proposals of NASU institutions on the cooperation were submitted to respective KCPA departments. One hundred and twenty seven developments that sparked the most prominent interest of KCPA departments were selected for the exhibition. Twenty two NASU institutions took part in the exhibition.

Upon the results of the meeting, 11 joint projects were selected to be funded from the city budget in 2015. The list of projects was approved by Anatolii Zagorodny, the Vice President of the NAS of Ukraine, and Vladimir Klitschko, the Kyiv Mayor. Below, there are brief descriptions thereof.

Energy-efficient electrode local heating systems have been designed by the V.M. Bakul Institute for Superhard Materials of NAS of Ukraine.

The existing system of centralized heating of buildings distanced from the boiler house at 800 m or more has been showed to be unprofitable. High heat losses, low service life of the equipment and systemic failures of heating mains lead to unreasonably high costs of their maintenance in proper operating condition.

The equipment of houses and buildings with energy efficient autonomous local heating units during the construction of new and reconstruction of existing housing and production facilities will contribute to the creation of new standards of living and environmental protection. The developed systems of local heating based on the use of electrode boilers have a set of advantages over the traditional electric heaters. The most important ones are as follows: high operational reliability (heating is based on ionic conductivity of water and is realized due to direct electric current running through the coolant); significant decrea-

se in consumption of electricity (30%) due to direct heating of the coolant and programmable control; high power transformation efficiency (up 99.5%); and long service life (15–20 years).

A technique for track rails welding is developed by the E.O. Paton Institute of Electric Welding of the NAS of Ukraine.

A technology and equipment for tension welding of rail joints has been proposed. The application of developed rail welding equipment of new generation makes it possible to receive seamless subway lines from station to station (the so-called «velvet» way). This will significantly improve the quality of upper structure of subway rails and conditions of passenger carriage and will bring them to European standards.

Advanced tools for control of track and conduct rail engineering parameters has been designed by the E.O. Paton Institute of Electric Welding of NAS of Ukraine.

A computerized system of operational control and record of welding parameters has been proposed. The system is designed for measuring, recording, and monitoring parameters of butt welding conditions to verify their compliance with applicable technical specifications. The system allows the operator to perform real-time monitoring of the welding parameters and to create a «passport» for each joint and a report to be stored in computer memory. The use of this system will ensure a consistent high quality of rail welding and prevent incorporation of rails with defective joints into the track.

To control the parameters of the conduct and running rails a laser track-measuring truck for recording, automatic processing, and reporting of the track conditions has been designed.

Strong, lightweight, repellent, inflammable fiberglass umbrellas to subway stations have been designed by the O.O. Chuiko Institute for Surface Chemistry of the National Academy of Sciences of Ukraine.

The safe operation of subway is ensured both by durable rolling stock and adequate properties of composite materials used for the construction

and decoration of stations and tunnels. The composite materials should be reliable in terms of their mechanical parameters and flawless in terms of fire safety and sanitation standards.

The epoxy-based fiberglass containing fire resisting and hydrophobic additives have the necessary mechanical performance and do not emit toxic products. Hence, they are safe for the use in closed areas. The proposed materials have significant advantage over the materials based on polyester resins that have been widely used in the subway in recent years. Their application would greatly improve the safety of passengers and the appearance of the crowns and tunnels of Kyiv subway stations.

Sylar waterproof, environment friendly, heat-resistant (from -60 to $+250$ °C) lubricating composite for friction joints of equipment has been developed the O.O. Chuiko Institute for Surface Chemistry of the National Academy of Sciences of Ukraine.

The composite consists of the components imparting important properties to it: non-toxicity, heat resistance, water resistance, and high adhesion to the solid surface. It has been approved by the Ministry of Healthcare for being used in friction joints of equipment as antifriction sealing material for the «*metal – metal*» and «*metal – rubber*» interfaces: dairy product line, vegetable oil refining lines, hot and cold water taps. The technique for preparing the composite makes it possible to obtain samples of varying consistency. The lubricant does neither cause any corrosion of metal nor affect the organoleptic properties of food. The composite is resistant to any fluctuations in humidity and temperature within the range from -50 to $+290$ °C, keeps tightness at a pressure of 5–6 atm and a hydraulic impact of up to 170 atm. The analogues have significantly lower performance.

Monitoring of the landslide progress within the city of Kyiv (using the results of remote sensing survey) (project designed by the Center for Aerospace Research of the Earth of the Institute for Geological Science of the NAS of Ukraine.

Landslides in Kyiv are caused by geological structure of the Dnieper right-bank side hills and the

erosional pattern of the plateau. The total area of zones is about 400 ha, with over 130 sites located within this area being prone to landslide. They are supported by 33 km retaining walls. The current intensification of gravitational processes in Kyiv is provoked by mass housing development on the side hills of small rivers and large valleys in urban landslide-prone area with difficult terrain. The slopes of indigenous plateau have been reported to slide because of destruction of plants that reinforce the soils, drainage abuse, and excessive load of construction objects.

The satellite survey technique ensures high visibility, promptitude, efficiency, frugality, regularity of data record, and the ability to receive information on large areas, to move from the discrete set of values of certain indicators in selected points to the continuous spatial distribution of these indicators throughout the whole territory surveyed, to get timely and objective information, and to complement the data obtained by contact measurement methods (in some cases the satellite survey can provide more informative data as compared with the contact measurements). The landslide-prone areas tend to geodynamic zones in the crust, which are traced as lineaments using multizone spacecraft imagery. The landslide are studied allowing for the geodynamic component, with morpho-dynamical structure of terrain analyzed and landslide-prone areas simulated.

Highly-precise detailed aerospace monitoring would make it possible to record with a high repeatability in time and to predict the development of gravitational processes that can trigger landslides. Environmental measures to prevent threats of further landslides and to mitigate the consequences have been recommended.

Monitoring of the quality of drinking water in the existing and reactivated pump rooms (the project is developed by the A.V. Dumansky Institute of Colloid and Water Chemistry of the NAS of Ukraine.

In Kyiv region, in recent years, the artesian water has been reaching the consumer (through a network of 200 pump rooms, at the end of 2004)

in its original form preserving its natural properties and chemical composition. The artesian water as opposed to the tap water does not contain such toxic and carcinogenic substances as mercury, thallium, beryllium, cadmium, lead, arsenic, nickel, chlorine-containing pesticides, poly-aromatic hydrocarbons, aluminum and volatile chlorine-containing compounds. However, the use of artesian water pump rooms in large industrial city requires systematic monitoring of water compliance with applicable hygienic standards for the chemical, microbiological, and radiological indicators. In addition, now, in Kyiv, about half pump rooms are out of operation and to resume their functioning it is necessary to make comprehensive quality testing of water.

The A.V. Dumansky Institute of Colloid and Water Chemistry of the NAS of Ukraine has all the necessary equipment and techniques to resume water quality monitoring at the pump rooms in Kyiv and to analyze the artesian water compliance with the state sanitary standards and rules and is ready to carry out all the necessary work at a high level.

Research of heat-retaining properties of house walling, including an additional layer of heat retaining material, with the use of thermal imager and heat flow meter (the project is designed by the Institute of Engineering Thermophysics of the NAS of Ukraine).

In Ukraine, the majority of buildings (over 65%) was built in 1946–1981. Heat-retaining properties of their walling do not meet modern requirements for power saving and appropriate indoor air-temperature conditions. In addition, due to the fact that the thermal properties of building materials change over time, their heat-retaining capacity deteriorates, with the thermal regime of the whole building ceasing to meet the sanitary standards.

The thermal condition of various buildings and their walling, as well as the effectiveness of heating and ventilation systems can be inspected using thermal imager and heat flow meter devices. The inspection identifies the most significant areas of heat losses, conditions of moisture conden-

sation, defect of structures and joints of the house, and failures of heating and ventilation facilities. The removal of defects and failures identified by thermal imager and heat flow meter makes it possible to save energy and to reduce heating costs in the housing sector.

As a result of the project based on the technique using the thermal imaging and heat-flow metering devices a system for monitoring the temperature condition of buildings, heat-retaining capacity, and level of heat losses through walling will be developed. This system will be used also for detecting defects and malfunctions of the engineering facilities. On the basis of information obtained, measures to reduce heat loss and to improve the efficiency of heating and ventilation systems will be designed.

Manhole covers and rainwater drainage facilities for roads (the project is designed by the Institute of Physics and Technologies of Metals and Alloys of the NAS of Ukraine).

Thanks to new techniques for production of ductile irons and efficient precise gasified mold casting developed by the Institute it is possible to develop a new design of manhole covers, rainwater drainage facilities, and cast accessories. The techniques allow the designers to create anti-vandal durable manhole covers of European type (with closures) that are in great demand in the residential sector of the city.

New developments of the Institute make it possible to reduce 2–3 times the mass of products as compared with those made on the basis of the existing standards of Ukraine and by 20–30% as compared with the mass of the products made in accordance with the international standards.

When issuing 10 thousand. Hatches using the proposed technology can reduce costs by 500 tons of metal and only obtain this economic impact of more than UAH 4 million.

The Institute of Physics and Technologies of Metals and Alloys of NAS of Ukraine in cooperation with the fabrication yard of the E.O. Paton Institute of Electric Welding can fully satisfy the demand of the Kyiv city for these products.

Implementation of technique for recovery of worn surfaces of tram wheel tires by deposit welding (the project is developed by the Institute of Physics and Technologies of Metals and Alloys of NAS of Ukraine).

Currently, the worn surface of tram wheel tires is repaired by arc deposit welding. The service life of repaired wheels is 10–12 thousand km that is much lesser than in the case of replacement of wheel tires (150–160 thousand km). On the basis of high temperature research of interfacial interaction between iron-carbon melts and metal surfaces made at the Institute, a technique for freeze crystallization deposition of wear resistant coating has been developed. The implementation of technique will significantly extend the service life of repaired wheels 2 or more times at lower cost of repair.

New nodes and components for structural elements of electric vehicle overhead wire suspension (the project of the Institute of Physics and Technologies of Metals and Alloys of NAS of Ukraine).

The electric vehicle overhead wire suspension is made using steel nodes and components manufactured by welding and machining with application of corrosion resistant coating. The service life of such suspension is up to 10 years that is less than the service life of overhead wire. The suspensions cannot be repaired because it is impossible to disassemble them, as a result of extensive electrical and chemical corrosion, so they should be replaced with the overhead wire.

The Institute has developed corrosion resistant alloys and techniques for melting and casting for electric vehicle overhead wire suspension and other related items. The proposed products have a much longer service life and can be easily replaced during repair. The products have been tested on at *Electric Utility Service* municipal enterprise of *Kyivpastrans*, the municipal provider of public transport services. The implementation of these solutions will reduce the amount of repair works and significantly increase the reliability and service life of components and nodes of electric vehicle overhead wiring.

All approved innovative projects are aimed at commercializing completed R&D projects for the sake of the Kyiv city. It should be noted that their implementation is not the only way of fruitful cooperation between the NAS of Ukraine and the Kyiv City Public Administration for addressing the problems of the city with the help of Ukrainian science. The decision of the new city leadership on the implementation of the above projects gives me cause for cautious optimism with respect to the further cooperation.

А.Г. Загородній

Президія Національної академії наук України, Київ

НАУКОВО-ТЕХНІЧНЕ СПІВРОБІТНИЦТВО
НАЦІОНАЛЬНОЇ АКАДЕМІЇ НАУК УКРАЇНИ
З КИЇВСЬКОЮ МІСЬКОЮ
ДЕРЖАДМІНІСТРАЦІЄЮ:
ОБЕРЕЖНИЙ ОПТИМІЗМ

Узагальнено досвід науково-технічного співробітництва Національної академії наук України з Київською міською державною адміністрацією. Наведена стисла характеристика затверджених до реалізації у 2015 році інноваційних проектів з впровадження у міське господарство розробок установ НАН України.

Ключові слова: Національна академія наук України, Київська міська державна адміністрація, міський транспорт, енергозбереження, гідрологічні моніторингові дослідження.

А.Г. Загородній

Президиум Национальной академии наук Украины, Киев

НАУЧНО-ТЕХНИЧЕСКОЕ
СОТРУДНИЧЕСТВО НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК УКРАИНЫ С КИЕВСКОЙ
ГОРОДСКОЙ ГОСАДМИНИСТРАЦИЕЙ:
ОСТОРОЖНЫЙ ОПТИМИЗМ

Обобщен опыт научно-технического сотрудничества Национальной академии наук Украины с Киевской городской государственной администрацией. Приведена краткая характеристика утвержденных к реализации в 2015 году инновационных проектов по внедрению в городское хозяйство разработок организаций НАН Украины.

Ключевые слова: Национальная академия наук Украины, Киевская городская государственная администрация, городской транспорт, энергосбережение, гидрологические мониторинговые исследования.

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