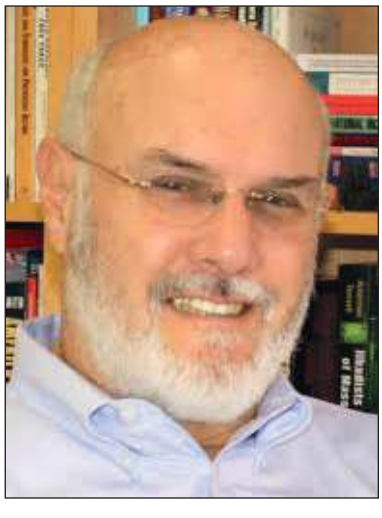
INTERNATIONAL SUPPORT FOR SCIENCE IN UKRAINE

I have written this essay over two very turbulent months, during which the world has undergone unimaginable changes. This turmoil has also caused me to make an unimaginable number of changes to the manuscript in a vain attempt to keep up to date. Thus, this essay can be no more than a snapshot in time. But I hope that this snapshot will help to capture the international community's remarkable effort in support of science and scientists in Ukraine and to give due credit to those both in the West and in Ukraine who have worked so diligently and creatively to make it happen.



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INTRODUCTION

The main purpose of this essay is to outline and describe the main components of international support for science and scientists in Ukraine beginning after the illegal, unprovoked full-scale invasion of Ukraine by Russia on February 24, 2022. It is not meant to be exhaustive, because the efforts of international actors are so diverse that it is virtually impossible to be comprehensive in this space. However, this very limitation suggests, as some have argued, that it might be useful for there to be some kind of international clearinghouse to register and describe succinctly the various initiatives. One of the most challenging obstacles in this regard is the lack of information, in two senses: the lack of practical information for Ukrainian scientists and institutions about the availability of opportunities to obtain foreign support, and the relatively isolated "bubbles" in which foreign donors dwell, potentially hindering potentially fruitful synergies and resulting in costly duplication of efforts.

In addition to being descriptive, I also attempt to be analytical in the sense of trying to characterize the evolution and types of international assistance and speculating about their effectiveness. Finally, at the end, I presumptuously offer some modest recommendations based on my personal experience of a half-century of managing scientific cooperation with Ukraine and other countries. The ideas presented represent only my personal opinions and not those of any group or institution.

Why is this important? Beyond the immediate humanitarian crises, international support for Ukrainian science can help Ukraine address longer-term legacy issues that have hindered Ukrainian science and education from fulfilling their full potential in service to the nation, from national defense to civilian technological innovation for economic development; from inefficient and rigid bureaucratic silos to more flexible and adaptable

communication and links among the research, education, and industrial sectors; from the legacy barriers between research and education to the near-absence of a middle generation of Ukrainian scientists, engineers, and educators, exacerbated by the exigencies of war.

I have purposely omitted scarcity of funding here because that is not an area where the international community can help in any meaningful and sustainable scale. That and more are issues for the Government of Ukraine and its emerging private sector. Two common complaints from Ukrainian scientists and science officials are that the government assigns a very low priority to scientific research and that industrial R&D funding is virtually absent. These are deep policy and institutional problems that only Ukraine can solve, although the international community, through its work with Ukraine, can provide ideas and examples, as well as carefully targeted programs and incentives, to help Ukraine make the best decisions for its path forward. I have also deliberately omitted the issue of rebuilding the physical infrastructure of Ukrainian science and education. The astronomical costs of such an effort, aside from very special projects, can only be met by large-scale interventions such as World Bank loans. It remains to be seen whether such contributions are going to be forthcoming.

Before proceeding further, I would like to frame the discussion with these four points:

- International activity to come to the aid of Ukrainian scientists began almost immediately after the brutal, unprovoked Russian aggression of February 24, 2022.
- This occurred against a backdrop in Ukraine in which the modernization and reform of the Ukrainian research ecosystem had finally taken its first baby steps after years of inertia and fierce resistance from the "old guard."
- International support efforts are having a critical role in moving those reforms forward, not necessarily by intent, but by virtue of the very nature of the science systems typical of the global community, of which Ukraine aspires to be part; and
- From a historical perspective, the impact of war on Ukrainian science offers a fascinating case study of how change, especially in stagnant systems during normal times, can be catalyzed and leap-frogged in times of great disruption. In short, the war between Ukraine and Russia, beginning in 2014 and exponentially deepened in 2022, may have provided fertile, albeit unwanted, conditions for real change to take place.

A FOREIGNER'S OVERVIEW OF UKRAINIAN SCIENCE

Before proceeding to discuss international support of Ukrainian science, allow me to paint a broadbrush and no doubt oversimplified portrait of the Ukrainian research and education system. It is admittedly superficial and overgeneralized and Ukrainian readers may well differ with this characterization in the particulars, or at all. I dwell on this topic at length because the short-term relief international relief efforts over the past two years that I describe below have not always been based on deep understanding of the nature of the Ukrainian research and education ecosystem and, as I will argue, going forward they must be well attuned to addressing the underlying strategic issues that will make their assistance of truly lasting value.

In short, Ukraine is one of the last outposts of the Soviet science system. In this regard, Ukraine, in comparison with almost all other post-Soviet countries, could be considered a case of "arrested development." Unlike virtually all the former countries of the Soviet Union, including the former Warsaw Pact countries, Ukraine clung to the old system of research, which was marked by the existence of enormous academies of sciences with a proliferation of sequestered institutes in which the most advanced research was performed, education sequestered in universities that with few exceptions were essentially pedagogical institutions, top-down funding and the absence of a government agency responsible for making competitive research grants, relative isolation from world science and the international scientific literature, and scientific publications appearing predominantly in domestic journals and only in exceptional cases in highly rated international scientific journals. It was a system that worked reasonably well in a military-oriented command economy, but not at all well suited to the challenges of taking full advantage of its substantial scientific talent in a modern, internationally competitive knowledge economy.

In Ukraine, some of these characteristics began to fade after independence in 1991. For example, scientists were able to travel freely to international conferences, they gradually gained increased access to international peer-reviewed journals, and they published more frequently in them. However, key core characteristics of the old system remained – continued bifurcation of research and education; the persistence of the old top-down funding system and

strong resistance to the introduction of competitive research grants; continued (and increased) proliferation of so-called "academies"; the stubborn persistence of rigid, vertical bureaucratic "silos" between research, education, and innovation; and rigid distinctions between and among narrowly defined disciplines, hindering the development of the kind of interdisciplinary research and innovation that is increasingly essential in the modern age.

Unlike other post-Soviet countries, which began almost immediately to experiment with projects to introduce competitive research grants, restoring significant research functions to universities, and paring back the bloated academy systems, Ukraine fiercely resisted change. It is important to understand that while there was much discussion about reform before then, with failed attempts that were ultimately blocked at the highest levels, it was the disruption of war that provided not only the opportunity, but also the need, to change direction.

The first tangible steps of reform began in 2015, following the 2014 crisis of Crimea's illegal occupation and the forcible seizure of territory in eastern Ukraine, resulting ultimately in the presidential election of Petro Poroshenko, who finally signed the reform legislation. I believe that much of the receptiveness to change arose from the very cause of 2014 crisis, namely, the Ukrainians' passionate desire to become integrated systematically into Europe and the pro-Russian Yanukovych regime's violent resistance, which proved to be its undoing. In the post-Maidan euphoria that followed, the atmosphere was ripe for efforts at reform in many fields, including education and science, to finally break loose from their stultifying shackles.

The pressure for change intensified with the Russian full-scale invasion of Ukraine in February 2022. Wars, like other kinds of disruptive change, put external pressure on otherwise stable (or inert) systems due to extreme stresses on resources and the need to address urgent and unanticipated needs. Tensions long tolerated within the system become existential crises. In the present case, the eruption of full-scale war in 2022 made the crises immediately apparent: widespread destruction of scientific and educational facilities; large-scale emigration of scientists; induction of young male scientists in the armed forces; and sharp reductions in research funding that exacerbated institutional rivalries for desperately scarce resources.

Some of these problems were not new. Emigration is a good example. It is generally estimated that some 2,700 scientists, almost all women, fled Ukraine after the invasion, mostly to Poland. However, careful analysis of scientific personnel data performed by Nataliya Shulga suggests that between 1991 and 2015, some 160,000 young scientists and science students (future scientists) left the country in search of better educational and research opportunities elsewhere. They left for positions in Germany and other European countries, Israel, North America, Japan, and even China.

Complicating this picture was the accelerating generation gap among Ukrainian scientists. It has long been known that one of the structural consequences of the Soviet research and education system was a gap between young and senior researchers. In post-1991 Ukraine, the situation became more pronounced due to the large-scale emigration of younger scientists and students in search of better opportunities elsewhere. The current full-scale war has elevated this problem into a crisis, as many young women fled the country and young men were drafted into the military, some never to return. As a result, looking forward, if there is to be a new generation of highly trained scientists, engineers, and teachers in Ukraine, the main burden falls on the nation's universities. However, this is an area that has in my view been under-addressed in formal international support programs and that should be targeted in the future.

It is not clear, however, that Ukraine's university system is well equipped to meet this challenge, due to the persisting legacy of Stalin's bifurcation of high-quality research from education. In the modern research universities of advanced countries, research and education go hand in hand, beginning at the level of undergraduate students, who get first-hand experience working in research teams led by leading scientists. Universities also host graduate students and post-docs who take part to a great extent in advanced research. In the classic Soviet model, in contrast, the best graduate students typically switched from the university to academy of science labs, which were usually better equipped and staffed with the country's scientific elite. These include young people who might otherwise have made excellent instructors of young students and future university professors. I do not have direct knowledge of the extent to which this pattern persists in Ukraine, but with the continued dominance of the enormous Academy of Sciences and its institutes, it seems likely that the institutional dynamics are similar.

Another problem under the Soviet model that persists in Ukrainian universities was the rigidity of a system that requires teaching staff to take a full course load, even if they perform research outside of their teaching duties, and the rigidity of a salary system that does not accommodate well to such conditions. One of the most lasting and inflexible holdovers from the Soviet period was the complete absence of what in the West we call "research time" or "release time," enabling university specialists to reduce their teaching load and to receive dedicated support for research projects. Indeed, for Academy researchers, the very act of teaching was illegal. In Ukraine, the persistence of the old practices, alongside the universities' rigid salary structure and introduction of competitive research grants, has even led to impressions by uninformed observers, including overzealous auditors, that the university grantees were double-dipping, receiving "bonuses," and outright fraud.

A draft law, passed by the Rada on June 6, 2024, but not yet signed into law, "On Amendments to Certain Laws of Ukraine Regarding Support for Scientific Work in Higher Education Institutions," tries to address this problem. According to the official announcement, the law was developed to fulfill the obligations stipulated in Article 431 of the Association Agreement between Ukraine and the European Union. Specifically, the law would allow university teaching staff to set aside time for research, correspondingly freeing them from teaching duties. This, to my knowledge, is a potentially transformative concept in Ukrainian universities, enabling the combination or research and teaching to be more than an exception than an accepted pattern.

Finally, a brief word about one of the key goals of research and education in Ukraine, especially as it looks forward to bolstering its national defense and becoming economically competitive and sustainable: innovation. In Ukraine, the highly vertical and insular nature respectively of scientific research, higher education, and industry has been one of the most critical problems facing the system and its ability to adapt both to transition to a modern knowledge economy and to the urgent exigencies of war. A promising attempt to break out of this stultifying impasse is the recently announced legislation on "*science parks*" *and "science cities*." First announced by the Ukrainian Ministry of Digital Affairs in late 2024and amplified by the Ministry of Education and Science in January 2025, these projects will bring together university and institute researchers with private industry to create legal entities that will be in a position to efficiently bring research to innovation and development in joint projects with full intellectual property protection. This innovative concept (in the Ukrainian context) may go a long way to addressing the stubborn problem of all well-entrenched bureaucratic systems, the "silos" that prevent cross-fertilization and innovation.

INTERNATIONAL SUPPORT PROGRAMS

For the period beginning with the full-scale invasion of 2022, it is useful to think of two broad phases of international response: the first, reactive, and the second, strategic. These phases were not, however, sequential. They overlapped even from the beginning, but in a sense got "stuck" on the first, reactive mode. In my view, although there was much discussion of the strategic dimension in the very early months, the actual actions have not moved very much from the reactive mode even to this day. This is not atypical by any means. The post-crisis issues of recovery and rebuilding are always exceedingly complex and require careful, collegial deliberation, conditions that are rare when the pre-crisis situation itself was one of institutional conflict and distrust.

Initial focus on refugees

In the immediate aftermath of the full-scale Russian invasion, the world scientific community's attention, especially in Europe and North America, was focused on the urgent issue of helping the estimated 2,700 scientific refugees. The first organized effort to come to their aid came from the U.S. National Academies of Sciences, Engineering and Medicine (NASEM), through an unprecedented collaboration with the Polish Academy of Sciences and the National Academy of Sciences of Ukraine. The Polish Academy agreed to open its institutes to the refugees, and NASEM was able to reach out immediately and effectively with funding to support the effort. In Europe, a nonprofit, student-run startup, Science for Ukraine, began assembling an extensive database of universities and research institutes offering temporary positions to the refugees; eventually their list extended to North American openings as well. The overall volume of these local, institutional initiatives, especially in Europe, was quite impressive.

While I do not know of any statistical analysis of all these efforts, my impression is that the European

efforts significantly exceeded similar ones from North America. Regardless, together these initiatives may have comprised the largest science refugee support program in history.

This first phase of out-placement of Ukrainian scientists continues today, and there is no doubt that it has been of benefit not only to global science, but also to science in Ukraine. As other scientific migrations have shown, emigres are an invaluable lifeline to those left in-country for access to scientific literature, equipment, and even virtual participation in foreign-based research projects. In some cases, this involves direct financial support as well. But it also has its downsides. Past scientific emigrations have shown that about one-half of the emigres do not return, which is certainly a loss to the domestic research enterprise. Moreover, even well-intentioned efforts to offer "temporary" positions abroad can become regarded negatively as "cherry-picking" and essentially extractive.

Please pay close attention to this figure: It is estimated that 87 percent of Ukraine's scientists remain in Ukraine. Not all of them are active in science; indeed, some have served in the military, and some have died in the war, either on the front lines or in bombings. But the main bulk of scientists, especially males, are still in Ukraine.

Strategic responses: An early beginning

The first to recognize and act upon this forward-looking, strategic dimension of the crisis, what I think of as "Whither Ukrainian science?", was NASEM and its European partners, who issued a June 2022 declaration of ten "Action Steps for Rebuilding Ukraine's Science, Research, and Innovation." These steps, while mostly focusing on the immediate human crisis of the refugees, also explicitly called attention to the more daunting task of rebuilding science in Ukraine, which at the time seemed to many as a much more distant project.

In September of the same year, NASEM convened a major, unprecedented virtual international workshop, Rebuilding Research, Education, and Innovation in Ukraine, featuring senior leaders of academies, universities, and grantmaking agencies from Ukraine, the United States, the UK, and Ireland, the purpose of which was to present various possible paths for Ukraine's development in the future. NASEM and other organizations, notably the International Science Council and ALLEA (the All-European Academies), followed suit with subsequent international conferences dedicated to deeper understanding of the crisis. In a report on a virtual three-day meeting in March 2023, the ISC/ALLEA organizers made it very clear:

In conclusion, the primary message is that in this phase of the crisis, the most urgent need is to support the research system within Ukraine itself to avoid losing an entire generation of researchers. Where we are now must be recognized as an opportunity for reform and transformation. External funding bodies, research-performing organizations, and philanthropic foundations need to respond with flexibility and with innovative solutions that are sensitive to local needs. The high quality of Ukrainian research cannot be lost.

While these forward-looking deliberations were getting underway, a second phase (though still reactive) in the support of Ukrainian science was gaining traction as well: direct financial support. Here, it is necessary to pause for a moment to understand the real-world constraints on sending funds to scientists in Ukraine, particularly government funds. This issue has been an enormous conundrum for Western institutions, particularly those with government funding, because the laws and policies of their countries typically prohibit them from doing so. However, where the Western donors happen to be able to draw on private or alternative funding, there are no such serious restrictions, and reliable channels do exist for transparently and safely conveying funds to scientists and institutions in Ukraine.

For a time, these circumstances put the Americans, primarily through NASEM, into an enviable position. Since NASEM had managed to raise very significant private funds for its program through Poland, it was able to leapfrog over this problem. In 2023 it leveraged its refugee relief program through Poland to include co-investigators in Ukraine as well, by virtue of which it was able to provide direct individual financial support to in-country Ukrainians. This was an important breakthrough, albeit available only to Ukrainian scientists with links to already-funded projects involving Ukrainian refugees in Poland. And in late 2024, NASEM announced of the creation of a Science and Innovation Fund for Ukraine. This new project, privately funded by the Simons Foundation and other partners, according to NASEM, "will provide near-term support to the Ukrainian research community and build the framework for a long-term innovation ecosystem in Ukraine based

on science and commercialization." This Fund has the hallmarks and potential of moving beyond the reactive mode to the strategic, but as of the time of writing, no announcements have appeared about the actual content of its work, although NASEM and European partners have organized two international workshops to explore potential priorities.

The largest and most organized intervention from Europe occurred in December 2023, when Horizon Europe, the European Commission's flagship program for research and innovation, opened its office in Kyiv to facilitate Ukrainian participation in the program. Horizon Europe had included Ukraine in its launch in 2020, but Ukrainian applicants at the time, lacking experience in writing high-quality competitive research grant proposals and in identifying potential European partners, did not fare well. The 2023 opening of the Horizon Europe Kyiv office was intended to help remedy this situation by providing "targeted support to researchers in Ukraine in preparing competitive applications and finding the right partners," offering "policy advice linked to Ukraine's integration into the European Research Area," and monitoring "the implementation of cooperative research projects." Their statistics show that Ukrainian investigators have been significantly more successful as a result of these on-site services. This extensive program soon attained high visibility in Ukraine, which was only natural given Ukraine's proximity and its aspiration to be known as, and to function as, a European country.

It would be interesting to be able to compare the size of the American and European support efforts to Ukrainian science, but it is difficult to come by hard data. It is my personal impression that the European interventions have far surpassed the American effort, including the work of NASEM as well as universities who were hosting Ukrainian scientists on an individual basis. One possible indicator might be the gross amount of money that each reports that it has poured into its support programs, but here we have to be very careful, because those figures may well include support for the European and American scientific partners. Despite these qualifications, the numbers seem to speak for themselves. For example, NASEM states that it has raised $13 million for its programs with Ukraine, while Horizon Europe advertises that it has invested €58.74 million in its activities with Ukraine. With all the foregoing reservations in mind, these figures seem to suggest about a 3:1 or 4:1 ratio of European to American support for science in Ukraine. A very recent article in Nature describes the incredibly broad and vigorous work on the European community in this area.

At a more local level, there are numerous instances of bilateral arrangements for scientific cooperation. The NRFU has been a leader, concluding agreements with grantmaking agencies in the Netherlands, Switzerland, and Germany as well as the University of Cambridge. NASU institutes have also been actively engaged with individual activities. In a 2024 retrospective interview, NASU President ***Anatoly Zagorodny*** detailed an impressive array of international interactions within the NASU community. These included both large and smaller-scale initiatives by the German government, CRDF Global, Research4Life, NATO, Horizon Europe, DESY (the German Electron Synchrotron), and multinational projects on the Danube River, the Black Sea, among others. Ukrainian universities have abundant "sister university" relationships with European and American counterparts, and university scientists, scholars, and students can participate individually in online courses and even research projects with universities and research teams abroad.

Finally, at the bench level, there is surely a proliferation of individual, informal partnerships of Ukrainian scientists, those in Ukraine as well as those who have managed to get positions abroad, who participate in independently funded research projects with scientists in other countries. These relationships are probably too extensive to document in this space. Suffice it to say, however, that beyond the organized programs and projects described above, this is a world unto itself that is within Caroline Wagner's "invisible college" of informal networks that increasingly underpin the global scientific community in the modern world. In her words, these are "researchers who collaborate not because they are told to but because they want to." Their work is typically funded through merit-based grants in the host foreign countries that are selected solely on the basis of their potential contribution to the advancement knowledge, without any direct intention to promote international cooperation, much less assistance to foreign scientists, and where the only criterion is whether a participant, regardless of country, can uniquely contribute to the success of the funded project. These informal relationships, from my own experience managing international scientific cooperation, tend to be the

most scientifically consequential and self-sustaining, beyond the limited lifetime of highly organized and specially funded projects.

SYSTEMIC IMPACTS

The next part of this story brings us to the third observation I made at the outset of this essay, the role of international support programs in interacting with and reinforcing evolution and reform in the very institutional infrastructure of Ukrainian science. In no case was this more evident than with the National Research Foundation of Ukraine (NRFU), the Ukrainian analog of the U.S. National Science Foundation (NSF) and similar European granting agencies. Founded only in 2019 (whereas other similar countries set up competitive grant agencies almost immediately after 1991), it is a very young organization that the scientific old guard in Ukraine had tried for nearly thirty years to prevent from coming into being. After 2022, the NRFU concluded agreements to conduct joint calls for collaborative research grants with the Swiss, German, and Dutch research-grant agencies, as well as individual European universities and research societies. Importantly, too, Horizon Europe's decision to locate their Kyiv office under the NRFU's auspices has given NRFU increased favorable exposure to Ukrainian scientists as well as to Ukrainian government agencies and European scientific organizations. It is nothing short of remarkable and a testimony to the NRFU's leadership to have accomplished this work in the face of the many challenges of a young organization that was seen by some in the "old guard" as a threat to the status quo.

Indeed, one of the clearest indicators of the NRFU's impact has been the strikingly changing attitude of the venerable and powerful National Academy of Sciences of Ukraine toward it. In the earlier days of the war, as research budgets were being slashed by half, the hostility was palpable. A common criticism was that government funds appropriated to NRFU meant less funding for NASU. This nearsighted, zero-sum mentality persisted for over two years and no doubt fueled a particularly ugly campaign against NRFU and its staff. However, as NRFU followed its procedures and awarded research grants on the basis of merit, it turned out that Academy researchers were doing rather well in competitions, which was little surprise since they are no doubt among Ukraine's leading scientists. In his review of NASU's work in 2024, NASU President Zagorodny proudly remarked,

I would like to note the rather good results of the participation of Academy scientists in the latest competitions of the National Research Foundation. In the competition "Science to Strengthen the Defense Capability of Ukraine" 39 projects of our scientists were selected for funding (this is 50% of the total number of projects); 38 projects of Academy institutions won the competition "Advanced Science in Ukraine" - this is more than 60% of their total number.

A further boost to the concept of competitive research grants in Ukraine was the NSF's decision to launch a very ambitious, jointly funded, and highly competitive multilateral program called "IMPRESS-U," involving not only Ukraine but the Baltic countries and Poland. Its two main goals are "to support excellence in science and engineering research, education and innovation through international collaboration; and to promote the integration of Ukrainian scientists into the international research community." The IMPRESS-U initiative is highly regarded in Ukraine, for while the number of grants is limited by the high bar it places on applicants, the quality of the work performed under them is also correspondingly high. At the time of writing, it is unclear to what extent this U.S. government-funded initiative will continue, as even its main sponsor, the NSF, is in the current Administration's crosshairs. But its architects and managers deserve enormous credit for its ambitious goals and commitment to the highest quality standards of scientific research.

Of all the international support programs, Horizon Europe, probably has the most potential to make a major contribution to lifting up science in Ukraine as well as well as at least indirectly stimulating reform of its research ecosystem. Not only is this evident by its size and proximity, as it is vigorously supported by the collective governing structure of Europe, which for the present sadly appears to be the most committed in the world to Ukraine's future as an independent and sovereign country. American support, while vigorous and exemplary through the U.S. National Academies as well as some private scientific societies, are now wholly dependent on the generosity of private donors. With regard to systemic impact, as no less a figure than NASU President Anatoly Zagorodny has approvingly observed, Horizon Europe's network of National Contact Points (as well of those of EURATOM) has been beneficial. Their "main task," he said in a January 2025 interview, is to inform

the scientific community of Ukraine about the announced competitions, familiarization with the general conditions of these competitions, assistance in the preparation and submission of applications to activate the participation of Ukrainian institutions, organizations and increase the level of Ukrainian applications in the Horizon Europe and Euratom programs.

Yet challenges remain. ***Peter Berczik*** of NASU's Main Astronomical Laboratory in Kyiv told Nature in February 2025 that

…Horizon Europe is much more than a fund; its support could help to revitalize Ukrainian R&I by promoting competitiveness and fairness in how grants are allocated. But this will be no small feat. Ukrainians themselves will have to untangle the ageing roots of the research system to make a lasting difference, says Berczik. "Horizon Europe can be a first step, but it will not solve our problems. These are deep and go back more than 30 years."

All the programs discussed above incorporating competitive research grants not only brought opportunities for capable Ukrainian scientists, especially young ones, to engage in world-class research with foreign colleagues and to upgrade their equipment. They also provided exposure to, and even training in, the methods and policies employed worldwide for bottom-up research grant competitions. In my own experience launching major competitive grant programs in the former Soviet Union in the 1990s through George Soros's International Science Foundation and later through CRDF Global, I have heard time and again the judgment that those scientists who learned the skills of grant-writing tend to be those who have sustained and advanced their scientific careers.

These grant-based programs are having a substantial impact on the evolution of the Ukrainian science system, simply by building confidence in the research grant system, which simply did not exist prior to 1991 under Soviet rule, and not even until 2019 in Ukraine. The idea that major science funding can be accomplished through bottom-up, investigator-initiated, merit-reviewed research projects, rather than top-down institutional block funding that tends to be less selective and is commonly criticized as being vulnerable to favoritism and corruption, has been transformative in nearly every post-Soviet country. In Ukraine, due to its late start and the fierce resistance of entrenched institutions, it has been a major challenge.

While the major international assistance programs have focused on research, where they have had a substantial impact, the same cannot be said of the sphere of higher education. While "twinning" and other one-off university-to-university partnerships have undoubtedly had some impact, unlike in the research domain, they may not have had serious structural effects. As I have argued above, there are stubborn structural legacies of the bifurcated Soviet system, particularly with Ukraine's large state universities, that seem to require more radical legislative and policy surgery if they are to be active, effective partners in building Ukraine's scientific, technical, and economic future and if Ukraine is to be capable of preparing the next generation of researchers and educators on a significant scale.

As we have seen, while there have been promising steps toward reform in Ukrainian toward reuniting research and higher education, the international community has not yet added them to their bucket-list of measures that deserve their attention and support. Understandably perhaps, foreign scientific organizations have tended to focus on science and thus on shoring up research and researchers in Ukraine, but it seems to me that universities, as a critical link in the scientist pipeline, have not attracted nearly as much attention. Yet the international community has much to contribute in regard to the role of universities, as well as the even more complex area of the complex, often nonlinear relationship between research, education, and private industry.

WAR AND ITS AFTERMATH

This brings us to the last point I alluded to at the beginning of this essay: the role of war as a catalyst for change.

What seems is exceptionally remarkable about all these recent, in some cases bold, departures is that they are taking place while Ukraine is conducting an increasingly difficult war with a brutal and determined foreign aggressor, a war that is taking a heavy toll on its people and its resources, including the science and education communities. Indeed, one of the most frequent complaints I have heard from Ukrainians over the past few years is that the government does not recognize the importance of science for the defense and welfare of the country. This is not only a Ukrainian malady, but unlike other countries in which distrust of science seems to be at all-time highs, in Ukraine there is the additional, undeniable problem of the utter destruction of scientific and

educational infrastructure. How can these two things be possible at the same time: widespread destruction and insecurity, and bold innovation?

Serious efforts at reform in Ukrainian science date from about 2005. The delay was testimony to the enormous inertia of the old system for reasons specific to Ukraine. But as noted above, it was not until December 2015, one year after the Russian occupation of Crimea and military seizure of parts of Eastern Ukraine, that the President of Ukraine, Petro Poroshenko, put his signature on paper to the "Law on Science" of Ukraine that authorized, among other things, the creation of the NRFU, and that led to other legal and policy issuances that began to change the landscape of Ukrainian research and higher education.

The ravages of war have had another beneficial aspect that is the subject of this essay – the engagement and support of the international community. Whether this would have happened without the catalyst of war is highly problematic, and certainly not on the same impressive scale. Moreover, this leaves both the international community and Ukraine with a conundrum: What happens when the war is over? And the conundrum exfoliates into many tough questions, among them:

- What kind of external support, if any, will there be for rebuilding Ukraine's destroyed research infrastructure?
- How strong will the rationale be for continuing to provide international support for Ukraine, and what will it be?
- How will the end of hostilities affect the perceived urgency of institutional transformation in Ukrainian research and education?
- If current donors slack off their support, will others with less commendable motives, such as China, take their place?
- What are the strategic challenges of Ukrainian science, and how can international cooperation help address them?

RECOMMENDATIONS

One of the most common failings of assistance programs is that they often miss the moment when the "assistance mentality" is no longer appropriate, when the immediate crisis has passed. At that point, the assistance mode, characterized by unilateral donor decisions and funding, comes to be perceived by the "receiving" country as condescending and oblivious of longer-term needs.

As the crisis phase of war passes, and as fewer domestic financial resources are diverted from civilian to defense activities, the international community should begin to shift its attention and resources from direct relief to more intentionally oriented initiatives meant less to support individual scientists and more to strengthen Ukraine's research, education, and innovation ecosystem. The term "assistance" itself should disappear, and in its place, we should start seeing "cooperation."

What is important for international donors to understand is that, beyond the first, emergency relief phases, they do not have all the answers and their traditional, comfortable ways of doing things are not necessarily those with the most lasting impact. In the end, it is only Ukrainians themselves who can make the most important decisions affecting their own future. International actors must now listen carefully to the Ukrainians, study their new efforts, and only then, and on the basis of joint decisions, strategically target those pieces of the puzzle that all consider critical but for which there are no other sources of support.

It would also seem highly appropriate for any such efforts to be jointly funded by the Ukrainian and foreign parties. The financial contributions do not need to be equal; what is important is that whatever the activities may be, they reflect the clear initiative, commitment, and needs of Ukraine as Ukrainians see them.

This more strategic, intentional orientation is where the diverse experiences of other countries can make "value-added" contributions of a structural nature that outlast the terms of individual financial support grants. By working with Ukraine as a full partner, its international supporters can help it to examine and test new ideas, to strengthen governance and management of scientific institutions, and to identify structural problems that inhibit or prevent Ukraine from taking full advantage of its scientific and technical capabilities on the world stage.

This is a very broad challenge, but such challenges often start with very modest ideas. Here is a list of some of my favorites:

- "Seed" or "pilot" projects to more fully integrate research and education at selected state universities
- A merit-based long-term fellowship program for young scientists to work in Ukrainian research or educational institutions of their choice. A fellowship would include generous support for research equipment, a small team of researchers including graduate students, and funding for short-term travel

to scientific conferences and international labs.

• Workshops and other training on research and financial management for scientific institutions, including visits at foreign agencies to "shadow" officials at their work.

• Initiatives to fund cost-shared projects of academic and university researchers with private industry, perhaps along the lines of the U.S. Small Business Innovation Research (SBIR) program.

• Removing legal and other obstacles to the presence of international researchers in Ukrainian institutions for the purpose of joint research.

• Enabling broader access to, and training in using, international scientific databases such as Web of Science.

These are merely a few examples. Ukrainian and foreign partners will certainly be more knowledgeable and creative. As a rule, though, the costs of such activities individually should be relatively modest.

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I will conclude with a moving anecdote from personal conversation with an anonymous Ukrainian scientist, testifying to the incredible grit, resolve, and vitality of the scientists remaining in Ukraine and their belief that their work, as well as that of the international community, in support of Ukrainian science is worthwhile. The day after the Russians started bombing Kyiv in October 2022, some of the first buildings to be hit were those of universities and scientific institutions on the borders of a small park where children were playing. I asked my friend, who worked in one of those buildings, what it was like. They said, "*well, first I lived for three weeks in the bomb shelter under our building with everyone else. But then I got bored and went back upstairs to my office. It was great! I got so much work done: no interruptions, no visitors, no phone calls, no e-mail!*" "But wasn't it dangerous?" I asked. "*Well, yes, but I did move my desk away from the window.*"

Слава Україні!

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Література:

There is already a rich literature on the impact of war on science in Ukraine, but I am not aware of any writings that have highlighted this "positive" aspect of war's disruption on science policy in Ukraine. See, for example, Analysis of war damage to the Ukrainian science sector and its consequences (Paris: UNESCO, 2024), and Gerson S. Sher, "Lessons learned for the international community about the impact of the crisis of war on science in Ukraine," Svitohlyad 2023, No. 2 (100), 13-15.

Under Soviet rule, Ukrainian scientists had been subject to a double dose of restrictions in this regard. Not only had they needed special permission to travel abroad like other Soviet scientists; they were also discriminated against by the Russian-dominated system, which limited such privileges for scientists from the non-Russian union republics.

Their access was quite limited, however, since their institutions generally could not afford subscriptions. After 2014, however, special portals became available to Ukrainian scientists and some publishers, such as Elsevier, opened their databases to Ukrainian researchers. The advent of Open Science in recent years has also helped to alleviate this problem.

Nataliya Shulga, "Science in postwar Ukraine," Science 379:6628 (12 January 2023), 119 (https://doi.org/10.1126/science.adg5733). In this article, Shulga cites a number of 200,000 scientific emigrants, but in a recent personal conversation noted that 160,000 would be a more cautious estimate of the younger generation in particular. Also see Igor Yegorov, "Post-Soviet science: Difficulties in the transformation of the R&D systems in Russia and Ukraine," Research Policy 38 (2009) 600-609, at https://www.sciencedirect.com/science/article/abs/pii/S0048733309000158.

Murray Feshbach and Harley Balzer, "A Summary of the Current State of Knowledge About Soviet Science and Technology Training and Personnel," International Science and Technology Insight Vol. 2, No. 4 (Fall 1990), 163-167.

I believe that there is a similar problem in Academy institutes, where research grants on top of flat salary structures create grounds for unsophisticated auditors to investigate alleged financial irregularities.

https://www.rada.gov.ua/news/razom/250490.html.

The creation of Kyiv Academic University, a specialized higher educational institution (so far in virtual form) embedded within and governed by the National Academy of Sciences of Ukraine, is also worthy of note. It would appear that a key goal is to provide a constant stream of younger scientists to work within the Academy system. While important for the research enterprise of the Academy, as well as, potentially, for bringing highly trained scientists into universities as both teachers and researchers, this initiative does not, in my view with limited information, appear to have the potential to address the scale of the deep and growing generational gap in Ukrainian research and education.

See https://dev.ua/en/news/v-ukraini-planuiut-zaprovadyty-spetsialnyi-podatkovyi-rezhym-science-city-dlia-naukovykh-parkiv-pry-universytetakh-1737023886, and "Ukrainian innovation strategy and development of science parks – uniting the efforts of science, government

and business," Ministry of Education and Science of Ukraine (16 January 2025), at https://mon.gov.ua/en/news/ukrainska-stratehiia-innovatsii-i-rozvytok-naukovykh-parkiv-iak-obiednaty-zusyllia-nauky-derzhavy-i-biznesu.

"NAS launches effort to help support Ukrainian researchers as they relocate to Poland," 29 March 2022, at https://www.nationalacademies.org/news/2022/03/nas-launches-effort-to-help-support-ukrainian-researchers-as-they-resettle-in-poland.

The Polish Academy of Sciences, the National Academy of Sciences of Ukraine, the U.S.National Academy of Sciences, the German National Academy of Sciences Leopoldina, the Royal Danish Academy of Sciences and Letters, the ALLEA European Federation of Academies of Sciences and Humanities, and the Royal Society of the United Kingdom.

National Academies of Science, Engineering, and Medicine, "Action Steps for Rebuilding Ukraine's Science, Research, and Innovation (Statement), June 13, 2022, at https://www.nationalacademies.org/news/2022/06/action-steps-for-rebuilding-ukraines-science-research-and-innovation

National Academies of Science, Engineering and Medicine, Rebuilding Research, Education, and Innovation in Ukraine: Proceedings of a Workshop – in Brief (Washington, DC: National Academies Press, 2022), at https://nap.nationalacademies.org/catalog/26795/rebuilding-research-education-and-innovation-in-ukraine-proceedings-of-a

2nd Conference on the Ukraine Crisis: One Year of War in Ukraine: Exploring the Impact on the Science Sector and Supporting Initiatives. DOI: 10.26356/UKRAINECONFERENCE2023, 7.

Thus, for example, in a typical international cooperative research project sponsored by a research-grant agency like the NSF and a Ukrainian partner, the Western partner is generally speaking unable to provide direct support to the foreign partner, whose support is normally provided by the foreign host government. In Ukraine, however, at least at present, that is not a real possibility.

https://www.nationalacademies.org/our-work/science-and-innovation-fund-for-ukraine

The first workshop took place in March 2024. See National Academies of Sciences, Engineering, and Medicine (2024). Rebuilding and Strengthening Ukrainian Science and Innovation in Support of Economic Recovery: Proceedings of a Workshop – in Brief. Washington, DC: The National Academies Press. https://doi.org/10.17226/27825. The second workshop is taking place as I write these words.

There is potential for some confusion here. While there is one single Horizon Europe Kyiv Office that is embedded in the National Research Foundation of Ukraine, Horizon Europe also has a network of seventeen National Contact Points distributed among Ukrainian research institutions. See https://horizon-europe.org.ua/en/heo-in-ua/ncp/ for further details.

"Ukraine: Horizon Europe Office." Flyer dated November 2024. doi.10.2777/404037 K1-01-24-077-EN-N.

On NASEM, see "Science and Innovation Fund for Ukraine," at https://www.nationalacademies.org/our-work/science-and-innovation-fund-for-ukraine. On Horizon, see European Commission: Directorate-General for Research and Innovation, Ukraine, Horizon Europe office, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2777/7404037. Another reason these numbers may not be directly comparable concerns the period of time they cover: NASEM, beginning in 2022, and Horizon, unclear, but probably from 2020.

Elizabeth Sweetman, "Ukraine's research sector is struggling— can Europe help?", Nature Index (28 February 2025), at https://www.nature.com/articles/d41586-025-00473-w.

"At the end of the year: Interview with the President of the NAS of Ukraine, Academician A.G. Zagorodny," Bulletin of the National Academy of Sciences of Ukraine, No. 1 (2025), https://nasu-periodicals.org.ua/index.php/visnyk/issue/view/1145. I am grateful to Yaroslav Yatskiv for bringing this interview to my attention.

Caroline S. Wagner, The New Invisible College: Science for Development (Washington, DC: The Brookings Institution, 2008), 2.

A disclaimer: I am a member of the NRFU's Council of International Advisers.

Zagorodny (2025), 5.

"International Multilateral Partnerships for Resilient Education and Science System in Ukraine." See https://new.nsf.gov/news/nsf-announces-international-multilateral.

Zagorodny (2025), 5.

Sweetman (2025). And I would add, much longer than thirty years.

Law of Ukraine About scientific and scientific and technical activities," https://zakon.rada.gov.ua/laws/show/848-19#Text.

China is already actively soliciting Ukrainian researchers to work in Chinese universities and laboratories. For example, in November 2024, Ukrainian scientists, including members of the National Academy of Sciences of Ukraine, received an email invitation from Yancheng Polytechnic College to apply to a grant program for long-term visits in China of two to nine months, with an option for online work, with an advertised generous salary of $3,000 to $4,000.

See Gerson S. Sher, "The Institutional Challenges of Technology Transfer in Ukraine as a Transitional Economy," Svitohlyad, 2024, No. 4 (108), 32-39. In Ukrainian and English.