



SEVENTY-YEAR-LONG EXPERIMENT GOES ON

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Abstract

This article is actually a scientific and historical generalization of the brilliant scientific and organizational experiment planned by Alexander N. Nesmeyanov and carried out by him together with the team of INEOS RAS. The work presents a brief historical excursion, motivation, as well as a description of the essence of the scientific and organizational experiment. It discusses the stages of development of the model and the results obtained in the course of its realization throughout the 70-year history of the Institute.

Key words: organometallic chemistry, organoelement compounds, synthetic food.



Introduction

During his scientific career, Nesmeyanov did a lot of important, irreplaceable and unique things. His role in the construction of Moscow State University, the creation of VINITI, the management of the Academy of Sciences and the creation of INEOS RAS is undeniable and recorded in historical documents.

But this year of historical anniversaries, I would like to discuss the creation of INEOS as the realization of a unique experimental project. The spirit of an explorer, which at one time brought Nesmeyanov to Moscow State University, never left him throughout his life. He experimented in everything: in chemistry, painting, poetry, and life. While in the case of other scientists, for whom the institutes were built, they were more as production associations with the strictest discipline and strict hierarchy, in the case of INEOS, it was an attempt to construct a model of a modern institute that would combine the academic hierarchical tradition of the Academy of Sciences and the realities of the flourishing post-war socialist system, where people are no longer cogs, but creators of a bright future.

The party winds of denial of Weismannism, Morganism, and other cybernetics were still raging, when Nesmeyanov was thinking about the future of the Academy of Sciences, about the future of science. Many, including the author, did not understand why, being the director of the Institute of Organic Chemistry (IOC), it was necessary to take on the burden of large-scale construction instead of developing this science in the old, sacred place. However, a careful reading of his memoirs gives a very simple and very instructive answer to this question [1].

Being the director of IOC and the resident of the Academy of Sciences and not being a direct student of Zelinsky in the sense of continuing his ideas, Nesmeyanov left IOC to the conti-

nuers, the scientific heirs. He took with him those with whom he was going to create a new direction. They followed him and formed his next brainchild—the "third chemistry", demonstrating that, when creating something new, it is not at all necessary to leave the former place in ashes. It can be done tactfully and for the common good. It was no coincidence that IOC was headed by people from Zelinsky's school, and within a few years it took its usual place as the flagship of organic chemistry in the country. Relations of good neighborliness, cooperation and mutual respect developed between the institutes.

Nesmeyanov did not turn the model institute into a new center of the Department; general meetings of the Department of Chemical Sciences of the Academy of Sciences of the USSR were still held at the IOC: the repository of the classical foundations of the academic chemical school. But innovations were rampant at INEOS. The physicochemical laboratories received a powerful boost. X-ray diffraction, molecular and NMR spectroscopy, chromatography, elemental analysis—all this was in demand and actively entered the daily life of chemical laboratories. The shoots in the new field responded with an abundant harvest, bringing the creator and seeder well-deserved world fame.

Meanwhile, he continued to study the model. The Institute summarized world experience and its own achievements in a fundamental 19-volume work, the *Methods of Organoelement Chemistry*, which to this day is the starting point for any researcher who has chosen a career in organoelement chemistry.

This publication showed how Nesmeyanov saw the report of an academic institute and the time lag when it is time to sum up the results. The model worked brilliantly in reality: a foundation was created for the development of a number of areas, in modern terms, low-tonnage chemistry, which is highly important for large-scale chemistry. We understand this very

well now, but Nesmeyanov understood this 70 years ago.

INEOS gradually straightened its shoulders. Along with the scientific life, the cultural life was also in full swing. The Institute had a unique film lecture hall, where the masterpieces of the world screen were demonstrated, and, perhaps, there was not a single celebrity who would not have been on the hospitable stage of INEOS at that time.

But there is a time for work and a time for fun. The fanfares were still ringing in honor of the Institute's successes, the young leaders of new scientific directions were still shining at the international conferences, and it seemed that new laboratories and groups were just getting underway, but one of the most talented visionaries of that time had already a new project.

Retelling the project "Synthetic Food" is a thankless task. It will not be possible to do it better than Nesmeyanov did in his speech at the Mendeleev Congress, so I refer you to its museum on the INEOS website, where you can get to grips with this brilliant creation [2], which simply needs to be included in the program of the candidacy examinations at all chemical institutes of the Russian Academy of Sciences. Very briefly, the essence of the idea of Nesmeyanov was to obtain the most important amino acids synthetically, which can be used to create the simplest sequences, which themselves have no meaning, but serve as a means of delivering the necessary nutrition to the digestive organs. The neutral and safe matrix must be endowed with the necessary aroma and flavors. This is where the delicacy forms came from: from black and red caviar to Podolsk sausage and jelly.

Nesmeyanov was clearly aware that he would not see the results of this project, and understood that the work would be abandoned and then returned to again. As always, he was right. The project stalled at the earliest stage of artificial food. The country wished to get a return as soon as possible. There was a problem with food, people went to Moscow for sausages. Nesmeyanov and the researchers of the synthetic food department overdid it with demonstrating finished forms. And here our applied science and ministries did not fail. The scale of production grew and there was no time for amino acids. In just a few years, the production of sausage with a 30% additive of the emulsion developed at INEOS increased to 100 thousand tons per year [3].

And again, everything was done without destruction. The synthetic food building was very organically attached to INEOS, and a team of followers gradually began to form, developing research on a broad spectrum: from the thermodynamic aspects of protein functionality and food preparation processes to amino acids with natural enantiomeric purity. The related processes of selective catalysis, chromatographic analysis, the theory of smell and taste developed around these main directions. The physicochemical methods worked at full capacity. The foreign scientific community gradually became interested in this field. And if Nesmeyanov had not passed away unexpectedly, world science would have received "The Methods of Synthetic Food".

In the book "Unknown Nesmeyanov", which is being prepared for publication on the occasion of the 125th anniversary of Nesmeyanov and the 300th anniversary of the Russian Academy of Sciences, dedicated to the decade of his presidency at the Academy of Sciences, there is a separate chapter about the genius of Nesmeyanov. Can he be put on a par with Lomonosov and Mendeleev, Vernadsky and Tsiolkovsky? Each of them is

certainly a genius, but a genius in his own way. The opinions are divided. The contemporaries, people who worked with him, mostly avoided discussing this topic, and people who came to science decades later, certainly put him in this line. Where does talent end and genius begin? Nesmeyanov was a very gifted and well-educated person and did not consider himself a genius, but when you see the relevance of his ideas decades later, thoughts about his genius offer themselves.

The main merit of the subsequent directors was, perhaps, that the Institute remained among the leaders of the Department in terms of publication activity, and that they all recognized the greatness of the founding father and did not try to put the Institute on new tracks, limiting their innovations to some additions, making only cosmetic changes to the profile of the Institute. Thus, under the full member of the Academy of Sciences A. V. Fokin, research into biologically active compounds took on new colors. At that time, two research teams were created at the Institute: the group of V. N. Kalinin and Fokin's laboratory, in which A. F. Kolomiets played the leading role. Both became notable phenomena in the scientific life of the Institute and solved the imposed tasks quite rapidly. Having retrained in a short period of time from organoboron chemists to pharmacists, the researchers from Kalinin's group created a whole series of variations of painkillers that were not inferior to their foreign analogs.

A bright spot in the scientific directions of the Institute was Fokin's laboratory. Remember the speeches of Kolomiets on the problem of dioxins—the impurities in standard defoliants, the danger of which was many times greater than the effects of using the main substance. During this period, Soviet scientists provided great assistance to their Vietnamese colleagues in identifying and assessing the enormous damage caused by the American military machine due to the reckless defoliation of the jungle with the infamous "Agent Orange". The amount of compensation from the American side increased significantly as the evidence base collected by Vietnamese scientists increased. In general, Fokin worked at INEOS strictly adhering to the principle of "do no harm", since he understood well the greatness of his predecessor, whom he knew personally and respected very much.

Experimental section

Nesmeyanov created an experimental model of an academic institute with a chemical profile and followed different stages of its development and modification. The main goal of the experiment was to find a form of a modern academic research institute that would meet the requirements of the time, that would be competitive with leading world centers, and that would be capable of smooth restructuring and changing benchmarks. The most important element of scientific research was the form of reporting on the completed work, which would make the main achievements of the Institute the property of world science and, at the same time, would be free from bureaucratic reporting and formalism.

Nesmeyanov transformed the plans for scientific research of the Academy of Sciences of the Soviet Union into a program of fundamental research, which had a different time scale and allowed for changes as required.

Nesmeyanov transformed the work of scientific councils into

instruments of interaction between academic science and university and applied institutes, turning the country's science into a single scientific and technical complex.

Nesmeyanov implemented a teamwork style of management of the Academy, which dramatically increased the efficiency and created continuity when changing the leadership of the Academy.

Trouble came from where it was not expected. On the democratic wave that swept the country, elections began for everything and everyone. This did not pass the Academy by. In 1988, the elections of the director were held at INEOS. In the competition between the prominent organometallic scientist the full member of the Academy of Sciences Mark E. Volpin and the young doctor of sciences, head of the laboratory of sorption processes and one of the key figures in the artificial food department Vadim A. Davankov, the "food" candidate won, which promised to preserve the dominant research of the Institute in this direction. The third candidate, Prof. Vladimir A. Sergeev, essentially turned out to be the third wheel in this fundamental dispute, despite the fact that he was highly respected at the Institute. But there were only two poles in this dispute.

At that time, the specialized departments had the final word in appointing directors in "their" institutes. And our Department of General and Technical Chemistry appointed Volpin as its director, rather than Davankov. It is hard to say whether the members of the Department understood between whom and what they were choosing. Most likely, the workshop solidarity and healthy conservatism prevailed: an academic institute should be headed by the Academy member.

Volpin was the first of the directors during the perestroika period, when changes rained down one after another. What to do with a new direction that had gained momentum? A number of companies and institutes began to compete for a profitable topic. That is, the choice was between bad and very bad. Either to place an applied institute developing the direction of ready food forms—artificial food—in the Institute, or to give this topic over to the hands of applied scientists.

The "Synthetic Food" project had to be closed. Volpin decided to return the Institute to the old beaten path of organoelement chemistry. "Food researchers" turned out to be like horses in midstream, which, contrary to the old saying, began to be changed, and they parted and wandered off to cities and villages. The return transition was done skillfully, without unnecessary lamentations and regrets. The staff appreciated these efforts, as veterans say: Volpin was loved at the Institute.

The suffering and previously cramped people were settled in the vacated areas. With the appearance of the full member of the Academy of Sciences Alexei R. Khokhlov at the Institute, the life of the Polymer Department noticeably revived. The X-ray structural analysis laboratory was still sparkling with paradoxical discoveries. For a long time, this couple provided traditionally high publication and conference activity of INEOS. A few organometallic conferences organized by Volpin also managed to thunder, and then the Institute began to slowly sour. The departure of many prominent scientists of the "Nesmeyanov call" from science could not but affect scientific life. Life in the model installations building was slowly dying out; the staffing schedule of the Institute was drying up like shagreen leather.

And what about the latest passion of Nesmeyanov, has

everything disappeared? Of course not. The largest part of the "food researchers" found shelter in the newly created Institute of Biochemical Physics of the Russian Academy of Sciences in the form of a large department including eight laboratories. The department still exists, and the Institute website presents many words about Nesmeyanov and his brilliant idea. If you look at the Department's profile, it becomes clear that, in essence, it is home to that part of the large team that focused its attention on artificial food, the first phase of the Nesmeyanov project: its demonstration and persuasive part.

But the main, synthetic component of the project is still alive and actively working at INEOS to this day. Belikov's backbone (it was Prof. V. M. Belikov who was the engine in this part of the project), who were in the shadow of black caviar, thousands of tons of sausage, jelly and other visible achievements, made amazing success in asymmetric synthesis, which is known to the world as Belokon's method of obtaining amino acids. The merit of Yuri N. Belokon is not limited to this most important achievement for synthetic food; a team formed around him that understood the significance of these works, continued to develop them and prepare students. So, the genes of the great project are in INEOS. All that remains is to use them for their intended purpose.

In 1996, it was the turn of the full member of the Academy of Sciences Yuri N. Bubnov to lead the Institute to new heights. He had a bad fate. It was the wild 1990s, science was in complete disarray, V. S. Chernomyrdin was in government—he wanted the best, but it was not going well. There was a high turnover of scientific staff at INEOS, a generation was leaving. Not everyone could take over the Institute at such a time. Volpin "pressed" Bubnov with the argument: "If not you, then who?" There was no crowd of candidates for the director's post. Bubnov could not refuse a colleague who became suddenly and seriously ill.

Bubnov did not make any sudden move, his rich life experience allowed him to maneuver in the stormy ocean of those events when prime ministers and presidents changed. When people voted with their hearts and faced default. He supported everything that was "moving", invited the active Varangians (O. A. Fedorova, Ya. Z. Voloshin, A. M. Muzafarov), maintained academic and international contacts and was remembered as the most democratic of the directors, open and accessible for discussion. The Institute completely switched to a grant-based option for conducting scientific research. There was no time to even think about continuing systemic research as a general line uniting the team. But the Institute continued to be afloat, it just switched from global tasks to grant-based small-scale topics. The 50th anniversary of the Institute was celebrated with the same enthusiasm, and the 60th anniversary was celebrated quite modestly, realizing that it would not be possible to add something bright, visionary, comparable in significance to the achievements of the Nesmeyanov times for their lack. At that time, I was entrusted with leading the Institute.

To objectively assess these five years, someone else is needed, and probably not now, so I will only briefly touch on the tasks and solutions that were realized during this period. First of all, it was necessary to restore the manageability of the Institute. It was necessary to liquidate two structural units, one of which openly ignored the formal reporting component of the scientific department, parasitizing on the labor union positions

of its leader; the second went much further, openly engaging in commerce within the walls of the Institute, violating all ethical and legal regulations of its activities. The administrative structure of Nesmeyanov's times was formalized: the allocation of specialized departments within the Institute, headed by leaders with the status of deputy directors. And, perhaps most importantly, the competition for the best research work was immediately transformed into an open competition INEOS OPEN CUP, with the publication of competition works in the special similarly named journal, created as an independent mass medium. Researchers from various scientific centers were widely represented in the jury of the competition and the editorial board of the Journal. All this allowed the team to take a close look at itself from the outside and assess the level of competitiveness of the presented works not through the eyes of narrow-profile representatives of funds, but through the eyes of independent experts, in comparison with the achievements of their colleagues from other scientific centers. The smooth slide of the Institute from the shining heights was stopped.

As is well known, a cursed cow has short horns, the time allotted for the directorship flew by quickly, and not all the planned changes were implemented. But there were no problems with the candidacy of the successor. Bubnov had his eye on Alexander A. Trifonov as a candidate for the director of INEOS, while he was still in the post of the director. Of course, I had no objections to a representative of one of the world's leading organometallic schools. Therefore, without thinking twice, we went to visit the full member of the Academy of Sciences Gleb A. Abakumov in order to obtain consent for the move with all due respect and piety. Everything went amicably, and to everyone's agreement, now I can say in the Nesmeyanov style.

Trifonov confidently won the elections, and a "board of directors" was formed at the Institute: this is how we jokingly called our "coffee on Tuesdays" at first. At the Institute, it was believed that we were "teaching him how to live". In fact, we simply encouraged him and tried to instill confidence in his abilities. My only personal request was to preserve the structure of the departments, the competition and the journal for the next two years, until he forms his own view of the Institute and its development paths.

Like all post-Soviet directors of INEOS, Trifonov had to take a blow no less, but more than before. He had barely managed to form his Scientific Council and the Council of Elders of INEOS RAS when the pandemic began with all the ensuing organizational and administrative restrictions. Then there was more: measures for partial mobilization, clear and consistent work of the administration to support young scientists, serious explanatory work—all these measures allowed the Institute to retain young personnel and even increase the Institute's output in terms of the number of scientific publications.

By his second term, Trifonov had already reached the rank of the corresponding member of the Russian Academy of Sciences with an updated composition of deputy directors, determined to use the credit of trust granted by the workforce to further strengthen and develop the status of INEOS RAS as an institute open to new experimental research, focused on fundamental research in Nesmeyanov's understanding of this term.

What is INEOS now? A lively and actively developing

institute. With an ambitious director, active youth and still powerful veteran corps. The Institute is experiencing another generational change and is celebrating its seventieth anniversary with outstanding achievements worthy of being placed next to the discoveries of its great predecessors. This will be covered in detail in the conference issues of INEOS OPEN. The Journal itself, slowly gaining momentum, is a sign of renewal and a return to the roots at the same time. The Institute continues to be experimental, the competition for the best research work, turned into an open and competitive INEOS OPEN CUP, has proven itself to be a generator of new faces, new ideas, new traditions. After a stormy takeoff, it calmed down for the period of quarantine and anniversary celebrations, but is about to sparkle again with new facets and ideas, focusing on breakthrough areas of scientific research and new mechanisms for interaction with the country's innovative business.

And what shall we save for the 125th anniversary of the founding father, wise visionary Nesmeyanov? Probably, the best gift will be a return to his unfinished song—synthetic food—at a new stage of evolution of this beautiful and endless idea. If we return to the famous metaphor of Nesmeyanov about synthetic food as a powerful tree, its branches reaching high into the sky, then we can say that the fruits were long to wait, this tree was cut down and very profitably disposed of. Many branches in the form of artificial food, biotechnology, microbiological production, and others began to live their own lives. But the mighty root remained and a new sprout is peeking out from under the ruins of the majestic structure constructed around. This sprout, synthetic food, freed from doubly artificial formations, can continue its development, free from forced opportunistic interaction, and return to one of the most relevant areas of modern chemistry.

In fact, this is exactly what Dmitri I. Mendeleev was talking about. The revival and support of this area at the Institute will be the best gift for the next historical date. This should be done slowly, but confidently and consistently, in the Nesmeyanov style. In the next five years, bring this area to the level of a topic in the state assignment of the Institute, and by the end of the decade, this topic should take a prominent place in the program of fundamental research and not only in chemistry, but also in related specialized departments: economics, medicine, biology, earth sciences. Yes, this is the kind of broad front that we need to solve this problem, precisely because of its global nature. And the first step has already been taken. During the anniversary conference, a plenary report was given by the young Doctor of Sciences Vladimir A. Larionov on this topic [4]. Unfortunately for the staff, this was at a session that was held at Moscow State University. But we assume that an expanded version of the report will be presented in the program of the Nesmeyanov Days in January next year and will become the subject of a comprehensive discussion by the Institute's Scientific Council, the Council of Young Scientists, and possibly the Nesmeyanov Seminar. This is necessary so that we can try and think: "What can I contribute to this area?", and I hope that movement in the right direction will begin, and practically everyone will find a point of application in it.

Conclusions

The anniversary celebrations make us return again and again

to the historical figure of the founding father of our Institute, to rethink his creative and life path again and again and to learn from him the ability to carry out transformations and reforms gently but persistently, slowly but effectively, by persuasion, not with a carrot and stick, but by revealing the prospect. It is no coincidence that this anniversary year the Nesmeyanov Seminar has started working at our Institute, where we try not to understand what he did, but to understand how he did it.

His heritage is endless. Only by coming closer to understanding how and based on what principles our Institute was created, we are faced with the fact that this is only a small stroke in the consistent transformation of the Academy of Sciences of the Soviet Union. And this system was a flexible but strong skeleton for managing the country's science and all, as we said then, progressive humanity, meaning science in socialist countries. As an advertisement, I would like to note here that in the anniversary book we found direct evidence of Nesmeyanov's genius and the uniqueness of his scientific and organizational activities. Using a specific example of solving global problems, we are convinced every day of the inability to solve any of them without the participation of our Academy. The suicidal sanctions policy of the West, including those in the field of science, has led to the fact that, having successfully saddled the global scientific and information process, they are leading it from one failure to another, while continuing to make money and turning science into a sphere of profit production. The Russian Academy of Sciences, with minimal funding, finds ways to solve global problems and consolidates the independent part of the scientific flow on solving the most pressing current problems.

The most recent example of the triumph of Nesmeyanov's fundamental approach to managing science was heard at the last General Meeting of the Russian Academy of Sciences. For 20 minutes, the full member of the Russian Academy of Sciences Georgy N. Rykovanov spoke about the problems and achievements in the field of nuclear energy, without avoiding the difficulties and comparing domestic approaches with Western ones. He accurately identified the fundamental differences and substantiated the position of the Russian side. He showed ways to solve the most complex and fundamental problems facing the industry in the next 50 years, and all this clearly, distinctly, radiating confidence based on the excellent correspondence of forecasts and plans to real achievements.

It became clear why our nuclear energy occupies a leading place in the world, and the country confidently looks to the future. Where production, applied and academic science are built in the right order, we are always accompanied by success. It is impossible to send the country on a false "carbon footprint of green processes", wandering from one delusional idea to another. There is a recording of the broadcast of this report, I recommend everyone to watch it.

It seemed to me that the audience should stand and applaud the speaker from the podium. But this is not the custom here, as if such reports happen every day. Of course, they applauded, routinely, and even scolded the speaker for exceeding the time limit. Under Nesmeyanov, this simply could not have happened. Meanwhile, the report, in terms of its level and significance for the entire world community, could well have been presented in Stockholm at the Nobel Prize ceremony, and even more so in Paris at the Mendeleev Prize ceremony.

In the draft, I had a different ending to this article, but I think it is simply impossible to come up with a better ending. Nesmeyanov would be proud, along with us, of such achievements by our domestic nuclear scientists, whom he greatly valued and admired. The academic tradition of thinking globally, originally, fundamentally and effectively is alive, which was beautifully demonstrated in this report.

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