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Responding to Impact Technologies

VIRUSES AGAINST COMPUTERS: VIRTUAL MODELLING IN THE DEVELOPMENT OF NEW MEDICINES

Russian Breakthrough Technologies

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Moderator:

Sergei Nedoroslev, Chairman of the Board of Directors, Kaskol JSC

Panelist:

Pyotr Fedichev, Director for Science, Quantum Pharmaceuticals

S. Nedoroslev:

Good afternoon to everyone who just came in, and thank you to those who have stayed through two technical presentations, because now we will have the most complex presentation of them all, which will be given by Pyotr. I think he will present it better than I can.

P. Fedichev:

Thank you to everyone who has just arrived or stayed. Thank you for the chance to tell you about our company at this remarkable Forum. Quantum Pharmaceuticals uses the most powerful, state-of-the-art computers to develop new drugs to treat different diseases. Our presentation is called 'Computers Against Viruses', and we will be talking about computer modelling in the development of new medicines.

Everyone gets sick. We all know that, especially in Russia, where people spend every rouble to stay healthy. The longer people live, the more they get sick, the more resources go to science, and the better medicine becomes at diagnosing diseases. The more diseases there are, the more medicines we need. So, the market for all sorts of drugs is huge. The longer people live, the more important it is to maintain the best possible quality of life too. The task of today's medicine is to provide not only a long life, but also an active life in the hope that people can earn more and return a part of this money to pharmaceutical companies so they can research new drugs.

Quantum Pharmaceuticals develops new drugs using regional computer systems. Most of our projects have been developed in the last two years. These are new antibacterials, antivirals, and recently anti-cancer drugs.

The pharmaceutical industry has not paid enough attention to bacterial infections in recent years. Most bacteria these days have developed drug-resistant forms. We expect that even more bacteria will become resistant to modern antibiotics in the next five to ten years. This is why we need new antibiotics.

As far as the fight against cancer is concerned, this is one of the biggest unsolved tasks facing humanity right now, and one of the biggest markets. I will try to show

how modern computing methods, based on theoretical physics and bioinformatics, give us reason to hope that our generation will see solutions that are effective against each of the diseases mentioned on this slide.

Drugs mean big markets, but also big investments. Our company was founded in 2004 by a small group with small funding. We thought that it would be possible to find medicines for the worst diseases only if we could reduce the cost of entry onto the pharmaceutical market. Developing a drug right now takes up to ten years and, according to various estimates, anywhere from USD 500 million to 1 billion, with a high risk of failure: fewer than one out of ten drugs makes it to the clinical trials stage.

To make it out of the clinical trial stage, we have to have from 10,000 to 100,000 molecules of the drug when we start. This costs vast amounts of money and prevents us from having effective therapies for various diseases right now. It is very expensive and very risky. Without government support, business is practically powerless to develop new areas in drugs. Therefore, we cannot dream of treating many diseases until new technologies appear to bring down drug development costs significantly.

Our company found its first industrial partner in 2010. Now we can afford to spend up to several million USD each year on development, thanks to government grants and private investment. We work with the Skolkovo Innovation Centre and the Ministry of Industry and Trade, so that in two or three years we can get a drug that is approved for use in the Russian Federation. We will be getting grants, investment, and also our first profit.

Our product lineup consists of several drugs. We are engaged in both science and commerce. On the scientific level, we are involved in the most interesting targets and most promising approaches for treating various diseases. We then take our best molecules from these drug candidates and commercialize them. Some of these right now are novel drugs against HIV, which is one unsolved problem. We also have a novel drug for influenza, another novel drug for tuberculosis (the drug-resistant form of tuberculosis), and for hospital staph infections.

We make commercial deals to support this research. In particular, two years ago we secured rights for our antibiotic as a future drug against tuberculosis or staphylococcus. In this case, our partner in the Russian Federation was Valeant Pharmaceuticals. Our HIV drug is under joint development with an American biotech firm which loves secrecy, so that is all I can say. In both deals we went beyond just selling our services as a research company; we reached an agreement on substantial royalties on sales, dividing the Russian and international markets.

Our company is small. We have fewer than 15 people. The company was created by people who still work there. I represent the scientific wing: I am the scientific director and co-founder. Our CEO, Andrei Vinnik, could not be with us today. He is busy receiving his MBA at the University of Chicago. His investments are a large part of why our company was able to get off the ground.

We had a small team when we started in 2004. In 2005, we obtained the first molecules, which formed the basis for the first scientific publications proving the power of our method. Our company became a resident of Skolkovo in 2011 and concluded its first contract with the Ministry of Industry in 2012. Our first deal with a Russian pharmaceutical company, in 2010, is not shown here. All told, this gives us hope that the flatline, 'horizontal' phase of growth is behind us. Today, with financing opportunities, proven technologies, and a number of molecules for very interesting targets, we hope that soon we will obtain something that we can touch, feel, and sell in pharmacies.

How do we do all this? It is a bit complicated.

S. Nedoroslev:

Offer a few details at least.

P. Fedichev:

Like any living creature, we consist of conglomerates of interacting organic molecules. All of these molecules are synthesized inside of us, interact, and provide what we call life. Quantum uses the latest features of mathematical modelling of interactions between organic molecules in order to stop interactions responsible for the progression of a particular disease.

This is what we can see on the slide here: an organic molecule associated with a certain form of disease is blocked using a molecule that has been pinpointed by a computer. Quantum is a technological platform that allows us to figure out the degree of interaction for each tiny molecule, or its degree of similarity to the biomolecule we need, so we can see which are potential drug candidates.

S. Nedoroslev:

Break it down for us.

P. Fedichev:

I will skip this slide, since I already described our company’s line of work. So what are the problems that can arise? You would think: here is a programme that ‘reads’ how a molecule interacts with something. However, difficulties remain. Firstly, all biomolecules and potential pharmaceuticals are very complicated physical systems. Just looking at *their* interactions would make for a very good journal publication. Secondly, molecules are not just interacting by themselves, one with another. They are in water, whose wondrous properties are still the subject of legends on Russian TV. Finally, the quantity that we want to measure is the product of interaction between so many components that calculating it usually takes a very long time. This forces the developers to either simplify things substantially or to calculate for a long time.

There were many other companies who engaged in computer-aided drug development before we did. Usually this is by means of simplified models. Simplified models are quick to compute but give unreliable results. There are people in academia who can calculate as well as we do, but they publish just one or two articles a year in major journals. What we bring to the table is the ability to compute as well as the best academic teams, but to do this for dozens and hundreds of millions of molecules in a year. With this speed of molecular modelling, we need just a week to sort through all the molecules available for order from synthetic chemists. For any biological target suggested to us by our biologist friends, we can come up with a candidate drug which we can try first in test systems, test tubes, animals, and ultimately obtain authorization to try it out in humans.

Computer modelling allows looking for targets not just where it is easy to do so, or where it is easy to check, but to look where we really need to be looking and researching. Our informatics tools let us determine the biological targets for developing drugs to which viruses and bacteria have minimal resistance. This helps us keep the most dangerous diseases, such as AIDS, under control, get closer to a cure for cancer, and make new antibiotics that work even against antibiotic-resistant bacteria. I will end my general remarks on that note, to avoid creating new terms, and answer your questions.

S. Nedoroslev:

Let us shift from theory to practice for a minute. Who is still unclear on how new computing methods and theoretical physics figure in pharmacology?

From the audience:

I have a few questions.

Firstly, can we apply these methods in other areas, say, for developing new materials? Do you plan to move in that direction?

Secondly, you said that developing a drug costs USD 1 billion. Why did you get into this business if you do not have that kind of money? I would also like to know the fate of the international rights to your drugs. Are you planning to sell them to Europe, the US, and the major markets that can make all these investments pay off?

P. Fedichev:

I will try to answer, to the best of my memory, in reverse order. We retain the rights to all of the drugs we develop. During development, we will try to keep these rights for as long as possible. Our licence to the Russian manufacturer is just for the production of the drug and its sale in the Russian Federation. You rightly noted that the amount of money required is quite a lot, especially if you get it certified abroad. All of the research we do today is done abroad, which we hope will reinforce confidence in the results. Secondly, we hope that after these drugs are certified in Russia, that is, after clinical trials on humans here, we will have greater opportunities for financing clinical studies abroad.

The first question was, why we are doing this, if it all costs so much? Our motivation comes from the fact that the cost of decoding a person's genome, for example, has come down very far in price. Ten years ago this cost USD 15 million, but now rumour has it that you can sequence a human genome for USD 1,000 or several thousand. So Moore's Law of technological progression will, sooner or later, give rise to a situation where drug development becomes much cheaper. We have believed and continue to believe that the vast computing capacity in the world will let us perform the initial steps of drug development at a very low cost. That is what our company demonstrates. We have obtained candidate drugs for very small outlays, for investments that are small even in comparison to what is customary in academia. With good molecules and good data, we are sure that we can attract funding for clinical trials. The last year of growth at our company shows that as long as you have good results published in the right places jointly with good academic biologists, you can find the money. And we have the money now.

From the audience:

It seems to me that it is all progressing even faster than Moore's Law. The genome used to cost USD 15 million, but now it is USD 2,000: now anyone can send a small biosample in an envelope, and for USD 2,000 you will get it completely decoded along with recommendations. Is it possible that in the next ten years, with your methods, medicines will be prepared for each of us individually depending on the flora, fauna, or whatever it is that is inside that person? Not against viruses in general – we know that there are seven billion people and we all have something special.

P. Fedichev:

I think that is where the logic of progress is pointing. A hundred years ago, people were treated with aspirin, arsenic, and this-and-that. But now the recommendations are more personalized: antibiotics for some people, antivirals for others. With the advent of new diagnostic methods and drug development techniques, it is clear that sooner or later we will have ‘cocktails’ for each patient. What we do not have ready yet is the procedure for regulating and approving new drugs, but that too will be solved sooner or later. You know, the largest part of pharmaceutical development expenses is incurred in clinical studies, where the regulatory bodies are involved. If we can solve that issue, then the overall cost will drop, both in our part of the development chain, and for clinical trials.

From the audience:

How much cheaper has it become to develop drugs this way, compared to the traditional expensive method?

P. Fedichev:

Here is an example. Recently we developed a new molecule against the influenza virus. Last year, we published an article in the same year with a group from a university in Hong Kong and also Bristol-Myer Squibb, all in different journals. In the case of those two competitors, developing a molecule with comparable properties took over five years. We derived this molecule and successfully tested it on animals in just six months. This is one example of how we can slash costs.

Sometimes it happens though that it is simply impossible to develop using another method. This includes developing analgesics and drugs against central nervous system diseases; without test animals, you have no idea whether or not your molecule can work. Studying thousands or tens of thousands of molecules in animals is really difficult. It involves a lot of research and a lot of expense. In these situations, our technology may be the only option. We can create medications where other methods would involve going through an extremely complex process.

From the audience:

Secondly, I would like to ask whether your technology is a purely Russian development.

P. Fedichev:

Yes, our technology is a purely Russian development. We are not the only ones in the world to use computers to search for drugs. But when we compare our results with other people, one could say we are best in the world by price/quality and price/efficacy.

S. Nedoroslev:

Are there any more questions?

From the audience:

Why do you not just sell your technologies to big pharmaceutical companies? Why do you develop medicines yourselves? After all, big companies spend billions developing new medicines and they could use this technology better than you, right?

P. Fedichev:

There is no clear-cut answer to that one. It is not quite clear whether the companies spend the kinds of sums we are talking about. Right now the market is undergoing transformation. The development tactics are shifting. We all know that pharma companies buy up new developments from small biotechs or universities, which usually get government financing. Almost nowhere do pharma firms finance the initial stage of drug development. If this is all as we imagine it, then we are where we should be.

As for selling our program, the situation is a tricky one. Many people and many groups say that they have programs that are able to count. Pharma companies show serious interest only when you prove that you can actually do something with your program. As soon as we can get at least one drug on the market, that will be sufficient proof for them to talk with us in earnest, including about the sale of our technology.

S. Nedoroslev:

You are a theoretical physicist who has gone into medicine and made a major breakthrough which, in your view and in the view of other experts, is one of the biggest breakthroughs in the development of next-generation drugs, or new approaches to making them, I should say. There is a huge category of practising doctors, who use standard methods on patients. What is their future, if we are able to make customized models for each patient? What will the role of the doctor be?

P. Fedichev:

The main thing for a doctor is to do no harm, right? We are likely witnesses to a transformation of today's medicine into next-generation medicine, which will impose different requirements, including on doctors. The doctor of yesteryear was a shaman, a far cry from today's doctor.

S. Nedoroslev:

He worked on the level of psychosomatics, by and large.

P. Fedichev:

And tomorrow's doctor, too, will be very different from today's. He will have a deeper understanding of the processes going on within the patient and use new tools for diagnosis and treatment. I think doctors will be alright, but they need...

S. Nedoroslev:

...to be moved from medical school classes to the hard sciences?

P. Fedichev:

We will probably have more of a convergence, which will provide better access to knowledge. Doctors will take greater risks and have a better understanding of the treatment process. They are some of the most conservative people on the planet.

From the audience:

You said that you are conducting most of your research outside of Russia. Does this mean that your drugs will be registered in Western countries first? How will Western doctors react to them?

P. Fedichev:

Conducting trials abroad does not affect obtaining marketing authorization. Russian regulatory bodies accept results from foreign labs for registering drugs in Russia. The logic of our business is such that we register the drug in the Russian Federation first, because it is cheaper and easier.

How will doctors react to such drugs? We are not the first people to develop drugs on computers, and doctors have had a good response to drugs that show efficacy. We think that performing research outside of Russia will help us show our results to international research companies earlier, get advice and expertise from them, thus greatly easing registration of the drugs in Russia and selling them elsewhere.

S. Nedoroslev:

Nobody is asking about money and how all that will happen. Let us say I have gone to the doctor, who cannot figure out whether it is microbes acting up inside of me or a virus. Then what? I go to the pharmacy, and a machine there analyses and synthesizes everything I need? Or will this be a certain class of drugs for typical situations?

P. Fedichev:

What we are talking about is what is happening today. Since medical professionals are conservative people, this ‘today’ will stay that way for a while, longer than in other fields. So right now we are thinking that, for each of the drugs we develop, we will make diagnostic equipment to measure how efficacious the drug is. This will help us to get through clinical studies and then apply the drug precisely in the people that need it the most.

S. Nedoroslev:

Could we hand the microphone to the middle row?

From the audience:

Are you planning to work with other companies at Skolkovo, in the biomedical clusters for pharmaceutical development?

P. Fedichev:

We are ready to work with any groups that have something interesting to say, because the program can churn out more molecules than we will ever be able to test. It seems the biomedical clusters mostly have companies already selling a certain product. Start-ups, as a rule, want to make the product they already have instead of broadening their pipeline. So our answer is as follows: we will be glad to work, of course, and will be thrilled when our neighbours in the biomedical clusters expand so much that they began to build up their pipeline with new products.

S. Nedoroslev:

With such a fine-grained understanding and mathematical mechanism for destroying protein structures, do you know how to make them?

P. Fedichev:

Destroying and building are two different things. It is much easier to interfere with a process than to help something. But there already are...

S. Nedoroslev:

Not generate cells, I mean restoring them. There is a lot of work into tissue restoration for heart attack victims…

P. Fedichev:

Cell-based techniques have been progressing a great deal lately. There is the problem of cell programming. When stem cells differentiate, for example, into the cells of the kind of tissue that you need, you get a lot of problems with halting differentiation, survival, etc. There is a lot of interesting work being published about impacting signalling paths for these transformed, reprogrammed cells. This allows for substantially better operative outcomes and better survival. This is where our technology comes into the picture: we use proven technologies, similar to low-molecular-weight substances, to precisely regulate intracellular processes. We are in contact with people active in this because we are confident that instead of squeezing us out, these cell technologies will use our technology with even greater precision, benefit, effect, and safety.

S. Nedoroslev:

Thank you. From today’s presentation and talking with you yesterday, many diseases cannot be cured but can be controlled, which allows life expectancy to be increased and, even more importantly, improves quality of life. It is possible to live with a lot of diseases, microbes, and viruses. So, the overarching objective of your work – besides making a profit, of course – is to improve lives and extend them as long as possible.

P. Fedichev:

Right, not fighting pathologies, but to fine-tune the body's settings and to live in a world in which any biologist who knows their way around the human body can configure it precisely in the course of a few years or months.

S. Nedoroslev:

Maybe then, without intervention by doctors or even the patient, an internal bioanalyser will kick in, synthesizing all the molecules necessary for fighting illnesses – even as we are out there living our lives, playing football or hockey or what have you.

P. Fedichev:

Until they turn us off.

S. Nedoroslev:

Until they turn us off. I would like to stop on that optimistic note to thank Pyotr and to wish success to him and to all of us, hoping for the successful use of his methods. Thank you.

S. Nedoroslev:

Good evening to those who have come again, and thank you to everyone who stayed on after the last presentation. Now we have a presentation with a romantic name, 'Taking Wing: Modern Technologies for Controlling Robot Planes'.

There is a lot of talk about unpiloted craft. One of the first was the Soviet *Buran*, the spacecraft, which in 1985 was able to take off and land with great precision without anyone on board. Just before it landed, it suddenly changed direction, veered off, came back, and landed on the runway from the other side. It did not like the wind, so the *Buran* decided to go the other way – and this was in 1985! Can you imagine what private companies are doing in this area, in 2012? Andrei Mamontov will tell us.

A. Mamontov:

I will start with a small film. We were testing our drones just a week ago and I wanted to show you this first, then talk about our team, the technology, and so on.

(Film plays.)

The film is without sound; I will be narrating. We are located on the Istra River Reservoir. This is when our craft is taking off. Right now, flying over, it is going to do a very tricky manoeuvre.

S. Nedoroslev:

And break a few federal laws in the process.

A. Mamontov:

That was a barrel roll manoeuvre. The drone resembles a flying wing, which makes it very manoeuvrable.

So, that is a short clip, and now I would like to talk about the know-how in our craft and what we are trying to do.

Our goal is to create a cheap, versatile technology that can collect and process data with the use of unmanned aerial vehicles. We need to do a few simple things for that: collect data well and process that data well, preferably automatically, so everything can go quickly and well. To collect good data, we need a good tool. The avionics have to be such that the drone can position itself correctly, find the right routes, and react to situations. After it collects photos or video, they need to be automatically processed, generating map information or processed video. The goal of the project is to create a handy tool like that. To that end we are using our drones, which are unique in their automated AI system.

We went down the tried-and-true start-up path: the main specialists sat down over a cup of tea, thought about what we know how to do, and decided to try making a good drone and a good system. The first investments were from the founders themselves, we started developing and making the system algorithms and architecture. We filed for several patents right away, and we approached the Skolkovo Foundation with the idea for this system in the beginning of 2012. They accepted us with delight and we took up residence in Skolkovo.

I was not in aviation originally. Together with Boris Satovsky, we monitored transport using GLONASS and GPS. In essence, we know and can do everything in electronics, but we did not have aviation people who could couple the microelectronics and the avionics to make the product we needed. So we invited over some amazing people: Vladimir Kulikov is our main specialist for aviation systems, the vehicles themselves; and also Vitaly Khorkov, who worked at the Zhukovsky Academy for many years and knows everything about aviation, including about unpiloted drones.

It was he who contributed the additional idea about artificial intelligence, which we have been able to implement in practice, more or less.

Here are the technical specs for our drones.

Job No. 1 for us is to get them used on the civilian market. We had to precisely set the ranges of the targets we plan to monitor or photograph. We decided to use internal combustion engines, in order to have staying power in the air and be able to go long distances. We went with a catapult launcher for our drones, because this can be performed from any site, even an unprepared site. Landing is performed with the help of special catching devices. Emergency landing makes use of a parachute. Cruising speed is around 120 kilometres per hour, which gives optimal video and photo resolution and allows for laser scanning. The weight is under 30 kilograms. Online data transfer works for up to 75 kilometres. It can fly up to 4,000 meters above sea level. Usually, drones are used for imagery at low altitudes – small areas, but quickly.

People always ask why drones are better than civilian planes, the standard aerial imagery methods, or satellite imagery. Everyone uses Google Maps. If it is already all recorded, then why reinvent the wheel?

Unpiloted aircraft have their niche. We are not competing with civilian aircraft or aerial photography. We are in the business of solving quick tasks and imaging small objects where it does not make sense to use big planes. Also, compared to satellites, we have the advantage in terms of responsiveness and all-weather capability. In addition, satellites are not good at monitoring sites over time. So we are not encroaching on others' markets. We are creating our own.

What do we offer to clients? We are not selling unmanned aerial vehicles. We are selling our drones' services.

Above all this is aerial photography of small objects, whether agricultural areas or construction sites, or environmental monitoring.

Then there is video. Videos must be of good quality. The technology is there already, i.e. at least HD, with a gyroscopic platform in the video cameras to avoid shaking, plus video in several spectral dimensions.

Most basically, drones are a platform on which you can strap on any package and switch it depending on the client's tasks.

The President of Sakha (Yakutia) Republic, came to our stand yesterday, and right off the bat he asked whether we could fly long distances? “Yes, we can”, we answered. He then said, “I need you tomorrow. I have forest fires and I need to see them. But I do not have the money for a large air fleet.” I said, “Tomorrow is a bit soon, but we can try to solve the problem the day after tomorrow.”

Why is the use of these drones of such interest? The technologies are so advanced that we do not even have to transmit an image to the emergency management headquarters. The aircraft itself can determine where the forest fire is happening and simply transmit the coordinates or help to determine which areas have been affected.

Monitoring of long objects is very much in demand. This can be oil companies with pipelines. They have many people on patrol with walkie-talkies, occasionally pressing the button to say, “All is OK, nothing to see.” Electrical companies have to deal with downed cables, the width of forest clearings, and monitoring emergencies when a tree falls on a power line and most of a neighbourhood is left without power.

Of course, we also offer quick-turnaround mapping of small plots of land with high precision, with the option to generate 3D models of the terrain. This is useful mainly to construction companies, surveyors, and people who work with the land and need to measure it somehow.

The idea for our next step is to put together geographical services that use drones. There are some problems here, though, which we will touch on. The basic idea is that a drone is smart and robotic, so off it flew and came back. You can go on the website and see the route on a 1:50,000 scale. The aircraft took its imagery and transmitted it to a cloud server, which processed all this and delivered the end product to the client.

However, there are number of questions here associated with the laws and the permitting system. In Russia, anything more precise than 1:50,000 is restricted by the government, and in order to provide such information, you have to have certain permits.

You can imagine who can benefit from our company's system. Developers, construction companies, the oil and gas sector, agriculture, power generation, and environmental monitoring. So, anything that you can see from the air, we are ready to offer you as an end product with the use of our systems.

S. Nedoroslev:

I would like to ask Valery Okulov, the Deputy Minister of Transport, whose life has been associated with aviation through and through, to share his thoughts on what we have heard and tell us the latest about changes in legislation. Since the *Buran*, perhaps, landed by resolution of the Central Committee of the Communist Party of the USSR and the All-Union Central Council of Labour Unions, and thanks to investments by many companies in the sector today, drones are already operational. So are our laws lagging behind or are we at the forefront of progress?

V. Okulov:

Thank you, Sergei. The laws are lagging behind, as always. It is no surprise: technological solutions always outpace regulatory ones. The first planes flew even without aviation legislation or a regulatory regime.

The topic is a proper one: here we are talking about control technologies. We can figure it all out when it comes to drones: a longer or shorter range, radius of effect, bigger or small size and dimensions, weight... But how do we control it, especially if we want to control it ‘without conflict’, that is, cooperating with other airspace users?

Alas, the regulatory regime here is in its very nascent stages. We are not the only ones though. The American Federal Aviation Administration and the Europeans have not developed a regulatory regime for drones either. All drones are used according to the archaic methods in accordance with the Aviation Code and legislation: drones can fly only in specially allocated airspace, with regulations on space and time, as well as short-term limitations for the sake of airspace users arranging unmanned flights. The current regime envisages the use of airspace for experimental, military, and combat drones. That is not the case for civil aviation.

The creation of a regulatory regime goes hand in hand with technical solutions which will allow us to conduct drone flights without conflicts. To avoid collisions, all aircraft are designed to technical requirements that envision crashing into a duck. Smashing into a goose, though, may cause irreparable harm. A goose weighs four or five kilos. Our whole drone weighs 32.

So, we are not going to strengthen the fuselage or engines. We are going to use solutions that will prevent these collisions, not simply reduce them, but prevent them altogether. We will install equipment which informs all parties of who is in the air, which risk advisory is in effect for a particular site, and how to avoid that risk.

These technologies exist and are being successfully developed, in Russia among other places. The technology is called Automatic Dependent Surveillance-Broadcast (ADS-B). The only promising broadcasting channel we have is VDL-4. We have deployed this technology already in a number of regions. We have used it for three years now. Even though we call it a pilot project, it is working in a very operational way in Yamal, we have a project in Moscow, and we are starting another similar project, called ‘Baltika’, with the Swedes.

A year ago in Pushkin, near St. Petersburg, we performed an experiment with two helicopters, one plane, and one drone. It provided an ample demonstration of how to provide complete information to all participants in the process – crews and controllers – to minimize risks.

So, we have technological solutions, and now they need to be reinforced in legislation. The Aviation Safety Collegium already has a road map. We are also looking to make amendments to the Aviation Code: we need to start with basic changes – foremost, definitions. What is an unmanned aerial vehicle? What does it mean to control one? What should be the requirements for drone operators? What basic education do they need to have? What training must they receive? What are the medical requirements? And so on. We do not have any of this, as yet.

As soon as we put this all in the Aviation Code, this knocks down the first domino in this many-tiered regulatory process. That is not everything, but if we look at this regulatory 'desert', we need to put in the seedlings and grow our garden so business can start reaping the fruit of this promising industry, which enjoys great demand.

Aerial pipeline inspections today are done with MI-8 helicopters. We know just how much cheaper drones will be by comparison. For finding fires, we use MI-2 planes that are obsolete and written off, and if they have not been written off then they probably should be.

We need new technology. I am happy to see enthusiasts who are ready to help drive forward a technology that is so important for so many industries. What I have shown in my presentation is a far from complete list of the potential areas of application.

S. Nedoroslev:

Thank you very much, Valery, for your comments. Companies and investors alike need to know that the Russian legislation is not something written once and for all and set in stone. The Ministry of Transport is working on the legislation, since such projects are very difficult without the right legislative environment. It is critical that we have a clear legislative foundation for all this, so that we are not subject to the permission of some aviation player. In that case, some may allow it and some may

not. The Air Defence Forces need to be warned, or else they might say no. There is no law, so they could say yes or they might not.
Back to the company. Perhaps the audience has questions for you, Andrei. We have microphones both left and right.
Let us hear from Sergei Generalov, shareholder in Tranzas, which is one of our biggest drone manufacturers.

S. Generalov:
My question goes like this: I caught on to a discrepancy between what Andrei was saying and what Valery was saying. Valery said that amendments to the Aviation Code will impose a number of requirements on operators. And my sneaking suspicion is that what Andrei is doing does not even contemplate operators at all. Is my understanding correct?

A. Mamontov:
Absolutely correct. As we understand it, a drone operator is the person who gives the assignment to the craft to get imagery at a certain scale, say. More likely, it is not even the drone operator, but some surveyor or programmer who is using our system. But this is all looking a few years ahead. At this stage, we still use operators, of course.

S. Generalov:
So it is like the film *Avatar*, where the operator sits in front of a screen with a joystick and is looking at where the drone is flying?

A. Mamontov:
There still need to be requirements for operators. Who knows what order that operator will send? The system will carry out whatever is sent, but the source data could really lead to unpleasant consequences. So, we have to certify, train, and do

something with people. But we do not have centres yet where we could say, that person is fine or that one is not. I think this question too will be resolved soon.

S. Generalov:

You cannot have aviation without operators: a pilot, a controller, someone must always bear complete responsibility for the flight of any given aircraft. Even if there is no pilot on it, all the responsibility is on the controller who is currently controlling the craft in that area.

A. Mamontov:

Yes, we need a controller by definition. In any event we strive to make our flights on a legal basis, in cooperation with the aviation control authorities. After all, as a commercial company, the main thing for us is to deliver our product to the client on time and with the minimum of hiccups.

From the audience:

We need to introduce a definition for a different sort of new participant in the process. Sergei is saying there is a pilot and then there is a controller. You do not have an operator, in essence what you have is a programmer who gives a flight assignment. Maybe there should be a different term with its corresponding niche in the legal framework?

From the audience:

I want to add that when a pilot sits down in a plane, he has to be qualified and know that there are restricted areas where you cannot fly. Say, the president’s country home. But what about the programmer? He is sitting there at the computer, wearing his glasses – how does he know what country home is where? He got his order to photograph the land over the Internet, got the coordinates, and gets to work. So the required qualifications have to be like those for pilots. He is not at the helm, maybe he is not even controlling it online, but he has to have the same knowledge set.

A. Mamontov:

We are trying to teach the system to indicate, all by itself, where flying is forbidden. But you can still force the system to anyway.

From the audience:

Andrei, I also have a question. You mentioned that when you went to surveyors about making a map, they laughed at you. Surveyors are serious people and their idea of a map is not like what you and I use on the Yandex website.

A. Mamontov:

Absolutely. They know that the technology really exists and can be used, but the pilotless craft that you can go and buy in a store, loosely speaking, suffer from some positioning problems. The drone determines its position in the air with an error range of 50 to 100 metres, and getting a picture of the earth where one photo pixel equals several centimetres with the appropriate coordinate tagging is just impossible. So, to get the necessary accuracy of data on the earth, you have to solve this problem in the air and know where the drone is, to at least within one metre.

From the audience:

How do you manage to do that?

A. Mamontov:

We use a whole range of sensors, narrow it down as much as possible with dual-band GLONASS receivers, and round this out with inertial systems. We are trying to get positioning accuracy down not to tens of meters, but single meters.

S. Nedoroslev:

Are there any more questions?

From the audience:

Andrei, you said very confidently that drone flights are cheaper. On first glimpse, it would seem so. But your flight radius is 75 kilometres. In Yakutia, that is nothing. There it might get you to the edge of the bog where they pick berries. You have to fly 500 kilometres. You also have to pay for coordinating with all the regulatory bodies and you have an operator, that ‘pilot’ who needs to have certain training. Are you also sure that drones will be cheaper for hovering than the MI-8 helicopters we have today, which have lost all value and sell for a song?

A. Mamontov:

Please bring back the slide with the tech specs. When we say 75 kilometres, we mean the ‘online’ radius with radio coverage and transmission of the picture. This limit is due to technology. The flight radius is 1,200 kilometres. So the craft is quite competitive, actually.

S. Nedoroslev:

All the way to the other end of the berry field?

A. Mamontov:

All the way to the end! Even if we cannot get an online relay of the picture in high quality at 600 or 700 kilometres, which requires great bandwidth, we can still get enough data via satellite to say that the berries are located in a specific place at these coordinates and that we need to take care of them.

S. Nedoroslev:

You can store data too, right?

A. Mamontov:

Naturally. How is 1,200 for Yakutia?

From the audience:

It is not a question of distance. You may still need a heavier craft. Are you sure that drone pilots will be cheaper than flights on old planes or even new, manned ones?

A. Mamontov:

I am. Let me explain why. An unmanned aerial vehicle is serviced by a maximum of two people, who need to deliver it, set it up, and press the launch button. Any civilian aircraft requires at least four or five people on hand, including technicians...

S. Nedoroslev:

A certification base, and so on.

A. Mamontov:

Correct. You also have to have infrastructure – an airport and landing strip – plus the cost of the plane itself, its depreciation be many times that of the aircraft cost.

Our goal is not a glider. Our goal is to create algorithms for controlling the glider and for processing the data we obtain. Our system is scalable. We can increase the size of the aircraft of whatever design and go about the same jobs, but at a greater distance if we have more fuel, engines, etc. So based on all these factors, we will certainly save money. At least four- or five-fold.

V. Okulov:

Much more.

A. Mamontov:

Indeed, even much more.

V. Okulov:

In the cost equation for the MI-8 helicopter, fuel takes up about 60%; its fuel consumption is 800 litres per hour. I do not know how many grams that is.

A. Mamontov:

But here, we have only 11 kilograms of fuel on board, with 12 hours of flying time.

S. Nedoroslev:

However old the MI-8 might be, if it is flying, it will simply cost RUB 3,200 or RUB 4,000 per hour to fly. Period. Old or new, no difference.

A. Mamontov:

Of course. The cost of operation is always higher than the cost of acquisition.

S. Nedoroslev:

You can take a single-seat Robinson, they do that in some of the rural areas. But pilots are expensive.

A. Mamontov:

Not to mention situations when it is simply better to not have a person in a dangerous zone at all, while the drone is still just a hunk of metal. Remembering Fukushima again, an American drone flew over and looked at the radiation background, because it would not have been a good idea to bring in people.

S. Nedoroslev:

Still more questions?

From the audience:

Economically speaking, things are not great...

S. Nedoroslev:

Not true yet. But it is good if the questions are about money: nobody doubts the future of drones, they are just discussing the cost.

A. Mamontov:

Again, our idea is not to sell drones, but to provide a service that makes use of unmanned aerial vehicles. Small and medium-sized companies cannot afford expensive aircraft. They just need to get imagery of their 10 kilometres. They come to us and say, “This is what we want”. We give them their 10 kilometres as a finished aerial photography product. This saves them money and allows reducing the cost of our product by several times, as well creating a new market for quick-turnaround cartography.

S. Nedoroslev:

Good. Andrei, thank you so much.

We will end the official part of the presentation now, you are free to share more with us in the lobby.

A. Mamontov:

Thank you to everyone here.