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Dear fellows!

We live in time of global transformations. Today, we face serious challenges for the pharmaceutical industry because the contemporary community demands more advanced approaches for treating various diseases.

Almost every day, novel solutions are reported in both medical practices and pharmacy. Neither does Farmak rest on its laurels. The rate of the Company development is outstandingly high as for the pharmaceutical industry. We introduce modern practices in all production areas, including personnel management, sophisticated technologies, manufacturing processes, etc. We also open up new opportunities and look to the future. Our focus is gene engineering and biotechnologies. We put a great deal of effort to make treatment with modern and efficient medicines affordable.

With the future in mind, we dedicate the new issue of our magazine to innovations. We are keen on sharing our experience in implementation of new digital solutions, we also describe how IT technologies are integrated into daily practice of Ukrainian physicians. In this issue, we share discoveries of the global importance, which prove that perseverance and desire to make this world better will end in success.

Modern technologies give us unprecedented opportunities amid the world becoming more open, approachable, dynamic and diverse. We are confident that, focusing on the global experience and caring for making medicines even more affordable and high quality, we make an important contribution to the development of our country and integration of the national science into the world's setting.

> Sincerely, Volodymyr Kostiuk, CEO, Farmak JSC

BIOLOGICAL MEDICINAL PRODUCTS: **TECHNOLOGY OF** THE PRESENT AND THE FUTURE

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Farmak Objective:

with Pharma 4.0

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Biological Medicinal Products: Technology of the Present and the Future

Intelligent System

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Artificial Intelligence Top 10 Smart **Devices to Guard**

> SCIENCE INSIDE "Farmak JSC" CORPORATE MAGAZINE

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Едермік

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Farmak's goal: compliance with Pharma 4.0

HOW TO BUILD A COMPANY OPERATING ON THE BASIS OF THE FOURTH INDUSTRIAL REVOLUTION, where to look for ideas and how to draw a line between beautiful fiction and practical expediency – Farmak's IT specialists know this.

oday there is all business processes are rapidly digitalized. And among them, there are priority

ones.

The first is the construction of Supply-Chain Management, a holistic business process that describes the planning of the entire production chain - from the moment of ordering raw materials and materials to the release of finished products. To make this process consistent with the best practices, we carefully study the Ukrainian and world experience - including the involvement of external consultants, and begin to build an appropriate IT system.

The second: the creation of the EBR – Electronic Batch Records, a production process control system. This requires such an extremely important element as the ability to collect information from all the huge number of devices involved in the production. The data obtained from them can be aggregated into a single information system. As a result, everyone, from shop foremen to management, will be able to receive online information about what is happening on each of the production lines, as well as to form an electronic dossier for each series. Finally, the creation of a full-fledged EBR system will allow to integrally calculate the efficiency of production.

The third direction is the completion of work on the construction of the Laboratory Information Management System, a laboratory information system, which is now being implemented at a very rapid pace. Thanks to this system, it will be possible to achieve automation of functions carried out by the Quality Directorate, automation of compliance with regulatory requirements of all processes etc. Moving away from paper documents and switching to electronic technologies will be an important milestone in the development of our company.



TRACKING DIGITAL TRENDS

We strive that Farmak become as close as possible to what we call Pharma 4.0, to ensure that wherever possible, end-to-end processes in the Company were digitalized. But studying what pharmaceutical giants make, we don't repeat all. The use of artificial intelligence is not an end in itself. We must study all the options, and then select the best practices that western companies have, and at the same time carefully analyse what we can apply in domestic realities with the budgets that we can afford, and the economic effect that will be clearly calculated.

For example, pharmaceutical giants are already beginning to implement such a modern trend as augmented reality in their work. The master can put on special glasses and see, in terms of the actions of virtual hands, how exactly to repair a certain unit. Fiction? Definitely! It will be interesting to play with such glasses? Undoubtedly. However, we are still stopped by the question of the economic feasibility of such innovations.





ESTIMATION FOR THE FUTURE

However, there are some solutions that will certainly be useful. We are considering the creation of an artificial intelligence system that would allow us to predict the future of our production process. Unplanned shutdowns due to equipment failure cause enormous losses. However, based on previous experience and taking into account parameters such as the life of the equipment and its service life, it is possible to bring all the data into a single network. In the future, it will be possible to calculate at what point and under what circumstances any of the components and assemblies with a high probability can fail – and prepare for this in advance.

CURRENT ACHIEVEMENTS

Only recently, a number of projects have been implemented, which give reason to be proud. Among other things, in 2018, the Company launched a planning and accounting system, which became the first cog in the future Supply-chain management system. Now the production can already solve online



issues related to the planning of purchases of raw materials, packaging and all other auxiliary materials, manage downtime, optimize the supply of certain materials for the formation of a finished series of drugs.

We are confidently going to create a business intelligence system - dashboards have already been prepared for our management. They allow to see in real time what's happening in the Company, what is the volume of sales and production plans, how it correlates with plans for this year and with the results for previous years – all on one dashboard, which can work

GREAT OPPORTUNITY

Today, the IT industry is steadily moving towards consumerization, that is, providing the user with more and more opportunities. Today, software and hardware vendors offer not just programs, which will then be finalized by our programmers, but a real designer. It will consist of blocks that we can combine the way we need. in a corporate network and beyond. And we plan to expand the scope of digital technologies in business processes. Probably, in the future there will come a time when IT will not be perceived as a separate direction, so completely it will merge with all other business functions. Only recently, a number of projects have been implemented, which give reason to be proud. Among other things, in 2018, the Company launched a planning and accounting system, which became the first cog in the future Supply-chain man-

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FOCUS -ON CYBERSECURITY

After the Company went through a difficult stage in June 2017, faced with a virus that affected a significant number of Ukrainian enterprises and institutions, very serious conclusions were drawn. We have conducted a full audit of the entire structure of our software, The Disaster Recovery Plan system was also built. It allows in a clearly prescribed mode to implement a sequence of actions that must be carried out in case of a particular danger: from the failure of the server or similar collisions to such force majeure situations as fires, floods etc.

Another important and interesting project was implemented with the help of Microsoft and their Azur cloud. In case of problems with the data centre on our sites, we will be able to restore the operation of our servers and systems directly from the cloud.

DRIVERS OF CHANGE

When deciding which project should be implemented, the IT Department and the Company's Management move towards each other. Colleagues from different units of the IT Directorate are actively monitoring current trends, are looking for interesting solutions - and they are always open to suggestions. Then, when the idea is voiced, we comprehensively consider it, discuss, arrange brainstorms, argue - in order to understand whether we can deduce from this idea a certain concept. Not all ideas come to fruition, but all are

OUR STRATEGIC GOAL IS TO BUILD A NEW INDUSTRIAL FARM WITH MAXIMUM ECONOMIC EFFICIENCY.

taken into account, and if the sentence has meaning, it can be embodied. We declare: we know how it will work, we are convinced that it is interesting, we have calculated what benefit this or that technology will give us. When the initiative to implement a certain project comes from the Management, the IT Department becomes a full participant in its implementation.

OUR TEAM

There are employees who have worked in different positions in the Company for a long time, they have significant experience. And there are young colleagues who may not yet have a solid credentials on their CV. but are ready to change the world! We appreciate each member of our team. try to understand their needs, worry about their joys or sorrows... We try to motivate our colleagues as much as possible. and we can promise: they will face very interesting tasks, they will participate in the construction of very interesting processes, we will always welcome their initiatives and ideas. And together we will create an atmosphere in which work gives satisfaction.



The art of information management



The development of a modern enterprise is impossible without effective digital solutions. DENYS KRESTOV, IT DIRECTOR OF FARMAK, SPEAKS ABOUT THE WORK OF SPECIALISTS.

Mr. Denys, please tell us how the IT Infrastructure Unit was created in the Company.

The history of the Unit dates back to 2008. At that time, the information and telecommunications sector was formed, from which different directions were separated over the years, becoming independent divisions, such as the technical support department. The infrastructure department was established in 2012. There has been a change in structure, and the electronic document management and base administration sectors have been separated. Today, the Unit includes the System Administration and the Cybersecurity Departments.

What are the tasks of these two departments today?

The System Administration Department provides 30 physical platforms and more than 150 virtual platforms that support business applications. It is the engineering kernel that manages the data centre, servers, networks. Every day we solve dozens of problems to ensure the smooth operation of all systems. Sometimes it may take a few minutes to solve a problem, and large projects can take up to a year to develop architecture, documentation, regulatory procedures, etc. The staff of the System Administration Department are responsible for the modernization of server systems and data storage systems; qualification of platforms during validation of a particular system; debugging, power increase;

automation of data collection from laboratory devices. The Cybersecurity Department develops security techniques, builds the right tools, tracks all issues related to potential threats or incidents, etc.

Employees of the Unit are constantly involved in various projects. Can you identify which ones were the most important?

There are a lot of them and the list is constantly growing. Among the important ones there are: the launch of serialization system; preparation for FDA inspection; investigation of viral incidents. In addition, a project for the quality control laboratory was implemented: Unit experts, together with the staff of the QCD, launched a system of centralized chromatography management.

The Company strictly adheres to GMP requirements. Do your Unit applies Good Manufacturing Practices?

Yes, of course. In 2012, Farmak was one of the first in Ukraine to launch a GMP IT infrastructure qualification project. It was carried out with an Italian company. It was this project that gave an understanding of how important it is to implement information technology, quality systems and processes.

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Biological medicinal products: technology of the present and the future

Pharmaceutical biotechnology is a field that is successfully applied in modern medicine, using the developments of a wide range of other scientific fields, SUCH AS GENETIC ENGINEERING, CELL AND TISSUE CULTURE TECHNOLOGY, NANOBIOTECHNOLOGY AND OTHERS.

THE ORIGIN OF THE INDUSTRY

The milestone achievements in genetic engineering gave impetus to the widespread use of biotechnological products in medicine in the last quarter of the 20th century. This research is related to genome sequencing, human and animal genome project development, biotechnology development of medicinal products for the treatment of chronic diseases of different aetiology, and other significant breakthroughs in microbial genomics. Eventually, medical biotechnology has reached a more advanced stage of its development. Today, it is a state-of-the-art medicine-focused industry based on modern biotechnology methods: recombinant DNA, enzyme immobilization, cellular biotechnology.

The development and manufacturing of biotechnological products require deep knowledge of biological processes in humans and animals, mechanisms for contraction of various diseases, as well as clear understanding of all biochemical, neurohumoral mental processes that occur in the body due to the development of a particular pathology. That is why the development of biotechnological products is impossible without the application of the developments of the sciences such as molecular biology, genetics, biochemistry, nanobiotechnology and others.

Creating effective and safe medicinal products for the treatment of chronic and autoimmune diseases is impossible without the use of biotechnological products because they are able to affect the cause of the damage and are able to regulate the damages that occurred in the body at the cellular level. In particular, these medicinal products are of primary importance in treating, for example, oncologic and autoimmune diseases, when the organism does not recognize the cause of the disease and cannot actively fight against changes. The understanding of the mechanisms of pathological disorders and the impact the biotechnological products have on them is the first and foremost in such cases.

REVOLUTIONARY DISCOVERIES

According to the data published by the Pharmaceutical Research and Manufacturers of America (PhRMA), US companies are now testing more than 600 next-generation drugs targeting serious and incurable diseases. The modern world seeks to ensure that terminal diseases are totally eliminated. Due to biotechnological products, we can and should find remedies for the diseases that are considered fatal, since these products can affect the cause of the disease directly. All medicinal products mentioned in PhRMA's report were created on the basis of biotechnology for the application of fundamentally new methods to fight against diseases. PhRMA emphasized that the advances in medical biotechnology have made it possible to use the technologies that have not previously been used to man-



ufacture drugs. For example, one of the recently developed medicinal products is capable of delivering nanoparticles, which detect and destroy pathogenic viruses, to the human body, while another medicinal product, which is being tested, regenerates the muscles - a feature necessary for the treatment of damaged tissues. Yet another medicinal product can stimulate red blood cell production. After all, some hematologic diseases remain incurable today. Many pathologies are treated only with blood products that are derived directly from the blood of healthy people by the separation of its components. In this case, therapy is not aimed at eliminating the disease, but at maintaining the homeostasis of the person, the viability of a particular system.

BIOTECHNOLOGY AT FARMAK

Farmak which is always committed to its motto "We work for you and your health" could not ignore the biotechnolog-

ical area of pharmaceutical industry development. The genetically engineered insulins were the first biotechnological products with which Farmak entered the pharmaceutical market in 1999. Today, Farmak has about 40 registered products based on biotechnological active ingredients obtained through various biotechnological processes. These are genetically engineered protein molecules, insulins, erythropoietin, a number of peptide products, biopolymers based on heparin and enoxaparin, probiotics and others. A number of biotechnological products are being under development. The molecules derived from the tissues of animals and plants, genetically engineered substances, isolated peptide molecules are used in the manufacturing. Moreover, in recent years, Farmak has been developing own genetically engineered substances. Today, it is important for the Company to continue

working on new effective medicinal products that will be targeted at the treatment of serious diseases, in particular, those requiring new approaches to therapy.

EVERYDAY IMPROVEMENTS

The development of each new medicinal product makes it possible for the Company to reach an ever higher level. The research and development of biotechnological products require a comprehensive approach and knowledge in many fields, the application of different methods: physical and chemical, molecular biological methods, methods involving animals, microbiological methods. Having developed about 40 products, Farmak has acquired competence in various approaches to standardization of biotechnological molecules, physical and chemical and microbiological methods, in some methods of molecular biology. Our Company meets all the



MARYNA BORSHCHEVSKA

Doctor of Pharmaceutical Sciences, Professor, Head of Biotechnology Department of JSC "Farmak":

At Farmak, we have a consolidated work of three services: the service of Business Development Director, the service of Technical Director and the service of Marketing and Sales Director, all of which inspire the Company with new ideas. The latest research, the most up-to-date ideas are being constantly searched for. Time within which we can achieve our objective is an especially important factor in the pharmaceutical development of biotechnological products which should be taken into account. Each new product requires the development of new facilities, the use of new methods and the implementation of new manufacturing processes. We take up the challenge and work consistently to improve and expand our competences.



necessary regulatory requirements for the manufacturing of already created medicinal products and has the potential to develop and integrate new innovative molecules and methods. Each new development is a step forward, because it is more complex than the previous ones: every time there is a need to use new facilities, to apply new discoveries in the field of other related biotechnological areas. The biotechnology trend which is expanding at an unprecedented rate has reached the level of IT in terms of growth. Farmak is looking for a range of drugs where the Company can be as successful and bring as much benefit to the society as possible. In order to achieve this objective, the specialists of the Company are constantly monitoring the industry development, the changes and emergence of new trends in medical biotechnology.

IF WEATHER CHANGES GIVE YOU A HEADACHE,





FARMADOL WILL COME TO THE RESCUE

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INTELLIGENT SYSTEM — confidence, economy, and safety





IT COMPONENT WHICH TURNS A SET OF MECHANISMS INTO A SMART SYSTEM PLAYS A LEADING ROLE IN TODAY'S ENGINEERING SOLUTIONS. Natalia SYMONETS, Head of the Industrial Wastewater Treatment Site, explains how the latest technology enables automation of extremely complex processes.



uring the construction of the manufacturing site in Shostka, Farmak focused on the most state-of-the-art technology. Realizing that the future belongs to the IT solutions, the management went for highintelligent systems. In particular, to achieve the highest possible performance in the wastewater purification from high-concentration

organic and inorganic pollution, the Slovak company AQUAFLOT has developed an operation line, which is software-guided and controlled.



Water is purified in several stages as follows:

contaminated water from all sites is collected and mixed, and pH is adjusted to 6 to 9;

then water is purified from mechanical impurities;

purification involves the use of the biologically active sludge, due to microorganisms that absorb pollution; and

finally, water is ultrafiltrated.

From start to finish, all these processes, including transition to the next stage, are completely automatic. And this gives a range of advantages.

NO HUMAN ERRORS

The software of the technological system uses sensors and, based on signals from them reading the levels of oxygen, pH or other parameters, adjusts the process according to the technological regulations. The system automatically responds to any deviation and performs the necessary correct actions requiring no external interference. For example, if the sensor indicates that wastewater with a high pH comes to the second stage of purification, the pump system will immediately feed a precisely calculated amount of chemicals to neutralize.

PROCESS VERIFIABILITY

The purification process is schedulable. The monitoring system displays the data on the computer screen, where the water purification process is shown as a diagram. It demonstrates where and which processes are currently in progress, what are the input, output parameters, as well as indicators at the intermediate stages, what sensors, pumping stations, pipelines, vessels and other installation elements are involved.

SAVING HUMAN RESOURCES

One site can be maintained by one operator, moreover, this officer should not be there all the time, constantly glued to the monitor. The operator may clean the premises, receive raw materials or do other production tasks, as the system operates independently.

DATA ARCHIVING

All data on the operation line performance is recorded, archived and stored for one month. This means that even if a certain deviation and its correction by the intelligent purification system occurred when the operator was not at the monitor, the data concerning this procedure will be still saved. Based on the recorded information, the search for the reasons that led to the deviation and data on elimination will be carried out immediately.

VARIABILITY OF SETTINGS

The standard average rate of reception, treatment and discharge of wastewater are set by the program responsible for the operation of the wastewater treatment site. However, changes can take place at the site at any time, including variations in the manufacturing plan, repairs, etc. Therefore, clearly understanding the entire process chain, subject to agreement with the site management, you may amend non-critical parameters, i.e. those that will not lead to equipment breakdown or other failures. Thus, the wastewater treatment process can be made more intense or, on the contrary, slowed down.

ROOM FOR IMPROVEMENT

To maximize the air quality indicators, following the main stages of purification, the air masses will undergo additional purification system using biologically active sludge (now this biotechnology is used only for water purification). In view of this, the program will be upgraded, it will consolidate two functions, such as actions directed towards water and air.

In summary, we can be confident that, given the undoubted advantages of full automation, investments in the purchase of precise software were more than justified.

The computer «brain» controls the important safety and comfort settings at the Shostka site. Indeed, the ventilation system software takes over the automatic heating or cooling of the outside air so that the room temperature is always maintained at 18-22°C as per regulations. Another example is setting up the blowing system of the equipment that compresses the air. To maintain the optimal temperature, in winter, the cold air intake is carried out in lesser amounts and in less time; while in summer, the air masses are more actively involved in cooling.

DNA robot as a new dawn for the treatment of Parkinson's and Alzheimer's diseases



The fight against severe progressive brain disorders may be soon pushed on to the next, much more effective level, and this would be due to the discovery by 17-year-old Sofia Lysenko, an American researcher of Ukrainian descent. SHE HAS CREATED A COMPUTER MODEL FOR A DNA ROBOT THAT CAN SIMPLIFY THE PROCESS OF DELIVERING DRUGS TO THE AFFECTED CELLS.

THE WINNER OF THE GOOGLE SCIENCE FAIR

Sofia Lysenko, born to Ukrainian emigrants, was fond of science since her early childhood. Her range of interests is wide and varied, including programming, maths, physics, chemistry, and biology. With her interest in many sciences, she has accumulated all possible knowledge and skills. About two vears ago, the future inventor became deeply interested in pharmaceuticals, and more specifically, in the treatment of progressive brain diseases. The girl had long considered how to ameliorate the treatment of people with severe disorders, and became interested in new ways of delivering drugs to the patient's brain. Soon her talent was brought to light as, in summer 2019, the young researcher came into the spotlight of the scientific community. She presented her invention, namely the DNA micro-robot, which. guided by specially designed computer programs, will be able to overcome obstacles and successfully deliver the necessary medicines to the relevant parts of the human

brain. Presenting this invention the girl won the Google Science Fair competition at the regional level. Although now it is too early to discuss the practical use of the Sofia's idea in medicine, it is already clear that the invention has considerable potential.

HOW TO OVERCOME THE BARRIER

A huge challenge in the treatment of brain disorders, in particular Alzheimer's and Parkinson's disease, is the inability to effectively deliver the drug directly to the affected cells - the blood-brain barrier is blocking the way. It performs an important function by protecting the human brain from viruses getting in. However, this "protective laver" hinders the effective treatment of the aforementioned diseases as it also impedes the successful delivery of medicines to their target. Sofia Lysenko developed her invention based on the fact that the blood-brain barrier passes DNA macromolecules without recognizing them as a threat. The robotic microcapsule developed by the researcher has a DNA structure and, therefore, is able to



overcome this obstacle. The inventor believes that once in the human body, the robot will be able to perform the necessary calculations and learn in which direction it should move so as to deliver the drug and provide the desired effect.

UNDER OWN STEAM

Sofia's path to discovery was not so easy. The inventor searched and obtained much of what she needed by her own efforts, enlisting the support of her parents and a school physics teacher. The girl sent her inquiries to professors in the USA and other countries, communicated with all the scientists she needed, whom only she managed to get in touch with. She was eventually lucky enough to get in touch with a Boston professor who helped with the research, and to get

Sofia does not want to stop there and continues her research in medicine. The project she is currently developing aims to apply artificial intelligence technology to diagnostics. Together with fellow scientists, the inventor is working on an algorithm that will diagnose cerebral palsy in newborns based on the analysis of movements, gestures and facial expressions. the school to support her project and provide her a place to work. Despite the difficulties, Sofia has conducted hundreds of computer experiments that allowed verifying the potential relevance of the invention.

NOT SO EASY IN PRACTICE

Currently Sofia Lysenko's discovery is an untested experimental computer model of a robotic DNA microcapsule, which has the potential to make a major contribution to medicine in the future and save millions of lives. In theory, the invention seems to be revolutionary, so it is not surprising that the Sophia's idea has already caught the interest of large pharmaceutical companies, in particular, Janssen and Merck, which themselves search for the ways to solve these problems. However, we still do not know whether her plan would be feasible to implement, at least in full. If so, the project is unlikely to be implemented in the near future. For pharmacists and physicians to use the idea proposed by Sofia in their practice, a complex supramolecular assembly must be created. Indeed, the implementation of such an invention would require the efforts of highly qualified scientists from leading world laboratories, who will work with the best equipment available. Purchasing the necessary equipment requires considerable investment, and if you take into account the complexity of the development, it is clear that we are talking about millions of dollars.

Artificial intelligence as healthcare professionals

ARTIFICIAL INTELLIGENCE BECOMES INCREASINGLY INVOLVED IN THE NATURAL MENTAL **ACTIVITY.** Its most prominent activity can be observed in economy, education, traffic, and industry, and medicine does not certainly stand by. Computerized systems are designed to facilitate to set up a more effective treatment process, monitor patients, and identify risky abnormalities at the early stages.



HOW TO PREVENT A MISDIAGNOSIS

Nobody is safe from mistakes, and medicine unfortunately is not an exception. Improperly prescribed treatment can result in dire consequences, though new methods of reinsurance are available in the 21st century. Artificial intelligence is what may help the imperfect human brain. The Watsons Health automated ly processing a large data array concerning a patient's health status: complete past history, all available test results for the relevant period of time, should only you upload the data into the database. The process takes a little time: the artificial intelligence system could analyse data retrieved from 20 million articles related to oncology in 10 minutes and,

a facilitating tool for



considering the information received, was able to correctly diagnose the patient.

Moreover, artificial intelligence may help predicting the risk of problems during surgery, which was investigated in an experiment published in Anesthesiology. The program analysed the data of more than 1,000 patients and could quite precisely (84% and 87%) predict aggravations during interventions – it was 10-15 and 5 minutes, respectively, before they occurred.

INNOVATIONS

Sometimes, patients cannot clearly explain where they feel pain or discomfort, not to mention children or people with severe mental disorders. Clarity is very important for diagnosis, therefore, sensors with automatic pain recognition would be useful. The technology allows diagnosing disorders of various types, from bone fractures to neoplasms. The computerized system will very carefully analyse X-rays or ultrasound findings, considering details that a person might miss. In addition, today we have various ways available to determine genetic problems, for instance, by scanning the face. Moreover, some systems are capable of detecting neurodegenerative conditions early on. such as Alzheimer's or Parkinson's disease, by analysing a person's gait.

DRIVING CONTROL

Many accidents occur as a result of alcohol intoxication or a dramatic deterioration in the driver's well-being. Due to state-of-the-art technology people can assess in advance their aptitude for driving. When we communicate we usually perceive information both via listening to words and by taking into account non-verbal means, since we pay attention to the spoken voice level, intonation, gestures and facial expressions of the person we are talking to. Modern programs of artificial emotional intelligence are endowed with similar skills. By getting information about non-verbal behaviour of a person through a webcam in a car, a specially designed application makes conclusions about their health and well-being. The application also monitors medical parameters such as heart rate and dyschroia, with the latter sometimes being a sign of a hypertensive emergency or stroke. Developers are working to improve the software so that enabling it not only to warn people in advance about the possible danger, but also to activate, if the driver suddenly loses the ability to drive.

THE COMPUTER SYSTEM ANALYZES X-RAYS OR THE ULTRASOUND RESULTS VERY CAREFULLY, PAYING ATTENTION TO DETAILS WHICH MAY BE MISSED BY HUMANS.

ACCURATE FORECAST

The latest technology enables monitoring the treatment effects in real time, and even making reasonable assumptions about whether a person will need to see a doctor again soon. The Quentus monitoring system analyses the patient's behaviour and well-being throughout the hospital stay. Then, based on the data obtained, the program suggests that the person's health may be impaired. Some programs can easily determine if a client is at risk of returning to the hospital within the next 30 days after discharge. If this is the case, the person receives additional recommendations for taking care of his/her health.

AUTOMATED PROCESSES

As we know, medicine is not just about diagnosis and treatment. Routine activities play a major role, the lack of which would completely smudge the industry. For example, this is the case with clinic appointments or, if necessary, their rescheduling or cancellation. If holes in the doctors' schedules are becoming the norm, considerable losses are inevitable. American experts estimate that each patient who missed an appointment costs a clinic about \$200 on average. And if you take into account certain factors, you can determine the probability of all changes in the schedule. The severity of a person's medical concerns, the weather conditions, and the features of the traffic infrastructure. all these allow predicting how likely it is that the client would reschedule the appointment, be late or not come at all. And if this is quite difficult for a person, artificial intelligence programs are ready to help, being capable of estimating the smallest details.

TOP 10 smart devices to guard your health

The «smart» time, in which we live, almost every day equips people with new convenient technological solutions. This also applies to medicine. INNOVATIVE GADGETS GREATLY SIMPLIFY THE LIVES OF PATIENTS, FACILITATING DAILY CARE OF THEIR WELL-BEING AND HEALTH.

SUGAR LEVELS -BY LOOKING INTO YOUR EYES

The ability to timely and accurately measure blood glucose levels is vital for a diabetic person. To always keep this under control the patient has to do blood tests several times a day using a glucose meter. This constantly requires your time and money spending. South Korean scientists have developed a device that can help control this parameter, namely the lenses that respond to the tears. If the glucose level in the tear is increased, the sensor responds to it, and the patient receives a message that they must urgently make an injection of insulin.

Similar developments have been made before, but at the time, the level of technology did not allow creating lenses that would not pose a danger to human vision.



2BANDAGE FOR PAIN RELIEF

Chronic pain can develop in different parts of your body and significantly impair the quality of life. To get rid of this annoying trouble, patients have to use painkillers, which is not always safe since some of these drugs cause side effects. However, there is no need now to resort to medications as there are alternative methods that have already proven effective. The elastic bandage Quell provides an analgesic effect due to the built-in neurostimulator plate. The device's mechanism of action is absolutely safe for human health: the gadget sends out pulses that block the pain. You just put a bandage on the part of the body that needs therapy, and soon the symptom will pass.





3 A GADGET FOR QUIET SLEEP

Snoring is not only tiring for people who sleep nearby — if the surrounding people can isolate themselves from the noise using earplugs, the snorer's body has nowhere to escape from the adverse effect. These people often wake up with a headache, and they have an increased risk of cardiovascular disease. Therefore, it makes sense to persistently turn the sleeping person to the side every time they begin to snore.



The latest development, Night Shift Sleep Positioner, can perform this function. Going to bed, the patient fixes the belt on the back of the neck. Every time a person rolls over on his/ her back, the device begins to vibrate. The vibration gradually increases until the body's position is changed.



The treatment success depends on the patient, their punctuality and strict com-

pliance with the doctor's instructions. Missing drug doses blocks the therapy success, and even nullify everything, so patients, especially those who have memory problems, have to write down the drug regimens in their notebooks or on paper sheets. "Smart" first aid kit developed by AdhereTech takes over the responsibility for the control of accurate intake of drugs. When it's time to take your pill, the device starts to glow.

SMART FIRST AID KIT HELPS PA-TIENTS TAKE MEDI-CINE ON SCHEDULE. WHEN IT`S TIME TO TAKE A PILL, THE DEVICE STARTS GLEAMING. If the patient did not respond to the reminder and did not take the medicine, sound effects are added, i.e. the gadget starts operating as an alarm clock and produce loud signals.





C DRESS SMARTLY

The functions of covering the body from the cold or other adverse environmental effects and highlighting the human individuality were supplemented by another one in the 21st century: the latest technologies give garments "smart" technological properties, in particular, medical.

In the early 2000s, a unique development was presented. The clothing manufacturer Reima, together with scientists from two Finnish universities, presented the idea of a snowmobile suit that was tailored to interact with the human body and the environment, with monitoring the body and air temperatures, and the person's movements. Today, the smart clothing is created following these very principles, because due to it you can control your own health and well-being.

Sensors are built into "smart" clothes to monitor most important medical parameters, such as body temperature, heart rate, respiratory rate, and blood pressure. Technology for creating smart clothing is constantly evolving, since manufacturers are looking for ways to make things as easy and convenient

Coats with built-in MP3players, garniture and remote controllers were invented by Levi Strauss & Co in collaboration with Phillips in the end of 1990s. But prototypes of such novations had existed long before that. First attempts to create clothes with electric illuminating elements were made in XIX century. as possible. The Smart Shirt Sensatlex T-shirt introduced in 2006 can monitor heart rate and human breathing as well as wirelessly transmit this information, with the T-shirt being quite lightweight and easy to wash.

Manufacturers are now not limited to incorporating sensors, they have already invented a "smart" fabric, which is essentially an entire sensor. The clothing made of such fabric may sense any movement of their "wearer" and instantly give advice, for example how to improve your posture. And within the SUITCEYES project, there is an evolving technology aimed at greatly facilitating the lives of people with vision or hearing problems. The idea is to create a suit with a built-in camera, through which a person will receive all the required information about the environment. The camera will capture the faces of the people surrounding the costume wearer as well as the objects near them. The recorded information will be transmitted to the person through tactile signals, such as vibration.



ORAL HYGIENE MONITOR GADGET -YOUR INDIVIDUAL HOME DENTIST, WHICH DIAGNOSES TEETH PATHOLOGIES AT EARLY STAGES JUST AT HOME. A SMALL PLATE EQUIPPED WITH SENSORS IS PUT INSIDE A MOUTH - IT SCANS JAWS AND DETECTS THE PROBLEM SPOTS.

6 DENTISTRY CARE WITHOUT LEAVING HOME

Dental treatment is expensive, besides it requires a lot of time. To prevent a sudden deterioration of the oral cavity health, it is advisable to find time for consultative visits to the dentist, at least once a year. Modern technology absolves patients from this need. The Oral Hygiene Monitor gadget is your home-based individual dentist that diagnoses early dental abnormalities right at home. A small plate, equipped with sensors, should be put in the mouth, and it will scan your jaws and identify problem areas. The physician will receive the information in soft copy and decide whether the patient needs a real consultation. The system is also convenient because the dentist draws conclusions by referring directly to the scan results, and not to the patients' words who usually find it difficult to clearly describe their dental problems.





GLASSES WITH RECORDING FUNCTION

Another gadget, ready to help the diagnostician, was developed by Wearable Intelligence. The smart glasses, which operate using the Google Glass system, provide the possibility to transfer information from doctor to doctor without making records in the patient records or lengthy explanations. For example, a patient is admitted to the hospital after an emergency call. First of all, the patient is examined by a paramedic wearing "smart glasses", which record all the required information and pass it to the next doctor, who will then see the patient. The Google Glass developments already include the function of video diary, photo and video shooting and are equipped with mobile communication and the Internet. In the future, these are going to be upgraded even more, such as adding the augmented reality function.

BOOTIES HELPERS

To reassure young mothers who are always concerned about the well-being of their babies, the developers from Owlet created a gadget called Owlet Baby Care. These are booties with a built-in mechanism for monitoring heart rate, blood oxygen levels, and other important medical parameters. The scanned data in the expanded form comes to the parents' smartphones. Parents can monitor their baby's condition and well-being around the clock, and in case of suspicious symptoms, promptly consult a doctor.



9 MULTI-FUNCTION STETHOSCOPE

A device, using which doctors can "hear" the heart and lungs, is one of the oldest medical devices. HD Medical decided to take it to the next level and created an improved version of the stethoscope, a digital ViScope MD with a display, on which you can view the patient's ECG. The gadget remembers the read information and transmits it to the computer. Another advantage of the development is that it is equipped with a special algorithm to detect abnormalities: during the examination, the stethoscope automatically detects suspicious heart murmurs, making it much easier for the physician to make a diagnosis.



10 MIGRAINE-FIGHTING TECHNOLOGIES

Currently, the disease can be relieved without resorting to drug therapy. As pain is by and largely the information that flows along the nerve to the brain, it is possible to apply technologies that will help to muffle it using electromagnetic impulses. Belgian scientists have developed a new device, Cefaly, that is put on the head like a hoop and relieves migraine symptoms.



Online Marketing:



IRYNA PASHKETNYK an internet marketer of the pharmacist marketing department of JSC «Farmak»

THE INTENSIVE DEVELOPMENT OF INFORMATION TECHNOLOGIES DICTATES THE NEW RULES OF THE MARKET GAME. Iryna Pashketnyk, an internet marketer of the pharmacist marketing department of JSC "Farmak", speaks about effective methods of internet marketing.



SOURCE

The purpose of online marketing is to provide the Internet consumers with the most comprehensive information about the Company's products, its advantages over competitors, features where the consumer can purchase them as quickly, profitable and convenient as possible. Due to effective tools that are constantly being improved, online marketing itself offers additional opportunities to keep in touch with consumers.

Farmak works in several areas of online marketing development, as the product portfolio is constantly being updated with new names. The official website Farmak.ua is a source for consumers, doctors, pharmacists. The focus is on the relevance of the information, new packaging photos, as well as the correct technical optimization for Google Search. Statistically, almost 70% of all website visits come from mobile devices, so effective optimization is performed to meet these needs: easy to find information via mobile phone, image quality, video. Before launching a website, first of all, they are tested on mobile devices, and then the full version of the website is checked.

be closer to the consumer



TYPES OF ONLINE ADVERTISING

These methods of influencing the audience remain effective. Several types of advertising are actively used on the Internet:

• Search advertising. When a consumer is looking for a solution to his/her problem, the task of advertising is to show what products can help. • *Video advertising.* Prerolls before video footage on YouTube, other sites.

Banner advertising. Displaying banners in articles read by the target audience.

• Advertising in mobile applications.

• *Advertising on social networks* (Facebook, Instagram) for a specific category of consumers.

SYNERGY IN ACTION

To maximize the impact, specialists combine various online marketing tools that are effective in pharmacy. How is everything working? For example, a doctor prescribed a Company product to a patient. The patient decided to read the instruction for use first and started looking for this product on Google. On the site he/she found detailed instruction, packaging photo. The consumer can then see the product advertising while watching videos on YouTube or advertising on TV. The patient can also search for pharmacies online with the appropriate medicinal products at the lowest price and book an order. That is, the customer chooses a channel where he can conveniently receive information about products, services. The Company's task is to help him/her do it as convenient as possible, i.e. through any online channel. In addition,

sites with consumer feedback, various forums, for example for parents, have a great impact

The company actively cooperates with doctors: conducts seminars, trainings, conferences, in particular, and online. Such

One of the main product criteria that drives sales is the product quality. Consumers respond positively to such products: comment on sites, shoot videos, recommend to friends, and more. And this is a success for the Company!

methods are effective, they increase the involvement of the medical community in various projects, increase the loyalty to drugs. Online conferences allow doctors from different cities to participate in the event at a convenient time.

WITHIN THE SCOPE OF THE LAW

Pharmaceutical advertising is strictly regulated both by the laws of Ukraine and by the requirements of Google, Facebook. Before posting anything on the Company's product network, this information is thoroughly scrutinized by the legal department and medical marketing, and the data is scientifically validated. And advertising information undergoes more and more checks from Google, Facebook. Therefore, all the information on the official resources of the Company is absolutely authentic, without any hidden facts.

CLOSER TO THE CONSUMER

Today, it is the consumer who sets the priorities. For example, in Marketing 4.0: Moving from Traditional to Digital, Philip Kotler says that with digital technology, customer engagement is not what the company but how the customer wants it. It is about omni-channel marketing - when different channels and different interaction points are used for different interactions with the client. Today, a classic client's pathway is: Knowledge -Influence - Questions - Action - Propaganda. Farmak is working to ensure that, at each of these stages, the information on the product network is authentic and available for consumers.

Through analytical systems such as Google Analytics, specialists carefully monitor site traffic, the effectiveness of various online marketing tools, and through Google Search Console – website positions in organic Google search results...

E-marketing rules of successful business

MARTECH IS RAPIDLY EVOLVING, AND DUE TO DIGITAL INNOVATIONS, now effective techniques are available not only for large companies, but they also give the opportunity for small businesses to win a broad audience.

AT THE DAWN

Online marketing began to capture the information space in the 1990s. In 1992. Charles Stack's first online bookstore was opened, and in July 1995, Amazon created its online store. For almost 30 vears in the area, there was a grandiose transformation by means of a transition from the promotion of goods and services to trade in information space, software, business models, etc. In the global market, Google, Yahoo, MSN and other leading companies have the upper hand.

DIRECTIONS OF DEVELOPMENT

From year to year, marketing technologies for the promotion of goods and services on the worldwide web prove their effectiveness for various fields of business and industry. No matter what the company sells, online marketing helps to create a perfect consumer profile, identify

EFFECTIVE MODELS

TODAY, SEVERAL MAJOR ONLINE MARKETING BUSINESS MODELS ARE REGARDED EFFECTIVE.

0

Business-to-Consumer (B2C) it is about direct sales to the final consumer. This model was the first one.

0

Business-to-Business (B2B) — this consists of companies focused on business activities with each other.

0

Consumer-to-Consumer (C2C) — Internet users sell goods to each other. For example, eBay as an international auction, the Kazaa file exchange system. customer needs, and create valuable online content. It is important for each business to have its own strategy, so along with the usual methods, such as SMM, SEO-optimization, e-mail and SMS marketing, experts are developing newer and more effective approaches. Several technologies are considered promising in the near future, including:

• *Mobile trend.* Every day, the number of people who browse online shopping sites using mobile phones is constantly growing. The sites are actively optimized for mobile search, and the rate of mobile traffic on commercial sites ranges from 30 to 50%.

• Video marketing. This is an effective tool, because the video is always easier to perceive than a large text body, it helps to better understand the features of a product. Videos can be shared via e-mail, posted on YouTube or Instagram.



Voice search. By 2020, 50% of searches will be through voice commands. Experts are working on the development of applications such as Siri, Google Assistant and Bixby. Active implementation of voice search will require some content optimization. Voice queries are formulated more freely than typed queries, and their average length is about twice as long, e.g. from 1-3 words in the printed search it increases up to 3-5 words in the voice.

RTB (*Real-time bidding*). The position of such a marketing tool as auction advertising

buying is strengthening. This process will continue to grow actively in the future and will cover TV, streaming channels, etc. It is believed that such a tool will not only be guaranteed to yield dividends, but will also facilitate capturing a wider audience.

Chatbots. The chatbot industry is booming. It is projected that by 2020, more than 85% of all company-to-customer interactions will occur through spam search engines. Operating 24/7, chatbots help you order food to be delivered at door, choose clothes, book tickets and advise customers.

This increases not only customer satisfaction, but also the response rating, which will have a positive effect on SEO and brand promotion.

• Augmented reality. The boundaries between the virtual reality and the real world are blurring. Augmented Reality technology is actively developing. It will be a powerful customer engagement tool as it will help consumers evaluate the product in the real world. For example, IKEA has long been successful in implementing this technology by developing a special Place app for smartphones. A person can choose an object of interest and see what it looks like in the interior.

Event marketing. Another effective tool is holding certain events, such as webinars, forums, or seminars. They help to establish emotional contact between the consumer and the brand. For maximum effect, it is very important to determine the target audience, purpose, task, time, and correctly submit your information about the brand. The event must be announced followed by maximum dissemination of information to keep the attention as long as possible.





PREPARING AND

PLACING THE

CONTENT ON HEALTHCARE AND POPULAR TOPICS TO ENGAGE THE TARGET AUDIENCE

Placing the articles on the website of

JSC "Farmak"

Publications on popular websites

Video content





UP TO 1 MILLION USERS PER YEAR VISIT WEBSITES OF JSC «FARMAK», ALMOST 70% OF WHICH ARE VISITS FROM MOBILE DEVICES, AND THIS FIGURE IS CONSTANTLY GROWING.

> Communication with doctors and pharmacists





31



Pocket medical care team

Today you can hardly imagine someone who would not have a smartphone. This small device comes in handy in all circumstances. And a variety of apps for the gadget can significantly save your time, money and nerves. **THE RATING OF SCIENCE INSIDE INNOVATIVE APPLICATIONS IS PRESENTED BELOW.**

ACT PROMPTLY AND ACCURATELY

First Aid by the International Federation of Red Cross and Red Crescent Societies is an application that saves lives. Literally. With simple step-by-step instructions and instant access to information, a common person will be able to provide first aid without getting lost in a difficult situation. Moreover, using this app, you can call 911, 999 or 112 at any time, even when travelling abroad. Another advantage of the application is the video and animation that make it easy to learn emergency rules. The application has pre-loaded content, so users can get information on safety regulations even if the device is not connected to a mobile network or Wi-Fi.

2CANCER PREVENTING

The SkinVision application is a unique product for the detection of melanoma through scanning skin lesions using a smartphone. The main purpose of this application is to prevent the disease and direct the user to consult a doctor in time if there is a need. The person just have to take a picture with his mobile camera, then the application will analyse the image and inform the user if there are any signs that may suggest the probability of malignant processes. When scanning moles, the application takes into account their size, shape and colour, calculates the UV index based on skin type, and even provides customized advice based on the skin type and risk factors.

3 ECG ON YOUR

Apple, the world-renowned American company, once again make people stare with its inventions. Electrocardiogram (ECG) reading is now available to all Apple Watch Series 4 users. The iPhone users can use this feature via the Health app. To display the cardiogram on the mobile screen you should open the app on your watch and hold your index finger on the Digital Crown button for 30 seconds. The Apple Watch records the user's ECG readings and heart rate. Due to the application, the user will be able to detect abnormalities in the body and promptly respond to them, thus preventing the cardiovascular disease. All the data

is stored on the iPhone in the Health app, and you can even create kind of a health report in PDF for distant consultation with your physician

4 ONLINE SEEING-

Microsoft has developed a unique application for smartphones based on the iOS operating system, which serves as a seeing-eye guide for people with poor evesight and even for the blind. The Soundscape program works as a GPS navigator and helps the user navigate the space, e.g. it can tell the user about the objects that surround him; tell which way is best to go and where to turn: remind the street names the user is walking along. Moreover, the voice prompts are available that hear surround sound from the stereo headphones from the side, on which there is an object, that the program captures and describes. This makes it easier for the person to understand his environment. In addition, the user can activate a sound beacon that notifies him if he lost the route or, to the contrary, moves in the right direction.

GLUCOSE METER

Researchers at the University of California decided to upgrade a regular smartphone cover transforming it in a device for measuring blood glucose levels. The GPhone cover was printed on a 3D printer; this device operates using the smartphone battery. The cover has a replaceable reusable sensor connected to the main printed circuit board. The kit also includes a stylus with 30 disposable granules inside, the user shall attach this to the sensor to activate the device. Next. vou should add a few drops of blood onto the stylus. The glucose oxidase enzyme, inside the stylus, begins to respond to the amount of glucose contained in the blood applied and delivers an electronic signal that is received by the sensor electrodes. Data from the cover is transmitted via Bluetooth to a special application on the Android smartphone. The received information is stored on the phone for follow-up. The test itself takes about 20 seconds.

GWHY DOES IT HURT?

First Aid is a mobile application of domestic production, created by Ukrainian developers Vadym Hrynchenko and Liliya Kurylets. This unique program helped users try to determine the cause of physical pain and get acquainted with probable diagnoses. The app asked appropriate questions to the patient (where the pain is, what the pain is by nature, what relieves the pain, etc.) to establish the probable cause of the physical discomfort. The program "is familiar" with the symptoms of 52 conditions, from the common cold to stroke. The user could also export the diagnostic results in PDF and provide the information to the physician during the visit. However, the inventors were not lucky to attract investors, while their own funds for the development of the First Aid app ran out. Anyway, the developers consider their project to be a success, because over 3 years of its existence, the app has helped 2,000 people get their primary diagnosis.

Breakthrough of South Korea



NATALIIA TULINOVA

an expert in development of medical institutions and advisor in transformations, marketing and services in medicine at Zdorovi agency

TO LEARN ABOUT HIGH TECHNOLOGIES OF SOUTH KOREAN MEDICINE - this was an opportunity a group of Ukrainian doctors and managers got in October 2019 thanks to the invitation from the South Korean Embassy in Ukraine. Nataliia TULINOVA, an expert in development of medical institutions and advisor in transformations, marketing and services in medicine at Zdorovi agency shared her impressions.

COMPETITION LIES AT THE CORE

One of the key features of the South Korean healthcare system is that 95% of all medical institutions are private. The country has a mandatory medical insurance. Therefore, a part of the costs is covered by state, and part is covered by employers, but medical institutions always receive payment for their services. And fight for each customer stimulates constant improvement of medical service.

As known, demand drives supply, so this country does not have such problem as shortage of high-end professionals in contrast to Ukraine, where the situation is very critical.

INTELLECTUAL ELITE

The number of future doctors and medical staff is deter-





mined by the government however, it does not cover the cost of education. As well as clinics, most educational institutions in Korea are private. At the same time, only applicants that scored 100 points at the ability test (an equivalent of Ukrainian ZNO), which is a maximum possible result (it would be 200 points in Ukraine), can enter medical universities. So, it is no wonder, that the medical practice is the most respected profession in Korea. Those who get a chance to study, are the best among their peers and by choosing medicine, students, and future doctors, invest in their growth.

CONTINUOUS LEARNING

In general, it takes at least 10 years to master a profession. And the growth does not stop



afterwards: additional scientific work and improvement of practical skills is a must. So, interns are entitled to 14 days of leave and sum of USD 2,100 per year for education, visiting of conferences etc.; a practitioner without a higher academic degree - 14 days and USD 4,000; and a doctor with a higher academic degree may have 21 days leave to pursue their educational activities with a budget of USD 6,400 per year.

GOAL ORIENTATION

Management of healthcare institutions do not occupy their positions forever. Many clinics regularly rotate top managers every 2-4 years. It is believed in Korea that managers lose their effectiveness, if they occupy the same position during a longer term. This does not mean that everyone is fired with a lapse of certain periods of time some professionals remain at their positions. However, when the company undergoes serious changes, it is always women who get fired. It is not because of overt gender discrimination in the country (we did not notice it), it is simply believed here that a woman, who treated business as her child during long time, is not capable to change her business thinking.

SMART SYSTEMS

Medical equipment must be regularly upgraded every 2 years, otherwise medical institutions will not pass a certification. This should not surprise, as Samsung and Toshiba, whose share in the global medical equipment market is almost 45%, offer the newest solutions to clinics.

There are many examples of uses of new technologies. Here are just few of them.

Exoskeletons are widely used after strokes, traumas, etc. They are special frame structures that allow even a paralysed person to move and help to restore motion behaviour.

In infertility clinics, patients can to the maximum extent keep track of what is bappening with their biomaterial. When the material is collected, it is assigned with a digital code that is sent to the patient`s special armband and a software tracks all possible manipulations and sends notifications to the armband.

In order to complete*ly protect prematurely born babies from undesirable external influences,* infant incubators are supplied with medicines by a special innovative remote system. And as electronics precisely control condition of babies, access to the special rooms is strictly limited.

DIGITAL SOLUTIONS

In general, the level of digitalization in healthcare is very high. While American clinics are nominally at the fourth level of digitalization, the Korean are at the fifth, and some clinics, as for example medical centre that has 39 (!) operating rooms, are at the seventh. It is clear, that no paper documentation is used here, everything is recorded and managed by digitally. Clinics may use their own software for time management and other organizational issues. At the same time, there is an e-health system managed by the government.

Mobile operators are also involved in some projects. For example, country residents receive notifications on their devices about an increase in air pollution or about other potentially dangerous factors, as well as about detection of



fast-spreading diseases in a particular region. In general, Korea is highly alert to the epidemiological situation. All starts at the airport, where absolutely every arrival is examined using a special scanner that reads body temperature and the condition of an iris. That is how the guests can immediately feel that they come to the country where both human and artificial intelligence safeguards human health. And closer knowledge of the healthcare system proves it over and over again.

Print the future

THE TECHNOLOGY OF MANUFACTURING THREE-DIMENSIONAL OBJECTS BASED ON THE USE OF DIGITAL DATA WAS INVENTED AND PATENTED IN THE 1980S. But it was only at the turn of the millennium that 3D printing began to be actively used in medicine – and today there is every reason to call the latest technologies truly revolutionary.

STRONG SUPPORT

The pace of 3D technology became the fastest where there was the need for auxiliary products made of solid materials. For example, dentistry – so, back in 1999 for the first time mouthguards for teeth alignment were printed, and today there are laboratories where after a full diagnosis 3D-printers can immediately create a variety of structures, from veneers to implants.

The accuracy of computer calculation and the ability to embody a complex three-dimensional model brought prosthetics to a new level, and it is likely that in the near future they will make it fundamentally cheaper than it was before.

In surgery, especially when it comes to lost bone fragments, individual implants are produced. Some of the materials used have such a structure that it becomes the "base" for stem cells, which can later turn into a real bone.

A PRINTED MAN?

Bioprinting, which is creating three-dimensional models of cells, is the next step to the future of medicine. The news is already full of reports about attempts to use 3D printing to create tissues and organs that are close in functionality to the natural ones - from relatively "simple" formations. such as artificial substitutes for skin or blood vessels, up to prototypes of the heart, thyroid, kidneys, liver. The creation of full-fledged organs is not yet in question, so researchers prefer the term "organoids" (that are not equivalent).

However, the new printing technology using stem cells and intercellular substance of the patient as "ink" for personalized hydrogel, has already allowed to create patches" for the heart, which match the immunological, cellular, biochemical and anatomical properties of the patient. And it took off from there: in Israel, a heart was modelled with a natural architecture (!), but in a mini version.

And if the transplantation of artificially created organs is still at least a decade away, organoids can already be successfully used for research, in particular – pharmacological.

INDIVIDUAL PHARMACOLOGY

3D-printing opens fundamentally new prospects for the pharmaceutical industry. The first drug created using such technologies and approved by the FDA was Spritam in 2015 - a combination of 3D printing with strictly planned treatments for epilepsy allowed to meet the needs of patients who previously had difficulties with taking medications.

Printing tablets is still too early to be considered as an alternative to mass manufacturing, but in the future, it is assumed that this technology will make it possible to move to personalized medicine. Probably, drugs with a well-defined amount of the necessary substances will be distributed right at the bedside; or, the patient, applying to an online pharmacy, will order the necessary "chemical ink, from which a printer capable of collecting chemicals at the molecular level, will create drugs.

Photo shutterstock.com



Restoring mobility

Orthopedics is one of areas in which 3D technologies are actively used. A leading expert in endoprosthetics will tell us what advantages they give and how know-how are created in Ukraine.



OLEKSANDR KOSIAKOV

Head of the Orthopedics Department of Kyiv Municipal Clinical Hospital No. 12, Honoured Doctor of Ukraine, Candidate of Medical Sciences, Head of the Kyiv Orthopedic Centre for Endoprosthetics, Surgery and Rehabilitation.

Orthopedics is a very wide field for the application of 3D technologies, and since 2016, based on foreign experience, we bave started to apply the latest solutions at our clinic. It turned out that in Kyiv there are quite a lot of experts who are engaged in three-dimensional printing, and now, while cooperating with them, we see a significant progress. In particular, we successfully use plastic models for different purposes and bave the opportunity to create metal structures for implantation.

PLASTIC MODELS: ACCURATE REPRESENTATION

Based on data from computer tomography and other research methods, we can create a virtual model of a knee, shoulder – any part of the body that is of interest to surgeons. Such models are widely used. When, as we first asked the nurse to bring that "white basin", she brought a plastic container in confusion... The joke about the "white basin" now sounds constantly, because the use of 3D models during surgeries and preparation for them has become a common thing.

COMPLEX CASES

The advantages of using such models are well illustrated by specific examples.

Protection of vessels.

A 3D model created based on CT data clearly shows visually where the veins and arteries pass and how they are located relative to the bone tissue. Its importance can be seen in the example of one patient. After rough childhood surgerv. vessels literally stuck to the bone, whereas normally they should have passed at a distance of several centimetres. If we were to intervene without a 3D model in front of us. the vein would very likely be damaged. However, we could clearly saw how to act in a difficult situation, and the surgery was performed with minimum blood loss, and now the young patient can dance!

Protecting nerves. A know-how of our clinic is a development that makes it possible to visualize nerves using MRI data. In certain cases, determining where the nerves pass is the most important thing. So, a patient who had a developed heterotopic ossification (overgrowth of bone tissue) after a severe injury, applied to the clinic. In order to restore the joint mobility, it was necessary to remove the huge ossified layers of tissue. This surgery had a complication - not being able to look inside the newly formed bone tissue, surgeons cut a nerve. There is an excuse for such a mistake: the scientific literature does not mention any cases of a nerve growing into bone tissue in that way. Neurosurgeons, who immediately came to the rescue and performed complex nerve plastic surgery, also confirmed that it was the first time they saw something like that. And despite some negative consequences, the patient returned again to have surgery on the second joint. He was convinced that his situation was really unpredictable and decided to appeal to those who are already familiar with the problem. A 3D model was also created for this case. Having become able to clearly see where the nerve passes, we performed the surgery together with neurosurgeons. They freed the nerve, while we removed the excess bone tissue and installed a prosthesis. The intervention was successful. And the MRI-based imaging technology was patented.

SURGERY WITHOUT SURGERY

In addition to the fact that modelling organs for a particular person allows for a much more accurate diagnosis, surgeons have the opportunity to practice before an important intervention. For this purpose, they order models with density of plastic matching the same of a bone, and those models can be drilled and sawed, working off necessary moves precisely. This allows to develop a plan for future surgeries and test it in a real model.



MINIMUM TRAUMA

Models become an auxiliary aid during real surgeries, since they can navigate clearly. It is impossible to see the full picture through a small surgical incision, and when you have a three-dimensional model in front of vour eves. vou can calculate the actions much more accurately than keeping the diagnostic data in your head. This is very useful when you need to remove fixators, overgrown with bone tissue, or synthesize a complex fracture. Targeted manipulations minimize tissue trauma, help to reduce blood loss, reduce the time in surgery.

THE CREATION OF SAFE FIXATORS

3D-printing is indispensable in the development of structures for connecting bones. The plate is designed in such a way that the hole in it is not located dangerously close to the vessel, and the length of the screws is exactly defined. To model such structures, we proposed the term SNAP -Screw Navigation Arhitectonic Plan (a plan that describes the best way and place to fix screws). This individual lavout provides not only reliable, but also secure fixation. Despite the fact that there are many vessels inside the pelvis, which can become a source of



fatal bleeding when damaged, we should have added Safety - "safe" to the name of SNAP.

DEVELOPMENT OF INDIVIDUAL PROSTHESES

Today, the peak of 3D printing capabilities in orthopedics is the creation of prostheses tailored to the needs of a particular patient. Usually, the need for individual artificial joints arises due to the consequences caused by prostheses that were installed a long time ago. If they become loose for some reason, defects of bone tissue develop, which can not be filled with standard hemispherical structures. None of available prostheses would fit, they turned out to be too small or to have the wrong shape. Until 2016, we had to turn patients with such problems away. Now, using a plastic model, we can develop an individual prosthesis, which will later be printed from titanium.

And perhaps this is not the limit of 3D printing. Autobioprinting – printing of tissues or organs grown from the patient's own stem cells, will open new prospects in all areas of surgery – probably, we will be able not only to restore the lost bone fragments, but also "grow", like a lizard's tail, the lost limbs.

To help doctors

Mykola BUT, an expert of 3D-Device, specializing in the supply of equipment and the implementation of specific 3D-printing projects will tell us about possible areas of cooperation with the medical community.

Today, 3D printing technologies - including in medicine - are rapidly developing. The opportunities that doctors and patients get through improving the 3D technology are really impressive - particularly when it comes to simplifying research methods and planning surgeries more carefully. In order to keep track of new solutions and new applications, experts in this area are constantly examine innovations of partner manufacturers, participate in summits and thematic exhibitions. And when it comes to the implementation of specific projects, of course, the initial request comes from the customer. But since the customer is not always aware of all the possibilities of 3D printing, our task is to submit proposals on improvements for the project from a technology point of view.

NO UNNECESSARY SURGERIES

One of the examples of our cooperation with doctors is a project that began at the request of a doctor who specialized in pelvic injuries. He suggested the idea heard from Western experts: Based on the patient's MRI data, we made an accurate 3D model of the skeleton and damaged bones. A plastic model of the damaged skeleton fragment was printed, then the surgeons used it to plan surgery and immediately developed a mock-up for an implant on the model. Then we restored the original position of the bones in a 3D model. Despite the fact that our experts are primarily engineers, the whole process was carefully supervised by a doctor. At this stage, the doctor could see the exact location of all the fragments, the picture that the surgeon usually sees during surgery. After virtual restoration of the bone position. we modelled an individual implant according to the doctor's description. After the implant mock-up was printed out of plastic, it was also "tried on" the bone mock-up. And then the model of the implant was printed of titanium. It was a ready-to-install piece. Thus, doctors were ready for implantation without two previous planned surgeries (for measurements and for fitting). In total, more than 10 such surgeries have already been performed.

REPRESENTATION OF PROBABLE SITUATIONS

There is another interesting project that concerns endovascular surgery – this idea is very popular in Western medicine. The idea is to create models with vascular aneurysms for testing and planning surgeries to remove them. More than 30 sample vessels with vascular aneurysms have already been produced. It is planned to produce a special multi-purpose stand for testing various fragments of vessels made of a transparent material similar to silicone.

A retrospective journey into the history of how personal protective equipment evolved



Working with sophisticated equipment and corrosive chemicals may not be safe enough, so employees of the pharmaceutical manufacturing sites cannot work without personal protective equipment. WHEN AND HOW THEY CAME INTO USE AND WHAT MEANS OF PROTECTION ARE CURRENTLY BEING USED.

HISTORICAL PERSPECTIVE

Face masks for mouth and nose, earplugs, gloves - they all went a long way, just like the occupational safety system itself, before being implemented. The first step was taken more than a century ago, in 1906, when the Permanent Commission on Occupational Health has been established, that remains operational today as the International Commission on Occupational Health. Almost 300 physicians and other healthcare professionals from around the world attended the conference in Milan, where they founded the association to share their experience and knowledge and gradually improve working conditions at the manufacturing sites. A total of 27 Congresses took place during the last century, and the 28th Congress was held in 2006, which adopted the Centennial Declaration. It calls for increased legislative control on occupational safety and unconditional respect for the health of people involved in manufacturing.

UNDER THE PROTECTION OF THE "BEAK"

The first means of respiratory protection were invented by medieval doctors who treated

patients during plague epidemics. When going to the patient, the doctor put on a face mask to prevent the transmission of the infection. Herbs with strong aromas were enclosed in a long, curved bird-like beak, which "neutralized" the smell of rotting bodies. Leonardo da Vinci is considered to be the developer of the first respirator; he suggested that sailors should protect themselves from smoke and dust, covering their

An addition to the image of the "plague doctor" is a waxed cloak. Now, instead of cloaks, doctors wear medical coats, while workers involved in manufacturing use overalls, semi-overalls or dressing gowns made of special fabrics designed to protect against the adverse environmental effects.

mouth and nose with a damp cloth. Since then, means of respiratory protection have experienced many transformations and gradually their appearance and functionality became closer to modern standards. Today, workers involved in manufacturing, including pharmaceutical, most commonly use respirators to Inventing of glasses for builders and welders started. Later glasses became a usual work wardrobe attribute of workers who represent various industries.

protect the respiratory system from harmful vapours and gases, which prevent the entry of hazardous substances into the nose and mouth. Particles of adverse gases and vapours do not pass specific catalysts and sorbents contained in the filters. With the catalysts used, the concentration of harmful gases is reduced to a safe level, and sorbents, having a porous structure. detain molecules that can cause harm to the body. Respirators with appropriate filters are selected for various external conditions.

GLOVES TRANSFORMATION

Though farmers and shepherds protected their hands from prickly grass long before the industrial era, in medicine, this tool was first used during those medieval epidemics of plague, when doctors did not dare to go to the ill people without leather gloves on. While in their modern form, they began to be used much later, at the end of the 19th century: in 1890, surgeon William Halsted used thin rubber gloves to protect the skin from mercury chloride and carbolic acid, caustic substances, used for disinfection. Gradually, the new tool began to gain popularity among medical workers. Subsequently, in 1964, Ansell developed the first ever disposable medical gloves made of artificial latex. Nowadays, not only doctors but also workers at the pharmaceutical enterprises take care of their hands, who use gloves made of rubber or elastic polymers as well as rubberized armbands, and in Class I rooms, only sterilized powderless gloves made of rubber, to protect their skin from harmful substances.

WHAT ABOUT THE EYES?

At the beginning of the industrial era, workers' eyes were protected by bandages made of dense translucent fabric. This facilitated exposure to bright light, although did not protect against mechanical injury. Towards the end of the 21st century, the situation improved somewhat due to train travels. Soot flew through the open windows into the eves of the passengers in then trains. To take care of customers' health, the railroad company developed the first safety goggles. Later on, in the early 20th century, protective glass was used in the production of gas masks, namely lenses were made of them. Since 1940, the development of glasses for builders and welders started, and gradually they became a familiar attribute of the working wardrobe for officers in various industries. In the 21st century, safety glasses can prevent damage as a result of blows, contact of the eve's mucous membrane with harmful vapours or splashes of chemicals, as well as the adverse effects of light. They are made mainly of polycarbonate

NOISE "SHUT-OFF"

The prototype of the wellknown means for isolation from unnecessary sounds was first mentioned in Homer's Odyssey. The protagonist put wax plugs in their ears to his rowers so that they would not hear the seductive sirens singing. At the beginning of the industrial and unusually loud 20th century, German scientists remembered the ancient invention and undertook to develop a new version of the means for sound insulation. They supplemented Odyssey's wax with cotton cloth soaked in vaseline, and this is how the first "modern" earplugs appeared. Gradually, people learned how to produce noise protection from clay, silicone and foam. Now they are presented in a wide range, from different materials, and for any taste. They are used by both "noisy" workers and anyone who wants to keep his ears free from unnecessary decibels.

Central Asia — New Challenges

UZBEKISTAN IS THE LEADER IN IMPORTING PRODUCTS OF JSC "FARMAK".

Pharmaceutical manufacturers face new challenges due to the current changes in the country. Which way will Farmak choose and why is this country so appealing? Learn more from Oleksii IVANCHENKO, Project Manager.

LONG-TERM COOPERATION

The significant success in the pharmaceutical market of Uzbekistan is achieved due to several factors. The representative office of Farmak has been operating here very successfully for 15 years. The well-coordinated teamwork of 90 employees involved in the promotion, logistics, registration of medicinal products and other activities gives a significant result our sales are over \$ 20 million per year, which is the largest Company's export share. In addition, Farmak ranks as the fourth best pharmaceutical company operating in Uzbekistan, which is evidence of the consumer confidence in the products. However, this is an intermediate step for the Company, and our aim is the confident leadership in this country. And today there are all prerequisites.





OLEKSII

IVANCHENKO

Project

Manager

FUNDAMENTAL CHANGES

The pharmaceutical market of Uzbekistan began to emerge 20 years ago. It started with the creation of representative offices of pharmacy chains, then their own manufacturing sites were created, and foreign companies came. However, quality and safe medicinal products and medical devices were still dramatically lacking. The situation with socially significant drugs, such as cardiovascular, endocrinological, and vaccination products, was particularly challenging. Then the government realized that they should act because the needs were constantly growing as the population increased from 20 million in the 1990s to 33.5 million now. Growth rates are rising, with an increase at 600,000 citizens over the first half-year of 2019. Therefore, a new pharmaceutical strategy





With colleagues in Uzbekistan

was developed in Uzbekistan: by 2025, to provide the population and health care facilities with domestic medicinal products and medical devices at 60% of the country's pharmaceutical market. Today, this figure is only 20 %.

The strategy includes: the creation of the pharmaceutical tech park, branches of foreign universities for training of industry specialists, organization of research works and activities for mandatory certification of domestic pharmaceutical manufacturers in accordance with the requirements of the Good Manufacturing Practice, cooperation with international structures for mutual recognition of GMP certificates, conducting preclinical trials, etc. It also involves raising foreign investments in the development of pharmaceutical manufacturing and creating certain preferences for them, including allocation of 7-8 areas for the construction of pharmaceutical facilities, tax benefits for investors (reduction of customs duties on imported equipment, raw materials, reduction of manufacturing taxes). All these activities will help improve the economic climate and become a good basis for the emergence of new companies.

WAYS TO STRENGTHEN COOPERATION

At the same time, the level of competition boosts, the risk of

losing certain positions in the market increases. Therefore, Farmak is actively working on a new strategy of cooperation and has a robust base for this, which is evidenced by high confidence in Farmak products, recognition of the Company in the list of leaders among other major world manufacturers, as indicated in the official government program. The promising options include the creation of in-house (localization) or contract manufacturing,

In-bouse manufacturing. The localization project is based on 4 "pillars", such as engineering stage (construction); recruitment, training; creation of pharmaceutical quality system; registration of medicinal products. In general, the project implementation can take 3 to 4 years.

Contract manufacturing. It involves the cooperation with local manufacturers who will manufacture products for the Company, according to Farmak's standards, all technologies, with strict compliance with the GMP requirements. And this is very important, because Farmak means quality!

The Company is still deciding on what direction we should choose to move on, however, we are ready to work on a fairly global scale. The enterprises available in the country do not meet the GMP requirements in all parameters, therefore, Farmak is ready to share its extensive experience and knowledge in implementing appropriate manufacturing conditions. arranging research work, conducting clinical, preclinical trials, and launching innovative processes. This is our social mission in the development of the pharmaceutical industry in the country. In addition, by strengthening our position here, we will also increase our presence in the Central Asian export markets. Due to the logistics component, neighbouring markets can also be of interest, such as Kazakhstan, Tajikistan, Kyrgyzstan, Pakistan, Afghanistan, etc. If Uzbekistan becomes a member of the EAEU, the list would include markets of the EAEU Member States.



Production equipment

INSULIN: with care for patients



Insulins manufacturing site

IN UKRAINE, OVER ONE MILLION PATIENTS HAVE DIABETES. UNFORTUNATELY, THIS NUMBER IS INCREASING EVERY YEAR. Farmak not only provides patients with quality and safe medicinal products, but also actively works on the creation of new and more effective forms of these medicinal products.



OLEKSII KOLOMOIETS

Marketing Consultant, Hospital Medicines Marketing Department

OUR EXPERIENCE

The first insulins in the Company's product portfolio appeared 18 years ago. In 2001, an agreement was signed between Farmak and the US insulin manufacturer. Initially, these were medicinal products in bulk in vials and cartridges. But due to technology transfer, creation of new lines, since 2005 Farmak started independent manufacture of bottle forms, and in 2012 – cartridges.

PRODUCTS

Farmak manufactures genetically engineered insulins – Farmasulin, Farmasulin H NP and Farmasulin H 30/70. In January 2017, the Company registered the long-acting equivalent insulin ILAR, which is a co-project between Farmak and Biocon. It is a new-generation, long-acting medicinal product, so sometimes a single dose is enough for patients.

WITH THOUGHT OF PATIENTS

The availability of Company medicinal products is one of the important aspects of work. For 2 years now the company has been actively participating in the program of the Ministry of Health of Ukraine "Affordable Medicines". All forms of Farmak insulin are available for insulin-dependent patients with diabetes. With an online prescription of an endocrinologist, they can get it at the pharmacy for free or at a small cost (depending on the medication form).

QUALITY IS A REASON

Ukrainian and foreign manufacturers, as well as distribution companies, are present in the insulin market. The desire to hold a leading position creates a competitive environment: patients have the opportunity to choose quality medicinal products, and companies have the incentive to work in accordance with the highest requirements of the pharmacological market. After all, the leader wins.

Today, Farmak indicators are quite good: it holds the leading position among Farmasulin patients and occupies over 30% of the market. Work with endocrinologists is also out of the question. Through active participation in scientific and specialized conferences, we strive to provide the medical community with information about the effectiveness of medicinal products.



Insulins manufacturing site





THE MISSION: to Learn and Help

DIABETES MELLITUS IS A REAL EPIDEMIC OF THESE DAYS.

Its prevention and treatment are always a prime focus to the medical community, as well as pharmaceutical companies, which commit not only to create quality medicinal products to combat the disease, but also to improve the qualification of doctors and patient awareness. OLGA GALILEYSKA

Marketing Consultant of Hospital Drugs Marketing Department

HCP-ORIENTED INFORMATION

Farmak has been working for many years in the diabetes control field, promptly and effectively responding to changes in the healthcare environment and offering its vision of helping patients and physicians. With the implementation of the healthcare system reform, family physicians became the first advisers for patients, in particular, in endocrinological issues. They consult, prescribe hypoglycemic medicinal products, keep a register of patients with type 2 diabetes, etc. Such innovations encourage family physicians to acquire additional knowledge in endocrinology, actively participate in targeted training and conferences. The Company's specialists can boast a really huge experience in conducting such events. Lectures, workshops are held for visiting physicians, which involve endocrinologists who share their practical experience. First of all, this is done in those regions of our country, where the number of endocrinologists is not sufficient. Last vear, 150 events were held, which allowed improving the qualification of about 3.000 family physicians.

PATIENT-ORIENTED INFORMATION

Diabetes mellitus is a rather insidious disease. because early on it is almost always asymptomatic, and most patients become aware that they are diabetic only when they develop complications. And the figures are really alarming as diabetes is diagnosed in only a third of the actual number of patients. To confront the situation, some actual steps are needed, and Farmak takes them. Diabetes schools are organized in healthcare facilities, where patients can learn important information about the disease, get advice and support. In addition, mobile teams work in areas where the endocrinological medical service is underrepresented. People have the opportunity to take a blood sugar test and, if necessary, to consult an endocrinologist. Several hundred Ukrainians undergo this diagnostic procedure every year.





Generic products in Ukraine and in the world

Importing or manufacturing company's own interchangeable drugs is a major way of providing medicinal products to underprivileged patients in all countries of the world. BY RAISING QUALITY STANDARDS AND IMPROVING LEGISLATION, UKRAINE COULD TAKE ITS DESCENT PLACE IN THE INTERNATIONAL GENERICS MARKET.

In the laboratory of JSC «Farmak»

he growth rate of generics sales in the developed countries is twice as high as that of the original medicinal products. The key factors contributing to the growth of the generics market are the high cost of original medicinal products, the loss of their marketing exclusivity, and the reduction of healthcare costs by governments of different countries.

N O O Y E A R

According to IMS Health, an American company that provides information support, service and technology to the healthcare industry generic drugs will account for 48 % of global costs and original medicinal products 52 %.

AFFORDABILITY POLICY

I

To reduce the cost of providing medical supplies to low-income groups of population, the United States, France, Spain and other countries are encouraging the manufacture of interchangeable drugs and their promotion has become a part of the official policy. The generic products are purchased for the population, the army, governmental and charity programs. The countries with a budget deficit for health care are recommended to develop the pharmaceutical policy focusing on the use of generic products. According to WHO, the regulation of the generics market is relevant for all countries of the world without exception.

NATIONAL FEATURES

As seen in previous years, the generics sales were as follows: 25 % in the USA, 35 % in Germany, 55 % in Hungary, 61 % in Poland, 55 % in the UK, 66 % in Slovakia, 78 % in Russia, and over 80 % in Ukraine.

In Ukraine, where none of the pharmaceutical companies can afford to make huge (especially by domestic standards) investments in research and development of brand new medicinal products, it is quite evident that the most realistic and at the same time effective strategy is the widespread use of generics.

IN A HIGHLY COMPETITIVE ENVIRONMENT

The generics market is one of the most competitive in Europe, so domestic manufacturers of generic products face considerable challenges. The generic manufacturer that enters the market first has the greatest advantage. However, there are some issues in the Ukrainian legislation that make it difficult to qualify for the championship. For example, in Ukraine, the right holder can extend the validity of a patent for a medicinal product for another five years after the expiry of the initial term, and declare it shortly before the expiry of 20 years of the patent validity. In this context, a generic manufacturer that has already invested in development and preparation for the

market launch should postpone the market launch over the period of the patent extension. In Europe, to the contrary, the right holder must declare the intention to extend the patent during the first six months of its validity. Therefore, Western companies benefit by being able to more accurately plan the R&D and preparation for market launch.

NEW OPPORTUNITIES

However, Ukraine has a chance of a breakthrough. In the world pharmacy, the so-called "patent cliff" is observed, i.e. the period of mass expiration of patents for original medicinal products of well-known brands, the socalled "blockbuster drugs", with sales hitting more than \$1 billion. This fact opens up new opportunities for the manufacture of generic products, which are copies of the drugs based on the same molecules. Generics are the main products of the Ukrainian pharmaceutical industry. Today Ukraine will have prospects to become a full player in the international pharmaceutical market. An important advantage is that Ukrainian medicinal products are 4 to 16 times cheaper than foreign equivalents.

A SAD FACT:

in Ukraine, every day more than 1,000 patients die from a lack of the necessary medicinal products, because they did not receive them in time. Almost 80% of urban residents and 82% of rural residents cannot buy medicinal products because of their high cost. One third of families with a severely ill patient find themselves below poverty line because of the high cost of treatment. This fact is a very convincing argument in favour of increasing the manufacturing of generics in Ukraine for being effective and at the same time more affordable drugs.

Lasers in medicine

Last year, American Arthur Ashkin, along with two other scientists, Frenchman Gérard Mourou and Canadian Donna Strickland, won the Nobel Prize for their inventions that revolutionized laser physics. FOR 96-YEAR-OLD ASHKIN, THE AWARD WAS A RECOGNITION OF THE LONG-LASTING INNOVATIVE WORK HE DEVOTED HIS ENTIRE LIFE TO.



shkin is considered as the "father" of optical tweezers, or "optical trapping", which allowed him to hold and manipulate small objects – such as living cells, DNA molecules, bacteria and viruses – and even atoms. In his most famous laser beam experiment, Ashkin, along with his colleague Steven Chu and other collaborators, learned how to cool and hold individual atoms. For this method, Chu received the 1997 Nobel Prize, while Arthur Ashkin was overlooked by the Nobel Committee, although without Ashkin's invention, Chu's experiment would hardly have been carried out. However, better late than never, and 21 years later justice was served – a phone call from the Nobel Committee came to Ashkin's house.

THE WAY TO SCIENCE

Arthur Ashkin was born in 1922 to a family of a Jewish immigrant from Odessa, Isadore Ashkinazi, and his wife. Anna. a native of Eastern Galicia, and grew up in New York, Brooklvn. The family made every effort to ensure that the children had a good education: Arthur's older brother became a nuclear physicist and participated in the Manhattan Project (Nuclear Weapons Development Program). Ashkin Jr. also studied nuclear physics but eventually decided to change his field of activity. For by staying at Cornell University with his brother, he would condemn himself to permanent existence in his shadow.

THE EFFECT OF LIGHT

Meanwhile, Ashkin Jr.'s research advisor, Sid Millman, went to Bell Labs, the largest research centre in those days, when in 1958 a maser, a quantum generator of light, a prototype laser, was invented. Since 1952, Ashkin had been researching microwave radiation, but in 1961 he turned his attention to the study of lasers and nonlinear properties of optical fibres.

However, Ashkin's greatest achievements were in the field of radiation pressure

"I was called Ashkin's brother."



research – he suggested that light and other forms of radiation can affect material objects. In Holmdel, one of the Bell Labs divisions where he worked in 1967, Arthur found that using a laser beam, one could push ultra-small (micron-sized) latex spheres through the water. He also found out that the spheres moved from the edges of the beam to the centre, allowing them to be grabbed and held. Pointing a second ray to the spheres, Ashkin was able to fix them with two optical beams, having invented the first optical trapping, or as it is called, optical tweezers. The publication of this invention appeared in 1970.

MICROBE HUNTER

After that, Arthur Ashkin focused on using optical tweezers to hold, "hunt," and study living organisms – various bacte"Some of my colleagues were shocked to learn that I was able to hold living organisms with light. I remember someone called out to the whole lab: "Look, look, Ashkin is catching germs!" ria and viruses. His invention was also useful for the study of human cells. Using optical tweezers, the cytoplasm of cells and organelles could be manipulated by intracellular surgery.

IN SERVICE WITH DOCTORS

Ashkin's invention led to a real revolution in microtechnology. Today, this tool makes it possible to study the structure of proteins. the movement of molecular motors responsible for intracellular transport, to study DNA. Other researchers used optical tweezers to measure the mechanical properties of intracellular components, investigate how infectious disease agents attack healthy body cells, identify new types of bacteria and viruses. Ashkin's technology is also widely used during artificial insemination, revealing possible genetic diseases of the future embryo. Optical tweezers are also used in ophthalmology: ultrathin laser beams make very thin cuts or drill tiny holes in a variety of materials, including living tissue. With this method, millions of laser surgeries are performed annually.

HOW TO GRAB AN ATOM

Ashkin's dream was to use optical tweezers to grab atoms, but he faced difficulties: because in order to hold atoms stationary for some time, they had to be cooled in some way to temperatures of several hundred or tens of microkelvins. In 1975, Theodore Gansch and Arthur

OPTICAL TWEEZERS ARE USED IN OPHTHALMOLOGY: ULTRA SLIM LASER BUNCHES HELP MAKE VERY THIN CUTS.

Shavlov proposed to cool atoms using the famous Doppler effect, which is used for police radars, to track storms, and to determine distances to distant objects in the universe. John Hall and his colleagues at the University of Colorado developed important methods for implementing this idea and developed a cooling technique called the "optical treacle".

With these new methods, Arthur Ashkin and his young colleague Steven Chu began an experiment in 1984 to cool and grab a group of atoms using optical tweezers trapping. As a result, the device looked like this: cooling occurred in a vacuum chamber, in the area where six laser cooling beams intersected (two along each axis obtained by three lasers and three mirrors). Due to the force of gravity, the cooled atoms rapidly, within one second, fell out of the cooling area. A quadrupole magnetic field was created to compensate for the gravity of the device using two solenoids. The magnets were placed coaxially before and after the treacle area, in a configuration similar to Helmholtz coils. In contrast to the Helmholtz scheme, the current in the coils flew in opposite directions. The researchers were able to hold a group of 500 sodium atoms cooled to 300 microkelvins within seconds.

Steven Chu continued to use cooled atoms to create the "atomic fountain", which

"Steve was a very practical man, a great experimenter. He conducted some absolutely brilliant experiments. I always thought then that one day he would receive the Nobel Prize. I am extremely happy for him." was used to significantly improve the accuracy of atomic clocks and to experimentally measure the acceleration under gravity. Subsequently, he won the Nobel Prize for his work with Claude Cohen-Tannoudji and William Phillips. At that time, Ashkin was not noted among the laureates.

NEW TURN: POTENTIAL IN ENERGY

In 1992, Ashkin completed his 40-year career at Bell Labs and retired, but enjoying the calm and inactivity was not for him, and he continued to do research in his home lab. Ashkin patented 47 inventions, received the **IEEE Ouantum Electronics** Award (1987), the Towns Award (1988), the Rank Award (1993), the Frederick Ives Medal (1998), and the Harvey Award (2004). Ashkin won the Nobel Prize as an opportunity to attract the attention of scientists to the technology he invented, which could significantly reduce the electricity cost. He told reporters that he had designed reflectors that increased the concentration of light and repeatedly increased the power of solar panels. Ashkin is convinced that his invention will save the world and hopes to win another Nobel Prize in his lifetime. However, his wife is somewhat sceptical: she says, one is enough. Arthur and Aline Ashkin have been happily married for over 60 vears, having three children and five grandchildren.

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