5. *Слободяник С.Н.* Методологические подходы к формированию информационной базы для оценки процессов энергосбережения в российской экономике. – М.: Федеральное государственное учреждение науки,ИНХП РАУ 2017. – 15с

***И.А. Шатрова, В.А. Белых***

***Активные дома, вырабатывающие энергию***

*В данной статье изложены проблемы энергопотребления и их решения с помощью технологий, применяемых при строительстве активных домов с положительным энергобалансом. Раскрывается концепция зданий, что сочетаются с природой, которая свидетельствует о том, что дома, находясь в балансе с окружающим миром, должны быть максимально экологичными и экономичными. Приведены альтернативные источники энергии, наиболее эффективны при строительстве таких домов.*

***Ключевые слова: органическая архитектура, нулевые выбросы загрязняющих атмосферу веществ, нулевые объемы отходов, нулевое потребление энергии с городской энергосисемы***.

***I.A. Shatrova, V.A. Belykh***

***Active homes that generate energy***

*This article outlines the problems of energy consumption and their solutions using technologies used in the construction of active houses with a positive energy balance. It reveals the concept of buildings that are combined with nature, which suggests that at home, being in balance with the outside world, should be as environmentally friendly and economical. The alternative energy sources are given, the most effective in the construction of such houses.*

***Keywords: organic architecture, zero emissions of pollutants, zero waste, zero energy consumption from urban energy systems.***

**UDC 69.03**

**Robert Zeltser**
PhD, Associate Professor
ORCID: 0000-0003-4433-6625
**Maksim Kolot**
postgraduate
**Ivan Panasyuk**
postgraduate
Kyiv National University of Construction and Architecture

## IMPROVEMENT OF ORGANIZATIONAL AND TECHNOLOGICAL DECISIONS OF BUILDING PRODUCTION AND REMOTE CONTROL OF CONSTRUCTION PROJECTS USING UAV

*The article highlights the issues of improving organizational and technological solutions for the construction industry, presents data on the experience of using unmanned aerial vehicles and special software for organizing remote monitoring of construction projects in Ukraine.*

*The experience of using UAVs in addressing such issues as the management's lack of relevant information on state of affairs at construction site, late identification of actual deviations from the project documentation, uncontrolled influence of human factor in the*

*process of checking the volume and quality of work performed by contractors, and insufficient communication between project participants.*

*It was concluded that drones are an effective tool that has a wide scope of application at the stages of survey and design works, zero-cycle works, construction of the above-ground part of buildings and further control of the technical condition of buildings during operation.*

***Keywords: drones, cloud technologies in construction, 3d model, orthophotoplan, remote control, construction organization, monitoring, construction project management.***

## 1. INTRODUCTION

The construction industry has reached a turning point. Firms are recognizing the need to enable better communication and access to project information for their entire team. However, many are off to a hard start in this transition and the opportunity remains for firms to optimize how to invest in and approach technology deployment.

Industry leaders need to better strategize the rollout of digital tehnologies that are proven to support the workflow needs of their teams in the field. With strategic deployment, companies increase the chance of achieving the high levels of technology adoption needed in the field and office. Objectively implementing and evaluating a pilot program will allow teams to make the right choices for technology rollout.

Today, Ukrainian construction companies are expanding the geography of their presence and implement projects throughout Ukraine and abroad. In this regard, management must cope with the problem of organizing integrated remote monitoring and management of construction works.

## 2. DRONES AS AN EFFECTIVE TOOL FOR MONITORING AND CONTROLLING CONSTRUCTION

The rise of mobile devices, cloud computing, and big data has opened up a new frontier for construction. And today the digitization of the job site is well underway. There are three main clusters where digitalization is happening: onsite execution, back office integration, and digital collaboration. But the transformation won't happen without its challenges. For larger companies, identifying and implementing new technology can't be done overnight. It takes time to make technology purchases, train workers, and integrate new field solutions with the back office.

If construction productivity—lead by technology adoption—can match the total economy, the sector could be looking at $1.6 Trillion in added value worldwide. So there's a good case for companies to make the investment.

One of the most promising technologies for increasing efficiency of the construction site is drones. With the costs of drone hardware bottoming in the last few years, and the advent of easy-to-implement software, many companies see ROI once UAV completes its first flight.

When organizing the management of the construction, it is important to ensure prompt and complete exchange of information between construction site and office. Traditional methods of photo and video recording, as well as written reports do not create a comprehensive description of the state of the construction site, and the influence of the human factor entails a lack of communication and distortion of information. Moreover, most often there is a discrepancy between the work schedule and actual situation on the construction site, which is caused by the lack of a digital tool for companies to integrate.

The consequence of the aforementioned negative factors is the management's lack of objective information on the state of the construction site. The situation is aggravated if the site is significantly remote and there is no possibility for its regular visits for

inspections. The result is the inability to identify risks and problems in time and make decisions necessary to avoid or solve them.

At the same time, management, which is located on the construction site (construction manager, site manager, foremen), is often unable to comprehensively assess the progress of the project, since it does not have a digital tool for quickly and accurately monitoring the progress of work, measuring lengths, areas and volumes of work performed, identify errors in the production of works at an early stage.

All of the above, as a result, leads to the lack of timely adoption of the necessary measures and, as a consequence, failure to meet deadlines and project budget overrun.

Drones in the complex with special software allow you to solve these problems. Drones are an on-line and accurate digital tool for remote monitoring of construction.

With the help of a drone an orthophotomap and a 3D model (Fig. 1) of a construction site are created. These results are created in the cloud software within a few hours (depending on the size of the site) and are the basis for detailed analysis, a valuable source of information and communication between project participants and stakeholders.

Figure 1. Construction site 3D model

Unlike conventional photographs, an orthophotomap provides a solid image of the construction site in high resolution, which eliminates the risk of losing sight of any part of the site during the analysis. The orthophotomap is created in conjunction with GPS coordinates in real world scale, which makes it possible to carry out high-precision measurements.

The ability to quickly measure large volumes of work allows for enhanced control of contractors, especially at the stage of the capital-intensive stage of earthworks.

It is important that access to the obtained results can be obtained from anywhere in the world through a web interface, which makes it possible to carry out remote monitoring and control of construction projects in almost real time.

Thus, with the help of drones, a real picture of what is happening on the construction site is created, and a detailed analysis of various parameters is carried out:

– tracking work schedule – Contractor's "monitoring wall" is presented below (Fig. 2), which clearly displays that digital technologies can be used both paperless and in traditional for construction manner;

– overlapping of project documentation on the orthophotomap and the identification of errors in the work at an early stage;

– measuring the volume of work performed using digital surface mode (DSM) (Fig. 3) and 3D model.

Figure 2. Contractor's "monitoring wall" for one of the projects located at a distance

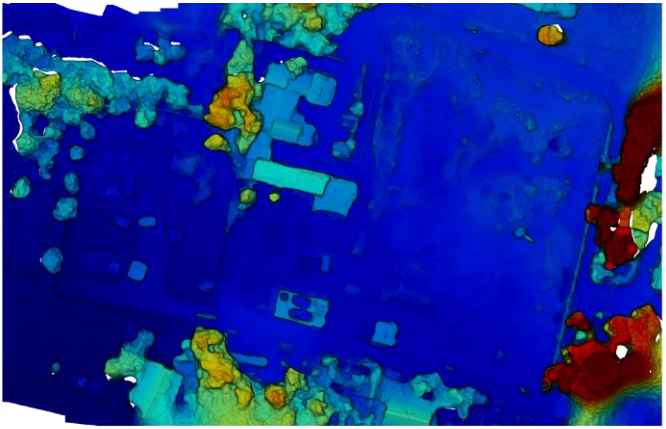

Figure 3. Digital surface model of the construction site

**3. EXPERIENCE OF ORGANIZATION OF THE REMOTE CONTROL OF CONSTRUCTION PROJECT WITH USE OF DRONES**

Currently, the Ukrainian company “Drone Supervison” is using the technology of monitoring construction projects using drones and cloud technologies in the project “Construction of the Vinnitsa Regional Clinical Medical and Diagnostic Center for Cardiovascular Pathology”.

The main office of the general contractor is located in Kiev, which makes the issue of remote monitoring particularly relevant, as key managers of the company are not able to regularly attend the construction site for inspections.

On a weekly basis, a qualified pilot collects data from using drone. The orthophotomap and 3D model are delivered to the main office of the general contractor within one hour. Next, the Drone Supervision employee analyzes the orthophotomap and the 3D model, after which he enters up-to-date data into the work schedule and identifies lags. Next stage of the analysis is comparison of actually performed works and project documentation by means of overlay. This method allows you to identify errors in the work at an early stage and save budget for their subsequent correction.

The necessary measurements are also performed, for example, the length of the installed pipeline, the volumes of earth mounds and pits, the area of the constructed temporary road, and others.

This tool has helped the general contractor to organize full remote monitoring of the implementation of construction work at a remote construction site, to switch to digital methods for organizing workflow. With this relevant and comprehensive information, the general contractor performs the following actions:

- promptly identifies deviations from the work schedule;
- determines the necessary scope of work for the next week;
- make informed decisions based on facts;
- heavily oversees subcontractors;
- captures the current state of the site and creates an archive of data that can be used for further resolving disputes;
- saves budget on the correction of errors in the work due to early detection before influencing the next stages of construction.

The result is a reduction in costs and construction time.

Figure 4. 06.06.2018

Figure 5. 17.10.2018

Figure 6. 23.10.2018

Figure 7. 11.12.2018

**4. FUTURE OF DRONES IN CONSTRUCTION IN UKRAINE**

One of the possible applications of drones in construction in Ukraine is their use by supervisory agencies (STATE ARCHITECTURAL AND BUILDING INSPECTION OF UKRAINE) to monitor the progress of construction projects, monitor the boundaries of land plots that are used for construction, as well as control measures for compliance with safety techniques. Government agencies of CIS countries are already using this technology in construction. Also, the Resolution of the Cabinet of Ministers of Ukraine №461 "The issue of putting into operation of completed construction projects" as amended at June 7, 2017 provides photo and video fixation for the preparation of a technical passport and certificate of the technical condition of the object. This work can be done with the help of a drone, with higher clarity and accuracy, since there are many places in the structures of buildings and structures that are physically difficult for a person to get with a camera, for example: enclosing structures and coatings.

The construction industry has significant potential for productivity growth, one of the sources of which is digital technology. Drones are a digital tool whose goal is to improve the efficiency of construction companies. Even today, the leaders of the construction industry in Ukraine are using drones to automate the processes of control and reporting in construction and their use will constantly increase. The development of technology will allow to deliver data in real time and apply new algorithms for their instant processing, including artificial intelligence and machine learning. In the near future, flights will be performed automatically, without the participation of the operator.

However, integration of new technologies is slow in construction industry due to the conservatism, long-established paper work methods and the unavailability of companies to experiment. Therefore, full implementation of drones requires requires attention from the state authorities of the construction industry, a large number of examples of the successful use of drones on construction projects in Ukraine and the relevant regulatory framework.

This will allow construction companies of Ukraine to make their activities more efficient and reach new levels of development, increasing their internal and global competitiveness.

**References:**

1. McKinsey&Company, Improving construction productivity, 2017
2. Busta, H. (2017, July 05). Balfour Beatty: Construction sites will be human-free by 2050. Accessed March 1, 2019. http://www.constructiondive.com/news/balfour-beattyconstruction-sites-will-be-human-free-by-2050/446352/

3. Зельцер Р.Я. Практика застосування дронів при реалізації будівельних проектів в Україні/Колот М.А., Панасюк І.О.// Шляхи підвищення ефективності Будівництва в умовах формування ринкових відносин: зб. наук. праць. – К.: КНУБА, 2018. – Вип.35. – С. 151-154.

4. Zeltser R. Organization of remote monitoring and control of construction works using drones and cloud technologies/M. Kolot, I. Panasyuk, V. Orishchenko// International scientific-practical conference of young scientists "Build-master-class-2018", 28.11-30.11.2018. – Kyiv: KNUCA, 2018. – P. 346-347.

5. DroneDeploy, The Evolution of Construction Technology, available at https://blog.dronedeploy.com/the-evolution-of-construction-technology-bdf3c120ed71

6. 5 Industries That Are Actually Ripe for Disruption. Accessed March 1, 2019. www.fortune.com/2016/05/13/5-industriesready-for-disruption.

7. McKinsey&Company, McKinsey Global Institute. Reinventing Construction: A Route to Higher Productivity, 2017

8. Andreas Renz, Manuel Zafra Solas. Shaping the Future of Construction. A Breakthrough in Mindset and Technology. Davos, World Economic Forum, 2016.

9. Chris Corody. Five Valuable Business Lessons Learned About Drones in Construction. Skylogic Research, 2016.

10. Colin Snow. The Truth about Drones in Construction and Infrastructure Inspection. Skylogic Research, 2016.

11. The Rise of Drones in Construction, available at: https://blog.dronedeploy.com/the-rise-of-drones-in-construction-5357b69942fa (Accessed 15 august 2018).

***Р.Я. Зельцер, М.А. Колот, І.О. Панасюк***

***Удосконалення організаційно-технологічних рішень будівельного виробництва та дистанційний контроль будівельних проектів з використанням БПЛА***

*У статті висвітлені питання вдосконалення організаційно-технологічних рішень будівельного виробництва, представлені дані про досвід використання безпілотних літальних апаратів і спеціального програмного забезпечення для організації дистанційного контролю будівельних проектів в Україні.*

*Викладено досвід використання БПЛА при вирішенні таких питань як відсутність у керівництва актуальної інформації про стан справ на будівельному майданчику, пізнє виявлення фактичного відхилення ходу виконаних робіт від проектної документації, неконтрольований вплив людського фактора в процесі перевірки обсягів і якості робіт, виконаних підрядними організаціями, а також недостатня комунікація між учасниками проекту.*

*Зроблено висновок про те, що дрони є ефективним інструментом, який має широку сферу застосування на етапах вишукувальних та проектних робіт, робіт нульового циклу, зведення надземної частини будівель і подальшого контролю технічного стану будівель в процесі експлуатації.*

***Ключові слова: дрони, хмарні технології в будівництві, 3D-модель, ортофотоплан, дистанційний контроль, організація будівництва, моніторинг, управління будівельним проектом.***

***Р.Я. Зельцер, М.А. Колот, И.О. Панасюк***

***Совершенствование организационно-технологических решений строительного производства и дистанционный контроль строительных проектов с использованием БПЛА***

*В статье освещены вопросы совершенствования организационно-технологических решений строительного производства, представлены данные об опыте использования беспилотных летательных аппаратов и специального программного обеспечения для организации дистанционного контроля строительных проектов в Украине.*

*Изложен опыт использования БПЛА при решении таких вопросов как отсутствие у руководства актуальной информации о положении дел на строительной площадке, позднее выявление фактического отклонения хода выполненных работ от проектной документации, неконтролируемое влияние человеческого фактора в процессе проверки объемов и качества работ, выполненных подрядными организациями, а также недостаточная коммуникация между участниками проекта.*

*Сделан вывод о том, что дроны являются эффективным инструментом, который имеет широкую сферу применения на этапах изыскательских и проектных работ, работ нулевого цикла, возведения надземной части зданий и дальнейшего контроля технического состояния зданий в процессе эксплуатации.*

***Ключевые слова: дроны, облачные технологии в строительстве, 3D-модель, ортофотоплан, дистанционный контроль, организация строительства, мониторинг, управление строительным проектом.***

**УДК 66.013.512**

**М.В. Клис,**
канд. техн. наук, доцент
ORCID: 0000-0001-6790-8281
**О.В. Катаранчук,**
студент
Київський національний університет будівництва і архітектури

## ВИКОРИСТАННЯ ВІРТУАЛЬНОЇ РЕАЛЬНОСТІ ПРИ РОЗРОБЦІ ПРОЕКТУ БУДІВНИЦТВА

*За допомогою використання новітніх технологій, може змінитися проектування в будівництві. Віртуальна реальність допомагає знайти недоліки в проекті і швидко їх коригувати.*

***Ключові слова: віртуальна реальність, нові технології, проектування, будівництво***

**Вступ.** Ще кілька років тому про віртуальну реальність говорили в майбутньому часі, оскільки дорожнеча технології не дозволяла використовувати її можливості в повній мірі. І хоча перший пристрій, здатний створювати повністю віртуальну реальність, з'явився ще в 50-і роки минулого століття. У 1961 році компанія Philco Corporation розробила перший шолом віртуальної реальності Headsight для військових цілей, і це стало першим застосуванням технології в реальному житті.

VR або віртуальна реальність - тривимірне середовище, створене за допомогою комп'ютера, яке відтворює фізичну присутність в точках віртуального світу і з якою користувач може взаємодіяти. Віртуальний світ передається людині за допомогою відчуттів - зору, дотику і слуху. Віртуальна реальність створює штучний світ і повністю занурює в нього людини.

**Аналіз досліджень і публікацій з проблеми.** Батьком віртуальної реальності по праву вважається Мортон Хейліг. У 1962 він запатентував перший у світі