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ANGSTROMTECHNOLOGY OF AVIATION CYBERSECURITY

Tetyana Kuznietsova, Artem Chyrkov

National Aviation University

KUZNIETSOVA Tetyana, PhD in Economics, Associate Professor

Year and place of birth: 1966, Ukraine.
Education: Sloviansk (Donbas) State Pedagogical University, 1988.
Ukrainian Academy of Foreign Trade, 2002.
Ukrainian State University of Finance and International Trade, 2011.
Position: Associate Professor in Applied Mathematics Dept. of National Aviation University.
Scientific interests: robotization, artificial intelligence, thought control, 3D modeling.
Publications: 105 scientific publications, including 5 monographs (2 of them without co-authors) and others.
E-mail: vottak@ukr.net.
Orcid ID: 0000-0001-7142-6314.

CHYRKOV Artem

Year and place of birth: 1990, Ukraine.
Education: Oles Honchar Dnipropetrovsk National University, 2012.
Position: Researcher in R&D Dept. of National Aviation University.
Scientific interests: computer vision, data analysis, applied statistics, artificial intelligence, information technologies, cybersecurity.
Publications: more than 25 scientific publications.
Email: a.chyrkov@nau.edu.ua.
Orcid ID: 0000-0001-6582-8018.

Abstract. *In the aviation industry the problem of managerial decision-making completely eliminating aircraft crashes and save human lives is particularly acute issue. Consequently, the authors introduced new economic concepts and determined the role of 3D-modelling in angstromtechnology of air enterprises from the point of view for cybersecurity. Successful managers are trying to "program" as many as possible management decisions to improve management effectiveness of cybersecurity. The authors made 3D-modeling of cybersecurity's decision-making in airspace issues, which can be regarded as a small-scale version of the simulation in Flexible Time Scale (FTS) using angstrom-management technology. The study defined means of mathematical modelling of managerial cybersecurity-making in air industry problems, consisting of software modules that are used to meet the needs of airspace designers. Modelling tools typically do not use curved segments. The exact description of the arrival and departure routes defined by curved segments could be determined using approximated linear model segments. The same method is proposed to use for describing standby areas. The conceptual model of information system by angstromtechnology of air enterprises was developed impact on air enterprises' decision-making cybersecurity's effectiveness was derived. The conclusions indicated that angstromtechnological model is a convenient tool of air enterprise's manager and powerful analytical tool in general. Through their use one can not only store and integrate data, but also reflect the process of objects' operation on 3D-models.*

Keywords: *modelling; technology; aviation; cybersecurity.*

Introduction.

The purpose. This article introduces the author's concept of angstromtechnologies and their relationship with cybersecurity. The possibility of 3D modeling for thought control is shown. The era of gadget management is changing.

Problem Determination. Successful business leaders are trying to "program" as much as possible management resolutions to improve the effectiveness of their management. In the aviation industry the question of management decisions making is of high importance as it can eliminate aircraft accidents and save lives. That is why the author introduces new economic concepts which define the role of neural networks in technology of Angstrommanagement airlines.

Analysis of recent research and publications. In the former time the problems were never investigated constructively. There are only eight scientists abroad (K. Arrow, G. Simons, P. Lucas, G. Kleiner, B. Kanaplyou, G. Baharev, A. Inshakov and T. Lyubimova) who are engaged in Nanoeconomic approaches and methods used to solve problems in the development of intellectual capital on the whole and knowledge control in particular. But in the aviation field and airline management there are no

studies or publications, either in Russia or in foreign countries.

Lack of theory and practical recommendations on airline Angstromeconomics, Angstrommanagement and Angstromtechnology taking into account the modern peculiarity of economic development of Ukraine determines the special urgency of the problem.

Presenting the main material.

Mathematics today faces the challenge of developing new mathematical tools to ensure cyber security in aviation.

1. Cybernetic objects are developing objects, they are characterized by a dynamic effect, when the cause begins to act after a certain time, so when developing dynamic models, it is necessary to take into account time lags.

2. When using the mathematical apparatus in cybernetic research and control, it is not the objects themselves that are studied, but their 3D mathematical models, the adequacy of which is very difficult to evaluate.

In the process of constructing a cybernetic-mathematical model, two systems of scientific knowledge are mutually adapted - cybernetic and mathematical.

With the development of information technology, this interaction has stepped from the field of cybernetic research into real business management practice in the field of aviation.

Knowledge of mathematical methods is becoming an integral element in the formation of professional knowledge of specialists in the field of cybernetics and aviation. In modern conditions, in connection with the increasing role of applied mathematics in cybernetics, the emergence of new technologies for the mathematical processing of information, an urgent need is to build an accurate mathematical model of aviation security.

The main purpose of this article is implementation of new concepts, the author's classification together with the arising the reform economic laws and properties, determination of the role of neural networks in Angstrommanagement technology of airlines.

Nanoeconomics (human economics) – a branch of economic theory which studies the behavior of economic agents in the market and non-market conditions, it is the deep level of study of economic phenomena and is a theory of transactions within the formation of decisions by market participants (collectively, the definition by K. Arrow, G. Simons, P. Lucas).

Angstromeconomics (economics of thought, gift, intuition) – a branch of nanoeconomics which studies the effect of the intellectual, moral and spiritual abilities of economic agents of productive management decision making.

Angstrommanagement (management of thought, gift, intuition) – a profound control of intellectual, moral and spiritual leaders capabilities of economic systems by selecting from a set of conscious and super conscious aspects for effective decision making.

More precisely, Angstrommanagement – science that studies "what" exactly manages the man and "what" does the man manage while making decisions.

To improve the economical and mathematical conceptual apparatus the author has used classification of different types of economics, but not in full compliance with the SI system, but according to the logical interpretation of the author:

– 10^{-10} – Angstromeconomics: economics of thought, gift and intuition;

– 10^{-9} – Nanoeconomics: economics of privately held company;

– 10^{-6} – Microeconomics: economics of an enterprise;

– 10^{-3} – Minieconomics: corporate economics;

– 10^{-1} – economics of art, management art;

– $10^{0} = 1$ – System;

– 10^{1} – economical good, economical human factor;

– 10^{3} – Mezoeconomics: regional (local) economics;

– 10^{6} – Macroeconomics: the national economics;

– 10^{9} – Megaeconomics: world economics;

– 10^{10} – Multieconomics: economics of "mason, The Heads of the World Bank", hitch govern global economic policy.

From the author's classification some properties and patterns based on disjunction (multiplication, intersection) of the economic categories can logically be noticed:

– $10^{10} \times 10^{-10}$ (Multieconomics on the basis of thought, gift and intuition) = $10^{6} \times 10^{-6}$ (micro and macroeconomics crossing) = $10^{3} \times 10^{-3}$ (regional and corporate economics crossing) = $10^{0} = 1$ – system;

– $10^{10} \times 10^{-1} = 10^{9}$ (Multieconomics creates Megaeconomics);

– $10^{10} \times 10^{-9} = 10^{1}$ (with the help of enterprise economics Multieconomics manages the creation of economical good).

The study these patterns with the help of mathematical logic and its operations can last long. For this article, the original ideas and evidences that is sufficient.

Creation of the Angstromtechnology of airlines lies in ensuring the most effective management decision-taking of airline leaders and safety managers at Mission Control Centers in emergency situations. Nowadays, within the current technological and informational economy, the consistent patterns of Angstromtechnology of airlines creation are closely associated with forecasting and modeling of neural networks and volumetric 3D-models.

Neural networks – are adaptive systems for data processing and analysis, which appear to be the mathematical structure that mimic some aspects of the human brain and demonstrate the capabilities such as the ability to non-formal learning, the ability to generalize and cluster unclassified information, the ability to build predictions based on submitted time series [3]. Their main difference from other methods, for example expert systems, is that the neural networks do not require previously acknowledged models but simply create them only on the basis of the information provided. That is why neural networks and genetic algorithms are introduced wherever you need to solve the problems of forecasting, classification, management (especially Angstrommanagement) – in other words, within each field of human activity where algorithmic process cannot be considered properly, for an instant resolution a group of qualified constantly working experts is required or the adaptive automation system, which the neural networks are.

The neural network receives the input information and analyzes it like the human brain does. While the analysis the network is learning (acquiring knowledge and experience), and then provides output information based on previously acquired experience.

The main task of the analyst, who uses neural networks to solve any problem, is to create the most efficient architecture of the neural network, which means to choose the right kind of neural network, the algorithm for its training, the number of neurons and types of connections between them. This work has no stated procedures, it requires a deep understanding of the various types of neural networks architectures, it includes a lot of research and analysis, and can take a lot of time for preparation, but as a result, it is able to issue the most effective solution for the definite moment and the specific situation in a short amount of time.

For informal tasks the neural network models can be far more effective than the traditional methods of solution.

Neural networks are especially helpful when there is a large amount of input data, among which there are implicit relationships and patterns. In this case, the neural network can automatically consider different nonlinear dependences hidden in the database. This is particularly important at decision taking systems and forecasting systems.

It should be noted since Nanoeconomical, financial and social systems are very complex and are the results of actions and reactions of different people, it is very difficult (even impossible) to create a complete mathematical model taking into account all the possible actions and reactions. It is almost impossible to approximate a model based on such conventional parameters as utility maximization or profit maximization.

In systems of this complexity it is natural and effective to use models which directly simulate the behavior of society and Nanoeconomics. This is exactly what the technology and methodology of neural networks is capable to offer.

It is a technology for purposes and means of behavior in a wide range identification, based on the simulation of intelligence operations; generated by the human brain research, aimed for building a logically functioning system with a large number of simple elements, conjugated with branched connections, designed to identify non-linear patterns in the absence of a simple knowledge about an object that is being studied, used for predicting the dynamics of market and in other areas of economy and Nanoeconomics.

While studying the network adjusts the coefficients of connections and polynomials of transfer functions, which would further determine the mode of operation. Multistep prediction of time series is performed as following. The known values vector is submitted to the neural networks input $x(tn-2), x(tn-1), x(tn)$. The predicted value is formed at the output $x*(tn+1)$, which determines the vector of the predicted outputs and joins to the initial set values, simply, approved. Next, the vector $x(tn-1), x(tn), x*(tn+1)$ is applied to the input and $x*(tn+2)$ is received at the output together with the further predicted values.

Vectors are applied to trained neural network serves inputs for multiparameter tasks

$$x(tn-2), y(tn-2), z(tn-2),$$
$$x(tn-1), y(tn-1), z(tn-1),$$
$$x(tn), y(tn), z(tn).$$

The output produces values $x*(tn+1)$, $y*(tn+1)$, $z*(tn+1)$, which form the output values vector and sequentially append to the initial set. If the icon is shifted to the step of prediction, which has been generated by the system, they are considered as real and participate in forecasting the next output, i.e. the vector is applied to the input $x(tn-1), y(tn-1), z(tn-1)$, $x(tn), y(tn), z(tn)$ $x*(tn+1)$, $y*(tn+1)$, $z*(tn+1)$, at the output we receive $x*(tn+2)$, $y*(tn+2)$, $z*(tn+2)$ and other predicted values.

Multistep forecasting allows to perform short-and medium-term predictions, because accumulation of errors at each step of forecasting has a significant effect on accuracy. In the application of long-term multi-step forecasting, particular for many predictive systems gradual attenuation process is observed, phase shifts and other distortions of the forecast. This type of prediction is preferable for time series, falling under the definition of a stationary process with a small random component.

A typical example of a network with direct drive signal is shown in Fig. 1. Neurons are organized in layers in a regular manner. The input layer is needed only for entering the values of the input variables. Each of the hidden and output neurons is connected to all elements of the preceding layer. Networks, in which neurons are connected only with some of the previous layer neurons could only be considered, however, for most applications, network connections with the complete system are preferable, and this is the type of networks implemented in the ST Neural Networks package.

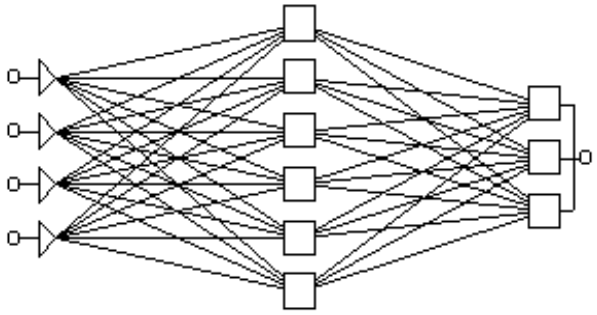


Fig. 1. Network with direct transmission signal [1]

Argumentive factors are often used for diagnosis and prognosis of nanoeconomical objects which are given by experts. After that they vote. However, such procedures can simply be incorrect, and the existing apparatus for constructing correct procedures is rather difficult to operate for receiving practical meaning decisions.

Today, aircraft diagnosis is one of the most difficult problems of the technical operation of the vehicles. Classical methods to make diagnosis of aviation equipment on the ground, which for timely detection of defects in individual objects diagnosing dismantled and installed on a special stand, which uses sensors removed indicators of efficiency. However, to increase the level of security necessary to produce a steady on-line monitoring and diagnostics of the most important parts of the aircraft during flight.

One promising area is the use of on-board diagnostics of neural networks. Neural networks allow to

cope with problems of diagnosis, as incomplete or obstructive input data, and have an instant response. The use of neural networks can significantly reduce the number of parameters measured, respectively, reduce the number of installed sensors.

The diagnosis objective with the use of artificial neural networks is reduced to the choice of the type of network, architecture and definition of parameters and its training. As the object of diagnosis the aircraft engine is examined. Since the required amount of statistical data on the aircraft engine diagnostic results is unavailable, for constructing the training sequence it is proposed to use the diagnostic matrix. Diagnostic data is obtained by physical linear mathematical model of the engine. During the experiments the input of trained artificial neural network was fed with full, partial or obstructive data stream and the ability to recognize defects on the quality of the input signals has been evaluated.

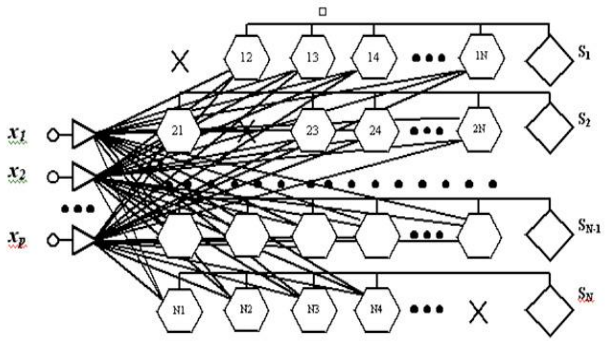


Fig. 2. Research Probabilities application of neural networks and discriminant analysis for solving diagnostic efficiency problems (obtained by the authors)

Nowadays, unmanned aerial vehicle are becoming increasingly popular in solving various problems, both civilian and military sectors. Thus for modern aircraft it is common: that constantly increasing volume of information received from on-board sensors, increased requirements for accuracy and speed of data processing systems, increased need for tactical decision-making in the minimum time, etc. These are the tasks, managed by modern airborne staff, which often exceed physiological human performance. The use of neural networks is one of the approaches aimed for increasing the degree of automation control of aircraft, its avionics – computing equipment. The need to use artificial intelligence in airborne systems of aircraft due to the fact that many of the subtasks that can be solved within the framework of its operation, either can not be solved by standard analytical methods, or application of these methods is limited to the requirements imposed on them and the speed of the system performance. Application of Neural Networks in aviation has found its niche in solving the following problems - choice of optimal flight path, obstacles overcome, identification of ground and air targets, etc.

The creation of Angstromtechnology of diagnostic cybersecurity's system based on neural network involves the following steps: identification of Control System, and Effective Decision Making, as the subjects of diagnosis, ire creation of the diagnostics (including its type and architecture), the input values of which are the parameters of Effective Decision Making, registered by sensors, and output - the parameters which define the state of Effective Decision Making with the possibility of self- correction in the operational process, the creation of a training sample for neural network based on statistical information about the functional parameters of Effective Decisions for all modes of operation and the most probable failure of operating experience (for stated decisions) or according to

For the construction and simulation of artificial neural network STATISTICA Neural Networks package has been used, as well as software developed by the authors in Java.

Fig. 2 is a graph showing prognoses dynamic change of the mean square error training and verification. the results of bench tests (for newly developed or upgraded Effective Decisions).

The basis of the proposed method in this article are the application of the combined model based on the use of expert systems and unstated logic method, which are realized in the MATLAB 6.5. These methods allow to perform system analysis of the electronic database on node technology developed lately.

In spatial form the compels of available in an electronic data node technology can be represented in the form of a surface (Fig. 3), where the grades of patent statistics are marked on the axes (intuition (ideas, knowledge), time, choice, solution), and the vertical axis of ordinates - point technology option.

According to Fig. 3 below there are low perspective technologies for effective decisions making. In the upper area "high technologies" are located, those which implement the most innovative and original solutions. In between these areas there are intermediate technologies.

According to the results of this analysis, on the basis of patent statistics can be distinguished a list of the most prospective technologies for new design solutions of effective management decisions making for the new generation, development of a preliminary set of design documentation and design decision Agstromtechnology cybersecurity's processes of airlines.

Angstromtechnology airline cybersecurity's solutions based on various technical and technological challenges of innovation in terms of technological software for creation and formulation of problems and solutions for new generations can significantly improve the technical level of airline management and its economic efficiency.

Multinode graph of technology development is core for possible construction design as well as and technological solutions (in the form of design, perspective and policy processes) for structural optimization of node technologies. Multistructural optimization technologies on network graphs is made using the theory of stochastic decision and game theory, dynamic programming, use of artificial neural networks and other methods of system analysis technology.

Neural network is adaptive systems for processing and analyzing data, which is mathematical structure that mimics some aspects of the human brain and demonstrate such its features as the ability to non-formal learning, the ability to generalize and cluster unclassified information, the ability to build their own forecasts based on lodged on time series [4]. Their main difference from other methods, such as expert systems, is the neural network does not require formerly known model and build it by itself through the provided information. Therefore, neural networks and genetic

algorithms included in the practices wherever necessary to solve problems of prediction, classification, management – in other words, in the area of human activity, which is bad for algorithmization. Neural networks are adaptive systems of automation to solve immediate problems or for continuous work of qualified expert group.

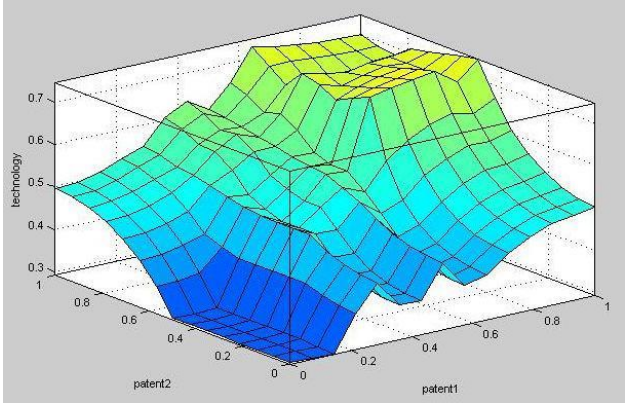


Fig. 3. Theoretical surface for development of unified Angstromtechnology making effective cybersecurity's management decisions (obtained by the authors)

The neural network receives incoming information and analyzes it in a manner analogous to human brain. When analyzing network learns (acquires experience and knowledge) and gives background information based on experience.

The main task of the analyst that uses neural network to solve any problem is to create the most efficient architecture of the neural network means to choose its form, its learning algorithm, the number and types of neuronal connections between them. This work has formalized procedures, it requires a deep understanding of the different types of architecture of neural networks, includes many research and analysis activities, and can take a lot of time to prepare. Thus, in the shortest time the neural network is able to give many the most effective solutions for a given time and the particular situation.

Neural network models can exceed the performance of traditional methods informal tasks in several times.

Neural networks present themselves in the best way where there are a large number of inputs, among which are implicit relationships and patterns. In this case, the neural network helps you automatically consider various nonlinear dependence, hidden in databases. This is particularly important in decision support and forecasting systems.

It should be noted that since the economic, financial and social systems are very complex and are the result of actions and reactions of different people, it is very difficult (if not impossible) to create a full mathematical model with all the possible actions and reactions. Almost impossible to detail the approximate model based on traditional parameters such as maximizing utility or profit maximization [7].

The criteria for selecting the most suitable network that delivers better classification error control are the value of the training and test subsets and summary statistics window «Classification Statistics». Network demonstrated best results has hidden layer that includes seven items that neural network architecture has the form: 6-7-1 (Fig. 4).

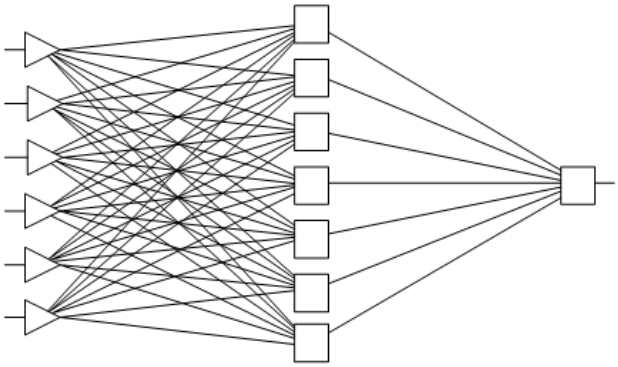


Fig. 4. Neural network architecture: 6-7-1 (note: created by authors)

The value of the control error is 0,016 for the training subset and 0,018 for the test. The network shows the highest number among the networks that correctly classified observations taken the training and test sets.

The results obtained via the 6-7-1 are shown in Tab. 1.

Table 1

Solution by neural network the problem of information protection in thought control when flying – results of angstromtechnology obtained by the authors

Network architecture	The value of the control error (the mean square error on training and testing subsets)	The number of classified observations on the test subset (valid observation class is the class assigned to the INS)					
		priori dangerous = potentially stable	priori dangerous = potentially stable	potentially stable = priori dangerous	potentially stable = priori dangerous	priori dangerous = potentially stable	potentially stable = priori dangerous
6–7–1	0,016; 0,018	99	–	96	–	1	4

Tab. 1 shows that neural network solved classification cybersecurity's task, put successful flights into two groups: potentially stable and a priori dangerous. Network accurately classified 96 potentially stable among a hundred experiments; among the same amount, 99 a priori dangerous were identified correctly. Network classified correctly all surveillances, which can be attributed to too tight confidence levels.

Fig. 5 shows Training Error Graph of the network.

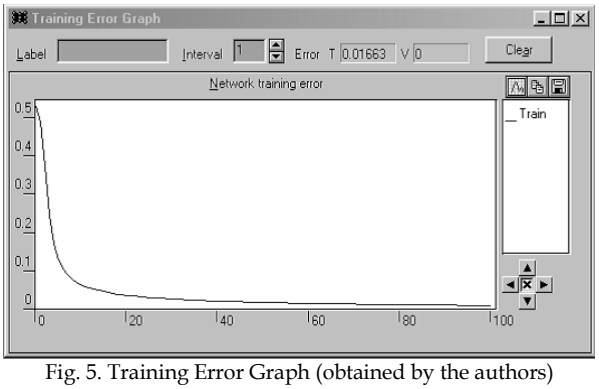
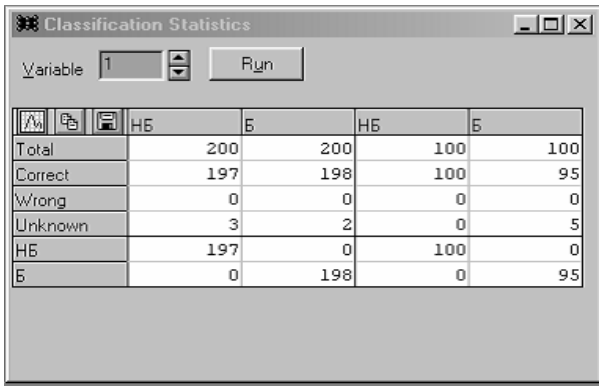


Fig. 5. Training Error Graph (obtained by the authors)

«Classification Statistics» contains very helpful information for analyzing the results, quality of classification and the choice of thresholds of acceptance/rejection, shown in Fig. 6.



	НБ	Б	НБ	Б
Total	200	200	100	100
Correct	197	198	100	95
Wrong	0	0	0	0
Unknown	3	2	0	5
НБ	197	0	100	0
Б	0	198	0	95

Fig. 6. Classification Statistics (note: created by authors)

Columns correspond classes; each column is divided into two parts: the summary statistics and statistics assignment. All data is displayed for each set (learning or test).

Conclusion

The performed analysis of the capabilities 3D-modeling and the concepts of «new engineering» showed that the modern cybersecurity's knowledge in technics is fundamentally changing the traditional principles, approaches and models. There is an intelligent value of the role of modeling. The intellectualization of technics activity requires the creation of intellectual automated systems, that contribute to more active use of modern intellectual, geoinformational communications, corporate integrated systems and technologies, and will improve the quality process and stimulate the development of intellectual cybersecurity's capital.

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Кузнєцова Т.В., Чирков А.В. Ангстремтехнологія авіаційної кібербезпеки

Анотація *В авіаційній галузі проблема прийняття управлінських рішень, повністю усуває авіаційні аварії і рятує людські життя, є особливо гострою. У колишні часи ці проблеми ніколи не досліджувалися конструктивно. За кордоном лише вісім вчених (К. Ерроу, Г. Сімонс, П. Лукас, Г. Кляйнер, Б. Канапльов, Г. Бахарев, А. Іншаков і Т. Любимова), які займаються наноекономічними підходами і методами, використовуваними для вирішення проблеми роз-*

витку інтелектуального капіталу в цілому і контролю знань зокрема. Але в області авіації і управління авіакомпаніями немає ні досліджень, ні публікацій ні в Україні, ні в зарубіжних країнах. Отже, автори ввели нові економіко-математичні концепції і визначили роль 3D-моделювання в ангстремтехнологіях авіапідприємств з точки зору погляд на інформаційну безпеку і кібербезпека. Успішні менеджери намагаються «запрограмувати» якомога більше управлінських рішень для підвищення ефективності управління інформаційною безпекою та кібербезпекою. Автори виконали 3D-моделювання інформаційної безпеки і прийняття рішень з кібербезпеки в питаннях повітряного простору, які можна розглядати як невелику версію моделювання в гнучкою шкалою часу (FTS) з використанням ангстремтехнології управління. У дослідженні визначені засоби економіко-математичного моделювання управлінської інформаційної безпеки і створення кібербезпеки в задачах авіаційної промисловості, що складаються з програмних модулів, які використовуються для задоволення потреб проектувальників повітряного простору. Інструменти моделювання зазвичай не використовують вигнуті сегменти. Точний опис маршрутів прибуття і відправлення, визначених вигнутими сегментами, може бути визначено з використанням апроксимованих лінійних сегментів моделі. Цей же метод пропонується використовувати для опису резервних областей. Розроблено концептуальну модель інформаційної системи ангстремтехнології авіапідприємств, отримано вплив на прийняття рішень щодо забезпечення інформаційної безпеки та ефективності кібербезпеки авіапідприємств. У цій статті висвітлюються результати використання нейронної мережі для управління людським мисленням. Зроблені висновки свідчать про те, що ангстремтехнологічна модель є зручним інструментом керівника авіапідприємства і потужним аналітичним інструментом в цілому. Завдяки їх використанню можна не тільки зберігати і інтегрувати дані, але і відображати процес роботи об'єктів на 3D-моделях.
Ключові слова: *моделювання, технологія, авіація, кіберзахист.*

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Аннотация. *В авиационной отрасли проблема принятия управленческих решений, полностью устраняющая авиационные аварии и спасающая человеческие жизни, является особенно острой. В прежние времена эти проблемы никогда не исследовались конструктивно. За рубежом всего восемь ученых (К. Эрроу, Г. Симонс, П. Лукас, Г. Кляйнер, Б. Канаплёв, Г. Бахарев, А. Иншаков и Т. Любимова), которые занимаются наноэкономическими подходами и методами, используемыми для решения проблемы развития интеллектуального капитала в целом и контроля знаний в частности. Но в области авиации и управления авиакомпаниями нет ни исследований, ни публикаций ни в Украине, ни в зарубежных странах. Следовательно, авторы ввели новые экономико-математические концепции и определили роль 3D-моделирования в ангстремтехнологиях авиапредприятий с точки зрения взгляд на информационную безопасность и кибербезопасность. Успешные менеджеры пытаются «запрограммировать» как можно больше управленческих решений для повышения эффективности управления информационной безопасностью и кибербезопасностью. Авторы выполнили 3D-моделирование информационной безопасности и принятия решений по кибербезопасности в вопросах воздушного пространства, которые можно рассматривать как небольшую версию моделирования в гибкой шкале времени (FTS) с использованием технологии управления angstrom. В исследовании определены средства экономико-математического моделирования управленческой информационной безопасности и создания кибербезопасности в задачах авиационной промышленности, состоящие из программных модулей, которые используются для удовлетворения потребностей проектировщиков воздушного пространства. Инструменты моделирования обычно не используют изогнутые сегменты. Точное описание маршрутов прибытия и отправления, определенных изогнутыми сегментами, может быть определено с использованием аппроксимированных линейных сегментов модели. Этот же метод предлагается использовать для описания резервных областей. Разработана концептуальная модель информационной системы ангстремтехнологии авиапредприятий, получено влияние на принятие решений по обеспечению информационной безопасности и эффективности кибербезопасности авиапредприятий. В этой статье освещаются результаты использования нейронной сети для управления человеческим мышлением. Сделанные выводы свидетельствуют о том, что ангстремтехнологическая модель является удобным инструментом руководителя авиапредприятия и мощным аналитическим инструментом в целом. Благодаря их использованию можно не только хранить и интегрировать данные, но и отражать процесс работы объектов на 3D-моделях.*
Ключевые слова: *моделирование, технология, авиация, киберзащита***.**

Kuznietsova Tetyana, PhD in Economics, Associate Professor, Associate Professor in Applied Mathematics Dept. of National Aviation University.
Кузнєцова Тетяна Вікторівна, кандидат економічних наук, доцент, доцент кафедри прикладної математики Національного авіаційного університету.
Кузнецова Татьяна Викторовна, кандидат экономических наук, доцент, доцент кафедры прикладной математики Национального авиационного университета.

Chyrkov Artem, Researcher in R&D Dept. of National Aviation University.
Чирков Артем Валерійович, науковий співробітник науково-дослідної частини Національного авіаційного університету.
Чирков Артём Валерьевич, научный сотрудник научно-исследовательской части Национального авиационного университета.

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