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DEVELOPMENT AND IMPLEMENTATION OF A "SMART HOME" SYSTEM FOR A MODERN RESIDENTIAL COMPLEX

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Abstract

The author of this publication, in the process of performing and supervising a comprehensive set of design works for the transformation of an outdated space with an obsolete ecosystem and infrastructure, has developed a fundamentally new space. This transformation aligns with the requirements and standards for spaces capable of optimizing all workflows while incorporating methods and parameters suited for startup ecosystem environments. Such spaces are designed to enable efficient collaboration, where connections between subsystems within the supersystem are facilitated through channels integrated with elements of artificial intelligence and artificial neural networks.

Furthermore, the suite of design solutions, including architectural and artistic elements, establishes comprehensive visual stabilizers for psychological well-being in the workplace. Within the startup ecosystem, these stabilizers evolve into ecosystemic and infrastructural instruments, enhancing psychological stability and productivity. This environment is optimized for brainstorming effectiveness, supporting the application of 40 primary and 10 supplementary methods and techniques to achieve an ideal final result.

Keywords: *Smart Home, Development of a Smart Home System, Implementation of a Smart Home System, Residential Complex, Ecosystem of a Smart Urban District, Application of Artificial Intelligence in Design Engineering, Use of Artificial Neural Network Elements in Design Engineering, Comprehensive Transformation of Outdated Spaces, Definitions and Standards for Spaces with Startup Ecosystem Capabilities, Techniques and Methods for Achieving the Ideal Final Result, Development and Implementation of a "Smart Home" System for a Residential Complex as Part of the Ecosystem and Infrastructure of a Smart Urban District in a Modern City; Application of Artificial Intelligence and Artificial Neural Networks in Design Engineering*

Purpose

In this publication, the author presents the results of supervising and performing a comprehensive set of design works aimed at transforming an outdated space with legacy ecosystems and infrastructure into a fundamentally new environment. This transformation meets modern requirements and standards for spaces designed to optimize workflows. Additionally, it integrates practical methodologies and parameters aligned with the definitions and standards of spaces featuring startup ecosystem capabilities. These capabilities ensure that connections between subsystems within the supersystem are facilitated through channels incorporating elements of artificial intelligence and artificial neural networks.

Introduction

In addition, a comprehensive set of design solutions, including architectural and artistic elements, establishes the necessary visual stabilizers of the psychological climate in the workspace. Within a startup ecosystem, these stabilizers evolve into ecosystem and infrastructure-based tools that enhance team efficiency and focus during brainstorming sessions. This design approach integrates 40 core and 10 additional methods for achieving the ideal final outcome.

Smart home technologies represent a priority in the evolution of the construction industry. However, their development and implementation are deeply influenced by the broader conditions of urban infrastructure within modern cities. The complexity of integrating smart home systems increases significantly when construction occurs in historical districts. In such cases, the challenge lies not only in developing new intelligent facilities but also in modifying and restoring adjacent older districts.

These conditions demand a highly creative and innovative approach to the comprehensive engineering design of smart construction projects. This includes a variety of combined solutions, each aligned with essential construction standards while also incorporating elements of artificial intelligence (AI) and artificial neural networks (ANNs).

Despite the challenges, there are positive examples of successful implementation of smart home projects. These solutions serve as benchmarks for new initiatives, offering models for achieving the ideal final outcome as outlined by the **Theory of Inventive Problem Solving (TRIZ)**.

As an example, the author of this publication emphasizes the unique experience and achievements of Vitiv Bohdan, a distinguished engineer and innovator. A Corresponding Member of the Ukrainian Academy of Sciences, the International United Academy of Sciences, and the New York Academy of Sciences, Vitiv's systemic approach is utilized in the training of engineering specialists in smart construction.

Brief Overview of Highlighted Projects:

1. Project: Development and implementation of a "smart home" system for the residential complex *Smart Home* (2020–2021)

- **Technologies**: Integration of IoT (Internet of Things), remote control systems for lighting, climate, and security;
- **Innovations**: Adoption of energy-efficient solutions and AI-based automation for home functions;
- **Partners**: Guver Investment Fund, developer BK Center Stroy;
- **Results**: A 25% reduction in energy consumption, enhanced resident comfort, and improved security.

2. Project: Creation of eco-friendly buildings with autonomous energy systems (2019-ongoing)

- **Technologies**: Solar panels, energy management systems, and autonomous water supply;
- **Innovations**: Integration of combined solutions for home autonomy, significantly reducing reliance on external networks;
- **Partners**: Guver Investment Fund, BK Center Stroy, EcoBud LLC, Green Energy Solutions;
- **Location**: Hodosiyivka, Kyiv Region (ongoing construction);
- **Results**: 80% home autonomy, reduction in CO_2 emissions, and minimized operating costs.

3. Project: Reconstruction of multistory residential buildings with integrated smart home systems in Kyiv (2021–2023)

- **Technologies**: Lighting and climate control systems, automated ventilation, real-time building condition monitoring;
- **Innovations**: AI-based predictive maintenance and enhanced energy management capabilities.

These projects exemplify the successful implementation of innovative smart home technologies, demonstrating the transformative potential of AI and ANN integration in construction. They set a standard for the future of sustainable and intelligent urban development the use of innovative materials and sensor systems for monitoring the condition of building structures. Partners: Guver Investment Fund, BK Center Stroy LLCLocation: Kyiv, Solomensky District Results: Improved quality of life for residents, reduced building energy consumption by 30%.

4. Project: Modernization of a commercial business center with the integration of "smart home" technologies (2022–2024)

- Technologies: Video surveillance systems, smart access control, automated energy consumption and climate management. Innovations: Integration of cloud services for building monitoring and management via mobile applications.Partners: Guver Investment Fund, BK Center Stroy developer. Results: 20% reduction in heating and electricity costs, increased building security;
- In contemporary conditions, when organizing production spaces for startups developing new smart technologies, there is a growing need to create a specialized ecosystem that accounts for the features and requirements of the supersystem of smart technologies. One of the subsystems of this ecosystem involves elements of contactless control and their processors, which in turn contain elements of artificial intelligence and artificial neural networks;
- This field is relatively new, and a significant contribution to its development has been made by Vitiv Bohdan through his original inventions, fundamental publications, and books;
- In his developments, Vitiv Bohdan has brilliantly combined ideas for preparing and optimizing the interior of production spaces with designs for parts of the infrastructure of a smart production complex, incorporating the latest technological solutions to increase the performance of electronic systems, ensuring compatibility with quantum computers and their processor equivalents expected to be introduced to the market.

As the complexity of innovative projects grows, automated design methods and systems are becoming increasingly important. Their significance is greatly enhanced when elements of artificial intelligence are integrated, fundamentally altering conventional automated design methods and systems.

For example, Google has introduced a new quantum computing chip, Willow, which, according to the company, can solve a computational problem in five minutes that would take traditional supercomputers thousands of years to complete. This breakthrough represents the cutting-edge progress in quantum computing and smart technology, directly impacting the design and optimization of future smart buildings and urban infrastructure.

These advancements highlight the profound impact of AI, quantum computing, and smart technologies on construction and urban development, presenting new opportunities for integrating these technologies into building systems, from residential complexes to commercial hubs the fastest modern conventional computer would take an inconceivable amount of time-10 septillion (10 followed by 24 zeros) years – to solve the computational problem that Google's new quantum computing chip, Willow, can solve in just five minutes. According to Hartmut Neven, the founder and head of Google's Quantum Lab, this supports the idea that "quantum computing occurs in many parallel universes."

However, the revolutionary nature of this breakthrough lies not in its data processing speed, but in the fact that developers have overcome a key problem with quantum computers.

Quantum computers leverage phenomena from quantum mechanics– quantum superposition and quantum entanglement. They don't operate on bits, which can only be 0 or 1, but on qubits (quantum bits), which can represent both 0 and 1 simultaneously. This exponentially increases the capacity for data processing and transmission, but it also introduces many errors. The more qubits used, the higher the frequency of errors. For nearly 30 years, scientists have been grappling with this issue.

The result is Willow, where recent "breakthrough" advancements have allowed developers to achieve an exponential reduction in error rates. Google claims that Willow is the first system to demonstrate results below threshold levels, paving the way for practical, large-scale quantum computers.

According to Neven, the new chip will be used in some practical applications, but details have not been disclosed. Experts, however, note that Willow remains largely an experimental device. It will take many years before quantum computers can be used in real-world applications, and this will require enormous investments.

A Technical System (TS) is defined as an artificially created material unity. The concept of TS allows us to formulate the fundamental feature of a technical solution. The creation of modern communication systems and the latest computing equipment requires constant tightening of the requirements for the cleanliness of the manufacturing process.

Scientific and technical information increasingly focuses on these processes, often at the expense of other equally important directions in the development of microelectronics and complex production technologies. This focus may be partially explained by the desire (and not without self-interest) to make the production process conform to established and existing environmental protection standards while achieving lower costs. Many believe that the costs of environmental protection reduce production efficiency and increase the cost of products and services.

However, there are certain minimum cleaning parameters or levels of cleanliness in the production process below which quality becomes uncontrollable, and this immediately impacts the quality of the manufactured products.

The usual method for ensuring minimal quality and cleanliness standards is continuous improvement in the composition and components of chemical reagents, which are increasingly used and intensify the cleaning processes as they are refined. This problem is particularly pressing in the food industry, where the costs of preparing water for food production and regenerating wastewater are rising rapidly, further driving up food prices.

These issues can be listed for a long time, so the author proposes focusing directly on the topic of this publication.

Innovation Strategy in Semiconductor Cleaning. Let's consider the process of developing a production module for cleaning 300mm semiconductor wafers. In this context, the question arises: Is it more practical to continue improving surfactants and chemical detergents, or should we explore innovative solutions to address these challenges?

The ongoing challenge of improving cleaning processes and chemical agents in production environments requires a thorough examination of new methodologies and potential breakthroughs. This process, while essential for maintaining high standards in the tech and semiconductor industries, also invites the opportunity to question whether traditional approaches are the best path forward or if innovative, less conventional solutions could offer better results in the long term.

It is indeed challenging to determine whether the process of modifying chemical reagents used in cleaning technologies constitutes an equivalent of an innovative process, or whether these modifications, while solving one problem, simultaneously create multiple new issues elsewhere, according to the criteria of achieving the ideal final result.

The analysis would be incomplete without considering the standard process of developing a new technical solution in a startup, which is integrated into a technical system of a higher compositional and layout level. We must examine how the modified formulations and definitions of technical systems at all levels correspond to the original formulations and definitions. This comparison is essential, especially when influenced by external factors related to the presence of various types and formats of visual stabilizers of the psychological climate in production and warehouse environments, as proposed by the author of this publication.

In such innovative systems, where new solutions are being applied, particularly in complex and evolving environments, it's critical to consider how external elements, such as visual stabilizers, impact the overall system. These stabilizers play a key role in creating a positive psychological climate that enhances productivity, creativity, and overall effectiveness in startup ecosystems, which are often under pressure to rapidly adapt to new technological solutions.

By understanding these interactions, we can evaluate the balance between technological advancements and their impact on the workspace environment, ensuring that modifications or innovations do not just address one problem but contribute to the larger goal of optimizing the entire technical system.

Figure 1. *The figure illustrates a comprehensive combined infrastructure stabilizer for all aspects of the psychological climate in production and warehouse environments. The stabilizing effect in the shown corridor occurs at the entrance to the working space where a team of developers is working*

It is the efforts of this team that drive the development process of the production module for cleaning semiconductor wafers with a diameter of 300 millimeters. The setup of the project team is based on the requirements and characteristics, which are classified as interconnected formats of smart technologies.

As innovation projects become more complex, the significance of automated design methods and systems grows. However, their importance is significantly enhanced when artificial intelligence elements are added, fundamentally changing the automated methods and systems familiar to specialists.

Only with the application of these elements can one complete an innovation project within acceptable costs and optimal time, while considering the heuristic elements that emerge during brainstorming sessions.

Upon reviewing the basic definitions and meanings of TRIZ (Theory of Inventive Problem Solving) and ARIZ (Algorithm of Inventive Problem Solving), with consideration for the modifications and optimizations proposed and derived by the author of this publication for practical application in the design processes within the framework of an innovation project, the following definitions can be used:

1. Systems approach is a reflection and development of the dialectical principles of "universal interconnection" and "development" and is, in essence, one of the principles of the dialectical method of knowledge. The methodology of the systems approach involves representing any object as a system and considering it comprehensively. Modern methods and capabilities of computer modeling fundamentally change and significantly complement the concept of the systems approach, making it more meaningful and effective.

The environment design proposed by the author, in addition to computer-aided design methods, constructs systems at all levels for parallel visual infrastructure stabilization of the psychological foundation of the work process.

This approach integrates both technological and environmental considerations, ensuring that the workplace environment, alongside technical advancements, contributes to the overall success of the innovation project, fostering a more effective and stable work climate.

System – a complex of elements that are systematically organized in space and time, interconnected with each other, forming a cohesive unity. A system is characterized by its composition of elements, structure, and performs a specific function. Here, computer control and monitoring systems, as well as various combinations of their control activities, significantly complement the concept of the system, making it more complete and adding analytical capabilities and characteristics. The interior design proposed by the author of this publication supplements these characteristics.

Elements – relatively indivisible parts of a whole; objects that, in combination, form a system. An element is considered indivisible within the context of maintaining a certain quality of the system. The process of innovative modification and optimization is most typical for elements, the result of which may lead to a technical solution that meets the four characteristics of an invention.

Structure – a consistent, stable connection between the elements of a system that reflects the form, arrangement of the elements, and the nature of their interaction, properties, and sides. Structure makes the system a qualitatively defined whole, distinct from the sum of the qualities of its constituent elements (since it implies the interaction of elements with one another in specific ways, through certain sides and properties, not as a whole).

Function – the external manifestation of the properties of an object (or element) within a given system of relations; a specific way in which the object interacts with the environment, its "capability."

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