Creative methods of finding innovative project ideas

for high-tech engineering

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Kryvova Svitlana Georgievna

Ph.D,

Associate Professor of Dynamics and Strength of Machines and Strength of Materials Department

National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”

skrivova@ukr.net

Trubachev Serhii Ivanovich

Ph.D,

Associate Professor of Dynamics and Strength of Machines and Strength of Materials Department

National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”

strubachev@i.ua

Introductions. High-tech engineering is one of the key areas of modern industry, where innovative ideas can have a significant impact on the development of technologies, increase production efficiency, and create new products. In this context, creative methods of finding innovative ideas are becoming an important tool for project activities.

Aim. The purpose of this paper is to analyze and evaluate the practical feasibility of using creative methods of searching for innovative ideas in the field of high-tech engineering.

Materials and methods. The study uses scientific works and articles on creative methods of idea generation, as well as examples of successful innovative projects in the field of mechanical engineering. The research methods include literature analysis, classification of idea generation methods, and their application to the development of specific design solutions.

Results and discussion. Creative methods that can help generate ideas are quite versatile and can be divided into two main groups:

1) linear methods (Pieces and Cubes, SCAMPER questions, Fan of Concepts, etc.) - contribute to the optimal organization of information or allow transforming information in different ways: combining, dividing, recording, which opens up new possibilities for seeing and solving the problem.

2) intuitive methods (Rattlesnakes and Roses, Truth and Lies, etc.) - create new information by using intuition and the subconscious.

Practical examples of the use of some creative methods to find innovative ideas in the field of high-tech engineering are presented below.

The Fan of Concepts method

This method is based on the idea that the process of finding solutions starts with a general line of thinking related to the main goal and gradually moves to more detailed concepts that correspond to this goal. Then, from concepts, one moves to specific ideas and ways to implement them. Let's assume that it is necessary to develop a concept for an innovative electric drill-screwdriver.

1. Determine the main goal: to develop an innovative electric drill-screwdriver that will be characterized by increased efficiency, ergonomics, and versatility.

2. Developing concepts that correspond to the main line of thinking

Concept 1: Efficiency; optimizing motor power; reducing energy consumption; selecting high-capacity batteries; using brushless motors to reduce wear and tear.

Concept 2: ergonomics; light weight and comfortable design; adjustable handles and grips; vibration minimization system; intuitive operating interface.

Concept 3: versatility; interchangeable bits for different types of work; modular design for quick parts replacement; compatibility with other tools; support for intelligent functions (synchronization with an app, setting up operating modes).

3. Finding ideas for implementing each concept

Ideas for realizing the “Efficiency” concept:

Motor: Use of brushless motors with increased efficiency to increase service life and reduce energy consumption.

Batteries: Developing battery packs with high-capacity lithium-ion batteries that provide long operating times without recharging.

Optimization of the cooling system: Implementation of an active cooling system to prevent overheating during prolonged operation.

Ideas for the realization of the “Ergonomics” concept:

Case design: Use of lightweight materials (e.g. aluminum, composites) to reduce weight.

Adjustable handles: Developing an adjustable handle system to adjust to the user's hand and reduce strain on the hand.

Intuitive interface: Implementation of simple and intuitive controls with LED backlighting for low-light conditions.

Ideas for the realization of the “Versatility” concept:

Interchangeable attachments: Creating a set of bits that can be easily replaced and are suitable for different types of work (drilling, screwing, hammer drilling, etc.).

Modular design: Designing a tool with a modular design that allows you to quickly change key parts such as the battery pack or motor.

Intelligent features: Developing a smartphone app that allows you to remotely configure the tool's parameters, store user profiles, and monitor battery status.

4. Selection of optimal solutions and their combination

The final concept of an innovative electric drill-screwdriver:

The motor: Brushless motor with improved cooling system to reduce wear and tear.

Battery: High capacity lithium-ion batteries with fast charging capability.

Body: Lightweight, ergonomic design with adjustable handles and vibration minimization.

Interface: Intuitive control interface with LED backlighting.

Modular design: Interchangeable nozzles and quick replacement of main modules.

Intelligent features: Support for a smartphone app to manage tool settings.

SCAMPER questions method

This method is used to modify existing ideas, products, or processes to improve them or create new ones. Each letter of SCAMPER corresponds to a specific creative step that can be used, for example, to find solutions when conceptualizing a future Unmanned Aerial Vehicle (UAV).

- S (Substitute): What components of the UAV can be replaced by more efficient or cheaper ones?

- C (Combine): Can the UAV's functions be combined with other technologies, such as using artificial intelligence to analyze real-time data?

- A (Adapt): How can the UAV design be adapted for use in other industries, such as agriculture?

- M (Modify): How can the shape or size of the UAV be changed to improve its aerodynamic performance?

- P (Put to other use): Can the UAV design be used in other projects, such as unmanned ground vehicles?

- E (Eliminate): What features or components can be removed to reduce the weight or cost of the UAV?

- R (Reverse): Can the development sequence or assembly process of the UAV be reversed to improve its performance?

As a result of the UAV conceptualization, designers may decide to change the UAV body material from metal to a composite (Substitute) to reduce weight and increase damage resistance. They may also decide to combine UAV functions with new sensors to analyze weather conditions in real time (Combine). As a result, this approach has led to a new model of the future UAV that is lighter, more stable, and more functional.

The Rattlesnakes and Roses method

This method is based on the technique of finding analogies between phenomena, objects, or actions that at first glance have nothing in common, but can provide new ideas for solving problems. This approach allows you to look at a problem from a different perspective and find non-standard solutions. Below, we will consider how this method can be applied to the development of an innovative metal-cutting machine concept.

1. Determination of the main goal: development of an innovative metal-cutting machine that would be characterized by increased accuracy, efficiency and safety in operation.

2. Search for analogies

Analogy 1: rattlesnakes. Similar features: rattlesnakes have high attack accuracy and can react very quickly to a threat; they use their tail segments to create a warning sound that can be interpreted as an analogue of an alarm or sensor system; the toxicity of snake venom can be a metaphor for the high power and sharpness of the metal cutting tool.

Analogy 2: roses. Similar features: roses are known for their thorns that provide protection, which can be associated with the safety functions of the machine tool; the beauty and complexity of the rose's structure can be analogous to aesthetics and engineering precision; the rose retains its best qualities under the right conditions of care, which can be correlated with optimal operating conditions of the machine tool.

3. Transferring analogies to the machine concept

Analogy 1: Rattlesnakes

Precision: Just as a rattlesnake pinpoints the exact place to bite, a machine tool can be equipped with a high-precision navigation system that allows for cutting with minimal deviation. This can be realized through the introduction of laser or ultrasonic sensors that provide precise positioning.

Fast response: The machine can have fast acting drives or servo motors that allow for instantaneous changes in settings or cutting speeds depending on the material or working conditions.

Warning system: The use of integrated sensors that monitor tool and workpiece conditions, issuing warnings of possible deviations from normal operation, much like a rattlesnake warning of its presence.

Analogy 2: Roses

Security: Implementation of special protective systems that automatically block tool movement when objects (e.g., parts of the operator's body) are detected in the cutting zone, just as a rose protects itself with thorns.

Precision and aesthetics: The use of a precision cutting mechanism that allows you to create complex and precise parts with a high level of surface finish, reminiscent of the elegance of a rose.

Optimal operating conditions: Implementation of a machine self-service or self-diagnostic system that constantly monitors operating conditions (temperature, vibration, tool wear) and optimizes the operation of the equipment, just as proper care of a rose allows it to bloom to its fullest potential.

4. Generate ideas for realizing the concept

After analyzing the analogies, you can generate specific ideas for realizing the machine concept:

Idea 1: High-precision positioning system - the introduction of laser sensors for precise positioning of the cutting tool.

Idea 2: Intelligent speed control system - development of algorithms that automatically adjust the cutting speed depending on the hardness of the material.

Idea 3: Automatic blocking system - integration of sensors that recognize the presence of a person in the cutting zone and block the movement of the tool in case of a potential threat.

Idea 4: Self-diagnosis and self-service - development of a system that automatically monitors the main parameters of the machine and recommends the replacement of worn components or equipment settings.

Conclusions. Creative methods of idea generation are a powerful tool for developing innovative projects in the field of high-tech engineering. Linear methods help to structure information and find new approaches to solving problems, while intuitive methods stimulate imagination and engage the subconscious mind. The combination of these approaches allows us to create unique products that meet the requirements of the modern market and lays the foundation for further technology development.

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