Інформаційні технології

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DIGITAL TECHNOLOGIES WITHIN INNOVATIVE TECHNICAL SYSTEMS

The Impact of Digital Technologies with Elements of Artificial Intelligence on the Structure and Nature of Modern Innovative Technical Systems in Smart Transport Vehicles

Summary. *In modern conditions, where new ideas are constantly emerging and, as a result, spontaneously identical ideas may arise in parallel across different developer structures in various countries, the tasks of correctly classifying and identifying innovative solutions based on TIPS formulations and definitions become particularly significant. At the same time, issues of patent protection are becoming an increasingly crucial element in the development of projects.*

Not long ago, most invention topics had a fairly localized nature, and the positive effect of their application was determined and identified relatively simply.

Today, as computer-aided design methods—particularly those from the SolidWorks software family, which can justifiably be identified with artificial intelligence—have deeply permeated the process of making technical and technological decisions, the number of facts and features of technical solutions and their evolution up to the level of technical super-systems has grown significantly. This necessitates a localized alignment with definitions, principles, and methods for identifying the entire hierarchy of technical solutions, ranging from local technical solutions with non-regulated technical and technological *connections to complex, highly intricate conglomerates of local technical solutions.*

Since the issues of identifying all types and levels of technical solutions primarily affect the ability to systematically protect existing and emerging intellectual property—both at the level of active and efficient subsystems and at the level of active accumulators of subsystem properties and characteristics, i.e., technical supersystems.

Key words: *Developer Structures, Classification of Innovative Solutions, Identification of Innovative Solutions, TIPS (Theory of Inventive Problem Solving) Formulations and Definitions, Local Technical Solutions, Facts and Features of a Technical Solution, Conceptual Decision-Making Systems, Presence of a Clearly Expressed Subjective Factor, Active and Intensive Brainstorming.*

Introduction. It must be acknowledged that, for the first time in global practice, the optimization of classification for such varieties of technical solutions was carried out in publications by a modern specialist who possesses equal expertise in both methodology and techniques of classical design, combined with methods and techniques for developing computer programs—**Oleksandr Zaitsev.**

In this article, the author sets out to link the fundamental conclusions and definitions outlined in Oleksandr Zaitsev's publications with a specific methodology and system for making conceptual decisions in modern machine design processes that incorporate elements of artificial intelligence.

With the increasing complexity of challenges related to the development, modernization, and optimization of technology and engineering, isolated local solutions fail to satisfy customers. They seek ways to achieve the **ideal final result,** and reality compels them to search for **compositional, integrative, and comprehensive solutions** to address complex problems. This aligns with the terminology and definitions optimized by Oleksandr Zaitsev in his latest publications.

For modern technological innovations—largely shaped by active and intensive brainstorming sessions involving a sufficiently large team or group of specialists, each with varying degrees of vested interest in achieving an efficient outcome (which, in essence, can be considered an equivalent of the ideal final result)—there are real challenges in organizing the innovation process. These challenges arise due to objective factors, including **psychological, technological, and structural stereotypes.**

The emerging and continually arising obvious technical and technological solutions are evaluated and analyzed through the lens of conclusions drawn from the practical application of the laws governing the development and construction of industrial technologies, machines, and mechanisms—laws that originated at least a century ago, during a time when none of the modern materials, components, and assemblies, in combination with contemporary industrial electronics and laser technology, were known or, accordingly, applied.

This situation is further exacerbated by the fact that the recognition of a technical solution as an invention is based on different criteria in the **United States** and most other countries—**four criteria in the U.S.** versus **three criteria elsewhere.**

The **fourth criterion**, specific to the U.S. system, serves as a **subjective evaluation factor** that gradually fosters the development and entrenchment of a **psychological stereotype**—one that divides new technical solutions into **obvious and non-obvious** categories.

The presence of a clearly expressed subjective factor introduces a comparison process into the evaluation of technical solutions, wherein these solutions are assessed against **known structural or technological elements and their combinations**—elements that are familiar from previous, well-documented developments.

However, the **familiarity** of a given solution and the nuances of its implementation **cannot be considered an objective factor** since the determination of a technical solution's **obviousness or non-obviousness** fundamentally depends on the **level of knowledge and professional competence** of patent office experts.

In **modern designs and technological solutions**, **novelty** is no longer merely a reflection of **a single technical discipline**; rather, it is a reflection of the **integration of multiple disciplines**, including **electronics, microelectronics, advanced materials science, fiber optics, and laser technology**.

This necessitates an **evaluation from multiple perspectives** of obviousness or non-obviousness—an assessment that can only be carried out by **highly specialized experts** in collaboration with **specialists in complex system integration**.

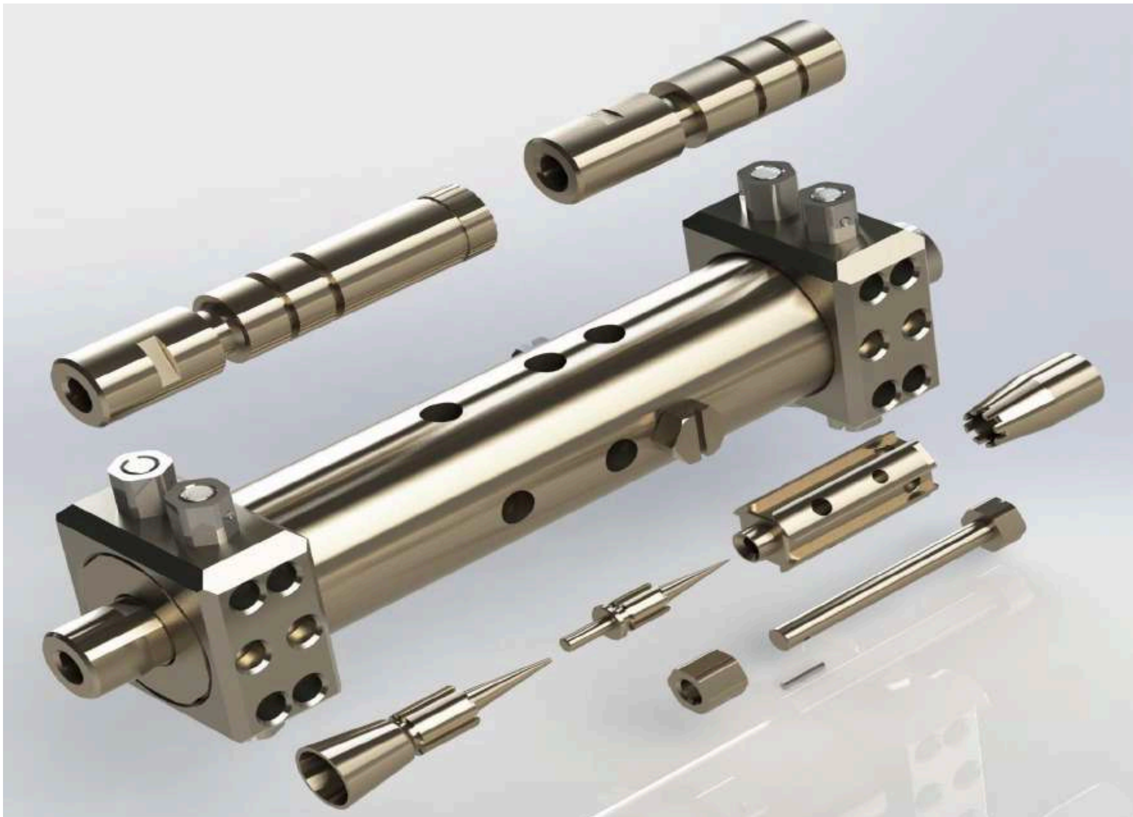

Fig. 1. The illustration presents an example of a modern design development of a real-time liquid homogenization system within a pipeline, operating without the use of chemical reagents or stabilizing mixtures

As shown in the figure, the capabilities of contemporary **SolidWorks family design software** allow not only for the representation of the system as an **assembly unit** but also as a **set of individual components** required for assembling this unit. The software enables a **visualization of both the external appearance of the individual components and the entire assembly**, taking into account the selected **structural material**.

If the development is intended as a **fundamental technical solution** for a **future invention**, these capabilities necessitate **full alignment** with the **laws and principles of TIPS** (Theory of Inventive Problem Solving).

TIPS was conceived in the post-war period as an **"exact science,"** despite the fact that, even then, the **inventor community** recognized a **critical question**: to achieve the declared **Ideal Final Result (or its equivalent),** the foundation of any **new technical solution** must primarily rely on **an individual capable of generating functional and innovative ideas**.

Today, we can confidently assert that an individual can play a **significant role** in this process **only if they possess appropriate intellectual tools**—first and foremost, **software tools**.

At the time, society assumed that **any qualified specialist** or **skilled worker**, when equipped with a well-structured and effective **theory of inventive problem solving**, could generate **new ideas** and refine them into **real-world results**. This belief contributed to the enthusiastic reception of the newly developed **TIPS methodology** within **the professional community**, as it was founded on both **scientific-technical** and **psychological principles**.

For some time, the **laws and methods** of TIPS remained **adequately aligned** with the **technological and engineering capabilities** of the era. However, the first **discrepancies** began to emerge **clearly** with the introduction of **automated production lines**, followed by **numerically controlled (NC) machine tools**, and, ultimately, the advent of **digital technologies** in combination with **innovative materials science** and **composite materials**.

Returning to the **optimized and refined definitions** and **classification terms** of **technical solutions and technical systems at all levels**, as formulated by Oleksandr **Zaitsev**, it is important to note that—even beyond their significance for TIPS—his **clear and unambiguous definitions** have **greatly streamlined** the development of key **engineering documentation**. These include **Technical Specifications (TS), Technical Requirements (TR),** and the **Technical Design Assignments (TDA) for new and innovative developments**, ensuring their **maximum compliance with current standards** at **all levels**.

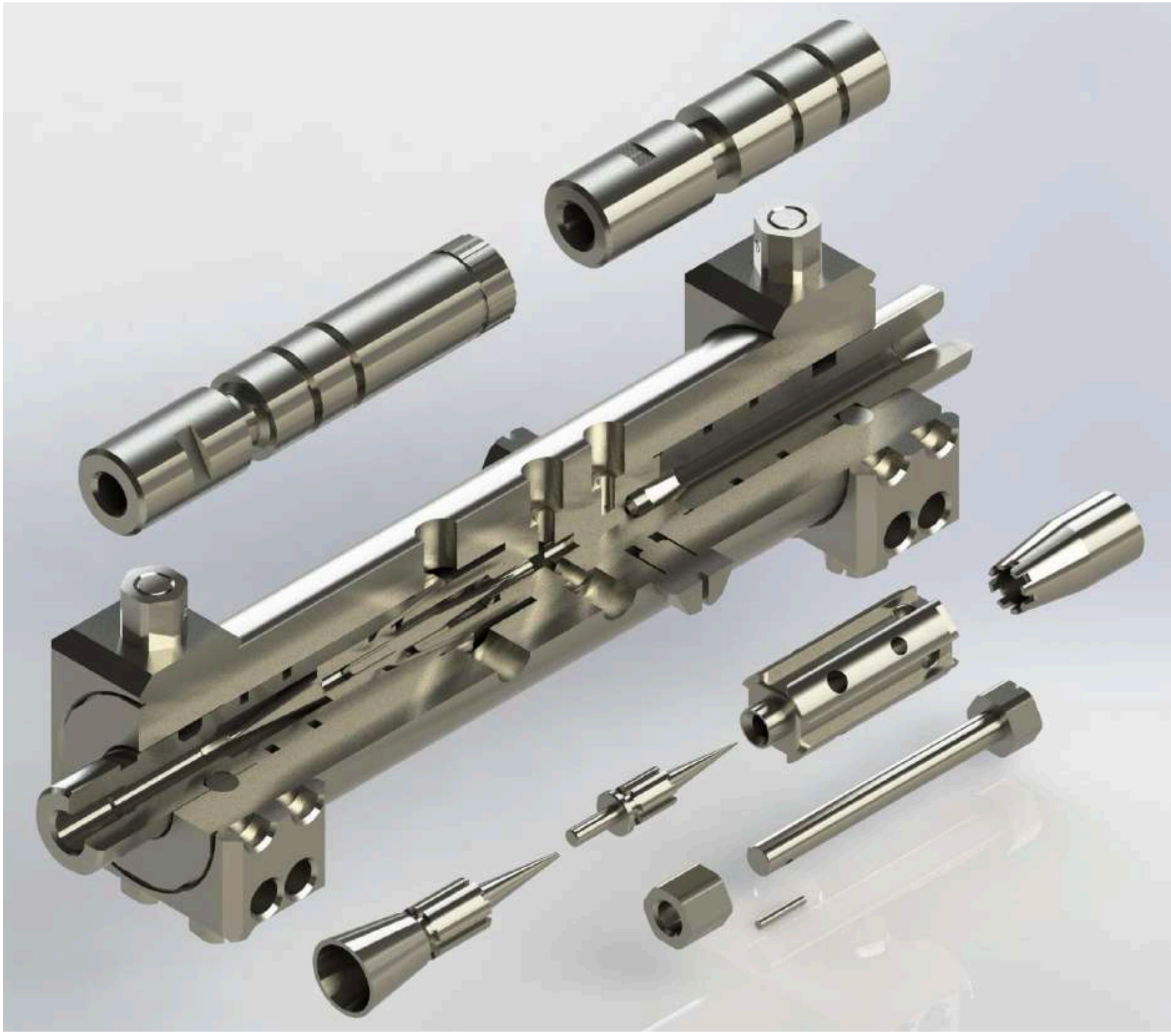

Fig. 2. The illustration presents the same project as in Figure 01, but with sectional cross-sections, providing a complete understanding of the internal structure of the technical solution and the geometrical requirements for its components

Of course, these are **not the only capabilities** of modern **computer-aided design (CAD) software**. However, when **combined** with the **principles, definitions, and methods of TIPS**, the **effectiveness of new innovative developments** can be further enhanced while simultaneously achieving a **significant reduction** in **design costs** and **time expenditures**.

What exactly is TIPS today?

How have modern **high technologies** and **processor-based systems** influenced its **compositional and integrational** capabilities?

These are **not the only questions** that require clarification. One important phenomenon to highlight is the **widespread trend of in-depth research into biological objects**, as well as **biomedical systems**, in search of **viable analogs** for **future inventions**—particularly within the framework of **biological aspects of mechanical research**.

How does this align with the **laws, methods, and techniques of TIPS and AIPS (Algorithm for Inventive Problem Solving)?**

At present, **many of the most intriguing and effective inventions** are emerging from **discoveries and systematic analyses** of **biological elements**, which **inspire** and **drive inventors** toward **new, complex, integrative technical solutions**. These solutions address **unconventional challenges** using **unconventional methods and techniques**, often **borrowed from the laws governing the evolution of living organisms**.

Thanks to **modern digital technologies**, these concepts can now be **modeled, systematically simulated, and tested** before formulating the **initial technical requirements and specifications** for inventors to work from.

Today, **numerous examples** of this approach can already be cited. More importantly, the **process of developing new methods and styles** in **computer-aided design (CAD)** continues to evolve and expand, aligning with the **ever-growing capabilities of computing hardware and specialized software**.

Challenges in Defining Key Parameters

For **inventors and developers**, one of the **most critical and difficult tasks** was the **precise definition** of **numerous parameters and relationships**, as these types of developments were being undertaken **for the first time**, with **no prior groundwork or established references** to rely on.

The application of **TIPS-recommended methods**, despite the fact that such **integration** had **never been attempted in previous projects**, made it possible to create a **fundamentally new product** that **almost reached the threshold of the Ideal Final Result (IFR)**.

This **immediately solved** a **series of technical, innovative, and integrative challenges**, enabling the **full autonomy** of the **newly developed object**. As a result, its **autonomous operating time** was rendered **practically unlimited**.

Thus, overcoming the **multidisciplinary technical problem conglomerate**, combined with **breaking through specific psychological barriers**, allowed for a **transition to the next phase of the design process**. This was achieved using **complex, integrative, modified, and optimized TIPS-based methods and techniques**.

The **integration methodology** described above, as applied in the **synthesis of innovative technical solutions**, is currently at the center of **numerous organizational, techno-technological, and scientific-technical initiatives**.

On **September 8, 2011**, the **U.S. Senate** passed the **Patent Reform Bill**, known as the **America Invents Act**. By that time, the **U.S. economy** had essentially become **innovation-driven**, with its innovative nature creating a substantial foundation for patent law requirements. Furthermore, the introduction of **artificial intelligence** elements in **software systems** and **process control program complexes** has created and continues to create a **conscious need** for a **systemic adjustment** of the core laws governing the development of **technical systems at all levels**.

The author of this publication provides a **typical example** from today's **design practice**.

In the catalogs and websites of all major suppliers of components, standard assemblies, and parts, along with the **drawings** of these parts and assemblies, there are also corresponding models in formats such as **SOLIDWORKS**.

In other words, the designer simply transfers these models into their own **technical solution**, which is also built in the **SOLIDWORKS** format.

This capability fundamentally changes the design process and enables the **selection and customization of component options in real-time** (while using the supplier's information as an integral and simultaneously **fundamental element** in the formation of the developed technical solution, with subsequent integration into all levels of the created technical system).

Such new capabilities allow for the introduction of the **new patent reform bill**, which proposes issuing patents based on the **time of filing**—whoever files first gets the patent. This approach has significantly simplified the resolution of disputed patents, as at the **patent registration stage**, there is no need to consider proof of priority. However, such evidence may still be used in court to declare a granted patent invalid.

This factor has a substantial **organizational, investment**, and **psychological** component, which shapes both the **psychological climate** in teams of developers of new technologies, as well as the system of relationships between **competing companies** and **investment structures**, including **component suppliers**, who are now considered an integral part of the **design process**.

At present, this patent filing approach based on **first-to-file** is used in almost all **developed countries**, including the **U.S.**

However, if we exclude so-called **hybrid inventions** in the field of **software**, then, in principle, nothing has changed. All derivative problems that arose because **software**, which can never be equated to a **technical solution**, for some reason began to be recognized as an **invention**, have led to the granting of patents for applications in which there is not even the slightest hint of a meaningful **technical solution**.

The evident ease with which thousands and thousands of patents have been granted for various **software** and partially **software-based** variations has led to the blurring of the principles of **workability** and **novelty**. As a result, including the **psychological discomfort** among investors, a parallel process has emerged that is not true **invention**, but instead driven by the **lawyer**, whose goal is not innovation but rather simple **litigation.**

Thus, the problems caused by the contradictions and imperfections of **TIPS** pale in comparison to the **global issues** that have arisen, and to some extent have been **initiated** by the **imperfections and vagueness** in the legislation.

When analyzing and forecasting future developments using the methods and analytical techniques of **TIPS**, as well as **computer modeling techniques**, during the **technological-dialectical synthesis**, this discovered phenomenon may provide real solutions for **effective use** in **innovative processes**, especially in the fields of **biotechnology** and **genetic engineering**.

An undeniable advantage of **TIPS**, since its creation, has been its attempt to apply **dialectical approaches** to solve **inventive problems** related to identifying and resolving contradictions.

To this end, **TIPS** developed a special algorithm (**AIPS**), which is a sequence of logical procedures aimed at presenting the inventive problem as a set of contradictions, along with a series of recommendations for their resolution.

In addition, **TIPS** books provided many interesting examples and problems, which in themselves had significant **cognitive** and **practical value**.

However, given the current state of affairs, the question arises: if contradictions in the classical sense do not exist, then how can we overcome **nonexistent contradictions**?

To some extent, answers to these questions are provided by the latest methods of utilizing the capabilities and advantages of modern design software.

Such depth and detail in the development of a design at the preliminary project stage allow, by using initial search versions of models, to complete the full cycle of computer modeling and simulation of the operating cycle of the device, without the need to manufacture prototypes for testing.

Moreover, the absence of the need for a special budget to verify the conceptual model allows for a significant reduction in development time and provides the opportunity to significantly increase the resources and time available for synthesizing innovative technical solutions aimed at the development and optimization of all project characteristics.

Within these capabilities, the systems of psychological relationships between technology developers, apparatus designers, and investors are substantially transformed, as the fear of making mistakes fades. With modeling and simulation of all processes within the device, errors are detected and, moreover, analyzed with suggestions for other, more efficient potential development paths for the project.

Let us now analytically examine the formulations of the laws of development of technical systems according to the TIPS classification:

1. The law of completeness of system components.
2. The law of increasing the degree of ideality of the system.
3. The law of displacing humans from the technical system.
4. The law of synchronization of system component rhythms.
5. The law of energy conductivity of the system.
6. The law of uneven development of system components.
7. The law of transition from macro-level to micro-level.
8. The law of increasing the degree of material-field interactions.

We also consider the modified qualification of technical systems proposed in Oleksandr Zaytsev's publications:

1. Technical system
2. Local technical system

3. Advanced technical system
4. Global technical system
5. Intelligent technical system

The Ideal Final Result (IFR) is the achievement of a result (problem solution) without complicating the technical system, with minimal resource expenditure (money, time, metal, clean water, etc.). From the perspective of solving environmental protection tasks, all resource-saving, waste-free technologies fall under the IFR framework.

How to formulate the Ideal Final Result? To do this, it is necessary to define the primary useful function of the technical system, i.e., to answer the question "What is this device created for?" For example, a mobile phone was created for communication in the absence of a landline phone. Therefore, the ideal final result is the ability to instantly connect with anyone anywhere on the planet (partially facilitated by the Internet).

The IFR in modern conditions must be formulated to:

1. Define the goal and direction of the solution; (today, the correctness of the goal selection is determined also by computer simulation methods and the imitation of output parameters and their variations depending on the variations and changes in the parameters of the technical characteristics of input standard components and subsystems, again taken from computer models of these components provided by companies—suppliers of components and standard parts and units).

2. Eliminate needless attempts when searching for a solution; (today, the number of attempts when searching for a solution is minimized due to the ability of the computer model of the technical system to simulate various versions of the model and simulate scenarios with the maximum number of versions of base parameters of technical characteristics, within the characteristics of all subsystems within the hierarchy of the super-system).

3. Guarantee high quality of the future solution. (Here, computer simulation methods of the production or operational cycle of the technical system take priority, and the task of comparative evaluation of the quality indicators of the system during simulation is set).

The concept of IFR is related to the concept of the ideal technical system – a system that does not exist, but its function is performed. Naturally, this is not always achievable. The IFR is not always attainable; that is why it is called an IFR. However, the so-called ideality of technical systems can be increased – this is the ratio of the system's useful functions to the costs of its development, design, production, and operation.

Everything said above suggests considering the basic laws of the development of technical systems in light of today's design, production, and operational capabilities.

Law of Completeness of System Parts

A necessary condition for the fundamental viability of a technical system is the presence and minimal operability of the system's core parts. Since the operability of the core parts of the system can be reliably checked through computer modeling already during the selection or classification stage in the design process, the minimum operability of the core parts of the system is determined quite precisely during the development stages. Furthermore, in modern technical systems, this law of its development does not pose any problems during its market introduction, falling within the scope of standard technical maintenance.

The Law of Energy Conductivity of the System

A necessary condition for the fundamental viability of a technical system is the continuous flow of energy through all parts of the system. Compliance with this law can also be accurately determined through computer modeling and by selecting only those components that fully meet the requirements of this law. For computerized technical systems, the law of energy conductivity is fundamental and ensures the most optimal operating conditions for technical systems.

The Law of Synchronization of the System's Parts Rhythm

A necessary condition for the fundamental viability of a technical system is the synchronization of the rhythm (frequency of oscillations, periodicity) of all parts of the system. Compliance with this law is ensured by the factor of computer modeling and the coordination of the local rhythm of all system components, including the rhythm parameters of all elements controlled by programmable processors and controllers.

The Law of Increasing System Idealization

The development of all systems is aimed at increasing their degree of ideality. Full-scale modeling and simulation of all system components, both statically and dynamically, in the context of modern integrative projects, allow for the optimization of the ideality of both local combinations of components and their ideality within the overall system.

The Law of Uneven Development of the System's Parts

The development of system parts is uneven. The more complex the system, the more unevenly its parts develop. Again, in the current conditions of real globalization, there are real opportunities to select all the basic and auxiliary components of technical systems that are at similar and equivalent stages of development, minimizing the disproportion between different subsystems within the framework of the super-system and within the subsequent hierarchy, where the considered super-system is a subsystem.

Law of Transition to a Super-system

Once the developmental capabilities of a system are exhausted, it becomes part of a super-system. Further development occurs at the super-system level. The current understanding suggests that with the presence of flexible computer control systems and data output through the internet, the transition of a subsystem to a super-system is largely determined by the level, power, and performance of the embedded computer systems.

Law of Transition from Macro-Level to Micro-Level

The development of the system's working components occurs initially at the macro-level and later at the micro-level. With the involvement of processors and programmable controllers at all stages of the design, manufacturing, and operation of the technical system, as well as the control and management of the working cycle and functions by controlling and monitoring computers with data output to the internet, the clear boundaries between the macro and micro levels become blurred. Furthermore, there is a situation where a system, while in the status of a subsystem, may, when connected to a cloud storage file, become a super-system in relation to a much more complex system.

Law of Increasing the Degree of Material-Field Connections

The development of technical systems moves towards an increase in the number of material-field connections. This factor, in conditions where technical systems are saturated with control and monitoring computer systems, adds numerous material-field connections, including both direct and feedback connections and lines for the exchange of information, as well as control and monitoring signals between all hierarchies of the technical system. This allows for the transition to a higher degree of material-field connections as the number of controlled and managed functions of the technical system increases.

It now makes sense to return to specific examples of modern developments, taking into account the comments on the laws of the development of technical systems and the modifications of definitions and classifications proposed in the publications by Oleksandr Zaitsev.

List of References, Patent, and Licensing Materials:

Appendix 1

United States Patent Application	**20110024842**
Kind Code	**A1**
Ferrao de Paiva Martins; Rodrigo ; et al.	**February 3, 2011**

PROCEDURE FOR THE USE OF NATURAL CELLULOSIC MATERIAL, SYNTHETIC MATERIAL OR MIXED NATURAL AND SYNTHETIC MATERIAL, SIMULTANEOUSLY AS PHYSICAL AND DIELECTRIC SUPPORT IN SELF-SUSTAINABLE FIELD EFFECT ELECTRONIC AND OPTOELECTRONIC DEVICES

Abstract

The present invention refers to the use and creation of natural cellulosic material, synthetic or mixed material and corresponding ***production*** process to be used simultaneously as physical and dielectric support in the creation of new field-effect electronic or optoelectronic devices, designated C-MOS structured electronic devices, designated interstrate, wherein its functionality depends on the capacity per ***unit*** area of the paper depending on how the fibers thereof are distributed, the fibers being coated by an active ionic or covalent semiconductor and allowing the ***production of flexible*** self-sustainable devices, disposable devices, based on the new integrated interstrate concept, of monolithic or hybrid types.

Appendix 2

United States Patent Application	**20180054464**
Kind Code	**A1**
Zhang; Yi ; et al.	**February 22, 2018**

METHOD AND SYSTEM FOR COLLABORATIVE INTELLIGENT VIRTUAL AGENTS

Abstract

The present teaching relates to method, system, and medium of ***automatic*** re-routing a chat user in a dialog. A request is first received for re-routing the chat user, currently engaged in a dialog involving a first agent, to a second agent. The request comprises relevant information and context of the dialog that gives rise to the re-routing request. Based on the relevant information and the context of the dialog, a re-routing strategy is automatically determined in accordance with re-routing configurations. A second agent to which the chat user is to be re-routed to is then selected based on the re-routing strategy. The chat user is then re-routed to the second agent to continue the dialog.

Appendix 3

United States Patent Application	**20170190052**
Kind Code	**A1**
Jaekel; Rainer ; et al.	**July 6, 2017**

METHOD AND SYSTEM FOR PROGRAMMING A ROBOT

Abstract

The invention relates to a method for programming a robot, in particular a robot comprising a robotic arm, in which method a movement to be performed by the robot is set up preferably in a robot programme by means of a predefined motion template, the motion template is selected from a database comprising a plurality of motion templates, the motion template comprises one or more execution modules that can be parameterized and at least one learning ***module,*** the one or more execution modules are used for planning and/or performing the robot movement or part of the robot movement, the leaning ***module*** records one or more configurations of the robot during an initialization process, in particular in the form of a teaching process, and the learning ***module*** calculates parameters for the one or more execution modules on the basis of the recorded configurations, preferably using an ***automatic*** learning process. Also disclosed is a corresponding system for programming a robot.

Appendix 4

United States Patent Application	**20170372247**
Kind Code	**A1**
Tauber; Richard ; et al.	**December 28, 2017**

METHODS, SYSTEMS, AND ARTICLES OF MANUFACTURE FOR IMPLEMENTING SOFTWARE APPLICATION DEVELOPMENT AND RELEASES

Abstract

Various aspects described herein are directed to a system that develops and manages releases of software applications. The system includes a server-side

branch management ***module*** to automatically create one or more branches for deployment of a software application release, a deployment repository to store one or more box sets for a plurality of artifacts for the software release, and a code repository to store the plurality of artifacts. The system may further include a release management ***module*** configured to manage continuing releases of the software application, a continuous deployment dashboard ***module*** configured to receive the plurality of box sets from the deployment repository, and one or more development modules configured to create or modify at least some artifacts of the plurality of artifacts. The plurality of artifacts are automatically tagged with respective packaging types for ***automatic*** generation of the plurality of box sets.

Appendix 5

United States Patent Application	**20180311822**
Kind Code	**A1**
KAMINKA; Gal ; et al.	**November 1, 2018**

ROBOTIC COOPERATIVE SYSTEM

Abstract

An ***automatic*** method for autonomous interactions between robots, comprising an action of automatically receiving, by a transport robot, a request for transporting a service robot. The method comprises an action of automatically computing a location of the service robot. The method comprises an action of automatically moving the transport robot to the location of the service robot. The method comprises an action of automatically sending a signal from the service robot to the transport robot using a signal emitter incorporated into a mechanical element attached to the service robot. The method comprises an action of automatically coupling, using the signal, the mechanical element to a carrier element attached to the transport robot.

Appendix 6

United States Patent Application	**20180085917**
Kind Code	**A1**
TASCHEW; Maxim	**March 29, 2018**

Method for the Automatic Configuration of an External Control System for the Open-Loop And/Or Closed-Loop Control of a Robot System

Abstract

A method is provided for ***automatic*** configuring of an external control system for open-loop and/or closed-loop control of a robot system. In the method, an external control system and a robot system, including at least one manipulator and a robot controller, are provided. In addition, a connection is made for exchanging data between the robot system and the external control system. Description data is transferred from the robot system to the external control system. A mathematical robot model is created by the external control system on the basis of the received description data, and a communication is established between the external control system and the robot controller on the basis of the received description data.

Appendix 7

United States Patent Application	**20180332817**
Kind Code	**A1**
LEPEK; Hanan ; et al.	**November 22, 2018**

DEVICE AND METHOD FOR STORAGE TRANSPORTATION AND RELEASE OF FRAGILE INSECTS AND OTHER FRAGILE ITEMS

Abstract

A fragile substance storage transportation and release device comprises a frame for inserting cartridges to hold the fragile substance; a propulsion unit for propelling the fragile substance out of successive cartridges, cartridge by cartridge; and an opening mechanism for opening each cartridge one by one in coordination with a propulsion mechanism. The device is useful for distribution of fragile insects such as mosquitoes and there is a mechanism for ***automatic*** collection of insects from pupae.