Інформаційні технології

Doroshenko Pavel

General Director of Utex LLC

THE NATURE OF MODERN TECHNICAL SYSTEMS OF VARYING COMPLEXITY

The Influence of Digital Technologies with Elements of Artificial Intelligence on the Process of Industrial Design, as well as on the Type and Nature of Modern Technical Systems of Varying Complexity

Summary. *Today, when the process of making technical and technological decisions is deeply influenced by computer-aided design methods — especially the SolidWorks software family, which can rightfully be associated with artificial intelligence — the number of factors and features in technical solutions and their development up to the technical supersystem level becomes so significant that it demands localized consistency with definitions, principles, and identification methods of the entire hierarchy of technical solutions: from a local technical solution with non-adjustable technical and technological links (a subsystem), to a complex conglomerate of local technical solutions (a supersystem).*

It must be acknowledged that, for the first time in global practice, such classification optimization of technical solution types was achieved in the publications of a modern specialist who equally masters the methodologies and techniques of classical design and computer programming — Dmytro Sumtsov.

As challenges related to the development, modernization, and optimization of technology grow more complex, isolated local solutions no longer satisfy clients. They seek paths toward the Ideal Final Result (IFR), and reality pushes them to look *for compositional, integrative, and complex solutions — in full alignment with the terminology and definitions optimized by Dmytro Sumtsov in his recent publications.*

Issues of identifying all types and levels of technical solutions primarily affect the systemic protection of created and developing intellectual property — both at the level of active and effective subsystems and at the level of active accumulators of properties within technical supersystems.

Key words: *Digital technologies, Industrial design, Process and methods of industrial design, Technical systems, Nature of technical systems, Invention topics, Classification of technical solutions, Active property accumulators, Technical subsystems, Technical supersystems, Classification of originality and novelty of technical systems.*

The Influence of Digital Technologies with Elements of Artificial Intelligence on the Process of Industrial Design, and on the Nature of Modern Technical Systems of Varying Complexity

Until recently, most invention topics were fairly localized in nature, and the positive effects from applying those inventions were relatively easy to identify and evaluate.

Today, largely thanks to the growing capabilities of CAD tools, particularly those in the SolidWorks software family, the results of the design process allow us to more precisely assess the originality and novelty of the created technical systems — at any level of complexity.

Fig. 0-1:

Device for Homogenization for Integration into an Internal Combustion Engine

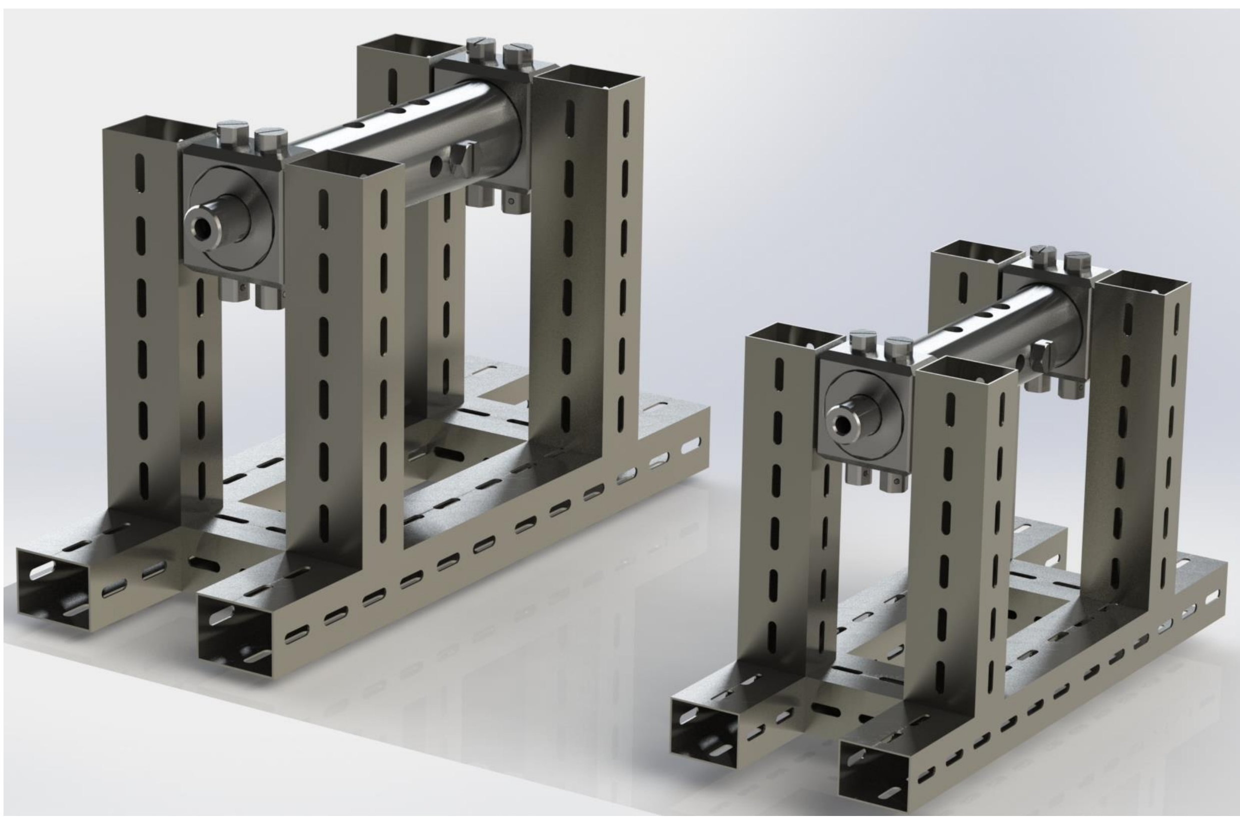

Fig. 1:

This image presents a design engineering concept for a real-time fuel mixture homogenization device.

As shown, the design process also simulates material-specific features and the influence of protective and decorative coatings used — all via the modeling capabilities of SolidWorks.

Designers can now create entire families of technical systems, which provides time-saving reserves and helps lower the overall cost of design work.

Today, with computer-aided methods — especially those in SolidWorks, which can reasonably be classified as tools of artificial intelligence — the amount of information relevant to a technical solution and its potential evolution into a technical supersystem has grown so much that this requires alignment with definitions, principles, and hierarchy-level identification methods: from local technical solutions with unregulated technical/technological relationships (subsystems) to complex conglomerates of localized technical solutions (supersystems).

It must be emphasized again that the first global-level classification optimization of such types of technical solutions was accomplished by a contemporary expert — Dmytro Sumtsov, who is equally fluent in classical design principles and modern programming techniques.

In this article, the author set out to connect Dmytro Sumtsov's key conclusions and definitions with the methodologies and systems used in conceptual decision-making during modern machine-based design with AI elements.

As technical and technological development tasks become more complex, isolated local solutions no longer meet the needs of clients who strive toward the ideal final result. Real-world demands now push them to search for compositional, integrative, and comprehensive solutions, as articulated in the terminology and optimized definitions from Dmytro Sumtsov's recent works.

Since the issues of identifying all types and levels of technical solutions primarily influence the possibilities for system-level protection of created and developing intellectual property, this applies both at the level of active and effective subsystems and at the level of active accumulators of properties and characteristics of subsystems — namely, technical supersystems.

For modern technological innovations — many of which are born through intensive brainstorming involving large teams or groups of specialists who are, to varying degrees, invested in achieving effective results (which can essentially be seen as analogs of the Ideal Final Result) — there are real challenges in organizing the innovation process. These challenges are caused by objective reasons, including psychological, technological, and structural stereotypes.

The technical and technological solutions that are either already known or continue to emerge are usually evaluated through the lens of historical experience — shaped by the application of industrial development laws for machines and technologies established at least a century ago, during a time when modern materials, components, industrial electronics, and laser technologies either didn’t exist or weren’t yet applied.

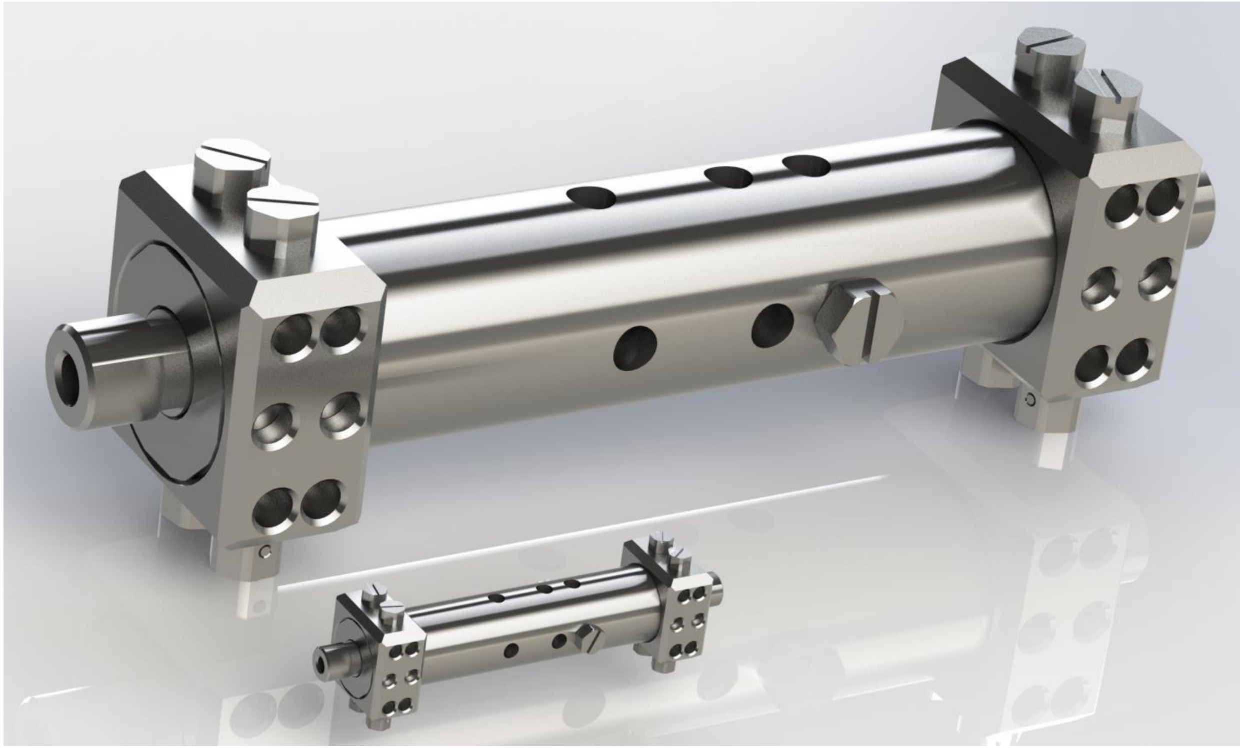

Fig. 2. Clearly demonstrates how computer scaling can be used to generate various standard sizes of technical systems within a single design process

The situation becomes even more complex when we consider that in the United States and many other countries, the recognition of a technical solution as an invention is based on a specific set of criteria — four criteria in the U.S., and three in most other countries.

That fourth criterion — a subjective factor in evaluating a technical solution — triggers the gradual development of a psychological stereotype that divides new technical solutions into "obvious" and "non-obvious."

This subjective element leads to comparisons between new technical ideas and well-known structural or technological components, along with their combinations — familiar from existing prior art.

However, the familiarity of any given solution, and all the nuances of its implementation, cannot be considered an objective factor, since the decision about the obviousness of a technical solution depends entirely on the knowledge level and professional competence of the patent office experts.

In today's designs and technical solutions, novelty no longer belongs to a single technical discipline. Instead, it reflects the integration of multiple fields — including electronics, microelectronics, modern materials science, fiber optics, and laser technologies — all of which must be evaluated for obviousness or non-obviousness by narrow experts in collaboration with integrative system specialists.

As a rule, CAD programs — especially those in the SolidWorks software family — make it possible to integrate brainstorming elements, allowing the designer to combine various features and tools in ways that support specialized design operations.

These operations are necessary to accurately account for the unique requirements and characteristics of a given technical system — or of a group of systems forming part of a composite supersystem.

Of course, much depends on the qualifications, experience, and adaptability of the operator (designer), as well as their flexibility in interpreting both standard and non-standard parameters and performance characteristics of the technical system — particularly when the system is regarded as a supersystem that contains multiple local technical subsystems.

This inevitably requires the ability to factor in standardization and unification principles and blend them seamlessly with original design elements.

Fig. 3. This illustration shows an example of a modern design concept for a real-time pipeline liquid homogenization system — executed without the use of chemical reagents or stabilizing mixtures

As can be seen, today's CAD programs (specifically SolidWorks) allow a project to be represented not only as a finished assembly, but also as a complete set of parts, with visual representations of both the individual components and the entire assembly, all while accounting for the chosen construction material.

If the development is intended as a baseline technical solution for a future invention, these capabilities must be fully coordinated with the laws and principles of TRIZ.

TRIZ was conceived in the post-war period as a “precise science,” despite the fact that even then, within the inventing community, there existed a critical question regarding the fundamental importance of having — at the core of the development and selection of a new technical solution — a person capable of generating useful, workable ideas, in order to achieve the declared Ideal Final Result (or its equivalent).

Today, we can rightfully say that personality may indeed play a significant role, but only under the condition that appropriate intellectual tools are available — first and foremost, software-based tools.

Back then, it was believed that any qualified specialist or trained professional, given access to a well-structured and effective Theory of Inventive Problem Solving (TRIZ), could generate new ideas and carry them through to a real-world final result. This newly established, scientifically and technically grounded — and even psychologically informed — methodology was enthusiastically embraced by the professional community.

For a while, all its laws and methods more or less aligned with the level of technological development at the time. But the first signs of misalignment began to appear with the introduction of automated production lines, then numerically controlled (NC) machines, and finally, digital technologies combined with advanced materials science and composite materials.

Returning to the optimized and modified definitions and classifications of technical solutions — and the systems that contain them — introduced by Dmytro Sumtsov,

we must note that even setting aside their value for TRIZ, his clear and unambiguous definitions have significantly streamlined the creation of vital engineering documents such as technical specifications, technical requirements, and, based on their content, Technical Assignments for new and innovative developments — all while ensuring full compliance with existing standards at all levels.

It is also important to consider the degree and level of unification for components and subsystems within a hierarchy, where technical systems function as subsystems relative to a larger supersystem, and where subsystems reside on the same hierarchical level, yet differ by level and degree of integration.

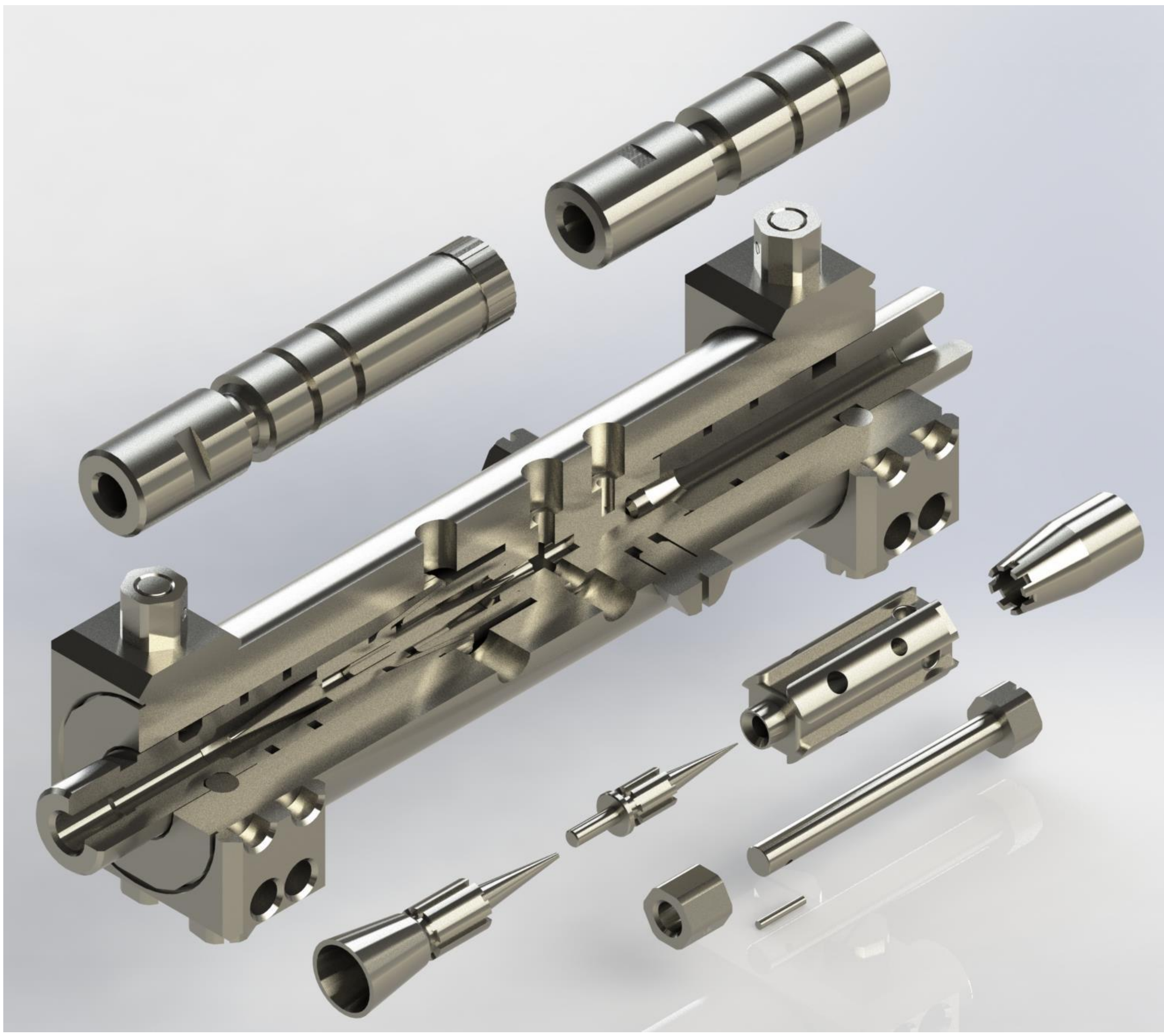

Fig. 4. Shows the same project as in Fig. 1, but with cross-sectional views that provide a full understanding of the internal structure of the technical solution and its geometric requirements

Of course, these are not the only features of modern design software. But when combined with the principles, definitions, and methods of TRIZ, they can significantly increase the effectiveness of new innovative developments — all while substantially reducing both time and design costs.

So what, then, is TRIZ today — in reality? How have modern high technologies and processor-based systems influenced its compositional and integrational capabilities?

These aren't the only questions to clarify. A particularly noteworthy trend is the deep search for analogs in biological systems — and also in medical domains that are biologically linked — as a source of viable prototypes for future inventions, especially when grounded in biological aspects of mechanical research.

So how does this biological analog searching align with the laws, methods, and techniques of TRIZ and ARIZ?

Today, the majority of interesting and effective inventions arise from discoveries, systemic analysis, and inspiration drawn from living nature, which push inventors toward new, composite, integrative technical solutions — often using unusual methods borrowed directly from natural development laws. Thanks to today's digital modeling technologies, these bio-inspired solutions can be simulated and tested long before formal technical requirements or specifications are finalized.

We can already point to numerous examples of this kind, and the trend continues:

The development of new methods and styles of computer-aided design is being constantly refined and expanded, in line with the ever-growing capabilities of computing systems and software.

For inventors and developers, it turned out to be both crucial and challenging to define a vast number of parameters and relationships, because this kind of work was being done for the first time, and there were no prior models or guidelines.

The use of TRIZ-recommended methods, despite the fact that such integration hadn't been applied in previous developments, made it possible to create a fundamentally new product — one that almost reached the threshold of the Ideal Final Result (IFR).

Naturally, this instantly resolved a series of innovative and integration-based technical problems and enabled the creation of a fully autonomous system.

In fact, the resulting autonomous runtime of the system turned out to be virtually unlimited.

Thus, overcoming a multidisciplinary conglomerate of technical challenges, along with a particular psychological barrier, made it possible to approach other design tasks using a set of complex, integrative, modified, and optimized TRIZ methods and techniques.

The integration methodology described above — used in the synthesis of an innovative technical solution — is now at the center of many organizational, techno-technological, and scientific-technical initiatives.

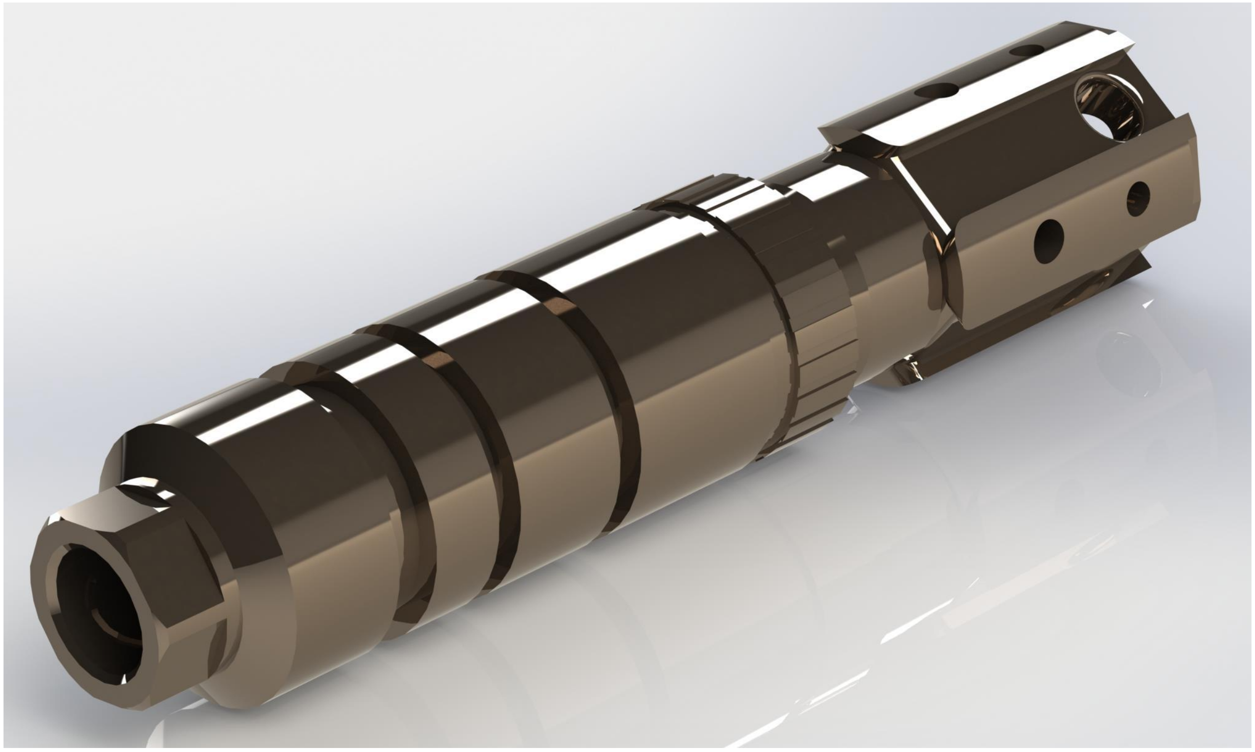

Fig. 5. Shows a component from the same technical system featured in Figures 3 and 4, but this version is not made of stainless steel — it's manufactured from metal-ceramic with a high content of carbon–carbon composite.

This Fig. demonstrates the expanded capabilities of full design simulation for all compositional elements. And when the external appearance and surface finish quality are crucial to the system's further use, these visualizations provide maximum information, enabling a comprehensive view of the assembled unit — presented as a technical system operating within a technical supersystem.

The author of this publication presents a typical example from today's everyday design practice:

In the catalogs and websites of all leading suppliers of components and standard assemblies, alongside the technical drawings, there are also ready-to-use 3D models — for instance, in SolidWorks format.

This means the designer simply imports these models directly into their own technical solution, which is also built using SolidWorks.

This capability completely transforms the design process, allowing for real-time selection and comparison of components and parts. Supplier data becomes an integrated and foundational element in the creation of the new technical solution, which is then fully integrated into all levels of the evolving technical system.

These new capabilities are so impactful that a new legislative initiative proposes shifting patent grants to a “first-to-file” basis — meaning, whoever submits the application first gets the patent.

This approach has greatly simplified the handling of patent disputes, since there’s no need to prove first inventorship at the time of filing. However, such proof can still be used in court to challenge an issued patent.

This factor has a serious organizational, investment, and psychological impact — shaping both the internal dynamics of development teams and the external relationships between competing companies and investors, including today's component suppliers, who are now a fully integrated part of the design process.

Today, this “first-to-file” scheme is used in nearly all developed countries, including the United States.

But if we exclude so-called hybrid inventions in software, then very little has actually changed — except that the resulting problems stem from the fact that software, which can never truly be considered a technical solution, has nonetheless begun to be recognized as an invention.

This has led to a situation where thousands upon thousands of patents have been issued for all sorts of software and partial-software solutions, often with no real technical content. The ease with which such patents are now granted has blurred the criteria for functionality and novelty. As a result — partly due to the psychological discomfort of investors — we now face a parallel system to real invention, in which the driving force is no longer the inventor, but the lawyer, whose goal is not innovation… but plain and simple litigation.

Thus, the problems caused by the contradictions and imperfections of TRIZ are not even comparable to the global issues that have arisen — and in some ways were even initiated — by the imperfections and vagueness of legislation.

When conducting analysis and long-term comprehensive forecasting using the methodology and analytical techniques of TRIZ, as well as computer modeling methods, this observed phenomenon can lead to real opportunities for effective application in innovation processes, especially in biotechnology and genetic engineering.

An undeniable strength of TRIZ since its inception was the attempt to use dialectical approaches for solving inventive problems — approaches based on identifying and resolving contradictions.

To that end, TRIZ developed a special algorithm (ARIZ), which is a sequence of logical procedures aimed at presenting an inventive problem in the form of contradictions and offering a number of recommendations for resolving them.

In addition, TRIZ literature presented a large number of interesting examples and problems, which themselves had significant educational and practical value.

But considering the current state of affairs, a valid question arises: What if a contradiction, in its classical sense, does not exist? Then how does one overcome a non-existent contradiction?

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

Such depth and detail in design elaboration — even at the preliminary design stage — now allow, using early draft versions of models, to carry out a complete cycle of computer modeling and simulation of the device's working cycle, without the need to produce physical prototypes for testing.

Moreover, the lack of a need for a separate budget to test a conceptual model makes it possible to significantly reduce development time, while also greatly increasing the available resources and time for the synthesis of innovative technical solutions, aimed at developing and optimizing all project characteristics.

Within these capabilities, the psychological dynamics between technology developers and investors also shift substantially — because the fear of making a mistake disappears from the relationship. During modeling and simulation of all device processes, errors are revealed and analyzed — and more than that, the system suggests other, more effective potential paths for project development.

Let us also adopt the modified classification of technical systems, proposed in the publications of Dmytro Sumtsov:

1. Technical System
2. Local Technical System
3. Developed Technical System
4. Global Technical System
5. Intelligent Technical System

The evolution of technical systems follows the path of increasing the number of substance-field relationships. This factor — in conditions where technical system complexes are saturated with control and monitoring computer systems — additionally provides a large number of substance-field connections, including direct and feedback links, as well as information exchange lines and control and monitoring signals between all hierarchies of the technical system.

This enables a transition to a higher degree of substance-field connections, while also increasing the number of controlled and managed functions within the technical system.

From here, it would make sense — in subsequent publications — to return to examples of specific modern developments, taking into account the commentary on the laws of technical system evolution, as well as the proposed modifications of definitions and classifications for technical systems of various levels of engineering and compositional complexity, as laid out in the publications of Dmytro Sumtsov.

References and Patent Materials

Appendix 1

United States Patent Application	**20170147681**
Kind Code	**A1**
Tankersley; Nicholas Matthew ; et al.	**May 25, 2017**

Portable Control Modules in a Machine Data Driven Service Monitoring System

Abstract

The operation of an ***automatic*** service monitoring system (SMS) is directed by stored control information. Methods and mechanisms are provided to create portable control modules based on the control information. The portable modules may be transmitted or otherwise conveyed to a second SMS and imported there to establish the control information that directs and determines operational aspects of the second SMS.

Appendix 2

United States Patent Application	**20170188352**
Kind Code	**A1**
LEE; Eunjong ; et al.	**June 29, 2017**

UPLINK DATA TRANSMISSION METHOD IN WIRELESS COMMUNICATION SYSTEM AND APPARATUS FOR THE SAME

Abstract

A method for transmitting uplink (UL) data requiring low latency in a wireless communication system according to the present invention, the method performed by a user equipment comprises transmitting contention PUSCH resource block (CPRB) indication information used for identifying a particular UE and/or particular data to an eNB; transmitting UL data to the eNB through CPRB resources of a contention based PUSCH (CP) zone; and receiving a hybrid ***automatic*** retransmit request (HARQ) response with respect to the UL data from the eNB through a physical hybrid ARQ indicator channel (PHICH).

Appendix 3

United States Patent Application	**20170017368**
Kind Code	**A1**
Maheshwari; Sonal ; et al.	**January 19, 2017**

INTERFACE FOR AUTOMATED SERVICE DISCOVERY IN I.T. ENVIRONMENTS

Abstract

An ***automatic*** service monitor in an information ***technology*** environment may be equipped to automatically process machine data originating from a running IT environment to identify the entities that perform services in the environment, and to reflect the discovered entities and service associations in the control and configuration data that directs the monitoring operations performed by the system. A related user interface is taught.

Appendix 4

United States Patent Application	**20160239761**
Kind Code	**A1**
SIMARD; PATRICE Y. ; et al.	**August 18, 2016**

FEATURE COMPLETION IN COMPUTER-HUMAN INTERACTIVE LEARNING

Abstract

A collection of data that is extremely large can be difficult to search and/or analyze. Relevance may be dramatically improved by automatically classifying queries and web pages in useful categories, and using these classification scores as relevance features. A thorough approach may require building a large number of classifiers, corresponding to the various types of information, activities, and products. Creation of classifiers and schematizers is provided on large data sets.

Exercising the classifiers and schematizers on hundreds of millions of items may expose value that is inherent to the data by adding usable meta-data. Some aspects include active labeling exploration, ***automatic*** regularization and cold start, ***scaling*** with the number of items and the number of classifiers, active featuring, and segmentation and schematization.

Appendix 5

United States Patent Application	**20160128090**
Kind Code	**A1**
AZARIAN YAZDI; Kambiz ; et al.	**May 5, 2016**

HYBRID AUTOMATIC REPEAT/REQUEST (HARQ) RELIABILITY IN WIRELESS COMMUNICATIONS

Abstract

Various aspects described herein relate to hybrid ***automatic*** repeat/request (HARQ) communications in a wireless network. A first instance of a HARQ communication is transmitted or received over a first set of one or more links. Based on the transmitting or receiving the first instance of the HARQ communication, a scheduling grant can be received for a second instance of the HARQ communication over a second set of one or more links different from the first set of one or more links. The second instance of the HARQ communication can accordingly be transmitted or received over the second set of one or more links based at least in part on the scheduling grant.

Appendix 6

United States Patent Application	**20160128091**
Kind Code	**A1**
AZARIAN YAZDI; Kambiz ; et al.	**May 5, 2016**

COMMUNICATING HYBRID AUTOMATIC REPEAT/REQUEST (HARQ) FEEDBACK IN WIRELESS COMMUNICATIONS

Abstract

Various aspects described herein relate to transmitting hybrid ***automatic*** repeat/request (HARQ) feedback. A HARQ communication can be received over a set of one or more links based on a first scheduling grant. One or more interference parameters related to receiving the HARQ communication can be determined as well as one or more predicted interference parameters for a next HARQ communication. HARQ feedback can be transmitted for the HARQ communication including the one or more interference parameters and the one or more predicted interference parameters.

Appendix 7

United States Patent Application	**20150363688**
Kind Code	**A1**
Gao; Jianfeng ; et al.	**December 17, 2015**

MODELING INTERESTINGNESS WITH DEEP NEURAL NETWORKS

Abstract

An "Interestingness Modeler" uses deep neural networks to learn deep semantic models (DSM) of "interestingness." The DSM, consisting of two branches of deep neural networks or their convolutional versions, identifies and predicts target documents that would interest users reading source documents. The learned model observes, identifies, and detects naturally occurring signals of interestingness in click transitions between source and target documents derived from web browser logs. Interestingness is modeled with deep neural networks that map source-target document pairs to feature vectors in a latent space, trained on document transitions in view of a "context" and optional "focus" of source and target documents. Network parameters are learned to minimize distances between source documents and their corresponding "interesting" targets in that space. The resulting interestingness model has applicable uses, including, but not limited to, contextual entity searches, ***automatic*** text highlighting, prefetching documents of likely interest, automated content recommendation, automated advertisement placement, etc.

Appendix 8

United States Patent Application	**20140304684**
Kind Code	**A1**
Howard; Kevin D.	**October 9, 2014**

Method For Automatic Extraction Of ***Design From Standard*** Source Code

Abstract

A system and method for ***automatic*** code***-design*** and file/database***-design*** association. Existing source code is analyzed for process and control elements. The control elements are encapsulated as augmented state machines and the process elements are encapsulated as kernels. The new elements can then have meta-data attached (including, a name, I/O method, and test procedures), allowing software code sharing and ***automatic*** code/file/database upgrading, as well as allowing sub-subroutine level code blocks to be accessed directly.