

An Official Magazine of the
American Composites Manufacturers Association

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CM

Composites Manufacturing

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Welcome to COMPOSITES 2005

How Composites Entrepreneurs Can Nurture Innovation, Invent on Demand, Incorporate Value Adds, Solve Critical Challenges, Get Ideas to Market, and Leap Frog the Competition

By Zion Bar-El

Today's marketplace is somewhat like a war zone with manufacturers battling to find the tools and technology that will help them beat the competition and keep their companies thriving. For the composites industry, the ability to expeditiously commercialize and integrate products in a broad range of applications requires what is fast becoming the greatest commodity in American business—innovation.

It is becoming more and more critical to solve problems during the design stage of a new product, to invent on demand, identify next generation products and leapfrog the competition to gain competitive edge. Ideation International is now marketing an operating system that nurtures innovation and cuts the time it takes companies to solve critical challenges and get their ideas to market.

Ideation's TRIZ (pronounced trees) is a knowledge-based, problem-solving methodology that offers the only operating system for innovation available today. Supported by software tools, publications, training, and analytical services, I-TRIZ helps companies control their marketplace with intellectual property management. The I-TRIZ method is a systematic methodology to promote technological innovation and inventive engineering that combines knowledge bases with a range of software tools intended for problem definition and solution, and for supporting development processes.

The method is studied at several universities in the world and is followed by leading companies in the United States, Japan, and Europe. In the automobile industry, it operates in giant companies such as GM, Ford, Chrysler, Toyota, Dana, Rockwell, and TRW; in the communications and electronics industry it is applied at Motorola, Honeywell, and Nortel; in petrochemicals it is used by such companies as Amoco, Dow, and Eastman; in the field of consumer products it is used at Xerox, Kodak, and Proctor & Gamble; and in aviation it is applied in foremost companies such as McDonnell Douglas, Allied Signal, Boeing, NASA, and Lockheed. In addition, the method has been used with the land and air forces of the American military.

Lou Luedtke, president and CEO of the National Composite Center (NCC), recently told *Industry Week* that if companies want to stay competitive in America, they will have to incorporate new value-adds more quickly into their product chains. Current trends point to the fact that over the next decade innovation will be the critical component to the survival of businesses around the globe. With I-TRIZ, composite and polymer-based companies can continuously build and increase intellectual assets while nurturing a culture for creativity within their own organizations.

"We want to provide industry with a system to help them innovate in a way they never thought possible before," said Zion Bar-El, CEO

and Founder of Ideation. Staffed by 85 percent of the world's leading TRIZ scientists, Ideation is active in 40 countries and 60 universities and has trained more than 250,000 people around the globe. Ideation has completed projects ranging from commercial products to fluid systems, material development, oil, medical, automotive, chemical, electronics/electrical, and heavy equipment.

Decision Support Systems

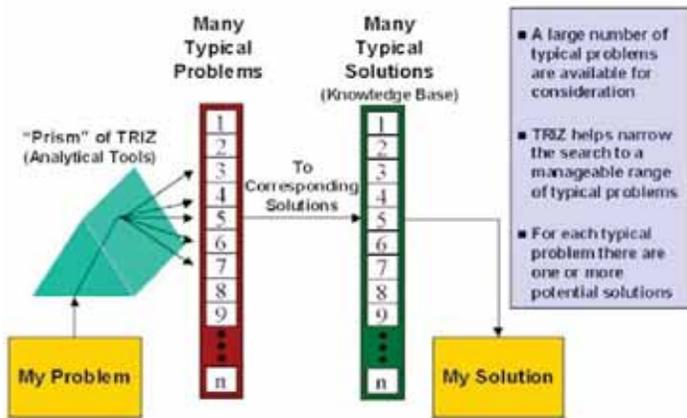
The I-TRIZ approach, compared with other conventional methods based on psychology and management theory (such as brainstorming), is that it is founded on the R&D of engineering sciences and technology. Three million patents were studied from across the globe and in all known domains of engineering with the goal being to identify and refine recurrent principles and to formulate them as a series of rules and structures transmissible across domains by means of computerized knowledge bases and software.

The software may be defined as a combination of decision support systems (DSS) and expert systems, and they are fed by the thousands of generic technological principles arranged and connected in the knowledge base that is primed for intuitive and friendly use. Accordingly, the link of the I-TRIZ method to managerial and psychological theories and models is primarily complementary, but it seems that its *relevance* to contemporary technology-based business ecology is much greater.

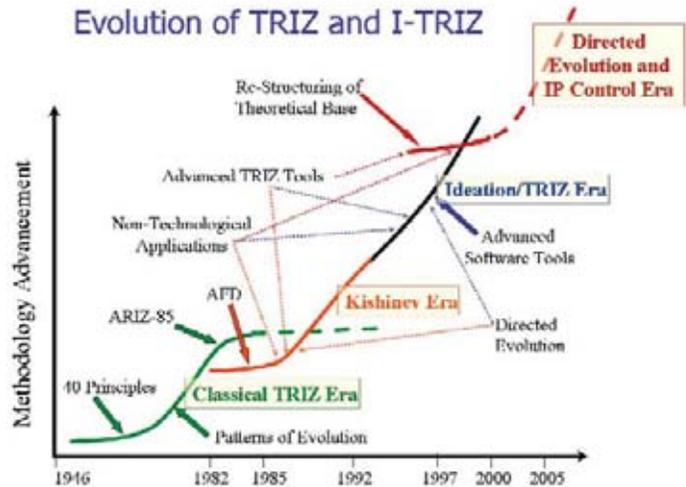
From the strategic-management perspective, correct application and embedding of the system leads to significant acceleration and improved efficiency of R&D processes, significant reduction in time to market, and a general and rapid rise in value of the firm's intellectual capital through registration of patents and copyright, and earlier identification of the firm's products as brand names. Furthermore, as we shall see, the very application of the method can serve as a lever for more profound changes in business processes associated with the work culture and with protection and development of the organization's intellectual capital.

From the engineering perspective, the method may be seen as a thinking tool and as a repository of applicable knowledge leading to intensification of the professional capabilities of the subject matter expert and to systematic exploitation of the professional and intellectual potential in the technical development, production, and support teams. The target audience that has to keep abreast of developments in the sphere includes CEOs, start-up companies, development managers, venture capital fund managers, production managers, industry and administration managers, product managers, engineers, inventors, and technological/engineering entrepreneurs.

How Ideation/TRIZ Works



Evolution of TRIZ and I-TRIZ



Origins and Transitions

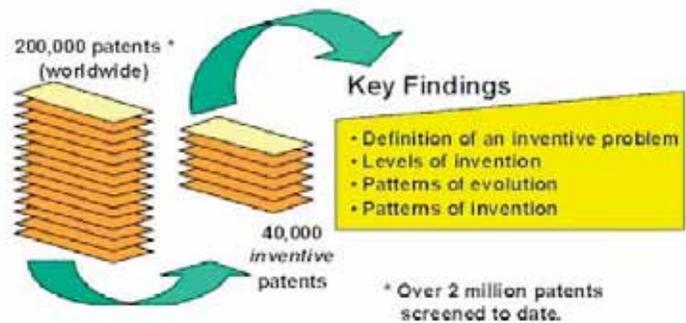
The history of the TRIZ approach is no less colorful and fascinating than its intellectual aesthetics. The “W. Edwards Deming” (TQM) of I-TRIZ is Genrich Altshuller, and in 1946 he fired the first round in a huge intellectual effort by hundreds of researchers and thousands of students. Already at age 14, Altshuller had won recognition as an inventor by virtue of a device he developed for underwater breathing. As an inventor he was recruited to serve in the Soviet fleet as a patent tester. During those years in which he assessed and studied thousands of patents he began his life’s work: identification of recurrent principles and patterns characterizing inventive engineering thinking.

The systematic study of these principles, he thought, could lead to more rapid and efficient application of inventive engineering solutions. He considered invention ability inherent in every person, if only he or she were trained to think in that way and to use the right tools. A letter of concern he wrote to Stalin in 1948 led to a year of interrogation and torture, at the end of which he was sentenced to 25 years imprisonment. In the frozen north of Russia jail, the first TRIZ research institute budded. Surrounded by intellectuals, engineers, artists, and scientists, Altshuller continued to develop the theory, and shortly after the death of Stalin in 1953 he was freed from prison.

Two years later Altshuller’s first publication on TRIZ appeared. As the years passed, with some advances and setbacks, the method was applied in the former Soviet Union to thousands of technological problems and in almost all the known spheres of engineering and science. Mainly for political reasons, in certain years occupation with the method went underground, and was studied by small groups of intellectuals—Altshuller’s pupils, with whom he never hesitated to generously share the knowledge and theory he had developed. Altshuller published 14 books and wrote hundreds of articles on TRIZ subjects. He studied over 200,000 patents, of which he identified about 40,000 as representing the most effective solutions in almost every domain. He established the classical era as a foundation for what was to follow.

A number of his outstanding pupils, headed by Boris Zlotin, founded in Kishinev in the early 1980s, a research institute engaged in the continued development of the theory and its application as a commercial enterprise. In 1992, an engineer and well-to-do business-

TRIZ is Based on Technology, Not Psychology



man entered the picture, an Israeli long domiciled in the United States, Zion Bar-El. He heard of the method, became enthusiastic about it, and acquired the research institute in Kishinev with all its scientists and intellectual capital, and transferred it to Detroit, the capital of the American automobile industry. There, orders and projects from several leading companies in the branch were already waiting.

The steadily accumulated experience about the way western economy works, combined with limited capital resources and time for development, allowed the team of scientists concentrated in Detroit to elevate the method to new and startling theoretical and practical levels. In recent years, the method has been augmented by dozens of additional engineering principles, more efficient work methods than the classical development, and new and original thinking and practical tools (especially in systems’ failure forecasting (AFD) and directed evolution of product development).

The entire approach has been geared to work in harmony with the new business ecology of contemporary information economy, a real-time economy, hungry for technological innovation, an economy in which, as the great guru of the management Tom Peters argues, a new product must get the “wow” response from its customers. The software tools for defining problems and the all-embracing computerized knowledge bases developed by the American Ideation company under

the leadership of Zlotin, Zusmann, and their colleagues, have magnified the method and advanced it so far that we now talk of the Ideation/TRIZ (I-TRIZ) method, which constitutes a huge leap forward as compared with the classical TRIZ approach.

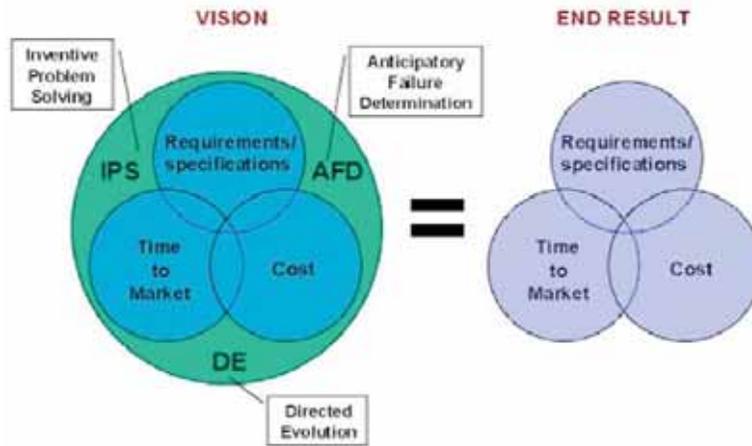
Principles and Applications

What is it in the method that allows anyone who has learned it and applies it properly to become a solver of technological problems? What does the method have that allows people with a natural bent for invention to become far more productive and efficient technological innovators? To answer these questions let us first turn to the matter of how the human brain works. One of the most striking analogies for describing the thinking process of the human brain is to see it as a barren wilderness stretching as far as the eye can see, scarred with gashed channels of dried-up riverbeds.

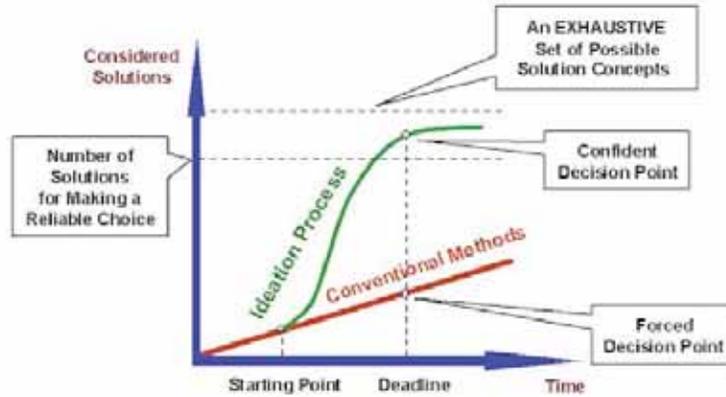
The raindrops that fall on this desert always drain into channels lower than the surface and are carried in them to the central channel, and thence to the drainage basin. The raindrops are like the information, the stimuli, and the experiences picked up by our brain from the environment. The river channels are analogies to the knowledge, experiences, paradigms, and earlier axioms that a person has experienced. As the previous rains dug deeper into the thinking channels, so does the rigidity of thinking that a person may suffer from become deeper and more firmly fixed.

Furthermore, as a person's area of professional expertise grows more profound, and as the level of his or her professional education in other fields sinks, (as a function of specialization and experience), so does the likelihood of his or her being able to see what lies beyond the walls of the thinking channel in which he or she is trapped. This comprehension of how the human brain thinks is not new. In the 1960s scholars in psychology and creative thinking wrote about it. The foremost and most vocal of them was probably Edward de Bono, whose techniques of lateral thinking

Development and Innovation Matching



Why is the Ideation Process Different?



were directed precisely to solving the problem depicted here: how to free the human brain from thinking in fixed patterns and channels, and to lead it to lateral thinking beyond thought channels.

The I-TRIZ innovation path provides a context in which brainware interacts with software, thereby leading to creative synergy. In essence, I-TRIZ may be seen as a way of thinking and methodical analysis intended to overcome the thinking rigidity by application of systematic principles of thinking for analysis and solution of problems, with emphasis on the engineering and technological domains. A problem-solver who uses the theory and its methodological tools dons a kind of pair of glasses that allow him a unique way of observing problems: a way intended to free the observer from psychological and professional fixations and preconceptions that restrict his or her ways of analyzing reality. The way of thinking and seeing reality by means of TRIZ encourages and almost forces on the

human brain creative thinking outside specialist channels and earlier paradigms. Compared with the usual methods, TRIZ does this through transferring scientific and technological knowledge across areas by means of analogical thinking. Exiting the regular thought channels is not done by general creative brainstorming but by the systematic examination of thousands of relevant applied analogies from variegated fields of science and technology.

The development from the 1990s of highly powerful computerized support tools, which include programs for defining and visual mapping of problems, alongside knowledge bases allowing easy, guided, and intuitive access to an enormous body of theoretical knowledge with over fifty years of thinking, make the I-TRIZ method a unique feature of the theoretical and applied landscape, in connection with modern managerial and organizational sciences.

The R&D person who puts on the I-TRIZ 'glasses' and uses its software tools and its knowledge bases analyzes the problems (problems of development and amelioration of an existing system, problems and

snags present in an existing system, problems connected with planning a new system from zero) in a special way, so in most cases he or she has a higher potential for identifying original and optimal solutions. What do the lenses of the TRIZ glasses consist of?

Let's look at problems from various fields and see how TRIZ lenses are applied and how they work. For demonstration purposes, we show only three principal lenses and the approaches to solutions deriving from them.

Lens 1: Principle of Ideality

Thinking components, methodology, and software (knowledge bases) that lead the observer to bring a system to its ideal state.

Problem: In a large poultry farm for egg production a conveyor belt carries the eggs from the laying house to the packing area. In the packing area an automatic arm lifts each egg off the belt and places it on the machine that stamps the production date, and then the

arm transfers the egg to the container. The farm managers want to improve the process in terms of time, cost, and complexity.

TRIZ thinking about the problems from the Ideality perspective: Problem solvers trained in the method and using its tools study the problem from the viewpoint that emphasizes a total solution to the problem and which avoids as far as possible offering solutions emphasizing local cumulative improvement. The assumption of the method is that the best system is one that performs its intended function at minimum (or without) existence of the system. Such a concept leads the problem solvers to identify the optimal and minimal solutions for achieving the desired action. Systems planned by the TRIZ concept will therefore use fewer resources, include fewer components, and their level of complexity (as well as the number of things that go wrong...) is expected to be optimal.

TRIZ solution of the problem by the 'principle of Ideality': A stamp with the production date will be placed on the inner side of the egg-lifting arm, so that whenever the arm lifts an egg it stamps it *with the actual stamping*, and then transfers the egg directly to the container. This solution will entirely eliminate the date-stamping machine, and will in fact achieve the desired result without the existence of a designated machine (with its cost and operation cost) and using existing processes. By applying the ideality principle, engineers of Ideation International Inc. engaged on a project for a large producer of vehicle brake assemblies were able reduce the number of parts in a certain braking system from twelve to only four, thereby reducing production costs by 50 percent, simplifying production processes, and raising the general reliability level of the system. The above principle may of course be applied to any system (electronics, mechanics, chemistry, optics, software) and to combinations of subsystems in various fields (electro-optics, biotechnology, etc.).

Lens 2: Principle of Contradictions

Thinking components, knowledge bases, and methodology leading the observer to identify and use contradictions in a system.

Problem: A big car maker faces the following dilemma: to reduce the weight of the car door while preserving the lateral protection it gives passengers against impact. To improve fuel consumption, the overall weight of the car is lowered and the weight of the door (because of a massive steel rod in its forward part that

serves to absorb the impact of collision) has to be reduced while its strength properties have to be maintained.

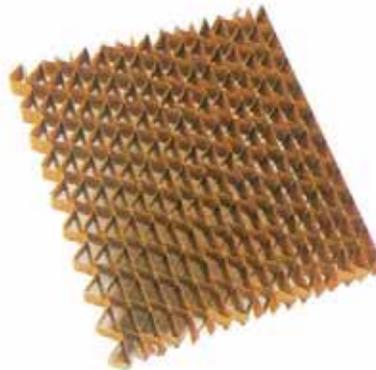
TRIZ thinking about the problem from the perspective of contradictions: The human thought pattern seeks to avoid opacity and situations of conflict and contradiction. These are therefore conceived as problematic and should be eliminated, and/or mitigated and adapted to familiar frameworks and thinking patterns. Problem solvers versed in the method

and who use its tools study the problem from the viewpoint that looks for contradictions in the system and utilizes them to its advantage. Contradictions exist in every engineering/technological system. For example, the physical strengthening of certain components will require an increase in the thickness or weight and by contrast will reduce the speed and/or will enlarge the volume of the parts. Every element and/or property in a system has positive and negative qualities. Classic improvement methods in systems strengthen



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working on a project for a large manufacturer of jet engines to reduce the weight of a particularly heavy engine part by over 30 percent, and thus increase the engine efficiency and decreased the energy loss of the aircraft.

Lens 3: Utilization of Resources

Thinking components, knowledge bases, and methodology leading the observer to identify and utilize most of the existing resources in the system.

Problem: Exhaust gas emissions from internal combustion engines (which use fuels) and/or from various production processes cause damage to the environment in general and to people working in vicinity of the systems in particular. New laws to protect the environment and the workers now require a significant lowering of pollution levels and the installation of expensive machinery in plants and cars to trace and control gas emissions.

TRIZ thinking about the problem from the perspective of use of existing resources in the system: Problem solvers trained in the method and who use its tools scrutinize an engineering/technological system from an angle that looks for overt and/or hidden and/or derived resources present in the system, and work to harness these resources for solving problems. The assumption is that an optimal solution to problems in engineering/technological systems does not add resources to the system but exploits existing resources, even if they are hidden. For example, in systems there may be energy resources (heat emitted in the system operation processes), time resources (dead time intervals in which a sub-component of the system performs its action), material resources (waste products and/or components present in the system), and more. The combination of existing resources allows production of many secondary resources, for example, a certain waste product in a system in combination with heat resources generated by the system may create a new kind of material resource that can be utilized for coating or energy, for example. The use of existing resources in a system allows better utilization and maximization of their advantages, and also firms up connectivity among sub-systems of the super-system without adding new components to it.

The TRIZ solution for the problem by the principle of 'Resource Utilization': The knowledge bases guide us to examples and principles indicating utilization of emission of gases in combustion engines for many positive purposes: exhaust gases from a car engine can

be used to operate alarm sirens in the case of auto theft, inflate airbags as necessary (for example to help change a wheel), and more. In some cases the problem can be solved entirely, together with a direct benefit: in advanced plows harnessed to tractors, the exhaust pipe of the tractor is connected to the plow and emits the gases next to the blade under the surface. In this process some of the noxious gases are filtered through the soil (an efficient filter), the plow blade gets a coating for its protection, and the soil is enriched by organic particles. This is a particularly elegant solution to the problem of gases because it achieves both a direct solution to the problem and a series of benefits without allocation of additional energy and/or material resources to

the system. This kind of solution makes possible identification of an endless range of specific gas emission problems.

In recent years these and many other principles have been arrayed in a framework of three systematic work methodologies (intervention areas) intended to lead the user along the path to identifying the principles most relevant to his or her specific problem in the shortest time. In practice, the method and the software tools support managers, R&D teams, work teams, and support teams in the following three intervention areas, each of which is now separate (with its own theory, methodology, and software tools), but which may be operated in an integral fashion.

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Inventive Problem Solving (I.P.S.)

The I.P.S. area is meant to support identification, definition, problem solving, and technological-engineering development in existing and planned systems. The problem solver who has to improve and/or plan a new system is conducted along a work path supported by software designed to allow him or her rapid and optimal detection of fundamental planning problems and their speedy solution. The software tools make it possible to formulate the various aspects of the problem and include production of flowcharts and computerized relationship systems among sub-systems, automatic production of the principal solution paths (concepts for solution), and direction to the parts of the knowledge base identified by the system as specially relevant to the application of the principal solutions. The problem solver exposed to the concepts of solution and the many illustrated examples showing earlier relevant patents used for solving similar problems to the one in hand may in most cases derive a creative analogy (solution) between the patent described in the knowledge base (which may come from any

existing area of knowledge and technology) and his or her particular problem (in any existing area of knowledge and technology). The I.P.S. domain has been applied in the solution of thousands of problems, from improving truck fenders (Ford) to optimal planning of complex production lines and processes in the oil and fuel industry (AMOCO). At present, advanced experiments are being conducted on the application of these principles to the software industry.

Anticipatory Failure Determination (A.F.D.)

The A.F.D. area is designed to support the location, diagnosis and anticipation of failures in existing and planned systems. The problem solver needing to identify failures in an existing system or to apply preventive anticipation (debugging) of failures in a new or planned system is guided along a software-supported work path constructed to allow him or her rapid and optimal detection of failures and their effective solution. The method user is required to engage reverse thinking; he or she becomes a 'saboteur' systematically testing how to wreck the system in the most efficient

way. To do so, he or she uses software tools that afford him or her systematic mapping of potential causes of failure in order of importance and probability, and automatic direction to those parts of the knowledge base identified by the system as specially relevant to solving the problem. In military terms, the approach is particularly efficient and applicable for locating the 'soft underbelly' of weapons systems in the hands of the opponent and inflicting damage on enemy systems. Here too the fundamental failures under consideration, like the abundance of offered solutions, are inter-domain in nature, so the problem solver is not restricted to solutions within his or her area of expertise or conceptual limits of thinking. The A.F.D. field has been applied to problems such as mechanical failure in helicopter rotors, producing microwire with intermetal compositions, and many others.

Directed Evolution (D.E.)

The D.E. area is designed to support technological prediction and active direction of evolutionary development of products and systems. D.E. is considered the latest and most complex area of the method, and space is too

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short to go deeply into detail about it here. In principle, it is identification of the place of a given system in relation to fundamental-general development tracks of technological systems as observed by longitudinal historical studies of thousands of products and systems throughout the course of human technological history. From analysis of the existing state of a system for which technological prediction is sought regarding these evolutionary principles, it is possible to identify the developmental stage at which the system is at the moment, and to identify alternative development tracks envisaged for it. Thus the system builders can actively steer towards whichever developmental alternative they choose, and prepare drawer plans (preliminary R&D) for the subsequent stages and define new markets for new products, while establishing the game rules and business primacy on the grounds of technological superiority (via securing its intellectual capital by means of patent fences, brand-names, and prior and obligatory definition of standards). Application of principles and tools in the domain allowed I-TRIZ people to propose R&D directions and strategies of commercial development to the American Northern Telecom (Nortel) company in the area of voice recognition. Similar projects are being conducted today for the petrochemical industry and in fields of wireless communication. In the world of business, where R&D constitutes an ever-growing part of company budgets, D.E. is considered the most promising and interesting area in the method. Because of its complexity, it is only partially supported by known software means.

Of two competitors working in the same eco-business branch, the one that adopts the method and inculcates it correctly may expect a more impressive adaptation ability to the contemporary knowledge economy, characterized by products' short shelf-life and encouragement of frequent technological innovation. The secret is simple, and in business terms it lies in the fact that the user of the method, its knowledge bases, and its software can gain more and richer solutions at a given point in time. The direct significance is higher potential to test and choose the best option for performance in a given time and/or to shorten the time of bringing to market a product that not only appears earlier but is also optimal from the viewpoint of production, development, and customer's needs. **CM**

Zion Bar-El is chief executive officer of Southfield, Mich.-based Ideation International Inc.: 248-353-1313; Cell: 248-613-3251; zbare@ideationtriz.com; www.ideationtriz.com

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