Do you have problems?

An obscure methodology originating in Russia in the 1940s, which has mainly been applied in engineering, is nevertheless being used today by CSC's solution architects working on their customers' most complex problems. It's called TRIZ. This article explains how TRIZ works and why we think it will become an important tool for the CIO and across the IT organization.

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Howard Smith and Mark Burnett are leading the development of CSC's TRIZ methodology.

The quotes shown in red in this article are the genuine responses of CSC staff to TRIZ in practice.

The IT portfolio brings a problem portfolio

Think back to the last time you delighted the business. Was it the result of systematic efforts or someone unexpectedly solving a key problem that was hindering progress? The problems you inherited from your predecessor are the solutions they created to counteract older problems buried deep in the history of your organization. How will you avoid leaving a similar legacy to your successor? If you must now cut further costs from IT budgets and at the same time develop valuable new business processes, there is no way out: problems associated with the existing legacy must be resolved. Can you afford to wait for flashes of genius by individual architects or for *ad hoc* ideas raised in skunkworks projects? Wouldn't you prefer to be a more reliable problem solver? Isn't problem solving your real job?

How do you feel about the problems you own? Do you bury those your team regard as insoluble? Do you believe the issues your organization faces are unique and have no known ideal solution? Do you often rely on compromise solutions rather than resolve real conflicts and so marry diverse requirements? Or are you of the view that, given sufficient time and resources, all problems that present themselves can be resolved? Perhaps you suspect that answers lie somewhere 'out there' and all that is necessary is to find the right book or the right consultant?

It's all too easy to give up on problems and abdicate responsibility for solutions. During moments of organizational stress, every manager has let staff leap to a sub-optimal solution and hastily proceed to implementation only to regret that decision at a later date. We all tend to believe our problems are exacerbated by factors outside our environment and therefore insoluble using only the resources under our direct control. Yet whatever we feel about the problem portfolio, only by solving them one by one can progress be made and services improved.

Beyond the specific problems CIOs face, every individual, every team and every organization share a common problem, that of *problem solving*. The solution to that problem is TRIZ.

TRIZ is the Russian acronym for the Theory of Inventive Problem Solving now being developed in North America, Europe and Asia. TRIZ is a systematic and structured approach to thinking supported by numerous tools. TRIZ is also a science based on patterns of invention and systems evolution. Companies using TRIZ find that it focuses their knowledge and talents on the problem-solving process.

To TRIZ, everything is a problem.

TRIZ can even answer these problems:

- I don't have any problems
- I have a problem but don't know whether there is a solution
- I have too many problems
- I have too many solutions
- I don't know where to start
- It's not my problem, it's their problem
- Why do these things always happen to me?
- Should I use TRIZ?

"TRIZ is a powerful way of boiling complex situations down to a sensible set of alternative ways of looking for a solution."

TRIZ is a treasure

It's easy to overlook TRIZ and easier to dismiss it as irrelevant. Most of the published case studies offer little of direct relevance to the CIO. For example, part of the TRIZ legendry is a problem in pile-driving.

The difficulty arises during construction of large buildings upon permanently frozen ground. Piles are driven into the permafrost to form a foundation. Piles need to be pointed at the bottom so that they could more easily penetrate the ice. On the other hand, for maximum load-bearing capacity and resistance to settling, piles must be blunt. Hence a contradiction: the piles should be both pointed and blunt. The presence of a contradiction is good evidence that a hard problem needs to be resolved.

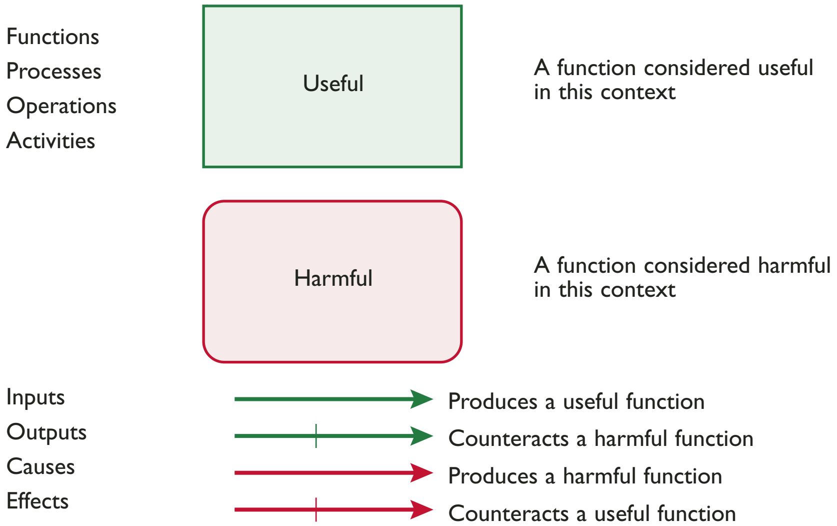
The solution to the pile-driving problem was to include a hollow chamber in the pointed pile and fill it with a wire, concrete rubble, and an explosive charge. After the pile was driven to its final position the charge was detonated, forming a blunt footing. This is an instance of the TRIZ inventive principle of 'separation in time': the pile is pointed while being driven and blunt when carrying load.

Examining the detail of many similar examples, CSC concluded that TRIZ principles can be used in any field, not just engineering. For example, separation in time has been used by a school child to resolve a conflict in the choice of school subjects and by a professional process engineer to reduce resource utilization. TRIZ is simple enough to be used in response to an email enquiry and sophisticated enough to guide an entire programme of activities. TRIZ is for school children as well as postgraduate scientists.

TRIZ is a large methodology being developed on multiple fronts. No single resource will fully inform you about TRIZ. It is a lifelong learning. At the same time, someone solved a problem with TRIZ after only two hours of initial training. Perhaps unique among structured methods, TRIZ is useful for everyday thinking as well as understanding a company's most complex problem, that of directing its future.

Most of the problems we now solve in information technology using TRIZ involve complex systems in which solutions are masked by myriad interconnected symptomatic factors. TRIZ has been used to strengthen the case for an IT change programme, to validate the case for outsourcing, to improve enterprise architecture to meet the needs of diverse stakeholders, to streamline the interface between service provider and service consumer, and to mobilize an IT systems migration previously dogged by analysis paralysis. When CIOs learn about TRIZ they discover a better way to make improvement decisions.

TRIZ models are a snap. They employ only two shapes and two types of connecting lines, shown in Figure 1. The simplicity is nevertheless sufficient for teams to focus on, collaborate around, share, agree, explore and resolve complex problems. Yet we know from experience of modelling business processes, data and architecture that business people won't invest time and effort helping IT architects draw diagrams unless they can clearly see the value to them – put simply, they want to bring the models to life in the enterprise.



"TRIZ smashes log jam decisions."

Figure 1 – TRIZ model notation

Fortunately, TRIZ diagrams translate directly to an exhaustive set of solution pathways, or 'directions for innovation'. These are the first step towards finding a solution to a hard problem, as shown in Figure 2.

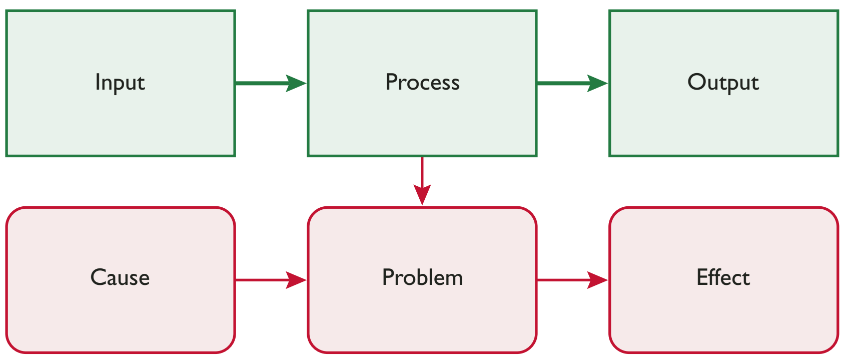


Figure 2 – One of many TRIZ patterns

Formulated solution pathways – Level 1

1. Find an alternative way to obtain [the] (Input) that provides or enhances [the] (Process).
2. Find an alternative way to obtain [the] (Process) that offers the following: provides or enhances [the] (Output), does not cause [the] (Problem), does not require [the] (Input).
3. Try to resolve the following contradiction: The useful factor [the] (Process) should be in place in order to provide or enhance [the] (Output), and should not exist in order to avoid [the] (Problem).
4. Find an alternative way to obtain [the] (Output) that does not require [the] (Process).
5. Consider replacing the entire system with an alternative one that will provide [the] (Output).
6. Find a way to eliminate, reduce or prevent [the] (Problem) in order to avoid [the] (Effect), under the conditions of [the] (Cause) and (Process).
7. Find a way to eliminate, reduce or prevent [the] (Cause) in order to avoid [the] (Problem).
8. Find a way to eliminate, reduce or prevent [the] (Effect) under the conditions of [the] (Problem).

Why models?

Models drive team players to focus rather than be distracted by unstructured discussion about the relative merits of solutions ideas thrown up at random. We have all been in meetings where time was wasted in undirected thought, and workshops that left many pathways unresolved, unexplored and with little or no convergence.

"The comprehensive output contrasts starkly with results from ad-hoc consulting approaches."

Ask someone to tell you about a problem situation and you will be showered with relevant input. Ask someone to contribute to the design of a solution and expect blank stares or a multitude of disconnected ideas. TRIZ focuses effort on problem definition and, from agreed models, automates the generation of solution pathways. By exposing all paths, team members are directed to consider all relevant solution options. TRIZ engenders a strong psychological benefit: by allowing the computer to make suggestions, people buy into promising solution options they might have dismissed if raised by a colleague with whom they compete. 'Not invented here' is minimized during workshops facilitated by TRIZ.

TRIZ converts vague aspirations into powerful statements about underlying problems. Instead of "I need to reduce customer complaints," TRIZ says "This service contains problems and needs to be improved". By rooting symptoms in the system that generated them and then striving to improve that system, doorways open towards solution concepts.

TRIZ automates the generation of improvement options from a model of a system's useful and harmful elements. In one case, a five-block model was sufficient to suggest, and commit to, a solution path. Following such pathways, teams reach out for and agree the solution action plan. TRIZ also provides the analogies, stories and illustrations necessary to help teams think laterally and convert concepts into concrete solutions.

TRIZ provides for iterative improvement. Solution concepts that emerge from TRIZ analysis can be improved by replying with the same method. Problems converted to solutions are iteratively analyzed to remove secondary problems that would otherwise impede implementation. Problems that are too large to solve effectively are decomposed and studied in the context of the larger system in which they exist.

TRIZ is fast. Models are easy to build and output is comprehensive. These advantages explain why practitioners take the time and effort to develop high-fidelity, finely detailed models. Models that describe problems in depth and breadth generate focused and relevant solution options.

TRIZ provides guidance on model building. For example, team members can challenge a cause and effect relationship to ask "what lies between?" or ask repeated questions to uncover root causes or generate projected effects. Using TRIZ, problem solvers work together to ensure that no stone is left unturned. They add detail to models through discussion with colleagues and focus model development on problematic focal points called 'contradictions' suggested by TRIZ tools. Refinement of a TRIZ model yields the domain knowledge necessary to generate solution-provoking ideas.

TRIZ models are intuitive and powerful communication vehicles. TRIZ embodies the multiple perspectives of stakeholders. What is useful to one person may be harmful to another. TRIZ enables the diverse views of key leaders in different parts of the business to be jointly brought to bear on the larger, systemic, problems facing the entire enterprise. A TRIZ model captures ambiguity and then resolves it.

TRIZ output can be voluminous. Problem solvers work through generated pathways diligently in order to select appropriate options. Some call it boring work. Directions are grouped and organized, for example into those that reduce cost, those that increase quality and those that require innovation. Often, directions are divided between specialist teams for further analysis. Yet experience shows that TRIZ is not obtrusive in business – on the contrary, once TRIZ is in use it gets applied in many ways. TRIZ models are frequently cut and pasted into other documents and TRIZ output provides a structure for report writing. Some TRIZ tools allow models, pathways and operators to be 'saved as' a Word document. TRIZ is often used as a consultant's report writer, template, methodology guide, knowledge base and analysis tool – which adds up to a significant productivity advantage.

There is no such thing as a standard TRIZ project. In one project, two hours with TRIZ may be all that is required. In another, TRIZ might become the dominant technique used over several weeks, or months. Sometimes, all that is required to find a solution is to read the generated TRIZ output, but more often than not additional work is necessary. The pathways guide brainstorming and many useful ideas are generated. Ideas are grouped to form prototypical solution concepts. The inventory of possibilities is fed back into TRIZ and new output stimulates a search for further options. As the TRIZ model approaches a description of reality, suggested pathways become ever more palpable and the solution is often realized.

"Anyone that is good at analysis would be able to understand a problem much more quickly by looking at a TRIZ model than a traditional 50-page analysis document."

The problem drives TRIZ. TRIZ is infused within the normal pattern of work of the organization. For hard problems for which there is no known solution in human knowledge, TRIZ provides the rigour needed to find a new approach. TRIZ is rarely, if ever, an overhead. Experience shows that TRIZ amplifies problem-solving capability by an order of magnitude or more.

A short, practical exposure to TRIZ is sufficient to produce a universally positive response. Everyone is surprised at the effectiveness of the method.

An everyday problem

TRIZ models generate pathways to solution options by following chains of useful and harmful functions, causes, effects and counteractions. Look at the TRIZ model in Figure 3 and then read the results below. Each is a distinct path along which to develop a solution.

"TRIZ will help build a business case for any change initiative among colleagues and management."

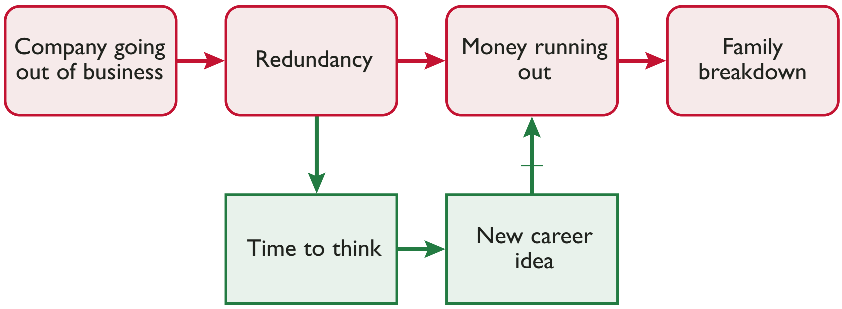


Figure 3 – Using TRIZ to address the problems of impending redundancy

Solution pathways are a starting point for problem solving. They originate from the TRIZ concept of 'ideality' – maximization of useful functions and minimization of harmful functions. Solution pathways for the model in Figure 3 include:

1. Find a way to eliminate, reduce or prevent [the] (Company going out of business) in order to avoid [the] (Redundancy).
2. Find a way to eliminate, reduce or prevent [the] (Redundancy) in order to avoid [the] (Money running out), under the conditions of [the] (Company going out of business), then think how to provide [the] (Time to think).
3. Try to resolve the following contradiction: The harmful factor [the] (Redundancy) should not exist in order to avoid [the] (Money running out), and should be in place in order to provide or enhance [the] (Time to think).
4. Find a way to eliminate, reduce or prevent [the] (Money running out) in order to avoid [the] (Family breakdown), under the conditions of [the] (Redundancy).
5. Find an alternative way to obtain [the] (Time to think) that offers the following: provides or enhances [the] (New career idea), does not require [the] (Redundancy).
6. Find an alternative way to obtain [the] (New career idea) that offers the following: eliminates, reduces or prevents [the] (Money running out), does not require [the] (Time to think).
7. Find a way to eliminate, reduce or prevent [the] (Family breakdown) under the conditions of [the] (Money running out).

TRIZ forces a close analysis of the chain of events leading to an undesired outcome (harmful function). It does so by challenging the tightly coupled events in the cause-effect chain, for example:

1. Consider opportunities for preventing [the] (Redundancy) caused by [the] (Company going out of business).
2. Consider opportunities for preventing [the] (Money running out) caused by [the] (Redundancy).
3. Consider opportunities for preventing [the] (Family breakdown) caused by [the] (Money running out).

TRIZ also allows for compromise, in a situation where it has been shown to be impossible or impractical to reveal and implement a solution that breaks an inherent contradiction within available time and resources. Examples include:

1.1. Find a way to benefit from [the] (Company going out of business).

1.2. Find a way to decrease the ability of [the] (Company going out of business) to cause [the] (Redundancy).

5.1. Find a way to increase the effectiveness of [the] (Time to think).

6.4. Consider modifying or influencing [the] (Money running out) to improve it being eliminated, reduced or prevented by [the] (New career idea).

7.2. Try to cope with [the] (Family breakdown).

More lateral thinking from TRIZ

TRIZ breaks distributed problems into domain-specific sub-problems. Personal experience is limited by the inventory of problems solved in the past. When confronted with a new problem, many consider only what they know and give up far too quickly when a solution does not readily present itself. Problems that arise from the interactions between elements of a larger system span so many fields that there may be no one person capable of solving it. TRIZ allows sub-problems to be farmed out to experts or specialist teams whilst maintaining cohesion over the whole solution. When solution parts are recombined the bigger problem is fully addressed.

Large or critical systems (in IT, organization or business) contain many problems and numerous potential failure modes. Instead of guessing the possible ways in which a design could fail, TRIZ recommends inverting the problem. Don't ask "Why did it fail?" after implementation; ask "How can we make it fail?" during the design phase. Bring in your best people and command them to create the failure using TRIZ!

"TRIZ could be perfectly easily coupled to other methods in use in the business – for example, Systems Thinking."

"How can we make this fail?" is specific and positive – it asks us to *create a solution to the problem of how to make something fail.* People are good at answering this kind of question, but bad at answering open and negative questions such as "What can go wrong?"

Be specific

"What can go wrong?" gives us no place to start. This is why, more often than not, we receive no answer to this question – or we end up relying on answers that are fatally incomplete.

Asking "How can we make this fail?" provides a place upon which to hang our reasoning – we start with 'this', whatever 'this' is – and consider it in the context of the whole, rather than starting with the whole – which is often too big for most people to get their heads around in one go. Identifying end states, intermediate events and initiating events provides starting points for formal analysis. Once we have starting points, we can follow the chains of cause and effect to see where they lead – or how one could arrive there. Once we have a place to start, we fan out and explore the possibilities systematically.

Be positive

Asking negatively phrased questions creates problems in the human psyche. When we ask ourselves "What can go wrong with our plan?" our minds go on the defensive, and denial kicks in to negate and minimize the possibilities of anything going wrong with 'our' system or plan. But when we ask the inverted question "How can I make something go wrong?" we focus on the offensive side of the game. Our mind's payoff now comes from finding possible failures and thus we engage our creative faculties actively to that end. When the problem is inverted, our attention is automatically diverted from *things that can happen* to *things that can be produced*. Therefore the next logical step is to identify the areas of science, business, engineering or even everyday life, in which the observed phenomenon is intentionally created. This directs us to a different information 'field' – namely, methods of production. The major benefit of this new resource is that it is always different from the area where the problem occurs and it is traditionally rich in options.

Intensifying failures using causes, effects and available resources opens problem solving to the entire TRIZ pattern and solution knowledge base to uncover all of the possible failures. A tree of possibilities is generated for each pathway. TRIZ reveals and predicts scenarios that would otherwise be obscured and which, if not addressed, could result in problems (harmful functions). For example:

1. Determine how [the] (Company going out of business) can be intensified.
2. Try to intensify the harmful impact on [the] (Company going out of business).
3. Consider additional ways to obtain [the] (Company going out of business).
4. Consider utilizing the resources of surrounding systems to intensify [the] (Company going out of business).
5. Consider utilizing the resources of [the] (Company going out of business) to deteriorate other systems.

...

12. Consider opportunities for intensifying [the] (Company going out of business) with help of resources of [the] (Time to think).
13. Consider utilizing the resources of [the] (Company going out of business) to deteriorate [the] (Time to think).
14. Consider opportunities for intensifying [the] (Company going out of business) with help of resources of [the] (New business ideas).
15. Consider utilizing the resources of [the] (Company going out of business) to deteriorate [the] (New business ideas).

SCOPE OF TRIZ

TRIZ applies to artificial systems created by humans as opposed to nature.

Social systems: Various groups of people, including organizations and associations, management systems, business processes, business model, legal systems, brands etc.

Intellectual systems: Religious and philosophical concepts, scientific theories and hypotheses, arts, etc.

Service systems: Education, healthcare, information technology, logistics, entertainment and similar processes.

Planning systems: Critical path analysis, strategy development, tactics, process improvement.

Technical systems: Machines, devices, equipment, manufacturing processes, design processes, utilization of materials.

"TRIZ helps a non-lateral thinker think laterally."

TRIZ applies universally

None of the techniques in TRIZ are domain dependent. Nevertheless, many people who meet TRIZ on the web or who attend a training course conclude it applies only in engineering and question its applicability to other fields. The reason is that many TRIZ experts who offer training or consultancy have an engineering background, because TRIZ originated there. TRIZ development began in the domain of mechanics and chemistry and progressed through other technical fields. Over the years consultants have developed specializations of TRIZ to cope with specific engineering situations. These specializations should not be confused with the underlying TRIZ theory. Today, TRIZ draws upon information science, creative education, medicine, management and business, social science, art, safety and security and life problems. More than five decades of research has resulted in the extraction of hundreds of patterns of invention and lines of evolution. TRIZ can be used to analyze and improve any system created by human activity.

TRIZ is universal because it strips domain knowledge from a problem situation and uncovers patterns of evolution toward system improvement. For this reason some regard it as an emergent science. They observe that artificial systems are stimulated by commerce and develop under selective pressures such as competition, economics, consumer's acceptance and buyer behaviour. The analogy is drawn between TRIZ and Darwinian evolution. Patterns of evolution – survival of the fittest solution – can be discerned, and codified, guiding innovation and problem-solving activity.

Modern TRIZ is entering the mainstream

The majority of the significant innovations that will appear over the next 20 years will be based upon scientific, technological and business knowledge existing now. The difficulty lies in identifying what knowledge is of real significance. With hindsight, what seems obscure today will be remarkably clear tomorrow. TRIZ evaluates today's knowledge systematically, thereby identifying what is achievable and, more particularly, how one advance in conjunction with another can fulfil a human need and generate commercial opportunity.

For many global organizations, the value in their industry is shifting from perfecting the old towards inventing the new, in processes, products and services. Today, companies are less certain that reducing development time, production costs and product price alone is a sufficient strategy for corporate sustainability. Global companies are wondering where the next generation of business value lies. Many have concluded that their innovation efforts are not systematic enough. There is great interest in any method that helps to create more reliable innovators who produce more significant innovations. This requires a subtle blend of process and science. These factors are creating interest in TRIZ.

Modern TRIZ applications are entering the mainstream via early adopters such as Computer Sciences Corporation, Procter & Gamble and Samsung. Users develop and extend TRIZ in ways that make sense to them. Just as we program computers from components, TRIZ processes can be combined to form problem-solving applications. Two examples are shown in Figure 4.

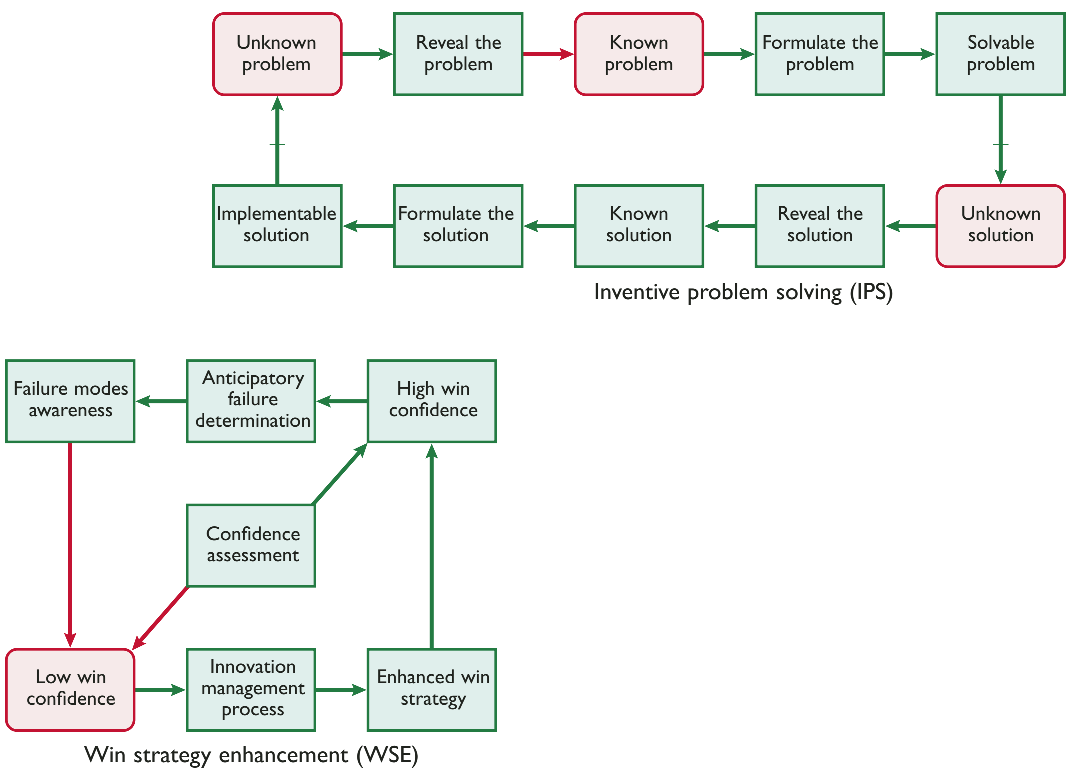


Figure 4 – Two example TRIZ applications

There are many TRIZ applications being developed. All of them generate solution directions which are exhaustive within the constraints of the accuracy and granularity of the models you create. Here are examples:

- **Inventive problem solving:** A systematic procedure for resolving tough problems, enhancing system performance, improving quality, reducing cost, etc for the current generations of product, service, process or business model (see Figure 5).
- **Failure analysis:** A systematic procedure for identifying the root causes of a failure or other undesired phenomenon in a system, and for making corrections in a timely manner.
- **Failure prediction:** A systematic procedure for identifying beforehand, and then preventing, all dangerous or harmful events that might be associated with a system.
- **Directed evolution:** A systematic procedure for predicting and evolving future generations of a system. Directed evolution builds understanding of where a technology, product, service, process, organization or business is in its development and derives the likely market evolution. This knowledge is used strategically to guide organizational development.
- **Control of intellectual property:** A systematic procedure for increasing the value of intellectual property and providing protection from infringement and circumvention. Control of intellectual property discovers additional innovations in technologies, products and services.
- **Accelerated decision commitment:** A systematic procedure for rapidly assessing a wide number of options and reaching consensus on and commitment to a solution pathway and its associated implementation concepts.
- **P-TRIZ:** TRIZ applied to process improvement and innovation. Exhaustively generates process reengineering alternatives and systematically solves problems in pursuit of quality goals: reduced cycle time; productivity; reduced errors; simplicity; flexibility; employee satisfaction; coordination; reduced cost; access; compliance; integration; reduced risk and waste.
- **Voice of the customer integration:** Captures customer requirements for products and services using TRIZ models. Integrates multiple models and perspectives on problems and requirements leading to holistic solutions that meet diverse needs.

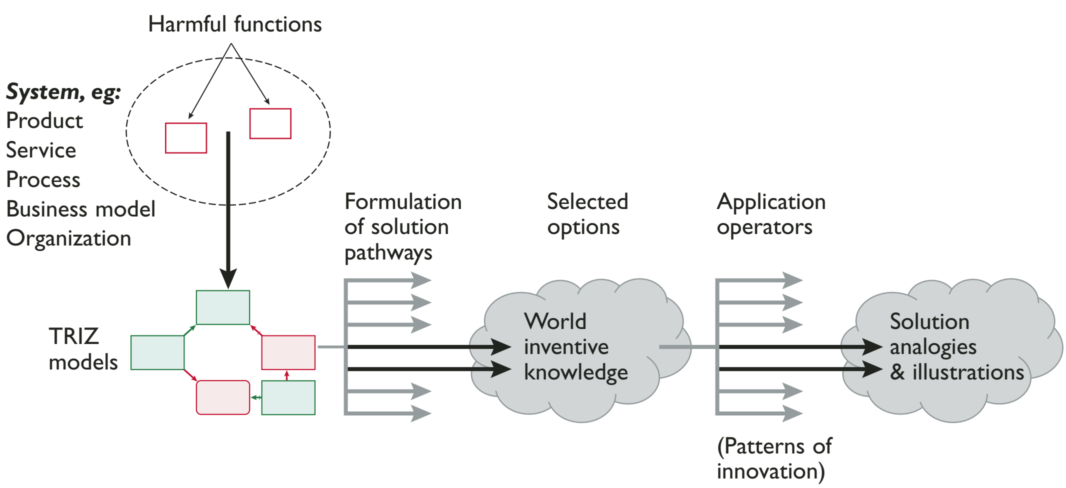


Figure 5 – Inventive problem solving (IPS) with TRIZ

TRIZ for the IT organization

The CIO owns a complex set of interdependent problems with multiple owners, each with their own goals and agendas. The problem portfolio represents the aggregated tensions of an entire organization along with its suppliers, partners and customer relationships. The corporation cannot afford to allow across-the-board uncoordinated problem solving in isolation, nor should departmental heads allow it. To do so creates inefficiency and, ultimately, unsustainable systems and processes. Enterprise solutions that are more useful than harmful must be created. Solving problems in isolation results in local usefulness that all too often causes harm elsewhere, such as additional costs arising from duplication. Everyone knows a story about departmental tribalism where one perspective on an issue is presented as the answer to the cost of the whole.

TRIZ can provide techniques for breaking the apparent contradictions faced every day by key decision makers who have the task of balancing the various conflicting requirements that result from complexity and diversity. It is tempting to ignore these apparent contradictions or place them on the 'too hard' list or the back burner. Yet very often it is precisely these paradoxical problems that are the symptoms representing the tip of the wider systemic iceberg-sized problems that threaten to fundamentally undermine the organization's ability to perform and adapt. TRIZ analysis dissolves the apparent paradoxes and contradictions, separating them into their component parts. TRIZ fosters progress in the face of previously recalcitrant difficulties, creating the agreed solutions pathways that re-allocate resources, turning harm into use and enabling a sustainable orchestration of change.

TRIZ recognizes that some problems may themselves be considered useful resources from the perspective of other problems, and resources should not just be limited to time and money. Neither should consideration of resources be limited to staff availability, budget, capital assets or other infrastructure. Resource analysis covers everything in the environment, including resources that can be leveraged from partnerships or other third-party relationships; by-products of processes or the operation of systems which are not utilized elsewhere; space – in offices, in data centres, on storage devices; informational resources; resources that can be used to serve more than one purpose either simultaneously or separated in time or space; and virtual resources which only become tangible once the context of your problems or the relationships of your problems to each other is changed.

TRIZ collaborates seamlessly with other methods

Classical TRIZ of old tended to dismiss other methods and developed a cult following. By contrast, modern TRIZ is complementary to and amplifies the value of other methods. TRIZ has been used to guide innovation in association with methods such as Lateral Thinking, Value Engineering, Robust Design, Technological Forecasting, Lean, QFD, FMEA, HAZOP, TQM, Six Sigma, Systems Dynamics and the Theory of Constraints.

TRIZ is easily woven into existing business processes. Conversely, it can be used to improve those processes. TRIZ provides a structure for the end-to-end improvement and innovation effort. Using TRIZ, innovators are able to combine concept development and implementation, with creativity and brainstorming, numerical modelling, analysis and simulation.

Existing methods can also amplify the success of TRIZ. Business case and selection models such as simulation, scorecards or quality functions can be used to choose between solution pathways generated by TRIZ, bridging the gap between qualitative and quantitative modelling. And the creativity techniques an organization already uses can be used to improve any TRIZ model. Doing so makes a lot of sense, yielding increased confidence that chosen solution pathways are focused, and relevant.

TYPICAL STEPS IN A TRIZ PROCESS

- Agreeing the problem and the perspective from which it should be solved.
- Collecting information about the system, the problem and its environment.
- Enumerating all of the system, sub-system and super-system resources.
- Describing the functioning of the system, past, present and future.
- Uncovering the root causes of the problem, and its downstream effects.
- Revealing the interdependence between system functions and root causes.
- Identifying the central resources that could play a role in the solution.
- Formulating possible sub-problems to be solved.
- Selecting the most promising directions for solving the problem.
- Refining and strengthening these directions leading to solution concepts.
- Evaluating recommended operators corresponding to problem type.
- Translating abstract solution patterns into concrete solutions.
- Applying operators and analogies to refine directions for problem solving and idea generation.
- Adding new ideas into the cause-effect models of both the problem and solution.
- Recognizing and iterating over sub-problems.
- Recognizing and solving subsequent problems created by the solution direction.
- Iteratively improving the solution by repeating this process.
- Summarizing concept description and protecting intellectual property.

Learn more about TRIZ

In the worst-case scenario, TRIZ provides the rigour to know that you have considered all of the solution options, enabling you to come up with the best solution, or the best compromise. In the best case, TRIZ can enable you to line up your problems so that their associated excesses or deficiencies in resource or constraint cancel each other out, eliminating problems and creating solutions. In either case, TRIZ provides the means to see, and act on, improvement options. Companies use TRIZ to guide the management of innovation. As Figure 6 illustrates, TRIZ helps to solve the problems that, if not resolved, would prevent products, services and processes from providing the next generation of value that customers demand and competitors will inevitably provide.

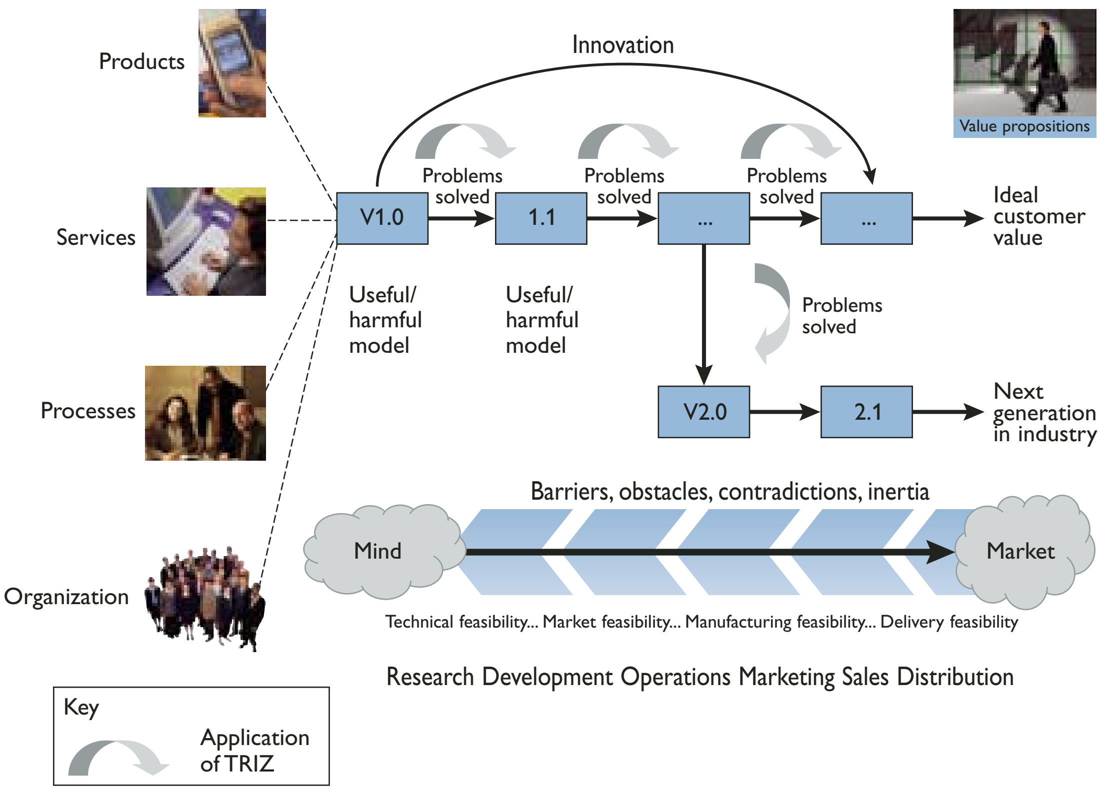


Figure 6 – Modern TRIZ supports innovation in products, services and processes

For more information on the potential of TRIZ in the IT domain, and for details of where to view examples of TRIZ in practice, please contact Howard Smith at hsmith23@csc.com

Glossary of TRIZ concepts

Primary useful function: The purpose for which the system was designed and a starting point for functional decomposition.

Primary harmful function: That which most contributes to counteracting the system's primary useful function.

Ideality: A subjective measure and the goal of innovation. Ideality is the sum of all useful functions in a system divided by the sum of all harmful functions in a system. The ideal solution is one which has only useful and no harmful functions. The ideal solution is always a matter of opinion and there are no such things as problems except in the mind of man.

Ideation process: A procedure used to guide the use of TRIZ. Different classes of problem-solving activity demand different ideation processes. TRIZ provides a library of such processes.

Functional decomposition: Every system element has useful output and harmful output. For example, a catalytic converter counteracts the harmful function of vehicle emissions (useful output) but also adds complexity to the engine (harmful output). By decomposing a system into useful and harmful functions we dissolve ambiguity and open pathways to analysis and improvement.

Problem decomposition: The process of breaking a large problem into a hierarchy of nested sub-problems, each of which can be modelled and solved recursively using TRIZ.

Iterative improvement: The process by which a system is refined by repeated application of the TRIZ methodology. Every problem has a solution, but this solution is itself viewed as a problem by TRIZ until it becomes ideal and has no harmful side-effects.

TRIZ model: The relationships between useful and harmful elements expressed via links such as input, output, cause and effect.

Formulator: An algorithm that transforms a TRIZ model into an exhaustive set of solution pathways. Numerous pathways are generated from even simple TRIZ models. The formulation algorithm can be implemented as a software tool (for example, see Figure 7).

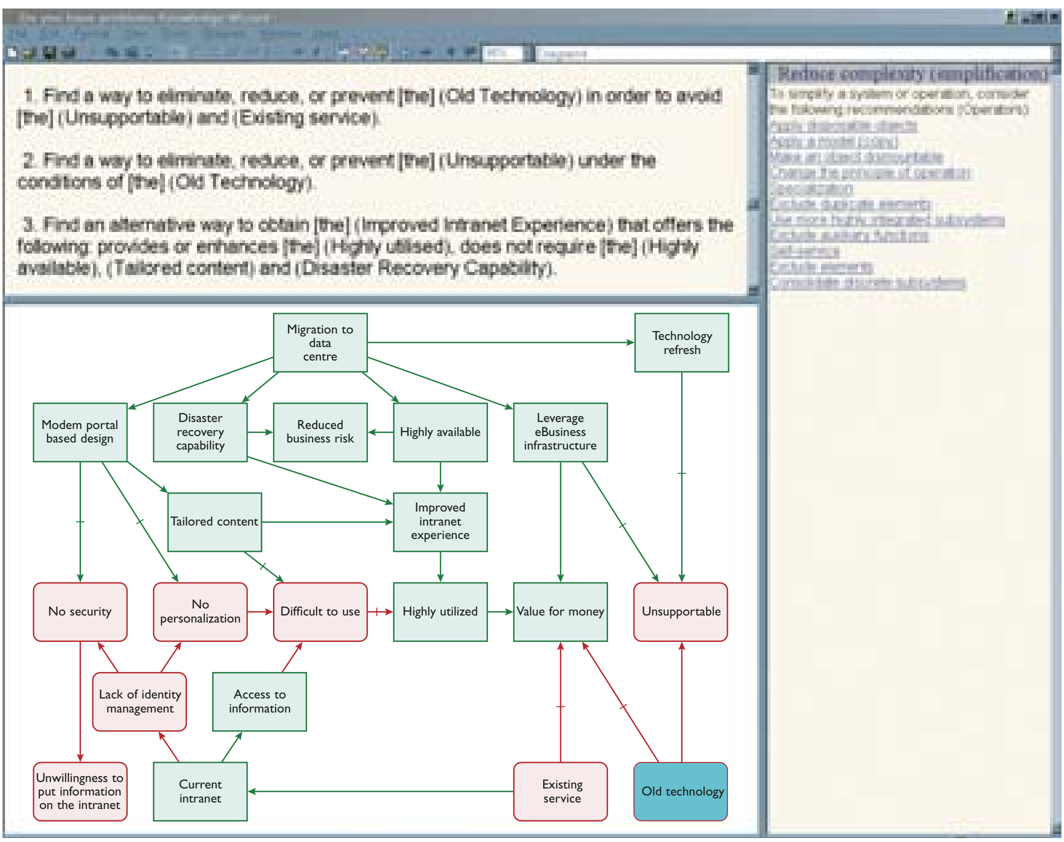


Figure 7 – Example TRIZ software tool

Solution pathway: One direction in which to improve a system. Pathways cover the gamut from outright system replacement to small, but possibly significant, changes applied to individual useful and harmful elements.

Counteraction: The introduction of a system element (useful or harmful) to counteract the output (useful or harmful) of another system element.

Contradiction: A relationship among system elements with contradictory effects. For example, enhancing one useful function diminishes another useful function or worsens a harmful function.

Contradiction matrix: A look-up table that summarizes problems and solutions that have worked in the past. The table provides a means of classifying TRIZ knowledge. The table may have multiple dimensions each being a parameter of the problem type. In classical TRIZ, the contradiction matrix had only two dimensions, each pair of coordinates being a contradiction. In modern TRIZ, more sophisticated tables are being developed.

Paradox: The (hidden) system element responsible for a contradiction. TRIZ analysis reveals contradictions and identifies paradoxical elements. Eradicating the paradox is central to problem solving.

Separation by perspective: A useful function from one perspective is often harmful from another. Recognizing this, TRIZ models are deliberately developed from multiple perspectives. Perspectives are combined to create agreed solutions.

Domain of proximal knowledge: People have knowledge relating to their current role, the experience they have gained in the past, partial knowledge of the roles of those people with whom they interact, and additional knowledge gained through exposure to other engagements or personal interest. People typically have in-depth knowledge within their specific domain and cursory knowledge within some nearby domains.

Psychological inertia: The limit on human creativity arising from psychological factors such as the retarding power of a word; a partial restriction perceived as a blanket restriction; traditions that cannot be broken; inadmissible ranges of data or knowledge; past association with entrenched methods and practices; a belief that all information given is valid; knowledge and experience that is not their own.

Abstraction: TRIZ provides a large knowledge base of abstract solutions and enables problems to be parameterized so that appropriate solution patterns can be identified and translated to a specific problem situation.

Classical TRIZ: An early form of TRIZ. Most public domain information about TRIZ describes classical TRIZ. As corporations adopt and contribute to the development of TRIZ, some classical TRIZ tools are falling into disuse.

Modern TRIZ: A term used to distinguish modern TRIZ practice from older methods. For example, the classical 'contradiction matrix' and 'library of effects' has been challenged by a 'system of operators', which provides solution patterns. 'Substance-field analysis' has been evolved to the simpler and more universal TRIZ 'cause-effect' model.

Operator or 'solution pattern': An abstract solution associated with a type of pathway. For example, it is possible to counteract a harmful function using operators such as 'isolation', 'drawing off', 'masking' and 'localizing'. In TRIZ, abstract operators are described in text and pictures using analogies and illustrations.

Parameterization: The means by which a problem is characterized to make it possible to look up a standard solution in a contradiction matrix. Typically this involves identifying the conflicts or tensions (contradictions) in a requirement or solution design. In classical TRIZ, parameters into solutions were simplified engineering rules, and this approach has been partially discredited today. In modern TRIZ, multi-dimensional systems of operators and parameters are being developed.

Resources: Anything that exists in a system and its environment and that can contribute to a solution. Engineering resources include substances and fields. IT resources include computing resources, finance, capital assets, human potential, competencies and informal and formal relationships. Universal resources include time, space, information, connections etc.

Constraints: Anything that exists in, or any limits placed on, a system and its environment that can hinder creation of a solution. For example: lack of authority, lack of budget, political agenda, limitations or rules imposed by systems, sub-systems, super-systems or people, law, regulatory requirements. In computing: storage, network bandwidth, processor speed, memory etc. Related to field analysis in engineering: gravity, electromagnetic, electrostatic, radiation, heat.

Lines of evolution: Universal principles observed by TRIZ practitioners as to how systems evolve over time under selective pressures such as competition and buyer preference. Examples include stages of evolution (S-curve); non-uniform development of system elements; evolution towards increased dynamism and controllability; cycles of increasing complexity followed by simplification or reduction; evolution towards the micro level; increased use of resources; trend towards decreased human involvement. TRIZ places systems on trajectories towards improvement. Lines can be used to predict necessary changes to systems thereby pre-empting competitors.

Bank of evolutionary alternatives: The forefront of TRIZ research. TRIZ scientists are distilling a history of human commercial and inventive activity across myriad domains thereby deriving TRIZ patterns. These evolutionary alternatives give skilled TRIZ practitioners a remarkable capability to know, not just predict, the future of products, services, organizations and markets and to determine the technological and commercial viability of systems. This knowledge can be inverted to show current or future failure modes.

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Designed and produced by CSC's UK Marketing and Communications department.