

Directed Variation
Solving Conflicts in TRIZ Part 2
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CREAX wishes to thank the TRIZ Journal readers for numerous comments and feedback on the September article. We hope to address most issues in the following papers.

Keywords: language, conflicts, contradictions, properties, adjectives, functions, verbs, DIVA, CREAX

Introduction

*Products are **NOUNS**. An analysis of one month's USPTO patents (Jan 2005) shows that in a pool of 16,000 patents, there are less than 2,000 unique nouns. But we're not interested in a noun or a product; we're interested in the difference, the variation of the product, the **ADJECTIVE noun**. Not the toothbrush as such, but the hollow toothbrush, the flexible toothbrush, the protruded toothbrush, the transparent toothbrush. Adjectives define variations. The analysis of the same 16,000 patents revealed less than 800 unique adjectives. These adjectives are related to functions, which are expressed in **VERBS**. The 16,000 patents distilled less than 700 unique verbs. (Part 1 September 2005 TRIZ Journal.)*

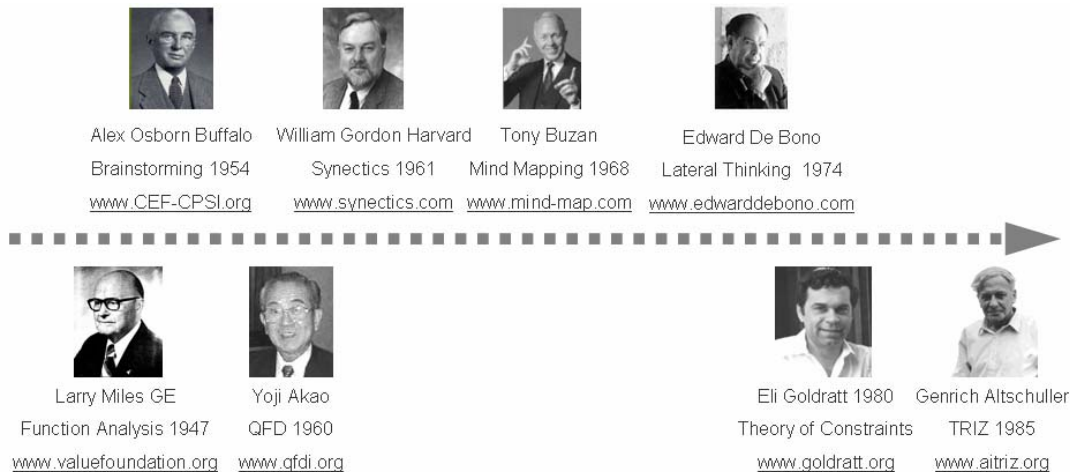


Fig 1 History of creative and functional thinking

In the early 50s Osborn started promoting brainstorming. With such principles as 'quantity breeds quality', 'postponement of judgement', 'hitchhiking' and 'freewheeling', brainstorming became the technique to bring a free flow of ideas on paper. Later on William Gordon at Harvard developed Synectics, adding 'advanced analogies' to the process. It was a form of comparing your 'problem' with a similar situation. Buzan brought structure in memory, and mind mapping is a popular tool in many of our client companies. Finally De Bono developed the six-thinking hats as well as lateral thinking. This limited collection of people start from the creative mind. The people under the arrow focus more on function and system. Starting with Miles's 'all cost is for function', QFD matches whether functions are required by the client, ending with the readers' more

familiar ToC and TRIZ. The core distillation of the above is abstraction and analogy, under that core is property and function.

Abstraction, Analogies and Comparisons

Abstraction into property for function is the key to culture. It is by seeing stones as strong enough to build; light enough to throw or sharp enough to cut that has started the culture of mankind. The native Americans regarded the tomato as poison, as it had similar properties to the *Solanum americanum* which was indeed poisonous.

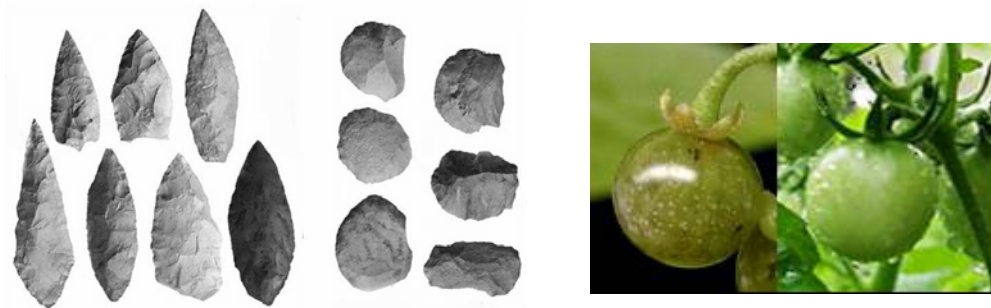


Fig 2 Left: Functional stones. Right: the poisonous *Solanum americanum* and the tomato

Abstractions are therefore *none perfect comparisons*, though I can imagine that the tomato was not worth the risk. None perfect, though good enough to perform a similar function. We can distinguish two main types of abstractions. What is/has it? What does it do or undergo? The first –property-type of comparison is the more obvious, in which you can compare the small, round, juicy and green vegetables or the sharp, grey, hard stones. It is based on what it is or has. The second –function-type of comparison is functional. Both the sharp stone and *Solanum americanum* kill.

Property Variation

Products (and processes) have properties to perform a function. *All the customer wants is function*. Function results out of one or more properties. For example, protrusions give grip. A similar function can be achieved by a different property, e.g. a hole can also provide grip.

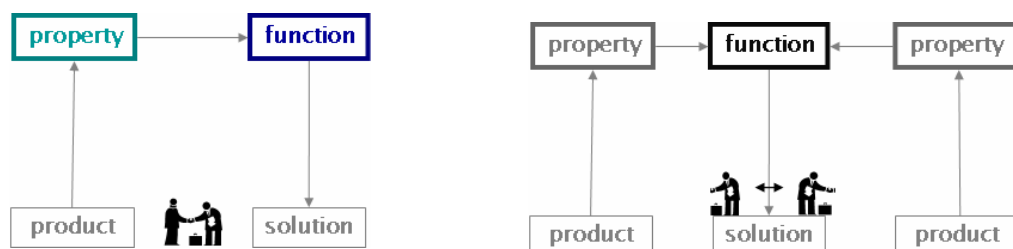


Fig 3 Property Function Diagrams

As function is the target, the exercise becomes to find the highest value solution; i.e. with the best 'property – function' equation. There is a direct and an indirect analogy. Take the function cutting; referring to the stone in figure 2. The direct analogy will look for the property that enables cutting: sharp edges. A knife, metal plate, broken glass, or even teeth have that same sharp edge, to cut. The indirect way can be to explore ways to have the function cutting, independent of the property sharp edges. Breaking, tearing, bending or pulling can perform the same function without sharp edge.

Think of how you open a Mars® bar. No sharp edges are needed. It is the same innovation that was transferred to Henkel's Pritt adhesive tape. You don't need the property sharp edge to cut the tape. They have designed the tape so that the protrusions at the side give you weak points to tear the tape into pieces. As you can see on the package, they even advertise the fact you don't need scissors (sharp edges). This is achieving the same function through a different property.

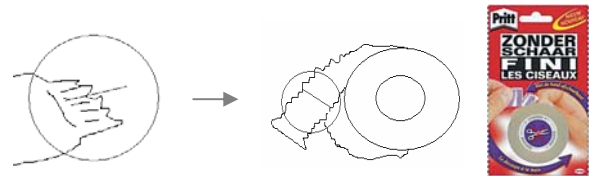


Fig 4 transfer Mars® bar to self-tearing tape

If the function is segmented tape, I can also solve it by purchasing pre-cut tape. Or even if, whatever I am taping is adhesive, I can forget about the tape in total. This typical playing with properties to achieve the desired function can be structured in a space-time diagram.

1. Properties of the bigger system and environment in the past <i>was part of that was or had</i>	2. Properties of the bigger system and environment <i>is part of that is or has</i>	3. Properties of the bigger system and environment in the future <i>will be part of that will be or will have</i>
4. Properties before the product or process <i>was or had</i>	5. Properties of the product or process <i>is or has</i>	6. Properties after the product or process <i>will be or will have</i>
7. Properties of the components and sub-components in the past <i>consisted of that was or had</i>	8. Properties of the components and sub-components <i>consists of that is or has</i>	9. Properties of the components and sub-components in the future <i>will consist of that will be or will have</i>

Fig 5 property space-time diagram (9 windows)

Every window has properties that can be evaluated to contribute or entirely perform the function required. To give a contemporary example (with four recent pregnancies in

CREAX), a puncture to evaluate the health of the babe is still not without risk. We can move the challenge to window 2; literally the 'mother system'. In every pregnancy, foetal cells (lymphocytes, trophoblast cells, erythrocytes) circulate in the mother's blood. These cells can be isolated and analysed for chromosomes 13, 18 and 21 with the help of special probes. The gender can also be determined. Any of the properties within these windows can therefore be evaluated to their possible contribution of the desired function.

Language based, properties are adjectives related to what it is or has; to be porous or to have holes. For a property analogy, a '9 windows' in figure 4 explores the possible analogies in space and time. As much as these properties are linked to the client's required function, the more they are relevant to analogy. Properties are linked to **SCIENCE**, the science about surface, strength, or porosity; this is mainly expressed in the product adjectives (a carved, strong or porous product). The property analogies are thereby resting on similar adjectives.

Function variation

Likewise a property can also provide different functions. This is where Part 1 (TJ September 05) has elaborated property variation as a means of creating new, better, cheaper, easier or nicer function. Where properties are linked to SCIENCE, functions are linked to **TECHNOLOGIES**.

SCIENCE	Property	'it is/has like x'	direct analogy
TECHNOLOGY	Function	'it also undergoes/does x'	indirect analogy

Analogies are: it **ALSO** cuts, cleans, moves, dries or joins; these are all verbs that express the **same function**. They can be grouped in active ('doing') and passive ('undergoing'). To direct a variation in the solution, there are two possible analogy routes:

1. Functions of the bigger system and environment in the past <i>was part of that did or underwent</i>	2. Functions of the bigger system and environment <i>is part of that does or undergoes</i>	3. Functions of the bigger system and environment in the future <i>will be part of that will do or will undergo</i>
4. Functions before the product or process <i>did or underwent</i>	5. Functions of the product or process <i>does or undergoes</i>	6. Functions after the product or process <i>will do or will undergo</i>
7. Functions of the components and sub-components in the past <i>consisted of that did or underwent</i>	8. Functions of the components and sub-components <i>consists of that does or undergoes</i>	9. Functions of the components and sub-components in the future <i>will consist of that will do or will undergo</i>

Fig 6 Function space-time diagram (9 windows)

They are the more disruptive kind of analogies as they can come out of a complete different property providing the same function. Referring to figure 6 below, if the function, for example water cleaning can be achieved before (preventive – cleaned well), or after (corrective – boiling). The sun shines ☺, and that function includes U.V. that can also provide clean water from the top windows (1,2,3). Note the strong link, as properties and functions are linked, between figure 5 and 6. The difference in the searching, however, is to look for the same property providing the function, i.e. directed analogy, and looking for the function rising out of a different property, i.e. indirect analogy.

Direct and Indirect Analogy

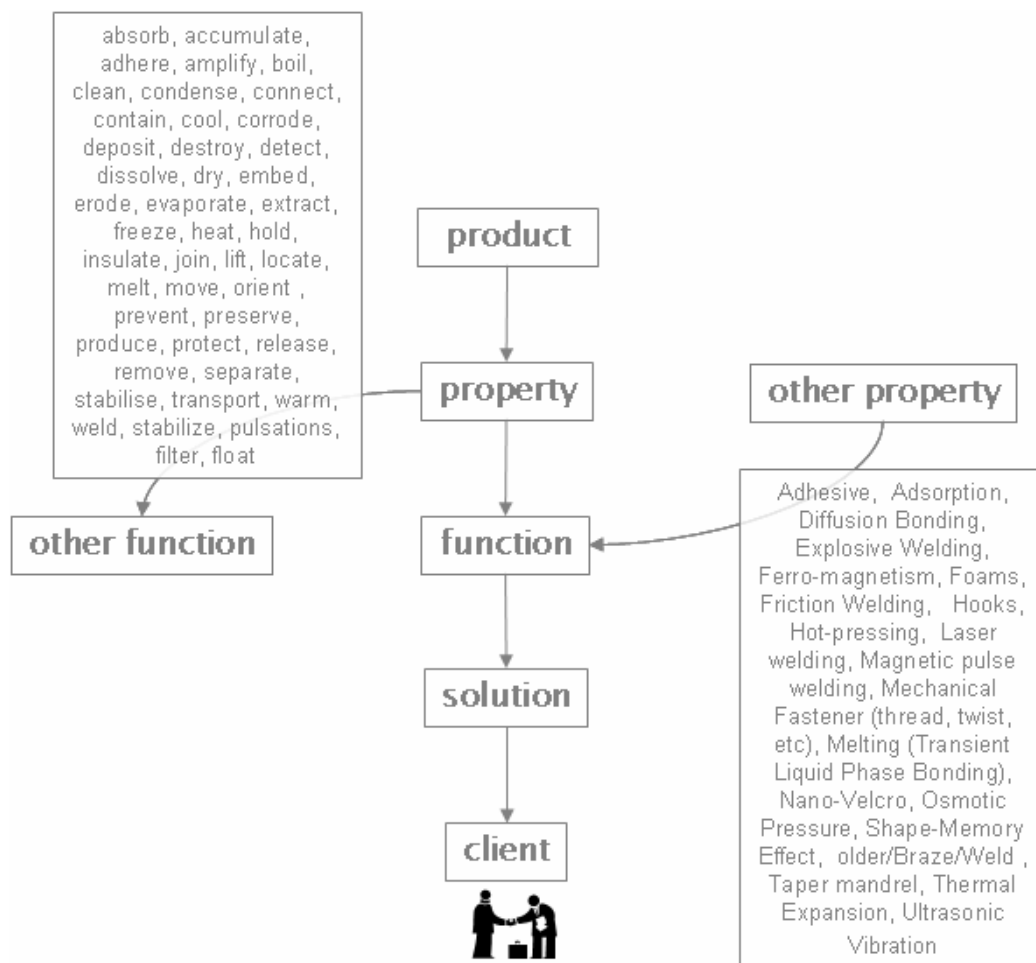


Fig 7 Elaborated property function diagram

The direct and indirect analogies can be illustrated as in figure 7. It defines the solution design freedom of an innovation engineer. The simple diagram (as in figure 3) describes a product, having properties that provide a function creating a solution. The design freedom opens (left) other properties that can provide that function. This is a list of technologies that can provide 'assemble'. Again, all of these technologies are based on properties magnetism, geometry, pressure or bonding forces. This is mainly used to create alternative solutions to the same function. The other list (right) provides possible

new functions that can be achieved by the properties of your product. This is mainly used in creating new solutions that can perform the function and other desired functions.

Property Function Analogies

In the table below the property variations are organised in functional groups. We are living in an examples society; any explanation is only clarified by abundance of examples. In the screenshot below, the variation in the property surface is expressed (the SURFACE SPECTRUM). As discussed above, many functions can arise from one property. Here the first 12 functions are illustrated. The folders are assembling examples across industries that use a surface variation for e.g. holding, transferring heat, draining or breaking. This type of direct analogy gives you an easier imagination, as well as a initial form of proof of concept (worked elsewhere).

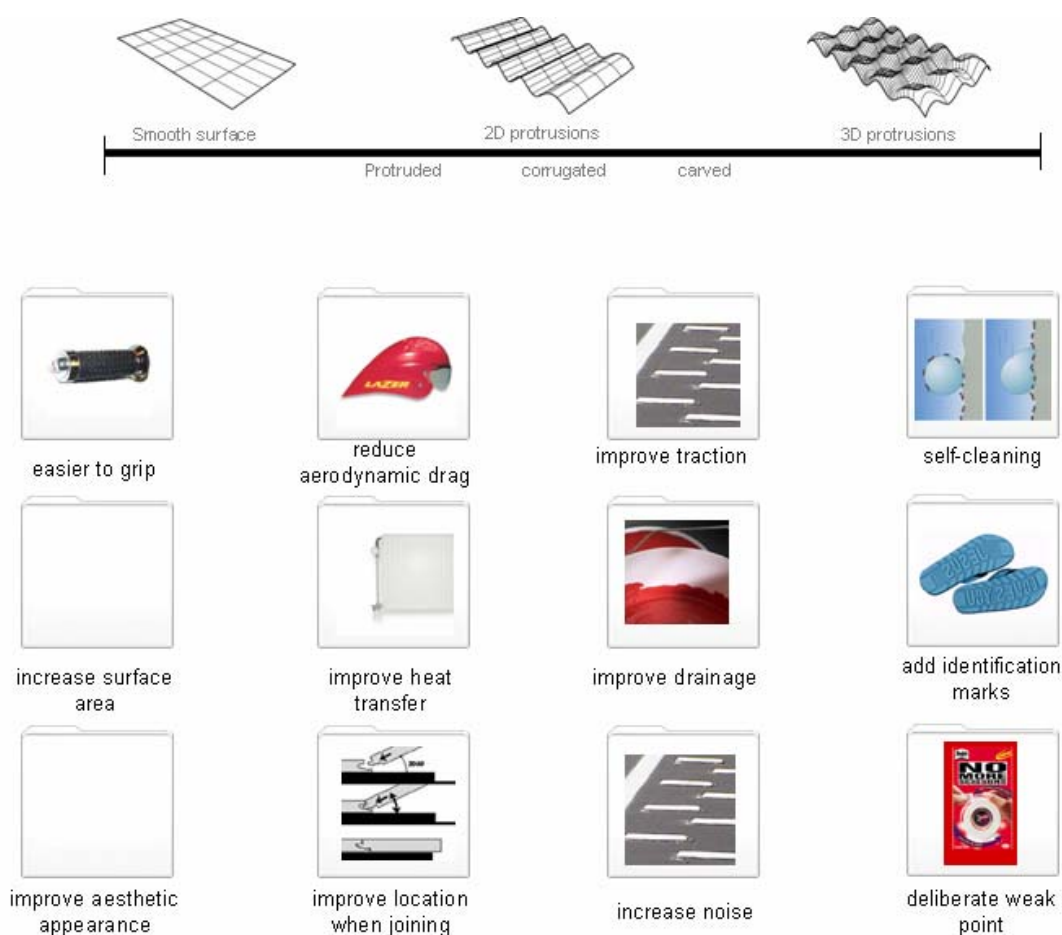


Fig 8 DIVA® software excerpt: variation chart: SURFACE SPECTRUM

The folders contain both product and patent information. Elaborated cases will be presented in part 3 of this paper. This structure, connecting properties to function examples, can be reverse searched. Give me all the property variations that can provide me grip, or fast dissolving. The latter will provide a listing including fragmentation to powders, fibrous, high porosity or liquid. There is a subtle, though important difference with the function database we provide on <http://function.creax.com>. The function

(technology) database is more technology driven, whereas the reverse searching is focussed on adapting the product properties.

Conclusion

'So advanced, it is simple' directed variation® integrates the performance of existing innovation methodologies. The interface of the tool allows more of the good (performance, integration, ergonomics, design) and less of the bad (complexity, confusion, time). (Part 1)

Properties are linked to SCIENCE, expressed in adjectives. They are the source of direct analogies. Functions are linked to TECHNOLOGIES, expressed in verbs, they are the source of indirect analogies. They are closer to disruptive innovation.

Directed variation provides the structure to group all properties into specific functional categories, which can be searched both ways.

Abstraction into property for function is the key to culture. Directed variation proposes a structure to compare function products, and extrapolate relevant analogies to any specific domain challenge. Opening properties and functions in space and time (9 windows) provides a checklist of all candidate solution routes.

Note that this paper is preceded by Part 1 (September 05) and followed by Part 3 (November 05)

Simon Dewulf is Managing Director of CREAX; a company of creative engineers active in innovation consulting, patents studies, systematic innovation methodologies, product development, training and innovation culture coaching. With directed variation®, DIVA, CREAX brings a checklist for innovation potential that acts as a turbo for new value creation. By combining worldwide best practices in Business, Technology and Management, CREAX offers an integrated innovation method that acts as a toolbox, a philosophy and a culture for value creation. CREAX works for market leaders and innovation driven companies in all sectors including Goodyear, P&G, Shell, Masterfoods, Atlas Copco, Solvay and Bekaert. CREAX teams up Bernard Lahousse, Nele Dekeyser, Mathieu Mottrie, Johan Langenbick, Lieven De Couvreur, Nadine Rits, Lieselot Vandecappelle, Vincent Theeten, Katleen Pyck, Frederick Florizoone, Thomas Valcke, Frederick Vandendriessche, and Simon Dewulf.