Directed Variation
Solving Conflicts in TRIZ Part 3

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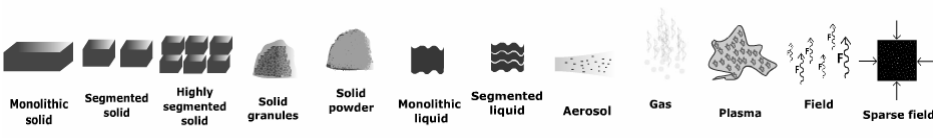
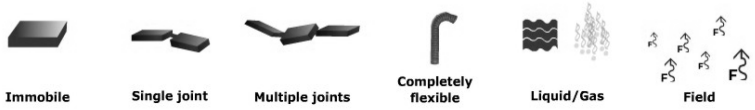
Introduction

In early days, Indian Vastu described the 5 elements. Earth; water, wind and fire and ether (vacuum). TRIZ refers to these as solid (earth), liquid (water), gas (wind) and fields (fire). There variation is expressed in both the Object Segmentation trend and the Dynamisation Trend'.



SOLID→segmented →powder→**LIQUID**→segmented liquid→aerosol→**GAS**→plasma→**FIELD** (1)



SOLID →single joint→multiple joint→flexible →**LIQUID** →**GAS**→**FIELD** (2)

Fig 1. Four element extraction; solid, liquid, gas and field

In directed variation® this spectrum has been defined as 'state change'. The variation solid, liquid, gas, field each loose a degree of expression; solids can have sound, touch, form, taste and smell, where liquids loose form, gasses have nor form or taste, and fields have no form, no taste and no smell. This shows that the finer the element, the lesser the degree of expression, but the *higher the degree of efficiency*. For power and energy, fields are more effective than gases that are more effective than liquids, that are more effective than solids. This introductory example again shows that the direction of variation is only defined by the required function. Example variations of state include train rails (solid) to maglev (field), Cutting with solid knife, water rays or laser, or extinguishing a fire with sand, with water, with CO2 gas or with an explosion, the latter applied for extinguishing burning oil sources.

Symmetrical variation

Suppose I'm on a terrace and I want something to drink. I can wait until the waiter comes by and then order my coffee. This gives the advantage that I can remain seated. I could also enter the bar and get the coffee myself. This approach has the advantage that I have the coffee right away. The main function 'get coffee' is the same but the 'solution path' is reverse; secondary functions like 'minimum effort' or 'minimum time vary.

When I want sugar in my coffee, than I can choose a sugar cube ('solid' object which is porous, it has 'gas' in it), or a sachet of powder sugar (air 'gas' with 'solid' particles). The solution is symmetrical, but the mian function 'dissolve sugar in coffee' is the same. The secondary function 'pore powder' or 'drop a cube' vary.

I can sit at a terrace where the tables are strong and light at the same time because they are hollow ('gas in solid' like the sugar cube). It is also possible to have tables to be strong and light because they are a combination of multiple smaller, portable tables (segmented solid, like the powder sugar). The solutions are opposite; the main function is the same, 'to be strong and light'. The secondary functions of a design in one porous piece, or two solid halves, vary. Every direction can be symmetrically mirrored.

	DISOLVING *(in liquid)*	FILTERING *(liquid)*	STRENGTH/ WEIGHT	SEPARATION
MALE 	SUGAR POWDER	POWDER FILTER	TABLE IN TWO PARTS	SEVERAL BINS
FEMALE 	SUGAR CUBE	SPONGE FILTER	HOLLOW POREUS TABLE	MULTIPLE COMPARTMENT BIN

Fig 2. Example of symmetrical variation porosity versus fragmentation

The variation of the property porosity is symmetrical to varying the degree of fragmentation. Examples like a sugar cube versus sugar powder are given in Fig. 2 above.

Similarly, inside a property variation like surface change, a symmetry can be found by adding protrusions (outwards) or bringing in carves (inwards), for the functions related to creating more surface area like cooling, grip, or breaking.

Sprays can be interpreted as symmetrical to foams as sprays are 'liquid segments in gas' and foams are 'segmented gas in liquid'. Yet a lot of switches from spray to foam; for example car wash foam, dish wash foam, cleaning foam and sun screen foam.

The realization of these symmetries in directed variation® . For example variation of the property 'flexibility'; adding flexible joints to hard parts (like a cardboard box) is symmetrical to adding hard joints in flexible parts (a plastic bottle). Symmetrical variation brings a new tool to IPR design as it allows to achieve the same main function with a completely reversed system. A spray can be patented for a hygiene application, a foam patent can still be granted. More symmetry is defined in absorption vs. emission, prior action vs. post action or pauses vs. peaks.

Directed Variation® idea generator

*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)*

Directed Variation® is a stepwise process to innovate products and processes. Based on the italic introduction above product differences are expressed in adjectives. Adjectives describe a property variation. The property variation is linked to a function; an adjective is linked to a verb. Based on the language the DIVA tool includes a patent analyst as described in Part 2 of this paper (Triz-journal Part2 Oct. 2005). The Directed Variation® idea generator is based on a similar principle.

adjective	noun	to	verb
hollow	product (toothbrush, brick, pen)	to	contain
protruded	product (toothbrush, brick, pen)	to	hold
flexible	product (toothbrush, brick, pen)	to	bend
transparent	product (toothbrush, brick, pen)	to	see through
jointed	product (toothbrush, brick, pen)	to	fold
PROPERTY	product	to	FUNCTION

Fig 3 Directed Variation ® idea generator

With the rules shown in Fig. 3 DIVA creates the text below; applied to a toothbrush, a brick and a pen. The colour codes property **adjective TEAL**, **function BLUE**, valid generations are underlined.

TOOTHBRUSH

Directed Variation® idea generator DEMO on the property POROSITY

A **hollow or porous** TOOTHBRUSH is easier **to transport** as it **reduces** weight, your **hollow** TOOTHBRUSH will have less material. By making a **hollow or porous** TOOTHBRUSH your TOOTHBRUSH can **contain** another material. A **hollow** TOOTHBRUSH allows you to **hang** your TOOTHBRUSH. Open holes in your **porous** TOOTHBRUSH will **improve** heat **transfer**. Closed holes in your **porous** TOOTHBRUSH will **improve the insulation** properties. A **porous** TOOTHBRUSH can **improve** the strength to weight ratio

Directed Variation® idea generator DEMO on the property SURFACE

Consider a **protruded or carved** TOOTHBRUSH. A **protruded** TOOTHBRUSH will be **easier to grip**. If your TOOTHBRUSH is in touch with moving air, your protruded TOOTHBRUSH **reduces aerodynamic drag,** a **carved or protruded** TOOTHBRUSH will also **improving traction**, or eventually **improve drainage**. Your **protruded** TOOTHBRUSH will have more surface area which will **improving heat transfer** properties. You can design the **carved** TOOTHBRUSH to look nicer. A **carved** TOOTHBRUSH can **break easily** at the carves.

BRICK

Directed Variation® idea generator DEMO on the property POROSITY

A **hollow or porous** BRICK is easier **to transport** as it **reduces** weight, your **hollow** BRICK will have less material. By making a **hollow or porous** BRICK your BRICK can **contain** another material. A **hollow** BRICK allows you to **hang** your BRICK. Open holes in your **porous** BRICK will **improve** heat **transfer**. Closed holes in your **porous** BRICK will **improve the insulation** properties. A **porous** BRICK can **improve** the strength to weight ratio

Directed Variation® idea generator DEMO on the property SURFACE

Consider a **protruded or carved** BRICK. A **protruded** BRICK will be **easier to grip**. If your BRICK is in touch with moving air, your protruded BRICK **reduces aerodynamic drag,** a **carved or protruded** BRICK will also **improving traction**, or eventually **improve drainage**. Your **protruded** BRICK will have more surface area which will **improving heat transfer** properties. You can design the **carved** BRICK to look nicer. A **carved** BRICK can **break easily** at the carves.
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PEN

Directed Variation® idea generator DEMO on the property POROSITY

A **hollow or porous** PEN is easier **to transport** as it **reduces** weight, your **hollow** PEN will have less material. By making a **hollow or porous** PEN your PEN can **contain** another material. A **hollow** PEN allows you to **hang** your PEN. Open holes in your **porous** PEN will **improve** heat **transfer**. Closed holes in your **porous** PEN will **improve the insulation** properties. A **porous** PEN can **improve** the strength to weight ratio

Directed Variation® idea generator DEMO on the property SURFACE

Consider a **protruded or carved** PEN. A **protruded** PEN will be **easier to grip**. If your PEN is in touch with moving air, your protruded PEN **reduces aerodynamic drag,** a **carved or protruded** PEN will also **improving traction**, or eventually **improve drainage**. Your **protruded** PEN will have more surface area which will **improving heat transfer** properties. You can design the **carved** PEN to look nicer. A **carved** PEN can **break easily** at the carves.

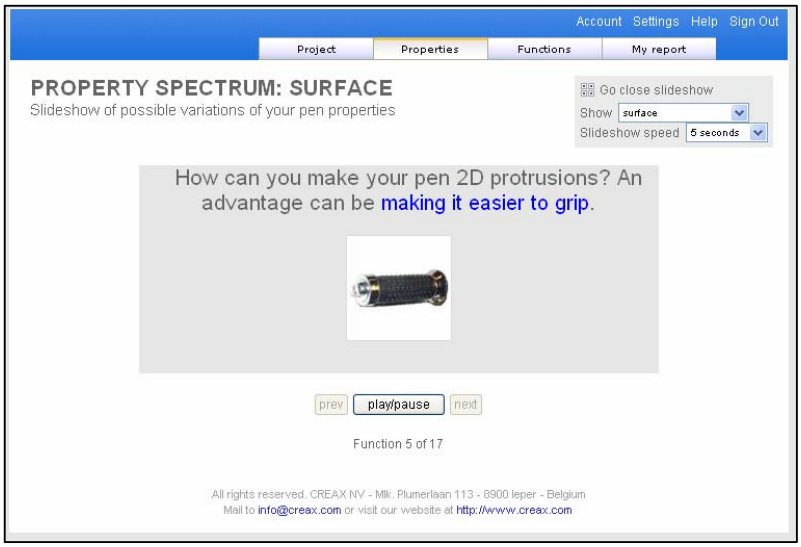

Fig 4. DIVA Screenshot; the Directed Variation® Idea Generator

This is a small demo with randomised text generated out of DIVA. Based on each and every property, pages of variation suggestions are presented tot the user. The more the functions of the product are known the more relevant the suggestions will be. Functions can furthermore be classified in the performance group, the sustainability group, the convenience and the cost reduction (see Part 1 September 2005 paper Triz-journal).

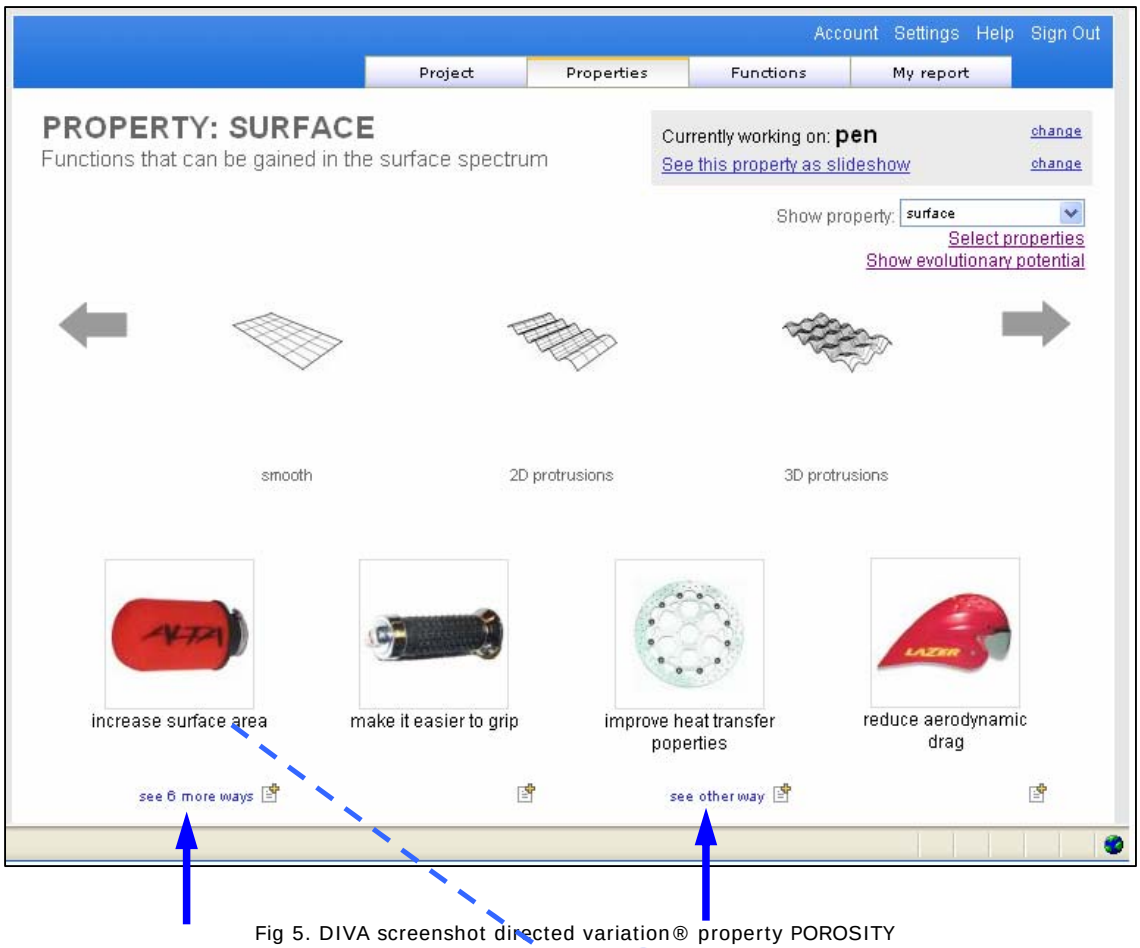

Fig 5. DIVA screenshot directed variation® property POROSITY

Once a certain function is accepted, the user is presented with other variations that can achieve the same function. For example if a variation to powder is selected for the function dissolution , then a porosity increase and a state change will be suggested as *other ways to achieve that function*. The screenshot below shows variations of the property SURFACE. Under the function '*increase surface area'* reads 'see 6 more ways' and under the function '*improve heat transfer properties*' reads 'see other way'.
This indicates that increasing surface area can be achieved with six other ways, namely shape, surface, geometry, asymmetry, porosity or fragmentation. Similarly improving the heat transfer can be done by changing the surface but also by changing the porosity (to open pores).

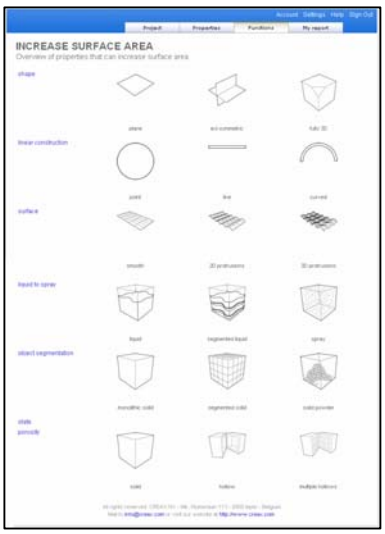

Fig 6. DIVA ways to increase surface area

Example for example

Whatever the theory whatever the suggestion, the easiest way to clarify a statement is with an example. It is through examples that structures appear. It is with examples that analogies can be formed. Over the year CREAX has reviewed thousands of examples of which many hundreds were collected in example databases. If you are part of our numerous newsletter readers, you've seen that all examples can be abstracted to their higher level of variation. So our commercially available example database is browsable not only by area but also by property variation.

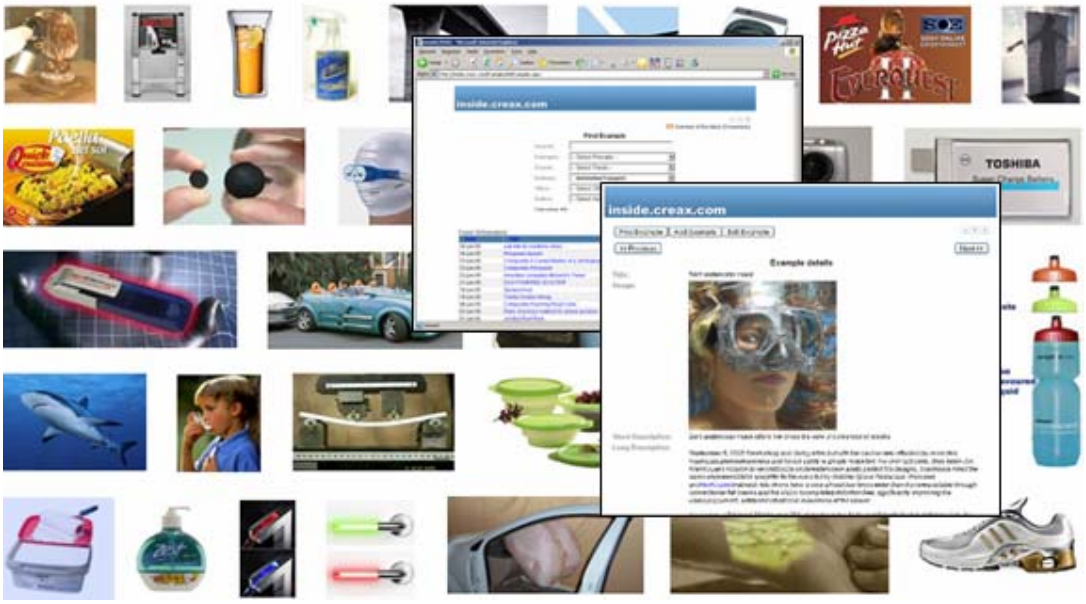

Fig 7. Newsletter Innovation Examples and screenshots of the DIVA example database

The examples of the colour changing tap water; red for hot water and blue for cold water, is abstracting the same innovation as the colour changing door handle, green for entrance and red for occupied: both examples are functional use of colour variation.

Furthermore, the kind of functional use of colour can be classified. Figure 8 shows the first 4 classifications of functional colour use. (1) Improve the aesthetic appearance is the first folder, full of examples that use colour for aestetics. The second folder contains examples where colour is used as a warning indicator, and so each of the pictures shown in figure eight represent a classification of one particular function that can be achieved by varying the property colour. By evaluating numerous examples in each classification, it becomes very easy to place a successful analogy to your product.

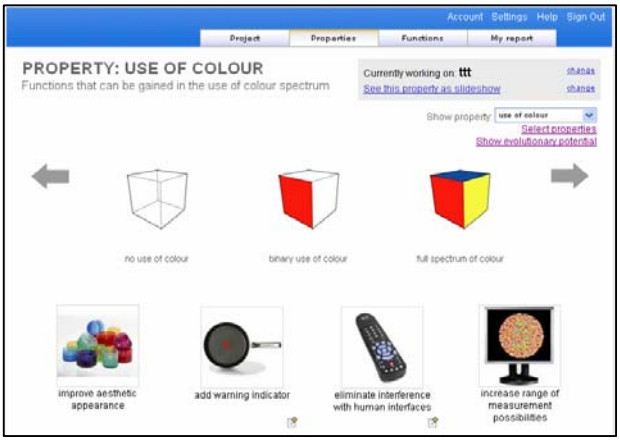

Fig 8. DIVA screenshot of property colour

Conclusion

Innovation through directed variation® comes down to listing your product's properties and changing those properties along a variation spectrum. Changes are expressed in adjectives, and linked to science. Successful changes result in new or better function, these being expressed in verbs, and linked to technologies. (Part 1)

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

The core of directed variation® is that whilst properties are directly linked to functions, they are independent of the specific product. It is thereby possible to generate randomised text, as described in this paper. The directed variation® idea generate makes an important shift in the innovation process: it changes the role of the user from 'generator' to 'evaluator' assuming that machine generation seriously competes with personal imagination.

The process remains natural as it is abstraction into properties and what made the human culture. Early mankind evaluated the properties of a stone as strong, light and sharp for the functions build, throw and cut. (Part 2)

Two types of analogies were identified, based open the property (what it is or has) or based upon the function (what is does or undergoes). They represent the entrée points of the users in the DIVA directed variation tool. The directed variation process brings speed and efficiency in value creation, without requiring any methodological prior knowledge from the user.

This paper is proceeded by Part 1 (Sept. 05) and Part 2 (Oct. 05) and will be followed by Part 4 (Dec. 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.