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THE USE OF TRIZ PRINCIPLES IN CONSUMER PRODUCT DESIGN

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The principles of TRIZ have been used extensively in manufacturing equipment and process troubleshooting and are beginning to find application in business, management, intellectual property, and strategic planning. There is a third area in which TRIZ principles are being applied and that is the design and application of everyday consumer products. Several large consumer products companies have made investments in TRIZ.

The interesting thing about applying TRIZ in the consumer products area is that the ideal consumer product means different things to different consumers and that is one of the uniquenesses of this area of application.

The Ideal Consumer Product

From a TRIZ perspective, an ideal product would perform its function and not exist—for anyone who might use it under any circumstance. The consumer and user would have their needs met automatically without cost and without expressing their need. We know that this goal in practice is unachievable, but we also know that, as TRIZ professionals, that this thought process will generate ideas and concepts not possible with incremental thinking and reactive problem solving—just as it does in the engineering problem solving arena. Let's look at several examples as they illustrate many of the most basic TRIZ principles, including ideal final result, resource utilization, and the use of separation principles to resolve contradictions.

A. Saran™ Bowl Covers. Saran Wrap™ consumer food packaging film was developed decades ago by The Dow Chemical Co., utilizing a unique copolymer of vinyl chloride and vinylidene chloride which had superior oxygen barrier properties compared with conventionally used polyethylene (PE). PE had excellent barrier properties to water, but limited resistance to oxygen transport. This film allowed food storage for far longer times without spoilage and oxidation. Unfortunately, one of the key physical properties of this new plastic film (its linear tear resistance) was very low resulting in consumers, after a film had split and torn, not being able to identify the location of the tear on the roll and

often throwing away the product. Many returned to the use of PE wraps, despite their poorer barrier properties, out of frustration. When S.C. Johnson, an experienced and very knowledgeable consumer products company, purchased this business from Dow, it looked at ways of utilizing the functionality of the plastic, but in a different form. The decision was made to fabricate the plastic in the form of what functionally was a hair net with an adjustable band, allowing the product to be shaped over many different size containers. The newly re-designed product was called a Saran™ Bowl Cover. The bags were fabricated in a separate location, bundled and wrapped with a rubber band in packages of ten, and then shipped to the final product assembly point in large container boxes. The manual compression and stretching of a thin rubber band placed around these bags at their manufacturing point was not a simple operation (potential for finger injuries) and the transportation conditions allowed further compression of the plastic enroute to their final packaging point. The bag bundles, in an assembly line type of operation, then had to be "unassembled" by technicians, stuffed into a cottage cheese type of container, and then a lid placed on the entire assembly. The key step of removing the rubber band from the middle of this plastic bag bundle, when it was at the most compressed point in the bundle, was a major bottleneck. This entire operation, in addition to its cost, impacted speed and ergonomics. The bags, under pressure in a container for an extended time, wanted to expand as soon as the wrapping band was removed.

A project team, assembled to use their newly developed TRIZ skills, evaluated this process for improvement. In asking the simple ideal final result question, the answer came back as "the bags unwrap themselves and reassemble into the final package" or possibly, "the bags need no assembly". (Note: competitors or users might express this differently as "the bags are not needed at all" or "food stays fresh all the time with no packaging"—the use of the TRIZ nine-box approach would be useful here!). In thinking about the concept and the parallel one of using resources already available, the team came up with a process concept where nine of the ten bags would be packaged into the tenth bag, which had the appearance of a stuffed hair net. This was a far easier job for the initial assembly technicians to do, and the final operation consisted only of moving the "bags within a bag" bundle from their receiving point into a container. This product can now be seen in the grocery shelves hanging on a shelf hook without the cost and rigidity of the original rigid plastic container and taking up much less shelf space (another move toward ideality in the eyes of the grocery chain). The simplicity of this operation also allowed improved automation and sterilization procedures through minimal human contact.

B. For years, men's undershirts have had an identification tag attached to their necklines that shows manufacturer, size, etc. This tag was typically sewn into the shirt in a separate operation. This labeling in now seen, in undershirt products from Fruit of the Loom, as printed information, eliminating the need for sewing and replacing it with a high speed, automated printing operation. The minor irritation of the label to the consumer is also eliminated. This is a step toward the

ideal concept of “the shirt identifies itself using the resources already present”. This can also be viewed as achieving a more ideal state through the use of the TRIZ trimming concept. We need the information on the label, but we arbitrarily eliminate one of the system components, the label itself, and ask how its function can be performed with the remaining components of the system, one of which is certainly the shirt. The printing directly on the shirt is also less exotic than what was then on the label.

C. Oral care also illustrates, in many different ways, the evolution of a system toward a more ideal state and the recognition and use of resources. Decades ago, a manual toothbrush had a single handle length, a single bristle length and a single choice in stiffness. As our knowledge of oral care has increased over time, we know that bristle and toothbrush design also impact gum care, which is now known to be equally, if not more so, important to long term oral health. In some cases oral health is an indirect indicator of other diseases in the body or the impact of certain drugs (i.e. Dilantin™, used for seizure control). Brush design has become more ideal in many ways such as bristle hardness being reduced, handles becoming flexible, and numerous physical sizes becoming available to accommodate different mouth sizes. We also see the use of separation principles in the design of the toothbrush head. We see softer bristles on the outside of the brush (which contact the gums) and stiffer bristles which are in direct contact with the teeth. We see different orientation of bristles inside and outside to provide friction vs. massaging. To freshen breath, it has been traditional to use a mouthwash, requiring a bottle or source of liquid, as well as a dispensing unit such as a cup. We now see products such as Listerine Breath Strips™ which use the saliva in the mouth (an already existing resource) and a physical strip containing the breath freshener in a concentrated form. “Traveling” toothbrushes are also now on the market where the toothpaste is stored in the handle of the toothbrush, permitting at least a week of use without the use of a separate tube of toothpaste (illustration of ideality, trimming, and resource utilization).

D. If we consider the use of the automobile as a consumer product, we can also see how the consumer interface with the car has become more ideal over time, sometimes as a result of the use of separation principles. Key entry systems now exist that automatically recognize the driver in a car driven by more than one person in a household. The electronic system in the car recognizes the different keys and adjusts parameters such as driver seat configuration and mirror setting to the desired settings of that particular driver. This is not only a more ideal system, but uses the separation upon condition/time principle. Separate temperature controls for driver and passengers in some are also more ideal and illustrate separation in space. In a much older example, tread wear requiring tire replacement has been illustrated by a smoothing tread surface in a regular pattern, easily identifiable by the driver (the worn tire identifies “itself”). The General Motors OnStar™ system, originally conceived to identify the location of stolen vehicles, has turned out to have many other applications including car assistance notification and automatic diagnostic repair and maintenance (“problems identify

themselves") as well as increased resource utilization—finding additional ways to use the OnStar™ system for other applications beyond its originally intended purpose.

E. The average consumer, frustrated by the fact that many products (flashlights of various sizes and light intensity, laser pointers, portable radios) each required different size batteries, kept an inventory of A, C, and D batteries around the house and office. The Eveready Corporation has recently commercialized flashlights that can accommodate any of these battery sizes. The system has become more ideal by the ability to use the resources readily available. Further development of this concept can be expected.

F. The car examples mentioned previously illustrate not only ideality, but also separation principles. Many other new products do as well. We separate bed segments by hardness. We design portable dumbbell weight lifting equipment (ordinarily too heavy or bulky to take on an airline trip) that are simple empty plastic bags later filled with water in the traveler's hotel room, providing a "local" gym. The equipment is light and low volume at the time required, and heavy when desired. We see milkshakes at the Steak and Shake food chain which offers any combination of chocolate, vanillas and strawberry desired by the consumer, in a physically separated presentation within the same glass.

G. Golf balls now "identify themselves". Golf ball locators are now available which use an electromagnetic signal generated by the ball sent to a global positioning satellite, which in turn transmits a signal to a golfer's handheld device.

H. Hot dogs and their buns take different levels and strengths of heat to produce an acceptable product. Heating a hot dog in a microwave in parallel to the use of a microwave oven is one approach. The other is newly designed "hot dog" toaster which separates the strength of heating for each product within the same machine.

I. The minor annoyance of needing to re-pump the reservoir of a garden sprayer has now been eliminated through the use of a wheel pump, which constantly recharges the pressure in the spray container. This not only eliminates the need for manual repressurization, but minimizes the need to carry the chamber back and forth for recharging. The TRIZ approach here is we want the tank to be constantly pressurized, but don't want to use the pumping device. What other resources do we have? This exact same concept can be seen in recent new product developments such as the manual rechargeable cell phone (using a hand crank), a hand crank rechargeable flashlight, and a new computer key board which uses the energy generated by the key stroking to recharge the computer battery or to provide energy to a small portable light to assist vision in poorly lighted areas.

J. 3M's new Notebook Privacy Screen™ allows clear viewing of laptop computer screen only by the person looking directly at the screen (180 degree viewpoint).

The design of the plastic and optics of the screen separates its visibility according to the angle of viewing (separation in space)

K. The continued advancement in razor blades from one up to four and five is based on a continued optimization of the separation in space principle. As we will mention later, this trend may be near an end if we also look at the TRIZ lines of evolution for future product ideas. The same multiple points of contact seen in newer razor blades can also be seen in a new windshield wiper design which increases the pressure points on the window from less than 6 to over a 1000, greatly reducing streaking. They are also made with no metal "superstructure", illustrating again system integration. New windshield products on the market are also demonstrating rain wiping with no wipers at all through the use of sophisticated surface chemistry.

L. Consumer product services also illustrate many of these principles. Though most airlines have virtually eliminated food service, it is still maintained on some long haul (greater than 2 hours) flights. America West analyzes the average fare paid on some long haul flights and offers a different "level" of food service. For example, flights from Dallas to Orlando are primarily filled with families traveling to Disney World. These passengers might receive a snack box, while a higher average flight fare (more last minute fliers), say from Newark to Chicago, might receive a larger, warmed snack at either lunch or dinner. Call routing into credit card service centers such as American Express also follow a separation principle. When a credit card use calls in and enters their credit card number, the system immediately knows the spending habits of this caller. A high level spender, reliably paying off their bills, is routed to a human being to talk immediately, and others put in the queue for several minutes of waiting time. The same kind of service separation is seen in the ability of amusement park visitors to both Bush Gardens and Disneyworld in Orlando, Florida to go the front of the waiting line after having paid a higher park entrance fee (separation in time/upon condition).

In another very recent example, a new service called EDiets™, is beginning to make inroads against the long standing Weight Watchers™ program. Instead of attending weekly meetings, a goal and diet plans are done on the web and personal coaching is available. This doesn't currently replace the group therapy aspect of the older program, but we can certainly envision a web cast involving 20-30 people that will serve the same function. We can also imagine immediate menu generation, appropriate coupons, etc. making this approach even more enticing to the busy woman who does not want to go to Saturday to "weigh in". She can just weigh herself and type in the number. Weight Watchers™ has not been putting on their thinking caps with regard to service evolution!

M. Another new consumer product from S.C. Johnson using the current trademark of Scrubbing Bubbles™ concept to improve shower cleaning. Instead of manually scrubbing a shower stall after a shower, an automatic dispenser releases the

cleaner which is activated by the consumer simply leaving the shower on for a short while. The existing water resources are used and the manual labor is "trimmed" from the process. They have also produced a product that generates room freshening via use of the byproduct heat from an electrical outlet. TRIZ was used to analyze the potential hazards with this product.

N. A recent development in home exercise is the use of the "do it in reverse" principles" in the design of a home pool where the water flow is pumped parallel to the ground, providing the same amount of exercise as someone swimming several miles in a lake or ocean, or multiple laps in a large pool.

O. One last important example is in the health care area. It is always desirable for an individual, when in a life threatening accident or dealing with a seizure preventing speech, to have medical records instantly available, as opposed to the alternative of paramedics calling for the information, or physically testing for it. New flash drive products have recently appeared that can capture a person's medical profile in an instantly retrievable fashion with the computers typically available on ambulances. The person's health situation identifies itself. This is in addition to the already existing alarm systems which an elderly person can use to summon assistance.

There are certainly many other examples that reader can see within their own use and purchase of consumer products. These are reviewed to provide some stimulus to further thinking about product development and use.

The Evolution of Consumer Products

The systems and products mentioned previously, illustrate the most basic of TRIZ principles, but in some cases also lines and patterns of evolution. While TRIZ specialists constantly debate how many lines and patterns exist, we will choose some of the most basic to illustrate how TRIZ lines and patterns of evolution have been used in this area. One of these lines is the evolution of a system to a more dynamic state and the second is the evolution toward a higher field level (mechanical----thermal----chemical----electronic----electromagnetic) and a third is the evolvement toward increased ideality. In all of these cases, there is strong overlap with the more ideal consumer product. Two others lines we frequently see are system integration and oscillation between simplicity and complexity via the integration into a super-system.

A. In considering the use of the automobile again, we can see a number of illustrations. The speed of the wiper system, in some new cars, varies with the speed of the car, eliminating the need for the driver to adjust the wiper speed. The radio volume also adjusts itself to the speed of the car, countering increased noise levels at higher speeds.

B. In the oral care area, we can see the total trace of the field lines. Initially, an oral care system consisted of any mechanical device that could scrub food particles from the mouth. Even the simple act of "swishing" water around inside the mouth is the application of a mechanical field. Hot water (thermal field) was found to improve this process slightly by increasing the solubility of some food particles. The appearance of tooth paste in its many forms illustrates the addition of a chemical field. This same chemical field, in some cases, also performed additional functions (resource utilization) such as decay prevention, breath freshening, and gum disease prevention. Toothbrushes with electromagnetic pulsing have now appeared. These latter brushes, sometimes costing in excess of $80 (US), are now being challenged in the market place with simpler brushes at significantly lower cost through the simplifying of the dynamic system Trimming and simplification are going on.

C. Cooking and food systems also illustrate many of these same lines. Basic cooking systems have evolved from a simple thermal field to microwave systems that are especially effective with water containing products and which uses the resource of the water's sensitivity to microwaves. This is no different, conceptually, than the use of the existing resource of mouth saliva in the previously mentioned breath freshening strips. A large number of customized, home delivered foods are based on an individual's heath conditions, which are can be monitored by the patient himself (using the resource available to generate updated recipes).

D. Documented communication is a fourth. Ages ago, we scribbled in the earth or scratched a message on a rock. We added a thermal field with burnt markers and smoke signals. By adding a chemical field, we painted and also developed printing and writing inks. We even used shorthand as mechanism to reduce the resources necessary to write words and this skill was required of many office assistants as little as 50 years ago. The typewriter combined chemical and mechanical fields. Now the vast majority of communication is done by Email and an electromagnetic field (wireless handhelds and cell phones).

E. Integration into a super-system is illustrated constantly in the office equipment area. At one time, telephones, fax machines, copiers, and printers were all separate pieces of office equipment. These products slowly but surely and predictably (from a TRIZ perspective) combined into integrated units where now all of these functions are combined in one machine at far lower total overall cost. This is no different conceptually than the simple toothbrush example mentioned earlier.

F. Dynamism, or increased response to conditions, is seen constantly in the evolution of consumer products. Beds, whose firmness can be adjusted, automatic adjustments in automobile comfort systems and the customization of food products for taste, calorie, and fat content, all illustrate designing

products for individual rather than mass marketing. The ability to take undyed cloth in large quantities (instead of pre-dying and guessing what would be popular at any time) was the basis for a successful clothing business based on last minute color dying. New car rollover technology is appearing wherein sensors automatically adjust braking in certain wheels (separation in space, condition) and engine speed. New design concepts from Mercedes Benz feature radar scans to warn the driver of impending collision (the potential collision identifies itself), and if this warning is not acted upon by the driver, the system automatically engages brakes, increases tension on seat belts, windows and sunroofs close, and seat return to their upright position. If the driver begins to activate the brakes during this process, the automatic systems proceeds, but compensates for this manual action. This is ideality in numerous forms

G. The line of decreased human involvement combines with ideality, resource utilization, and increased field level to produce our current check out systems seen in major grocery chains and home product stores. The customers check out themselves (use of resources vs. the store's employees), the products identify themselves (bar code scanning via an electromagnetic field), and coupons are automatically generated based on the products purchased to encourage future visits or competitive product purchase.

H. The evolution of our communication systems not only demonstrates evolution along the entire spectrum of field use (mechanical- marking on the ground or wall; thermal—smoke signals and thermal etching; chemical—writing ink; chemical plus mechanical—typewriter; electronic—telephone; electromagnetic—wireless communication), but we see system integration as well. Separate services such as cable and long distance are being integrated into one of these super-systems. Hybrid cell phones are now appearing, integrating many previously separate functions in the same way that occurred with the office copier.

I. Entry systems of all kinds have evolved from simple mechanical closures to lock and key systems to both fingerprint and keycard (electromagnetic) systems.

J. Fuel cells, contain numerous design contradictions to be commercial successfully, will contain mechanical, chemical, and electromagnetic fields in one package. Hybrid cars currently perform their function, using some of these combinations.

Consumer Product Research

There are numerous firms that research for major consumer product producing companies who try to do one of two things: (1) assess a consumer's reaction to a proposed new product, or (2) develop insights into future consumer needs and desires. Major limitations

of such research are the lack of foresight on both the producer and consumer side as to the inevitable evolvement in defined areas that TRIZ teaches us and the inability of the consumer to picture a certain function or service being done in a certain way.

TRIZ can assist in these efforts in the following ways:

A. When a consumer products company is developing a questionnaire regarding a consumer's preference about a "new" way of doing something, pro-actively include concepts from TRIZ. For example, would you like a toothbrush that didn't require a separate tube of toothpaste (as opposed to how would you improve the toothbrush?)? Would you like a way to carry your phone around the room (as opposed to how would you improve the telephone?)? Would you be interested in a cooking system that didn't use gas or electric heat (as opposed to how would you like to improve your stove or oven?)?

B. Some consumer studies are run via the filming and recording of consumer behavior and use of products. When evaluating these types of inputs, the product developing company can ask, "how could we eliminate one of the items used by the consumer in using OUR product"? They can also ask many simple ideality questions after observing the difficulties the consumer is encountering in a product's use. Many consumers also go to great lengths to accommodate an irritating aspect of a product in a trade-off with its primary benefit. If these accommodations can be captured in a visual image or interview with a consumer, then these extra activities can be included in the functional design of an improved product and, from a TRIZ perspective, resolve contradictions.

Conclusions

Though not as glamorous as many large scale engineering TRIZ projects, the application and impact of TRIZ in the day to day consumer and office products area yield both many examples and many as yet unexploited opportunities. It is possible, with the use of simple TRIZ techniques, to improve both the design and market research for consumer products.