

TRIZ: The Theory of Inventive Problem Solving
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BREAKTHROUGH PRODUCTS AND PROCESSES WITH 7 INVENTIVE TECHNIQUES

This is the last, in a series of five articles that outline the sequential application of seven TRIZ techniques or tools. First, each tool is introduced by using a conceptual example. Next, each tool's use is reinforced by applying it again to the same technological system, a vacuum cleaner. The reader may want to review our first article which provided general background material and introduced technique 1, Contradiction formulation. Our second article introduced technique 2, Ideal: Final result/Machine concepts, and technique 3, Function diagrams with 'pruning'. The third article described the use of technique 4, Physical separation and technique 5, The Contradiction Matrix. The fourth article illustrated the use of technique 5, The Trends of System Evolution. Our last chapter, will outline the use of technique 7, The Physical Effects Data Base, provide summary/conclusions from all articles, and finish with keys to success in applying TRIZ.

TECHNIQUE 7: SOLVE THE PROBLEM USING THE PHYSICAL EFFECTS DATABASE

Thousands of physical effects from science and examples from many industries have been captured in a software² knowledge base using written descriptions, animation, technical and patent references (see the endnotes for details). By using various 'functional' search words, the software provides numerous product differentiation examples that can be used to create brand new product applications and features. In addition, these databases are especially helpful when trying to improve a system's performance or when it must be made to work again after costly and poor quality functions are pruned away. The effects database provides us with answers from industries or areas of expertise outside our knowledge base.

As an example, suppose that NASA was forced to reduce the weight of their space probes. During their 'pruning' process heavy batteries, a source for electricity, were removed. Is there some in-situ source of electricity in space? Typing into the computer various search words like temperature and electro-motive force (EMF), produces the Seebeck Effect as a potential solution (see Figure 15). This is an effect whereby voltage is generated across a metallic object that experiences a temperature differential such as a space probe. The probe's side facing the sun experiences blistering heat, whereas the side facing interstellar space is at sub-zero temperature.

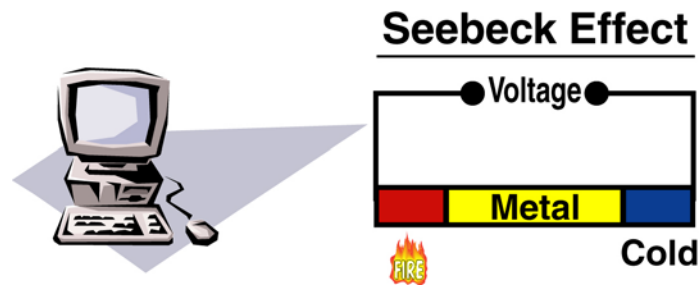


Figure 15. Seebeck Effect

Use the Physical Effects Database to solve for the vacuum cleaner:

Using search words like separate or move substance, the database repeatedly provides examples (similar to those derived from previously used techniques) recommending the use of high pressure, pulsating, and resonance inducing air jets.

SUMMARY AND CONCLUSIONS:

These five articles introduced seven inventive TRIZ techniques, first by defining them and using general conceptual examples and subsequently by applying them to a mature technological system, the vacuum cleaner. For each inventive technique our goal was to improve the vacuum cleaner's performance by eliminating the trade-off that deteriorated the system's primary function, suction. In addition, Inventive technique number 6, The Trends of System Evolution, was used to illustrate not only how it can be used for system performance improvement but also for:

1. Product renaissance via genesis of brand new product applications and features,
2. Innovation potential assessments that define a system's potential for performance improvement, and
3. Competitive analyses and benchmarking.

SUMMARY:

Using Technique 1, the Contradiction was defined as producing maximum suction and maximum flow concurrently, and the concept of high-low oscillating pressure pulses was obtained as a possible solution.

Technique 2, The Ideal Final Result and The Ideal Machine concepts, suggested use of electro-static force generated by the air's friction, to assist the vacuum cleaner's suction.

Technique 3, Pruning suggested:

- A fan that supplies both: suction (high flow), and high pressure (low flow)
- Air (assisted by pulsating high pressure air jets, >>> the 3 PSI of current vacuum cleaners)

- Cyclonic self-cleaning air (no filter required) e.g. the Dyson Cyclone vacuum cleaner.

Technique 4, Physical Separation, suggested separating with time the contradictory requirements of high suction and high flow by using pulsating high/low pressure suction.

Technique 5, The Invention Matrix, suggested Inventive Principles to improve performance:

- 18, Vibration, i.e. pulsating air
- 26, Copying, a multi-furcated nozzle for localized high pressure
- 29, Pneumatics, compressed air for high pressure, or
- combinations of the above.

Technique 6, The Trends of Evolution, suggested:

- Trend 15, Coordination of Force Dynamics: ultra-sonics, resonance and intermittent steady state flow with pulsed pressure spikes
- Trend 19, Anti-bi system: the combination suction and pressure
- Trend 30, Evolution of Fields (force): use of electro-static force

Technique 7, A Software database search recommended, once again, pulsed, high pressure air, and the use of centrifugal force to separate the debris from the air and thus eliminate the need for the filter (Dyson Cyclone vacuum cleaner).

From the above recommendations, three stand out as potentially world class solutions.

- First, the use of the vacuum cleaner's fan to provide both high flow and high pressure pulsed air flow. This solution should allow for removal of the expensive electric power brush add-on.
- Second, the use of resonance as an amplifier to transform low suction into a high output force through increased carpet fiber oscillation. This phenomenon is the same as using a violin's amplification effect, resonance, to break a wine glass.
- Third, the elimination of clogging filters through the use of self-cleaning cyclonic air, i.e. the Dyson Cyclone vacuum cleaner.

And finally, the following list of additional surprise benefits, or super-effects, is a secondary outcome:

- Improved, deeper in-pile carpet cleaning through the use of carpet fiber resonance,
- Reduced weight and size resulting from the elimination of the electric power brush and air filter,
- Intermittent, on-off air pulsations facilitate cleaning of drapes without pulling them off their rack,
- The additional capability to use of the vacuum cleaner as a mini-compressor,
- Synergistic force amplification resulting from the combined force differentiation of suction with pressure, and finally
- The many fold increase of force over the 3 PSI provided by current vacuum cleaners.

KEYS TO SUCCESS IN APPLYING TRIZ TECHNIQUES:

The terminology used to describe the 'Invention Matrix, (Attributes, Inventive Principles) and The Trends of System Evolution is, at the start, a bit confusing, but with some practice, becomes very easy to use. Another point to keep in mind, don't become a prisoner of your words when formulating contradictions, the ideal final result, or function diagrams. Avoid the use of technical jargon, like centrifugal motion, and use simple, all encompassing phrases or verbs like rotate instead.

Preoccupation with software can be disappointing without a fundamental understanding of TRIZ. It's analogous to using spreadsheet software without a basic knowledge of mathematics. Acquiring a thorough understanding of Techniques 1 to 6 is recommended before using the TRIZ software packages. Software automates analyses, but most problems can be solved without it. Also, after selecting a physical effect for possible use from the software database, consult an expert regarding in-depth understanding of its use and any possible negative side effects.

In order for TRIZ techniques to become part of an organization's culture, it is of key importance that an enduring commitment is made to it, and that individuals who genuinely enjoy problem solving and teaching are selected to become their corporate TRIZ champions.

ENDNOTES:

2 TRIZ Software:

Invention Machine Corporation, Goldfire Innovator™ Software provides:

- Inventive Principles and examples from industry for solving contradictions,
- The Trends of System Evolution for optimizing and differentiating systems,
- Physical effects database with examples from industry, and
- Function diagram mapping software.

Their website is: www.invention-machine.com

THE AUTHOR:

Gunter R. Ladewig is president of PRIMA Performance Ltd., www.primaperformance.com, a consulting company that specializes in product, process, and operational renaissance using TRIZ, TOC, Six Sigma, and Lean manufacturing techniques. In 1992 he was winner of IBM's Innovation Invitational, and in addition, twice on IBM's winning team of the **Government of Canada Award for Business Excellence**: The Gold Award for Productivity, and the Gold Award for Quality. Gunter is a Goldratt Institute certified TOC 'Jonah'. PRIMA provides fast track customer teaching tools with 'One Look TRIZ', and tough quality solving techniques like 'KISS', Keeping It Statistically Simple.