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Systematic Innovation

e-zine

Issue 5, June 2002

In this month's issue:

The Systematic Innovation e-zine is a monthly, subscription only, publication. Each month will feature articles and features aimed at advancing the state of the art in TRIZ and related problem solving methodologies.

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Readers' comments and inputs are always welcome.
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Watching Systems Evolve

Introduction

Further on from our initial publication of CREAX work on the evolutionary potential concept (Reference 1), we present here a simple example to illustrate how the evolutionary potential radar plot idea can be used to track the evolution of products. Building on the toothbrush case study we sometimes look at during our courses, we will use a part of that system – an individual bristle (Figure 1) – as the basis for the example.

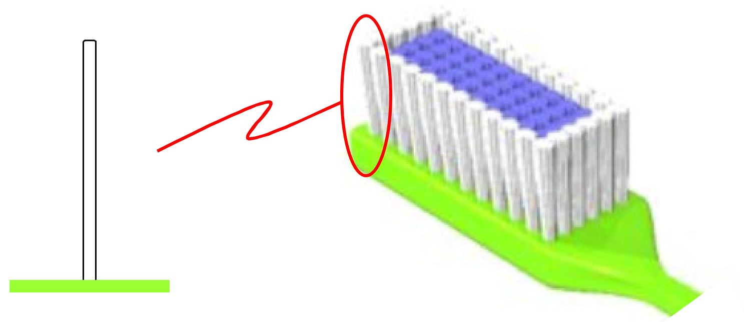


Figure 1: Individual Bristle of a Conventional Toothbrush

As stated in Reference 1, it is possible to plot the current evolutionary state of any system by comparing that system – or in this case component – to each of the known technology trends. Figure 2 illustrates the results of such an exercise for a typical toothbrush bristle for some of the most relevant of the trends.

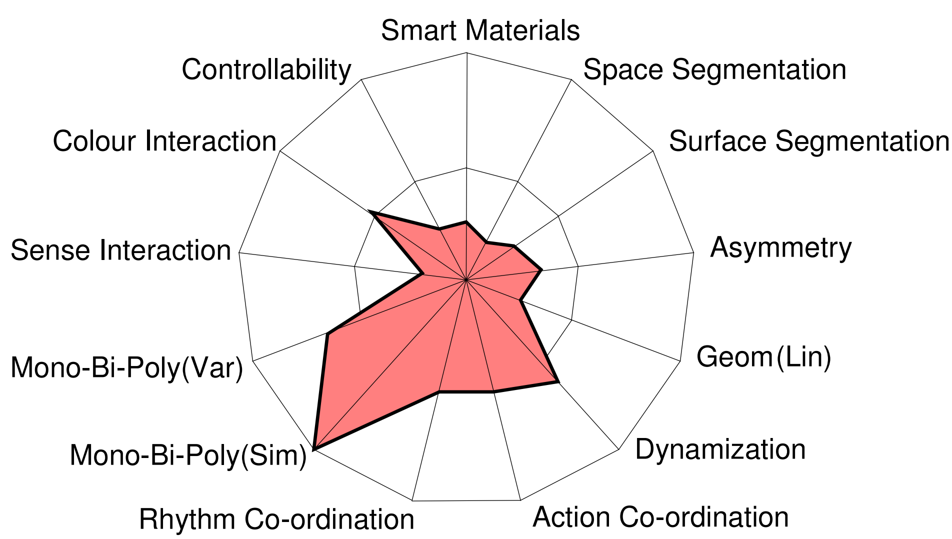


Figure 2: Simplified Evolutionary Potential Radar Plot for Initial Toothbrush Bristle

The plot is of course the result of a degree of interpretation on the part of the constructor. The underlying mechanics of that process is beyond the focus of this article. By way of example of a typical interpretation however, you may note that we have drawn a point at the perimeter of the spoke for the Mono-Bi-Poly(similar) trend to signify that it has reached

the end of the trend. This conclusion has come after asking the question ‘is there any advantage in adding more bristles?’, and answering no.
The main point of the article is to illustrate how the plot changes as evolution of the toothbrush advances.

In the first instance, we might speculate how the toothbrush might take further advantage of the Mono-Bi-Poly(Various) trend by adding bristles of different kinds. This kind of advance might include bristles with, for example, different functions like ‘massage gums’ ‘clean teeth’ and ‘probe small gaps’. Assuming that these are the only useful functions we can think of to add to the brush, we might then say that once different bristles have been added to delver these different functions, the Mono-Bi-Poly(Various) trend will also then have reached its logical limit – as illustrated in Figure 3.

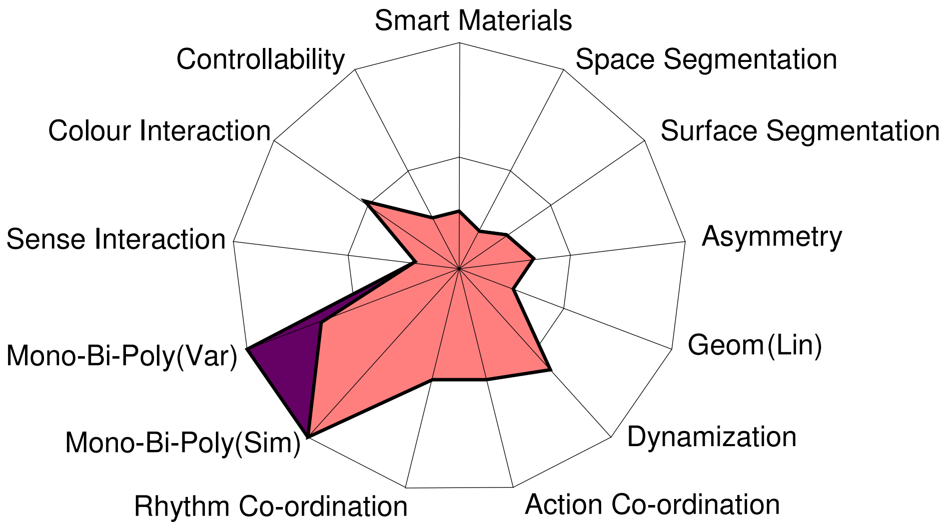


Figure 3: First Example Evolution – Addition of New Bristle Functions

This evolution step is one that many brushes have now taken. Similarly, many bristles have also made another jump from cut fibres with flat tips to moulded tips. We can represent this as a jump along the Geometric Evolution trend as shown in Figure 4 below.

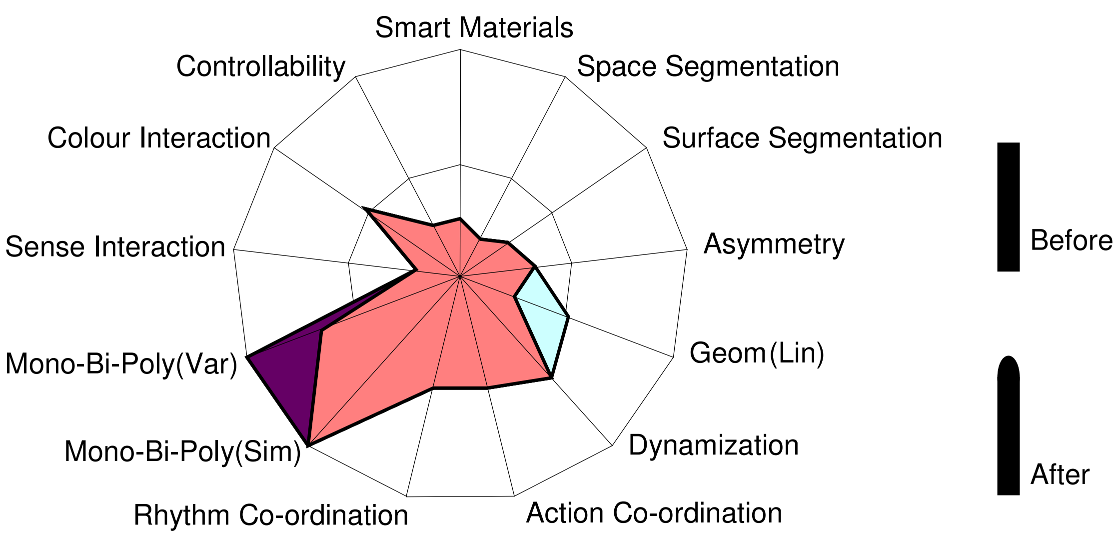
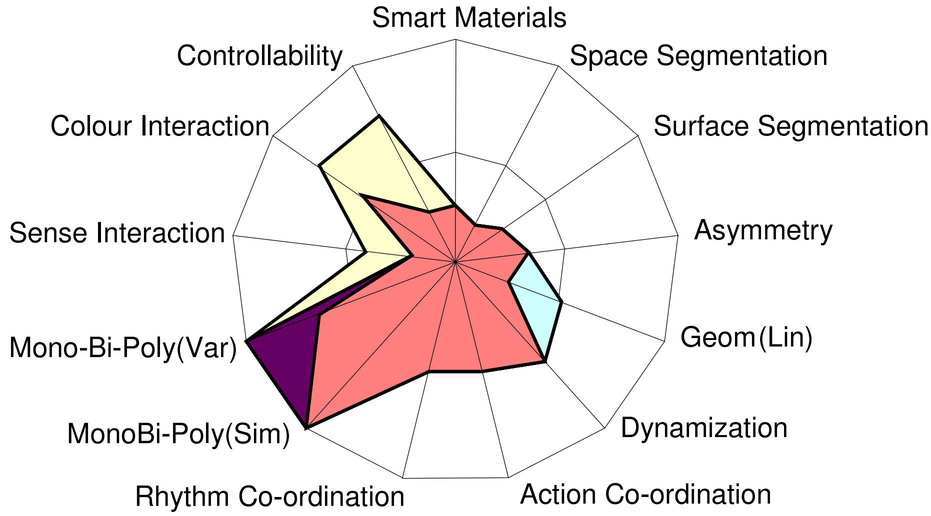


Figure 4: Second Example Evolution – Geometric Evolution of Bristles

Next, we might note how some bristle designs have evolved to add a function whereby the inform the user when the brush needs replacing. The usual way of delivering this function has thus far been to introduce a colour change capability into the bristle, and as such, this



evolution represents evolutionary jumps along the controllability (addition of feedback), sense interaction (addition of 'sight' sense interaction) and use of colour. This jump is represented by the radar plot shown in Figure 5.

Figure 5: Third Example Evolution – Colour-Based 'Bristle Wear' Indicator

Figure 5 takes us to the state of the art for the large majority of toothbrush bristles. We might, however, examine some of the unused potential to see where and why the bristles may evolve in the future. Firstly, we examine the space segmentation trend and speculate on the potential advantages of evolving from the current monolithic bristle structure to a hollow one – Figure 6.

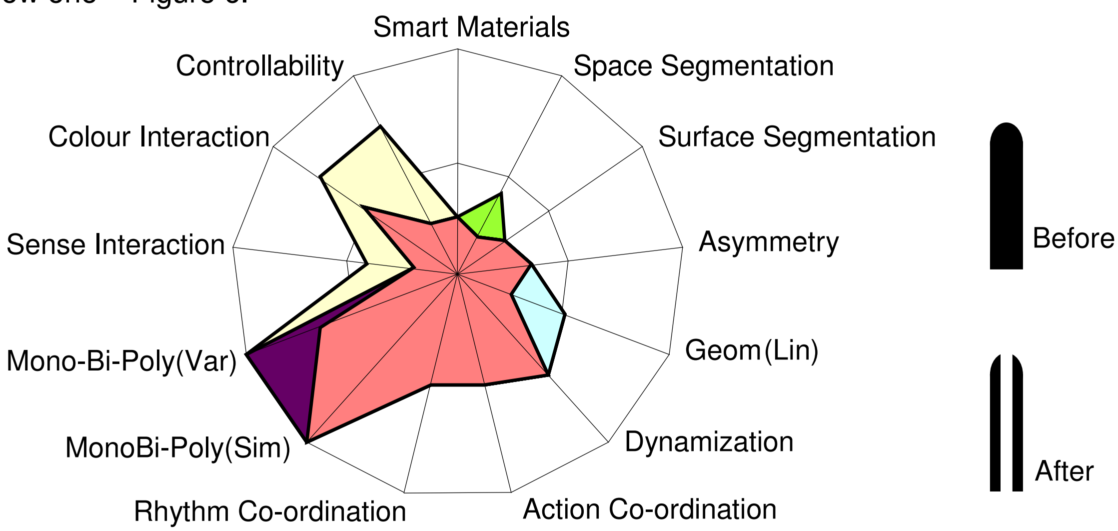


Figure 6: Speculative Future Evolution – Hollow Bristles

In trying to identify possible advantages of evolving to this kind of bristle structure, we might speculate that the hollow bristle may be used to add a variety of benefits – for example to allow transmission of either toothpaste or water up through the bristle, to improve strength or flexure properties, etc.

Figure 7 takes this one step further by speculating that the tip of the bristle may further evolve from a smooth surface to one that incorporates local protrusions to the benefit of the user – for example to improve the cleaning action through increased number of tooth contact points.

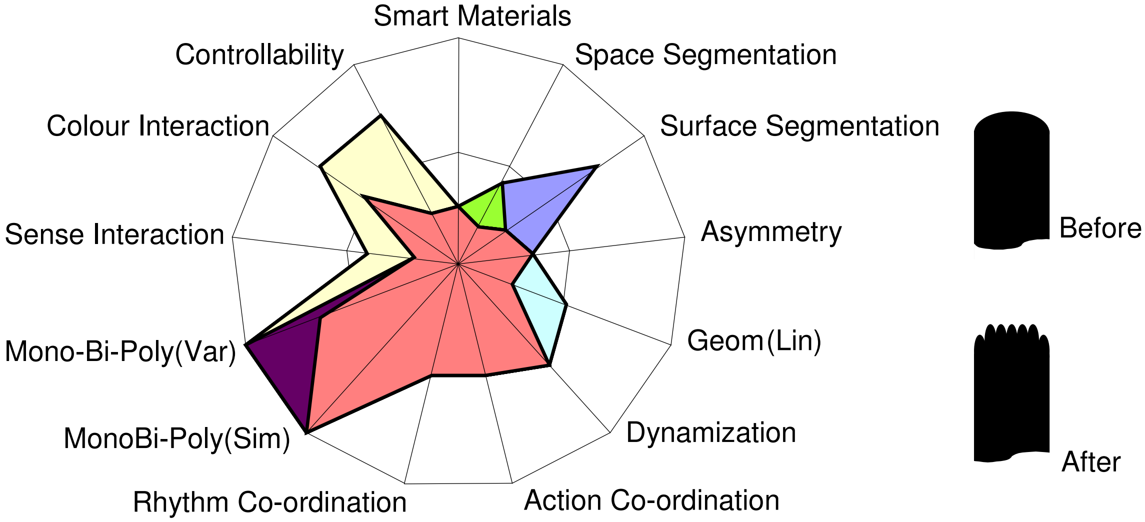


Figure 7: Speculative Future Evolution – Bristle Tips With Protrusions

Another toothbrush evolution currently taking off in Japan and the US is based on evolution from a flexible bristle to a field-based solution – in this case through the emergence of tooth-cleaning devices based on ultrasound. This jump affects the above radar plot in two ways; firstly it would see the dynamization trend hit its evolutionary limit, and secondly, it would make the whole 'bristle' radar plot irrelevant and hence cause it to be removed from the series of component-based radar plots that would make up the overall toothbrush radar plot hierarchy.

Conclusions

These ideas are purely speculative of course, and merely used as examples to demonstrate the main point of the article – that as systems evolve, the evolutionary potential radar plot will gradually be filled up. Animated versions of this particular series of radar plots give a useful image of the evolution process in action. Meanwhile, expect to see more of this sort of image in future articles.

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Value Differentiation and Contradiction Finding

Some people find it easy to identify the things in a system that are in conflict with one another, and some people don't. For those that don't we present here another strategy that may help. We hope it is a strategy that also offers some useful insights to those natural contradiction finders among us.

The strategy is new to TRIZ, but has been around for some time in other fields. It is generally known as 'value-differentiation', and works something like this:

For any given system, define the attributes that are important to users of that system. These might be things like weight, size, performance, aesthetics, reliability, etc. The selected attribute parameters are placed along the x-axis of a graph at discrete points. The y-axis of the graph is then defined as a graded scale from 'poor' to 'good' as shown in Figure 1.

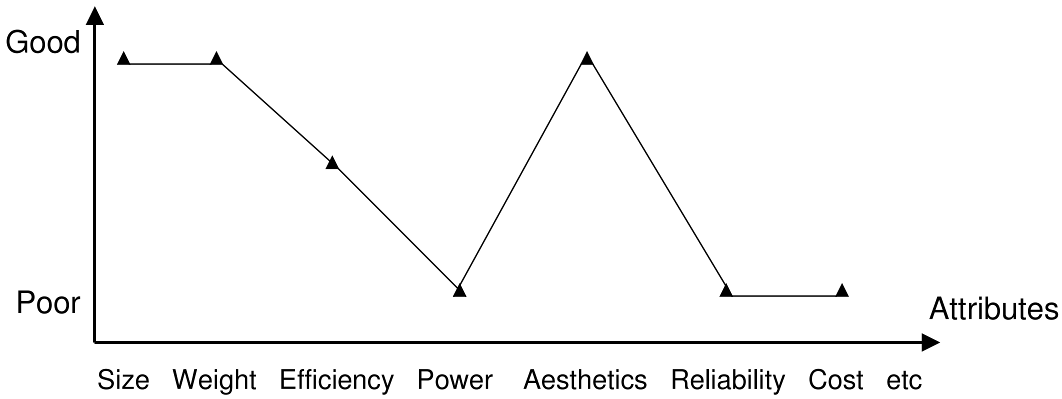

Figure 1: Example Value Differentiation Graph

The graph is then filled in by grading the system under evaluation against each of the attributes included along the x-axis. Usually this is done on a qualitative basis, although there is nothing to stop a quantified analysis being conducted if this is preferred.

In its traditional role, the value differentiation graph is used to compare different systems – usually competing ones, and hence the picture may be expanded to illustrate how several systems score relative to one another for each attribute of interest – Figure 2.

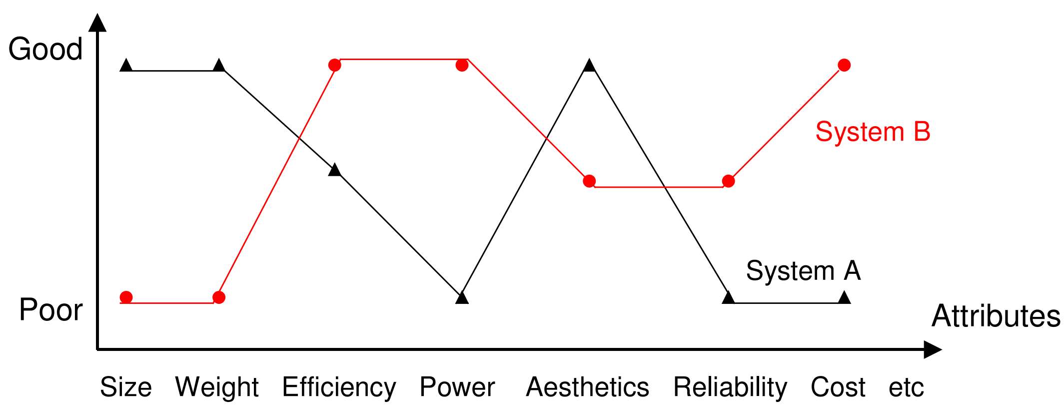

Figure 2: Value Differentiation Graph Comparison Between Two Competing Systems

In many senses, this picture is another means of presenting the information that might be found in a typical House of Quality system comparison exercise. The main difference – and the reason for the term 'value differentiation' is that this graphical approach is easier to use from the perspective of discriminating one system from another. In other words, it is used as a visual means of identifying or defining the unique selling propositions of a given system.

From a pro-active perspective, the value differentiation graph is often used to guide the design of a new system such that it discriminates itself from other existing systems – so that, for example, if a competitor's system is rated 'good' on attributes A, B and C, and 'poor' on attributes D and E, and all of these attributes are believed to be important to customers (usually the most difficult part to gauge), then focusing the new system on achieving good performance on attributes D and E would be the most effective means of discriminating the new system from the existing one.

Of course, what usually happens during this kind of exercise is that, in designing the new system to achieve a 'good' rating for attributes D and E, it achieves a less good rating for the other attributes. This is an expected phenomenon within value differentiation because traditionally it is yet another method based on trade-off and compromise. In the example illustrated in Figure 2 for example, the two systems are differentiated, but only because the trade-off has been shifted from one set of attributes to another – as evidenced by the fact that the area under each line is pretty much the same.

From the TRIZ perspective, two points are important; the first is the fact that when we construct the value differentiation graph and see that some things are 'good' and some are 'poor' these will tend to be the things that are in conflict with one another. If we compare any 'good' attribute with any 'poor' one, we are highly likely to find that our traditional design options allow us to have one thing or the other. In other words, we have found a contradiction. This is the main point of the value differentiation graph as far as this article is concerned.

The other point is that from the TRIZ ideality perspective, what we would like from the system is that it score a 'good' for all of the important attributes under consideration. A TRIZ person would look to discriminate their system from competitor systems not by shifting the trade-off from one place to another, but by creating a system whose graph is a horizontal line showing all attribute scores to be 'good' – Figure 3. If our x-axis is constructed to show all of the important attributes of a system, we can use this picture to help define the (practical) Ideal Final Result of the system.

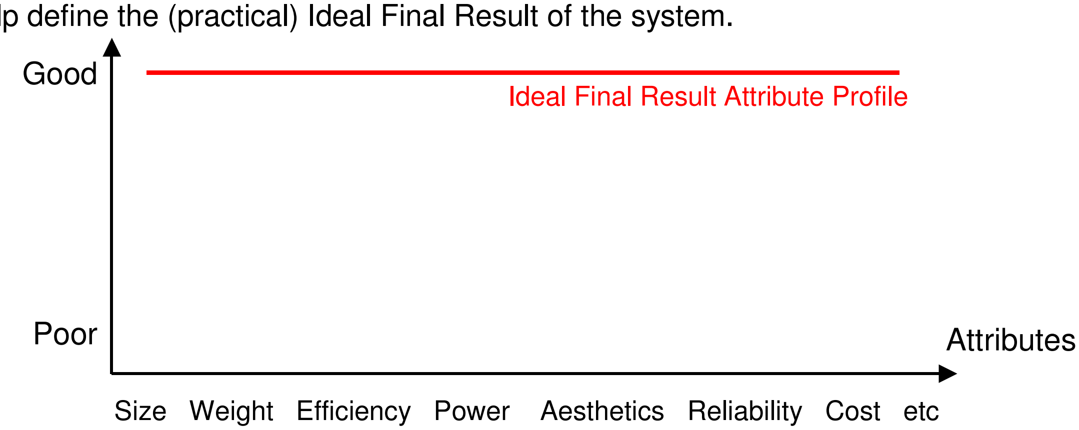

Figure 3: Value Differentiation Graph Helping to Define Ideal Final Result

(Final thought: the value differentiation graph idea is like the incompressible bag idea described in several places in CREAX texts – only here the skin of the bag has been unraveled and laid out along a straight line axis.)

Humour

Another cartoon by one of our favourites, Gary Larson. This time illustrating one of the conceptually more difficult of the Inventive Principles – Number 9 'Preliminary Anti-Action. To be honest, we usually find ourselves using this cartoon as the way we remember what Principle 9 is trying to tell us to do.

Patent of the Month

Patent of the month this month comes from the medical field; US6,389,313 granted on 14 May 2002. Our attention was drawn to the patent because of its use of a field (in this case laser) to deliver a drug. Anyone that has been on one of our courses will know that we quite often talk about medical examples when looking at the Trends part of TRIZ, and particularly the Dynamization trend – which suggests the increasing use of fields in order that doctors and surgeons can avoid the use of invasive (and hence mechanical) procedures. US6,389,313 falls directly into this category of field-based systems. Specifically, the patent claims:-

"… an optical device designed to enhance delivery of a compound by a method selected from the group consisting of applying optical pressure to generate propagating pressure waves in a medium to increase diffusion of a compound through said medium; applying optical pressure to a compound to directly drive said compound through membranes and tissue by optical propulsion; creating an optical trap to drive diffusion of a compound; and, directly applying radiant energy to tissue to increase the permeability of said tissue to a compound."

In terms of 'reasons for jumps' between the TRIZ trend stages, although 'non-invasive' is a good enough reason in a medical sense, it is clear that this patent also delivers other advantages over mechanical drug delivery systems, namely:-

"It is an axiom in pharmaceutical science that it is usually beneficial to maximize the local concentration of a biologically active material (pharmaceutic or biologic) in the tissue volume of interest. Similarly, it is typical that local administration is more desirable than systemic administration since the latter requires a higher dosage necessary for a therapeutic treatment, and often leads to an increase in side effects either systemically or at specific sites distal from the target tissue. However, local delivery of compounds is often not practical because the compounds do not significantly penetrate target tissues or tissues adjacent to or surrounding the site of interest."

In other words, the laser offers a means of delivering medication to a very localized area.

and in summary, also from the invention disclosure:

"The prior art is deficient in the lack of effective means of enhancing local administration of pharmaceuticals and/or collection of biological materials. The present invention fulfills this long-standing need and desire in the art."

US006389313B1

(12) **United States Patent**
Marchitto et al.

(10) **Patent No.:** **US 6,389,313 B1**
(45) **Date of Patent:** **May 14, 2002**

(54) **LASER PROBES FOR DRUG PERMEATION**

(76) Inventors: **Kevin S. Marchitto**, 127 Bellbird Road; **Stephen T. Flock**, 17 Gillards Road, both of Mt. Eliza 3930 VIC (AU)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/535,910**

(22) Filed: **Mar. 24, 2000**

Related U.S. Application Data

(60) Provisional application No. 60/126,290, filed on Mar. 26, 1999.

(51) **Int. Cl.**[7] **A61N 1/30**
(52) **U.S. Cl.** **604/21**; 607/92
(58) **Field of Search** 604/19–21, 113; 607/3, 88 94, 100 101, 104, 105, 120, 138; 600/101, 121, 127, 139, 153, 156

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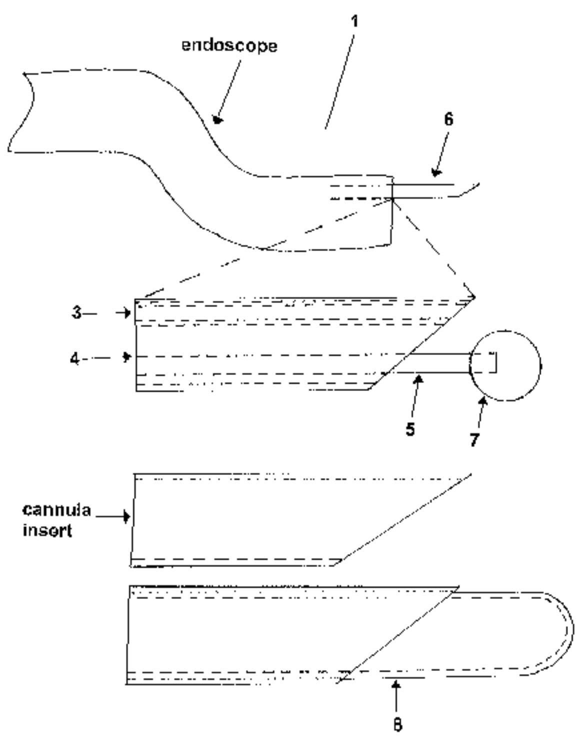
Primary Examiner Sharon Kennedy
(74) *Attorney, Agent, or Firm*—Benjamin Aaron Adler

(57) **ABSTRACT**

The present invention provides an optical device/method for enhancing local administration of pharmaceutical compounds and/or collection of biomaterials. Such device/method is used for various situations which require high concentrations of drugs that are delivered locally.

28 Claims, 6 Drawing Sheets



Best of the Month

This month, we join Ellen Domb of TRIZ Journal in sending our best wishes and congratulations to Nikolai Shpackovsky for the award he received for his TRIZ work at Samsung. Check out the May issue of TRIZ Journal lead article.

The award was presented on the basis of over 91 million US dollars of savings to the company through the application of TRIZ.

Investments – Linear Motors

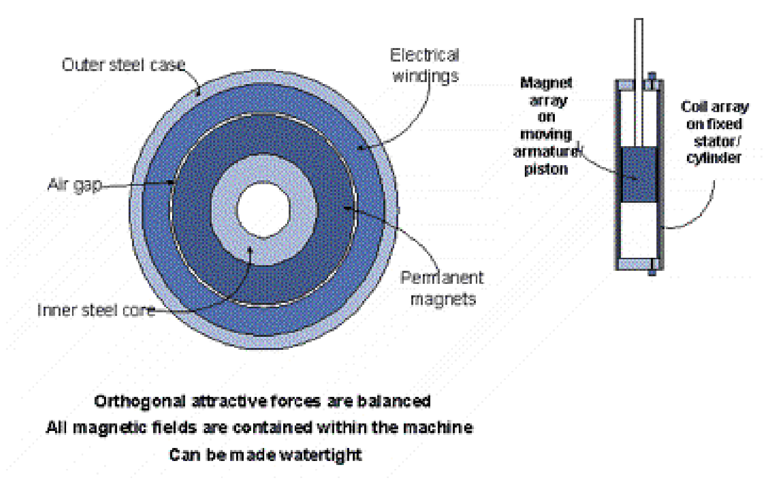
Our investment of the month this month was inspired by a request to find a better means of delivering the function ‘move structure’ than a traditional electric motor, gearbox and lead screw arrangement, or a hydraulic system.

The question reminded us of a particularly pleasant meeting with inventor Phillip Denne a few years ago. Mr Denne is a prolific inventor responsible for a number of important motion control innovations. His latest work looks like the most profoundly important yet. His new linear electromagnetic rams are currently being exploited through Advanced Motion Technologies, Inc. (check out http://www.q3000.com/). AMT® is the sole producer of this technology in the world and possess over 80 patents in 80 countries related to this technology and its applications.

The Q3000® line of ServoRams® achieves unparalleled power and precision in a completely sealed, silent, maintenance free design featuring:

Extreme positioning accuracy, independent of load or velocity
Speeds to 80 metres/second
Thrusts to at least 100 tonnes
Strokes to more than 100 metres
High efficiency - actually increases with speed of movement
Zero mechanical backlash - force is created at the point of load
Zero electrical hysteresis
Zero transport lag
Control time constant in milliseconds
Inherent force sensing
Dual pneumatic/electromagnetic action that minimizes power demand
Fail safe dynamic braking

The AMT ServoRams® are linear motors. The actuator is essentially a multi-pole permanent-magnet rotary electric motor com split down to the middle, rolled out flat and then rolled back up again by taking the long edges of the strip and bringing them round to form a cylinder.



The armature is treated in the same way and the armature shaft is then inserted along the axis of the cylinder to make a piston shaft. Finally - and most importantly - the outer surface of the armature is sealed to the inner surface of the cylindrical stator, so that they act simultaneously as a fluid piston and an electromagnetic force generator. Because all the electromagnetic fields close back upon themselves within the steel housing, the machine is very efficient and environmentally benign.

The basic design is currently scaleable from less than 10 Newtons to more than 200 KiloNewtons thrust, in strokes from 10 mm to 100 metres and velocities to at least 100 metres/sec.

We think the whole thing is well worth a look.

If you are more interested in TRIZ than investments, the web-site also contains a number of papers. The one that particularly caught our eye was 'The Mother of Invention', which contains an elegant discussion on why the TRIZ trends show systems evolve from fluid to field based systems. Quoting from the paper, which is primarily about application of the new servo-rams to motion simulators:-

'Electric motors driving screw-jacks can be beefed up to produce a large thrust but they cannot be designed to also have the extreme sensitivity and fast response which is vital to [certain applications]. A good motion system must be equally capable of producing the strong sensations of 'cornering' in a vehicle as in providing the differences in road feel from gravel or tarmac to grass. Hitherto, only hydraulic rams have been able to do this, at great expense and complication and with the inevitable oil leaks and fine oil spray onto the surroundings. When the simulator is used indoors, the damage to nearby fabrics, the fire hazard and the possible toxic effects of the oil mist create major problems. Further, hydraulic motion systems waste a lot of energy. Whenever a hydraulic ram is moved, oil at high pressure is transferred from the power unit into the system and an identical volume of oil, at zero pressure returns to the tank. 98% of the energy disappears as frictional heat when the oil passes through the various control valves.'

Check it out.