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Evolution Predictability, Lamarck, Altshuller, Darwin and Chaos

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Abstract

Predicting the future at the system level can be accomplished using the Theory of Inventive Problem Solving's (TRIZ's) Laws of System Evolution. The problem is that TRIZ's theory of evolution is founded upon Jean-Baptiste Lamarck's theory of biology evolution, which after being proved inaccurate, was replaced by Darwin's theory of evolution. In this article we will claim that it is also possible to explain TRIZ observations using Darwin's theory, and that doing so will open the door for further development, and improved accuracy of the laws using Chaos mathematics.

Keywords: Evolution, Lamarck, Darwin, TRIZ, Ideality, Determinism, Attractors, Chaos

a. Prediction of the future

"The best way to predict the future is to invent it"[1],
Alan Kay

The other way around view is:
"The best way to Invent is to know the Future"
Is the future predictable?

At the Supersystem level, predicting and even forecasting of the future of technology is achievable by applying R. Kurzweil law: "The Law of Accelerating Returns"[2], stating that:

"Evolution applies positive feedback in that the more capable methods resulting from one stage of evolution progress are used to create the next stage. As a result, the rate of progress increases exponentially over time".

A well-known example is "Moore's Law"[3] predicting that: ***"the number of components per integrated circuit for minimum cost doubling every two years"*** Each new generation of computer (which appears approximately every two years) is based on successful designs from the previous generation along with newly incorporated features, this results in twice as many components per unit cost, each of which operates substantially faster.

Can prediction be accomplished at the System level?

This is a question that Genrich Altshuller and his successors were trying to answer through development of his TRIZ Laws of System Evolution [4][5].

b. Platonism vs. Aristotelian theories [6]

It is possible to classify all theories into two categories: Platonism and Aristotle's theories

2.1. ***Platonism, Theory of Forms*** – according to Socrates and Plato, the material world is an image or copy of the ideal world, the ideal world is built upon archetypes of forms which can only be perceived by reason. These forms are the cause of the apparent world which is constantly in changes. A Platonism type of theory will describe a phenomenon, provide tools for making associated predictions but will not look for an explanation of what caused the phenomenon.

Example: Newton's Classic Mechanics is a Platonism type of theory, based on Newton's theory it is possible to predict the gravity of an object with great accuracy but the theory does not explain the cause of gravity.

2.2. ***Aristotelian Theory –*** Aristotle saw the existence of the Material world as the only real existence. Understanding reality is done through empirical experience. Everything in the world exists under the four factors: the material cause (what it is made of), the form cause (what has shaped it), the causal factor (what brought it into existence) and the goal-oriented factor (purpose for which it exists). An Aristotle's types of theory describe the reason or drive behind a phenomenon.

***Examples*:** Einstein's Theory of relativity is an Aristotelian theory which provides an explanation of what is the cause of gravity and the experiments to prove it.

TRIZ with its System Evolution Laws, and mostly with the concept of Ideality, is a Platonic type of theory. The evolutions laws effectively describe the observed phenomenon and provide decent prediction tools, but do not explain the cause of Ideality. What is forcing a system to evolve towards an Ideal system?

Is it possible to explain the causes for the phenomenon observed by Altshuller, making TRIZ an Aristotelian theory?

c. TRIZ, Lamarck and Darwin - can the accuracy of TRIZ prediction be improved?

3.1 *Lamarck and TRIZ theories*

TRIZ presents a set of laws describing system evolution. These laws are based on observations and identification of repeating patterns. Since their inception, the laws have been repeatedly validated by the amazingly accurate predictions made by a growing number of practitioners.

The main concepts behind the TRIZ Laws of System Evolution are:

a. The driving force for Man-made Systems Evolution is "Needs"
b. Man-made Systems Evolution is not random, but instead follows an S-Curve towards increasing Ideality
c. Systems evolve toward better use of resources, increased Dynamization, increased synchronization, reduced human involvement and increased, followed by reduced complexity.

TRIZ Laws of Evolution can be viewed as a projection of the theory of evolution proposed by Jean-Baptiste Lamarck[7] onto the world of technology:

a. The development of an organism is based on needs
b. Evolution happens according to a predetermined plan
c. An organism changes during its life in order to better adapt to its environment. Those changes are passed onto its offspring. The development of an organism trait or feature is proportional to the usage of that trait or feature and therefore, if it is not in use, it will eventually disappear.

However, in the biological world, Lamarck's theory has been proven to be wrong.

An organism is able to develop an inherent trait by exercise, but it cannot bequeath its life time developed expertise to its offspring by birth. The long neck of the giraffe did not evolved as an individual phenotype successfully extending its neck until it become longer, followed by the inheritance of the extended neck by its posterity. Rather the giraffe's unique trait appeared by the accumulation of generations of small changes of the giraffe genes, in an environment that gave advantage to a slightly longer neck as describe by Darwin's theory of evolution [8].

If Lamarck's theory was wrong when applied to nature, then can it be correct when applied to man-made systems?

Is it possible to apply Darwin theory over Altshuller's observations?

3.2 *Can Darwin's Theory explain TRIZ observations?*

Darwin stated that evolution is based on three elements:

a. **Preservation** states that there is an accurate copying of successful traits from one generation to the next.
b. **Natural Selection** states that since the environment resources are limited and therefore more organisms are produced than can survive, those organisms having the most beneficial traits are more likely to survive and reproduce and therefore adaptation is ever increasing.
c. **Variety** states that new traits are introduced through a random transfer of traits by way of mating, cross-species gene transfer and mutations.

There is no Ideal system. The path of evolution is governed by the environment, but the environment is influenced by the new generation and therefore changes as well. The result is a feedback mechanism and therefore the evolution is much less deterministic than initially thought.

In her book: The Meme Machine, Susan Blackmore[9] has proposed a distinction between the different evolution models of *copy the product* (a Lamarck type of evolution) and *copy the recipes* **(**a Darwin type of evolution). The differences come from the method by which knowledge is being transfer over generations. In *copy the product* evolution the knowledge is transferred by non-documented methods and reproduction is done by reverse engineering a product. Therefore many of the product "secrets" do not pass to the next generation and the developer must create new solutions herself/himself thus limiting the survivability of knowledge. In *copy the recipes* evolution the knowledge is transferred through documented code or recipes. Therefore the accuracy of copying and survivability of the knowledge are much higher. Evolution then occurs by way of variation in interpretation of the recipes.

Example:
The iPad tablet was first introduced by Apple in Jan 2010, the iPad is based on Apple previous products the iPod and iPhone and has therefore evolved through *copy the recipes* or Darwin's type of evolution. Since appearing the iPad is serving as the reference product to all other tablet manufactures. Apple's second generation, the iPad 2 (introduce in Mar 2011), was again developed using Darwin's type of evolution based on the original iPad. However, the original iPad recipes were not externally available therefore other tablet manufactures had to reengineer the iPad, using a mix of *copy the product* and *copy the recipes* (where possible) methods. This resulted in a high number of tablet variants all closely resembling the iPad in from.
So far, most of these variants have failed to show an advantage over Apple's iPad 2. This situation can be change when Darwin's type of evolution will take place with the development of Apple's competitors second generation of tablets.

As can be seen by the example above, technology can evolve using either type of evolution, However, Darwin's type embodies better knowledge survivability and therefore is a much more powerful and thus more likely to dominant evolutionary patterns.

In this article we will try to explain Altshuler observation using Darwin's evolution theories solely.

The main questions to be answered are: how can the success of the Ideality law be explained?
What mechanism in Darwin's theory can cause deterministic results?

The first candidate is the phenomenon of Convergence Evolution. Convergence Evolution is defined as the acquisition of similar traits by unrelated species. Convergence evolution occurs in the presence of strong environment restriction forces.

Examples of Convergence Evolution:

a. Deer & Gazelle. Deer and gazelle are both herbivores which evolved separately and at different latitudes. Both spices have developed horns for a similar purpose of marketing an individual's fitness. However, the deer's horns are made of skin cells while the gazelle's are made of bone cells.

Fig 1. Deer and Gazelle

b. Wolf & Hyena. These are mid-size carnivores that share many physical similarities although they belong to different families. A wolf is part to the Dog family while the Hyena is a part of the Hyaenidae family.

Fig 2. Spotted Hyena and Wolf

c. Pen & Scalpel. The shape of a pen and scalpel are similar, although their starting points were far from each other. The pen evolved from the feather while the scalpel evolved from a stone knife.

Fig 3. Scalpel compare to Pen evolution

d. Distances and Measurements. The length of a football field is 100 yards, the length of Olympic swimming pool is 50 meters and there are ten events in the Men's decathlon. Is it a coincidence that all these numbers can be divided by ten? Probably not, the most likely reason is that humans have ten fingers, which drove the evolution of the decimal numeral system and a tendency to design systems as divisible by ten.

What is the cause of restriction forces which influence the evolution of man-made systems? The most probable answer is the human effect. Man-made systems are designed to serve individual human or groups of humans (i.e., the automobile amplifies the capability of a human to move). Hence the evolution of man-made systems is not a standalone process but rather an extension of human evolution. All man-made systems are extensions of human's traits, capabilities and needs. For example, the convergent design of the writing pen and the scalpel were influenced by the restriction force created by the anatomy of the human hand.

A second candidate driving factor of determinism comes from chaotic behavior of the system. According to Darwin, evolution is a "Nonlinear Dynamical System," where each generation is depending on its previous generation:

$$G_n = f(t; G_{n-1}; E_{n-1}), \quad E_{n-1} = f(G_{n-1})$$

Where:
G – Generation
t – Time
E- Environment
n – Generation number

These type of systems were first modeled by Edward Lorenz[10] the founder of Chaos Theory. Under certain conditions chaotic systems evolve toward *attractors*. *Attractors* are points or curves through which nonlinear dynamic systems tend to pass over time. The *attractor*s can be the explanation of the evolution mechanisms like: Mono-Bi-Poly, Line-Plane-Volume etc.

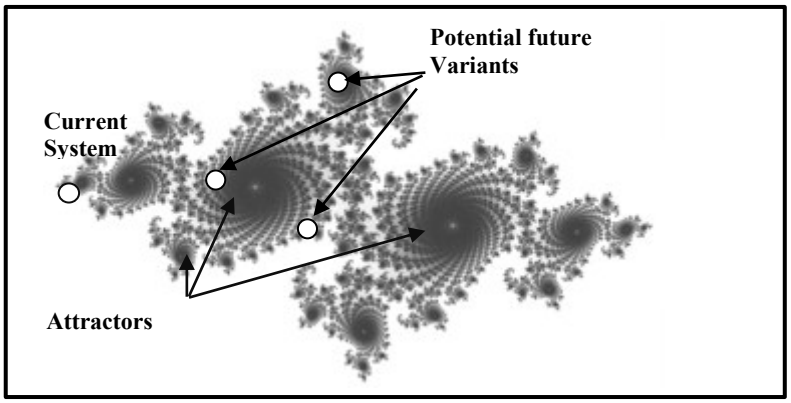

Fig 4. Fractal behaviour as explanation of trends of evolution

The combination of attractors and convergence evolution make it possible to explain the determinism proposed by TRIZ Evolution using Darwin's theory. Though systems evolve in a chaotic manner toward attractors, the restriction forces reduce the number of potential attractors and therefore the number of potential variants. The outcome is somewhat deterministic.

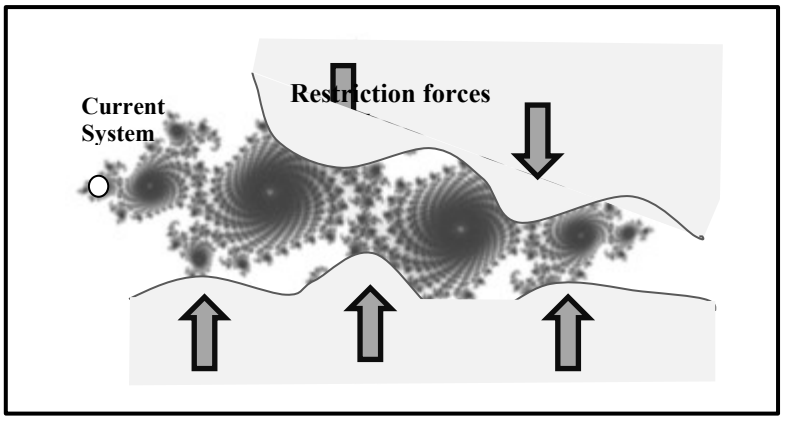

Fig 5. Restriction forces reduces the field of potential variants

It is important to notice that:

$$E_{n-1} = f(G_{n-1})$$

Therefore, some of the restriction forces change over generations and thus decrease predictability. While other forces like ergonomic standards and the like are more stable and therefore increase predictability.

d. Chaos Mathematic for TRIZ

Looking at evolution as a chaotic system and applying Chaos mathematics can provide tools for improving predictability. Furthermore, the Chaos Theory could also support movement into the space of forecasting if and when proper equations can be developed. As an example, advancements have been made in the accuracy of meteorology forecasting since Lorenz first published his article in 1963.

According to Chaos mathematics, the coefficients of the non-linear equation control the predictability. For a certain coefficient range an equation tend to convergence and stabilize towards a specific value. For a higher coefficient range, the system will stabilize towards a few attractors, while further increasing the range will cause the system to behave randomly.

Therefore we would like to propose the existence of a similar behavior with technology evolution. There are most likely cases where there are only a few attractors, so those system will stabilized at certain values not showing a tendency to evolve further.

Examples of system stabilized by a low number of attractors:

A toothbrush form is dominant by three primary constraints: The anatomy of the human hand, the anatomy of the human mouth and force required to press the bristles onto the teeth. Therefore this relatively noncomplex set of constraints results in the system stabilized toward a "mono" toothbrush head, a somewhat common and stable toothbrush design which appeared rather early in the evolution of that system. "Bi" and "Poly" brushes did appear on the market as predicted by TRIZ, but so far failed to make an impact, if survive at all. Dual heads toothbrushes, tends to impair the interface with the human hand or mouth and therefore rarely survive.

Fig 6. Examples of a 17 century "Mono" head toothbrush, Vs. "Bi" and "Poly" Handle phenotypes

b. Eating technologies[11] - The needed function is to move food from the plate to the mouth. The constraints are coming from the human anatomy and the food traits. From these simple sets of

constraints we can see the emergence of three eating tools: hands, cutlery and chopsticks, these tools in turn act as attractors as each "utensils" has influenced its environment resulting in changes to the way people are preparing their foods. Therefore, the tools and the food are adapted to each other. Try eating Sushi using a fork and there is high probability that the food will dismantle. Or, try using chopsticks for cutting and eating steak and you will find it impossible.

e. Summary

The mission in writing this article was to apply Darwin's evolution over the observation and axiom of TRIZ. The main focus was given to the law of ideality, the determinism of TRIZ and the mechanism behind the trends of evolution. The model proposed explains these observations by way of a combination of Convergence evolution and Dynamic System Mathematics.

During the last 50 years, the field of Dynamic System mathematics known as Chaos mathematics has evolved dramatically, increasing the accuracy of predictions based on Chaos models.

We believe that developing models based on Chaos mathematics and TRIZ observation can improve the precision of TRIZ based predictions.

Our model proposed that Chaos attractors phenomena are appearing in man-made system evolution as the steps found in the TRIZ Trends of evolution. Restriction forces induced by the environment and mainly by humans are reducing the number of potential attractors so the system becomes more deterministic and behaves like it is evolving towards an ideal system. Most importantly it is possible to explain the phenomenon observed by Genrich Altshuller and his successors, using Darwin's Theory of evolution, and therefore turning TRIZ from being a Plato type of theory to an Aristotelian Theory.

c. References

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