Reply to comments on the article “Su-Field: An Educational Example of Inventive Problem Solving in Electrical Engineering”

by Antonio Cesar Lettieri, Takashi Yoneyama

As authors of the January/2006 article, “Su-Field: An Educational Example of Inventive Problem Solving in Electrical Engineering”, we would like to contribute with some additional material based on the comments by Richard Kaplan, published in February/2006.

Firstly, we would like to thank Mr. Kaplan for his very interesting comments on our work and that were crucial in providing us some new perspectives to the presented problem.

Therefore, the idea is not to confront subjective views, but only to follow the guidelines of the TRIZ journal “that by sharing information we will all learn more, learn faster, and learn in more depth than if we each stand alone.”

We also take the opportunity to provide inventive alternatives to Kaplan's classic puzzle.

In the Kaplan comments, he states that the circuit problem may be solved in other ways without the help of Su-Field Analysis. He showed that we could achieve the same solutions just using effects directly.

We fully agree with Mr. Kaplan. Su-Fields are not the only way of solving the inventive problem. There are more ways of solving the same problem in TRIZ weapon inventory.

Indeed, we had the same success with our students in solving the circuit problem using yet another TRIZ tool: Resource Mapping. After teaching the students to look for available resources, they easily identified the thermal and magnetic fields as resources and find the two solutions we pointed in our article. Mapping available resources is a simple and powerful tool of TRIZ and is found also in the Kalevi Rantanen´s “*Simplified TRIZ”* book.

It may be convenient to explain some details about our understanding of TRIZ fields and Su-field modeling, as these details are important for understanding the arguments that will follow:

1) <u>TRIZ engineering fields are different of “just physical fields”.</u>

A TRIZ engineering field models an interaction between material objects. The mere presence of a physical field in a system does not automatically imply presence of a TRIZ field. A TRIZ field appears in a model only when we decide to use it to model an interaction that can be useful, harmful our insufficient. All inventive Standards refer to TRIZ engineering fields, more than “just physical fields”.

2) <u>What is meant by “to introduce a field" (in Inventive Standards)?</u>

In a manner similar to what happens with the term “field”, the use of expressions occurring commonly in the daily normal language may induce people that are not familiar with Su-fields to misinterpret the Inventive Standards.

The introduction of Su-fields is an addition of an interaction in the problem model. In order to accomplish this introduction one is allowed to use internally available physical fields. Inventive Standards have ways to “introduce fields without its introduction”. The Inventive Standards of the "group five" describe the rules for introduction of substances and fields in Su-field models. In fact, the Standard 5-2-1 states: “Use fields readily available in the system”

3) <u>What we mean by saying that a student “has only to learn a few basic elements of TRIZ to solve the problem alone”</u>

For an adequate understanding of Su-fields, students shall learn all correct definitions of all the terms and concepts employed in the Inventive Standards. The students shall also learn and understand all the Inventive Standards of "group five".

Given these explanations, we may now proceed.

Kaplan points out correctly that Altshuller already used Su-fields to solve the problem of distinguishing two objects. There is also yet another Altshuller´s example of comparing two apparently similar objects using Su-fields. It can be found in the book “And Suddenly the Inventor Appeared” (translated to English by Lev Suliak), in the chapter 23, problem 43. There, Altshuller presents us the problem “Investigation is done by experts” were the expert says, “I need to know whether or not this rifle fired a bullet a week ago”. There is also a drawing of the expert looking for two rifles. Altshuller solved this problem with Su-fields.

Kaplan expresses some concern on using Su-field completion because the fields are already present. We note that the <u>physical fields</u> are present, but the <u>TRIZ engineering fields</u> will be present only after we decide to use it to model a useful interaction. It may appear a little bit strange to some readers, because it appears that we are stating that the thermal field will be only present because we proposed to sense it with a finger. Actually, we need to realize that we model only entities that ate in the focus of our attention and we are aware of existence.

We also understand Mr. Kaplan's discomfort regarding the inventive standard 1-1-1. We provided some explanation to justify our usage of the already available and internally generated Thermal and Magnetic physical fields, but we pointed to the inventive standard 1-1-1 that allows us to use external fields.

So we decided to add newer solutions for the circuit problem, considering the usage of external fields.

<u>Circuits - New Solution 1</u>:

First we will consider the magnetic field again (we used it in the second solution in the original work), but with another point of view, i.e., the field from outside. We will use magnetic field of the Earth.

By suspending both circuits with a fishing line, the Norton circuit that has a loop of current will align itself in the direction of the Earth's magnetic dipole. In our previous solution we mentioned that one can use a compass, but we do not need it. The Norton circuit itself may behave like a compass. As we pointed Su-field is not mandatory. You also may start from the original proposal (the external compass) and then eliminate it considering ideality.

Circuits - New solution 2:

Now let us consider another solution using an external field, namely a mechanical field. Just apply an externally generated mechanical vibration to both circuits. Vibrating the Norton circuit will cause it to produce electromagnetic waves that may be detected by a field detector such as a radio receptor. This will not happen with the Thevenin Circuit.

Circuits - New solution 3:

Now let us consider a solution with the aid of the gravitational field. With a help of a fishing line we suspend the two circuits again. But now we make each one oscillate like a pendulum. The Norton circuit will produce electromagnetic waves like in the second example. Again we agree that Su-fields are not mandatory. We may start from the second new solution and then eliminate the vibration machine by considering ideality.

Now one can realize that the physical presence of the earth magnetic field and of the earth gravitational field were of no use up to the moment we considered them for usage for useful interaction.

Kaplan also provided us a very interesting classical Creativity Puzzle that he solves using effects. We thank to Kaplan for this interesting "lamps puzzle" we did not know before. We found it a nice puzzle and we want to provide some alternative solutions to it.

If someone already saw the Kaplan comments and did not imagine new alternative solutions to the classical lamps puzzle you will understand our point that the image of an a given existing solution activates our psychological inertia and prevent us to see other solutions.

We intend to show that even the classical lamps problem may have interesting solutions by application of Su-field Analysis.

The classical lamps problem is stated as follows:

“There is a lamp in the third floor of a house and three switches on the first floor. One of the switches controls the lamp. How could one determine which switch controls the lamp, with only one trip to third floor? The lamp is operational, the lamp can not be seen from the first floor, and the lamp can not be controlled from any floor other than the first.“

Kaplan correctly states that our circuit problem resembles this classical problem. From Su-Field perspective we have the same generic problem. We want to distinguish objects (the switches). We want to identify the switch that is attached to the third floor lamp.

In order to find a solution conceptually similar to that of our circuit problem, first we "increase" the problem to make it easier to solve. In order to make the problem more interesting we say that we may have more than three switches. A good inventive solution shall be robust so as to allow an arbitrary number of switches. Then, the number 3 would appear to us only as a detail. Usually numbers incite us to use trial and error, so we try to avoid it.

Now we will abstract the problem and we found again the inventive standard 1-1-1 (and group five included). We have different objects (the switches), and want to identify just the switch that has the property of being attached to the lamp that is located in the third floor.

Classical Lamps Puzzle - Solution 1:

For the first solution we will consider the olfactory field. Many engineers do not like to think in olfactory field, but it is a classical TRIZ field.

For use of olfactory field we will allow ourselves to use the same information that Kaplan uses in classical solution that the positions ON and OFF are marked on the switches. So we can now verify whether the switch is in position ON or OFF just by looking to them. The information that each switch have markings ON and OFF is not in the problem statement, but we will consider it as valid because it is present in the classical solution.

So, with all switches initially in the OFF position we make our allowed trip to the third floor. We cover the lamp with a substance that is normally solid but that when heated, it vaporizes and provide a strong smell.

Then we go back to the first floor and turn ON the first switch and wait sufficient time. If we do not feel any smell then we repeat the procedure until we find the switch that makes us to feel the smelling of the substance we used to cover the lamp.

We point that Su-field is not the only way to achieve this solution; we can find it using Inventive Principles also.

Classical Lamps Puzzle - Solution 2:

For the second solution we will consider the light field.

Thinking in light fields we are induced to make the light “bend” to arrive at the first floor. Solutions with mirrors came into the mind.

But for the second solution we decide to use pieces that are cheaply available today (although maybe not the case at time the classical puzzle was set). The pieces are an optical fiber cable plus an adhesive tape.

So as first step we go to the third floor the optical cable, fix it near the lamp and extend it till near the switches location in the first floor.

At this point is easy to check what switch controls the third floor light. No need of switches having the ON and OFF positions marked.

Some readers may now object that we are using external devices to solve the problem. So, we now present the third solution:

Classical Lamps Puzzle - Solution 3:

For the third solution we will consider the acoustical field. How could we produce one acoustical field? Thinking in generating the acoustical field we remember that electrical switches produce characteristic sound of electrical spark that is characteristic when switch is near to the ON position. This is quite convenient because the switches do not need to have the ON/OFF positions marked. We may just test the two positions of the switch to find the spark noise.

First Step: we perform this test for all available switches and annotate the switches that produce spark (the problem statement assures that lamp is operational, so its switch surely will provide a spark).

Second Step: we perform our allowed trip to the third floor. When we arrive there we remove the lamp of its socket. We know we can reach it otherwise we could not feel its heat it the classic solution.

Third Step: we return to the first floor and check again all switches for the spark noise generation.

The desired switch will be the one that produced spark noise at the first step and did not provide noise at the third step.

Again Su-fields are not mandatory to achieve this solution. You may prefer to consider it as an example of the Inventive Principle 22 “transform harm in benefit”. We used one effect usually considered undesirable (the electrical spark), to help us in this solution.

Note that this solution is a bit harder to find than the other solutions due to the problem name. Kaplan named it “the classic lamps creativity puzzle”. Perhaps one could call the problem as “the classic switches creativity puzzle”?

So, we showed three conceptually different solutions that are stronger than the classical solution, because they may apply even when a greater number of switches are present in the problem, not restricted to only three switches.

The third solution is a strong solution. Switches do not need to be only three. The ON/OFF markings in the switches are not needed. External devices are not needed. The base of this solution is yet easier to find if we add to the problem the imaginary restriction that the third floor is locked in mode we can not enter.

We solve it with a variant of the third solution. You just remove the lamps of the first and second floor and then test the switches for sparking noise. The only switch that will produce the sparking noise will be the switch that controls the lamp on the third floor. And none trip to the third floor was needed at all.

So we solved the classical puzzle not with a mythical “spark of a genius”, but with a Su-Field induced inventive approach that lead us to the solution that use “sparks”.