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DESTROYING MENTAL BARIER - AGENTS' METHOD

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Abstract – The article illustrates some concepts and methods less familiar in the word of "pure engineering" but very usefull in "shattering the mental barriers".
Keywords: TRIZ, ARIZ, CSP, IFR, CONTRADICTION

I. INTRODUCTION

We can consider the Agents Method as a modelling method. This approach appears for the first time in Gordon's Synectics where the use of empathy is proposed for the process of inventive problem solving. The process presupposes a merging of the solver with the object under study in an attempt to imagine the actions to be undertaken in order to find the solution. Altshuller noticed that the usefulness of the method is limited because of psychological considerations connected with people's reactions to the idea of getting exposed to risk factors involved in the simulations of the method, therefore he elaborated what he called the Method of Smart Little People, later improved by the continuators of TRIZ under the name of the Agents' Method. The latter uses inanimate particles for simulations thus getting rid of the last psychological barrier that prevented people from exposing themselves to noxious factors.

II. Historical facts

Let's start with the Smart Little People Method elaborated by Altshuller. Some historical aspects are necessary in order to understand the origins and the importance of this method in problem solving. In [2, 109], Altshuller quotes Kekulle [7, vol.2, 80/81] ----------

(op cit 7 vol 2, pp 80-81): "One evening I was in London, and was sitting in an omnibus and thinking about how to depict the molecule of benzole C6H6 in the form of a structural formula answering the properties of benzole. At that time the bus passed a cageful of monkeys which were chasing and catching hold of each other, breaking the chain and once more linking up to form a circle. Each one held to the chain with its back paw, and the next one held on to its other back paw with both forepaws, waving its tail merrily about in the air. In this way five monkeys by holding each other formed a circle and the thought immediately crossed my mind that this was a representation of benzole. Thus arose the formula quoted above, and it explains for us the firmness of the benzole ring."

The history of science registers another example of modelling used by the famous physician Maxwell in studying the dynamic theory of gases. In the mental experiment he considered two vessels with gases at the same temperature. Maxwell wanted to know how he could have obtained "rapid molecules in one vessel and slow molecules in the other, since the temperature of the gases was the same and the molecules would not divide of themselves," so Maxwell "mentally joined the vessels by a tube fitted with a valve which was opened and closed by 'demons.'" [2]

These facts were differently interpreted, respectively Kekulle's story as being the result of the role played by chance in science, while Maxwell's experiment as the importance of imagination for scientists, but "none of them has linked them together or pondered over applying these two instances to different branches of science and converting them into a method to be deliberately employed." [2]

III. The Method

SLPM is an independent method, but in TRIZ it has a well-defined position within ARIZ methodology [].

The Agents' Method comprises five stages:

- formulation of CSP and IFR
- choosing starting point
- conceptual steps between CSP and IFR
- agents actions and properties
- solution generation

In order to better understand these steps some explanations are necessary. We shall start with the agents' sources. As already mentioned the agents are a kind of "ideal universal instrument" that have properties allowing them to carry out any kind of action, even actions that do not have any technical significance. In order for the AM (Agents' Method) to work, several conditions are necessary which the agents have to fulfil. A first compulsory condition is that the agents must be part or subsystem of a tool or a

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product. For those unfamiliar with TRIZ terminology we clarify the following notions:

- product - the element that requires "processing" within problem situation
- tool - the element that directly interact with the product

In ARIZ there is a stage devoted to defining the substance and field resources and it is mentioned that strong solutions are obtained when only the available resources are used. This fact is indeed specified in the very first part of ARIZ when the concept of mini-problem is defined [8,p.2]. From these considerations results the hierarchical order of the agents' sources, starting with those available in *TS*(Technical System) or *TP*(Technical Process) taken together, continuing with *external resources*, the *super-system* and finally *external environment*. Once the source of the agents is settled we shall see where and when to place them. As a general principle, the agents are placed in the *operation zone* of the tool-product interaction. Placement in time must be carefully considered, some problems existing only in the operative zone, and therefore agents should be placed before, during and immediately after the moment of the action.

In specifying the requirements for the agents, one had better take into account Ockam's Razor Principle: "It is useless to use greater means to achieve a goal attainable by fewer means." This is a warning to maintain a minimum number of agents, and also to maintain a small number of actions which an agent can carry out, if possible only one action for each category of agents. Different categories of agents have to behave identically in identical working conditions.

Before presenting other aspects of the Agents' Method, we will give an example for the use of the SLPM, the precursor of AM, which would allow a better understanding of these simulation methods. We will chose an example that has become a classic of TRIZ literature, introduced by Altshuller in [2, 287]. The problem consists in the protection of an aerial of a radio telescope from lightening. Lightening rods used for protection negatively influence the propagation of radio waves. We will not go into details regarding the solution to the problem but will state some elements that will allow us to understand the introduction of the SLP. Thus one of the elements is that, in order to solve the problem, external environment was used, respectively the air in the external space of the aerial. We also mention the existence of a physical contradiction [7, p.1]: the presence of lightening rods protects the aerial but negatively influences propagation, the absence of lightening rods eliminates the negative influence upon the propagation but the action of protecting the aerial disappears. The solution will be connected to the existence of a column of air that is electrically conductive during the lightening and respectively, electrically non-conductive in the rest of the time in order to prevent the absorption of radio waves. In [6,p57], one of the possible representations of the problem using SLPM, is illustrated; this can be seen in Fig.2

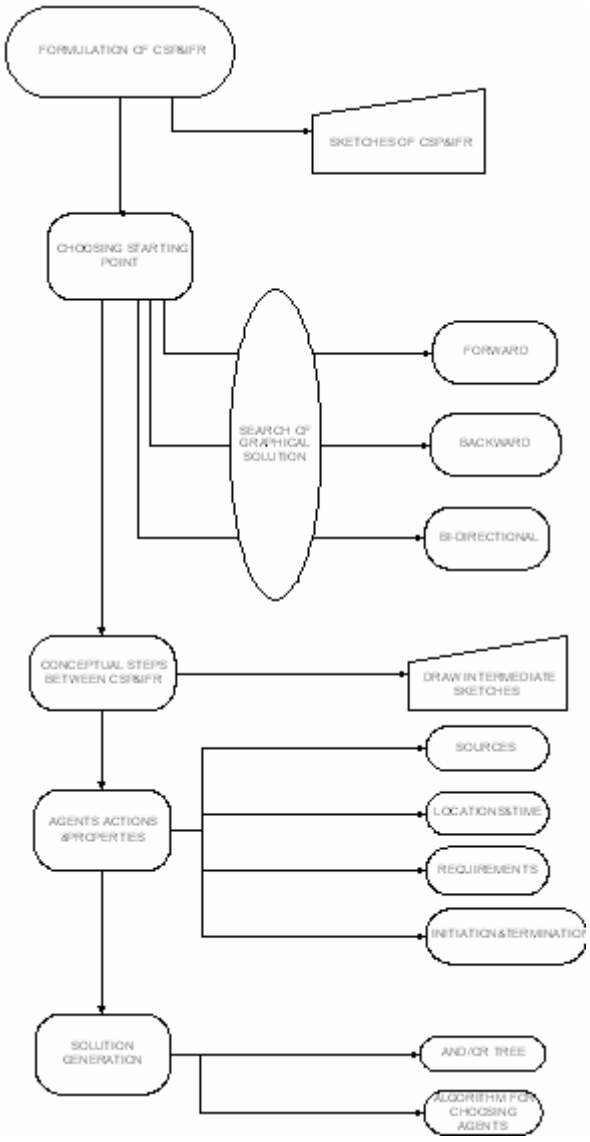

Fig. 1

Now, the following concepts involved in AM are easier to understand. One of them is Initiation/ Termination of Agents. The agents have to somehow appear in the operative zone. They are either already there – "being present," or placed there at the operative moment – "being put there,", or they are created in the operative zone – "created there." In the previous example the agents may appear as a consequence of the ionization of the air in the proximity of the aerial under the action of the atmospheric front. One way or another something must happen to the agents after the time of action, they either continue to remain there, or are eliminated by something, or annihilated, like for example the recombining of the ions in the example with the aerial, etc.

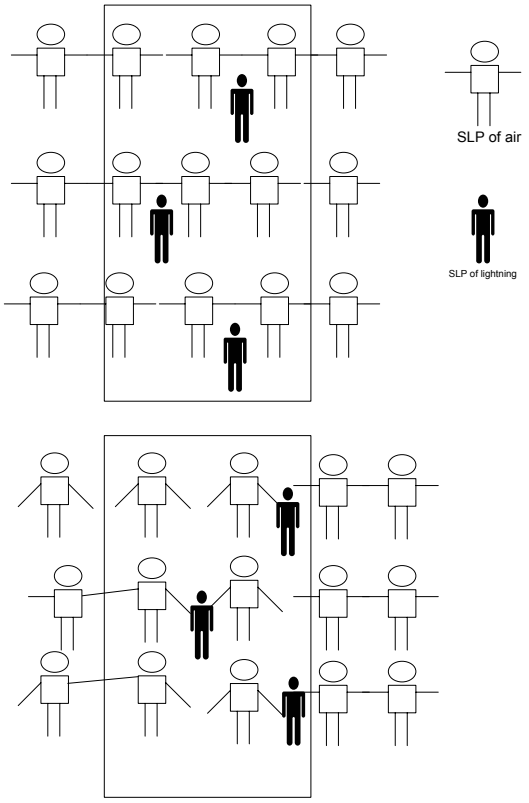

Fig. 2

The Agents' Method started as, and continues to be a visual instrument. Independent of the type of search for a solution, *forward*, *backward* or *bi-directional*, informative sketches will be executed, that contain all the essential details of the system under study where the problem appears. Necessarily there must be sketches for the CSP(Correct Statement of the Problem)[8, p.3] and IFR(Ideal Final Result) [1, p.???], which should contain all desirable aspects. From the technical point of view, the CSP sketch will be the first and placed leftmost, the IFR second and placed far right. The two sketches practically impose the actions that the agents have to accomplish in order to carry out the requirements of the problem. Supplementary sketches may be necessary as far as there are significant differences between the two solutions. Actually the representation of the details of the transition from CSP to IFR is nothing else but the conceptual steps of the process of solution development. The Agents' Method is meant to eliminate both mental barriers and the psychological inertia, therefore it is recommended during the process to eliminate thinking about or guessing the modalities by which IFR can be reached.
As it results from Fig. there is a difference between the ways of carrying out the solution search process regarding the possibility to achieve the IFR, respectively, in the case of a forward search it is not necessary that the IFR be technically achievable, but in the case of a backward and bi-directional search, the IFR must be technically possible and probable.

We will use a case presented by Semyon D.Savransky in [5, p.293] to illustrate some other concepts used in AM. The problem under analysis belongs to the domain of micro-electronics, more precisely the creation of some microscopic patterns on the surface of semi-conductor wafers. The surface is made of materials which "cannot themselves create the patterns," and therefore are covered in photoresist which is an active substance, and which, under certain circumstances, slightly modifies its properties. Photoresist is uniformly spread, and by a photolithographic technique, semiconductor devices are created, several on the same wafer, structures presenting certain symmetries.
As it has been shown [8, p.2] in the phase of problem analysis, it is recommended to eliminate specialized terminology, which, in this case, has a limitative character; the authors of the example recommend for this situation replacing terms such as 'photoresist' with a more general one like "layer" and replacing the statement of the problem with a more general one, like producing "symmetric pattern on a condensed matter's surface." [5, 294]. Fig.3 shows three sketches suggested by Semyon Savranski in [5, 294-295] which illustrate the CSP, IFR and a possible arrangement of the agents. Without detailing, we remind that the algorithm created by M.Pinyayev for the selection of agents based on their properties uses a representation widely spread in Artificial Intelligence, namely AND/OR trees.

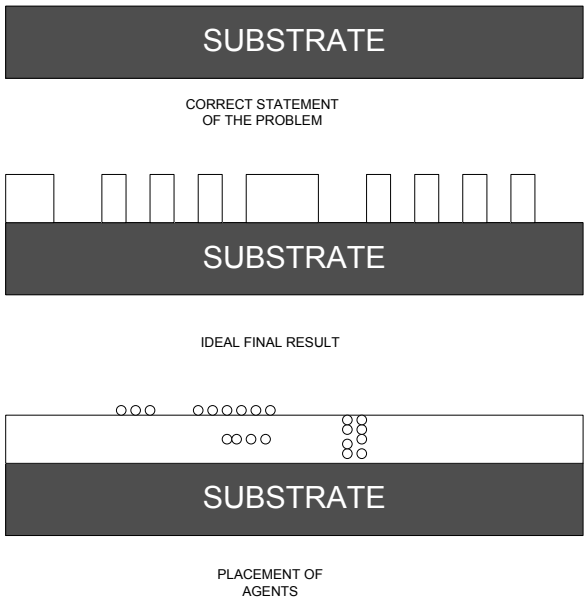

Fig. 3

AND/OR trees are specialized structures used in problem solving methods for keeping track of wich subgoals have been attempted and which combinations of subgoals are sufficient to achieve the initial goal. If a set of problems can be solved only if its members can all be solved we call the subproblems nodes AND nodes. If the problem can be solved if any of the subproblem sets can be solved then the

node is an OR node. We give in Fig. 4 an example of such an AND/OR Tree [5,295] usefull in understanting the realization of the solution to our last problem.

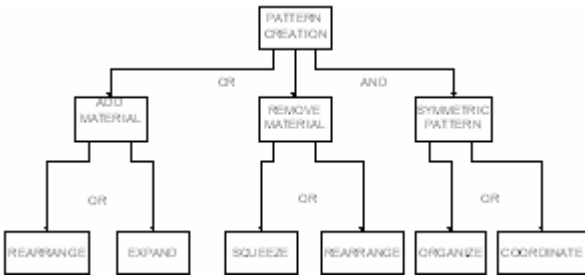

Fig . 4

There is no room for showing all the algorithm application so we give some ideas about the solution: semiconductors are not active to reorganize the materials themselves (shockwaves could be used to temporarily create the pattern needed). In the production of semiconductor the following are available: energy wastes, chemicals, electricity etc.
The choosen idea: incorporate scatter-centers in the layer's surface.
The Agents Method is well incorporated in ARIZ wich represent an almost complete "formula" for obtaining solution to inventive problem.

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