Proposal Of A Set Of Fundamental Principles For Knowledge-Based Creativity Techniques

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Foreword

TRIZ methodology and related techniques were classified as knowledge-based by Alla Zusman (**1**). The knowledge-based concept was also used by Seymon Savransky in his proposed definition of TRIZ (**2**). This classification is accurate and useful for grouping a series of creativity techniques that share a theoretical basis, as well as heuristics and procedures to solve technical problems.

Common theoretical basis is usually described by means of *principles*. Known examples are the *principle of abstraction* and the *principle of closed world.*

The aim of this paper is to reformulate and complete the *principles* in order to make them more general and more comprehensive of the specific techniques that can be included in the knowledge-based group.

Six fundamental principles are proposed, as shown in **Figure 1** and described in detail in the body of this paper.

1. Principle of abstraction of systems
2. Principle of unity of behavior
3. Principle of increase of ideality
4. Principle of decrease of complexity
5. Principle of simplicity of operators
6. Principle of limited number of operators

Figure 1. Principles of knowledge-based creativity techniques

The foundation of contemporary TRIZ was established by the Ideation Research Group (**3**) by means of eleven postulates, focused on systems evolution. This was an excellent procedure because the possibility of systems evolution forecasting is a unique feature of TRIZ. The principles proposed in this paper have a different meaning, as they intend to be the theoretical basis, emphasizing the problem-solving possibilities, for a group of creativity techniques that includes, but is not limited to TRIZ.

Definitions

1. **System**. Set of components and its interactions, intended to perform some required functions in a given environment.

2. **Component**. Part of a system that can be studied in an isolated manner. Subsystems can be considered as components.

3. **Interaction**. Relationship that exists between a pair of components in a system.

4. **Feature**. Characteristic that can be defined in a system, including intrinsic ones and side effects.

5. **Useful Features**. Features of a system which are valuable.

6. **Harmful Features**. Features of a system which are not valuable.

7. **Ideality**. Sum of the useful features divided by the sum of the harmful features of a system.

8. **Complexity**. Sum of the components and the interactions of a system.

9. **Physical system**. System made consisting of physical components and its physical interactions.

10. **Abstraction**. Procedure used to categorize a system and include it in a more general one, from which said system is a particular case. Can be applied to physical systems and abstract systems as well.

11. **Abstract system**. Conceptual system obtained from a physical system or another conceptual system through abstraction. An abstract system always contains, at least, a category of physical systems.

12. **Level of abstraction**. Number of times the procedure of abstraction was applied to a system to obtain the one that is being considered.

13. **Specification**. Procedure used to individualize a system by extracting it from a more general one. This procedure is the opposite of abstraction and can be applied only to abstract systems.

14. **Operator**. Abstract procedure that transforms an abstract system into another that has, at least, one feature different from the original system.

15. **Scale**. Characteristic dimension used to describe and study a system.

Comments on definitions

Systems can also be named "Technical Systems". The environment is included in the definition of system because the best solution for a given problem or "Ideal Final Result" must be related to a specific environment.

The components of a system can be, depending of the scale that is being considered, major subsystems, small pieces or subatomic particles.

Interactions include all kind of relationships. For instance, a bolt attaching a metallic piece to a frame defines a mechanical interaction between the bolt and the frame and another one between the bolt and the piece. If the piece is heated, three additional heat transfer interactions arise: piece/frame, piece/bolt and bolt/frame.

Cost considerations can be made when defining the features of a system. The cost of manufacturing and operating a system must be included in the calculation of ideality.

The concept of complexity is very helpful one and plays a major role in the proposed principles. It is related to the “closed world” philosophy and can be useful when defining the “Ideal Final Result” for a given problem. For the purpose of calculating complexity, each single relationship between two components must be considered as an interaction, whether or not this relationship is relevant in terms of the performance of the system.

Specification is sometimes referred to in the literature as “specialization”.

The number of components considered for a system increases as the scale decreases.

Fundamental Principles

The proposed set of principles is the following:

1. **Principle of abstraction of systems**

   Physical systems can be abstracted at least once. The abstract systems obtained can be transformed and then specified to obtain a transformation of the original physical systems.

2. **Principle of unity of behavior**

   The behavior of physical systems follows the behavior of the abstract systems obtained from them.

3. **Principle of increase of ideality**

   The ideality of abstract systems can be increased without increasing their complexity by means of, at least, one operator, with a finite number of exceptions.

4. **Principle of decrease of complexity**

   The complexity of abstract systems can de decreased without decreasing their ideality by means of, at least, one operator, with a finite number of exceptions.

5. **Principle of simplicity of operators**

   As the level of abstraction of a system increases, the operators that increase ideality or decrease complexity become simpler.

6. **Principle of limited number of operators**

   The number of operators required to increase ideality or to decrease complexity in abstract systems is finite, and becomes smaller as the level of abstraction increases.

Discussion

The essence of knowledge-based creativity techniques is the combination of principles 1 and 3, as shown in **Figure 2**. All physical systems can be abstracted a number of times in order to reach an abstract system of some level. The abstract system obtained can be transformed by means of an operator and this transformed system can be specified to obtain again a physical system with a higher ideality than the original one.

The physical solution of a problem is obtained by analyzing the original and final physical systems to determine the physical transformation that leads from one to the other.

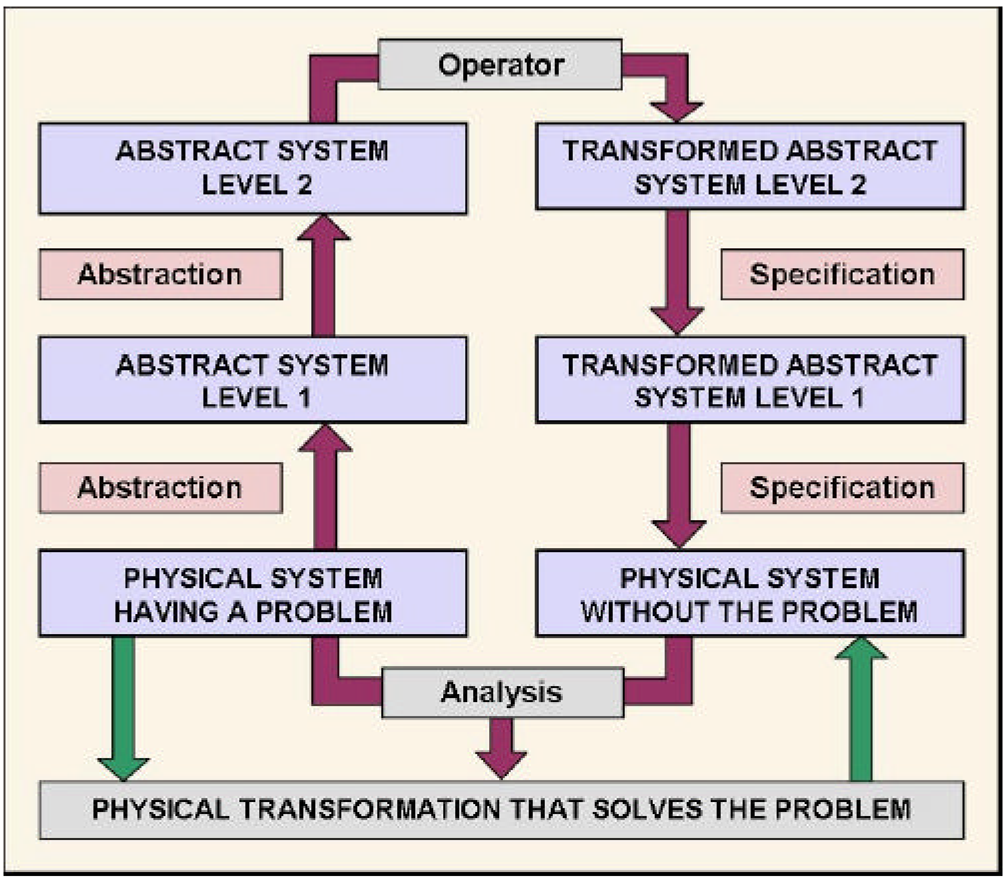

Figure 2. Sketch of a knowledge-based procedure for solving a problem

The aim of the knowledge-based techniques is to perform the ideality-increasing procedure without increasing the complexity of the system. Principle 4 states that this can be done either in two steps or in one step, the latter through a combination of the operators used in the two-step procedure.

Complexity can be considered as a lack of ideality because the infinite-ideality system would be a zero-complexity one. Under that point of view principle 4 would be redundant, but having two separate principles seems advisable for the sake of clarity. Complexity is related to ideality, but it is not defined as a direct function of ideality.

On the other hand, both principles 3 and 4 allow the possibility of having a finite number of exceptions to account for technological limitations.

Principles 5 and 6 are the roots of the techniques. It is possible to define a finite set of operators to perform all required transformations. As the level of abstraction increases, the operators become simpler, and their number smaller. It seems probable that at infinite abstraction, only a single operator might be necessary.

Finally, principle 2 states that the behavior of physical systems is related to the behavior of abstract systems in such a manner that the results, including evolution predictions, arising from the study of the behavior of abstract systems, are applicable to the original physical systems.

Bibliography

(1) Alla Zusman, *"Overview of Creative Methods"*, included in *"TRIZ in Progress, Transactions of the Ideation Research Group"*, 1999.

(2) Seymon Savransky, "*Engineering of creativity"*, CRC Press, 2000, Chapter 2.

(3) "*TRIZ in Progress, Transactions of the Ideation Research Group"*, 1999. Appendix 13.

About the author

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