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SIMPLIFIED TREND SYSTEM FOR TRIZ BEGINNERS

Peter JANTSCHGI

Abstract: *"Technical systems evolve according to describable patterns" is one of the basic theses of TRIZ. TRIZ practitioners can use the trends of engineering system evolution to discover new potentials for further development of their products. In this paper, an approach of applying the trends of engineering system evolution is presented. The developed trend system is easy to understand and actionable, so that especially TRIZ beginners can apply it quickly and easily.*
Key words: *Trend system, TESE, trends of evolution, evolution tree, morphological matrix, evolution potential radar, laws of systems evolution*

1. PROBLEM DESCRIPTION

For TRIZ beginners it is sometimes not very easy to work with the trend of engineering system evolution. There should be an easier way to work efficiently with the concept of trend.

2. APPLICATION FIELDS

Application fields of the simplified trend system could be:

- Quick entrance on TRIZ workshops
- technical development departments
- construction departments
- design departments

3. RESEARCH STAGES AND METHODS

The basis for this paper is a bachelor thesis written on the University of Applied Science Campus 02, Department Innovation Management, Graz, Austria.
The task of the bachelor thesis was to develop a trend system which combines the advantages of at least 2 analyzed trend systems. A further aim was that it should be possible to explain and apply the trend system within a duration of two hours.
The following 5 existing trend systems have been analyzed:

- "Laws of Evolution" from Altshuller
- "Patterns of Evolution" from Terninko (Herb/Gadd)
- "Trends of Engineering System Evolution" (TESE) from MATRIZ
- "Trees of Technology Evolution" from Shpakovsky
- "Trends of Evolution" from Mann/Dewulf

Every trend system has advantages and disadvantages. In an online survey TRIZ experts were asked to answer what advantages and disadvantages every single trend system has. Further the topics in the survey were which trend systems are easier to use and which trend systems are more concrete or abstract. Experts were interviewed to get further findings for a simplified trend system.

4. IMPORTANT FINDINGS FOR DEVELOPING THE SIMPLIFIED TREND SYSTEM

4.1 "Need or good to know" trends

Many trends in Altshullers laws of evolution and a few TESE from MATRIZ are just statements or evolution facts. Those trends give the user no specific practical advises for how to apply single trends on a real technical system. For example, the trend of increasing ideality or how Altshuller

named it the law of increasing the degree of idealness. This trend is just saying that systems are getting more ideal over the time. [1]
The user should try to give the system more functionality or should try to decrease costs. But how?! This trend does not help really on practical using. In my opinion that is a “Need or good to know” trend for practical users. Other similar trends for beginners are the trend of S-curve evolution and the trend of uneven development of system components. Those three trends can be mentioned before working with trends but in the end, they are just evolution facts. Therefore, they are not needed for the simplified trend system.

4.2 Applicability of trends

It is essential in a simplified trend system there should be no trends which are hard to apply or hard to understand. For example, the trend of flow enhancement. TRIZ beginners would get overloaded when they get confronted with such a trend. So those kinds of trends are also not needed in the simplified trend system.

Figure 1 is showing the MA TRIZ Trend system. The trends which are not needed in the simplified trend system are crossed out.

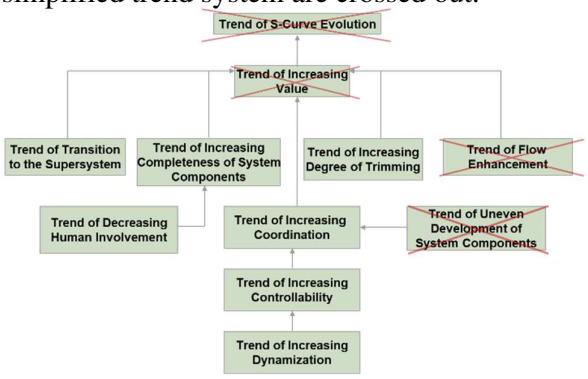

Fig. 1. Trimmed TESE from MATRIZ Trends [1]

4.3 Manageable number of trends

When you give a student, a completely new toolbox and in this toolbox are about twenty tools the student newer heared before, the student would get overloaded when you ask him or her to work with that toolbox. Maybe the student is lucky and takes the right tool for starting. But when the student takes three or four times “wrong” tools for a special problem, the trainee gets frustrated and the student does not like to work with that toolbox anymore. That is similar when potential new TRIZ users are getting a huge amount of TRIZ tools in their hands and then getting frustrated when there are less results. When beginners work with trends the first time, they should not get overloaded with more than 15-20 trends. So there has to be a manageable number of trends.

4.4 Combination of trends

Altshuller already had the idea to use the laws of evolution in combination with a morphological matrix. The basic principles of the trees of evolution from Nikolay Shpakovsky are based on a morphological matrix. [2] To remember a morphological matrix is a creativity tool for the creation of new product variants. The parameters are listed one below the other in a table and their possible options are listed in the columns next to them.

Table 1,

Morphological Matrix

Parameter	Option 1	Option 2	Option 3
P 1			
P 2			
P 3			
P 4			

In his book “Tree of Technology Evolution” Shpakovsky describes how to work with trends in a tree structure not in form of a standard table or a matrix. The options in the morphological matrix correspond to the evolution steps in the evolution tree. [2]
Figure 2 is showing the schematic structure of a trend tree.
At the beginning one has to choose a main evolution line and analyze which evolution steps on this main trend could be interesting. After that the user should take another evolution line and on the base of evolution step, he selected before he or her builds the trend second order on the trend tree. The same procedure with trends of third order on trends second of order. The aim is to identify where in the system could be unused potential in the gaps of evolution steps.

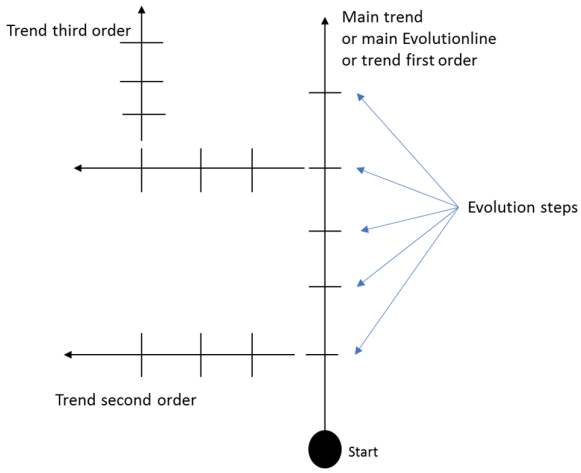

Fig. 2. Evolution Tree [cf. Shpakovsky]

For experienced trend users that could be a very efficient way how to work with trends. But for beginners the evolution tree is too abstract at first. For that reason, the simplified trend system is oriented on the base of a morphological matrix.

4.5 Stepwise Evolution

Another finding by analyzing the trend systems was that there were trends which are describing a stepwise form of evolution and there were trends which are describing different variants how a system can be designed.
An example for a stepwise evolution is the trend of decreasing human involvement. At the beginning, the human is completely dependent for the fulfillment of the function, at the second stage one element takes over the performing function, then a transmission element will be added, after that an energy source and at the end a control system takes control of the whole system.

Figure 3 is showing the trend of decreasing human involvement on the example personal transportation.

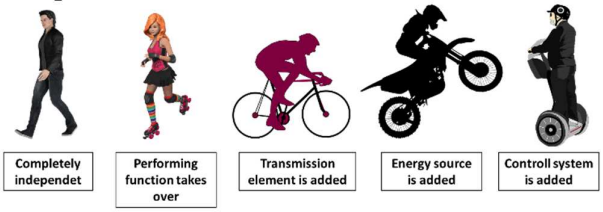

Fig. 3. Trend of decreasing human involvement [cf. Ikovenko]

An example for a trend which describes different variants of a system is the trend coordination of forms. These variants are identical shapes, self-compatible shapes, compatible shapes and special shapes.
Darrell Mann describes in his book “Hands on Systematic Innovation” how to work with his 35 Trendlines in an Evolutionary Potential Radar Plot. [3]
The evolution potential radar is visualized as a polygon. Each corner represents an evolution line. The number of corners depends on how many trends the user wants to represent with the evolution radar. A line is drawn from each corner to the center of the polygon. The lines are divided according to the stages of development of each evolution line. On each evolution line (shown as a distance) is marked on which level the considered system is at the moment. The "deeper" one is on a development line; the more evolution potential is available for this development line. Figure 4 shows an evolution potential radar.

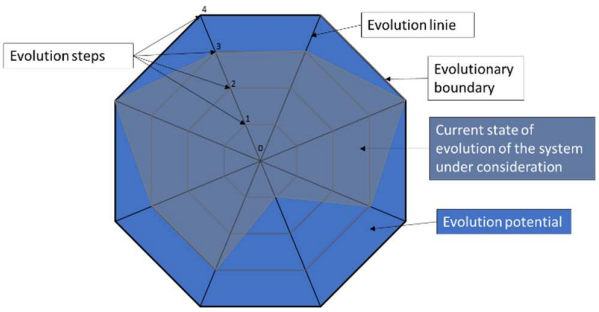

Fig. 4. Evolution potential radar [cf. Mann]

The evolution potential radar plot is very effective tool to detect evolution potential. For that kind of application only trends with a stepwise evolution are needed. If there are trends which are describing variants not the evolution potential would be seen but it would be a visualization of options. In the simplified trend system, there are only trends which are describing a stepwise evolution.

5. SELECTION OF THE TRENDS FOR THE SIMPLIFIED TREND SYSTEM

As mentioned in chapter 4 there are the following criteria for the selection of simplified trends for the simplified trend system.

- **"Need or good to know" trends** are **not needed** in the trend system. These are trend which does not give the user a concrete recommended action.
- Only trend which are **easy to apply and easy to understand** are getting in the trend system.
- In the simplified trend system should only be a **manageable number of trends**. (8-10 trends are a manageable number for beginners).
- In the simplified trend system only **technical trends** should be implemented.

For choosing the trends the trend systems Trends of Engineering System Evolution (TESE) from MATRIZ, Trees of Technology Evolution from Shpakovsky and the Trends of Evolution from Mann/Dewulf were used.

As basis template for the trend system the ten trends which Shpakovsky uses for his evolution trees were analyzed and were aligned with the trends from Mann/Dewulf and MATRIZ.

The eight trends from Shpakovskys were chosen as the basis for the simplified trend system. An explanation for each trend follows. The adaption with other trend systems is described below:

- **Mono-bi-poly**: In the trend system from Mann/Dewulf there are the trend Mono-bi-poly similar and Mono-bi-poly different. Mono-bi-poly gets in the trend system because it is very easy to use and understandable.
- **Trimming**: MATRIZ has the trend increasing degree of trimming in the trend system. Trend of transition to the supersystem is in my opinion attached after the maximum of trimming components. The trend can be applied easily. So, it also gets in the trend system.
- Expansion and trimming of system components: This trend relates to trend of increasing completeness of system components from MATRIZ. The trend line trend of decreasing human evolvement is subordinated the trend of increasing completeness of system in MATRIZ trend system. These evolution lines were summarized as trend **completeness** in the simplified trend system. This trend could be also seen as the opposite of the trend trimming.
- Segmentation of objects and substances: This trendline is very similar to the trendline dynamization in the trend system from Mann/Dewulf. In Shpakovskys trend system the trend dynamization is described on an own trend line a little bit more exact than on the trendlines from Mann/Dewulf. Also MATRIZ has the trend of increasing dynamization in the trend system. Segmentation and dynamization were simplified and summarized in the trendline **segmentation/dynamization** in the simplified trend system.
- Evolution of surface properties: In the trend system from Mann/Dewulf is the trendline surface separation. It is easy to understand and easy to use. So, the trendline **surface** gets in the trend system.
- Evolution of internal structure: Space segmentation is the name of the trend in the trend system from Mann/Dewulf. This trend also gets in the simplified trend system named as **internal structure.**
- Evolution of geometry: Same case as the two trends named before. **Geometry** gets as a trendline in the simplified trend system.
- Increasing controllability: In MATRIZ trends there is also the trend of increasing controllability. This trend gets named **controllability** in the simplified trend system.

6.THE SIMPLIFIED TREND MATRIX

The Trend Matrix is based on the idea to combine the evolution potential radar plot and the morphological matrix. The advantage of the evolution potential radar plot is the detection of evolution potential. The morphological matrix has the advantage that trends can get better combined, and the user also can see the evolution potential there.

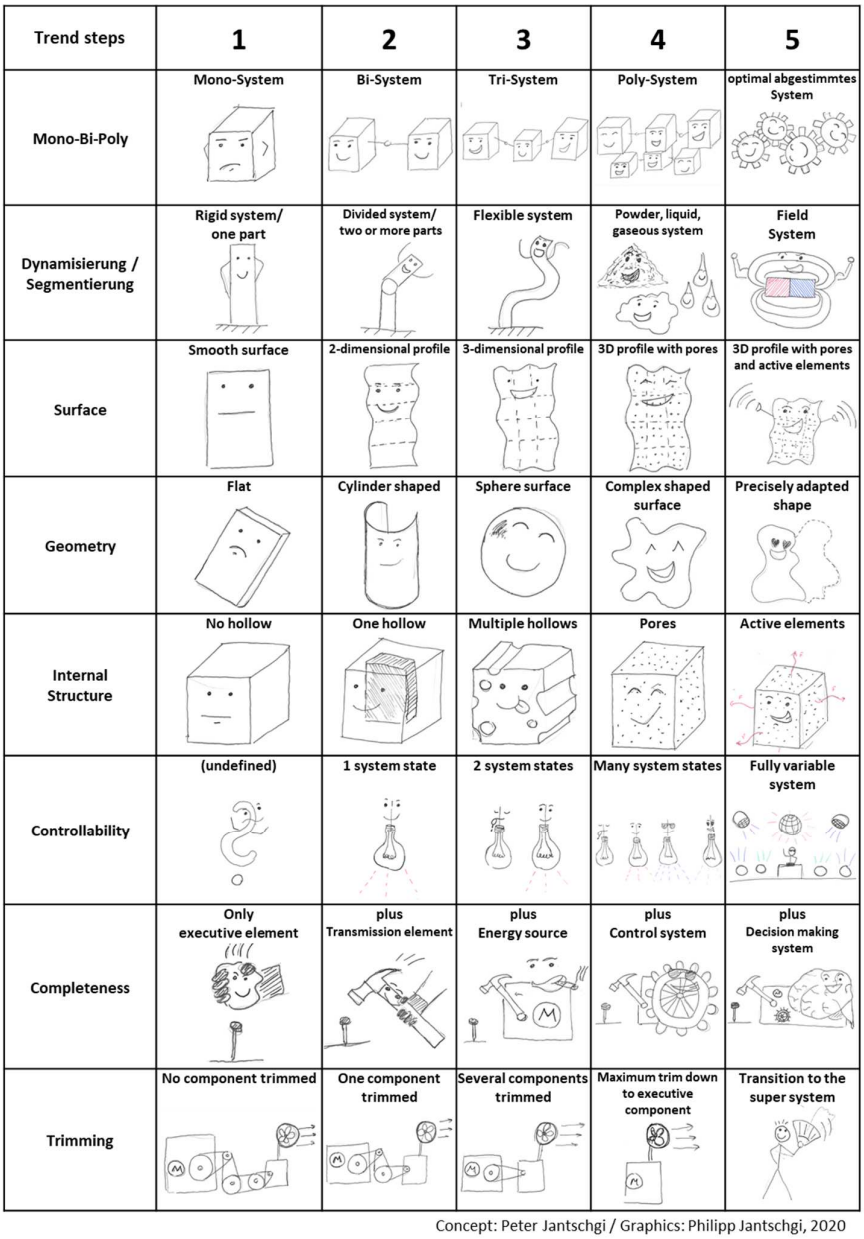

Fig. 5. The simplified trend matrix

The options in the morphological matrix correspond to the evolution steps of each trend line. For getting a unified table every trend line had to cut down or extended to exactly 5 steps.

The table shows the trend matrix with emotionalized depictions of each trend step. At the beginning the depictions are less happy and after and after the depictions are getting happier, the more the trend line comes to the evolution boundary.

7. PROCESS FOR USING THE SIMPLIFIED TREND SYSTEM

The following is a concept for a procedure on how to work with this simplified trend system. The input is a system which the user wants to develop, and the output should be a developed system. The steps of the process for using the simplified trend system are shown in Figure 6.

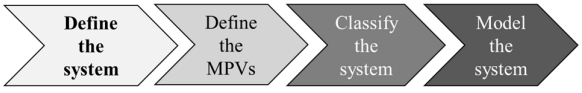

Fig. 6. Process for using the trend system

Step 1: Define (and understand) the system:
At the beginning a short component analysis should be accomplished, in order to understand the system better. The component to be developed gets selected and its (main) function should be defined.

Step 2: Define the MPVs:
It would be very useful to prepare a list of MPVs (Main Parameters of Value) that should get improved. When developing the system, the user also can think about if by developing the system also the MPVs are increasing. This can also be done afterwards.

Step 3: Classification of the system:
In the third step, the positions (evolutionary stages) on the respective trends or trend lines are determined for the selected component and marked in the trend. These positions can be connected with straight lines to illustrate the current state of the system.

Step 4: Model the system:
In step four, the evolutionary potential is graphically marked in the trend matrix by identifying all development stages not yet used by a frame. This frame now provides information about the abstract models of further development potential. Other way of using the trend matrix is thinking about what is happening on the system when going forward or backwards each trend line. The combination of that information could be a input for system which satisfy costumers MPVs or PVs better than the current existing system. This is where the creative idea generation process begins, in which the abstract solution models are transformed into real development suggestions.

8. EXAMPLE FOR USING THE SIMPLIFIED TREND SYSTEM

This process is demonstrated below using the example of the further development option of a pan.

Fig. 7. Pan

Step 1: Define (and understand) the system:
The main function of the pan is to heat food.
The pan consists of the components "bowl" and "handle". We decide to further develop the component bowl. This component performs the main function of the system, which is to heat food. Another function of the component "bowl" is to hold the food.

Step 2: Define the MPVs:
MPVs of this system and component could be, for example, how good the heat transfer of the pan is, or how scratch resistant the pan is.

Step 3: Classification of the system:
The line in the trend system in Figure 8 on the next page shows at which evolution stage the component “bowl” is located on each evolution line. Currently the bowl is a mono-system, it is rigid, it has a smooth surface, …

Step 4: Model the system:
Now it is time to go on with the idea generation step. It should be considered how the MPVs of the pan can be improved with the existing potential. Let's take heat transmission as an example. Could a 2D profile of the surface of the pan improve heat transfer? Or could the handling of the pan be improved in which the bowl has two system states? Or could a "novel" bowl be developed by a certain combination of the development lines? On Figure 9 at last page of the paper the evolution potential of the component “bowl” is marked.

9. OUTLOOK

Till now it was not possible to test the simplified trend system described here in workshops. Such a test would be the logical and necessary next step in order to identify errors and to be able to make improvements.
It is important to apply and test this system in practice. Subsequently, examples of each trend line and its stages should be described in order to make the system more demonstrative.
Furthermore, the individual development stages of the selected trends should be presented with examples. These activities were not in scope of the research.

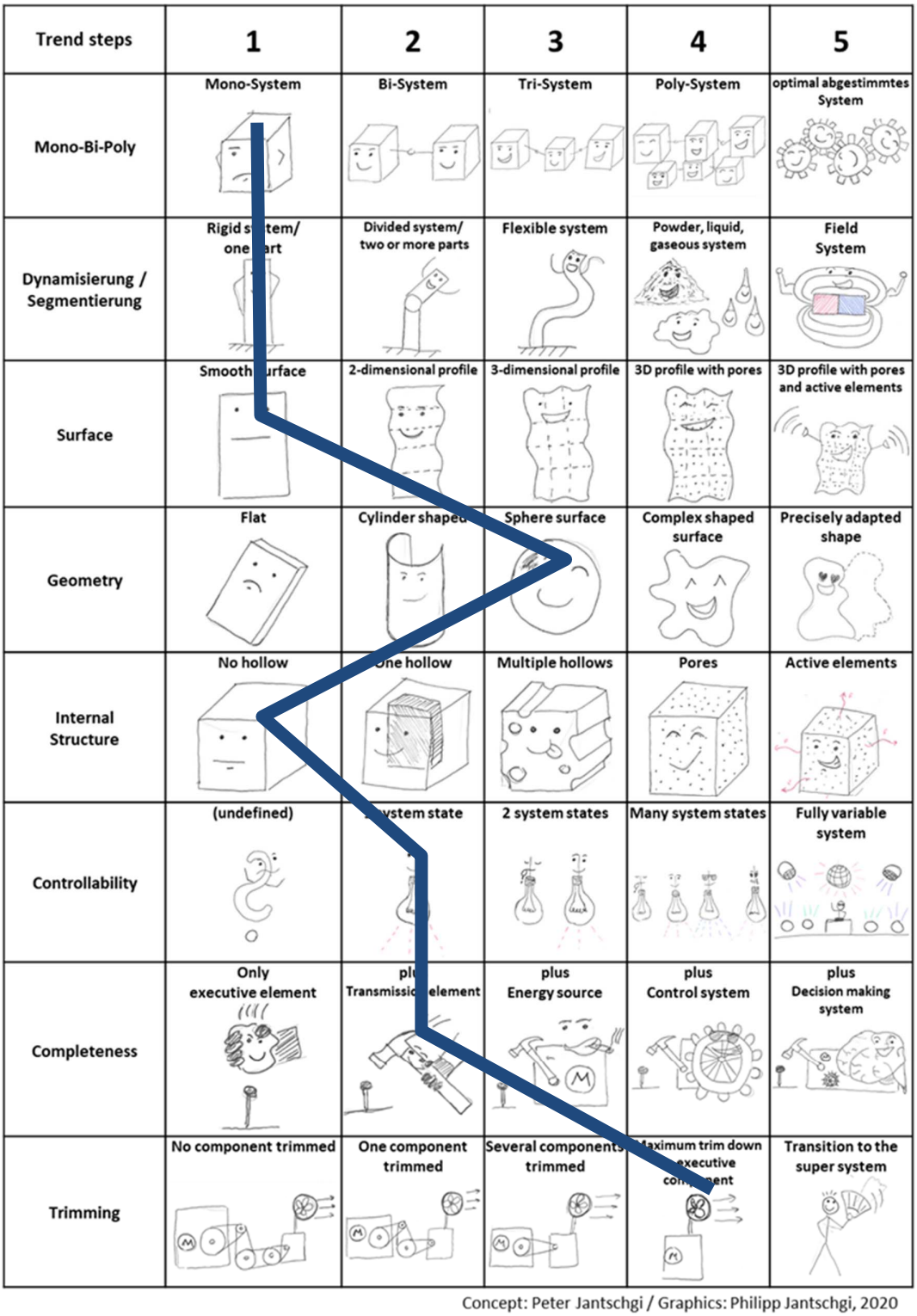

Fig. 8. Classification of the pan

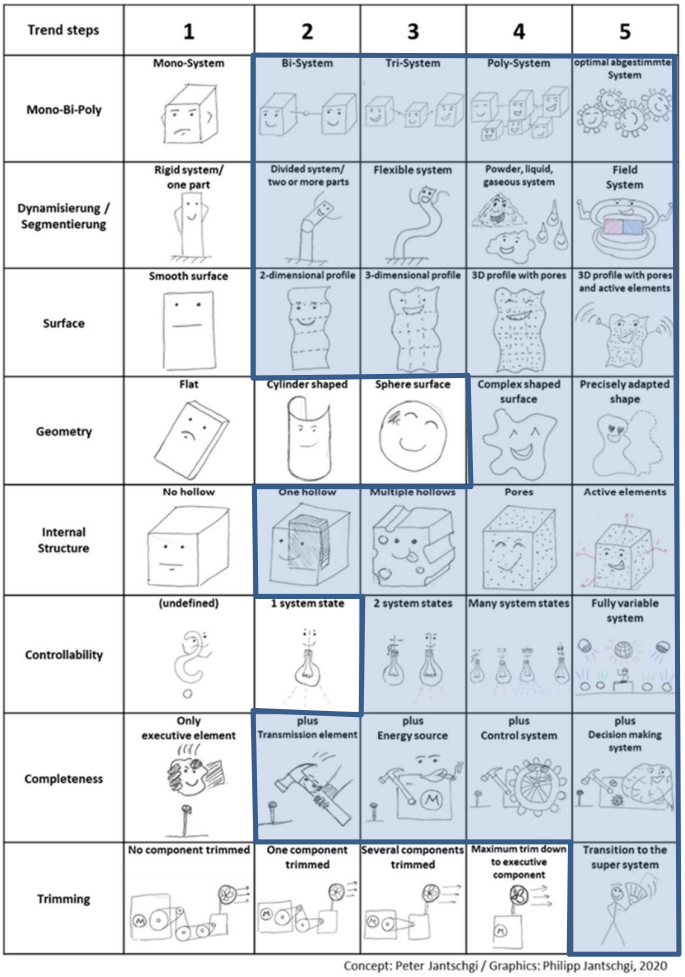

Fig. 9. Evolution potential of the pan

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SISTEM DE TENDINȚE SIMPLIFICAT PENTRU ÎNCEPĂTORII TRIZ

Rezumat: „Sistemele tehnice evoluează după modele descriptibile” este una dintre tezele de bază ale TRIZ. Practicanții TRIZ pot folosi tendințele evoluției sistemului de inginerie pentru a descoperi noi direcții pentru dezvoltarea în continuare a produselor lor. În această lucrare, este prezentată o abordare a aplicării tendințelor evoluției sistemului de inginerie. Sistemul de tendințe dezvoltat este ușor de înțeles și de acționat, astfel încât în special începătorii TRIZ îl pot aplica rapid și ușor.

Peter JANTSCHGI, University of Applied Science Campus 02 Graz, jantschgi96@gmail.com, +43 664 2172494, Eppensteinerstraße 36, 9400 Wolfsberg