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Multi-Screen Analysis for Innovation Roadmapping

Valeri Souchkov

ICG Training & Consulting, 7511KH Enschede, The Netherlands

Abstract

The paper presents an approach to enhance innovation roadmapping with the use of a tool "Multi-Screen Analysis" (MSA). MSA is based on extracting changes of the functionality of a system by exploring its historical evolution and discovery of contradictions emerging during the system's evolution. Such information helps to identify and structure resources for future evolution of the system.

Keywords: Multi-Screen Analysis, System Operator, Innovation Roadmapping

1. Introduction

1.1. Multi-Screen Scheme of Thinking (System Operator)

G. Altshuller originally presented a Multi-Screen Scheme of Thinking (also known as System Operator") in [1]. He considered a capability of seeing the world as a system, at many levels, or "screens" as one of the key features which distinguishes between thinking of a talented inventor (or any talented person who uses creativity to produce positive changes) and thinking of a person who is not engaged to creative activities. He proposed to use System Operator as a tool for developing creative imagination.

A basic model of a System Operator is well known in TRIZ and is shown in Fig. 1. It consists of nine boxes, or "screens" which present: i) a specific system of the latest generation (central box), ii) the upper and lower boxes representing its supersystem and subsystems, as well as boxes representing the previous and the future generations of the system given including its past and future supersystems and subsystems. Nine boxes are the minimum number; while more boxes can be added along any axis as soon as a more detailed study is required.

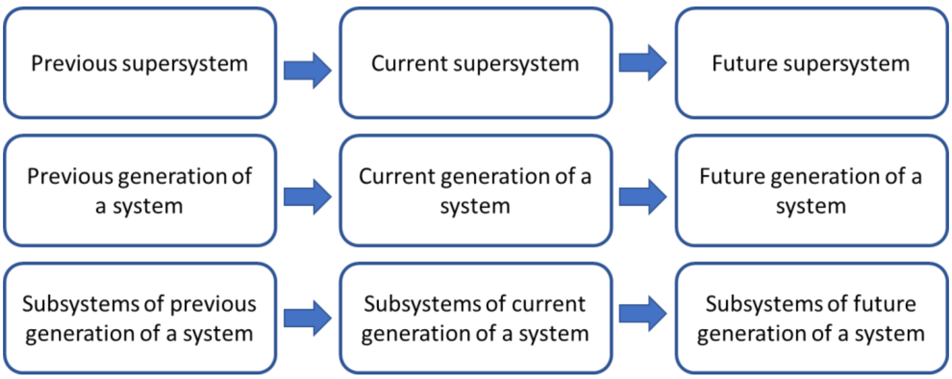

Fig. 1. Basic Multi-Screen Diagram of Thinking (System Operator)

A core idea behind System Operator is that when we attempt to effectively forecast future evolution of a system it is not enough to focus on the system only without taking into consideration information about its past and future changes in its supersystem which are expected to produce impact on the system's evolution. The boundaries of the system under analysis thus have to be expanded along both the time and space axes. One can only produce a more or less reliable forecast by taking into account how evolution of the system will impact evolution of its supersystem and, in return, how evolution of supersystem is going to impact evolution of the system. In addition, it is important to understand what factors can be considered as driving evolution of the system therefore one has to analyse connections between the past generations of the system and its latest generation to extract this information.

1.2. Using System Operator as a Tool for Innovation Roadmapping

Although System Operator is a very valuable tool for developing creative imagination skills, lately it has been used in a broader context for producing innovative ideas for actual innovation projects. However, a general problem with using System Operator as a tool for producing new ideas is the lack of guidance how it can be used and how new ideas can be produced.

Motivation to use System Operator for dealing with pragmatic innovative tasks resulted in the development of a number of ideas and methods which propose to deploy Multiscreen Thinking in its existing form as a tool for producing new innovative ideas [2],[3],[4]. Another research work proposes to extend the basic model of System Operator with new dimensions and parameters [5]. Although increasing complexity of System Operator might lead to increasing its capabilities, a problem is that even using its basic model creates certain difficulties since it requires upgrade of a thinking paradigm of majority of people. It is however not easy to achieve.

One of the potentially promising applications of System Operator resides within innovation roadmapping [6] which targets the development of a shared vision of the future of a specific system presented in form of time-based scenarios. Today several approaches to innovation roadmapping are known which include various supporting means such as technical tools and best business practices. The TRIZ tools can also be effectively used for innovation roadmapping, for example, the Laws and Trends of Technical Systems Evolution or Function Analysis and Trimming. In turn, System Operator can also be used to support the analytical stage of the innovation roadmapping process.

2. Multi-Screen Analysis

2.1. Approach

One of the primary challenges during the process of innovation roadmapping is a lack of a structured methodological support for gathering and processing information. A problem is rather similar to the problem inherent to a traditional non-systematic approach to solving inventive problems: without a proper guiding method, too many trials and errors are produced and it is not clear what to focus on. In addition, there is a high risk of producing wrong results. In TRIZ such a problem is solved by narrowing the task through abstract modelling and reducing search space by using empirical rules.

Multi-Screen Analysis (MSA) uses a similar approach to structure the process by dealing with a number of abstract concepts such as functions and contradictions which can be considered as driving forces behind evolution of any man-made system. MSA is therefore based on the TRIZ philosophy to forecast future innovations by exploring current and future problems. However, if such tools as for example Function Analysis provide useful information about functionality-related problems of the latest generation of a system, Multi-Screen Analysis helps to identify problems and challenges which relate to the dynamic changes occurring during evolution of the system towards its latest generation.

MSA thus focuses on those problems that have been created during the process of evolution to a more innovative generation of a system. The primary subject of study by MSA is exploration of issues emerging because of transition from the past generation of a system towards the latest generation.

The goal of MSA is to identify the following sources of problems and challenges:

1. Functions that are available but not delivered with the desired degree of performance.
2. Missing functions that are required by supersystem.
3. Functions that will become necessary to adapt the system to its future supersystem but not delivered by the current system yet.
4. Contradictions that still remain unsolved.
5. Contradictions that will emerge between the current system and its future supersystem.

To extract such problems it is proposed to perform a study of effects produced by innovative changes experienced by a system during transition from its past generation(s) towards the latest generation. In principle, an idea of the analytical part of MSA is similar to the process of "genetic analysis" proposed in [7] which is used to discover problems that emerged during transition between several generations of a system. Besides extracting the existing problems and challenges, MSA also includes a creative phase to discover problems that might be experienced by the system in future.

The output of MSA consists of two lists:

1. The list of problems and challenges experienced by the latest system generation.
2. The list of problems and challenges the system will experience in the future.

As clear, some problems and challenges will belong to the both lists. A process with MSA is shown in figure 2.

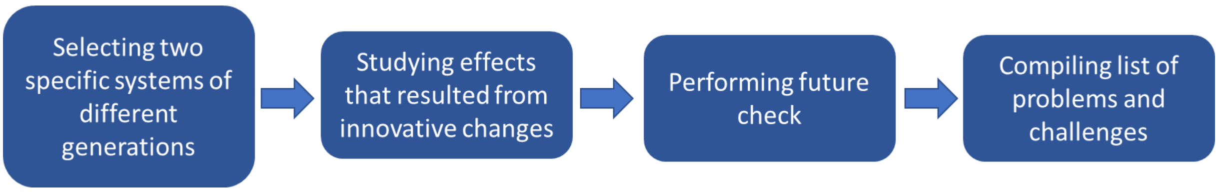

Fig. 2. Process with Multi-Screen Analysis

2.2. MSA Checklists

In order to perform MSA, a technical system of the latest generation and a system of the previous generation are selected. In a situation when there are a number of competitive systems available, a choice of a specific latest generation system depends on the matching interests of all stakeholders involved.

To perform analysis, a component model of the technical system is used which is comprised of a number of subsystems to list all the subsystems of two systems. Certain subsystems can be aggregated to create bigger subsystems if necessary in order to simplify the component model. It becomes useful for those subsystems that have not experienced innovative changes. Alternatively, any subsystem of a more complex system can be taken for analysis as a standalone system.

MSA consists of a number of questions, which are divided to four categories to gather the following information:

1. Information about impact of innovative changes of subsystems.
2. Information about impact of newly added subsystems.

3. Information about impact of subsystems which ceased to exist.
4. Information about impact that will be produced by future supersystem.

Below we consider examples of specific questions in each category, which are used to gather information for MSA.

2.2. Specific MSA questions

The first category of questions concerns changes, which occurred in the system with respect to its subsystems. In MSA only innovative changes are a matter of interest.

A number of questions are asked about each subsystem that experienced significant change in order to gather information on the following subjects:

1. If a specific change removed any useful function(s).
2. If a specific change added new useful functions(s).
3. How did a specific change negatively affect quality and robustness of the subsystem or the entire system.
4. How did a specific change negatively affect performance of the subsystem or the entire system.
5. How did a specific change negatively affect usability of the subsystem or the entire system.
6. How did a specific change negatively affect life-cycle of the subsystem or the entire system.

After performing the study, similar information is gathered about effects resulting from adding new subsystems to the system and from removing specific subsystems from the system. As a result, we obtain three groups of answers which summarize all the effects produced by innovative changes of the system.

After obtaining responses to the questions from categories 1-4, one can make conclusions about:

1. Parameters of quality, performance and usability that require improvement.
2. Functions that are not delivered yet with the desired degree of performance.
3. Functions that are missing in the system.
4. Contradictions which still exist in a system.
5. Contradictions which were created by a transition from the system of previous generation to the latest generation system.

The final, fourth category of questions deals with future changes of supersystem. If previous four categories of questions use information which is readily available, the fifth group of questions require imagining how the supersystem is going to change within the proposed period of forecast. Answering the questions of this category requires performing a creative phase first to develop an image of a future supersystem and creating a list of future supersystem changes. After all the ideas about changes in the supersystem have been produced and accepted, the following questions are asked:

1. Will future supersystem's changes demand new functionality and if yes then what functionality?
2. Will future supersystem's changes require removal of any of the existing subsystems and if yes then what subsystems?
3. Will future supersystem's changes eliminate the existing contradictions and if yes then what contradictions?
4. Will future supersystem's changes create new contradictions and if yes then what contradictions?

3. Case: Multi-Screen Analysis of an Umbrella

In this section we present a fragment of a project which involved MSA to "multiscreen" the evolution of umbrella (Figure 3) at the analytical stage of the innovation roadmapping process.

Fig. 3. Selected previous generation and modern umbrellas

The first step is to analyze which components belong to the subsystems and supersystems of both umbrellas (Figure 4).

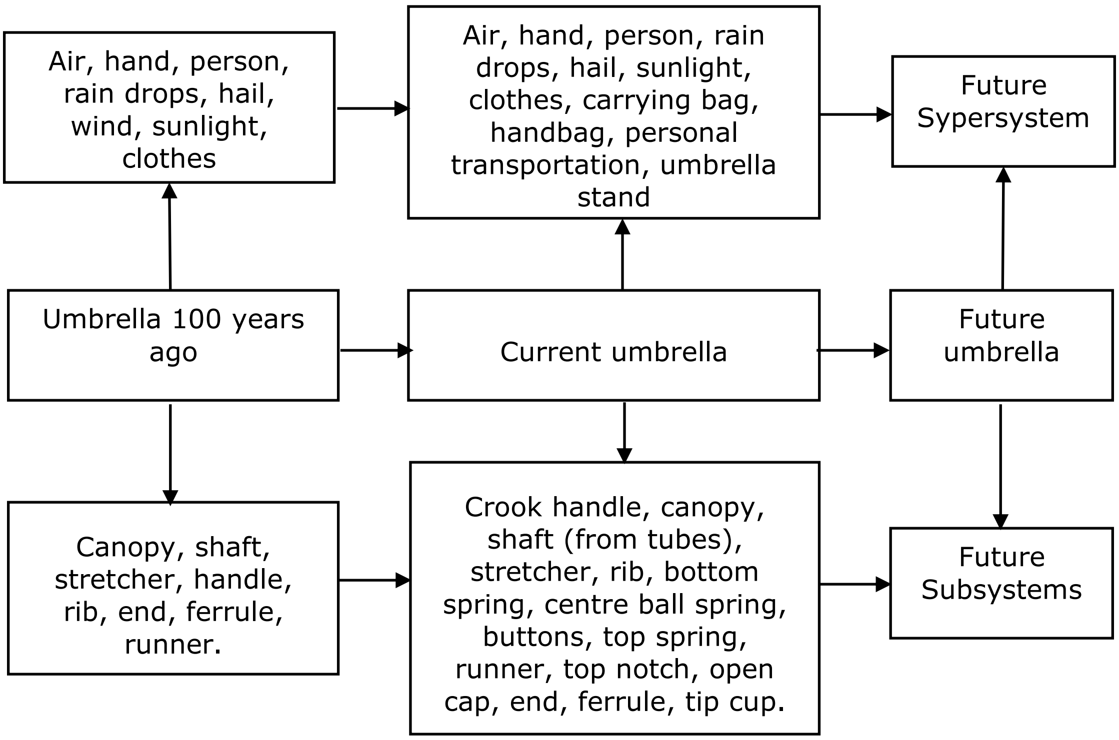

Fig. 4. Analysis of two umbrellas of different generations by identifying their past and current subsystems and supersystems.

The next step is to select each subsystem which was changed and describe what innovative changes it experienced. Against each change all questions mentioned above in the first category of MSA checklists have to be answered and translated to contradictions. The results of this study for the umbrellas's subsystem "shaft" are shown in Tables 1 and 2. In the example we only included several changes while there were more changes, for example we omitted the fact that wood as a material of the shaft was replaced with metal (or plastic).

Table 1: Exploring functionality change

Shaft	*Innovative Changes*		
	Became telescopic	Became hollow	Contains openings
Removing useful functionality	none	none	none
Adding new functionality	- Provides extension and contraction of the shaft.	- Provides space for springs. - Provides space for inserting the other tube of the shaft.	- Provides open space for buttons
Affecting existing functionality	- More difficult to open	none	none
Affecting existing quality	- Easier to break	- Easier to deform	- Water can get inside - Buttons can stuck
Affecting existing performance	- More time to open the umbrella	none	none
Affecting lifecycle	- More difficult to assembly - More difficult to utilize - More difficult to produce	- More difficult to produce	- More difficult to produce

Table 2: Exploring contradictions

Shaft	*Innovative Changes*		
	Became telescopic	Became hollow	Contains openings
Affecting the existing contradictions	- Shaft should be long to comfortably use the umbrella and short for convenient transportation	- Shaft should be hollow to provide telescopic effect and contain other parts and monolitic to avoid easy deformation.	none
Creating new contradictions	- Shaft should include one piece to be easy assembled and maintained and many pieces to provide telescopic effect - Shaft should be complex to enable telescopic movement and should be simple to prevent from being easily broken		- Shaft should be sealed to prevent water from getting inside and open to let buttons move - Openings have to be narrow to not let rain getting inside and wide enough to avoid the buttons from being blocked inside. - Shaft should contain

	- Shaft should be complex to enable telescopic movement and should be simple to easier produce and recycle - Shaft should include a number of pieces to stay short and to stay one piece to avoid applying too much effort to open - Shaft should include several pieces to stay short and to stay one piece to avoid spending more time to open		openings to provide path for buttons and do not contain openings to be easier to produce

A study of tables 1 and 2 results in formulation of the following problems and challenges expressed in terms of contradictions (only opposing demands are shown):

1. The shaft should long and short.
2. The shaft should be complex and simple.
3. The shaft should be hollow and monolitic.
4. The shaft should be fully sealed and contain openings.
5. The openings in the shaft must be narrow and wide.
6. The shaft should contain openings and do not contain openings.

Note that the first two contradictions refer to both generations of umbrellas while the remaining contradictions are only present in the umbrella of the latest generation. Although transition to the telescopic shaft partly resolves the contradiction concerning the length of a shaft, it is still not fully solved and therefore it was brought to the list of existing problems and challenges.

Similar tables can be created, and conclusions are made for other two categories of questions dealing with added and disappeared subsystems listed in Section 2.2.

Regarding the third step of MSA Process "Performing future check" (Figure 2), it refers to the fourth category of questions presented in Section 2.2. Table 3 shows a fragment of extracted challenges at this step.

Table 3. Challenges revealed at the stage of Future Check

Future change	Impacts			
	System	Subsystem(s)	New Function(s)	Contradictions
Water-proof clothing	Umbrella disappears. Its function is transferred to clothes.	The canopy should not protect from rain any longer. Only protection from sunlight is required.	Function protect from rain/hail disappears	
City districts under rain/hail protecting cover	No umbrella is needed			

Smaller carrying bags	The whole umbrella should become as tiny as possible (e.g. to be carried in a pocket).	Canopy, shaft		All large parts of the umbrella should be big to protect from rain and enable convenient use and small to become portable
Climate control / eliminating rain in populated areas	Umbrella only for the use outside cities		Protecting from rain outside cities	Umbrella does not exist while in a city and emerges only when outside the city.
Shorter travel times in open air	No impact	No impact		
…	…	…	….	…

After all information has been gathered and analyzed, all discovered problems are brought together and ranked to identify innovation priorities. Ranking the problems is not part of MSA, any available ranking method can be used.

4. Conclusions

In summary, MSA provides the following:

1. Observing and mapping problems and changes were experienced by a system under analysis with respect to the selected past system generation.
2. Learning what factors negatively influenced the system's development from both subsystem and supersystem perspectives.
3. Understanding what we want to change and improve in order to create a system with a higher degree of ideality.
4. Formulation of problems to solve to develop a future generation of a system.

It is obvious that MSA enables performing system analysis from a single perspective only: exploring what problems and challenges were created by a transition from the past generations of a system towards the latest generation of a system. Therefore, further MSA development will be focused on integration of MSA with other methods of analysis and innovation roadmapping.

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Author (co-author) to contact: *Valeri Souchkov*, *valeri@xtriz.com*