NOVA IMS
Information Management School

MGI

Mestrado em Gestão de Informação
Master Program in Information Management

A Creative Information System based on the SCAMPER Technique

Rute Gomes Lopes

Dissertation presented as partial requirement for obtaining the Master's degree in Information Management

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

A CREATIVE INFORMATION SYSTEM BASED ON THE SCAMPER TECHNIQUE

by

Rute Gomes Lopes

Dissertation presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in Information Systems and Technologies Management

Advisor: Vitor Santos, ISEGI, vsantos@novaims.unl.pt

July 2017

ACKNOWLEDGEMENTS

I would first like to thank my thesis advisor Prof. Vitor Santos of the Nova Information Management School at Universidade Nova de Lisboa. The door to Prof. Vitor Santos office was always opened whenever I ran into difficulties or had questions about my research or writing. He consistently allowed this paper to be my own work, but directed me in the right course whenever he thought I needed it.

I would also like to thank the experts who were involved in the validation survey for this research project: Henrique Mamede and Guilherme Vitorino. Without their passionate participation and input, the validation could not have been successfully conducted.

I would also like to acknowledge all the people that are not referred but, in one way or another had an impact on the development of this thesis.

Finally, I must express my very profound gratitude to my parents and to my family for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them.

Thank you,

Rute Lopes

ABSTRACT

Nowadays, the use of creativity in business has been increasing drastically because it is important for the market to come up with new ways to find answers to the problems proposed by the users.

There are several different creativity techniques that can be used in different contexts. One of the most important techniques is the SCAMPER technique, which is based in reorganizing, modifying, adding and eliminating information.

An automated system will provide answers and solutions to creativity problems and contribute to minimize the cost of innovation in the companies. For that reason businesses will be able and willing to continue to use creativity when innovating.

The aim of this thesis is therefore to design an architecture system for a creative information system based on an automated system that relies on the SCAMPER creativity technique.

KEYWORDS

Creativity; Creativity Techniques; Information Systems Architectures; SCAMPER; Creative Information Systems

ARTICLE

Lopes, R. and Santos, V., A Creative Information System based on the SCAMPER Technique

SUBMISSION TO CIMPS'2017 – 6TH INTERNATIONAL CONFERENCE ON SOFTWARE PROCESS IMPORVMENT

INDEX

1 Introduction 1
1.1 Scope 1
1.2 Motivation 1
1.3 Objectives 1
1.3.1 Main Objectives 1
1.3.2 Specific Objectives 1
1.4 Document Organization 2
2 Literature review 3
2.1 Creativity 3
2.1.1 Creativity Techniques 3
2.1.2 SCAMPER Technique 5
2.1.3 In Businesses 6
2.1.4 In Computers (Future) 6
2.2 Information System Architecture 7
2.3 Creativity and Information System Architecture 9
3 Methodology 12
3.1 Design Science Research 12
3.2 Research Strategy 12
4 An Information System Architecture for the SCAMPER technique 15
4.1 The artefact 15
4.2 Hypothesis 23
4.2.1 Input 23
4.2.2 Lists 24
4.2.3 SCAMPER Generator 24
5 Evaluation and discussion 26
5.1 Evaluation 26
5.2 Discussion 26
5.3 Global appreciation 28
6 Conclusions 29
6.1 Synthesis of the developed work 29

6.2 Limitations and recommendations for future work..30
References……......31
Annex 1…….33
Annex 2…….35

LIST OF FIGURES

Figure 1 – The cretivity continuum. 5
Figure 2 - DSM representation using values or colors. 7
Figure 3 - Zachman Framework. 8
Figure 4 - TOGAF and ADM. 8
Figure 5 - General Scheme of a CIS (Santos et al. (2008)). 9
Figure 6 – CIS architecture for the Whiteboard technique. 10
Figure 7- Architecture of semiautomatic system of the Brute Thinking technique. 10
Figure 8- Peffers et al. (2007) Framework. 12
Figure 9 - CIS for the SCAMPER technique. 15
Figure 10 - Type of input for the CIS. 15
Figure 11 - Change the material of Phrase A for another of the List M. 16
Figure 12 - Change the second instance material in Phrase B for other from the List M. 17
Figure 13 - Substitute the subject in Phrase A for other from the List S. 17
Figure 14 – Add materials, in the second instance, in the Phrase B from the List M. 18
Figure 15 - Change the materials and/or verbs within the Phrases A. 18
Figure 16 - Change the materials within the Phrases B. 19
Figure 17 - Join the materials of Phrase A or Phrase B. 19
Figure 18 - Change materials in Phrases A and B for materials with the same utility. 20
Figure 19 - Change randomly the verbs in Phrase A for another from List V. 20
Figure 20 - Change the utility in Phrase C with a different utility of the same material. 21
Figure 21 - Eliminate one or more materials of second instance in Phrase B. 21
Figure 22 - Eliminate a pool of Phrases A. 22
Figure 23 - Substitute a verb from Phrase A for the opposite verb. 22
Figure 24 – Diagram of output of the CIS. 23
Figure 25 – Example of lists of verbs, materials and subjects. 24

LIST OF ABBREVIATIONS AND ACRONYMS

ADM	Architectural Develop Method
CIS	Creative Information System
DSM	Design Structure Matrix
IMS	Information Management School
SCAMPER	Substitution, Combination, Modification, Put to other use, Elimination, Reversion
TOGAF	The Open Group Architecture Framework

1 INTRODUCTION

1.1 SCOPE

There is a variety of definitions and ways to use creativity, over the years it has been studied the impact and uses on our day to day and on the business. The use of creativity techniques is a way to help improve and trigger the creative thinking.

The range of use of these creativity techniques is vast and all of them have drawbacks and advantages and depending on the situation can be more or less useful. Nowadays the capacity to innovate is gaining importance not only on a personal level but also in a business level and the number of academic studies made across these topic have been increasing.

The use of technology for recreating creativity using the creativity techniques, where a system could help to increase creativity giving different and original answers to a context, would be an important step to give in this field of study.

1.2 MOTIVATION

We live in a world that is always changing, and one of the main reasons for that is the developments in products and services. Creativity and innovation are topics that are trending all around the world, so there is an increasing importance in studying them, and in finding ways to make it easier to accomplish.

When proposing the topic there was a clear vision of what we could do, and how could it change the way of thinking and interacting for its readers. What we realise is that proposing an architecture for a system in this terms would take some work and an understanding of how the SCAMPER technique is used, but what motivates us to complete this work with success is being able to tell that there is an approach that can facilitate the way creativity is accomplished these days and it is feasible by applying an already existing and well known creativity technique.

1.3 OBJECTIVES

1.3.1 Main Objectives

The main goal of this thesis is the creation of a model for a Creative Information System (CIR) using the SCAMPER technique, based on studies of Vitor Santos and Henrique S. Mamede, that propose a generic architecture for a CIR. We want to propose the best architecture of the SCAMPER technique and understand in what outside sources can the proposed system use to support the answers.

1.3.2 Specific Objectives

To achieve the main goal it is important to analyse the possibility to automate all the cycle of creativity for this technique, identify the minimum inputs need for a reasonable number of answers, understand how can the methods in the SCAMPER technique be automated, identify what type of answers will the system give to the user and, finally, evaluate the final architecture according to the basic rules.

1.4 Document Organization

In this section we present the thesis organization of the thesis and a synthesis of the work displayed in each chapters, that are structure in the following way:

In the second chapter we do an literature review, focusing on the topics of creativity, information system architecture, and the relations between both of the topics, focusing on previous work on this field. There is not only an historical approach of creativity, the studies made in the field, and the future that may exist on the creativity field, but also a more in-depth approach of the creativity techniques, namely the SCAMPER technique. In the sector about information system architecture we focus on the models and characteristics that help structure and build an architecture, using the most well-known models. In the final part of this chapter we give an overall approach to the role of creativity in information systems but we put our attention to previous work related with this topic.

The third chapter is dedicated to the methodology applied during the development of the work, the Peffers framework for Design Science for Information Systems and research strategy applied, meaning the way found to build this specific architecture.

In the fourth chapter the design of the information system architecture is presented with an explanation of how it works and all the rules that the system has.

The latter is then followed by evaluation and discussion of the work performed. To conclude, there will be a final chapter with a synthesis of the work developed, what limitations were encountered and references for developing future work.

2 LITERATURE REVIEW

2.1 Creativity

Many studies about creativity have been presented since the 1950s. Between theories and models that explain creativity as an intellectual process, all come to an agreement in explaining creativity as a process that results in something new.

In the first studies creativity was rapidly assumed as an intrinsic characteristic of a person, although Guilford stated that the studies were inconclusive. Later, the term design thinking emerged, this term describes the mind set and strategies of thinking, where the different styles and characteristics of the individual have a big role on the process of creating something new (Adams, 2005; Bono, 1989).

A person that has an easier time approaching design thinking is expected to have a fluid, flexible, and original thought. These characteristics are the ones tested when creativity is in focus, but in any case the investigators have come to the conclusion that there is a need for a more lateral thinking approach when searching for new solutions (Cross, 2011; Young, Binning, & Young, 1997).

For years the analytical thinking has been in the base for problem solution where the thought is made in a recognized process and the solutions are grounded in hypothesis, analogies or synthesis. This stages of the vertical thinking can be accomplished not only by the use of data, but also using creative thoughts (Guilford, 1986).

In the hypothesis stage there is room for divergent interrogation that can result in valid answers. Another creative way to solve the problem is using analogical-comparative thoughts which allow new and different ways to relate facts and circumstances. In the last stage is used intuition that is a non-processed way to synthetize information and take actions towards the results (Guilford, 1986).

Many theories have been formulated around creativity, such as lateral thinking. Edward Bono described lateral thinking as a way to solve problems moving from a known idea to a new idea relying on patterns and tools, as opposed to the traditional approach of step-by-step solution finding (Bono, 1989).

Lateral thinking uses techniques that serve as a trigger for people who are not as much predisposed to creative thoughts and to promote the training of creativity on those who are, forcing the user to answer questions that normally would not come to mind and reorganizing information in new patterns, resulting in a problem and an opportunity (Eberle, 1996; Michalko, 1993).

2.1.1 Creativity Techniques

The creativity techniques or idea generation methods are methods and techniques that, when put into practice, help trigger creative thoughts leading to creative solutions. It can be performed in a group or as individuals, but the latter is seen in many studies to be more efficient than the first one. There are techniques suitable for different situations and persons.

An idea can be generated through problem definition (analysis and redefinition), idea generation (divergent process), idea selection (convergent process), idea implementation (definition) or processes (schemes and steps) (Michalko, 1993; Toubia et al., 2003).

It is important to notice that the methods of reorganizing information are working on the premises that every new idea is a modification or an addition to something that already exists. Also the aim of the creativity techniques is to help people create as many solutions (new ideas) as possible, because, even though some are not valid, the probability of having a valid good answer is higher (Michalko, 1993).

2.1.1.1 Classification of creativity techniques

There are various amount of classification or categorizing creativity techniques, some authors have a more breaking down classification with a considerate amount of categories, others choose to have less categories. For example, in 1992 VanGundy divided the techniques by group or non-group, or in 1998 Alla Zusman divided them in 7 categories which include organizing, randomization, focusing, system, points, evolution or innovation knowledge-based (Mcfadzean & Waterman, 1998; Zusman & Zlotin, 1998).

In “Thinkertoys”, Michalko (1993) states that there are three different types of techniques:

I. “Linear Thinkertoys” are the ones that reorganize and manipulate information, creating different ideas until the one needed is reached;

II. “Intuitive Thinkertoys” focus on the unconscious to find new ideas that are already planted there; and

III. “The Spirit of Koinonia” holds all the techniques that implicate exchange of opinions between groups of people in the process of creating ideas.

Other classification is based on the solution that is given after the technique is used, using a classification by Nagasundaram and Bostrom (Figure 1), this method of classification is called the creativity continuum and focus on the fact that the groups/individuals will go progressively through all the classification methods (Mcfadzean & Waterman, 1998):

I. Paradigm preserving where there is a direct association between the problem and the solution;

II. Paradigm stretching where there will be new elements or relations added to the problem stretching its boundaries ; and

III. Paradigm breaking in these case both new relations and elements are added to the problem creating a complete new problem.

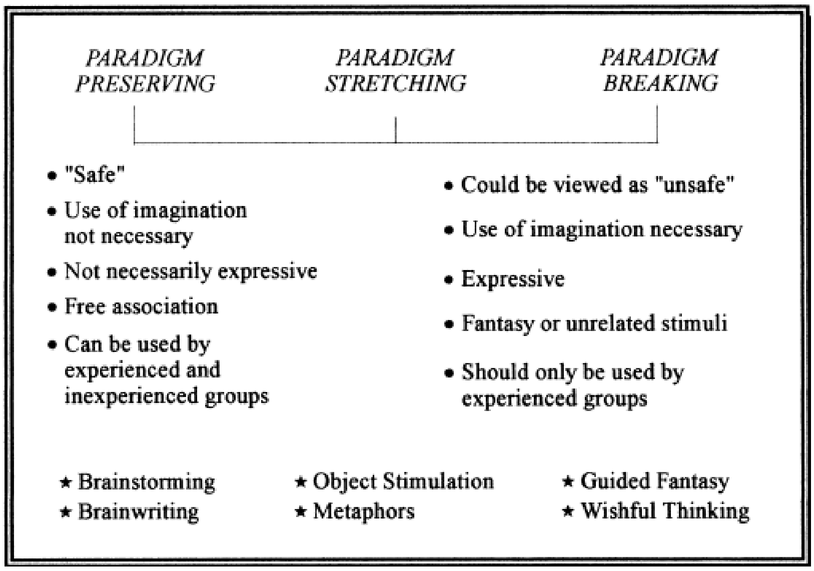


Figure 1 – The cretivity continuum.

2.1.2 SCAMPER Technique

Some people believe that the best ideas come from the combination of different ideas. The SCAMPER technique is one of the techniques that reorganizes and combines information in order to create different ideas according to a problem or situation. Created by Alex Osborn in 1953 (develop by Bobo Eberle and later published by Michael Michalko), is one of the most complex techniques because each letter of the acronym represents a different method to use (Baecker, 1995).

These methods are: **S**ubstitute (materials, components, people), **C**ombine (mix, combine, integrate), **A**dapt (change function), **M**odify - Michalko added **M**agnify- (increase or reduce in scale, change shape), **P**ut to other uses, **E**liminate (remove, simplify, reduce), and **R**everse - Michalko added **R**earrange – (change components, change the speed, turn inside out or upside down the order) (Michalko, 1993).

A way to use this technique is searching for different knowledge to find a solution using similar problems and the incentive for creating new ideas is the creation of answers to questions that otherwise would not be asked.

There are some typical questions that can be used as a starting point to use the SCAMPER technique:

- Substitution - “what can be replaced to improve?” or “what happens when something is changed?”,
- Combination - “Can parts of the problem be combine to create something new?”,
- Adapt - “Can we create different synergies within the problem?”,
- Modify/magnify - “Can something be change in adaptation to the problem?”,
- Put to other - “There is any other uses for the problem?”,

- Eliminate - “Can elements of the problem be eliminated?” and
- Reverse - “Can the order of the problem be change or reversed?”.

The main advantages of the SCAMPER technique is that it promotes creative thinking when analysing the problem and generates various amount of new ideas. It is considered a weaknesses of the SCAMPER technique the fact that it only works on limited environments, the ones that encourage free-form thinking, and the fact that the technique discourages group thinking being itself a non-group technique even though it is also recommended to be performed in a group all discussions can lead to a dead end (Michalko, 1993).

2.1.3 In Businesses

Creativity has been gaining importance in the past ten years, managers try to combine knowledge, creative thinking skills and motivation to achieve maximum creativity of collaborators (Adams, 2005).

In Sutton (2001) studies, he acknowledges that companies allocate resources and dedicate time and money to the creation of new ideas. They try to balance motivational incentives, working environment, and management practices to increase the efficiency when innovating. However, managers have not been as successful as they could be. Therefore, Sutton studied different rules for creative management, focusing on the hiring process and the characteristics of the person.

Nevertheless, the problem when dealing with people is that mistakes are inevitably made, and since the world has started to develop computerized everyday actions that eliminate the risk of human error, especially in the world of business, there is an opportunity to create a system that can provide answers to problems that humans tend to take more time solving.

Since creativity is a skill that requires motivation and knowledge, as previously stated, it comes with the costs of training, time and incentives. These costs may be high for a company where the goal is to maximize their profits, however, they are needed for the permanency of the company in the market (Bilton, 2007).

2.1.4 In Computers (Future)

Creativity is one of the least understandable parts of intelligence by science, hence the difficulty in developing further studies in the subject. However, artificial intelligence studies focusing on creativity have been multiplying. The focus of this studies is in replicating arts, as for drawing, music or writing, but these programs are fairly flawed (Dartnall, 2013).

The question “Can computers be creative?” is still far from being answered. On one side is believed that there is no reason to answer with “No” because of freewill[1], it is believed that computers have freewill based on their code, because freewill on humans is created by preferences and desires. In the other side it is only believed that computers can create the allusion of creativity, because only humans can decide if it is creative or not (Dartnall, 2013).

[1] Freewill – free and independent of choice (*Oxford Dictionary of English*, 2017)

2.2 INFORMATION SYSTEM ARCHITECTURE

To create a system – set of entities and relationships – there is a need to identify the functions, entities and context, and identify the relationships. For that, an architecture should be constructed, as well as a visual description of the relationships and the entities (Crawley, Cameron, & Selva, 2015).

A System architecture is a conceptual model where there is an allocation of the information and the elements of form, and the connections between them and the context. To understand the relationships of the formal entities and the information/context one must design a blueprint named "Design Structure Matrix" (DSM), as represented in Figure 2 (Eppinger & Browning, 2012).

In the DSM blueprint the aim is to represent the relationships and what type of relations the entities can have, focusing on the true and real representation of the system.

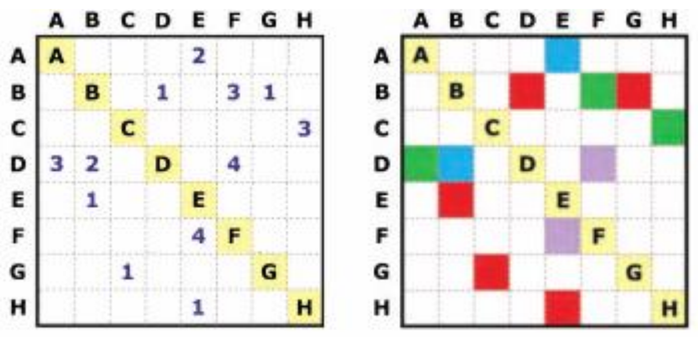


Figure 2 - DSM representation using values or colors.

When constructing a system architecture there are some models that should be taken into account. Although these have different usage, drawbacks and benefits, they all agree that they are ways to organize a system (Crawley et al., 2015).

First the Zachman framework, one of the most common to use among the enterprises. It is a structure for classifying and organizing the representations of the system. As we can see in Figure 3, in the Zachman grid there are intersections (36) that depend on the perspective and descriptive emphasis the user give them. On the horizontal axis are different descriptions from one player and on the vertical axis there is one focus only but from different players (Zachman, 1987).

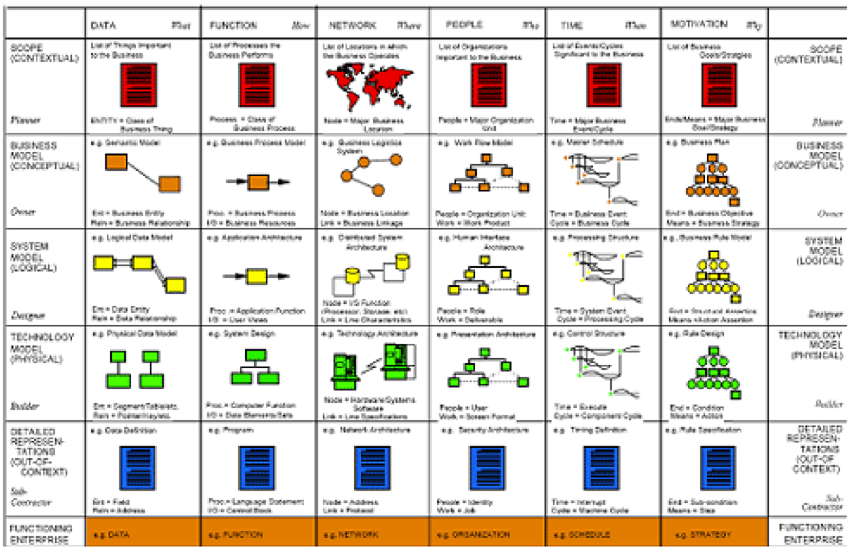


Figure 3 - Zachman Framework.

The other model we should consider is the The Open Group Architecture Framework (TOGAF) that focuses on the processes of creating the artefacts. This framework is divided in different levels of specificity, and uses the Architectural Develop Method (ADM) that provides a procedure for going from generic (Enterprise Continuum) to specific (Organizational Architectures), as shown in Figure 4. The TOGAF is a flexible method but there is no way to know if the final work is good because it is dependent on the people who are building it and analysing the work the method is only an approach that leads to an architecture (Haren, 2011).

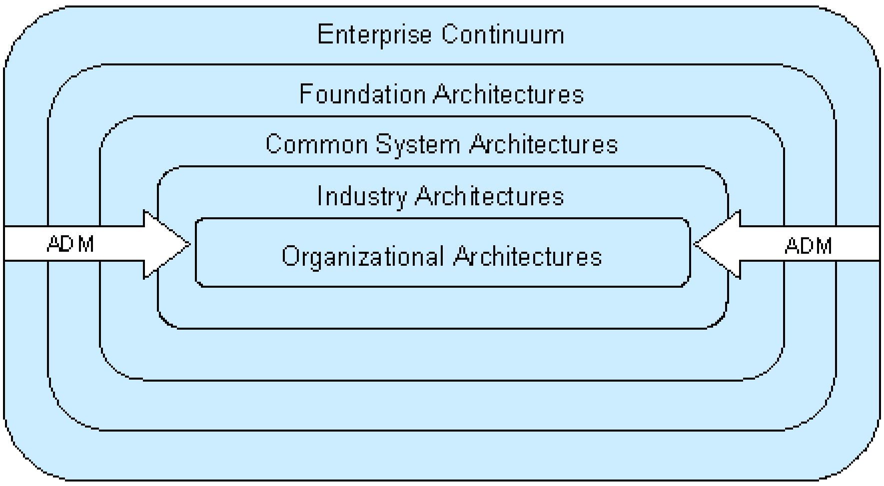


Figure 4 - TOGAF and ADM.

A good architecture should allow a visual and interactive design, as well as be functional, feasible, coherent with the approach, and able to propose answers. It has to not only meet the needs of the users, but also allow the maintenance, evolution and embedding on the industry. Most importantly, this specific architecture has to provide a competitive advantage to the business, as it provides answers to the problems. Although every architecture has its risks that cannot be completely eliminated, it is a goal for every model to minimize them (Spewak & Hill, 1993).

2.3 Creativity and Information System Architecture

Creativity has been introduced in the information systems mostly as a way to produce and create new systems, plans, projects, etc.

In recent studies a "Creative Information System" (CIS) was created, which consists in an automated system that produces answers unattended using a creative technique as an intellectual base. It is important to notice that there are minimum requirements for the inputs, namely the specification of the problem, its context and the restrictions. Depending on the creativity technique, the system will generate the answers through the process chosen (Santos & Mamede, 2008).

Hence, this system can recreate the original technique with minimum human interaction: the system will receive an input with the context and restrictions of the problem and will generate answers or solutions that can later on be analysed (Santos & Mamede, 2005).

The model presented in Santos et al. (2008) work states the way to plan and design an architecture for CIS. As shown in Figure 5, the input indicating the problem and context has to be specified by the user; then the design is produced in two stages, the first one representing the application of the creative technique and the second the generation of answers, resulting ultimately in the output for analysis.

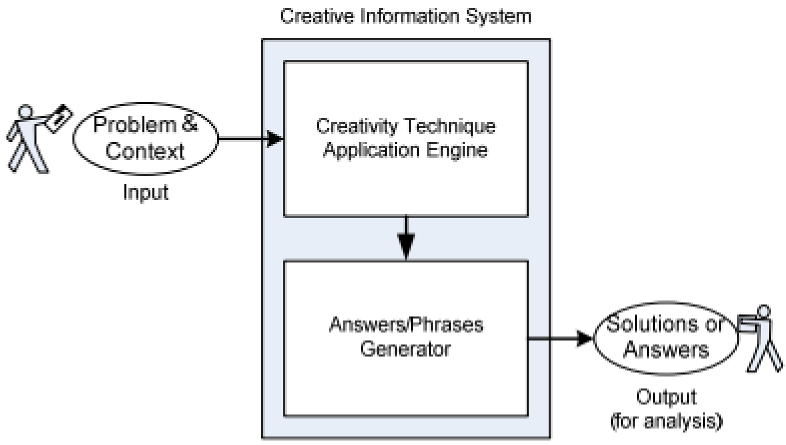


Figure 5 - General Scheme of a CIS (Santos et al. (2008)).

This model was used to propose architectures for two different creativity techniques: "Whiteboard" (Figure 6) and "Brute thinking" (Figure 7). These techniques are also explained by Michalko and are based on the random association of words. The process goes through 3 steps: the first is to bring in a word (dictionary and internet); the second step is to combine the random word with the context given; and the final step is the list of phrases (context and random words) (Santos & Mamede, 2005).

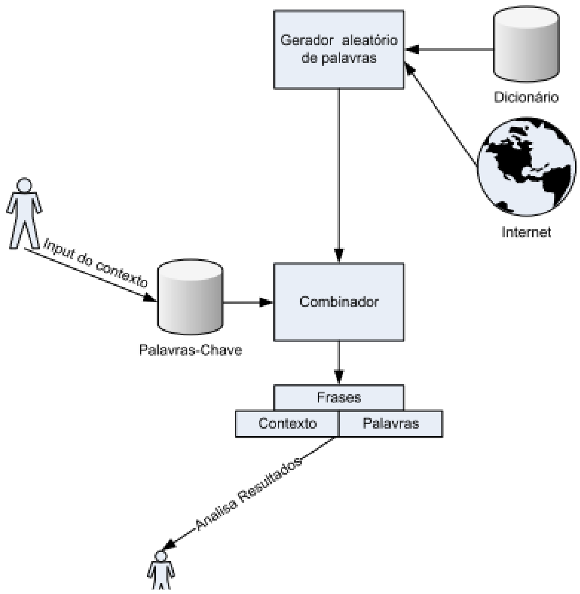


Figure 6 – CIS architecture for the Whiteboard technique.

In the CIS architecture for the Whiteboard technique the input is made by the user using keywords related with the context. Simultaneous is generated a group of words randomly from the dictionary or the internet, using the context establish by the user. With these elements the system will generate phrases relating context and the random words. The analysis of this list of combinations is made by the user and it is his goal to know which ones are valid or not (Santos & Mamede, 2006).

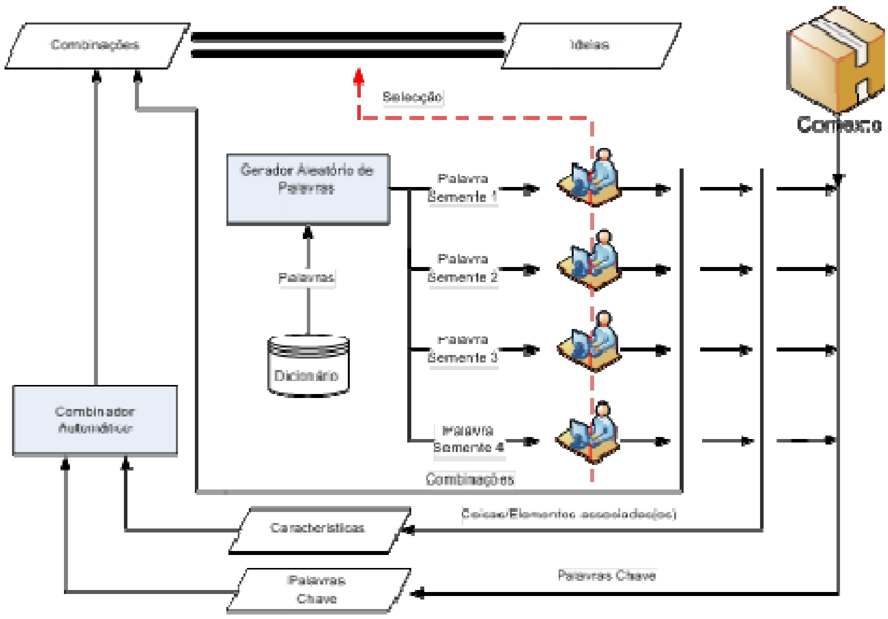


Figure 7- Architecture of semiautomatic system of the Brute Thinking technique.

The system for the Brute Thinking technique goes roughly through the same process as the one explained before. The major difference between both of these models is that the architecture for brute thinking is a collaborative semiautomatic system (more than one user at the same time).

AS represented in Figure 7, the first input is made by the users with all the context needed, this context will be used by the other participants to generate and register keywords that can describe and classify the context. The same happens for a seed word. After these two steps the system can generate a random combination of words with the following structure: keyword, verb (random generated), and a characteristic of the seed word.

3 METHODOLOGY

The methodology chosen for this study is based on Design Science for Information Systems, and the chosen framework as presented by Peffers et al. (2007).

3.1 DESIGN SCIENCE RESEARCH

This framework, in Figure 8, includes all the steps starting from the identification of the problem until the communication with the users, combining different methods for the development.

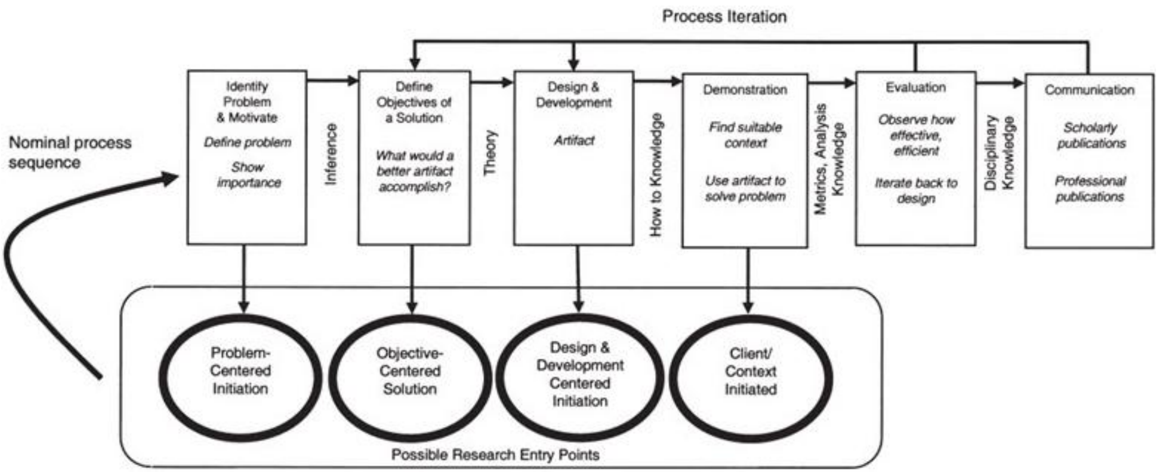


Figure 8- Peffers et al. (2007) Framework.

This type of framework aims to produce an artefact that addresses research through the building and evaluation of methods. The artefacts are designed to meet the identified business needs, however, the framework can be changed accordingly, so it may incorporate elements specific of the type of research (Hevner, March, Park, & Ram, 2004; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007).

This method was chosen because it identifies clearly the steps to take when building a research in information systems. Figure 8 represents all the steps to take into account in the process of building a research, differing from others on the steps of Design and Development and Evaluation. For the step of Design and Development, there is plan and analysis of the literature and conceptualization of the model, for the Demonstration phase will be used a confirmation trough hypothesis method and for Evolution a focus group. It is important to mention that this process is a continuous and looping work that can only be finished when there is an approval by the focus group.

3.2 RESEARCH STRATEGY

In the first phase of the research we identify the problem and the motivation to make this thesis, we focus on the developed studies and the different connections between creativity and information systems. Defining the problem and showing the importance a solution can have in the future, was an important step that helped delineate the rest of the work.

The second phase is to describe the goals of the solution; in this phase the procedure to take was to understand the goal of the research, specified before, and convert it into the specific goals of the artefact. For that, a research of the history of creativity and the SCAMPER technique, as well as the overall usage of the information system architecture, was made. At this point we could, in a learning process, transform the knowledge into the goals of the artefact.

After careful reading of the literature and understanding how the SCAMPER technique and a CIS work, we were able to create a system that can provide the functionality needed for an automated SCAMPER technique. Achieving the conclusion that every method used in the SCAMPER technique correlates directly to questions that can be answered was an important step to better understand how could a technique be transformed in a system. To analyse the different ways that the system could be made we resort in making examples to each method trying later on to generalise and build the system architecture.

The first step is to understand the elements of a problem that can be changed using the SCAMPER technique. This identification will lead to a creation of a list of specific elements and the relation between them, to use in the input. It is important to notice that each method of the SCAMPER technique can make different changes in the problem, so the elements and relation between them will change for different methods and questions.

The second step is to recognize how can the input be made in a way that it is, not only, efficient, but also easy to handle for the user, and what are the fundamentals of the input. In this step it is important to take into account that the elements established in the first step have to be a part of the input, not all of them but at least some, depending on the origin of the problem.

The third step is to understand how can the system work in different ways to perform the changes that are needed to complete the SCAMPER technique. The different methods imply different changes in the input and the technique does not always use all the methods. Therefore, the system has to, not only follow the different methods in order, but also use them as many times as the user wants, giving different answers each time.

The final step (fourth) is the organization of the output. The number of answers may vary depending on the input, but one thing we can conclude is that the number of the output has to be the same or higher than the input.

The different steps explained above will result in a system that can automate the SCAMPER creative technique giving answers to the problems proposed by the user. In chapter four we follow the steps explained above with the goal of proposing the information system architecture for the SCAMPER technique.

In the phase of demonstration, we used the architecture in different context, putting it through various examples and hypothesis. We pick out different contexts that can be applied to the SCAMPER technique when used without an architecture and apply this same contexts using the architecture. The goal here is to understand, before going any further, if the architecture is capable of performing in theory.

The evaluation phase, that is demonstrated in the chapter 5, is using a focus group (including professionals with different backgrounds and knowledge in the area of study) to establish if the architecture is useful in the field and to do an evaluation of the artefact. The focus group will be performed in three stages: the conceptualization, where the people are chosen, as well as the questions and the goals that we want to achieve at this stage; the meeting, where we gather the participants and asked them to analyse the study; and finally the analysis and conclusions where we discuss the different opinions and conclude if the study is finish or if it needs to be reviewed.

The final phase is the communication. As a part of the master thesis, this paper will be presented in the repertory of the faculty Nova IMS. We also intend to publish it, as a paper, in the journals about information system and creativity.

It is important to mention that, with the exception of the first step, which is the problem definition, all of these phases are in a continuous loop of work, so there is the possibility of reviewing and improvements during all the phases until the work is considered finished for publication.

4 AN INFORMATION SYSTEM ARCHITECTURE FOR THE SCAMPER TECHNIQUE

4.1 THE ARTEFACT

Figure 9 represents the system created following the steps explained above. The goal of this architecture, besides automating the SCAMPER technique, is to give the user a valuable experience from the start, with the input to how the output is presented.

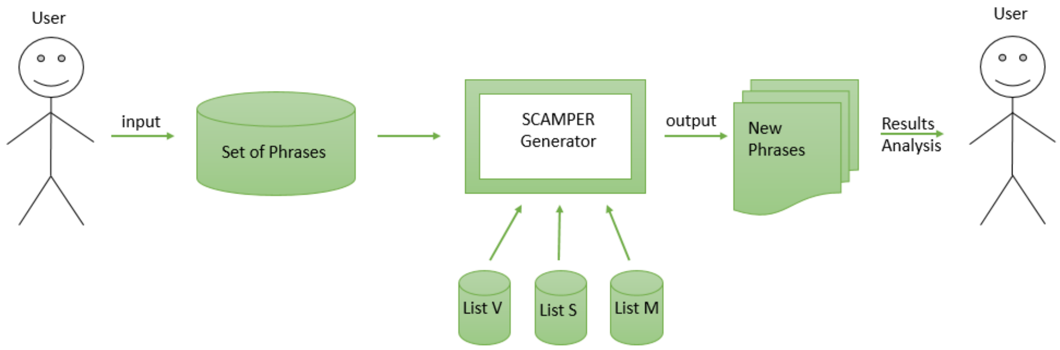


Figure 9 - CIS for the SCAMPER technique.

As demonstrated in the figure above, the process starts when the user inputs the information asked by the system. These sets of phrases go through the SCAMPER generator, which is the part of the system that does the changes in the input using the three different lists as an external input for the changes. These changes are documented in the output resulting in new sets of phrases in equal or higher number as the input phrases. The final instance is the analysis that the user makes of the result, determining if the answers are valid and if they are direct or indirect answers.

The input (Figure 10) made by the user has specific characteristics, namely being sets of three or more phrases that combine four types of elements. The user can input as many set of phrases as he wants, and can also leave in blank one or two of the phrases. In this case only some of the methods on the SCAMPER technique will be used, depending on the phrases that the user leaves in blank.

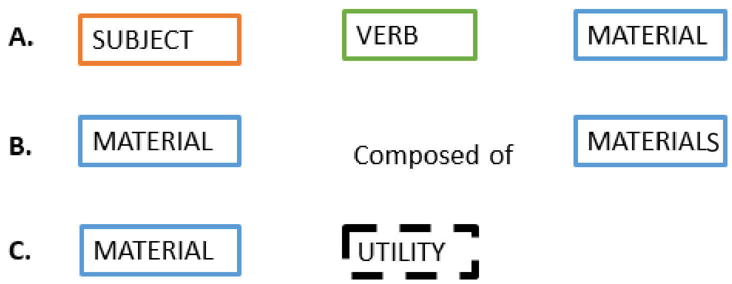


Figure 10 - Type of input for the CIS.

The goal with these phrases is to combine the necessary input in a way that is easy for the user and also that can be functional to the architecture. The phrase A combines a subject that can be a specific product or person/name, a verb which is an action or a composition and a material that can be a fabric or a wood. The phrase B associates two or more types of materials, and the final phrase (Phrase C) is a material combined with a utility that can be a type of object or a name of an object.

There are three types of lists that are an external mid-system input for the system. They can be fulfilled with words from a dictionary, or the internet. The lists are directly connected with the types of elements that are introduced in the input.

The List V represents the list of verbs and it has two different columns. The first column contains all the verbs necessary, and the second column has the opposite of the verbs in the first column. In this list the verbs can be repeated since they can have more than one opposite and the same verb can be on both columns of the list. The subject is represented in the List S and contains only one column with the name of the subject - it can be a product, a person or a category. The List M consists of, in the first column, the name of the materials and, in the second column, the utility of the materials in column one. The materials can have more than one utility and vice versa, therefore the materials and utilities can be repeated.

The SCAMPER generator works in a different way for each method used in the SCAMPER technique, following various actions using the particular inputs explained above, and it is important to realize that all the changes in the input are randomly made by the system. The main goal of this SCAMPER generator is to make the same changes as it would do when a person or a group of people performs the SCAMPER technique.

The first method is substitution and for that method the generator can use three different actions. These processes change directly two elements of the phrases, the materials and the subject, because the goal is to substitute materials to transform the final product and to change the subject to transform the way a task is performed.

One of the actions in the substitution method is to change the material in the Phrase A for another of the List M. Changing the materials will give different ways to have the same product but with distinct characteristics. As represented in Figure 11, using the List M the system will find and randomly choose the materials that differ from the one that is already in the phrase, and substitute that one for a material from the list. In this action the only focus is on the materials and they can be changed regardless of their utility.

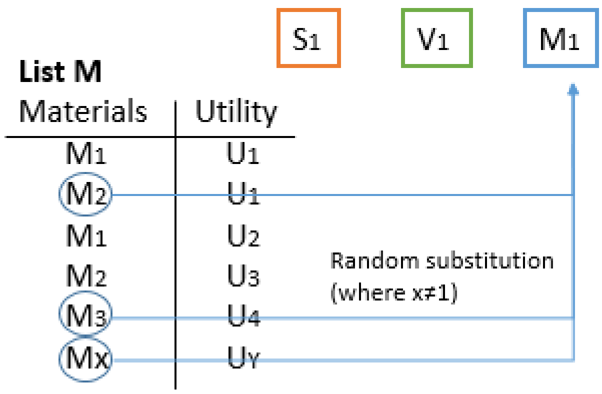


Figure 11 - Change the material of Phrase A for another of the List M.

The second action that we can list on the substitution method is also focused on the materials, but in this case uses the Phrase B. As shown in the Figure 12, the action is to change the materials of second instance for others that do not coincide with the ones that are already in the Phrase B. The system will go through the list of materials and choose randomly a material that is not the same that the system is changing. The action is performed as many times as materials of second instance exist as part of the Phrases B. The intent of this action is to have other materials to be part of the composition of the final solution. Once again, the utility of the materials is not important to this step, as it only gives other options of materials that exist.

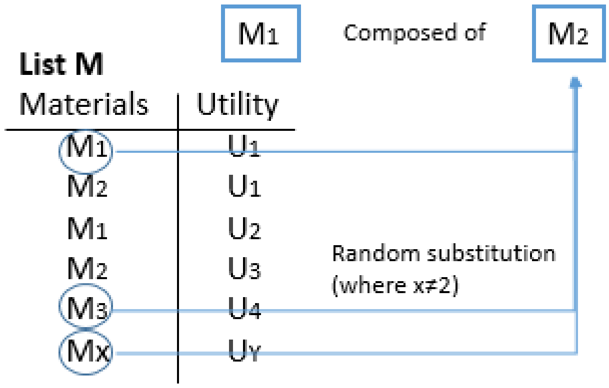


Figure 12 - Change the second instance material in Phrase B for other from the List M.

The final action for the substitution method is focused on the subject on Phrases A. The goal is to substitute randomly the subject in Phrases A for others from the List S. In this case, the system will look for subjects in the List S and randomly choose one to substitute in the phrase that differs from the one that is already there (Figure 13). This action intents to maintain the purpose of the subjects, maintaining the verb and material, but changing what or who performs it, altering the subject with the goal of finding new ways to perform the task.

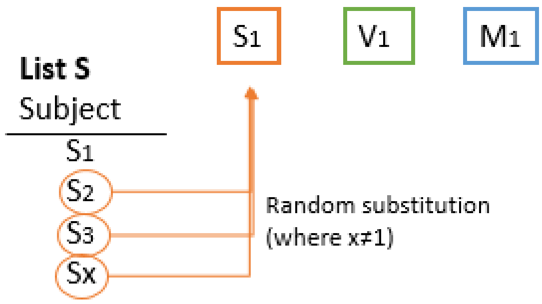


Figure 13 - Substitute the subject in Phrase A for other from the List S.

The second method in the SCAMPER technique is combination and for that method the generator uses only one action. This process will not change elements; instead it will combine different materials to the input of the phrases, as the goal is to add materials to transform the characteristics of the final product.

The system, as represented in Figure 14, will go through the list of materials (List M) and choose randomly a number of materials to add to the second instance of materials in the Phrase B. These materials are all different than the ones that are already included in the phrase in question. The number of materials to add is a random number between zero and five, and it can create the same combinations in different phrases or all different combinations, since it is a random procedure. With this action the SCAMPER generator will be able to give different combinations of materials that can have the same utility or not. These is, therefore, a focus on the different materials and not in the utility they have.

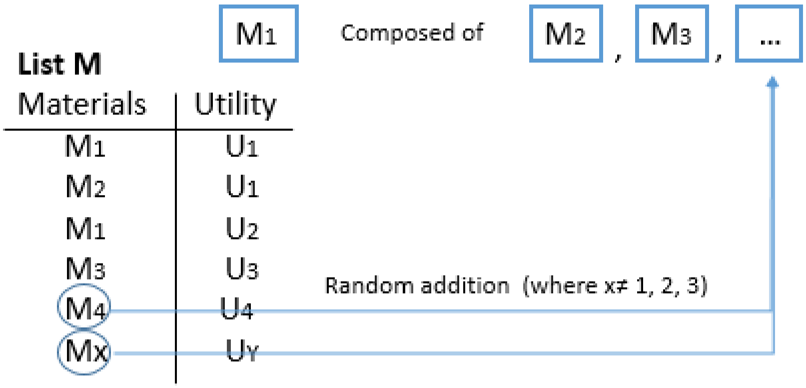


Figure 14 – Add materials, in the second instance, in the Phrase B from the List M.

Other method of the SCAMPER technique to adapt to this architecture is Adaptation. In this case the goal is to make changes in the materials or actions in a way that the initial product can be adapted to perform other actions or to adapt materials to perform the actions of the initial product. For this process there are three types of actions that can be performed using the materials and/or verbs.

The first procedure the generator uses with this method is related with the materials and verbs used in the input in phrases type A. The goal is not to add or change the input using the lists but rather to adapt the materials and actions already used in the phrases A to other subjects. This procedure can only be performed by the system if there is a number of Phrases A larger than one, since the system will, as represented in Figure 15, change the materials and/or verbs within a set of Phrases A. The focus is in adapting the materials and actions to other situations, using the subject as a constant.

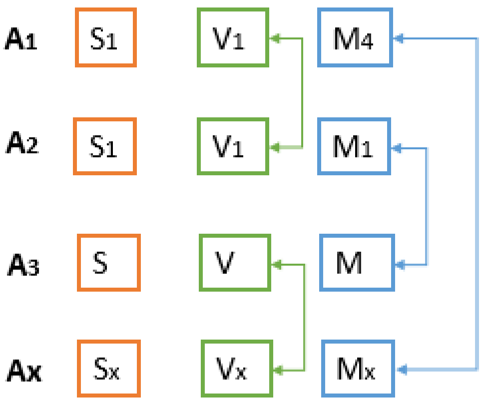


Figure 15 - Change the materials and/or verbs within the Phrases A.

The second action to take into account is centred in phrases type B and the materials chosen in the input. The aim is to change the composition of the products. The system can change the materials within one or more Phrases B, so the primary materials become secondary and the same in reverse. As represented in Figure 16, the system will make these changes so that, in the output, the materials are composed by different elements and, consequently, the solutions become more inventive.

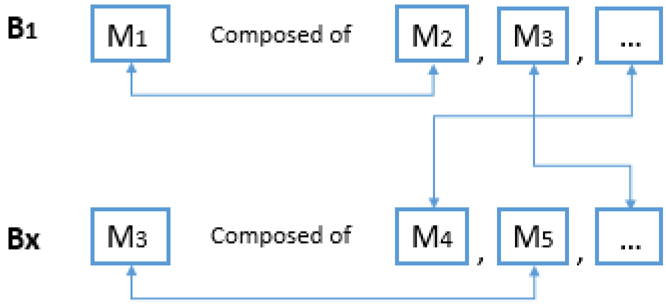


Figure 16 - Change the materials within the Phrases B.

Another action the system can make when using the adaptation method is to join the materials of phrases type A and B to other phrases of these two types of input. The aim is, once again, to change the materials in a way that makes them adapt to other actions and compositions. The system, in Figure 17, will select some of the materials in Phrase A and Phrase B and change them , so that a material that, for instance, is part of the composition, will become a main part of the product. Furthermore the materials in different phrases type A can be added to the phrases type B without an exchange of materials, maintaining the material in phrase A. To perform this action there must be at least one phrase type A and one phrase type B in the input.

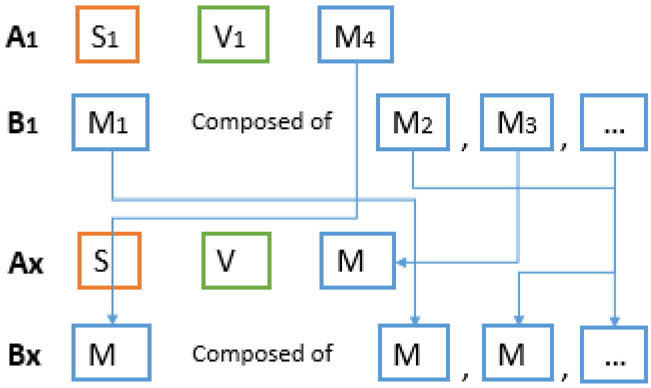


Figure 17 - Join the materials of Phrase A or Phrase B.

The fourth method of the SCAMPER technique is to magnify, minify or modify. When adopting this method the changes are made in the utility of the materials, since the goal is to modify. There is only one action to perform with this method and it will change the materials in two different places.

The action for this method is to change randomly the materials in the Phrase A and the materials of second instance in the Phrase B. The system, as represented in Figure 18, will go through the list of materials (List M) and choose randomly some materials to substitute in the phrases A and B. The system will identify different materials that have the same utility that the ones that are in the input. With this action, the SCAMPER generator will be able to give different combination of materials that can have the same utility. This action is focused on the different materials that have the same utility.

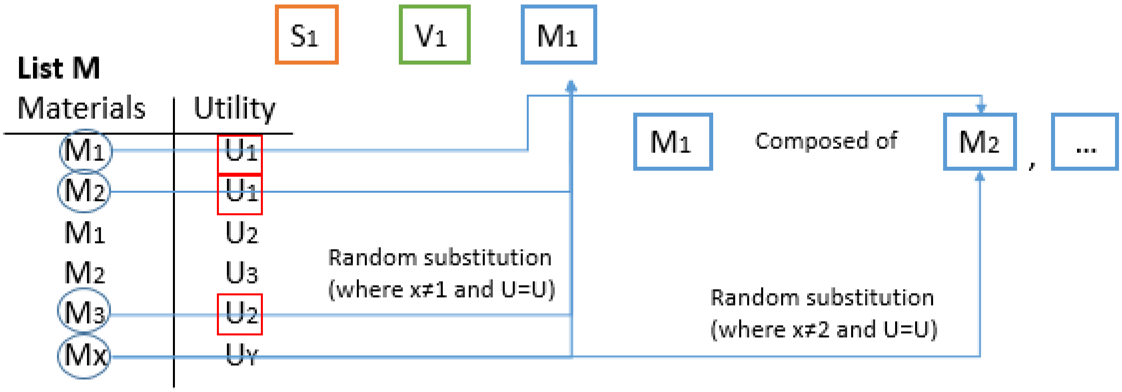


Figure 18 - Change materials in Phrases A and B for materials with the same utility.

Put to other use is the next method in the SCAMPER technique, and there are two actions that can be performed in this method. The goal is to change the aim of the input, the actions it performs and the utility it has. The main changes will occur in the utility and in the verbs in the different types of phrases. These two actions will make the output change according to the essence of the method of put to other use.

The first action is related to the verbs in Phrase A. The aim is to change the action of the problem putting the subject and materials to different uses. The system, as represented in Figure 19, will randomly look and find verbs in the List V that are not the same as the one that is already in the input, and substitute the input verb with these new verbs creating new phrases. The only focus of this procedure is in the verbs and they can be changed regardless of their opposite.

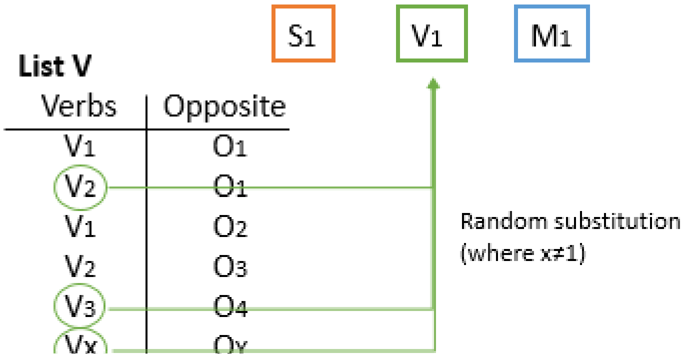


Figure 19 - Change randomly the verbs in Phrase A for another from List V.

The second procedure of this method to be applied by the system relates to the utility of the different materials. The goal here is to change the utility of the materials so that it can give new ways to use the materials. The system, in Figure 20, will go through the first column of the list of materials (List M) and find the same material as the one that is in the input in Phrase C. It then substitutes the utility, in the second column, with the ones that correspond to the material in the input, without repeating the one that is already there. The focus of this action is in the utility and the materials, as the system is looking for new functions of that material.

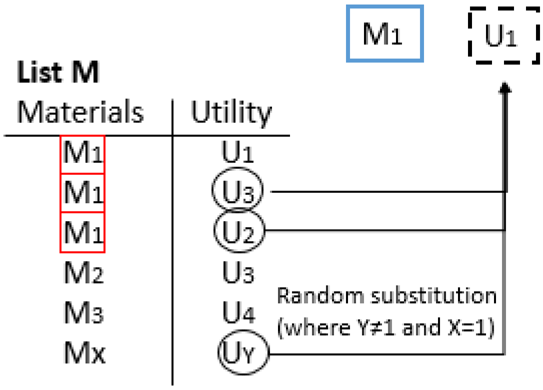


Figure 20 - Change the utility in Phrase C with a different utility of the same material.

The next SCAMPER technique method is eliminate. There are two actions for the system to perform within this method. The impact of these actions is in all of the elements in the system, regardless of their origin and according to the essence of the method eliminate. The goal is to eliminate parts of the input so that in the end the output becomes something different in terms of materials, actions, utilities or subjects.

The goal of the first action in this method is to change the composition of the different products. In order to do that, the system will eliminate the materials in Phrase B. The rules for this elimination are: the Phrase B has to have more than one material of second instance on the input; and it can eliminate a random number between one and the number of second instance materials minus one, so it can not eliminate all the materials of second instance. The system, Figure 21, will go through all the Phrases B on the input and eliminate a number of materials of second instance. It is important to notice that the materials are also eliminated in a random order.

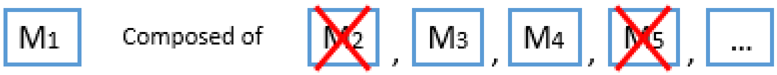


Figure 21 - Eliminate one or more materials of second instance in Phrase B.

In this action, the system will also need to modify the phrases type A, and consequently the subject, verb and materials. The goal is to eliminate parts of the input so that the system outcome becomes different in the various situations. To accomplish this goal, the system, in Figure 22, will recognize the Phrases A and eliminate a pool of arbitrary phrases, in a random number. The rules for this procedure are the fact that the system can never eliminate all the phrases type A, as well as the fact that the number of phrases to eliminate is small and dependent on how many phrases type A the input has, so the system will eliminate a number of phrases between one and the total of Phrases A of input minus 1.

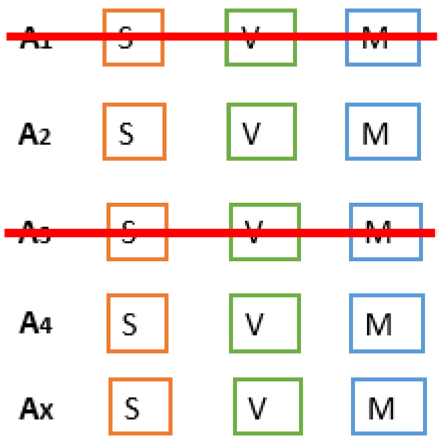


Figure 22 - Eliminate a pool of Phrases A.

The last method in the SCAMPER technique is reversing and, as the name demonstrates the goal is to transform the input into their opposite. In the system there is only one action to perform using this method, which will handle the verbs, changing them. The goal is to substitute the verbs to transform the actions the final product produces, changing the main task to perform.

The procedure in this final method is to change the verb in phrases type A, converting them on their opposite. The system, in Figure 23, will identify the verb in Phrase A and look for the same verb in the column of verbs in the List V and identify their opposite. The SCAMPER generator will then substitute the verbs in Phrase A with the opposites found in the column of opposite in the List V. The goal of this action is to overturn the action in the original input and transform it into a different outcome, comparing it to the action made in the SCAMPER technique.

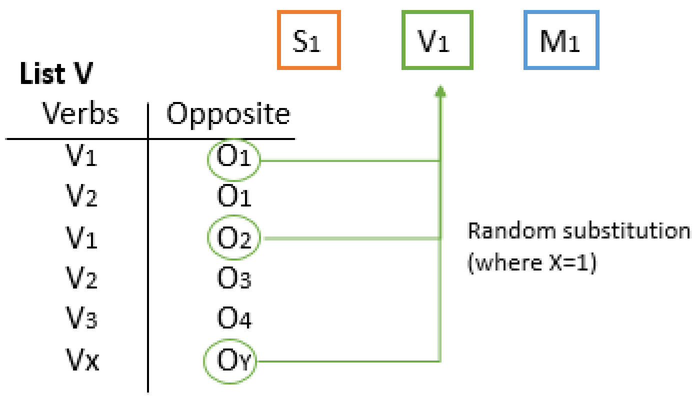


Figure 23 - Substitute a verb from Phrase A for the opposite verb.

All of the actions of each methods can be performed all the time, one time, or none. The system will randomly choose what actions to perform and in what order they are performed, but at least one of the methods has to be performed to use the SCAMPER generator.

The output is organized by sets of phrases with the same structure as the input. For instance if the user inputs ten phrases, the output will be a selected number, larger than one, of set of phrases that were changed by the system. The work in this thesis raised some questions about the analysis of the output, Figure 24 represents the output presented to the user.

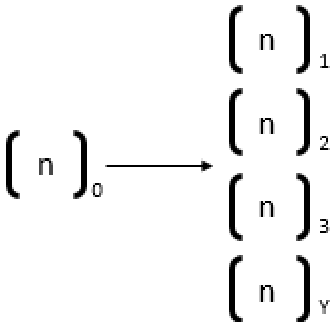


Figure 24 – Diagram of output of the CIS.

The number of sets of phrases in the output is chosen by the user in the input, to facilitate the analysis of the answers. The answers are provided in sets of phrases and the number of sets is a result of the number of times the system make separate changes in the input. That way the user will receive the number of output that is possible for him to analyse.

It is important to notice that the system may not give valid answers for the problem, as the system only gives multiple random answers that later on are presented to the user. As explain the system can give valid or invalid answers and, within the valid answers, they can be direct or indirect outputs of the system. As such, an analysis of the answers has to be made.

4.2 Hypothesis

To demonstrate the usage of the architecture, and also to make a first assessment of the artefact, we choose to use some hypothesis and examples to demonstrate in what contexts it can be used.

The input for the hypothesis do not represent a real problem, and consist only in an association of words that may or may not represent a real product or action.

These examples were made without access to a system. The list of verbs and materials were retrieved from different places on the internet and the dictionary, and the changes were chosen randomly using Microsoft Excel© tools. Since there is no access to a system, all the actions were randomly used in number and the output is also a random usage of the architecture of the system.

4.2.1 Input

A. Person spins plastic

A. Pen writes paper

B. Fabric composed by velcro, plastic

B. Glass composed by hardwood, metal, plastic

C. Hardwood furniture

C. Plastic bottles

And the output number is one.

4.2.2 Lists

The next figure (Figure 25) shows the examples of the list used in this hypothesis theory.

Subject
Plate
Glass
Phone
Spoon
Table
Botle
Chair
Pen
Sisors
Bag
Wallet
Sheet
Watch
Person

Materials	Utility
Velcro	Clothes
Magnet	Electronics
fabric	Clothes
Plastic	Botles
Plastic	Magazines
Foam	Matresses
Metal	Electronics
Plastic	Electronics
Brick	Houses
Hardwood	Furniture
Softwood	Furniture
Marble	Kitchen
Metal	Kitchen
Glass	Cups
Glass	Botles
Paper	Magazines

Verb	Opposite
Write	Read
Agree	Disagree
Wear	Uncover
Appear	Disapear
Spin	Straighten
Arrive	Go
Ask	Answer
Attack	Defence
Build	Destroy
Wear	Refuse
Close	open
Spin	Untwist
Create	Distroy
Destroy	Constroy
Write	Ignore
Like	Unlike
Offer	Refuse
Open	Shut

Figure 25 – Example of lists of verbs, materials and subjects.

4.2.3 SCAMPER Generator

The output of the SCAMPER generator will be, for example:

Substitution

Person spin Metal

Pen write softwood

Fabric composed by hardwood, glass

Glass composed by foam, metal, marble

Sheet spin plastic

Scissors write paper

Combination

Fabric composed by velcro, plastic, metal

Glass composed by hardwood, metal, plastic, glass, softwood

Addition

Person spin fabric

Pen write plate

Wood composed by fabric, glass

Glass composed by foam, fabric, marble

Person spin glass

Fabric composed by wood, marble, plastic

Modify (Magnify/Minify)

Person spin metal

Pen write plastic

Fabric composed by softwood, plastic

Put to other use

Pen build paper

Person close plastic

Plastic Magazines

Elimination

Pen writes paper

Fabric composed by plastic

Glass composed by plastic

Reverse

Person untwist plastic

Pen ignore paper

The next step consists in selecting the phrases that are valid and understanding which of these are valid answers and direct or indirect solutions for the problem.

5 EVALUATION AND DISCUSSION

For the evaluation of the artefact, we chose the focus group method, as it is a form of analysis using a qualitative method. The group interaction is important to create a discussion and promote shared opinion, this way generating a complex evaluation with the input of every party.

5.1 EVALUATION

The evaluation of the artefact was made in three steps: the first step is to prepare guidelines for the focus group; the second step is to execute the meeting; and the third and final step is to analyse the results.

The meeting was made in six stages. The first stage is the identification of the participants (this stage was made before the meeting). Secondly, the SCAMPER technique was presented and thirdly the introduction to the Creative Information System was made. The fourth stage is the explanation of the solution to the group, and the fifth stage consisted in asking question to the participants. The final stage is the collection of the suggestion made by the participants.

In the identification of the participants (Annex 1), it is important to take into account not only their names and the institution that they represent, but also the field they familiar with. All of the participants should have different backgrounds so that the discussion can be open to different ideas. As organiser of the meeting, the writer of the study – Rute Lopes, must provide and present the explanation of the study, answer any questions, and raise discussions and shared opinions between participants asking questions about the artefact.

The second, third and fourth stages are presentations of the work. The presentation of introduction and explanation of the topics is attached in Annex 2. Then, the collection of the suggestions is made during the meeting for subsequent analysis.

The final phase of the evaluation is the analysis of the result of the meeting, and it is done in two steps. The first step is to do a report of the focus group with all of the insight that was given by the participants and, afterwards, to do an analyses of the results and suggestions made by the participants in the meeting.

5.2 DISCUSSION

The focus group took place on May 15th 2017, at NOVA Information Management School in Lisbon. The goal of the meeting was to understand if the solution proposed in chapter 4 of this thesis followed the matrix of the SCAMPER technique and the rules of an information systems architecture.

Vitor Santos, Guilherme Vitorino and Henrique Mamede participated in this focus group. Vítor Santos is the thesis supervisor, and helped with explanations of the artefact. Guilherme Vitorino is professor at bachelor and master levels in design thinking, marketing and innovation in NOVA Information Management School and tutor at a doctoral level. Besides he has also more than 15 years of career in senior Marketing positions in several industries and different countries. Henrique Mamede is a specialist in information systems architecture and professor for more than 15 years in the department of science and technologies of Universidade Aberta. He has also written many articles in the area of information system, including CIS, and worked in different industries in the area of IT.

After the introductions of the participants, brief comments were made on the SCAMPER technique, since both participants had knowledge on the topic. The meeting advanced to a more specific conversation on CIS, and a more detailed explanation of the artefact.

The next step consisted in questions for the participants. It focused in four topics: importance and utility, replication of the technique, usability of the tool, and suggestions/feedback.

In the first topic, professor Henrique Mamede said there is a large interest in this type of work for the different techniques, as there is some difficulty in their direct application due to the possibility of distortions. He also emphasized that there is an increasing importance in having more information in a more direct and automatic way and that this tool would possible contribute to this.

As for professor Guilherme Vitorino, he felt like there is an extreme importance for this type of systems, since it can generate a set of solutions and it might lead to a global optimization of the technique. However, he had some doubts about the practicality of the system when using a group of people. He believed that it could become a barrier to a group dynamic because it does not seem to allow progressive discussion between people.

The second regarded the representation of the SCAMPER technique in the artefact. They both agreed that the artefact represents the SCAMPER technique, even though there were some doubts about how the method of elimination worked. After some explanation, it was agreed that the artefact replicates the technique.

As for the usability of the tool, there were doubts on how the input is made, since it may take some time to insert all the necessary elements for a precise answer of the system. Another doubt that was raised was how long would take for the system to present the answers, this question was fast answer since it is an automated system it has no problem in giving random answers fast. Regarding the output the question was what is the number of solutions presented by the system.

These issues were discussed and the conclusion reached that the more specific the problem (with more elements), the more time consuming it will be for the user to insert the input. At this point some suggestion were made, for example joint web-descriptions with crowdsourcing or using tools of open code with Google© and voice recognition or translation. Finally regarding the output, it was settled that it has to exist such a number of output that can be analysed by the user, thus making it necessary to include an output diagram with a random number of output in Chapter 4.

The participants made also other suggestions on future applications for this field. The system could be self-learning, especially for the output, so that it would not give physical impractical answers (using feedback from the user), meaning that the system was also considered ideal for artificial intelligence. Moreover in terms of context, it was felt that the user should be able to choose a context between services or industry. That way, the solutions could be more suitable with the situation, as the system would have different lists and choose the more appropriate one.

In the end of the focus group, some advices were given concerning the importance of the pitch presentation, in particular the importance of the system on the market, that way ensuring the involvement of a group in business.

5.3 Global appreciation

The parties showed a lot of interest in the solution and agreed on the importance of a system able to replicate the SCAMPER technique. We must state that this is a work on a conceptual level, for that reason the suggestions for future work must be acknowledge, but at this point it will not result in direct changes in this work.

Some of the questions that were raised in this focus group were important to develop and redesign parts of this work and all recommendations were taken into account. Segments of this suggestions were identified as important to consider in the future work and essential to understand in what else can the system become. With special attention to the guidance on the output, some changes were made in chapter 4 of the thesis, with the introduction of a diagram of output that, it is our belief that will allow the analysis of answers in reasonable amount of time.

Both parties gave different perspectives on the system, which lead us to understand that the artefact can reach different types of people. On one side Guilherme Vitorino showed how could the system be functional in focus group and focused more in the practical side of the system giving also some insight in the usage for marketing. On other side Henrique Mamede focused more in what the future of the system could be, giving a vision of the conceptual part of the system and the usage it can achieve.

The feeling at the end of the focus group was that, not only we achieved the goals of the meeting by the answers and suggestions made, but also that the work done can be put into practice. The crucial enthusiasm that the parties demonstrate in this meeting made us understand that the work presented in this thesis is relevant and can become a great functional system in the future.

6 CONCLUSIONS

6.1 SYNTHESIS OF THE DEVELOPED WORK

The main goal of the thesis was to suggest an architecture for a creative information system that can replicate the SCAMPER creativity technique. We focused primarily on the issues of automation of the cycle, the necessary inputs, the methods in SCAMPER technique, the type of output and the basic rules of an architecture system. We believe we were able to achieve relevant conclusions on these topics and answered the questions that were initially proposed, thus fulfilling our goals.

We started by defining creativity as a process that results in something new. The importance of creativity and innovation in current society was also discussed, as well as its increasing influence in business, especially in the creation of new products/services.

It was also pointed that an individual that is more propitious to have a creative thinking is expected to have a fluid, flexible and original thought. Nonetheless, there are techniques (patterns and tools) that can provide ways to solve problems moving from a known idea to a new one, a practice known as lateral thinking.

Creativity techniques are methods that trigger creative thoughts leading to creative solutions. There are a lot of creativity techniques scattered around different categories. The thesis focus on the SCAMPER technique, which reorganizes and combines different information using seven different methods that make the acronym SCAMPER. These methods are put into practice using different types of questions.

Using examples of previous studies, it was pointed out that it is possible to use an information system that supports automatic functions of the creative process to implement different creativity techniques. The name of this type of information system is "Creative Information System", and the system will recreate the original creativity technique and automate it. The conclusion of these studies was that there is the possibility to automate any of the creativity techniques.

In the new creative information system architecture for the SCAMPER technique there is three different steps that allow the user to receive answers that may be valid (direct or indirect) or not valid. The input is made up of four different elements and composed in three different types of phrases. The SCAMPER generator reproduces every method in the SCAMPER technique using the input given by the user and three different lists of subjects, materials, and verbs in different ways. The generator is then divided in the different methods and each one of them has actions that are equivalent to the actions of the seven methods in SCAMPER. The output is finally organized in sets of phrases in the same structure of the ones in the input.

This conceptual model of an information system architecture based on CSI and on the SCAMPER creativity technique is a model that not only satisfies the goals that were proposed in the begging but also prompted some experts in the area.

6.2 LIMITATIONS AND RECOMMENDATIONS FOR FUTURE WORK

The biggest limitation we encountered in making and validating the thesis was the fact that the architecture created is a conceptual model, i.e., a representation of a system. This becomes a limitation when proving that the architecture is valid, since there is no way to put the architecture through a conclusive test. This adds to the fact that in the phase of conceptualizing it was also difficult to formalize the architecture.

In the topic of future work there is a lot that can be further studied. For example, the system can be a web-based crowdsourcing platform to be used in groups, or a system to use with artificial intelligence with the ability to learn the validation of the different answers. Going away from artificial intelligence, the system can also be reformulated to have pre-chosen contexts. One other obvious improvement to this thesis would be the construction of the system having the architecture model as a base. This type of work can also be applied with certain modifications to various types of creativity techniques.

REFERENCES

Adams, K. (2005). The Sources of Innovation and Creativity. *National Center on Education and the Economy (NJ1)*.

Baecker, R. M. (1995). *Readings in human-computer interaction : toward the year 2000*.

Bilton, C. (2007). *Management and creativity : from creative industries to creative management.* MA: Blackwell Publishing.

Bono, E. De. (1989). *Lateral Thinking*. Penguin Books.

Crawley, E., Cameron, B., & Selva, D. (2015). *System Architecture: Strategy and Product Development for Complex Systems*.

Cross, N. (2011). *Design thinking : understanding how designers think and work*. Berg.

Dartnall, T. (Ed.). (2013). *Artificial Intelligence and Creativity* (Vol. 17). Dordrecht: Springer Netherlands. http://doi.org/10.1007/978-94-017-0793-0

Eberle, B. (1996). *SCAMPER - Games for Imagination Development*. Prufrock Press Inc.

Eppinger, S. D., & Browning, T. R. (2012). *Design structure matrix methods and applications*. *Engineering systems*.

Guilford, J. P. (1986). *Creative talents: Their nature, uses and development*. Bearly limited.

Haren, V. (2011). *TOGAF Version 9.1*. Van Haren Publishing.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75–105. http://doi.org/10.2307/25148625

Mcfadzean, E., & Waterman, R. (1998). The Creativity Continuum: Towards a Classification of Creative Problem Solving Techniques. *Creativity and Innovation Management*, *7*(3), 131–139. Retrieved from http://s3.amazonaws.com/academia.edu.documents/39834075/McFadzean_1998b.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1488542079&Signature=pedMWWucl6ujiMgHHIZOG4EfxSQ%3D&response-content-disposition=inline%3B filename%3DThe_Creativity_Continuum_Towards_

Michalko, M. (1993). Thinkertoys: A handbook of business creativity for the 90s. *Long Range Planning*, *26*(3), 142. http://doi.org/10.1016/0024-6301(93)90038-H

Oxford Dictionary of English. (2017). Oxford University Press.

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems*, *24*(3), 45–77. http://doi.org/10.2753/MIS0742-1222240302

Santos, V., & Mamede, H. (2005). Uma Arquitectura para um Sistema de Informação Criativo.

Santos, V., & Mamede, H. (2006). Um Sistema de Informação Criativo baseado na técnica de criatividade whiteboard.

Santos, V., & Mamede, H. (2008). Creative Information Systems. In *Encyclopedia of Internet*

Technologies and Applications (pp. 126–131). IGI Global. http://doi.org/10.4018/978-1-59140-993-9.ch019

Spewak, S. H., & Hill, S. C. (1993). *Enterprise Architecture Planning, Developing a Blueprint for Data, Applications and Technology*. QED Information Sciences, Inc.

Toubia, O., Simester, D., Frederick, S., Prelec, D., Ariely, D., Wernerfelt, B., … Shampagn, K. (2003). Idea Generation, Creativity, and Incentives.

Young, M., Binning, C., & Young, M. (1997). *Motivating people: using management agreements to conserve remnant vegetation;rft.aufirst*.

Zachman, J. A. (1987). A Framework for Information Systems Architecture. *IBM Systems Journal*, *26*(3).

Zusman, A., & Zlotin, B. (1998). Overview of Creative Methods. *The TRIZ Journal*. Retrieved from https://triz-journal.com/overview-creative-methods/

ANNEX 1 – BIOS OF THE FOCUS GROUP PARTICIPANTS

Vitor Santos

Vitor Santos, is an invited Assistant Professor at NOVA Information Management School (NOVA IMS) of Universidade Nova de Lisboa and at European University, teaching "Information Systems", "Artificial Intelligence", ”Compilers” and ”Digital Systems” courses in Computer Science and Informatics Engineering Degrees. Before that, he was an invited Professor Trás os Montes e Alto Douro University and Minho University. This year he'll complete 23 years teaching in higher education.

He integrates several national and international conferences scientific committees and has authored several academic publications (~90).

He was the Microsoft Portugal Academic Computer Science Program Manager for almost a decade. Before that he occupied senior management positions at Santander bank companies and has developed Computer Engineering activities for about 15 years (>40 IS projects).

Vitor Santos holds a PhD in Science and information and Technology Systems from University of Minho, a B.Sc. in Informatics Engineering from Cocite, a Postgraduate course in Computer Science from Science Faculty of Lisbon University, a M.Sc. in information Systems Science from University of Minho, a D.E.A. from University of Minho and a Computer Specialist title from polytechnic institutes Guarda, Castelo Branco and Viseu.

Vitor is currently working on a second PhD in Culture and Literature at FL-UL.

Guilherme Vitorino

Guilherme Martins Victorino is a invited assistant professor at NOVA Information Management School (NOVA IMS) of Universidade Nova de Lisboa in the areas of Marketing, Innovation and Knowledge Management and coordinates two Post Graduations in the areas of Health and Information and Safety. He is also coordinator of the Doctoral course of Design Thinking at Universidade Nova de Lisboa and has accompanied PhD students in disruptive innovation processes.

Guilherme Vitorino has a career of more than 15 years as Marketing Manager in the sectors of Health, Media and Telecommunications being a certified trainer in Design Thinking and Change Management, having had opportunity to work on new approaches to innovation and change management in reference companies in Portugal And in Brazil and the United States in specific organizational challenges related to commercialization, marketing, process redesign and capacity building using advanced simulators.

Henrique Mamede

Henrique Mamede is an assistant professor at Universidade Aberta in Lisbon in the Department of Science and Technology. He has taught in higher level education since 1994, having taught at several universities and colleges. During this time he has authored several academic publications.

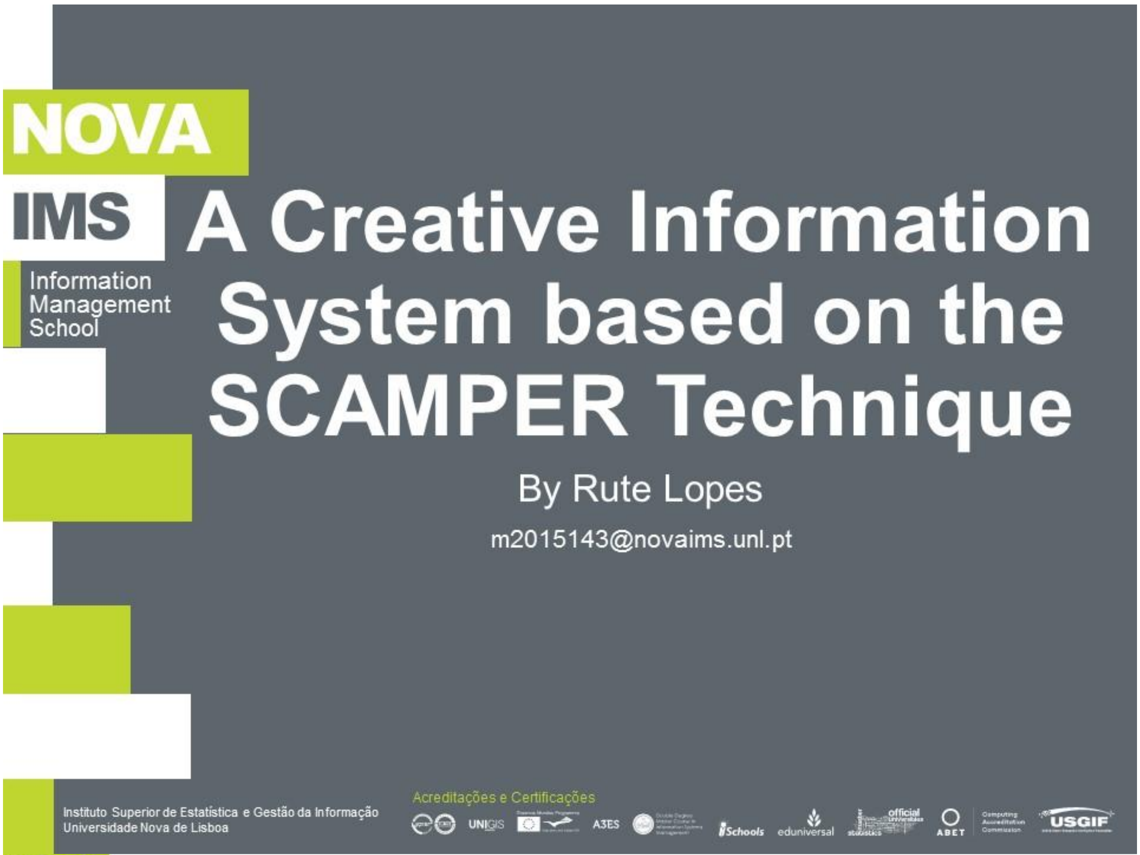
He is member of the direction of the Order of Engineers, College of Informatics. He was a founding member and director of the Association for the Promotion and Development of the Information Society.

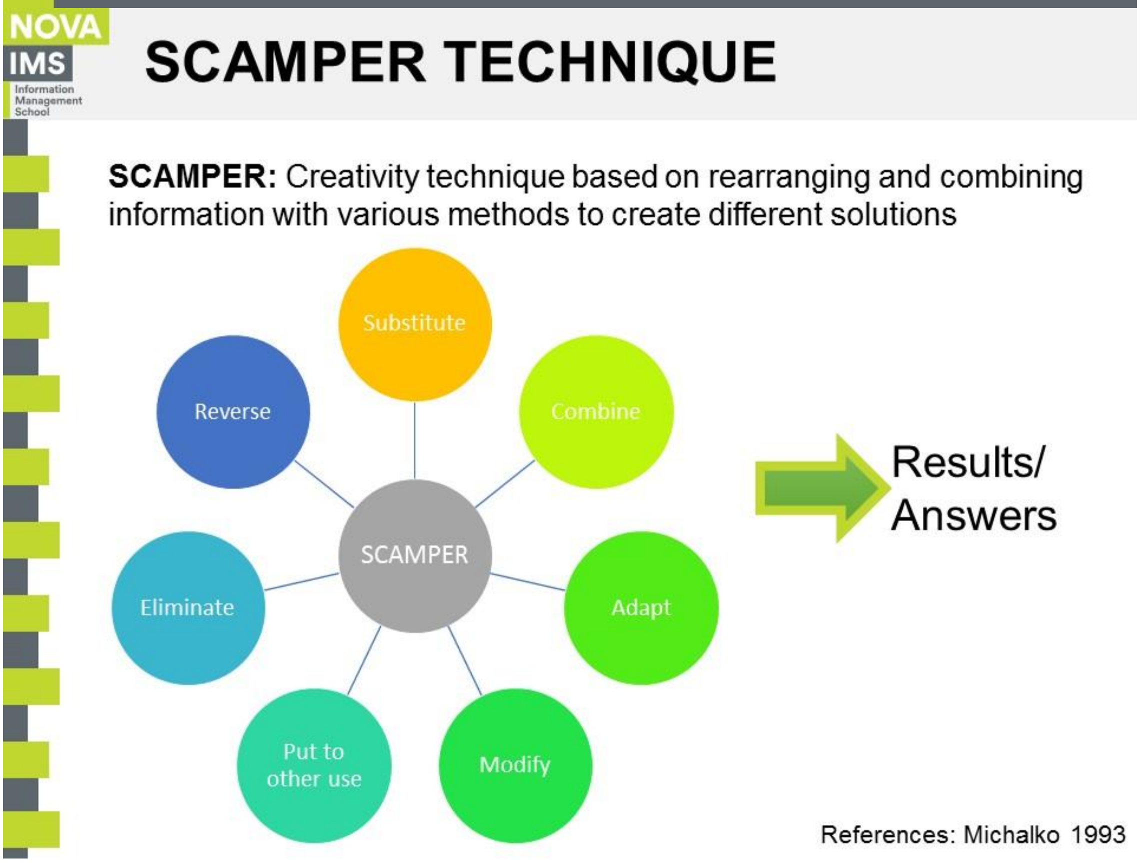
He has worked as an independent consultant in information systems and technologies, in medium and large projects, both for private and public organizations.

He is a member of the scientific program of several conferences and reviewer of the Journal of Computer Science of the Open University.

Henrique Mamede holds a Doctoral degree in Information Systems and Technology, a Masters in Informatics a B.Sc. in Informatics Engineering from Cocite.

ANNEX 2 – PRESENTATION USED IN THE FOCUS GROUP





CREATIVE INFORMATION SYSTEM

- **Creative Information System** – Information System that facing a problem (context), and using an adjusted creativity technique, is able to generate automatically a set of potential innovation of a problem

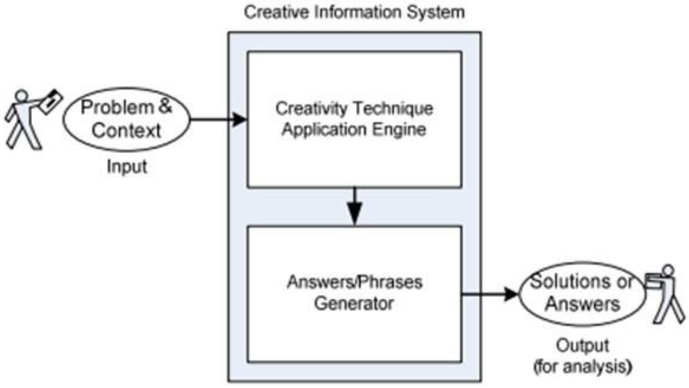
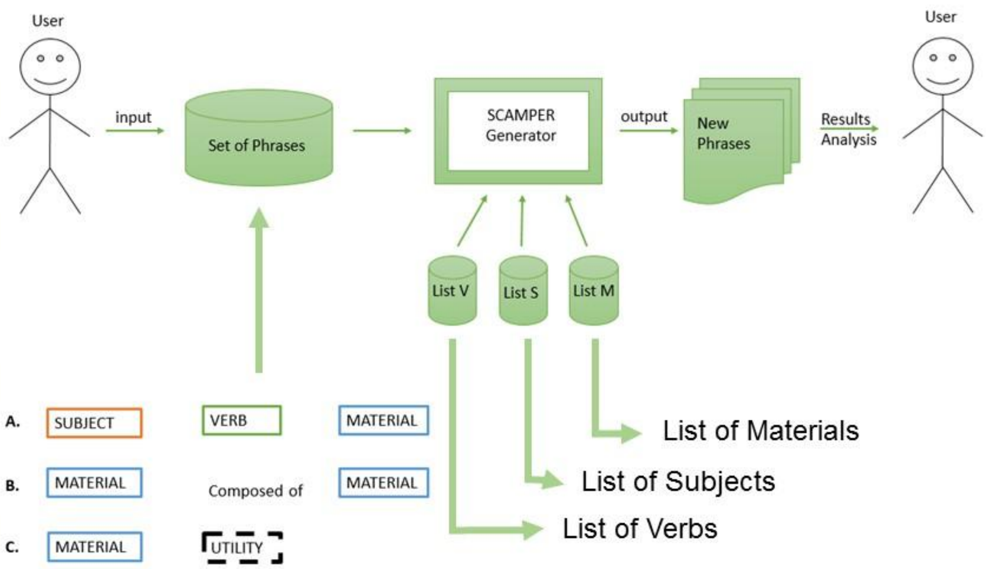


Figure 1 - General Scheme of a CIS

References: Santos 2013, 2005, 2008

ARTIFACT – CIS for SCAMPER



NOVA IMS Information Management School

ARTIFACT – CIS for SCAMPER

Substitution:

S1 V1 M1

List M

Materials	Utility
M1	U1
M2	U1
M1	U2
M2	U3
M3	U4
Mx	UY

Random substitution (where x≠1)

1. Change the material of Phrase A for another of the List M

2. Change the second instance material in Phrase B for other from the List M

3. Substitute the subject in Phrase A for other from the List S

M1 Composed of M2

List M

Materials	Utility
M1	U1
M2	U1
M1	U2
M2	U3
M3	U4
Mx	UY

Random substitution (where x≠2)

S1 V1 M1

List S

Subject
S1
S2
S3
Sx

Random substitution (where x≠1)

NOVA IMS Information Management School

ARTIFACT – CIS for SCAMPER

- **Combination**

M1 Composed of M2, M3, ...

List M

Materials	Utility
M1	U1
M2	U1
M1	U2
M3	U3
M4	U4
Mx	UY

Random addition (where x≠ 1, 2, 3)

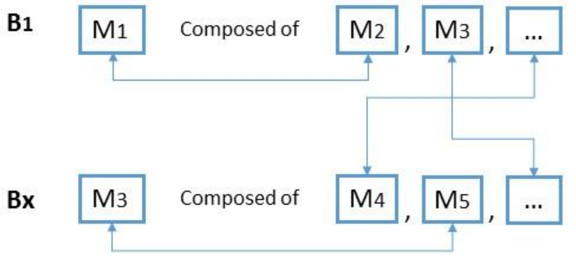
1. Add materials, in the second instance, in the Phrase B from the List M

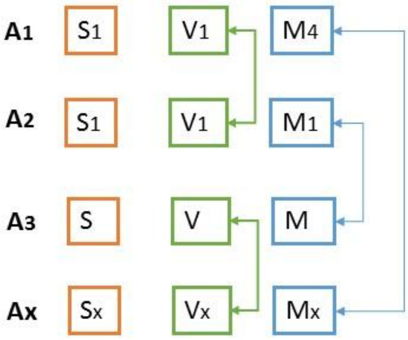
NOVA IMS Information Management School

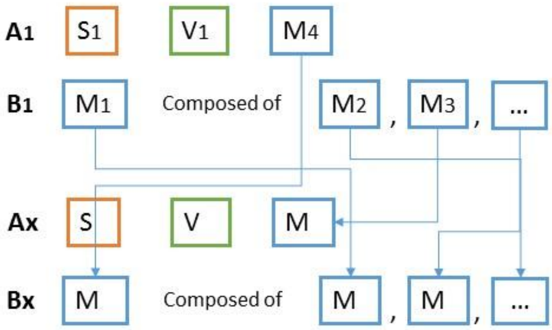
ARTIFACT – CIS for SCAMPER

- **Adaptation**

1. Change the materials within the Phrases B
2. Change the materials and/or verbs within the Phrases A
3. Join the materials of Phrase A or Phrase B





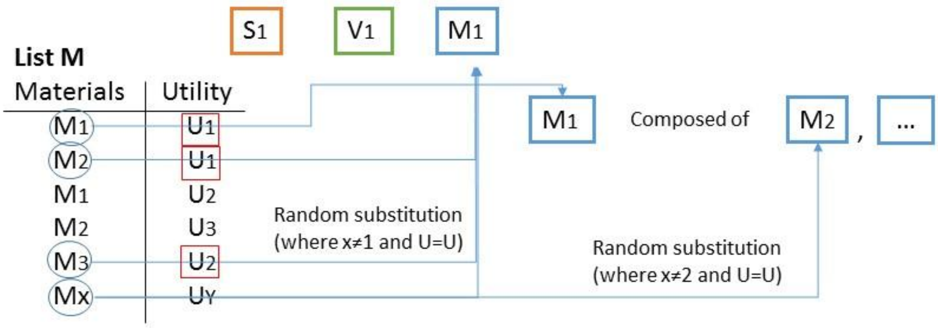


NOVA IMS Information Management School

ARTIFACT – CIS for SCAMPER

- **Modification (Minify/Magnify)**

1. Change materials in Phrases A and B for materials with the same utility

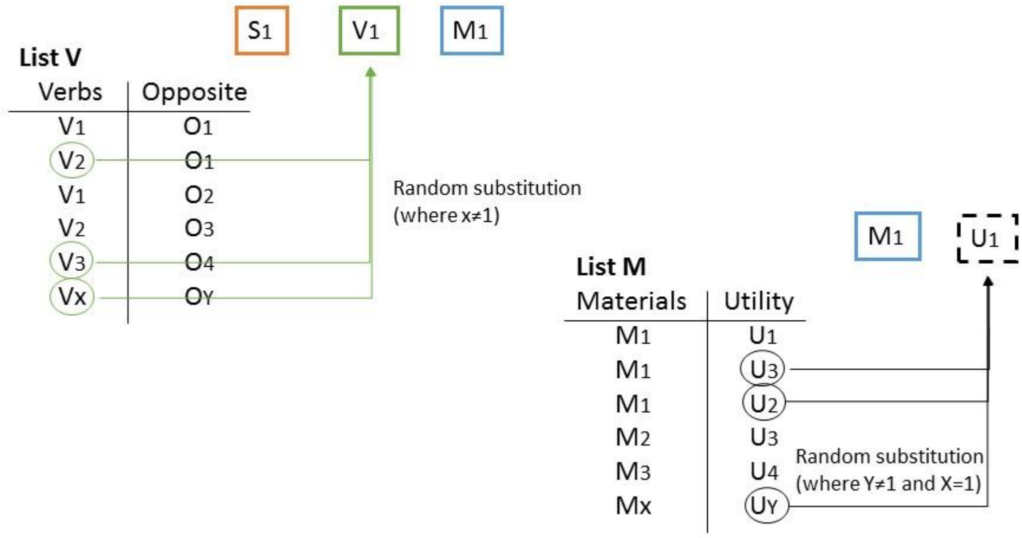


ARTIFACT – CIS for SCAMPER

• Put to other use

1. Change randomly the verbs in Phrase A for another from List V

2. Change the utility in Phrase C with a different utility of the same material

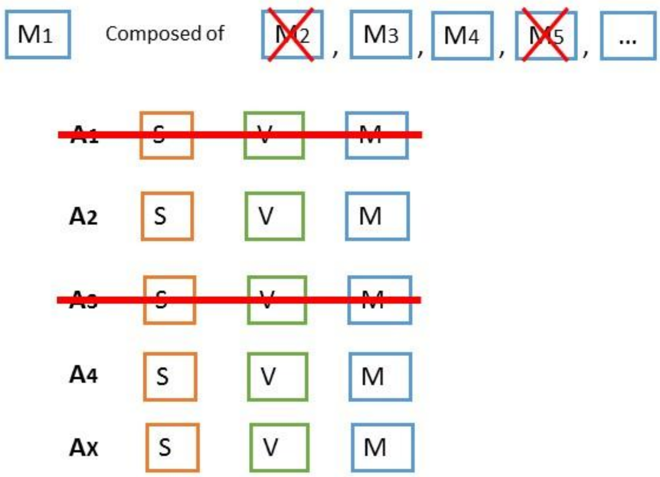


ARTIFACT – CIS for SCAMPER

• Elimination

1. Eliminate one or more materials of second instance in Phrase B

2. Eliminate a pool of Phrase A

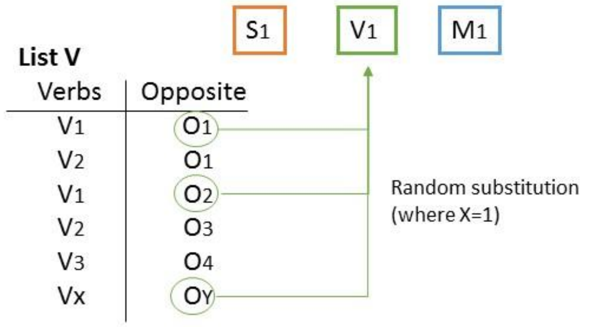


NOVA IMS Information Management School

ARTIFACT – CIS for SCAMPER

- **Reversion**

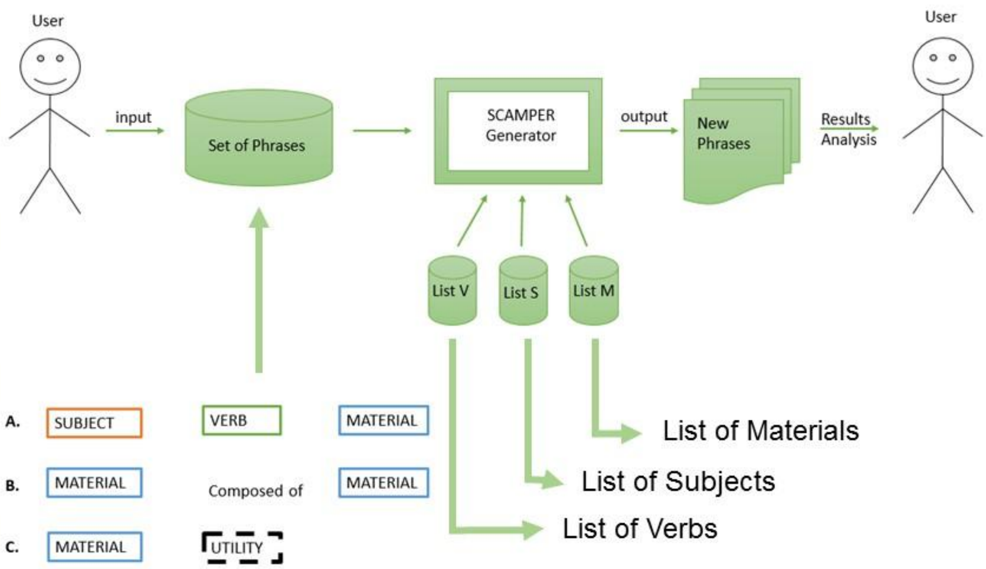
1. Substitute a verb from Phrase A for the opposite verb



Verbs	Opposite
V1	O1
V2	O1
V1	O2
V2	O3
V3	O4
Vx	OY

NOVA IMS Information Management School

ARTIFACT – CIS for SCAMPER



Thank You!

Address: Campus de Campolide, 1070-312 Lisboa, Portugal
Phone: +351 213 828 610 Fax: +351 213 828 611

Acreditações e Certificações

Instituto Superior de Estatística e Gestão da Informação
Universidade Nova de Lisboa