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CAN ARTIFICIAL INTELLIGENCE SUPPORT CREATIVE PROBLEM-SOLVING?

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Abstract

The process of creative problem-solving and stimulating innovation in organizations is long, costly, and high-risked. While risk is by definition included in the creative process, ideation can cut down time and costs of fostering innovative solutions. Inventive systems such as TRIZ (*Теория решения изобретательских задач*), CPS (Creative Problem-Solving) or DT (Design Thinking), have paved the way in supporting creators, designers, inventors and scientists in innovative solutions seeking. However, only a few of these systems are scientifically proven to be effective. It seems that CPS, initiated by Osborn, is the best evidence-based inventive system, as well as it is still developed both in empirical research, and in real-life practice (Buijs, Smulders & van der Meer, 2009; Isaksen & Treffinger, 2004; Puccio, Murdock & Mance, 2005). The main assumption of CPS is that creating innovative ideas is a phase process, i.e. following a certain universal pattern. Baer and Kaufman (2005) argue that CPS involves various skills, especially domain-specific creativity (i.e. related to expert knowledge), which is embedded in general abilities such as intelligence and motivation. However, the use of CPS requires high-class experts who are not only specialists in a specific field but also trained in creative problem-solving. Regardless of the costs, it is a bottleneck for the application of such inventive techniques on a larger scale. Therefore, new approaches in development of AI-powered creative tools to assist creators and designers seem to be emerging. One of them is @CREATE – an expert inventive system based on CPS and supported by artificial intelligence. The idea of @CREATE will be presented by the authors.

Keywords: *Creativity, creative problem solving, innovations, antifiction intelligence.*

1. Creative problem-solving in practice

The process of creative problem-solving and searching for innovation in business is ineffective, lengthily, and costly. Achievements of companies such as Apple or Tesla are enviously looked at and the careers of Steve Jobs or Elon Musk are analysed, concluding that their success cannot be simply copied. And rightly so, because if Steve Jobs wanted to repeat someone's success, he would achieve nothing unique. Innovation cannot be repeated, because it is, by definition, something that has never happened before. However, organizations lack the knowledge of how to foster creativity and stimulate innovation.

Many tools have been developed in the field of invention, such as the widely known brainstorming, which, drawing from tricks observed in the case of outstanding artists, scientists, inventors and entrepreneurs, supports the search for creative solutions (cf. Proctor, 2014). Excellent inventory systems have already been created, such as Altszuller's TRIZ (Теория решения изобретательских задач) and Osborn's CPS (Creative Problem Solving), which paved the way for the conceptual support of creators, designers, inventors and researchers in the search for innovative solutions and creative problem solving. Their effectiveness seems unquestionable (Vernon, Hocking, & Tyler, 2016). Over the past several decades, many variants of this type of systems and marketing strategies have appeared, more or less related to the inventive area. They include, among others: Design Thinking, Crowdsourcing, Customer-Made Approach, Customer Relationship Management, Customer Experience Management, Innovation Styles, Rapid Prototyping, Lean Management, Re-engineering, Six Sigma, Just-in-Time, Automation, User-driven Innovation, Open knowledge/innovation, User Experience, User Interface Design, LEAN START-UP, etc. The problem is that for most of these new ideas no empirical data have been collected to prove if their implementation can significantly increase the effectiveness of the creative outcomes, understood as originality and usefulness of the developed solutions (Carson, 2010).

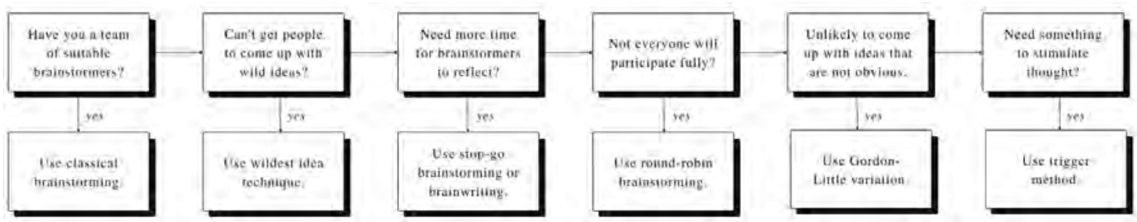
Among the above-mentioned "innovation methodologies", CPS has the strongest scientific base and was developed and tested both in research, and in practice (Buijs, Smulders and van der Meer, 2009; Isaksen and Treffinger, 2004; Puccio, Murdock and Mance, 2005). The elementary assumption of CPS is that the emergence of innovation is a phase process, i.e. following a certain universal pattern. Baer and Kaufman (2005) argue that CPS involves different domains of ability in which domain-specific creativity (i.e. related to expert knowledge) is embedded in general abilities such as intelligence and motivation.

Nowadays, despite the lack of an unambiguous consensus, most researchers in the field of inventions assume that the creative process consists of the following phases: (1) problem situation analysis – the purpose of which is to properly formulate the problem and gather all the information and tools necessary to start generating ideas; (2) ideas generation - the aim of which, in line with the excess strategy, is to bring together as many diverse and original ideas as possible; (3) evaluation and implementation planning – consisting of assessing the developed solutions, and then selecting the solution(s) that meet the assumed boundary conditions for implementation. For many practical problems it is unnecessary to go through all these phases, much less strictly in that order. It has been also pointed out that efficient problem solving requires flexibility (Pretz, Naples & Sternberg, 2003). A full cycle of problem-solving appears to be necessary when dealing with problems new to the individual (Mumford, Peterson, & Childs, 1999). In many other instances, CPS can be used in an interactive and iterative fashion, rather than simply as a linearly ordered set of steps.

2. CREATE expert system

Based on the collected research results, the CREATE Expert System has been developed. It consists of a set of decision trees comprehensively referring to the entire process of generating innovations, taking into account the type of innovation (incremental, radical, process or in the field of services) and phases (analysis, generation and evaluation). The CREATE system includes 26 inventive techniques supporting creative problem solving and the emergence of innovative solutions. An exemplary decision tree dedicated to the generation phase is presented in Figure 1.

Figure 1. Example of Decision Tree for Brainstorming (based on Proctor, 2014, p. 151).



3. @CREATE platform supported by artificial intelligence

Currently, the prototype of the @CREATE platform based on the CREATE Expert System is in the implementation phase. The platform task will be to support generating innovation and problem solving in organizations. The @CREATE platform is going to replace an expert in the field of inventions, suggesting which inventive techniques to use in a specific problem situation and how to put them together in the full cycle of design thinking or problem solving. @CREATE will be based on artificial intelligence solutions. It will allow the accumulation of unique knowledge concerning innovation in organizations thanks to implementing the do-it-yourself idea (DYI) based on the CREATE expert system.

As in any system based on machine learning methods, the key issue in @CREATE is the data used for training and testing of the system, recommending techniques in a creative problem solving field. This type of information will be collected on an ongoing basis from users using the application. We anticipate using the program to collect differentiated data at several stages of interaction. Firstly, the system will use demographic data about the users themselves: their age, gender, position, team size, and others (unchanging or weakly variable data). The engine will also be largely fed with data relating to the problem itself. Users will be asked about the multidimensional characteristics of the problem, including its type, specificity, perceived difficulties, etc., and the expected solutions, i.e. the type of innovation sought, boundary conditions, including solution evaluation criteria, etc.

In the next step, the records for working with a specific method will be included (subjective data). Assessment forms will be displayed in the app when the creative process step is completed. We will ask about the satisfaction with the developed solution, the estimated value of the ideas or the satisfaction with working within the application. Depending on the type of user, the meaning of the answers will be more or less crucial for the recommendation engine (assigning appropriate weights). In the surveys, we plan to include mainly quantitative or ordinal scales, for example Likert's scales or scales with a slider. Such data, in addition to the potential impact on the development of the recommendation engine, will also help us to improve the platform. The last type of data used by @CREATE will be the objective measures of working with specific inventive methods. We are talking here, for example, about the number of solutions developed, as well as time spent in the application. All data will be collected at the application level, encrypted, and sent to the server via a secure connection. The core of the @CREATE system - the recommendation engine, will work there as well. After collecting new information, training and replacement of the engine version will take place.

The recommendation engine will consist of two artificial intelligence models. After collecting the appropriate amount of data, we assume they will be in the form of deep neural networks, but the first experiments will be conducted using more standard methods of machine learning. The role of the first model will be to suggest inventive techniques that can be applied at a given stage of the creative process. At this phase, data characterising the problem and expected solutions will be of key importance. The similarity to the problems solved earlier will be determined (both by a specific user and other people using @CREATE). In turn, the role of the second model will be to personalize and match specific recommendations to a specific recipient and their team, taking into account, among others, demographic data, preferences, level of satisfaction, history of working on problems.

At a given stage, the user will be offered various options to choose from, along with a rationale. The distinguishing feature of our system will be the indication of parameters that contributed to a given recommendation, which will increase the transparency and trust of users. Choosing a particular technique by the user will have an impact on the recommendations in the next steps. The user will also be offered various paths that will allow, for example, to get as many solutions that are significantly different, or one solution, but in the shortest possible time, etc. In the initial phase, to solve the cold start problem, @CREATE platform will work based on the CREATE expert system. Thanks to this, users who solve the problems unknown to the engine will also be able to use the recommendations. Likewise, the expert system will also be used in the initial data collection process itself.

4. Summary

The @CREATE platform will be an innovative solution *per se*, having no counterpart in the world. So far, no one has invented an algorithm to recommend inventive techniques, which in @CREATE will be implemented based on artificial intelligence solutions. Other software supports individual creative techniques (such as brainstorming) or contains a database of techniques, but does not support the decision-making processes. @CREATE will moderate the process of creation, "advising" methods, leading to the implementation of innovative solutions. However, the highest anticipated value and social mission of the @CREATE will be to support the innovativeness of its future users.

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