Simulation for the Common Man: How do We Make M&S Accessible?

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ABSTRACT

Given the power of insight and learning that simulation provides, you might question why simulations are not more widely used. To try and understand this problem, a facilitated workshop was conducted at the MODSIM World Conference & Expo 2018 in Norfolk, Virginia, USA. This paper title is the same title used for this workshop session at the conference and it forms the main question asked of participants. The question was discussed to try and understand how our M&S community can reach new users and decision makers. To make sense of the discussion, a Problem Structuring Method (PSM) was employed. The Strategic Options Development Analysis (SODA) was the PSM used to facilitate the workshop and its resultant cognitive map is presented in the paper. Though the workshop did not provide an answer to how to ensure simulations are more widely used, it did provide insight into what stumbling problems M&S faces. For example, there is a need for easily understandable evidence to show the power of simulation and there are problems with M&S being a multidisciplinary approach.

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INTRODUCTION

There are many papers that talk about the future of simulation (Cheng, Macal et al. 2016, Nelson 2016) but, as Abraham Lincoln once said: "the best way to predict the future is to create it." What can we do as a community to improve our future? How do we make Modeling and Simulation more accessible? Before these questions can be answered, we must first understand our current situation. In an effort to understand our current situation, we conducted a workshop at last year's MODSIM World conference. At this workshop, a score of Modeling and Simulation (M&S) experts convened to discuss the accessibility question of M&S. To enable a structured discussion, a Problem Structuring Method (PSM) was employed. PSMs provide a systematic way to discuss a problem and are designed to avoid some of the pitfalls of an open discussion, e.g., "going down rabbit holes." PSMs also tend to provide a useful visual approach for collecting the information, allowing workshop participants an easy way to review their previously discussed items. The PSM used in this workshop was the Strategic Options Development Analysis (SODA) (Eden 1989, Eden and Ackermann 2001). The output of SODA is a cognitive map, that is, a visual diagram that connects concepts. The majority of this paper is dedicated to discussing the cognitive map and its implications.

METHOD

Strategic Options Development Analysis (SODA) is one of the Problem Structuring Methods (PSMs) (Rosenhead and Mingers 2001). Pidd (2009) defines problem-structuring as "a form of exploration in which the analyst develops a map of what is happening and of what might be done about it" (p. 61). The fundamental importance of SODA is that the method helps individuals to explore the problematic situation before making any decision (Ackermann and Eden 2001). SODA is also a model building and the analysis tool within a social setting (Eden 1988). According to the personal construct theory by Kelly (1955), an individual has different ways to process information. To ensure an efficient problem-solving process, a formal representation of a problematic situation is required (i.e., to make sure that everyone in a group is on the same page). This problem representation can generate shared understandings among people in a group before making an important decision. The outcome of SODA has been widely used as a representation of focusing situations (Ackermann and Eden 2001, Westcombe 2002, Georgiou 2011).

SODA has a cognitive mapping concept as its backbone. A cognitive map is a modeling technique which captures how individuals perceive the situation they are facing. The two main components of a cognitive map are constructs (nodes) and arrows (Eden 1988). A node represents a statement or concept which, in SODA, is written in the form of two contrasting poles: one pole representing the positive part of the concept and the second its psychological opposite. An arrow represents the means-end relationships among nodes. These relationships can be both positive and negative. SODA can create a bigger picture of a focusing situation through a group cognitive map. A group cognitive map is comprised of the individuals' reflections which create a more in-depth understanding of the focusing situation. The map-making process stimulates both discussions and negotiations among people which lead to some form of shared understandings.

The primary purpose of SODA is not acting as a problem-solving tool but rather a reflective device of a problematic situation – reflective problem solving (Eden 1988). A cognitive map not only generates a chain of argument through a means-end format, but it also represents the way individual comprehends a problematic situation. As mentioned,

SODA is designed to help a group of people to generate a form of consensus and commitment to a course of actions through discussions and negotiations – a negotiating device (Eden 1988). In other words, it is a "making-sense" tool.

SODA was used at our workshop as the primary facilitation tool to understand how the M&S community can reach new users and decision makers. There have been concerns that the propagation of M&S has stagnated and there is a need to make M&S more accessible.

RESULTS

To understand the stagnation in the use of M&S, a workshop was conducted with subject matter experts. The workshop was held on the last day (April 26, 2018) of the MODSIM World Conference & Expo 2018 in Norfolk, Virginia, USA. MODSIM conference is a practitioner focus conference with most attendees coming from the public sector (especially the military), and the private sector. Academia is underrepresented that the conference which means that most conference attendees had significant real-world experience, which is ideal for our workshop. Approximately 20 individuals from the conference attend the workshop and where evenly drawn from the public and private sectors. From personal experience of the workshop attendees, an estimate of the medium work-experience within M&S would be 15 years, with some workshop attendee have significantly more experience.

The SODA process was completed over 1.5 hours and the cognitive map output of the workshop is shown in Figure 1. One of the authors, Ying Thaviphoke, facilitated the workshop while Dr. Andrew Collins acted as the scribe. Due to space limitations, the cognitive map had to be constructed over several sheets of flipchart paper. The facilitation team merged these parts into the cognitive map shown in Figure 1 with only a few minor changes and corrections.

As the cognitive map has thirty-two concepts, the authors will not provide a description of each one individually. Description of key concepts is given in the analysis of the cognitive map, when appropriate. The arrows are either blue or orange; blue represents a positive influence between concepts and orange represents a negative influence. Some of the concepts are colored either yellow or green; the authors felt that these concepts were unique to M&S and wanted to highlight them. The remaining concepts could be applied to a variety of different fields, for example, it has been noted in that PSM also lacks good case-studies (Collins, Shull et al. 2018). The map was created in a freeware package called Mental Modeler, which was designed for use with another cognitive mapping PSM called Fuzzy Cognitive Mapping (Kosko 1986) but can be used for SODA also. Mental Modeler is available for use at www.mentalmodeler.org, and it was developed by a consortium of U.S. universities and industry partners.

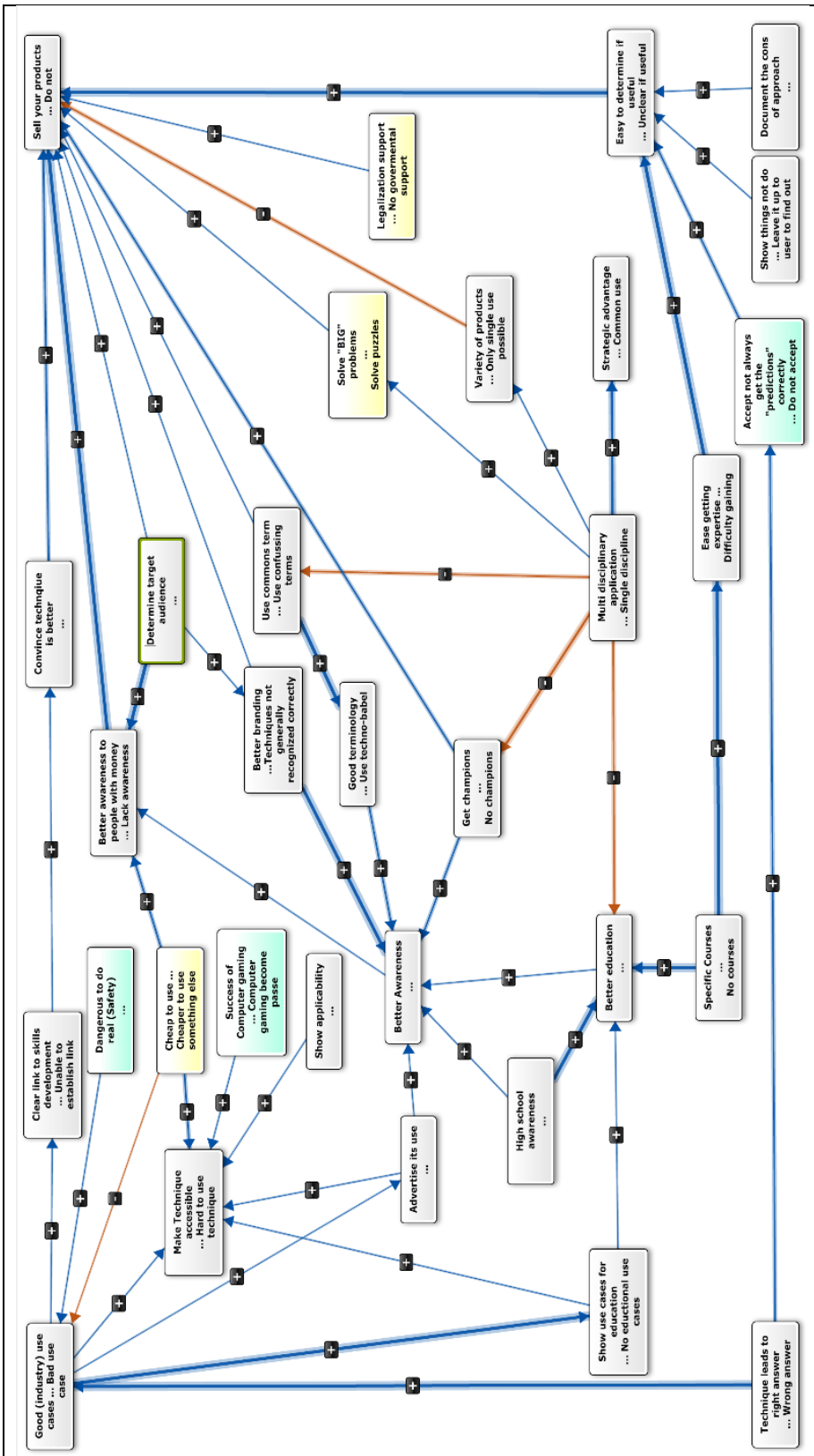

Figure 1 Cognitive map of workshop output

The purpose of the workshop is to gain a better understanding of the question – "how can we make M&S more accessible?" Therefore, with the means-end construct in mind, our first node for our map was "Make techniques accessible … hard to use technique". As discussed in Eden (1988), the "…" is read as "rather than" which separates the contrast (psychological opposite) ideas of that node. The first node focused on the accessibility to the M&S techniques – whether it is hard or straightforward to access them.

One key factor in understanding a cognitive map is the present feedback loops. An analyst will look for both virtuous circles (positive feedback loops) and vicious circles (negative feedback loops). Feedback loops (or circles) are useful, from an analysis point of view, because they indicate where to focus the energies to make the necessary changes to the system. What is noticeable about our cognitive maps is that there are no feedback loops. The lack of feedback loops implies there must be terminal nodes within the cognitive map. The two main terminal concept nodes are "sell your products" and "make techniques accessible."

Ackermann and Eden (2001) argue that a complete cognitive map should bring about three aspects which are the feedback loops, key strategic issues, and the potential goals/constraints of the focusing situation. As discussed above, there two main terminal concepts node which now becomes our key strategic issues: "Sell your products" and "Make techniques accessible". This is because they are *the most* "Popular" nodes. Popularity can be defined by the number of arrows pointing into the node (Opsahl, Agneessens et al. 2010). We noticed that "Sell your products" is more popular than "Make techniques accessible" – our initial focus. This might have occurred because this workshop was hosted among practitioners and the result might have been different if academics were the main participants.

We believe that the goal of the workshop was translated from "Why has M&S stagnated" to "How do we sell M&S products" by the participants. The concept "Sell your products" means the selling, to new potential customers, of existing M&S software packages and M&S paradigm as a solution to problems. There are several concepts that feed into the "Sell your products" concept; these include product variety, easy of determining usefulness, and awareness. Thus, to sell M&S, there needs to be a focus on not only awareness but also on enabling new potential users a way to determine its usefulness easily. Determining the usefulness of M&S is not easy, neither is determining the return on investment (ROI) of M&S (Oswalt, Feinberg et al. 2012).

The other key strategic issue was "Make techniques accessible." This concept means that the M&S should be easy to use or, at least, obvious how to develop the skills to use it. A reader might expect that more accessible techniques where easier to sell and hence "Make techniques accessible" should, indirectly, feed into "Sell your products." However, in retrospect, this not necessarily true; for example, SODA is a very accessible technique but it is underused (Mingers 2011). What matters is that the method is useful and, preferably, cheap; not that a technique is accessible.

There are also three subgoals that emerged from the process of forming the cognitive map. First, the *"Good (industry) use cases"* can be considered as a subgoal since it shows a direct impact on "Make techniques accessible", and an indirect impact on "Sell your products". It means that if there are more good use cases from the industry, it will elevate the success of both accessibility and selling opportunities. The second subgoal was the *"Better awareness"* node. This node has a powerful indirect impact on the "Sell your products" node. One of the reasons that can elevate this node is "Better education." A better education – courses, certificates, and degrees – may be able to help enhance some level of awareness of M&S discipline to people (with a potential of investments) outside of the community. The third subgoal was the *"Easy to determine if useful"* node. The reason is simply that it has a strong direct impact on the "Sell your products" which is one of our key strategic issues. It makes the most sense since the potential customers will wish their return of investment (ROI) be maximized. Purchasers of simulation products, not the user, might not pay attention to the process but are concerned with the outcome of a simulation use. Hence, the easier to determine the usefulness of the product, the better the chance of selling the method.

Opsahl, Agneessens et al. (2010) defines two key properties of concepts within a directed graph as popularity and activity. Popularity is a concept node with a high number of arcs pointing towards it. Activity is a concept that has many arcs pointing away from it, i.e., it feeds other concepts. Our cognitive map has seven popular concepts (three or more inward arcs) and four active concepts (three or more outward arcs). The popular concepts include the two terminal nodes that we have already discussed. Examples of other popular concepts include "easy of determining usefulness," which leads directly into "Sell your project" terminal node and "Better education" which leads into "Better awareness."

The examples of active concepts are "Good (industry) use cases" and, "Multidisciplinary application." Active concepts are important because they influence many other concepts so are worthy of investing time into them. "Good (industry) use cases" feeds into, indirectly, better education, better ability to advertise, better selling, and better accessibility. This implies that investing in better case studies might help the M&S community in propagating M&S. This point was also highlighted by Hamill (2010).

"Multidisciplinary application" being an active concept is generally bad for selling M&S because it negatively affects many other concepts within the cognitive map that support selling of M&S. Therefore, being a multidisciplinary field can be considered as a constraint in our focusing situation. A multidisciplinary subject is not owned by one community which makes standardization difficult and the multiple communities involved have developed their own terminology, de facto standards, and educational approaches. For example, in the agent-based simulation (ABS) community, the social scientist have developed their own specification standards, called the ODD protocol (Grimm, Berger et al. 2010), whereas the engineers have developed another specification standard, using UML (Bersini 2012); this has lead to confusion within the ABS community (Collins, Petty et al. 2015). Since M&S is not "owned" by a single community, it tends to be on the fringes of the communities it is used in and, as such, makes it difficult to find effective champions within those communities. One way that has been advocated to overcome these multidisciplinary issues is for M&S to become its own discipline (Padilla, Diallo et al. 2011) thus allowing for a more centralized clarity to the subject. The one advantage of being multidisciplinary is that the problems that M&S can address are not restricted to normal subject boundaries, allowing for M&S to be used to tackle "big" problems.

CONCLUSIONS

This paper presents the cognitive map output from a workshop, at last year's MODSIM World Conference, that looked at the making M&S more accessible. The cognitive map was produced using the SODA approach with approximately 20 participants and resulted in thirty-two interconnected concepts. From analyzing the cognitive map, it became clear that making M&S accessible and selling M&S were quite distinct which negated an initial assumption by our research team. A key difference between these two concepts is the need to be able to show easily the benefit of M&S to potential customers.

The multidisciplinary nature of M&S negatively impacts the selling of M&S because of its impact on standardization as there are multiple communities with different needs. The need for good case-studies could potentially benefit both the accessibility and selling of M&S in the future.

One of the original intents of the workshop was to try and determine what M&S' "get milk?" slogan would be but the analysis of this paper shows that selling M&S is a much more complicated affair than a single slogan could fix.

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