Freie Universitat Berlin
FB Informatics / Mathematics
Cognitive Systems Seminar
Winter Term 2018/19
Instructor: Ana-Maria Olteteanu

Discussion about the paper "A computational model of visual analogies in design" by Davies, Goel & Nersessian

Cedric Laier
Warschauer Str. 15, 10243 Berlin
cedric.laier@fu-berlin.de
Informatik, Master (Freie Universität Berlin)
5153575

1 Introduction

This essay focuses on a study conducted on the research of problem solving by using visual analogies. The particular paper discussed within this essay is: "A computational model of visual analogies in design" (Davies, Goel, & Nersessian, 2009). The research goal of this paper was to examine the role of visuospatial knowledge in enabling the transfer of the problem-solving procedure from the source to the target.

An *analogy* itself is the process of finding and using correspondences between concepts. The term *visuospatial* refers to the ability of represent, analyse, and mentally manipulate objects; *transfer* is the application of knowledge from the source analogue to the target analogue. Research has shown that visual analogies, which are part of visual reasoning with visual knowledge, are an important role when it comes to design. Goldman and Casakin have even described visual analogies, on a basis of case studies performed on architectural design, as a core design strategy in architectural design (Casakin & Goldschmidt, 1999). That's why Davies, Goel and Nersesian hypthothise in their publication that visuospatial representation of intermediate knowledge states, organized in chronical order can enable transfer of problem solving-procedures. The idea is that by looking a visual representation (e.g. drawn with a pen on a piece of paper) of a solution for a given problem, humans are able to transfer the learned knowledge and use it to draw correspondences between the solution and a new upcoming problem. Within the next paragraph an example will be described, where we have a written description and a sketch solution for the problem. So we as humans gained new knowledge for this particular problem. The goal now is to find out is if visual perception of the spatial relationships of objects from the solution can contribute to solve a problem by using an analogy.

An example for using this kind of visual analogy for problem solving is by taking the classical fortress and tumour problem (Duncker, 1926) and sketching it as done by Davies and Goel (Davies & Goel, 2001). The participants got the task to read a text about a problem solving situation: A general with a large army wants to overthrow a dictator who lives in a fortress. All roads to the fortress are armed with mines that will go off if many people are on them at the same time. Figure 1 shows the initial situation. To solve this problem he breaks up his army into small groups and has them take different roads as seen in Figure 2. The groups arrive at the same time and take the fortress.

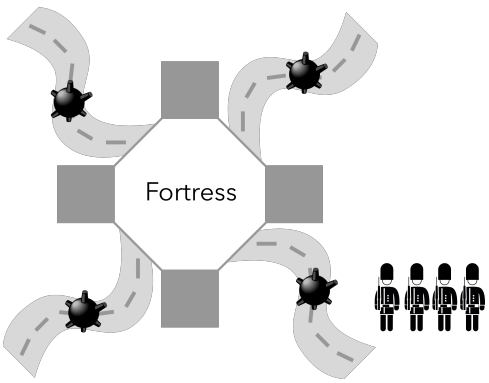

Figure 1: Initial situation of the fortress problem

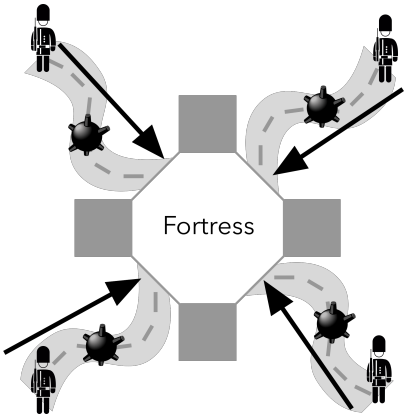

Figure 2: Solution for the fortress problem

Now they get a new different problem as stated as from Gick and Holyoak (Gick & Holyoak, 1980, 307-308): "Suppose you are a doctor faced with a patient who has a malignant tumour in his stomach. It is impossible to operate on the patient, but unless the tumour is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumour. If the rays reach the tumour all at once at a sufficiently high intensity, the tumour will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumour will also be destroyed. At lower intensities the rays are harmless to healthy tissue, but they will not affect the tumour either. What type of procedure might be used to destroy the tumour with the rays, and at the same time avoid destroying the healthy tissue?". Finally, the participants are asked to solve the tumour problem. The expected behaviour is now that the participants are able to find a solution by looking at the sketch and use an analogy they've learned from the fortress problem before. Figure 3 illustrates again the initial scenario and figure 4 the solution.

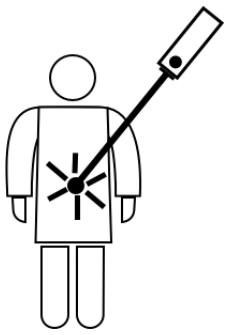

Figure 3: Initial situation of the radiation problem

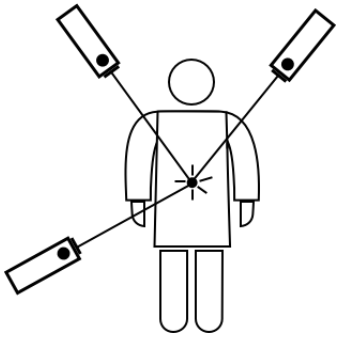

Figure 4: Solution for the radiation problem

Even though using this analogy was not obvious enough for the participants in the study of Gick and Holyoak as subjects had to explicitly get told that the military problem would be applicable to successfully solve the radiation problem, it should already give a better idea of how we might draw a solutions by using the source design case to the target problem.

A major difference to all the case studies that were performed on this topic before and this one is, that this paper hypothesizes that at least in design, humans can usefully represent the problem-solving procedures using visuospatial representations in which relation between cause, impact and intent is mostly implicit.

The following chapter will focus on the detailed research described and analysed based on a cognitive study conducted by Craig (Craig, 2003) on novice designers and it's respective results. The chapter will also describe the computer program (Galatea) they were using to simulate visuospatial in- and output representations of some of the participants that took part of the study. Closing with a discussion on the findings and a brief evaluation of the results.

2 Overview of Research

Basis of the analysis performed was Craig's (Craig, 2003) doctoral publication about 34 novice designers from the Georgia Institute of Technologies. In this study the 34 undergraduate students were shown a source design case about a clean room laboratory. This source design case contained a description of a design problem in a written form of text and a corresponding drawing of the solution for the given problem. Right afterwards the participants of the study were encouraged to solve an analogous design problem. This time the problem was represented with text only and it was up to the participants to draw a solution based on the solution of the first design case.

3 Discussion / Critical Evaluation

References

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