

## TORQUE's Imagination

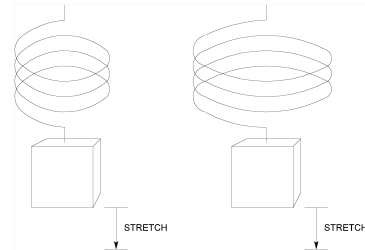
Abstract for AAAI-2008 Spring Symposium on Creative Intelligent Systems

Author information suppressed for blind reviewing

Keywords: Analogy, Mental Model, Control Architecture

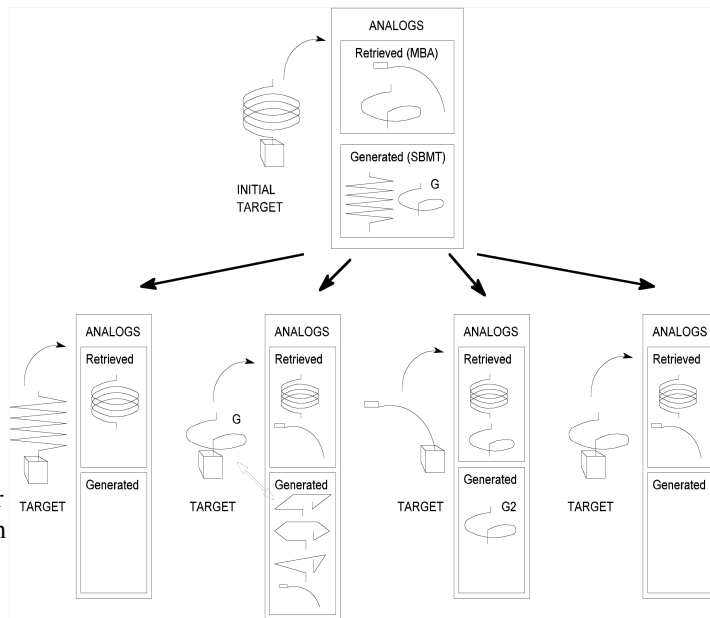
Imagination appears to be a fundamental process of creativity. When scientists build new theories they often view familiar concepts, relations and processes in new and imaginative ways, for example, viewing the earth as a point mass and imagining the concept of anti-matter. TORQUE is a computer program that emulates verbal protocols of physicists addressing difficult problems pertaining to spring systems. In its problem solving, TORQUE imagines new concepts of springs. Thus, TORQUE provides insights into the processes of imagination and imagination's roles in creativity.

Let us consider the two springs Figure 1. The two springs are identical except that the diameter of the coil in the second spring is twice the coil diameter in the first. If the first spring stretches by some amount (x) when a mass (m) is applied to it, what is the amount (y) by which the second spring will stretch when the same mass (m) is applied to it? Verbal protocols of physicists addressing this problem indicate the difficulty in answering this question: since the relationship between the coil diameter and the amount of stretching in a spring is hidden in the constant of proportionality (k) in Hooke's Law ( $F = kx$ ), the model of the spring system fails to provide an answer to the above question.



To address this problem, TORQUE imagines spring systems of many forms and shapes as illustrated in Figure 2. As it generates mental models of the imagined springs in its working memory, one of the spring forms (in the bottom right of Figure 2) reminds TORQUE of a beam attached to a wall at one end and bent because of a mass applied to it at the other end.

It then retrieves its model of bending of beams, finds from the model that the amount of bending is directly proportional to the length of the beam, transfers this knowledge to the spring problem, hypothesizes that the amount of stretching in a spring may be directly proportional to the length of the spring coil, computes that a coil whose diameter is twice that of another coil has a length that is twice the length of the other coil, and proposes that the amount of stretching in the second coil of Figure 1 would be twice as much as that of the first (i.e.,  $y=2x$ ).



Our work on the TORQUE system indicates that one of the (possibly many) functional roles of imagination in creativity is analogical reminding of distant concepts and models. The issue of reminding of distant concepts has long been a major issue in creativity: TORQUE suggests that imagination may provide one answer to the issue. Further, the TORQUE system suggests that one of the (possibly many) processes of imagination entails the use of generic mechanisms to transform conceptual representations, the generation of mental models of new concepts in working memory, and the use of the mental models to probe long-term memory. This process of imagination requires a sophisticated control architecture for managing multiple mental models in the working memory including the generation, use and updating of the models.