"VISUAL THINKING" RECONSIDERED: SOME IMPLICATIONS FOR COMPUTER GRAPHICS

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SUMMARY

The computer has been hailed in recent years as a breakthrough in visual communication. The machine's ability to allow a human operator to quickly and effortlessly create, manipulate, store and retrieve visual images has encouraged some enthusiasts to describe the computer as a unique tool for giving visible form to our internal thoughts and even our feelings. For these authors, computer-generated imagery holds the promise of significantly enhancing our cognitive and artistic capacities (e.g., Huggins, 1971; Kay, 1977; Kay and Goldberg, 1977; Smith, 1976).

One hypothesis that seems to underlie much of the enthusiasm about the potential of computer graphics is that thinking itself is "visual" (c.f. Smith, 1976). Perhaps the strongest support for this hypothesis comes from Rudolf Arnheim's (1974) important book called Visual Thinking. Here, Arnheim presents many compelling arguments for the view that thinking is not "inner speech" -- as once believed by many psychologists and linguists -- but rather that thinking involves operations on "mental images." What makes images a good medium for thinking, according to Arnheim, is that mental images bear "structural" resemblances to objects and events in the world. Moreover, a mental image does not have to be a "picture" in the "mind's eye" of a particular thing, but could exist at many levels of abstraction (for example, a diagram representing generic forces).

Arnheim's forceful advocacy of "visual thinking" has made psychologists and educators more sensitive to the role of imagery in cognition and has helped redress an unhealthy bias toward equating being intelligent with being verbal. In light of this new awareness of the potential of "visual thinking," it is not surprising that researchers in computer graphics should search for ways to link the images of thought with machine-generated imagery. This I believe is a worthwhile goal. But in the rush of excitement about the new forms of computer-mediated imagery, could it be that the "visual thinking" hypothesis is being pushed too far? For example, are we forcing imagery to express ideas that are perhaps more naturally transmitted by the medium of words? Or, in the process of becoming visual thinkers are we neglecting to exploit the complex interplay between words and images? The idea of "visual thinking" is seductive but we should not forget that language is still an extremely powerful vehicle for human communication. Being overzealous about visual thinking could have negative consequences. It could lead to wasted time, effort and money, in trying to get computer-images to do what is best accomplished by words alone. And it could lead to user dissatisfaction as someone tries to puzzle-out the meaning of a highly abstract or complex image -- a meaning for which there exists a perfectly good word.

At this stage in the growth of computer graphics systems, a useful exercise would be to attempt to pin down more precisely how words and images function as pathways into the human mind. The goal of the proposed paper, therefore, is to review some basic issues concerning how words and pictures communicate in the hope of clarifying their role in human-computer interactions. The main theme to be dealt with can be summed up as follows. We have to ask ourselves not only how a picture might be worth 1,000 words, but also how a word might be worth 1,000 pictures.

Here is a preview of some of the issues to be examined:

Can you ever replace a verbal statement with a picture? Answering this question is

one way of beginning to isolate the relative merits of words and pictures in the communication process. Playing the substitution game can tell us something about what language can do that pictures cannot, and vice-versa. For example, could a purely iconic language match the functions of syntactical units such as "the," "if", "although", and so on. Conversely, are there visual concepts which are not translatable into words alone?

In what sense does verbal language activate "images" in the head? Although it might not be wise to replace a word like "if" with a picture, this is not to claim that such words do not involve mental imagery. In fact, I think it would be useful to look at some recent work by linguists who have described how words such as "through," "over," "back," "some," and "all" -- linguistic units which at first glance seem non-imageable-- function as "image schemas": i.e., are units which evoke what appear to be best described as "spatial" or "topological" operations on mental representations which result from understanding linguistic strings (e.g., Talmy, 1975; Langacker, 1981; Lindner, 1981). The point here is not that you would want to replace a word like "over" with an abstract image. But the fact that we can use abstract visual diagrams to represent the role these syntactical units play in linguistic comprehension provides a useful insight into how linguistic units evoke imagery.

How does image meaning depend on word meaning, and vice-versa? While not well-understood by cognitive psychologists, an important issue for workers in the area of computer graphics is how language can guide the meanings we assign to images and, correlatively, how images can influence the comprehension of text. Moreover, there can be "forced matchings" between word meaning and image meaning where having to understand how a word fits an image requires significant changes to the kernel meanings of both.

What does computer-imagery do best? Finally, given what words can do and what images can do, how could one best harness what computer imagery can do? The paper will close by considering some examples where computer graphics could indeed enhance "visual thinking."

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