CREATIVE PROBLEM SOLVING AS AESTHETIC EXPERIENCE*

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In this paper I will outline some ways in which we can better appreciate computer-based interactive art by placing it in the context of the psychology of creativity and problem solving. I will use examples from my interactive art works, which are themselves artistic and conceptual statements of perception and cognition. Within these works I view the physical environment as the art object, and the process of interaction as the art work.

All art objects can engage the viewer in active forms of perceptual selection. We choose to look at a part of a sculpture, or do a structural analysis or an interpretation of a painting. Traditionally this is done as part of the detached contemplation often associated with the aesthetic experience - the phenomenon of aesthetic or psychical distance (1, 2). Interactive art, in contrast, requires that viewers become behaviorally involved with the object and directly manipulate it, creating a new art work within the constraints of the environment created by the artist. It is thus a dynamic processes that changes over time and includes a high level of personal involvement with the work. In this process, interactive art is an extension of the ability of the viewer to analyze and interpret the work, but it is closer to the task of the traditional artist in which creative expression and problem solving are explicit parts of the process.

In my own work, relatively simple hand or body movements by the viewer activate photocells or other sensors which then, through a computer interface, change the sound or visual environment. Viewers usually do not develop a high level of technical competence. Some critics might argue that whatever the tool, the traditional brush or the interactive hand movements, some level of mastery is required to be creative. According to this argument, the lack of skill of the first time viewer and manipulator of an interactive art piece would preclude the possibility of any meaningful or creative result. But I would suggest that this confuses craft and art, where craft determines the object and art is the process of the experience.

One dimension that distinguishes my interactive art from other computer related interactive activities such as video games, is the openness of the work or the extent to which the nature of a desirable outcome has been defined. Video games have well defined outcomes where the goal is to avoid being eaten, to get points, etc. They often result in highly compulsive and competitive behaviors on the part of the participants. Loftus and Loftus (3) have developed a theory to explain these behaviors based on well-established

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psychological concepts of partial reinforcement schedules and cognitive dissonance. In interactive art, on the other hand, the outcomes are more defined by the viewer, although there are always constraints imposed by the art objects and the particular computer program. My goal as artist is to create a situation that minimizes constraints, and this seems to eliminate much of this competitive behavior. In the problem-solving literature, interactive art would be referred to as an ill-defined problem, while video games are well-defined problems. I will come back to this later.

Creativity. The term creativity has been used in a variety of ways. Traditionally a distinction has been made between the artist as creator, and the viewer or audience as the consumer or appreciator of the work already completed by the artist. In interactive art this distinction is blurred since the work is never complete and the art experience depends quite explicitly on the viewer's behavior. The activity of the viewer becomes part of the art work itself. The viewer becomes creator in this restricted context. Therefore it is necessary to make the distinction between creativity in a specific situation and long term creativity associated with a lifetime of work.

One of the recurring issue concerning creativity is whether it represents a set of special abilities or is an extension of normal cognitive abilities. Coupled with this issue is the validity of the romantic idea that true creativity is the result of great and sudden leaps of insight of which ordinary people are incapable. Weisberg (4) argues that creativity is most often the result of a long, slow, incremental process that is based on previous work. He makes this argument based on experimental studies and the analysis of well documented cases in which there is a clear creative output, e.g. Picasso's **Guernica**. Weisberg's view is consistent with the idea that interactive art can help the viewer develop the less formal aspects of creativity, namely personal expression and informal problem solving.

Irving Taylor (5) some years ago defined different levels of creativity. At the most basic is expressive creativity in which spontaneity and freedom are the dominant characteristics. He suggested that expressive creativity serves as the necessary foundation for higher levels of creativity, all of which are forms of problem solving. He distinguished among technical, inventive, and innovative creativity on the basis of the conceptualizations required. At the highest level is creativity resulting in a new conceptual framework for a problem area.

I will be primarily concerned with two aspects, creative self expression and creative problem solving within the specific situation of interactive art. I also assume that nearly everyone is capable of being creative in this situation. Only indirectly will I address the issue of the creative personality or the processes involved in creating masterpieces.

Interactive Art Works. In order to make the discussion more concrete I will describe some of my work. Over the years, I have constructed interactive sculptures and transformed a number of galleries into interactive spaces. I have done installations using existing environments, such as a collection of junk at Ars Electronica, an ornate Victorian staircase, and a large outdoor bell tower. All were interactive reinterpretations of existing parts of the

environment, and served as statements about the perceptual nature of reality. Two specific works will be described in some detail: 1) a gallery space, **Doorways of Meaning**, and 2) a large willow tree at an outdoor arts festival, **Mayfair Network**. I will use them to illustrate some preliminary ideas about creative self expression and creative problem solving and the relationship between these two processes.

Doorways of Meaning, was shown recently at the Galerie Rene Blouin in Montreal, Quebec, Canada. The room, approximately 16 x 20 feet, was hung with red and green cord networks that created spaces and doorways between the spaces. Around the boundary between the floor and the walls were eight photocells embedded in shredded paper. Light from red and green spotlights in the ceiling shone on the photocells so that viewers moving in the room cast shadows on the photocells and changed their resistances. The microcomputer was continually monitoring the photocells and when changes occurred, it was programmed to send MIDI signals to a sampler, a drum machine and a synthesizer. The audio outputs from these devices were then mixed for the speakers in the room. The sampler was loaded with eight voice samples that spoke to the nature of experience and the metaphor of doorways as ways of perceiving and knowing reality. Half of the voice samples were in English and half were in French, as a tribute to the bilingual city of Montreal. Half were male and half were female.

People moved around and through the cords, creating shadows on the walls and individual sequences and patterns of voice, percussion and electronic music. For example, by moving rapidly, a babel of sound could be created which could fade out to a single voice when the viewer stopped. A number of people varied their speed and moved their arms. Others moved very slowly and meditated. While all seemed to understand that their movements caused the sounds, several tried to work out certain regularities in the pattern and tried to understand how it worked. Some expressed the belief that moving the cords caused the sound. Others seemed to just accept the relationships between movement and sound and developed their own expressive experience.

For **Mayfair Network** I used a large willow tree 35-40 feet high with a low wall, made of logs, around the tree, about 15 feet from the base of the tree, and about 3 feet high. This formed an inner circular path under the boughs of the tree. This inner path was further defined by pieces of red rope which were tied to the high tree limbs and rested on the logs. Photocells connected to a small computer-controlled sound system, were placed around the circular path. Walking through the openings in the wall and on the path activated the photocells which caused sounds in four speakers in the tree and four among the logs.

The piece was for me a somewhat playful commentary on the inner-outer nature of perceptual experience. The inner circular path, with the viewer activated and controlled sound, reflected our somewhat nonspatial inner world over which we have some direct control. Beyond the wall and red ropes was the external world of light and sound, only indirectly under our control. The response to the piece was mixed. Some people saw the inner-outer metaphor right away. Others treated it as a piece of playground equipment,

suitable for climbing, sitting and swinging. In both cases, many people wanted to know how it worked. Some correctly understood the relationships of the photocells to the sound, while others thought that pulling on the red cords caused the sounds, and shared this information with others. This idea seemed to arise from a form of superstitious behavior in which people pulled on the cords and sounds were produced in the proper sequence for an apparent causal relationship. However the sounds were produced by others who happen to be inside activating the photocells at the time.

Creative Self Expression. These examples of interactive art certainly generated self expression, in which individuals were quite spontaneous and had a certain freedom of action. This was clearly present in the creative exploration of **Doorways of Meaning**, which seemed to promote free exploration. Part of this may have been due to the voice forms of free verse that were heard, since most tried to listen to the words as they moved in the space. The room was talking to them as the moved. The free play of climbing and swinging on **Mayfair Network** seemed much different and was directed at the logs and the space around the piece. This may have been due to the festival atmosphere, the large number of children, and the physical construction of the piece.

In creative self expression there is creativity as a process which may not produce tangible objects. Most of the creativity research has dealt with products, such as drawings, which are judged by independent evaluators. Much has been done to determine the conditions under which more creativity has been displayed in these products. For example there is experimental evidence that intrinsic motivation, an internal desire to do the task just for self-satisfaction or enjoyment, leads to more creative output than extrinsic motivation, doing the task for external rewards, such as money or prizes. However, external praise can be effective in increasing creativity if perceived properly by the subject (6). In my interactive works, there are no external rewards, and so the conditions would favor whatever intrinsic motivation that the viewer brings to the piece.

These data clearly support an earlier theory of Taylor (7) in which he developed the core idea of a transactional system. He made the distinction between responsive, interactive and transactional systems for understanding the personality-environment relationship. In the responsive system the determining source of energy is the environment, while in the transactional, the source is the individual, and in the interactive system the drive emerges from both. He argued that true creativity results from a transactional system. This raises the question as to whether interactive art is or should be transactional art? My own tentative answer is that interactive art allows for transactional processes, particularly to the extent that intrinsic motivation may be involved. Appropriately Taylor (8), drawing upon others, argues that the characteristics of the individuals that are related to transaction include openness, internally developed systems and resources, and internal control with a kind of courage. In applying his model to interactive art we need to make the distinction between stable personality characteristics that contribute to creativity and environmental processes that foster creativity in us all. The extent to which the art museum/gallery environment is open and promotes the expression of these personality characteristics may be the extent to which

interactive art becomes transactional art. This situation should also provide a favorable climate for developing creativity in problem solving behavior.

Creative Problem Solving. Creative problem solving is defined as cognitive processes that produce a solution that is novel or new to the individual or society (9). Since there is such a large psychological literature on problem solving, I will only point in some directions. Some of the following material about problem solving and mental models is an extension of my other work (10).

One of the important dimensions of problem solving is the extent to which a problem is well-defined or ill-defined. Newell and Simon (11) in their classic work formalized an approach for well-defined problems, which they proposed might also be appropriate for ill-defined problems (12). The idea of a problem space is central to their formulation. Within that space there are 1) the initial state for the problem solver, 2) a goal state defining what is to be achieved, and 3) rules and strategies for moving from the initial state to the goal state. Sometimes the rules are well defined, as in a game of chess, and sometimes they are heuristics, which are rule-of-thumb strategies that may or may not lead to a solution. Some strategies that can operate are problem solving by analogy and working backward, among others.

This formulation has been challenged as being too limited and too removed from the everyday world of problem solving (13). This kind of critique suggests that it may be difficult if not impossible to define the problem space because it is so subtly and differentially influenced by context. This context includes personal, social, developmental, and moral factors. Furthermore it is often unclear to the individual in everyday situations if there is a problem, what constitutes a solution, if there is one solution, or what means are available for approaching the situation/problem (14).

It is obvious that I can not deal in this short space with all of these and other related issues. But acknowledging them, I will sketch some likely scenarios that illustrate how a problem solving model might work and how some of these factors can be conceptualized as operating in interactive art.

If the goal is to experience the art work, the viewer might move to the art object and stand passively looking at it. This would be analogous to the typical approach to traditional art works. Since the two works require the viewer to enter either the room or area under the tree, no sound will occur unless the viewer or someone else is in the space. In both cases, the viewer would initially have a very minimal experience. This may be as far as some viewers go, depending on their levels of curiosity, age, and past social experience, as they interact with the social constraints of the environment. For example, the public nature of the festival for **Mayfair Network** or the elite quality of the art gallery environment for **Doorways of Meaning** may inhibit further exploration and thus limit the mental representations or models of the work in the viewer's mind.

But for other viewers, movements by themselves or others might cause some sounds to occur. Observing this a viewer could extend the goal of experiencing the work by moving into the space and discovering something about the contingencies between sounds and movement. The motivation for this may be related to creative self expression described above. In any case the viewer then further develops a model for understanding each work: the work as a room to be explored for **Doorways of Meaning,** or as a piece of playground equipment for **Mayfair Network**. Both analogies work pretty well as ways to proceed. As I indicated particularly for **Mayfair Network** many individuals developed the idea that pulling on the cords produced the sounds, and thus solved the problem of how it works although it was a false mental model. They produced this solution either by trying the cords themselves or by communicating in the social context of the festival atmosphere.

Other heuristics might also be used. Working backwards might be tried for **Doorways of Meaning**. Here the viewer might recognize that every time she moved forward or brushed against a cord, a voice was heard. By asking why that occurred, she might find the photocells, and develop an accurate idea of the way it worked, or by concentrating on the cords, she might develop the false model that brushing on the cords produces the sounds.

In these problem solving examples, there are no specific outputs such as paintings or drawings. Instead there are cognitive models for understanding the piece by the viewers, which we can call functional mental models (15). The term functional is used to reflect the causal and interactive aspects of the art work. The details of these models are different for different individuals depending on their experiences with the pieces and the total context of those experiences. The models may be vague or very specific.

I should make one other point about the influence of my interactive art works on problem solving strategies. In all of my pieces, the relationships between movements and the sounds (or video patterns) are not completely predictable. While they all fall within a general type or quality of stimulation, the details will be slightly different with each activation, even if the viewer makes precisely the same movements, because there is randomness in the programs. This reflects the variability in human behavior and provides a level of mystery and surprise. This kind of program is, of course, different from programs designed to do spread sheets or word processing where predictability is paramount. How this randomness effects the problem solving strategies and resulting mental model is unclear. Several viewers have found the randomness somewhat frustrating and have commented that it would be better to have a piece with greater predictability so that it could be played like a traditional musical instrument. Here they have attempted to solve the problem of how the piece works by treating it as analogous to a musical instrument with part of the resulting mental model including ideas about it being a deficient instrument. It also raises an interesting question about the extent to which interactive art ought to be predictable.

But the creative self expression, problem solving and functional mental models appear to be especially important in understanding interactive art, since they describe the cognitive operations and behaviors of the viewers. And as an artist I include these cognitive processes,

behaviors and the associated memories as parts of each process art work.

Measurement Problems. I have described in general terms the kinds of responses that are involved. But there is a serious question about the degree of creativity involved. As a way of determining creativity, some investigators have used judges to rate the creativity of the outputs. But of course this still depends upon the criteria that the judges bring to the task. This approach seems to work best for existing art in which the criteria of creativity are to some extent established, such as poetry, painting etc. But as Weisberg (16) among other has pointed out, what appears as one subject's great creative leap to one judge, may simply be a logical and very small application of the subject's knowledge to the problem. Should the creativity of the solution be based on the individual or the total context? And how is context defined for everyday problems?

In my earlier work I was not as concerned about recording output. However with the computer it is possible to record responses. Yet, it is still difficult to know under what conditions the responses occurred. I am currently working on more sophisticated systems that will guide viewers through certain experiences and be able to collect reactions in more controlled ways, although we are still dealing with viewers in the relatively uncontrolled art gallery environment. With this sort of situation there is always the problem of the measurements interfering with the art. If the viewer knows that his or her responses are being recorded and analyzed, will the behavior be the same? Some informal interactions with viewers suggests that this could be a problem. On the other hand, it would be very helpful to have more systematic data on these issues. And then there is the question of whether I am making art or making experiments; or can I do both at the same time?

Summary. In this short paper I have tried to sketch very briefly how we might conceptualize interactive art within our psychological understanding of creativity and creative problem solving. While we obviously need better models, especially for ill-defined problems in everyday situations, this unique conceptualization provides an added layer of meaning to the aesthetic experience. Further, the application of a creative problem solving model to the process helps to understand the nature of the interaction. Some interesting questions revolve around the relationships between levels of creativity, and the extent to which experience at the level of self expression influences abilities at more complex problem solving levels, and then how that will work within the context of different individuals operating within the total environment.

Interactive art clearly extends the boundaries of art by involving the viewer in the creation of art works, a role traditionally reserved for the artist. It also extends the definition of art to suggest that the object becomes a means of producing art works as mental processes. Electronic media play a critical role in this kind of extension because they are clean, flexible and fairly transparent media that invite participation. Using these electronic tools, creativity becomes art.

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