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Panlelists:

George Chaikin - Brain Research Laboratories, NYU Medical Center

Kenneth Kahn - Logo Group, Artificial Intelligence Laboratory, MIT

Marvin Minsky - Logo Group, Artificial Intelligence laboratory, MIT

Stephen Smoliar - Moore School of Engineering, University of Pennsylvania

Woody Vasulka - Center for Media Studies, SUNY at Buffalo

George Chaikin

(After introducing panelists) I am not certain of this, but this may be the first panel of its kind to discuss the connections (if any) between problems of computer art and artificial intelligence. For me it represents something I've been trying to get together for a long time. In fact it ws this question that brought me into computer science in the first place. I was in architecture and there were questions of aesthetics in architecture that neither I nor my instructors could answer to my satisfaction I decided I ought to use computers to design solutions to these questions - you couldn't wave your hands at a computer. I did so with a blind naivete that the solutions would be rapidly

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forthcoming. It has been many years since I made that jump, and it has arrived at this panel, which might possibly conclude that there is no connection - I hope not, but at least the issues will be joined. The people participating have varying mixtures of experience in both fields, and I hope we will be able to bring our collective experience to some illumination.

In part because there is not very much precedence for this, I have drawn up a few questions to make sure we don't sit here and not know where to start. The questions naturally reflect my own orientation to these problems; they may not be precisely the questions that the other panelists would like to address, and if that is the case (and this goes for the audience as well), please dont hesitate to inject your own questions or perspectives reflected in questions.

To begin I want to pose the following: Three different views on artificial intelligence. These viewpoints are not necessarily contradictory, but they do represent a different focus in each case. The first is a statement by Martin Davis of the Courant Institute to the effect that the best mechanism for studying artificial intelligence is mathematics -- in particular theorem proving. The reasons for that were that mathematics and mathematical proofs are very well understood phenomenon and therefore the problem of

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tackling questions of creativity in a computer are best dealt with in a clearly defined framework like theorem proving. Implicit in that statement is the assumption that a subject area as vague and ill-defined as art is precisely the wrong area to try to consider questions of artificial intelligence, because even artists and aestheticians and philosophers can not agree on what art is; consequently it is very difficult to determine whether a machine is doing it or not.

The next viewpoint is that of Roger Schank, who contends that the primary reason for engaging in artificial intelligence research at all is to expand our understanding of human intelligence. The objective is fundamentally a deeper understanding of human consciousness -- the primary question is not necessarily to make intelligent machines, but rather to understand our own conscious activity.

Finally, and I am perhaps taking a little liberty here, Joseph Weizenbaum would argue that precisely the existence of of human activities such as art are sufficient evidence to indicate that a genuine artificial intelligence is not possible. The machine can not hope to be a Dostoyevsky because the kinds of consciousness reflected in what human beings understand to be art simply can never be incorporated into a computer or robot.

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I would guess that we ought to begin our discussion by going serially around the panel, and then we can shift into a semi-parallel mode.

Kenneth Kahn

I was thinking that if you look at just the question of art and artificial intelligence from those different viewpoints, it sort of gives a different viewpoint of those particular views in the sense that the theorem proving one I would say that art is a very good attempt to apply theorem proving and some sense must be inadequate just because it seems very hard to get anywhere with art and any creative activity with theorem proving because that is not what it was intended for -- not at all what it is about. On the other hand if you take Schank's view of human understanding and it seems like it is a very good additional topic to study because it is a very good additional topic to study because it is very different from what much of the AI research has been centering on and yet if someone does investigate -- tries to build programs to perform in some sense as an artist, then presumably, if they are built on reasonable principles, they may have some better understanding of what humans are doing as artists and also what art is all about, just because you are forced to explicate things and describe things at a level of detail that normally one doesn't do.

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With Weizenbaum's view of things, as I understand when you have people of that viewpoint it really boils down to fundamental distinctions at a very philosphical level about nature and humans and minds and thinking. There is nothing that could be demonstrated, it just gets to very different points of view, but the thing that -- not that it would necessarily settle any of these issues, but that if people did some research on it and found it was either so ridiculously difficult that they gave up or made some reasonable progress, that would sort of -- I mean I don't exactly know what Weizenbaum would say if someone built a program that produced film or works of art that everybody agreed was as good as Picasso or something...

Marvin Minsky

He would say it should be stoned. Not that it is impossible but that it is bad. There are a lot of issues in that. I think as far as the idea of choosing theorem proving as an example of a well understood activity, in some sense Davis is exactly wrong. The process by which mathematicians prove theorems is as little understood as the process by which artists create drawings or music. It is true that the surface structure of a mathematical proof -- once it is done -- is fairly well understood, but what turned out in artificial intelligence in the attempt to make the creative process equally formal,

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failed rather miserably. Over the last ten years or so people have kind of drifted out of that. There is a good review of the enterprise by Bledsoe in the latest issue of Artificial Intelligence in which he describes his own evolution of thinking in that direction. He still works on mathematics as the target and to make a beautiful proof is an enterprise discussed by mathematicians in much the same way as literary critics, in the same vague terms very often. Studying theorem proving as a problem solving activity is fine. Studying the surface methods isn't. One issue that comes up is the gap between the artist's perception of what he is doing -- or some artists' perception of what they are doing -- and the audience's perception. My impression, knowing a lot of artists, is that most of the ones I know -- and that may be a kind of subselection -- deal with their subject very much like the scientists, so the stereotype of artistic endeavor as being more intuitive than the technical problem solving is just plain false. Most of the artists I know treat the subject somewhat more seriously than the scientists in the sense that the scientists certainly are always trying to understand the material that the scientists don't try as hard as the artists do to understand the process of problem solving. The artists try very hard to understand problem solving. They are afflicted unfortunately, with a lack of respect or training in -- I hate to say scientific, but the methods of careful thought, so that we have the paradox in which neither area advances very well. The technical peo-

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ple don't respect the complexity of psychological processes, the artistic people do, but they are also subject to fits and fads and generally uncritical attitudes toward trying to see how their unconscious works. That is not necessarily a handicap because in the present state of things if you understood your unconscious works, it is not clear that it would do you much good. It might slow you down and I thaink that most people know that. Improvisers who try to compose, which is my problem, get into this. When I understand a little fragment of how to shape two phrases to fit one another, then I write very bad music if I try to exempiify this little bit of understanding, whereas I have the unconscious processes taht are better at that and presumably mastery involves both understanding these things and not letting the understanding get in the way, slowing down the process. One thing more, with respect to the Weizenbaum attitude. Joe's attitude is rather complex. He says that he is not arguing whether it is possible to build machines that are smart or creative -- it is pretty clear that he doesn't think you can, but he doesn't want his case to rest on the notion that you can't do it, because he feels, unfortunately the brain probably is a machine, and therefore you probably could build things like it. He wants his case -- first it is not clear what his case is about -- to rest on questions of what would happen to people if you did these things and so he has obscure -- I think fairly obscure -- arguments about some sort of morality or systematics of the whole issue.

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On one side he says even if you could make a machine that was potentially creative or humanoid, it couldn't be because it wouldn't have human experience and that that is the nonsequetor because there is no reason you couldn't do a little android robotics and give it human experience. He just leaves that possibility out. The other thing is what is the function of artistic activity anyhow? I will just close by saying that I havea theory about that which is a sort of neo-Freudian theory, namely that we have this mechanism for thinking and it has to run -- it is like a computer -- it doesn't have a program counter, but it has processes and if something happens to the process that is currently being executed, then another gets executed and you don't really have any choice, you can't stop thinking completely, so -- yes you can, but ... there are ways of doing that I suppose. Then why do people like things like music, and I have asked a lot of people that and they all give funny answers, and I get the impression -- and this isn't just my theory, I have heard Roterer (?) the psycho- accoustician believes something like this -- music is very much like language. It is not linguistic, but has the same sorts of complicated processes, at least complicated music, and so it is a way of exercising the higher levels of intellectual activity except that there is no meaning so you get to run your thinking machine without the pain of having to think about anything in particular and so one theory of artistic expression, or subjective experience, why people like it is that it lets

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them run -- it hurts to think about anything in particular, but it hurts not to think at all, so having these images and partial complex structures without any fixed meaning, any clear definite semantics is a great relief because it gets you to run most of your thinking apparatus but you don't have to think about anything in particular, you dont have the pain of ordinary thinking and having to solve problems.

Stephen Smoliar

Whenever I am besieged by quotations I find myself at least subconsciously, if not consciously, trying to fish out a quotation in reply. This one is unfortunately not one that I heard, it was reported to me from a conference on natural language processing in Hawaii last spring, and the speaker was John Anderson, author of "Language, Memory, and Thought", and what he said stirred a certain amount of controversy -- it was in the form of an equivalence relation: That good artificial intelligence is good cognitive psychology, good cognitive psychology is good artificial intelligence. My own work, which is now incorporating both tonal music and classical ballet, has been very heavily influenced by my being surrounded by people in natural language processing and my reading a lot of literature in natural language processing, and I think everybody agrees that any kind of artistic activity is a cognitive process. I tend to throw my vote in along with Marvin

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and Juan Ritterer, that indeed you have got the same sort of cognitive processes going on when you are composing a piece of music or even listening to piece of music. The same sorts of processes as when you are listening to a story about a child's birthday party. In a sense I agree that the mechanisms are there and this is yet another way to exercise those mechanisms. I would like to take the risk of being a little poetic and extending that a bit further and saying that what makes art interesting is that we go through life building up our own internal representation of knowledge, our own programs for our own cognition and these programs grow and what interests me most about art, I think, is the fact that it is one of the strongest mechanisms for stretching the bounds of those cognitive processes and I don't like value judgments, but in a sense I would say that those pieces of art that impress me most are the ones which always -- no matter how my cognitive state tends to be defined -- tend to find another way to jab at one of the boundaries and push it further. When I try to explain what I am doing with tonal music, I like to make it clear to people that I am in a ball park other than the pattern recognition ballpark, and the argument I use is that the brain does not shut down after the first four minutes of Beethoven's Fifth Symphony because it has recognized the pattern. In fact the remarkable thing about Beethoven's Fifth Symphony is it is constantly bashing against the brain from start to finish and it is doing things. It is reorganizing structures up there and I

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think the most important thing we can do is begin to get a better handle on the nature of these structures, see if we can model them with computer programs whose behavior can then be compared with the behavior of human subjects and then maybe we would know a little more about the way we react to art as a result of that.

Woody Vasulka

I guess that I should probably state first the position which I have found myself in computing [--]. First of all I have always claimed that direct access to these forbidden areas like the [--] consciousness is a direct report to the structuralist gods that this is in any case an exclusive area because the sciences always try to bound [bind?] themselves into some sense of [the mind?]. But in a way some phenomena like a system which claims to have a memory up here becomes an incredible challenge. What [part?] is the memory and what is [and there is a?] a computer which has artificial intelligence it suddenly becomes a whole issue in a very special competition. I was lucky to arrive in this competition sort of emotionally through the medium I dealt with before which was video and so for me this [drama?] I entered this [drama?] sort of as a [naturalist?] compared to a formalist who would try to make a particular effort in performing certain standards or positions. Further I would like to say that my thing today artists feel that they can't

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practice disciplines that are normally decided as to be scientist's like artificial intelligence which always, I thought, was high science to which I could not possibly break through, and also students that would come eventually around to what I was interested in in my way of teaching, would migrate after [straight return?] artificial intelligence because they had been frowned on to death so it is an area which I would claim wide open to all of us as amatuers to practice. I think we have arrived to have our own views on what it is and how usefule it is to us, and how far we can stretch it. We don't have to accept, in fact, any boundaries, and we can speak about whether it is matter or biomatter which supports intelligence on not regardless of whether it has been proved, or other questions which are of total impertinence to the scientist. But I may be creating antagonisms which don't exist. I don't know, I am just fantasizing, just trying to deal with it. As Mr. Minsky said, it is achance for an artist to get into this particular hypnotic spell when he or she is relieved in fact of the responsibilitites of how things are created because there is a tool to do it. I think it is a great pain that an artist is inflicting upon himself or herself just to deal with systems like that and trying to rationalize them, at least to some particeular degree. It seems like the whole art theories and art practices have been stopped in order to pass through this extremely narrow gate bit by bit to enter this new freedom of an absolute command and compositional

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freedom and [periodicity] or whatever is behind it. I found it the first time that aesthetic principles became kind of moral duties of a whole generation of people just to deal with it because there is another way just saying lets forget it and there is also opposition from the true artist with a heart and blood in his or her veins that rejects technology as in fact a kind of an establishment, non-human obstruction. An idea I don't want to bring in too much, about religion, but somewhere in this ambiguous argument I want in which the result of the product is sometimes very minimal yet the profit is so precious to emphasize [-].

George Chaikin

Regarding the process that I think it was Professor Minsky first brought up the term of intuition, and I didn't in quoting three other people, I think I didn't really give it much of my own viewpoint, except when introducing myself and why I had gotten into this in the first place. I think I did sort of put myself close to Roger Shank's viewpoint. In other words, I got into the whole field in the first place because I wanted answers about human consciousness, not that I set out to build a robot and was unconcerned with whether it behaved like a human being or not. On the question of intuition, I think I agree with your criticism of Martin Davis (or of his comment as I reported it) that in fact the pro-

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cess of proof is really a very creative process involved in arriving at proof which is in fact very poorly understood. Very often the term that is used in that context is intuition. Intuition is a very slippery term. We use it easily, but I don't think that we really understand whatit means. I'm sure that I don't.

Marvin Minsky

It stands for that for which we don't understand the mechanism. It is very clear and you can use it easily because we don't understand somethings. It doesn't make them vague, it means that it is useless.

George Chaikin

Well, I once had a nice experience of being introduced to someone as an intuitive geometer, and I felt that that was a very nice compliment. But I don't agree with that characterization. I know what they were referring to; they were referring to the fact that I do my geometry visually.

Marvin Minsky

Usually it means you do it without knowing how you do it. I don't think intuitive means visual in general.

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George Chaikin

Well, let me clarify how I do it as best I understand, and that is why I didn't agree that it was intuitive. I work on it visually, I mean my conscious process is deliberately a visual process, as opposed to one oriented to writing down formulae. If I write down the formula, it comes subsequent to the visual process. Very often i could not understand it if I went at it the other way. As a rule, I think, this process of visualization in human consciousness is often incorrectly lumped into this intuitive bag. When we think visually, this is termed intuitive thinking as opposed to analytic thought. One of the things I had written down as a possible question was in fact inspired by a talk that Marvin Minsky gave here two or three years ago on parallel processing in which he argued that in fact most high-level intelligence activity was serial, and not parallel. To me there is an analogy between that argument and the argument on human consciousness which has come forward recently on holistic versus analytic thought, in which it is argued that there is a left and right hemispheric dominance in different people, and some people are better equipped to holistic thought; those with a right hemisheric dominance. Those with a left hemispheric dominance were better equipped for verbal or analytic processes. I think it is probably true that most of us conceive of visualization in general as being in

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the holistic camp. Do you think, perhaps I should address this directly to you since you have in my mind joined the issue in contending that most high level conscious activity is serial? Do you think that applies to this ill-defined bag of holistic thought? Is most holistic thought serial, or is that an appropriate question?

Marvin Minsky

Well, first I think I changed my mind about all that. I think there is a top level serial process, but it is ver shallow and that below it things are much more parallel then I might have said in that talk. The holistic local distinction I think is very bad. There are different methods and the common sense for I'm not sure what kind of characterization is of global versus local is usually very misleading. There are of course global processes people use. If you look at a chess board and blur your eyes, then you will see that there are more pieces on the left than on the right. Now that is the only example of something that I can think of legitimately as a holistic geometric process that is of much use where the idea is seeing something as being symmetrical. But there is nothing very deep or mysterious about those and they hardly ever get you anywhere. I think it is a regretable tendency these days for people to believe other people's statements about holograms and thing like that. There is a tremendous amount of garbage about gestalts and

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holism, but none of it seems to hold up, at least to any important extent. In AI research, what we do find is that if you have a very complex body of knowledge then you need some simple-minded, coarse, low grade ways of classifying things. You look at a problem and you say this is a geometric problem. It has to do with parallelism, or this has to do with angles, or this has to do with curvature, or something like that and you make coarse judgments, and I think these coarse judgments , which are the ones nearer to consciousness and the most serial because they are coarse and have to be done before others, get identified with holistic and maybe intuitive terms, but I think that is a big mistake. It is just that they are coarse, fast, simple and early rather than fine grained, detailed, using specific knowledge later and more parallel in the process. Besides, I think all of the left- brain, right-brain stuff is very early. Ther is an accident that you can divide the brain from left to right because there happens to be this fissure in to which the surgeon can cut. If you cut it almost any other direction you also get other things and so people are being fooled into making certain clinical distinctions, because they are convenient and saying the mind must be made of those two things. But if you cut the brain at 37 degrees you'd also get, I think, different separations of personality components. So don't be fooled by that stuff. You notice that it is suspicious how humanistic the division comes; it is like evil and good. There is an affective

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and an intellectual, there is local and ther is global, there is intellect and emotion, maybe I said that, there is logic and intuition and so forth. Now it can't be that all dumb-bell distinctions are the same. There must be more to it than that. So the very fact that the left-right brain theory fits any classical dichotomy of the good and evil must make you suspicious that what you are seeing is not a careful collection of conclusions from clinical evidence, what you are seeing projected on a single canvas is the same cultural prejudice about human nature as seen by all of these pseudo-scientists. And if you interview any particular scientist, you will discover that he has no direct experience with this, but he has read something by a journalist who read something by Sperry, and so forth. What you are seeing is a wonderful social communication phenomenon, not a wonderful scientific discovery. It is against the artist, scientist, and everyone else. They see a dumb-bell theory and it satisfies some of their needs and so they want it to satisfy others, like any piece of art.

Stephen Smoliar

George, one thing is, whenever you are going to get into a can of worms like that you have at least got to face some physiological facts as to how the human being is being exposed to a particular artistic opus. The fact is that in Beethoven's Fifth, for exam-

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ple, it is being played out to you in real time. You may have heard it many times before and that is obviously going to affect what is going on, probably to the point of setting up certain anticipations. But nevertheless, you are receiving the data along a serial channel and I think similarly they have done enough work with eye tracking that we know you are not going to go look at "Aristotle Contemplating the Bust of Homer" and zap! - the eye goes one place and there is the whole global image, and that is artistic experience then and there. Ther is a serial process; the eye is going to move around the canvas and a lot of visual art is a matter of how do you design the canvas in such a way as to direct the eye serially the way you want to.

Kenneth Kahn

One question I thought you were going to ask when you started talking about the way in which you do geometry so visually, is that people often will say that it is a prerequisite for having, say, a computer produce visual art [that it is serial] that it would have to hear before it could produce music. That is the question I thought you were about to ask, which is an objective one.

Marvin Minsky

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That is the one that really worries Dreyfus and that you can't do something without direct experience of it.

George Chaikin

Let me go back for a moment to my comment about intuition, holism and split brain theories. I think the fact that certain phenomena are observed when you make this particular cut down the hemispheric divide in the brain, because certain visual abilitites are lost if one side is damaged or verbal activities are lost if the other side is damaged is fairly well established. However, I think you are right that we tend to project social prejudices on this small body of scientifically demonstrated phenomena. When I felt that the term "intuitive geometer" was incorrect, it was because I know from my own experience that the process that I go through is quite the opposite of intuition. It is very hard work. It is in a sense very serial actually. One presumes that a certain degree of parallelism is going on in the formation of an image. One doesn't go from an image to a conclusion, and one doesn't immediately formulate the concluding image. One goes from one image to the next and all of that is very serial and very deliberate. That was the reason for my feeling that intuitive was inappropriate, because it is a consciously serial activity. However, the question of intuition keeps recurring as it does in the mathematical

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proof. When the point of your criticism of Martin Davis' viewpoint is that one doesn't know how you first arrive at the proof, it is only after it is written down that the steps become clear. At this point we are still compelled to revert to that term of intuition, and really the point in the analogy to the split brain theory was: Does there exist a non-analytic, more holistic process in the brain?

Marvin Minsky

I think that the myth is that there are analytic processes, that people do logical deduction. It is possible that people who are interested in logic maybe use specific processes as if you have A and A equals B, then you get B. But an equally comfortable theory is that you have in your head a lot of scenarios of things that have happened to you, kind of a prototype theory, and among the things that you remember are incidents in which there was something that looked like A and something that looked like A implies B, and somebody said therefore B, and the people about you were happy, and you had good results and so forth, so that the scenario of sucessful logic is as much an affective early traumatic memory of a positive sort as anything else. I think that is the more serious bug. The artist defends himself by this inferiority complex and says (and by artist I mean anyone) "Well I don't have that clean, neat analytic process those mathemati-

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cians do, I have something else." So it is not that there is a process in addition to intellect. I think that what we have in our culture is that everyone has an inferiority complex because they think that other people think clearly and logically, and I don't think that there is any of that, that is really the place to attack the issue in the first place, all of the computer programs that work that way; of course there is a surface thing and that is as Piaget shows, when children are 10 or 11 they begin to be able to explain that they reasoned this because of this formal argument and he call that the formal stage. That happens, but by that time they are already very advanced in all other fields except rationalization of the formal processes that society provides.

Stephen Smoliar

Yes, George, there is music theorist named Micheal Kastler who for the last five or so years has been trying to approach tonal music by saying a tonal composition is a theorem and that music theory is the question of a proper set of axioms and rules of inference by which one can prove this theory, and I don't like that at all. I have had to formulate in words why I didn't like it several times in the past. I think one reason I don't like it is that we do not go into a concert hall and immediately say "This is tonal, therefore I am going to try to prove it while listening to it". I don't think any

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conductor approaches a Mozart symphony, for example, that way when he is trying to put a performance together.

Marvin Minsky

But like language it maybe formal, structural components that we are all used to and it might make it easier for the conductor to think...

Stephen Smoliar

I think it is a little bit like your world of inference, that little Wolfgang spent two or three years of his life copying out piano concerti by Carl Phillip Emmanual Bach and then one day he decided to put some different notes in there on his own and got strokes of approval, but he had now made a composition and sort of acquired a practice. Then many years later Beethoven went through a similar stage, first playing and copying out earlier sonatas and gradually doing other things to it, not always necessarily getting stokes of approval from the surrounding community, but getting something which gave himself -- at least internally -- those strokes of approval.

George Chaikin

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Would it be fair of me then to suggest that possibly there is a perhaps physiological, perhaps social mechanism which pushes us in this direction. In other words there are certain things not strictly physiological or neurological which bring us gratification and that these things then become subsequently rationalized into a formal theory at the age of formalism and that there is not necessarily a connection between the formal rationalization that we do and the conclusions that we reach which are derived from a more primitive gratification syndrome, either in our physiology or in our society.

Marvin Minsky

Well you probably can't separate the forces that cause you to condense and abstract and represent experience compactly from the gratification. Probably you are forced to develop mentally for the same reasons that you are not satisfied by infantile things anymore. There doesn't have to be any conflict.

George Chaikin

That leads to another question, though, because this is fine for human cognitive psychology, but we must relate this discussion to machines. Do you foresee or see a similar apparatus in machines? Is ther something that will compell a machine, either the

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machines we have or the machines we expect to have, into a certain direction? For example, my own research leads me towards a physiological gratification orientation, one similar I think to that of Herman Helmholtz, who developed an aesthetic theory based on the correlations between art and human physiological response. It is often said that if you examine human musical experience, it is all rythmically in the range of the human heart beat.

Marvin Minsky

That is just plain false, isn't it. The average piece has several rhythms, and one of them by definition has to be near there but...

Stephen Smoliar

No, I think thatif you look at some of the theoretical writing on musical rhythm that has come out in the last five years that that just doesn't pan out anymore.

Marvin Minsky

Why isn't the speed the speed of walking? Undoubtly, some peoples pulse get locked to some kind of music. Let's consider the heartbeat for a moment as a physiological phenomenon. One of the most remarkable things about our bodies is the heart, which is

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standing there and if you look at someone else, have you ever noticed that you can see their heartbeat? Look at someone and you see there is this big thing in their chest that is going like that (thump, thump, thump); their whole body shakes. If you stand on a bathroom scale you will see the thing going up and down several pounds unless it is a good scale, which is very rare, and the sounds in your ears -- in your head -- the blood squirts through even if you have normal arteries, there are all these things going on and you don't hear them. So if you consider the masking or habituation of effects like that, it is really very remarkable that you look at someone else and they have this big mechanical organ and they are shaking all the time but you can't sense your own. That in itself makes me doubt the importance of the heartbeat to a long subjective experience right from the start. Another thing is that if you look at any piece of music, or anybody playing, you will see that the tempo varies in any piece except the most mechanically performed thing by 20% or 40%, somewhere in the course of it it has allegrettos or scherzi and it has accellerandos and so forth and so you can't have it both ways; the heartbeat in people is between 70 and 80 or 90, and the music goes between 10 and 120 and you either lose or win but I don't see what the point is. It is just not clear that most music has a pulse between 70 and 80, is it.

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George Chaikin

The point was that you don't have tempos of 1000.

Marvin Minsky

You cannot have a low note whose duration is less than a number of cycles. For example, you notice that people don't play very fast the lowest notes of the piano. You have notes of 30 cycles a second and if you finger it at 20 cycles you cant tell what note it is, and people don't do that. So you can't have a frequency of a 1000 when the fundamental pitches are 150.

Stephen Smoliar

George, there was a dancer once who strapped a contact around his chest and made that his score for a dance he would execute. He would start dancing and naturally as he started the heartbeat would get faster and what do you suppose happened? At a critical point he was no longer dancing to every beat, he danced to every second beat or every fourth beat. The point is that depending on his mood -- this was an improvisation piece -- sometimes he would dance to every fourth beat, sometimes he would dance to every third beat if he happened to be in a rather Straussian mode that evening. Sure, he would never

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be dancing at a 1000 steps per second or something like that, but there is so much fudge factor in how you choose to interpret the indidvidual heart and pulse as it were and sure, in a wishy-washy way you could always use any rhythmic pattern as something that could be correlated, but I don't think you could correlate it in any meaningful way.

Woody Vasulka

I would like to think something maybe more meaningful. Sometimes, especially if you have a system that is performing [real-time?] output of images, you find yourself starting very calmly and come on top of it. But eventually you build up certain frenzy and that can end in a certain orgasmic manner and when you start thinking about it [Mahler's 6th ?] seems just perfect for that. There is another of integrations. It disregards the heartbeat, but it has a very precise model. That as far as I would say is a bio-modeled composition.

Marvin Minsky

It is very precise in a rather imprecise way.

George Chaikin

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Really, in what Ken was asking about whether the computer must see and hear in order to produce art is, I think, a part of the question. Do we respond to things because of certain features in our physiological structure which give us gratification because of certain responses, and if that is the case regardless if the heartbeat question can be settled or not, I tend toward that particular viewpoint for a variety of reasons, which would suggest to me that indeed a machine would have to see in order to really develop an aesthetic sensibility of its' own. It would have to have an input and moreover it would be a function of the structure of its' visual mechanism, the kind of visual aesthetic that would develop because it would have to respond, perhaps to rhythms, perhaps to other features of its' physiology.

Marvin Minsky

In infancy surely the physiological equipment you start with gets transformed and transcended in stages of development so that by the time a mathematician is enjoying some formal, beautiful characteristic of a theorem or an artist some representation in a painting, it has very little to do with how you started. I think you must be right for infancy, but it is an infantile theory to say that this persists to explain adult experience.

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George Chaikin

I don't know adults who were not first infants.

Stephen Smoliar

Beethoven was tone deaf by the time to the Seventh Symphony but he had all that experience by the time he got to it. It doesn't seem unreasonable to say that by that time there was some kind of a data structure that was lodged inside his brain, and if we knew the nature of that data structure, we could put that inside a machine and it would also be stone deaf but it wouldn't have to hear anything.

Marvin Minsky

The early development influenced that which Gordon Olport called functional autonomy set in but the data structure you have built up has enough strength and coherence that at that point if you are perverted enough you can invert pleasure and pain and go on with the abstract structure which any kind of mature sadist is able to do, and in all other ways the flexibility of the human mind is such that if it is inclined to, it can ignore physiology, even change facade. It would be perhaps easier just to ignore those constraints because internal things are strong enough. Any obsession can overcome reality.

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?Kenneth Kahn

There is a problem I am having with all of this talk of gratification. It doesn't seem to explain very much in terms of why and how somebody actually goes about creating a work of art or perceiving. It just seems to say that you do it because you are gratified. It doesn't explain too much.

George Chaikin

I hope that you don't think that I was trying to explain everything by that. I ws simply trying to pick on one facet of the process. But I think it is a fundamental facet. When I listen to a work of music or look at a painting, there is a very strong gratification component to it. However, it's possible that gratification is no longer for an adult human being merely a physiological one.

Marvin Minsky

You may be running certain gratification structures in you that it just has very little to do with the phenomenon. We forget when we discuss art that if you take a typical piece of music, then most people won't like it, and if you take a typical picture, most people in the world won't like it, and so we are very individual. We have been

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brainwashed to believe in from our childhood, not consciously, that there is great art and bad art and every normal person, unless he is perverse, is going to like Beethoven Quartets or da Vinci paintings, but it is not true. Most people in most cultures don't like those things at all. All great art is generally atrocious by primitive standards.

?Kenneth Kahn

I have a somewhat far-fetched analogy to Marvin's initial statement about the idea of exercising intellectual activity just because you can't not think, which sort of gets gratification out of it. It comes from my experience of using the LISP system on Marvin's computer. LISP is one of those programming languages which is very wasteful -- it is free storage and it just creates lots and lots of wasted space which when it finally doesn't have any free space it has to stop doing real computation and perform a subsidiary computation called 'garbage collection'. One of the features of the first LISP I ever used was the fact that there was a way by which a programmer could automatically invoke garbage collection. In the interests of efficiency if he knew that a complex calculation was coming up which needed to run efficiently, he could clean up the storage first and then proceed to go ahead with it. I think that is a sort of analogy to the aesthetic experience, that when we are doing hard thinking, real thinking in a sense, we are really

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overloading the data structures. We are overloading our storage capacity and we are driving it very hard and in fact there is such a thing as cognitive fatigue and times when you know you can't think about something anymore, and you want to take a break and one of the things that perhaps these intellectual activities which don't "mean anything" do is they serve, like this induced garbage collection function. This sort of allows us to rehash the storage structures we have got to play around with them, manipulate them in such a way that there is a little more order in there when we want to go back to our serious thinking, to our real semantic reasoning. I warned you it would be far-fetched.

Marvin Minsky

There is no critic.

??

There never should be a critic.

Woody Vasulka

[behind this type of behavior is models and ...?] which is man as a hunter and collector, that is [fine art?], it should be all fine arts [in the computers?]. It is in fact [a found object, visual object?] or any other thin and this urge in fact [of obtain-

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ing] certain valuable objects and then show it to the next person and want that to be appreciated same way, or simply to get a good catch or kill. These things help probably, also, at least in my case because I collect mushrooms [and you go in the woods and the rare or the very rare is found one becomes hysterical, has a hysterical fit?] and it is very much related, in fact to other creative processes that urge to do or obtain a value almost for free that was given to you by the gods in the forest or in the machine, and to claim that they are yours. It is mine and I am responsible for it and then you convince the rest of the world that that is the case.

George Chaikin

(to Kenneth Kahn) I would like to take issue with the notion that art is for entertainment and relaxation, period. In fact what we do get away from a real [thnking ... precisely accept ... graphic thinking?] hard thinking. Yes, even hard thinking. That just doesn't conform to my experience...

Marvin Minsky

Well you are blurring it because clearly there isn't just one kind of art. You are going to say "well it is wrong to say that all art is x" -- of course it is wrong, so

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let's pick what you ... Do you disagree that any important artistic expeiences are of that character?

George Chaikin

No

Marvin Minsky

Then that is what you should say.

Stephen Smoliar

You could turn it around the other way, you could have the composer who is spending hours upon hours working on a given symphony and he will fatigue just as much as a mathematician trying a theorem, and for all we know, what he does when he fatigues is that he goes off and reads a book on analytic geometry. I am not thinking only in terms of my experience as a creator of art, but also as a viewer or appreciator of art. It is itself often a very fatiguing activity.

Marvin Minsky

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Is it the same activity?

Stephen Smoliar

No it is not, one of the things we are trying to figure out is what kind of...

Marvin Minsky

Then how can... if you say it is often A and often B, then it is the same thing...

George Chaikin

I said at the outset that we all can agree that art is very difficult to define, but suppose I suggest that art is different from most other activities in that it is a means of objectifying ideas, in a very concrete form... I can see by the raised eyebrows that not everybody can agree with that either.

Marvin Minsky

I don't think you can get anywhere by trying to define art as this or that. You have to talk about varieties of experience which are considered to bear on art, but clearly the word art is a child's word -- things are either art, or science or art or reality or something, and that is a dumb-bell distinction to start with. Then when you

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want to go into detail...

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I always have different distinctions between the things we do to relax and the things that we are doing when we are doing hard thinking.

Marvin MInsky

That is a different distinction and there are those kinds of activities. There are also many ways of doiing them and some of them intersect with these ideas of art and some don't.

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Perhaps the word relax is a poor one. Perhaps it is just a matter of the fact that whatever the nature of the processor is, it can not do one single kind of processing for a sustained period of time. At some point it has to shift the nature of the processing activity to something else and that sort of throws out the word relax, it throws out the word gratification, and it just reduces to the fact that there is a need for variety.

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Marvin Minsky

Steve and I are talking about somethng similar, namely a very particular image that is false itself but is an approximationto something that there are thinking, formal syntactic type processes involving understanding and belief and so forth and in some cases you get tired of having these critics in your mind asking whether something is true or consistent or coherent of logical or whatever, and so there is a pleasant activity of running the formal processes of fitting things together in asort of syntactic manner without worrying about the meaning, and so that is one kind of relaxing artistic activity. It would be foolish to say that is the only kind because in the case of listening to a piece of music we are really involved in then it surely has its' own semantics which aren't verbal but not very different from our thinking.

??

What has been bothering me about this distinction between the formal thinking and the semantic thinking is that I don't see art really fitting on one side or the other. Maybe music fits more on the side of the formal, but somehow if you think of literature maybe, you think of it as being more semantic and maybe representational art more in the middle of things -- I don't see that art fits much on either side of this...

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Marvin Minsky

I don't either. Clearly the putting of literature and music and these things into the same boxes is a political and not a psychological classification.

Woody Vasulka

I would like to object to this civilized mummery when you talk about art. I think maybe the best artists commit suicide because it is not relaxation that is involved...

Marvin Minsky

Are you suggesting more than other people?

Woody Vasulka

You are speaking about art as an activity of every individual, which of course it isn't. Beyond migrating into Afghanistan, I know on a microprocessor scale that is what is happening anyway. If you are talking about art as a particular specfic process, I think it may be unavailable. In many cases it is and influences profoundly a lot of people and infact as I said it may lead in many cases to total self- destruction in a social or other sense, so art is a savage environment as well. It has been proven that it can

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even create wars and kill millions of people, so I guess these are the dimensions that we cannot of course define here, but I just wanted to say that it is alsp a possibility.

Audience

I would like to pick up on something that Woody said at the very beginning that I think pertains to the relationship between computer art and artificial intelligence: Some people, considering linear art, may think of the subsystems and routines as external to the artist -- to be used by him or her -- but not created by him or her. On the other hand a more intimate practice of computer art is that the artist creates the routines. In the field of artificial intelligence, the very phrase suggests that some people will create routines which are then used by different people. [There is?] a suggestion of passivity that -- it suggest that the creator of a system which somehow exhibits intelligence, is doing something quite similar to what an artist might do.

Woody Vasulka

I think artists act like an intelligent detective. There is no doubt intelligence created when you first approach the computer you are in fact astonished and you pick up these clues of intelligence that you don't have any idea where they came from, so this

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moment of astonishment is maybe then replaced by practice, like assembling the intelligence, but that is where I just express this possibility that we all deal with artificial intelligence in our own terms in our tool. In other words, take it away from the hands of the specialist, because the invention is ours, not only the scientists'. That is a rather rhetorical phrasing.

Audience

I don't know how to exactly react to what you just said, because I think in terms very often of dance, choreographies, dancers, the interaction between the two. Choreography can be done by interaction with another individual, by obtaining feedback from an entirely different individual and the creative process, therefore, involves not the choreographer only but the interaction with the system -- the whole way of communicating froma a framework from which the dancer will respond to the certain way and the choreographer will say "Yes that is what I want!" or "That is what I want, only change this" or "I want somethng different from what you are giving me, you are not giving me what I want". I think that whenever you have artistic relations of this type they can be compared, they can looked at in the same way that a computer system can be looked at -- reacting to the artist. I think that artificial intelligence definitely is linked there. I am not sure

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how. I am personally not experienced in the other arts and working with the computers for the other arts.

Stephen Smoliar

George, we never really hit on the word communication in any of this session we have had, and I think that it is important that a lot of the work in natural language processing, that aspect of artificial intelligence generally assumes some sort of a bilateral communication channel in which on the one hand you have an individual who has a knowledge structure and he is trying to do something to get that knowledge structure into the other individual's own memory bank, and indeed I think choreography is an excellent paradigm, because there is a case where a choreographer has to communicate information and the question is does artificial intelligence tell us enough about the nature of that information that he as a choreographer, as an artist, not as a computer scientist, would have a better understanding as to how he could communicate information.

Woody Vasulka

Let me comment on something very pragmatic. All electronic systems behave as communication systems once you have set them up to do it. It does not require any particular

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artificial intelligence to induce a workable environment [say to create a video tape]. I have been [searching with the computers to get something which would give] me the input/output area in which I can work with, but I don't know if that is recognized. Maybe we should have a deffinition of what is artificial intelligence after all.

Audience

Is it true that when you finally arrive at a system which you enjoy working with to in fact model a certain amount of information which you have within your head, which you are trying to model the process?

Woody vasulka

I would say you negotiate it, because [model] is a big word. I don't have the mode of controlling the system as [a model], I can only mediate or accomodate or somehow change -- I change -- because the system won't change because I am unable to change it, so some [moral] pragmatic decisions I am, for example, making in my own work. But others, veterans in programming, for example, can negotiate how different is the brain so it is what is fascinating about a computing system at one level, but there are many levels, there are baroque structures which can be very elaborae and they can behave, I would say,

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as if organs with the behavior. eventually from that organization of behavior I guess you can step into the intelligence step, but intelligence in my sense exists and is stable -- it is a particular interactive possibility -- but it has to be as alive as you are. If it is less alive, then it is less intelligent.

Audience

George, It seems to me that in this discussion you ....are very concerned about modeling, or artificial intelligence models which are humanly based, I mean why are we obsessed with left and right brain and this kind of thing, when it is very likely to have genuine artificial intelligence -- whatever that means, we might not even recognize the art objects that we can predict, they might be inside those dimensions in which a human being can see a thing.

George Chaikin

Frankly I thought I posed exactly that question. I think in trying to answer some of these questions, some of the thoughts that I have had on it are that when we talk about intelligence at all, we are the only model we've got. The whole concept of an artificial intelligence derives from the fact that we recognize human intelligence. I rather suspect

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that if it is the case that indeed there is some sort of gratification compulsion involved in the development of intelligence, that the gratification compulsions of a machine would be very different from those of human beings. Consequently you may be very right, that we would not recognize it as art in a human sense. It is also related to the issue that Steve just raised with regard to communication. There may be a certain sense of gratification on the part of a computer if it can read a file without a parody error, or when the communication between two computers can take place in the most efficient manner, for example, without having to convert from one code to another. If we look at human societies, I don't know of one without art of some kind regardless of whether one society agrees that another society's art is art. Every society has something that atlea least anthropologists can agree is art.

Marvin Minsky

You are going to trust their judgment?

George Chaikin

I think it raises a question of whether artificial intelligence is possible without art, because from the circumstancial evidence, there is no intelligence without art. I

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don't know if that is too much of an answer or not enough.

Audience

Is it a by-product or a prerequisite?

George Chaikin

I rather suspect it is a prerequisite. I don't think its a by- product. My opinion derives from the writings of Christopher Caudwell on aesthetics in which he argues it is an essential for human development, for human intellectual development.

Marvin Minsky

So before you had a sidewalk and there were all of these footprints wherever people were and you might have said that was necessary for intelligence, but once we had concrete ... It might be just a product, don't animals have art? Maybe a more perceptive anthropologist is necessary to see what the lizards do.

George Chaikin Perhaps they do -- I feel certain that they don't -- but perhaps I don't recognize it yet if they do. Maybe dogs have art at fire hydrants -- I don't know what kind of activities they are engaged in there, but they are definitely involved in

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some sort of recognition/communication activity, but I don't think its art.

Audience

This is just a comment on Steve's description of artistic communication in terms of information transfer. I suspect that in many systems, he transfer of information per se is just a means of engendering certain transformations of ongoing processes, that the communication involved in things like this is esssentially that of communicating or recreating this ongoing process of the kind of activities that [-] has been playing with [-]. But the information transferred is not what is communicated but simply a mechanism for getting patterns along with different kinds of activities [-].

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Well I think we are getting into too many dangers of breaking things down into dichotomies, but if you take the example of a computer's machine language, you can talk about communicating data information, or you can talk about communicating control information -- the sequence of instructions. It is quite possible that what actually goes along the channels of communication, of artistic communication is some mix of both data information an control information.

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Marvin Minsky

I think the dichotomy is pretty bad because the span of activities that the... under different conditions people will say have artistic components weem to be spread out over so many psychological domains and then the other ones, well I hate to say, sounds like a semantic error...there is a problem when the anthropologist says there is art everywhere. He is smearing this -- is he really recognizing a particular psychological activity. We see paintings that people are developing representational skills and the anthropologist says "This is just like an art gallery" when he draws this buffalo the same as it has been drawn down in the [Village?], but why does he think that? A by-product of developing the representational skill is having the result of some work that you want to show and these are all common sense things and we don't need the word "art" to say I have made a new thing. If anybody looks at it he will see that he has never seen it before and get some interesting thoughts and feelings and so I will put it up. Then if you say that for intelligence to need art may be necessary, you are absolutely right. We can't have intelligence without creating new things that other people or other parts of the mind will recognize as important themes for proving a new theorem. I go back to what I said before, which is that the mistake is believing that there is anything other thatn art in the sense

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of there is a kind of rational way to solve problems that is of any value or any power.

Woody Vasulka

Again, I am a newcomer and would say that the only sort of artificial intelligence that I can detect around the computer is in fact the operating system of the computer [- doesn't have the same implications as for anything I have ever done before, including video?]. So I have come to a whole different idea about what in fact would be artificial intelligence of a system, and I found kind of a synthetic model that suddenly there is the possibility of having a basic verbal structure and it is of the next generation... it is the sound generation in which in some cases may be music. There is some innate process of image generation. There can be two kinds of [-]. When we speak, there may be some primitive clues to our switch between what we call syntax in cinema or television. It is so suddenly if this also exists, even if it is extremely minimal, just say "something just came through the door" I would just gog because this would be an absolute appreciation of machine intelligence. In that way I could build a model that I could respect and once I could respect it I can call it intelligence, so it is a totally dynamic model that [-] it is something that we assemble as being a respectable model and build it, into the future increasing its complexity and hopefully being dependent on it and always having

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this mysterious quality, yet there is nothing here today. It may never be disclosed as [fully?], but eventually we associate with it, whatever that is and [-]. I think we keep on changing as an express property of the super structures of our own understanding and we will always worship that as we do now as a particular quality. [-]

Kenneth Kahn?

What I wantedto do was make a point that someone commented yesterday [-]. The point that I want to ask especially of Dr. Smoliar, is: What do you feel about the question that the art now of composers and composition and interactive systems determines an overt sort of act, what we call it and can be analyzed and in which you hvc to communicate to an [-] on a computer machine [-]. Therefore in the sense of artificial intelligence as has been carried out in past years, this is what is called a discipline to analyze the communication process and maybe should cause us to reevaluate how we think about musicology, traditionally was a tri-dimensional [-]. I am trying to make the point that in fact there is a strong potential...

Stephen Smoliar?

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Well we had some dark time on this, most music departments that I have had contact with -- both visiting and attending -- and the American Musicological Society congresses, now seem to decide that music departments are some kind of a holy trinity. Musicology, music theory, and music composition. The trouble is that where theoretically all of these are supposed to be in one, usually such poltical things as whodo you hire for faculty will stand on the fact that no one branch thinks that what the other two are doing is worthwhile although the composers like to rely on the theory department to teach them basic harmony. What I have been talking about so far is really music theory. That is the question of what sort of perceptual and cognitive activities go on when a musical stimulus is hitting you. I believe, and the first time I saw this written down was in a paper by Otto Lasky, so I believe with him, that the similar activities take place when one is composing and in fact that sort of came out of the examples we were talking about with logical inference and with Mozart writing his own sonatas after he spent several years writing other people's sonatas -- copying other people's out. I think that a lot can be done to put so called historical musicology, convetional musicology, in teh same frame-work. I think that that is probably the hardest task of all. I think that what it amounts to is that we want to get inside the brains of people from the past. Where this is probably going to be most useful and of course where the work is going to be most dif-

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ficult, is that the sort of models that artificial intelligence pose should eventually begin to give us some information as to how information is communicated in oral tradition. Eventually we would like to know, as it were, the brain behavior which took place in Pope Gregory's skull, how is it that you could have several dozen monks all of whom knew exactly what antiphons to sing on what day at what hour. How is it that this vast body of chants got created on a purely oral basis, and how is it maintained. I think that those questions will eventually be answered by the same artificial intelligence mechanisms we have been discussing all along.

Audience

Why are you trying to focus on getting into the head of somebody in the past, when you could perhaps learn more about the compositional process by getting into the heads of people composing right now?

Stphen Smoliar

That is where we are starting. What I am saying is that is why this is going to be so difficult. If we ever figure out how to get into the heads of people in the present, then maybe we can start hypothesizing about the heads of people in the past.

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Marvin Minsky

But a lot of that is impatience. As the field develops, you... we are talking about pschology in general and artificial intelligence is important because it is the latest wave in psychology, because of its name and perhaps you have to study how little children do these things before you can ever understand how adults do it also.

Audience

I have seen many analyses of compositions from the past and I have never personally seen an analysis done of a composer composing with it done under observation.

Marvin Minsky

That would be no use either. The only sensible thing to do, if you want my advice, is to get a lot of video tape and you have to get a small child who has never touched the instrument yet and follow him for several years -- and there is no reason you can't record all his musical experience -- you do this for a few thousand children and you get a lot who are pretty bad composers, but that is just as useful and one of the troubles with people trying to study phenomena is their snobbishness, it is easier and you will learn a lot more from studying somebody who is a very bad amateur composer than from studying a

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good one because the good one presumably has 20-30,000 subroutines of various well developed sorts whereas the other one has only a few hundred and you might gain some understanding by that. The worst thing you could possibly do is to try to figure out the processes of very exceptional composers who have been dead a very long time.

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Fortunately you can't get your hands on very much of the data of the mediocre ones.

Marvin Minsky

It is very easy, it is thatnobody bothers. The data can be produced faster...

Stephen Smoliar

Not the dead ones.

Marvin Minsky

You can make it as you need it. There must be some bad composer each of us knows.

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Perhaps that is the Socratic motto, then, model thyself.

George Chaikin

I would like to terminate this by going back to what I said at the beginning, to the best of my knowledge this may be the first time this kind of panel has occured. I would like to do perhaps a frightening thing -- have we accomplished anything, should we be doing this again, or is there really much of relevance that we have gotten out of this morning's discussion? May I ask each of you to comment on that in conclusion.

Kenneth Kahn

If we do it again it seems to me there are a lot of questions that never got asked or were barely touched upon and a whole set of which I am interested in is... I am interested vermuch in what we talked about in the sense of what is an AI view of what art is all about. There is also the question of if you are interested in trying to build an artificial intelligence that is able to be creative or create art, where do you start, what do you think, what are the problems involved and those kinds of questions.

Stephen Smoliar

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I was saying that while much of what we talked about is very interesting and relevant, there is a whole set of topics that were never touched upon, which are questions of what is involved in actually producing a computer-artist.

Marvin Minsky

That is a good question all right -- I suspect that the thing to do is to create an intelligent machine and then try to get it interested in art. That will not be a terrifically difficult problem to do so. As artificial intelligence gets smarter and as better theories of how people think and I guess it is only fair to say the rest of cognitive psychology gets dragged along into taking its job seriously, there will be more and more reasons to talk to people to try to get them interested in artistic processes, and maybe AI has got to the threshold here because those people have already something useful to say. There would be no point in holding another meeting in three or four months -- there might, you get other AI people to [get their inference around this same time?]. It is several years between significant advances in the area. I wouldn't have an annual meeting. The AI profession itself has started meeting every two years which appears to be a justifiable distance.

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Stephen Smoliar

I think this has been a very conducive environment to the kind of discussion we have been having, to follow up on [Bill Buxton's?] question, I would like to see a panel like this being conducted at the next session of the American Musicological Society rather than have to sit back and have to listen to three more reports on new [dramatic?] indices that are instead of thinking about using a computer. I think that because there is this trinity within music, that it is necessary to bring together those people doing music scholarship and those doing scholarship in psychology and those people who are involved in artificial intelligence. See whether or not in a in fact less conducive environment, ther is still the ability to get some constructive thinking coming.

Woody Vasulka

[-] throw a parallel to what happened in film with semiology [-]. But it is generally in two areas with only one area only most common is the most banal which is the Hollywood movies and so what we call avant garde or progressive escapes the discipline totally and it is [-]. [We needn't go to the children to show that it is the commonest, most natural approach to study -----]

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George Chaikin

I would like to thank all the panelists for appearing and giving their views. Obviously I feel that the topic merits study, further study. I don't know how soon we can practically get back together to persue this further, but I do want to make a perhaps semi-political statement. I think it is a time for computer science to pay more serious attention to computer art. I think it has tended to view computer art as a non-serious activity -- drawing Snoopys or something like that. The funding agencies also have to be convinced. I had a very telling experience in that regard recently when I attended two conferences on related subjects -- one on computer art and the other on pattern recognition. While both conferences were of high quality, the computer art conference in Buffalo showed more innovation and new information than the other. Had anyone compared the funding supporting the reported work at each, however, they ought to have expected the opposite. Certainly the research represented at the pattern recognition conference cost many millions of dollars, while the relatively few participants at the computer art conference who had any funding must have totaled collectively a few tens of thousands of dollars. Now maybe I am making the argument that if you don't pay anything, you get really good work, but I think the time has come to start getting down to the specifics, to take con-

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crete steps to incorporate computer art and computer artists and the contributions they clearly have to make, into the mainstream of computer science.