THE SYNTHETIC IMAGE AS LANGUAGE

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In the memory chest of computer graphics there is a photograph from back in 1963 which has a special significance, in that it shows Ivan Sutherland using one of the first systems of drawing by computer, the *Sketchpad*. This old photo sums up almost everything: a screen to show the drawings on and a person —Sutherland himself— who, by handling various tools (electronic pen, potentiometers, keyboard, etc.), is working interactively with the computer. A similar photograph, taken in a studio for producing computer images today, would show us a scene that had changed considerably in its forms, but nevertheless with the same actors —a person, a computer and a screen— devoted to the same mission, a mission which takes advantage like no other of the human ability to co-ordinate eye, hand and brain.

From this ability, say the anthropologists, comes almost everything. By means of their eyes, men and women discovered their identity. With their hands they made the first tools. With their eyes, with their hands and with their brains they drew the first symbols on the ground. These signs, about ten thousand years ago, announced the language of writing. Likewise, the worker in computer graphics today or his predecessor of twenty-five years ago babbles away with his computer in another language, that of images.

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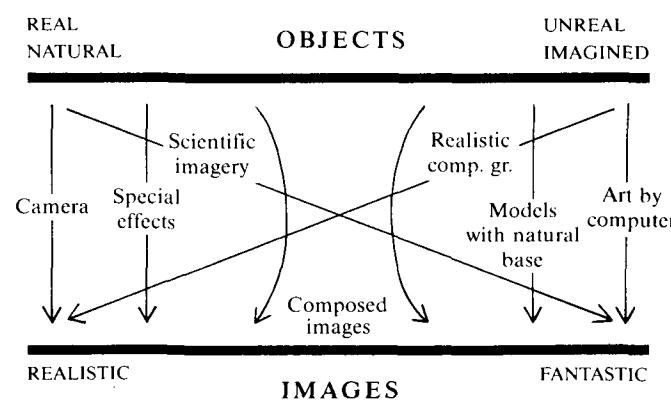
Until very recently the only instrument available for making images, apart from the brush, was the camera. The invention of the camera gave rise to photography and the cinema, but types of photography and cinema almost always of a very specific nature, one which reflects reality. This is because the only things that the camera-instrument knows how to record are physically existing real objects. The computer shatters this limitation.



The above figure is a plan of the connections which, through the technology of visualization, exist between the world of objects and the world of images. At the top left are the real and natural objects; at the top right are the imagined objects, non-existent in reality but exist-

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ing in the mind of an author. From these real objects the camera generates realistic images. There are techniques, always based on the camera, such as the traditional animated cartoon and special effects, bent on creating images of illusion, unreal images; these techniques, however, always end up succumbing to the unavoidable physical laws of the materials with which the illusion is created: acetates, maquettes, etc. The computer, on the other hand, permits the visualization of objects which do not exist in natural reality, producing at the most creative or artistic extreme immaculately fantastic images without any precedent in reality. There are other connections like that which gives rise to «compound images», that is to say, a mixture of real and unreal, which are the result of the use of image mixers, also with a digitally based technology like the computer. «Realistic electronic graphics» is that system which, although it still handles intangible objects, produces images which imitate reality, thereby constituting a whole school of «computer graphics». Another connection, which crosses from left to right and from top to bottom, is «scientific imagery», which is devoted to visualizing natural things such as the world of the cell, the universe from satellites and telescopes, the DNA spiral, etc.; that is, natural things which are real as life itself but which look as if they are totally invented images. Then there are the computer graphics based on mathematical models of natural phenomena, such as complexity, chaos, fractals; still directly inspired by the real appearance of nature and without any *a priori* artistic pretensions, these graphics provoke fantastic and often very beautiful images.

With computer graphics imagined objects can adopt an electronic existence which makes them calculable so that the working field of their creator is extended to an extraordinary extent. As with all technology, the computer acts as an amplifier of a human ability. When the computer creates images, it amplifies this creative ability with an amplifying effect far greater than that provided by a camera. René Berger, a French art critic interested in new technologies for creation, says that the computer, more than any prosthesis, is destined to become an organ for the creator of images, an organ as much part of himself as a hand.

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Who are the users of computer graphics? Who are those that are at present producing images with the help of a computer? The computer for making images was born in the military and scientific laboratories. Those who at once set to use them, and those who, in fact, were responsible for the relative spread of this type of image, were industry and its professionals.

The industry of the production of computer images experienced a yearly growth of about 500% between 1985 and 1988, of which 50% was attributable to North America, 33% to Europe (the U. K., France, Germany, Spain and Italy) and 14% to Japan.[1] Although this might seem a very high rate of growth, this industry has, in fact, not progressed at the speed initially anticipated; industrial computer-aided design (CAD), for example, is another sector in the application of computer graphics that has grown much more.

One of the difficulties from the industrial point of view has been, until recently, the need to manufacture not only images but also the programs that allow these images to be produced; this implies the co-existence of two activities —the manufacture of software and the production of images— which are very different from the industrial point of view. The companies, moreover, depend on machinery which is in a process of constant development and which has very few norms; there is no guarantee that today's technology will also be of use tomorrow. They also depend on persons whose opportunities for formative training are practically non-existent and whose experience is thus a scarce and highly sought after value. The result of this series of difficulties is evident: industries devoted to synthetic images appear and disappear in a very short time; those companies that have been in existence for more than five years can be counted on the fingers of both hands.

The first computer images produced industrially in significant quantities were the «flying logos», that is, logos and anagrams of trademarks in movement, each of about ten seconds, to be added to publicity sequences. With this type of animation there is usually no metaphor; it is simply a matter of giving tridimensionality and movement to an emblematic figure.

Among the principal consumers of computer images are television stations, which use them to introduce programmes. Television headings try to describe, usually in no more than a minute, what is coming in the next hour or so. They are images which must be carefully formed, since they are seen repeatedly. This application, increasingly successful, brings into play one of the peculiarities of the new language: the ability it has to represent, to abstract ideas. Most headings opt for purely formal solutions, which constitutes a prolongation of graphic illustration, with movement. But the best headings are those which, besides effectively symbolizing the programme they head and being attractive in form, have a meaning in themselves.

One important sector of industry that manufactures and consumes images, and for this very reason is well disposed to using the computer as a tool, is publicity. However, the number of spots produced by computer compared with the total number of publicity spots that are made is ridiculously low. At the last Festival of Publicity in Cannes not one single computer spot was presented, which goes to show both the dearth of productions of this type and the low degree of interest on the part of advertising agents in promoting them. The few computer produced spots that do exist tend to present the image of a make or brand, promoting an ap-

1. Roncarelli, R., *The Roncarelli Report 1988*, Pixel - The Computer Animation News People, Inc., 1988.

proach to a whole rather than to a single specific product. This demands a certain quality of abstraction in the message but abstraction is not precisely the favourite method of the advertiser. From the industrial point of view, companies that produce images by computer find themselves waiting for more favourable and less conservative winds to blow across from the creative temples of the advertising agencies.

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James Blinn is one of the persons with greatest charisma in the professional world of computer graphics. He was one of the first, among other things, to apply computer graphics to teaching and education. Blinn, besides creating very important algorithms for the representation of images, has taken part in audiovisual documentaries, such as *The Mechanical Universe* and *Mathematics!*, in which the explanation of concepts of physics and mathematics rests on synthetic images. Blinn combines the irony of the drawer of comics with an exceptional mastery of computer graphics; the result is images which attract and explain at the same time. Synthetic images serve well in helping to visualize concepts and Blinn is one of those who has demonstrated this.

Another field for the application of synthetic images is scientific imagery, that is, images which scientists use in order to investigate and to discover. Since 1987, in the heart of the ACM, one of the two most important computer associations in the world, there has been a movement in favour of the spread of computer graphics visualization tools, no longer merely interesting but now indispensable, according to this movement, for the progress of science. Bruce McCormick, Tom DeFanti and Maxine D. Brown are part of this movement and are the authors of a document which sums up the present panorama of scientific imagery and its needs for the future. They say in this document:

> Scientists need an alternative to numbers. The use of images is a technical reality nowadays and tomorrow it will be an essential requisite for knowledge. The ability of scientists to visualize calculations and complex simulations is absolutely essential to ensure the integrity of analyses, to promote scrutiny in depth and to communicate the result of such scrutiny to others [...]. The purpose of scientific calculation is looking, not enumerating. It is estimated that 50% of the brain's neurons are associated with vision. Visualization in a scientific calculation is aimed at putting this neurological machinery to work.[2]

The application of computer images thus presents the following panorama: the audiovisual industry, especially television, has adopted the computer as a creative implement; it is supposed that educators will soon realise its advantages; scientists are increasingly regarding the computer as a tool for getting to know and for discovering. It is a question of experiences which show the ability of computer images to communicate, to abstract, to explain, to know.

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The first examples of computer created animation, the offspring of scientists and image technicians, are characterized by their certain obsession with demonstrating the technically most spectacular visual effects. Carl Rosendahl calls this stage *Techno-marvel*,[3] a stage which passes like adolescent acne. Following this stage there comes a tendency to imitate other not so distant language, such as illustrations and traditional animated cartoon, just as photography did in its day with regard to painting or the early cinema with its insistence on imitating the theatre. Once these youthful illnesses of self-indulgence and imitation have passed, then the way is clear for a language with a personality of its own and with original expressive ability. Broadly speaking, synthetic images are now at this stage of clarification, according to Rosendahl.

Books and articles referring to computer art are concerned above all with static images; animated images are cited as being interesting experiences but too conditioned by the stigma of technology or by their industrial/commercial motivation. Static computer images are in the phase of being openly explored by persons with artistic training, while animated images are still at the point of having passed through a first stage which these same persons manifestly repudiate.

The static computer image, by reason of its far less exacting technical difficulty, is now relatively well established as far as cost, interactivity, etc., are concerned, so examples of the work of static image computer artists are more abundant. Notable computer generated static images are those of Barbara Nissam (delicateness), Latham (impossible objects), Kimura (exquisiteness of form), among others. It is the British painter Harold Cohen who has gone furthest: once the parameters to describe the figures, the colours and the composition have been entered, his programs automatically paint the pictures onto a tracer, pictures which the painter himself then transfers to canvas. Another notable example is that of Matta, the famous plastic artist, creator of a series of semi-animated sequences carried out with a Paintbox, an experience which Matta recognizes was easy and gratifying for him. By the way: as an alternative to the technologies of destruction and in support of the human ones —as the computer for the creation— Matta himself, in his reference to «animate» meaning

2. McCormick, B. H., DeFanti, T. A., Brown, M. D., «Visualization in Scientific Computing», *Computer Graphics*, 21, 6, 1987.

3. Rosendahl, C., in the round table «Four paths to Computer Animation: Entertainment, Broadcast, Education and Science, will their futures converge?», SIGGRAPH '88, Atlanta, 1988.

'to give anima', proposes the following inphographic warcry: «To the anima, cityzen!»

Although they may be formally original and different, static images by computer nevertheless remain imitations of arts such as painting and photography. The result is that, from the point of view of a new language, this kind of image contributes nothing specially significant. On the other hand, animated images *do* contribute something. Painting, photography and the cinema have created a flat visual tradition of only two dimensions, or at most two and a half in the case of the cinema. This tradition can make one believe otherwise but a world of two or two and a half dimensions is a completely fictitious world. On the other hand, the language of synthetic animated images opens up for the artist a world of creation which has, for the first time, three dimensions (four, counting that of time); in the words of Escher the world of three dimensions is «the only true reality we know».

Among the creators of the animated image, the ones that stand out are those who program their own software, in this way succeeding in imprinting their works with noticeable personality. Yoichiro Kawaguchi, for example, bases his work on a program written by him in 1984, which reproduces the form and rhythm of growth of the shells of mollusc and other submarine creatures. Michel Bret, a French computer artist, achieves with his programs an aesthetic style in the line of Kawaguchi. David Em is another animator; he uses the programs of others, precisely those of James Blinn, but he uses them in his own way to animate planetary landscapes. One of the problems with «style» animation is the premature exhaustion of this style: the figures tend to be repeated and the visual effects call up immediate reminders of others.

One of the first creators of animated synthetic images, although based on analog systems, is John Whitney Sr., responsible, together with Saul Bass, for the credits of Hitchcock's film *Vertigo*. In 1960 Whitney founded the company Motion Graphics Inc., which makes him not only a pioneer in the field of the artistic synthetic image but also one of the pioneers in that of the industrial synthetic image. The sequences of John Whitney Sr., like those of his disciple Larry Cuba or those of Adriano Abbado, represent a different style of computer image. Their images correspond to musical harmonies; their base is periodic mathematical functions which take their inspiration from music which is also periodic. The dream of these men is to succeed in playing the computer in real time in the same way that a musician plays an instrument. Whitney said of his pioneering experience:

> It is ironic, as it were, that most artists who experiment with the computer must face the fact that all their graphic conceptions must be translated into numerical functions. After a period when I tried to resist this considerably tedious task, I now welcome the mathematical base of computer graphics, precisely because of the structural advantages I have discovered in it [...]. My acceptance of this has opened the door for me to a new kind of visual design in movement, the true essence of which is digital periodicity [...]. This is a very similar world to that which the composer has known for at least a thousand years, dedicated to composing his works with a base of audio periodicity.[4]

All cases of synthetic images suffer from the same limitation, their visual quality, which is not really the consequence of a limitation of the computer but rather of using such a limited support as video to show the images. Technically the computer is capable of making images to any degree of resolution required, although images with resolution equal to that of the cinema are far more expensive to produce. John Whitney Sr. himself affirmed in 1970 that the artistic reputation of computer animation would only come through the use of support devices of a quality superior to video. This argument may equally serve to explain what has happened in the world of television, a medium which has proved its ability to communicate information but which is rarely able to reveal itself as an original and powerful medium of expression. Apart from musical clips and publicity spots, television programming has relegated the creative urge to cinema sessions or, much more specifically, to programmes for the nocturnal avant-garde. This is doubtless due to audience measurement figures and to the commercial demands in which all television appears to be inextricably entangled, but something can also be attributed to the difficulty in creating really handsome images with a base of 625 lines.

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For the synthetic image to serve as a language that is also creative, there are two principal needs to be met. One is the cheapening of computer equipment so that this is within the reach of a wider community of workers in the field; the other is the improvement in its interactive properties, such as the reduction of its technical complexity.

Progress made in the purely electronic aspect of computer graphics, as in computer science in general, is impressive. In 1984 a graphics unit reached a processing speed of 1 MIPS and the processors specialized in images reached 40 MIPS; in 1987 a unit already gave 10 MIPS and a processor 800. Today there are units of more than 100 MIPS and processors which exceed the million. On the technical horizon we can also discern a series of innovations, such as calculations in parallel, transputers and neural computers, which will permit a much shorter time for calculation, above all in «rendering». Together with this geometric increase in power,

4. Whitney, J. H., «A Computer Art for the Video Picture Wall», in Russett, R., and Starr, C., *Experimental Animation*, Da Capo Press, 1976.

there is also a constant lowering of the prices of these machines: somewhere around 40% a year.

From the electronic pen and the potentiometers of *Sketchpad*, however, it cannot be said that there has been any great development as far as interaction tools are concerned. In a present-day installation the only new things are the mouse and the icon and window systems, which were invented by Xerox in 1972 and popularized for masses by Apple's Macintosh in the eighties. The man/machine dialogue is carried out with tools similar to those in use since the beginnings of computer graphics. However, there have recently appeared a number of inventions which will without doubt lead to progress in the interactivity of these systems. These new devices permit interactivity in three dimensions, instead of the previous two-dimensional interactivity. VPL's «data glove», for example, transfers the hand of the operator to the inside of the screen so that he can grasp the objects and figures as if they were real. Likewise, NASA is investigating a setup consisting of a data glove, voice recognizer and glasses to project the image in front of the eyes, which are capable of taking in views of 360 degrees. Another new invention is the «eye-tracker», able to respond to movements of the retina, or the «spaceball» for moving objects as the mouse does but with six degrees of freedom instead of two. Jaron Lanier, the inventor of the data glove, says that the interactive scene will make us participants in a «virtual reality».[5] There exist systems of image projection, like *Showscan*, which are already beginning to offer this reality: the spectator sits in a seat which moves in relation to the movements and effects taking place on the screen. Thus, as a prolongation of computer graphics, a new kind of means of communication is coming, in which, besides audiovisual sensations, sensations of a mechanical, tactile nature are brought into play.

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A fundamental aspect of computer images is the software, that is to say, the package of programs which, when inserted into the computer hardware, tries to simulate the logic of the activity of the one who wishes to visualize an idea, be he scientist or artist. The software brings into play what is «soft», that is, smooth ideas and, perhaps, ethereal emotions. The evolution of software has lagged considerably behind the hardware, thus provoking the technological orgy of the first synthetic images, closer to the medium —to the support, to the material— than to the message.

Despite the abundance of slogans like «in real time» or «your imagination imposes the limits», programs are still limited in their ability to animate figures. Until now programs have been made for the visualization of a real appearance, which, apart from the technical origin of software factories, is attributable to the greater accessibility of knowledge about the real optics and physics of bodies than of anything else, with the result that what can be modelled are this real optics and this real physics. Modelling a graphic style, for example, is something far more difficult, because the mental process that leads to a particular way of designing is very difficult to codify.

The software building rises brick upon brick; each piece of software rests on one or more other pieces beneath it, whose job is to carry out more primitive functions. In the construction of this building various signposts stand out. For Roy Hall these signposts are the following algorithms: geometric softening; «antialiasing»; the mapping out of materials and geometric parameters on surfaces; the mapping out of reflection; illumination; generators of data such as particles, fractals, etc.; methods of recursive and distributed drawing of rays and «radiosity» techniques. They are algorithms for achieving realism in the images, although, of course, they can be used for non-realistic effects. The use of these techniques, however, is not free from problems. Roy Hall himself comments:

> There are many techniques available for generating spectacular images. But to succeed in generating the desired results, these techniques often require special programs and a tremendous interaction on the part of the operator. In creating images, the usual thing is for a condition to be created in which the computer is part of the problem rather than of the solution. One of the challenges of research in this field is the continual development of new techniques. The challenge is to convert these techniques into tools that will help to solve the problem instead of being part of it.[6]

Suppose an animator has to visualize in a sequence the flight of a swarm of bees. With existing programs he will have to animate each and every single bee; if the cost is reasonable, the result will hardly be credible. The animator needs a program that will define the trajectory of the swarm as a whole and this program must also be capable of calculating the individual trajectory of each bee, including the interaction of its neighbours. Thus the animator needs the help of a kind of apiculturist/mathematician, a programmer who will first devote himself to describing the behaviour of the swarm as a mathematical model. In order to advance, computer graphics needs knowledge before machines and before programs. It needs mathematical representations of things, and it is because of this that computer graphics, as a means of manufacturing images, connects with the deepest tradition of science. The difference is that the objects of study of computer graphics are not natural phenomena but the aspect of these phenomena.

The spearhead of present research into software is devoted to the modelling and codification of the behaviour of objects, once their visual representation has been resolved. This research attemps to reproduce automatically the movement, reactions and performance

5. Lanier, J., «Virtual Reality», IMAGINA '88, Montecarlo, 1988.
6. Hall, R., «Algorithms for Realistic Image Synthesis», Course notes, ACM SIGGRAPH, 1988.

of objects by simply describing the general laws of their behaviour and the behaviour of the physical environment which harbours them.

Craig Reynolds is the creator of a program of this type, which was applied in the productions *Behave*, by Rebecca Allen, and *Stanley & Stella*, in the latter for the animation of a school of fish. In a similar vein are the programs of Karl Sims for the animation of particles, in which masses of very small objects are animated, something visually useful, for example, for reproducing effects such as waterfalls. Sims has used his particles programs not only as a demonstration of technical skill but also as a demonstration of undisclosed expressive possibilities; one of his shorts, *Particle Dreams*, has gained international awards for its aesthetic originality and quality.

Another example in the same vein is the simulation of the dynamics of bodies. In this case the simulation is that of the behaviour of bodies composed of specific materials in natural physical environments: balls falling down a flight of stairs, tissues dropping down onto furniture, prisms of royal jelly bouncing on the floor... Noteworthy too are the studies of James Hahn (rigid bodies), Jerry Weil and Alan Barr (flexible objects). Their differential equations and their programs reproduce the movement of these bodies, taking into account all the physical parameters which act in reality, such as the moments of inertia of masses, the distribution of forces, the structure of materials, etc.

One of the recurrent motifs in the naturalistic school of computer graphics is the human body and face. It was Frederic Parke who began this type of research at the end of the sixties; following him there has come a series of investigators like Keith Waters and Daniel and Nadia Thalmann, who devised a system of programs called precisely «The Human Factory», with which were created the famous animations of Marilyn Monroe and Humphrey Bogart. Another recent synthetic human example is that of DeGraf and Wahrmann, called *Mike, the talking head*. DeGraf and Wahrmann have set as their final objective the creation of a speaking bust, a kind of synthetic announcer, which would perform in real time in the same way that a musical instrument responds immediately to the actions of programs through a MIDI interface.

Far more than the friendly attraction that replicas of behaviour and humanoids evoke in onlookers of in artist-spectators, what is most notable in the evolution of software is the creative potential it unleashes. The existence of simulators of a more general type can now be envisaged, in which their inventor will, before everything else, define the behaviour of his imaginary characters, characters which, in their turn, will inhabit environments that will no longer respond to natural physical laws but to laws that have also been invented. The graphic computer, in the future, will therefore be a most powerful simulator.

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The computer is an instrument prepared for trial and error, with its properties of erasing, repeating, copying and simulating, properties which have great advantages in tentative processes such as the creative process. This in itself would be sufficient to refute the typical accusation laid against the computer as being an instrument which excessively mediatizes the creative task, which restricts or eliminates the possibility of purely intuitive action. But besides this, experience corroborates a practice in which intuition is indispensable. A creator of computer images cannot foresee the visual result of every single one of the programmed effects; he has to see them to be sure of their quality. He even frequently plays with the surprise factor: sometimes the images he obtains are different from but surprisingly better than what was expected, the phenomenon the English call «serendipity».

In a meeting at SIGGRAPH '87, Alan Barr spoke in favour of those models for creating images based on determinist and exact models as a means of improving the traditional way of creating animation. For his part, William Reeves said: «There will always be something the animator does which a differential equation will never be able to represent.»[7] Barr represents the realistic school of computer animation, while Reeves represents the more imaginative and intuitive school. One school complements the other and the development of computer images is unthinkable without a deep mutual influence between them.

In the use of the computer, reason and intuition live side by side; the acceptance of this fact owes more to an updating of attitudes than to the overcoming of some objective difficulty in the computer. With respect to this modernization of attitudes, Herbert Franke says:

> It is not a question of replacing conventional methods of artistic creation with electronics or with a machine. What makes sense is to use all possible means so as to extend the field of artistic expression. In order to give form to artistic innovation, art in all epochs has used the means of its day. This has never occurred solely for technical or practical reasons; it is also determined by the communicative behaviour of the public.[8]

Reason/intuition, reality/fantasy, hardware/software, science/art. The dialectic of duality hovers over computer images, which has its social repercussion in the fact that, in order to create them, both technical and creative personnel intervene at the same time and nei-

7. Frenkel, K. A., «The Art and Science of Visualizing Data», *Communications of the ACM*, 31, 2, 1988.

8. Franke, H. W., «Refractions of Science into Art», in Peitgen, H. O., and Richter, P. H., *The Beauty of Fractals*, Springler - Verlag Berlin, Heidelberg, 1986.

ther group can do without the other. There are those, such as the patriarch of computer science, Donald Knuth, who affirm that between the task of constructing a program and the task of conceiving a work of art there is less difference than might be imagined, so that one can arrive at the point of talking of «the art of computer programming». But it is true that, in his work, the programmer/operator of images is subject to much stricter laws than the creator of these images, which explains the difference of personality between them. Kenneth Knowlton says:

> The external actions [of the programmers] are separated from their emotions by layers of logical defences which always enable them to reply to «why» they have done some particular thing. Artists, on the other hand, seem to be more free, illogical, intuitive, impulsive, implicit, perceptive, sensitive and vulnerable. They sometimes do things without being able to say why they do them and one must be obliging enough not to ask them.[9]

There may be men and women capable of combining technical knowledge and aesthetic knowledge at the same time, but there will always be a level at which it will be necessary to specialize in both jobs. Images of synthesis are the result of synthesis of skills.

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The specialization of those who make computer images has its almost perfect analogy in what is experienced when it comes to the writing, production designing, photographing, editing and developing of a cinema film. Producing images for computer, because of the method of working and of the brevity of sequences, is like making films on a small scale. The ideal background for a computer image designer/creator is, besides graphic design, the cinema: the cinematographic language of editing, movement and camera angles, etc. The most suitable background for a technician in computer graphics is without doubt computer science but it is even better if this is accompanied by a knowledge of the cinema, even if this is amateur.

The animated synthetic image drinks from the founts of the cinema, of the cinema of animation in particular and of all cinema in general. In this sense, reflection on the language of synthetic images in the light of the language of natural images —the cinema— can be illuminating. There appears a curious difference of birth between these two types of image: if the first cinema images were the demon and life —this is why the first zoetropes were called «the devil's wheel» or «the wheel of life»— the first synthetic images were fighter planes and teapots, which corresponds with the military and university environments in which they were cradled.

9. Quoted by Goodman, C., in *Digital Visions*, Harry N. Abrahams, Inc., New York, and Everson Museum of Art, Syracuse, 1987.

Can the computer be used to tell stories? The fact is that computer stories tend to be rare. There are very few examples in the cinema, owing, above all, to the high cost of production but also to the lack of enthusiasm shown by the Hollywood industry in this respect, after a number of attempts which coincided with economic failure. Really, these failures are not a consequence of the unsuitability of the synthetic image but rather of the fact that feature films with this type of image attract the weaker type of scripts. The man who has done most to visualize stories by computer —although very short and with simple plots— is John Lasseter, a former Walt Disney animator and at present a member of the Pixar company, whose best publicity is its annual film. Thanks to this modern patronage, Lasseter gained an Oscar from the Hollywood Academy, awarded in 1988 to *Tin Toy*, which is the first Oscar for animation received by computer images. He had previously directed the animated films *André and Wally B.*, *Red's Dream* and *Luxo Junior*, which received an Oscar nomination in 1986. Other computer storytellers are Philippe Bergeron, the principal animator for the classic *Dream Flight*, *Tony de Peltrie* and *Stanley & Stella*; and Bill Kroyer with his *Technological Threat*, although in this short, as in *Oilspot & Lipstick* from Walt Disney, the computer was not the exclusive medium of production.

One of the areas which aroused great expectations in the early days of computer graphics is that of the animated cartoon. But so far, animated cartoons have used the computer only in an indirect way, due to the fact that it has still not proved possible to represent the method and creative style of an animator (the style applied in the deformation and evolution of figures) further than the standard systems of interpolation among key photograms, which are purely lineal systems. Present-day software imposes the undeformability and rigidity of the figures, which constitutes a creative obstacle, especially to the telling of stories based on deformable caricature, so characteristic of the animated cartoon. This kind of software, however, is progressing in a significant way in the next few years, which will end up by marrying the synthetic image with its most natural relative in the film family (a visual creation quite unknown —apart from Disney, Hanna Barbera and one or two other giants— and undervalued).

The computer is an instrument with which to underscore, from a theoretical point of view, all the creative potentialities of the cinema. Rudolf Arnheim, in his book *Cinema as Art*, gives a theoretical justification for the artistic potential of the cinema after analysing the creative resources contributed by the camera, the editing process and the cinematographic tape. But if, in this book, the word «camera» is replaced by «computer» and the cinematographic medium is extended to that of computer graphics, then all its arguments become even more telling. Arnheim says, for example:

> The cinema artist selects a certain scene he wants to photograph. Within such a scene he can exclude ob-

jects, cover them up, make them stand out and, in spite of all this, not clash with reality. He can increase or diminish the size of things, he can make small objects appear to be bigger than the large ones and vice versa [...]. [The cinema artist] shows the world not only as it appears objectively but also as it appears subjectively. He creates new realities in which he can multiply things, reverse their movements and actions, deform them, slow them down and speed them up. He instils life into magical worlds in which the force of gravity disappears [*sic*], where misterious powers move inanimate objects and where broken things put themselves together again. He establishes symbolic bridges between events and objects which had no connection with reality. He intervenes in the structure of nature to transform concrete bodies and spaces into flickering and disintegrated spectres. He paralyses the flow of the world and things, converting them into stone. He infuses life into the stone and invites it to move. From a chaotic, limitless space he creates images of beautiful form and deep significance, as subjective and complex as those of painting.

These words were written in 1957, when no one thought of the computer as an instrument for making images, but they can be applied to the computer much better than to the camera. Arnheim closes one chapter of his book with these other words, also transferable to the synthetic cinema:

> It must be recognized that the great majority of cinema directors do not apply much originality to the use of the artistic means at their disposal. Instead of producing works of art, they recount anecdotes to the public [...]. In spite of everything, there are a considerable number of films which reveal, in certain scenes, in the use of certain resources, in the effort of certain actors, just what this art could be, just what is still hidden and unexplored. And in matters of art there is nothing to prevent one from holding on to the little that is good instead of paying attention to the profusion of what is bad.[10]

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The medium of computer graphics opens up a horizon which stretches beyond a simple increase in the number of means of communication and expression. The culmination of computer graphics will be to convert images into manipulable symbols, in the same way that the notes and the stave constitute the objects involved in the language of music, and the letters, words and sentences constitute the objects of the spoken and written language. Like music and words, images will have profound repercussions on the cultural and civilizing environment; herein lies the importance of the computer as a medium capable, for the first time, of objectifying them.

Words have conditioned our culture, or rather the form of our culture, raising our sense of hearing —the most sequential of all— above any other sense. But it is a proven fact that the human eye is capable of processing a flow of information some ten times greater than the rest of the senses all together. As a means of communication, the image is profoundly different from the word. If the language of words is one-dimensional and sequential, the language of images is, on the other hand, multidimensional and furnishes information as a network, as a simultaneous set of messages. The image allows for the expression of an overall picture but one which, at the same time, is rich in details; the image makes possible the expression of the nuances and diversity of truths. If the word is the ideal vehicle for orders, the image is ideal for tolerance.

There is no guarantee, however, that images, every day more abundant on a planetary scale, will promote a culture and a civilization in a truly tolerant and creative direction. This depends in the end on the intentions of the men and women who use the technology —camera and computer— which serve to produce these images. It depends, therefore, on the concepts and objects —which exist before the images— which are to be visualized. The computer makes this dependence tangible, breaks through the limits which until now have existed in the creation of images and, consequently, facilitates the consolidation of this culture of images, a culture which includes among its agents scientists, educators, manufacturers, artists and, above all these, the powerful.

Ivan Sutherland, in the days of *Sketchpad*, said that one of the most important problems which computer graphics systems would face would be the definition of methods for abstraction. Now twenty-five years older —both he himself and the computer graphics he invented— Sutherland recently said: «The most exciting thing about computer graphics is that it enables you to make abstract concepts real, but this is also the most difficult thing to achieve because it implies visualizing new ideas.»[11]

Visualizing new ideas: this is probably the best for the new iconic language in industry, education, science, art or the corridors of power. In short, the language born of computer graphics promotes a different type of imagination.

10. Arnheim, R., *El cine como arte*, Paidós, 1986.
11. Frenkel, K. A., «An Interview with Ivan Sutherland», *Communications of the ACM*, 32, 6, 1989.