The Digital Art: Pictorial Arts from the Computer
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FROM PLOTTER SKETCHES TO INTERACTIVE GRAPHICS

The roots of artistic activities are buried somewhere in the darkness of prehistory–and this applies also to pictorial arts. The chances to get an impression of the development of motivations, the motivations themselves, and the different styles are much better in respect to those forms of art, where technical media are employed, for instance the different kinds of printed graphics, photography or film.

In the case of computer art ,we have the special situation to observe it still in its nascence. One of the reasons is, that the computer itself, as well as the graphic output systems, are still in development. In the short history of computer art–not much older than 20 years–a strong interdependence between the technical stage of development and the artistic possibilities can be watched. But even if this irritation by the continuously changing (and improving!) auxiliary devices should not exist, the time would not have been sufficient for the development of a canon of aesthetic rules, as in other disciplines, where it took hundreds, if not thousands of years. So books and exhibitions of computer art show an astonishing *omnium-gatherum* of makes and styles, a wide variety of different and sometimes contradictory conceptions, some being completely in contrast to the traditional rules of pictorial arts, some being absolutely trite, others being indeed astonishing artistic innovations. To him, who prefers consolidation, self-contention subject to rules and criteria, to him the playground of computer art must seem somewhat dubious.

Nevertheless it must be extremely remarkable to him, who is interested in the interdependencies between the artistic means of expression and the modern technical media–always considering our perpetually changing society. Furthermore, nevertheless, some of the expressions of computer art show traces of new artistic ways, which seem worth to be followed.

PRINT AND LINE GRAPHICS

The automatic printers used by computer artists were in no way developed for aesthetic purposes. They rather served the objective to express information hitherto out in the shape of long data lists in a concise–a graphic–shape.

The first computer graphics were graphs and block diagrams without any artistic ambition. Consequently the computer–with a graphical system assigned to it–turned out to be a very effective playing and design instrument, and many of those mathematicians and programmers usually considered "dry" persons started spontaneously with free graphic experiments. When in 1963 the editorial staff of the "Computers and Automation" magazine invited entries for a computer graphics contest, many more prints were presented than expected and some of them are still respectably good from today's point of view.

The year 1965 is considered the year of birth of pictorial computer graphics. Independently from each other, three mathematicians and programmers presented to the public what they designated "computer art". They were the two Germans Frieder Nake and Georg Nees and the American A. Michael Noll. They worked with computer controlled mechanical plotters, designed for simple line printings. If the painting of areas was desired, one had to put many lines (as thick as possible, e.g. with felt-tipped pens) as near to each other as possible.

Impeccable results were limited to vertical and horizontal lines, everything oblique was reduced to a staircase-like approximation. These limited possibilities naturally influenced the style: The principle of "horizontal–vertical" dominated the first computer graphics–lines crossing each other and squares. Anyhow, there was one peculiarity- The use of random generators. Although some of the neoconstructivists, e.g. Herman de Vries, had introduced random factors in their works (but with the aid of stochastic calculation processes integrated into the programmes), the computer artists came to much more complicated and thus more interesting results.

These graphics, very close still to strict mathematical thinking, lead to the erroneous conclusion, that artistic computer graphics are limited to sober geometrical figures. Although a number of examples has proved in the meantime, that any stylistic conception is open to realization by computers, this prejudgment is still alive as tough as ever even in the era of screen graphics. For the rest, the mechanical plotter has not completely lost it rights, for instance for the plotting of architecture or electric switching diagrams. The newer models work so exactly, that every curve whatsoever may be reproduced with sufficient exactness–and thus many important restrictions in the artistic field have disappeared. Some artists, in fact, prefer line plotting even today.

In the sixties there were only a few computer controlled designing units, the common means of data output was the fast printer. Now this instrument cannot be considered an ideal thing for the production of drawings, nevertheless it was used for this purpose at least as an expedient. An early example is given by Katherine Nash, other artists using the printer mainly for sketching purposes. As an example we name the Spaniard Manuel Barbadillo, who occupied himself with the permutation of graphic elements.

CONCRETE IMAGES

One of the objectives near at hand for every artist is the reproduction of real objects. early examples are to be found in the area of technical and scientific computer graphics. William A. Tetter, for instance, has become famous for his representations of different positions of a person in the cockpit of an airplane–for ergonomic studies concerning the optimal cockpit design. Although his creations originally had nothing to do with Art, their aesthetic note was unoverseeable since the beginning; even today they are considered remarkable examples of figural computer graphics.

With the reproduction of persons and things also professional artists inscribed themselves into the list of computer graphics' artists. So the team formed by Charles Csuri and James Shaffer–an artist and a programmer -, who became famous when winning the first prize of the "Computers and Automation "-Magazine's contest in 1967 with their portrait of the "Sine Curve Man" (this prize being regularly awarded and institutional by now). The works of the Canadian Leslie Mezei must be mentioned. Like Charles Csuri his work is based on hand-drawings "fed" into the computer and processed. So, fascinating variations were developed Csuri and Shaffer for instance superposed reproductions of a woman's face at different ages, and Leslie Mezei distorted the outline of a beaver in a raster field.

This method of work already shows the transition to the so-called picture processing. The goal of this technique was originally the amelioration of photo- or video-recordings, later on it turned out to be an independent scientific-technical area of work, of digital analysis of images. The same techniques used by the scientists for the improvement of images are exploited by the artists in order to alienate images. One of the pioneers of this method was the

German Manfred R. Schroeder–then living in the USA–who made his first experiments with this method on a multiply variated photo of a girl. But also the early works of Kenneth C. Knowlton, H. Philip Peterson–Americans both–and of the Brazilian Waldemar Cordeiro are worth mentioning.

The transformation of pictures by means of picture processing were still very complicated then. As in the case of programme-generated plotter configurations the basic information for the pictures had to be punched on card or tape, so that the work went on in different separate steps. Today the usual method of work is mostly interactive. This means that the image can be altered as often as desired without any time-lag, until the desired result is achieved.

COMPUTER GRAPHICS ON THE MONITOR

Only with the introduction of real-time processing, with interactive operation, did computer art overcome its dependence from technical methods and work processes. Technically the new methods were surely even more complicated, but they allowed the user to concentrate almost without reservation on the design activities. The decisive step was the use of the screen for the output of images. In the place of the slowly moving colour pencil we now find the practically lag-free deflectable electron beam. If on the mechanic plotter an image calculated in seconds could take an hour to produce, the image set-up is now negligible in terms of time. As soon as the programme is through the run, the image appears on the screen. It is expedient to work with programmes allowing graphical interference at any time: while the first version is still stored, desirable variations can already be tested and are immediately to be seen on the screen. Intermediate results may be stored and recalled, whenever desired, they may be brought on the screen together in diminished size.

Hand in hand with the improvement of the hardware also the advance in software design makes its welcome appearance. If programming until some time ago was a task requiring knowledge in mathematics, logic, and data organization, today we have problem-oriented languages the use of which can be learned within hours and trained within a few days.

The last step, finally, leads us to the so-called "paint systems", allowing the painter or graphic artist to use his traditional methods of image production. With the aid of a light-stylus he may draw directly on the screen, and still more in use is the so-called tableau, serving as a drawing plate, while the drawing appears on the screen. Some units offer a variety of many thousands of different colours in addition to a much better dissolving power compared to traditional TV-screens, with a screen-raster of many thousand lines and columns. For movie production even more sophisticated screens are available, offering even the quality of a photograph. And thus, all the restrictions imposing certain stylistic limitations have fallen. Many people discovered only recently, that the term "computer art" does not define a certain style, but rather a method, an instrument.

It is strange that the use of paint-systems not only brings along greater freedom on one side, but also new restrictions on the other. The experience gathered in twenty years of programmed graphics shows that mathematical functions and processes mean a new design instrument, a new access to pictorial arts. If in traditional drawing and painting the interventions are only punctual, i. e. only the spot, where the pencil or brush touches, is changed, the mathematical method presents an instrument allowing the "integral" intervention. An easy example is for instance the change of colour all over the image, always at the computer artist's disposal. But there are many other possibilities, transformation processes, construction of gradients, matrix calculations etc.–all of them mathematical terms

forming graphically interesting variations of the images. The programmers deriving from science and technique have developed a high standard in this kind of image synthesis–too bad, that much of this is lost through the paint systems, which are too oriented towards manual dexterity.

3-D AND REAL SIMULATION

The change from plotter to monitor, too, was not initiated by artistic goals, but resulted from the sober necessities of technical applications. The latter had considerably spread out, constructions sketches, molecular models, weather forecasts, radiogalaxies . . . all that is represented today with the aid of computer graphics. In the last years a remarkable enlargement towards pictorial arts and design has taken place. The preliminary studies of the graphical artists have become commercially interesting. The most important applications. are in the advertising business and in the trick-film. Other actual applications can be found in business areas in the shape of the so-called business- or management graphics. The observer will notice that many of the computer-generated pictures are astonishingly real, in exact colouring and designed according to the rules of perspective.

Also these newly developed possibilities are based on real, demands of our technical world. The problem of perspectivity has been dealt with since the beginning of computer graphics research–for technical constructions, for instance–and the basic solutions are not new any more. But only now we have the systems necessary to carry out the immense number of calculations needed for three-dimensional reproduction in an acceptable amount of time. A special problem for instance was the question, which of the surfaces reproduced are in the foreground and thus covering the others.

Usually the starting-point is the so-called wire model: the objects are given as a skeleton by their edges only; but even this simplified graphical reproduction has its interesting aesthetic aspects and is widely used in advertising, for instance in TV-spots showing cars. For a real, image, several additional steps of approximation are necessary. After the calculation of the covered surfaces, the areas encircled by the edges are attributed a color, the degree of brightness is calculated according to the position of fictive sources of light. As a next steps the edges are "chamfered" and the surfaces bent accordingly, wherein the hard contrasts give way to soft intermediate shades. Finally the kind of surface can be determined–flat or glossy, metallic, relief-like patterned or glass-like transparent. In this way companies are enabled to reproduce products still in the phase of planning with a photo-like quality.

ARTIST/TECHNICIAN

In a certain sense the situation at the beginning of computer graphics is now repeated- The modern systems are so expensive, that a merely artistic use cannot be justified. The few professional painters and graphic artists trained on high-quality paint-systems are mostly entrusted with commercial objectives, and only once in a while a freely designed work shows up at an exhibition or in a book. A real bonanza in this sector are the yearly SIGGRAPH conferences in the USA, where the most important representatives of computer art gather. It must be remarked that art is not under-represented- The most popular presentations are those of computer-generated videos and films.

A new generation of computer artists comes on the stage- Many of them have collaborated in the technical development, but also use their medium for free artistical performance. So they are entitled to call themselves artists as well as technicians. Among them ranks for instance

Larry Cuba, who worked at the trick sequences of Kubrick's "2001–A Space Odyssey" together with the grand old man of computer films, John Whitney; not to forget James Blinn who not only worked out the Saturn and Jupiter photos for NASA, but also came forth with own image-creations, and Alvy Ray Smith, today in the computer team of George Lucas Productions. In the meantime a regular computer graphics training has established itself in the USA, the initiatives of Thomas DeFanti and Dan Sandin at the University of being of particular importance.

DYNAMIC COMPUTER GRAPHICS

The circle of fellow workers and students around the two artists/technicians Thomas DeFanti and Dan Sandin is particularly engaged in the study of motion graphics. Already the classical plotter graphics had turned out to be an excellent means of production for movies: A considerable part of the drawing work until then done by hand can be transferred to the computer. In this way single images of movement phases are printed, which give the movie sequence when following each other in the prescribed order.

The fast set-up of images suggests the wish to create moving sequences in real-time. If relatively simple configurations–from points and line-elements, for instance–are used, even the smaller home computers are capable of calculating the images so fast, that dynamic sequences are showed on the screen. For the first time in history the old wish for some kind of "graphic music" can be met, the free operation of colours and shapes is made possible, which had to express itself in coloured jets of water, fireworks and kaleidoscopes until now. For such kinds of creations we now have the full palette of computer generated images at our disposal. So the designer sets off 'into a new dimension.. Some insiders of the scene are of the opinion, that this be the real importance of computer graphics: a method of design impossible with any other medium.

The occupation with dynamic computer graphics leads to new experiences, for instance about the co-ordination of images following each other, of questions of measure and rhythm, of arrangements to the patterns of musical works. As the computer now not only allows the synthesis of images, but also of music, we find the ideal case that the design of an optical-musical opus can be made by one artist. On the other hand, naturally, a co-operation of dynamic graphics with traditional or modern musical instruments is possible. So the opportunity presents itself to send out signals with the same programme "painting" the elements of the image on the screen, signals to be received by an electronic music instrument and used for total synchronization. The programmes can be prepared in a way to allow a kind of graphic improvisation–an extremely stimulating free artistic activity.

According to today's technical possibilities real-time dynamic graphics are limited to relatively simple image structures, but the next step is already in view: the output of real simulated image sequences. Great interest is shown by the film industry, where they hope to be able to replace sooner or later the expensive scenery by computer-generated images. Some examples are already to be seen, for instance the film "Tron", where seventy percent of the backgrounds are computer-generated. Even though these were not synthesized in real-time, but image by image, there is plenty of hope that in the near future also this last obstacle will be overcome.

The pioneers of computer art were often told by their critics, that the instruments used were only accessible for a few people, thus computer art never could develop broad effect. The fast development of microelectronics has shown the invalidity of this objection. There are cheap

personal computers–not more expensive than a TV-set –which allow not only to create static, but also dynamic graphics. Practically the same applies also to the more ambitious methods, as the photorealistic image requires them–in a few years also those will be accessible to the private user.

When in the sixties the first examples of computer art showed up in public, everybody expected that the artists would start using the new methods with enthusiasm in order to fathom their hitherto unheard-of possibilities. The experience has shown that only a few were ready to take this step–and they already went beyond the limits of their training and activity. Similar to photography and to the movie business a new profession seems to be materializing, may be really something like the "artistic technician" or the "technical artist"–with the term "technical" referring only to the fact, that the artist is controlling the technical side of the medium. Many practical applications in everyday life are already visible today, comprising not only applied arts in every sense, but also the visualization of subject-matters in the educational area. More and more freely designed artistic works, nevertheless, will find their way to exhibitions and museums–and they will be integrated as easily as this has already been the case with plotter graphics.