BECKMANN'S STUDIO COMPUTER

## Horst Oberquelle, Oskar Beckmann

Abstract
At the time when the pioneers of computer art produced their works by programming mainframes, using plotters for output and began to show their works in public exhibitions the Austrian artist Otto Beckmann took a different path. He used a computer constructed by his son Oskar Beckmann, dedicated to the special art experiments his father wanted to make. This computer seems to be the second computer developed in Austria, after Heinz Zemanek's Mailüfterl.
Descriptions of the technical context of early computer art, the interdisciplinary team "ars intermedia", the development of the studio computer and works produced with it add to the history of computers in Austria and to the history of computer art.

1. Introduction

Looking into the history of informatics and its applications sometimes means to use an unexpected chance and follow many paths backward. This happened to the first author of this contribution. A short description of the research process may give an impression how Beckmann's almost forgotten *studio computer* was found and motivate others to follow seemingly uninteresting hints.

Two years ago the first author got some pictures as a present. Some of them seemed to have been produced by computers. Fig. 1 and Fig. 2 show two typical examples.
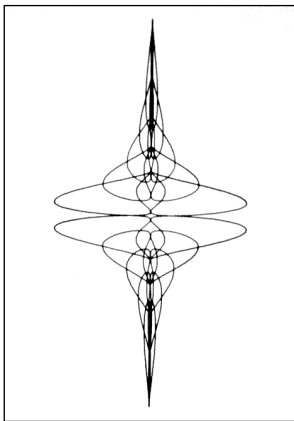
Fig. 1: Algebraic Curve
       Herbert W. Franke with
       Peter Henne, 1969
       silk screen printing

Fig. 2: Upraising of the Masses
        Beckmann / Beckmann, 1971
        aluminium plate, WVZ 90060

Not knowing what kind of material this was he asked two older colleagues, Frieder Nake at Bremen and Kurd Alsleben at Hamburg. Surprisingly, both of them knew most of the pictures: They were mostly reproductions of pictures by pionieers of computer art. By incident, he had asked two of the pioneers of computer art themselves. Pictures like that in Fig. 2 were on thin aluminium plates and had a hardly visible dedication scratched with a steel needle: "Dedicated to Käthe Schröder. Otto Beckmann".

It turned out that all the pictures were part of the 3rd version of an exhibition that had been sent around the world by the German Goethe Institute in the beginning of the 70ies. It had been prepaired by Käthe Schröder from Hannover, Germany. The Beckmann pictures looked very different from the others which had a very technical, abstract appeal. This was the starting point for the first author's research in computer art history. During this journey he digged into the history of early computer art (The best survey contains [11].), and finally met with the second author and his brother Richard Beckmann, and an intensive cooperation began.

The second part of this contribution will describe the context of early computer art and the mainstream approach. In the third part we describe briefly steps of the development of Otto Beckmann's work from using algorithms (already before computers were available !) to forming the interdisciplinary team called *ars intermedia*. In this context the *studio computer* was designed, built and used. Its description and examples of its use are the topic of part four and five. Finally, we will conclude with some reflections on the role of the *studio computer* in the history of computer art.

2. Pioneers of Computer Art and Their Technical Context

Pioneers of computer art started their work in the era of mainframe computers in the early 1960ies. Very few forerunners had used analog devices for producing aesthetically pleasing oscillograms (Ben F. Laposky, since 1953; Herbert W. Fanke) or curves (e.g. Alsleben in 1961). Since 1963 Frieder Nake began at TH Stuttgart to produce computer graphics on a Standard Elektrik Lorenz computer SEL 56, using the now available plotter Zuse Graphomat Z64. The work process was in batch mode: Programs were designed on paper, punched into cards, and delivered to the computing center. After running the program results were printed or punched into paper tape and delivered to the user. The Z64 made it possible to draw computed results very exactly. The commands for drawing - as a result of a program run - were stored on paper tape and fed into the plotter. It could use four different pens under program control. Drawing a medium sized graphic took a lot of time, often hours. The user did not have immediate feedback about the results. Any modification of a drawing usually took a long time, sometimes a day.

Alternative technical devices for graphical input had been invented already, but were not publicly available. Pointing devices like light-guns were invented in a military context (Project SAGE, 1955). Lightpens were developed in 1957 (MIT LincolnTX-0) and were used for graphic input by Ivan Sutherland in his famous system Sketchpad (1963). In the same year Douglas Englebart invented the mouse. Scanning technolgy for photos has been available since 1957, but only in special laboratories.

The graphical presentation of output was restricted to printers and plotters. Displays were used in measuring instruments like oscilloscopes. Storage tubes were introduced by Tektronix in 1966/67. Storage displays have the advantage of storing displayed material for longer time due to their special phosphor coating. Raster displays were not available at that time. The same holds for printing the content of displays. Taking pictures from the screen with a camera was the only way to keep display contents. The first text and graphics terminal Tektronix 4014 was invented not before 1974.

Using computers interactively was just on its rise. CTSS (1962) and Project MAC at MIT (1967) were the first timesharing sytems. The idea of a personal computer was formulated by Alan Kay in 1967/8 (Flex machine, Dynabook), but it took many more years for the first text-based personal computer to come (commercial success of IBM PC from 1981).

1965 is usually considered the birth year of computer art since in this year the first works were shown in public exhibitions. In January Georg Nees showed first examples in the Study Gallery of the Technical University of Stuttgart, in April the Howard Wise Gallery in New York showed pictures of A. Michael Noll, and in November works by Nake and Nees were shown at Gallery Niedlich in Stuttgart. All three of them were scientists and programmers with artistic interest. They

programmed digital mainframes and used plotting devices at their companies or institutes. The programs they developed were able to draw whole classes of pictures, and they used random generators for the generation of variants. They never knew in advance what a generated picture would look like. Many attempts were necessary to get pleasing results. Randomness was considered an equivalent for the intuition of the artist. The theoretical background of the Stuttgart group was the information aesthetics of Max Bense who tried to find aesthetic measures and had described the idea of generative computer graphics: using algorithms for the regular parts and randomness for surprise.

Shortly after the first scientists had used computers for aesthetic production artists began to use computers in their work as well. Manfred Mohr and Vera Molnar at Paris learned to program or let a specialist program, respectively. Harold Cohen dedicated most of his work to the construction of a program called Aaron which was able to produce artistic output. His work is considered fundamental meta-art by the AI community (see [9]).

Exhibitions since 1966 showed works by Alsleben, Nake, Nees and many other pioneers. Since 1967 Otto Beckmann was present as well. In a sense he came a little later and presented pictures of a very different kind.

3. From Early Algorithms to the *Studio Computer*

Otto Beckmann was a sculpturer by education. Long before computers were available he used algorithms for the construction of nice forms, e.g. of vases. By geometric construction (cf. Fig. 3) he found the form of the vase of Fig. 4. The details of this approach have been reconstructed by the second author [4]. They cannot be treated here. What is important is the fact that Otto Beckmann was familiar with many materials, technologies and algorithmic thinking, as well.
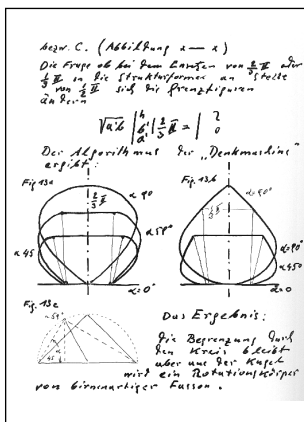
Fig. 3: Notes about the geometric algorithm, about 1940
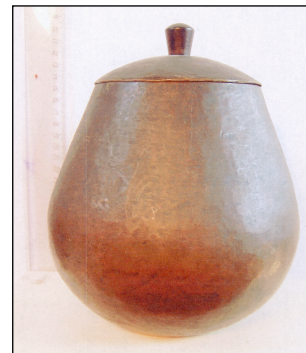
Fig. 4: Vase
OttoBeckmann, about 1940

In the early 1960ies he experimented with different forms of light: ultra-violet and polarised light. He was interested in making films with lighted moving plastic figures (called "cinematric films").

Otto Beckmann was probably first informed about the new computer art exhibitions by the Bauhaus teacher Georg Muche who had visited an exhibition with pictures by Nake in early 1966 at Darmstadt (see [10]).

In discussions with his son Oskar, a student of electrical engineering at the Technical University of Vienna (TH Wien), the idea of using technical random generators for art work was born. During the following months Otto Beckmann made contacts with people at TH Wien, especially in the research group of Prof. Kraus where the first Markoff generators had been developed (see [8]). They were used there to simulate noise phenomena on telephone connections which could be made visible on oscilloscopes.

Seeing this combination of using randomness and visualisation on displays triggered the formation of the interdisciplinary team *ars intermedia* in August of 1966 in Vienna. It consisted of the artist Otto Beckmann; his son Oskar Beckmann, the student of electrical engineering at that time; Alfred Graßl, a former assistent of Prof. Kraus, who had developed Markoff generators himself; Gerd Koepf, a specialist for laser technology; and Gerhard Schedl, a camera man.

In the beginning in 1967 Otto Beckmann made first experiments with support of Graßl at TH Vienna: Using different probabilities for the Markoff generators, they first produced penta-tone sound sequences for the sonification of the "Cinematric" films. In 1968 they began to produce pictures by manipulating the output on the storage oscilloscope (Tektronix 564B, 4(!) inch diameter, one of the first storage tubes) (parameters brightness, focus and astigmatism) and taking photos of it. They called them "electronic computer grafics". The analog Markoff generator and the oscilloscope were operated by Graßl under the supervision of Otto Beckmann, not by Beckmann himself. This technical setting was mentioned in [7]. Using Markoff generators, Otto Beckmann also refined his split technique for making sculptures: A rectangular plane was split into regions by a Markoff process. The resulting pieces were cut out and turned rectangularly against each other to form a sculpture. The retangle was hidden in the sculpture.
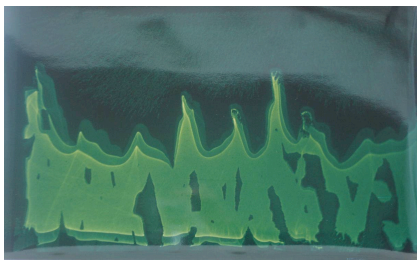
Fig. 5: Structure and Half-tone
Beckmann/Graßl, 1969
photo from slide, WVZ 23030

Fig. 6: Electronic Computer Graphic
Beckmann/Graßl, 1969
aluminium plate, WVZ 90048

In this context the idea for a special computer was born. Otto Beckmann was interested in a computer different from those used by the other pioneers:
"The efforts to get an own computer were motivated on the one hand by the insight that usual computers were not optimal for artistic work, and on the other hand by the wish to be independent" ([2], p. 6; translation H.O.) and "We considered it important that ars intermedia would be largely independent in its way of working and aims from material influences and intellectual patronat by established companies and institutions by having a computer of its own."(ibid.)

In addition, Otto Beckmann had a vision of a unity of art forms [6]: "The idea of a unity of art forms means that the key programs of different art forms have equal or similar structures with a common origin." (translation by H.O.) That meant that from the same basic structures graphics, sounds, films, and texts should be generated.

In a sense the circumstances were optimal. There was Graßl as a specialist for random processes, son Oskar Beckmann knew the Markoff generators from his studies at the TH Wien and dared to develop a special computer for his father. He started a new branch of ars intermedia at St. Pölten. He designed the *studio computer* in 1968-1969. In June 1970 the first version *a.i. /70* was operable. It was a hybrid computer build with analog and digital components. The heart of the computer was a Markoff processor with 8 states.

4. The *Studio Computer* and its development

The design of the *studio computer* was based on a cybernetic model of creative work (see [3]) in which the artist remained in the loop.
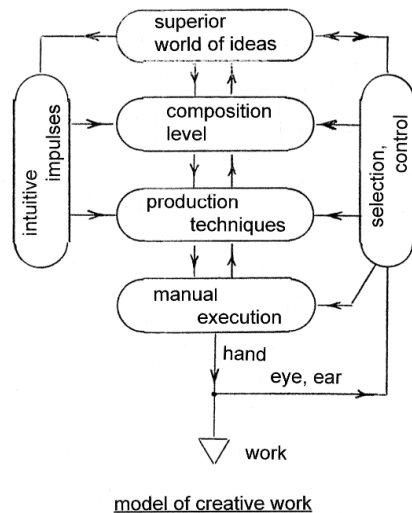

model of creative work

Fig. 7: Oskar Beckmann's model of creative work (translation H.O., [3], p.16)

The model shows four levels of work. On top we see the superior world of ideas of the artist. This level remains completely under his control. The second level, composition, was partially supported by the computer. The lowest level is the level of manual production. It can be transfered to a computer. The same holds for the third level. The upper two levels have to remain under the control of the artist. Consequently, Oskar Beckmann designed a computer which supported levels 1, 2 and partially 3, but let freedom for the upper levels to his father. Before we can discuss more details of how the computer was used we provide a description of the machine itself.

The fundamental requirements for the *studio computer* read as follows:
- A computer for the workplace of the artist, operated only by himself, i.e. by Otto Beckmann.
- Real-time interaction of the artist with the machine when significant results for a class of pictures should be obtained. This meant to be able to influence important parameters of the program while it was running, e.g. by pressing buttons or manipulating complete matrices of regulators. The "detour" of programming should be avoided. Output has to be very fast, in the range of 0.1 seconds.
- New classes of pictures, i.e. new algorithms, should be implemented by the constructor of the computer, i.e. by son Oskar Beckmann.

Different from usual digital computers, the basic elements were not integers, reals, characters etc. but those provided by the medium: amplitudes, frequencies, graphic symbols. The design even aimed at a system which could equally well be used for the generation of graphics and sound out of the same program.

The studio computer was developed in several steps. The basic version *a.i. 70* was running in June 1970, the first extension *a.i.70/71* in 1971. The computer was packed into a 19 inch rack and had a black & white TV monitor as its output device. The central component was a state machine, with state changes controlled by Boolean logic and probabilites. A digital random generator produced an almost "white noise" which was used for probabilistic decisions. Using correlated programs brought more expressive power to the machine.
The *a.i. 70/71* contained already several state machines operating in parallel. They were connected by logical, statistical or time relations. The output of the processors produced the components of an abstract multidimensional state vector, which was rhythmicly updated according to the cycle frequency.

In a second step each state vector was mapped into a picture element, controlled by the components of the state vector. By these mappings coordinates, brightness, form and texture of picture elements could be controlled, for instance.

A third step was a step of composition: the raw pictures composed from picture elements were mathematically or geometrically transformed (e.g. by superposition, integration, symmetry constraints, axionometric representation) yielding tree-dimensional shapes which were visualized on the display. Due to the cycle frequency and implemented probabilities one always saw series of pictures on the display.

In August 1970 the mapping module was extended with a picture-sound correlation which was controlled by the components of the state vector as well. This was the basis for so-called sound figures and a picture-sound-identical film (BTZ film). Computer-generated films were presented in public in the ARRI movie theatre in Munich in November 1970 - probably for the first time worldwide.

The *a.i. 70/71* was used for most of the computer-based work of Otto Beckmann in the ars intermedia group. In November 1972 the work of Oskar Beckmann was honored by the "Adolf Schärf Award for the Advancement of Science".

Further extensions were designed and developed by Oskar Beckmann in computers of the P.l. series: *P.l.73* was a test version, followed by *P.l.74*, followed by *P.l.77*. In 1977 several new ideas were integrated into the a.i. machine, resulting in the *a.i.P.l.77*. This machine has been rescued, but up to now it was not possible to revive it. In the middle of 1978 first tests for an even more advanced machine, called *P.l.80*, were made. But in the end of 1979 the work on the *studio computer*s was stopped. At this time Otto Beckmann had decided to move in new directions of his art work.

We can explain the main components of the *studio computer* by using a picture of the *a.i.p.l.77* (see fig. 8, next page).

The *studio computer* opened a way of working quite different from the algorithmic computer art of most other pioneers. While they followed the programming track, Otto Beckmann was the first artist to use the computer interactively for producing new worlds of pictures, sounds, films and more. Interactivity was available on three levels:
  - By controlling the probabilities of the state machines: Only on this level randomness was influential.
  - By control matrices for the mappings of state vectors onto the basic forms.
  - By combining the preprogrammed compositions by pressing keys or by dynamic wiring.

In addition, he could influence the visualization on the display by adjusting its controls.
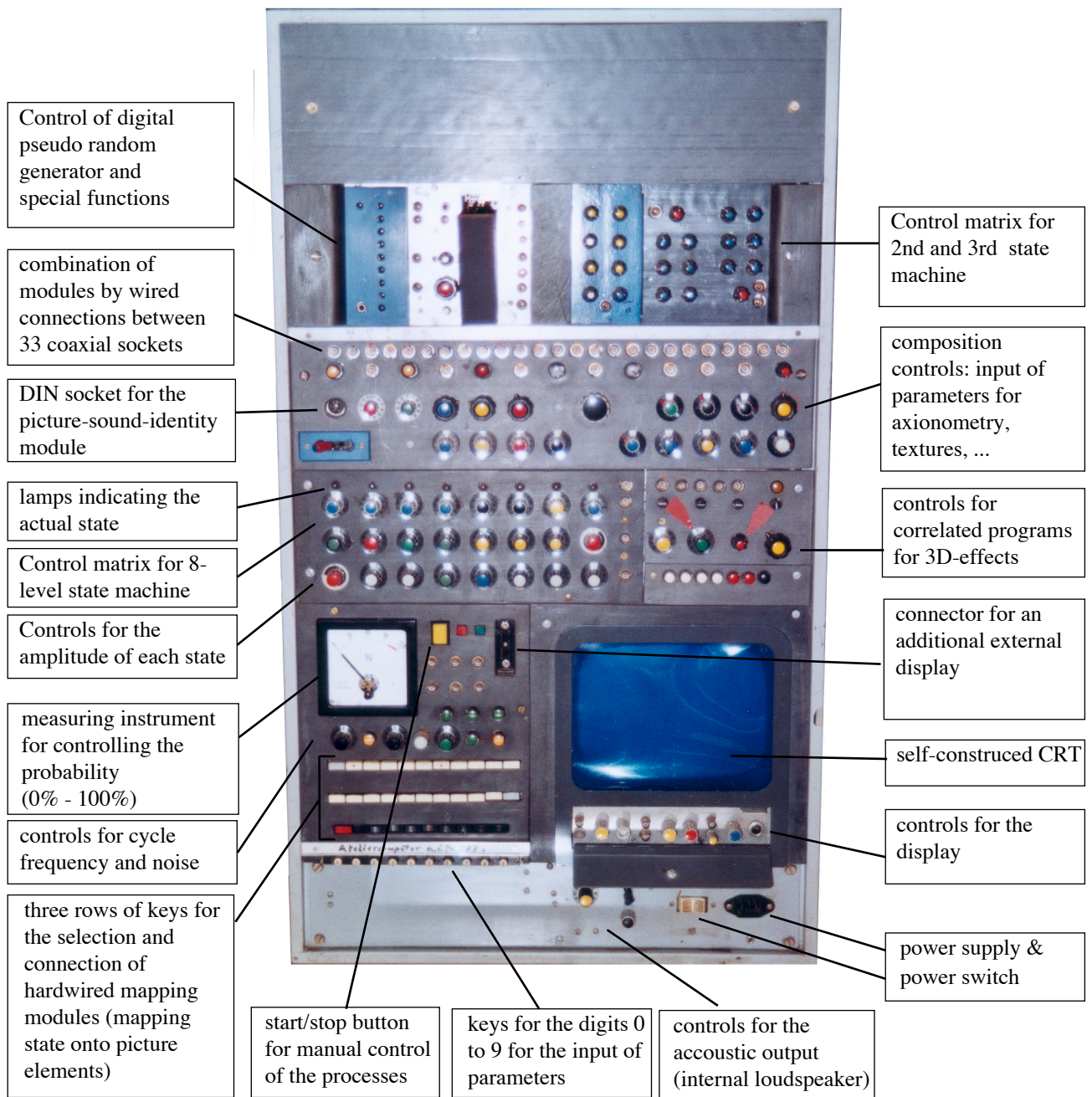
Fig. 8: The *Studio Computer a.i. P.l. 77* and its components
(Photo by Horst Oberquelle)

5. Pictures Made with the *Studio Computer*

By exploiting interactively the different possibilities of the *studio computer* Otto Beckmann developed an own picture language. Taking notes of parameters and sequences of transformations and compositions in his workbooks he was able to reproduce certain interesting effects, if needed. The following examples show different variants of computer art produced with the *studio computer*.

In the beginning silhouette pictures and serial pictures dominated.
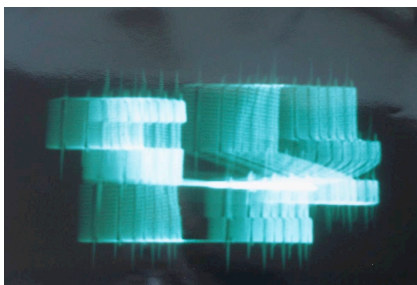

Fig. 9: Venezia morta
        Beckmann/Beckmann, 1971
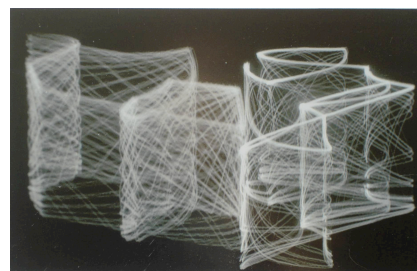   **offset printing, WVZ 10001**
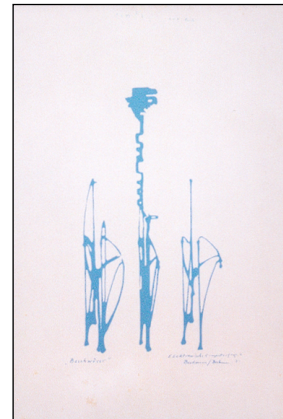
Fig. 10: Exorcist
        Beckmann/Beckmann, 1971
        aluminium plate, WVZ 90062

A next step was the generation of pictures with 3D appearance, "imaginary architecture", and of axionometric pictures.

Fig. 11: Imaginary architecture
        Beckmann/Beckmann, 1970
        photo from slide, WVZ 13046

Fig. 12: Axionometric picture
        Beckmann/Beckmann, 1974
        photo from slide, WVZ 16021

Experimenting with sound generation Otto Beckmann produced interesting pictures as well, which he called sound figures. They were symmetric vase-like pictures originating from the visualisation of sounds. One interesting experience was that nice sounds gave nice pictures, i.e. the artist could know by listening to the generated sounds whether the corresponding pictures would look nice. A very special kind of multimodal interaction und feedback.
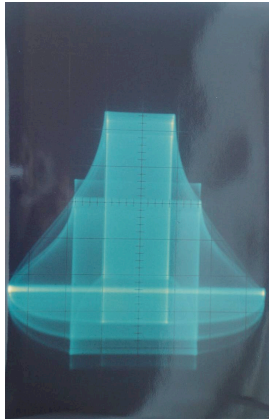
Fig. 13: Sound Figure
Beckmann/Beckmann, 1970
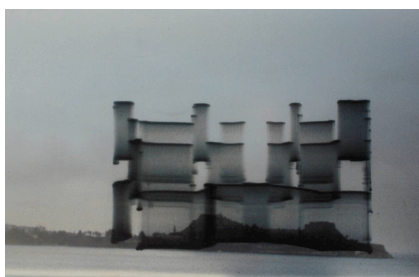**photo from slide, WVZ 60002**

Fig. 14: Laser Graphic
Beckmann/Koepf, 1970-73
photo from slide, WVZ 40004

In parallel, Otto Beckmann also experimented with laser light since 1970, supported by G. Koepf. Output of the *studio computer* was transfered into thin transparent plastic cards. In laser light these cards produced interesting inference pictures which were kept by photography, again. For the production of 3D pictures first experiments with holography were conducted, before Koepf left for a professor position in the U.S.

The work of Otto Beckmann was honored in 1971 by an award of the Vienna "Culture Fonds for Art in Technical Media".

Finally, using the a.i.p.l.77, Otto Beckmann was able to integrate examples of his picture language with photographs of landscapes, thus visualizing visions of architecture a hundred years ahead. A resulting film (Linz 2080) was shown at the first *ars electronica* at Linz in 1979. The vision of showing non-existing architecture in real contexts was revolutionary at that time, but has become a standard possibility nowadays. In [1] Otto Beckmann mentioned the possibility of extending the film into a film called "Metropolis 2080". There exists a rich series of slides with Metroplois 2080 motives in the Archive Otto Beckmann (AOB).

Fig. 15: Metropolis 2080 (Example1)
Beckmann/Beckmann, 1977
photo from slide, WVZ 30004a

Fig. 16: Metropolis 2080 (Example 2)
Beckmann/Beckmann, 1977
photo from slide, WVZ 30062

A special aspect of his work with the *studio computer* was the production of films. There was not enough space in this contribution for treating this aspect in detail. The same holds for other activities.
In parallel with working with the *studio computer* Otto Beckmann used his contacts with the TH Wien for further experiments. In H. Zemanek's group there had been built a version of Shannon's labyrinth by R. Eier. Beckmann put text elements into the positions of the labyrinth and let a plastic figure "dance" through the labyrinth thus producing surprising text sequences.

When in 1979 the series of annual *ars electronica festivals* at Linz began and many artists started to exploit computer technology, Otto Beckmann turned his back on computer art and technology and continued with randomness of objects found in the open nature and among real artefacts.

6. Reflections

In a sense, the development and use of the *studio computer* by the Beckmanns seems to be the first example of participatory design of hardware, software and a very special user interface. The interaction of Otto Beckmann with his computer was very personal. He used it in isolation in his studio. The computer was a kind of very special tool and extension to him. He called it an "intelligible tool with dialog properties", which artificially mirrors part of the artist and shows aspects of a partnership. For him "intelligible" meant "to be understood by intellect only, not by sensual perception". Randomness was not considered as an important part as other pioneers did. For Otto Beckmann it was just another means for the generation of interesting variants. He even critized the work of most other pioneers:
"The fundamental error of Bense is that he wants to propose something new, but he remains at the level of Galilei. Heisenberg would have added uncertainty to all aesthetic measures. Computer programs which are constructed according to static aesthetic rules remain sterile. Useful programs have a mantric nature, are evocations, invocations built from functional blocks." ([5], translation H.O.)

Further research will show more details of Otto Beckmann's visions and and bring to light more works of the ars intermedia period. In a sense, the curiosity and questions of the first author have triggered the second author and his brother Richard Beckmann to dig into and reconstruct the Beckmann history, including the history of the *studio computer*.

7. References

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