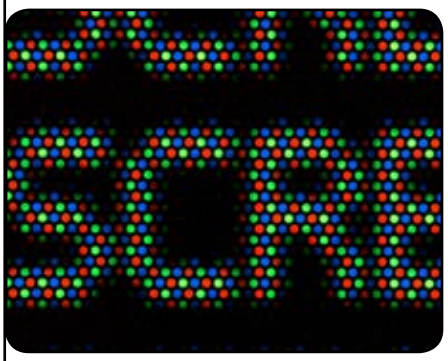
1) VsstV - Very Slow Scan Television

VSSTV - Very Slow Scan Television - is a new television format.

It builds upon *SSTV*, an image transmission system developed and used in the parallel universe of Ham Radio amateurs. Remarkably, this SSTV standard *(see section 2)* has been available for decades. In contrast to regular TV, SSTV runs on a dramatically reduced frame rate.

VSSTV uses broadcasts from this historic public domain television system - available anytime over freely accessible frequencies - to construct an analogy: it recreates a cathode ray tube (CRT) with regular *bubble wrap* taking the role of the aperture mask. Just as a CRT mixes the three primary colors to create various hues, *VSSTV* will use the surprisingly similar yet magnified structure of *bubble wrap (see section 3)*, commonly used as a packing material.



Surface close-up of a cathode ray tube with its aperture mask. Note the similarity in structure to bubble wrap.

We developed a device to receive images and output those images onto a new visual medium. A plotter-like machine fills the individual bubbles with one of the three primary CRT colors (red, green, and blue), turning them into pixels on the *VSSTV* screen. Observed from a distance, the clusters of pixels/bubbles merge into the original image.

Large and permanent television images are the result, images that take the idea of slow scan to the extreme: due to our process, the frame rate decreases to only one frame per day, down from one frame in 8 seconds possible with the underlying SSTV format!

The combination of Ham Radio SSTV television and the new output medium's extremely reduced frame rate suggests the name for this system: *VSSTV - Very Slow Scan Television*.

A few further remarks:
The *VSSTV* device incorporates analogies on many levels: the transmission of images vs. the transmission of sound; digital vs. analog technology (in a sense,

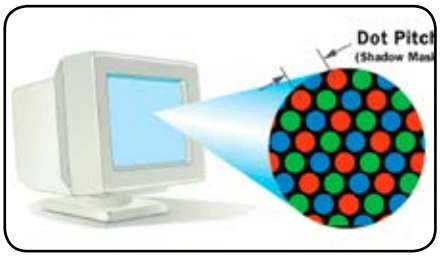


Diagram: cathode ray tube with RGB aperture mask

VSSTV employs analog technologies to result in digital images); CRT screen vs. bubble wrap.

VSSTV makes us recall the elements present in every television image.

VSSTV reveals a hidden universe of amateur television broadcasting (going back to 1957). A world of public domain television, accessible even with simple technology, independent of the commercial or monopolized television networks prevalent in Europe and the US.

At the same time, *VSSTV* adds an ironic twist to the use of a material familiar to every artist. Bubble wrap, normally used to wrap and protect art, becomes a medium and an artwork in itself.

2) SSTV

Slow Scan Television (SSTV), developed in 1957, uses the shortwave radio band (Ham Radio) to transmit television images.

Ham Radio not only broadcasts information (going back to Marconi's 1895 invention of the radio), but also uses the radio spectrum for personal communications, usually on a point to point basis over a previously negotiated frequency. In contrast to telephone conversations, this communication is open and can be listened to by anyone who happens to be tuned into the same frequency.

The Ham Radio band was reserved for the purpose of voice transmission, therefore using only a small bandwidth. Broadcasting images within this narrow bandwidth requires reducing their quality and rules out transmitting moving images. Furthermore, the visual information has to be converted into an audio signal.

Martin Diamant, co-author of VinylVideo™ *(see www.vinylvideo.com)* remarks: *"For the technician it's quite simple: if he listens to [the signal], it´s audio, if he synchronizes, decodes and watches it, it's video."*

Still valid today, the *SSTV* standard was formulated and realized by Copthorne Macdonald in the late 1950s.

A pioneer of SSTV technology, shown here with the equipment developed by him: Volker Wraase, 1972 in Altenholz, West Germany

British Ham Radio operator Guy Clark (N4BM) writes: *"SSTV was originally invented by Copthorne Macdonald and first used by Radio Amateurs. The original idea was to find a method of transmitting a television picture over a single speech channel. This meant that a typical (at that time) 3MHz wide television picture had to be reduced to around 3kHz (1000:1 reduction). It was decided at the outset that the scanning rates must be very slow, which precludes the use of moving pictures. The choice of time base for synchronizing was the readily available domestic power supply at 50 or 60 Hz (depending on the country of origin). This gave a line speed of 16.6Hz and 120 or 128 lines per frame (against the then UK standard of 405 lines (now 625) per frame), giving a new picture frame every 7.2 or 8 seconds. The composition of a single SSTV line to the original specification of 8 sec is*

Figure 7: SSTV image, received in the 28,680 MHz band by DL6XG

as follows: The maximum bandwidth is 3kHz, therefore the SSTV signal's bandwidth is restricted to 2.3kHz; Black is represented by a 1500Hz tone and white by a 2300 Hz tone together with a sync pulse at 1200Hz (well below the black level so that it is invisible). The Sync pulses are sent at the end of each line. These are 5ms in length, and 30ms at the end of each frame. The original SSTV systems were based on ex-government Radar screens and long persistence cathode ray tubes. SSTV started out with surplus radar display tubes with very long persistence ("P7") phosphors. This allowed an image to be painted on the screen over a period of a few seconds."

The modulation technique often transmits defective images, evident in trapezoid distortions in the image caused by time synchronisation problems.

The images *(see figures 1-9)* have a very personal flair. Texts and pictures refer to the location of the sender and his or her identifier. Self-referential features dominate. Guy Clark (N4BM) writes: *"What kinds of pictures are sent? Reviewing pictures saved during the last few weeks I found: Hams in their shacks, lots of pet dogs, a frog, kangaroo, astronauts in the Space Shuttle (SSTV has been transmitted from some missions!!!), bridges, birds, Elvis Presley, rock formations, an old fashioned microphone, antique cars, flowers, children, Jupiter, a cow, someone playing bagpipes, a UFO, many colorful butterflies, boats, and cartoon characters with personalized messages. Even the Russian Space Station MIR has been transmitting SSTV pictures recently!"*

Bubble wrap, bulk ware (© Scotch/3M)

We might see *SSTV* as a parallel TV universe, dating back to an era of television monopolies. But it also shows similarities to current streaming and netcasting technologies (in a sense, internet chat rooms today resemble the role of Ham Radio in previous decades).

3) Bubble Wrap

Bubble wrap is a common material used to pack fragile goods. Obviously *VSSTV* is a variation on bubble wrap's usual role in the art world. (There are perhaps only two ways to turn a profit in the arts: running an art shipping company and manufacturing bubble wrap.) Bubble wrap consists of small transparent plastic bubbles, filled with air, arranged in a honeycomb pattern on transparent plastic sheeting.

The aperture mask-like structure of bubble wrap and its similarity to a cathode ray tube constitutes an important basis for VSSTV *(see figure)*.

4) Implementation

The technical implementation of *VSSTV* and the construction of the actual device posed challenges in the areas of telecommunication, computer technology, control engineering and electromechanics.

Starting with the a short wave radio receiver station, the images are transferred to the computer via an SSTV converter. Furthermore, a computer program parses the incoming images into lines, pixels, and hues, corresponding to the "resolution" of bubble wrap.

The greatest effort went into the assembly of the machine to deliver the correct amounts of ink from the appropriate color tanks to the individual bubbles via tiny nozzles. This process results in groupings of three bubbles/pixels (red, green, and blue) that merge into one shade of color when observed from a distance. Three full bubbles correspond to "black"; three empty ones (illuminated from behind) correspond to "white."

We developed methods and sensors for the precise vertical and horizontal alignment of the sheeting. Furthermore, it was necessary to select an appropriate, lightfast dye. For manufacturing of parts, programming and electromechanical assembly, we cooperated with partners in technology.

The project is up and running, with a fully functional prototype that was first exhibited in September 2004.

5) Shows

The *VSSTV* machine is the main focus of the exhibition: as with an oversized plotter, bubble wrap unrolls, monitored by sensors controlling vertical and horizontal positioning. The observer can witness the extremely slow transformation of the "blank" bubble wrap into an image within 10 hours.

Several audiovisual elements parallel this process: speakers play back the original radio signal (a peculiar chirping sound that represents and transmits the SSTV image); at the same time, a video monitor displays the current SSTV image while an oscilloscope renders individual scanlines. Additionally, a miniature camera mounted on the print head observes the filling of the bubbles. Magnified, the images of this camera will be visible on a second monitor.

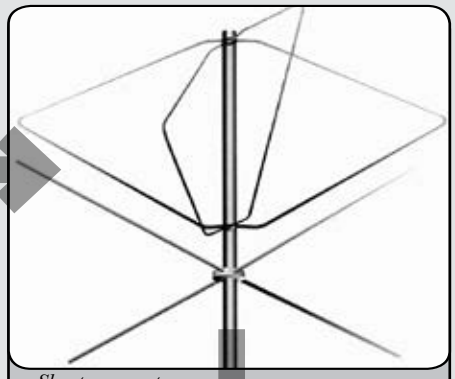
A growing collection of *VSSTV* displays (1.5 by 2 meters in size) accumulates during the exhibition.

Bubble wrap in the art world: packing an installation before shipping.

Figures 2-6: SSTV images

VsstV - Functional Diagram

Figure 1: SSTV image



Shortwave antenna

Shortwave receiver

Loudspeaker

Step 1

SSTV (Slow Scan Televison) signals are continuously broadcast by Ham Radio operators around the world on several short wave bands used for voice communications (e.g. 3.845 MHz, 7.171 MHz, 21.340 MHZ).

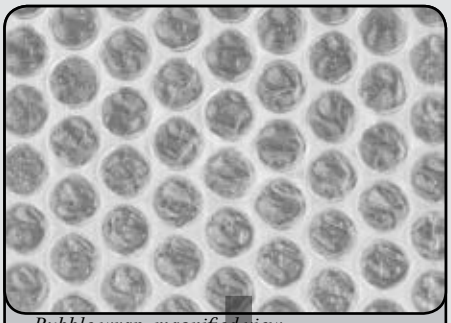
Step 2

An open air antenna, together with a short wave radio receiver, tunes into the SSTV band and receives the Ham Radio signals.

Speakers play back the sound signals to illustrate the process.

SSTV converter (with built-in monitor)

Personal computer: image processing, process control



Bubble wrap, magnified view

Bubble wrap, 50 meter bulk roll

Oscilloscope displaying scanline

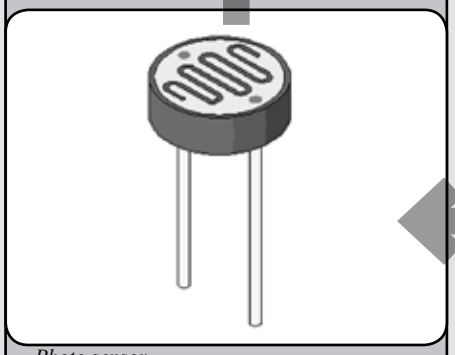
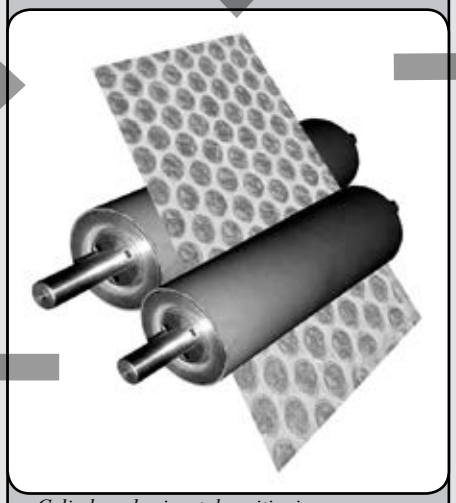


Photo sensor



Cylinders: horizontal positioning

Step 3

An SSTV scan-converter recognizes and decodes the images carried by the sound signal.

A monitor displays the images while an oscilloscope renders individual scanlines, making visible the gradual flow of the image (X-resolution: amplitude, Y-resolution: time).

Step 4

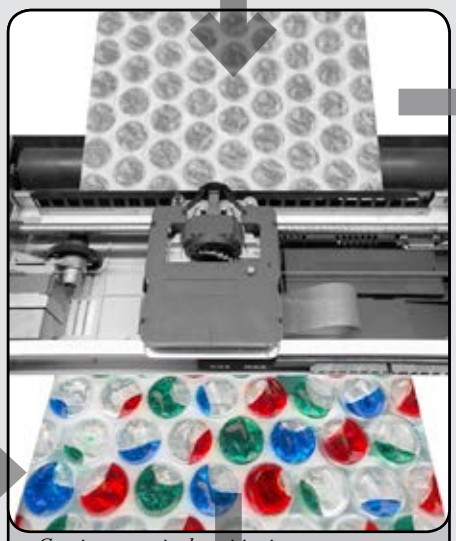
The image processing PC selects a random sequence of individual pictures from the SSTV converter.

A program rasterizes these images into pixels and breaks them down into their RGB components. The same PC also takes on the role of process controller in the following steps.

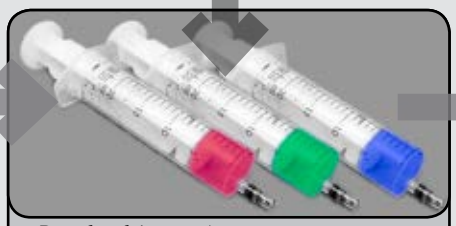
Step 5

The mechanics: Bubble wrap sheeting (width: 2 m, in bulk from roll) is fed between two cylinders for horizontal transport.

A photo sensor, together with the PC controlling the process, manages the exact, real-time positioning of the sheeting via a feedback loop.



Carriage: vertical positioning



Print head (concept)

Close-up view of bubble wrap, filled with ink

The same detail, viewed from a distance of 5 meters

Miniature video camera

Video monitor with magnified view of bubble wrap

Overview from a 5-meter distance, image size 1.5 by 2 meters

Step 6

The mechanics: a carriage (also controlled by the PC) vertically positions the print head.

Step 7

The print head consists of three needles fed by three tanks holding red, green and blue ink.

Controlled by the PC, these needles inject the bubbles with the exact amount of colored ink corresponding to the brightness and hue of the pixel.

A miniature, closed-circuit video camera mounted on the print head captures the process and the resulting image is displayed on a video monitor.

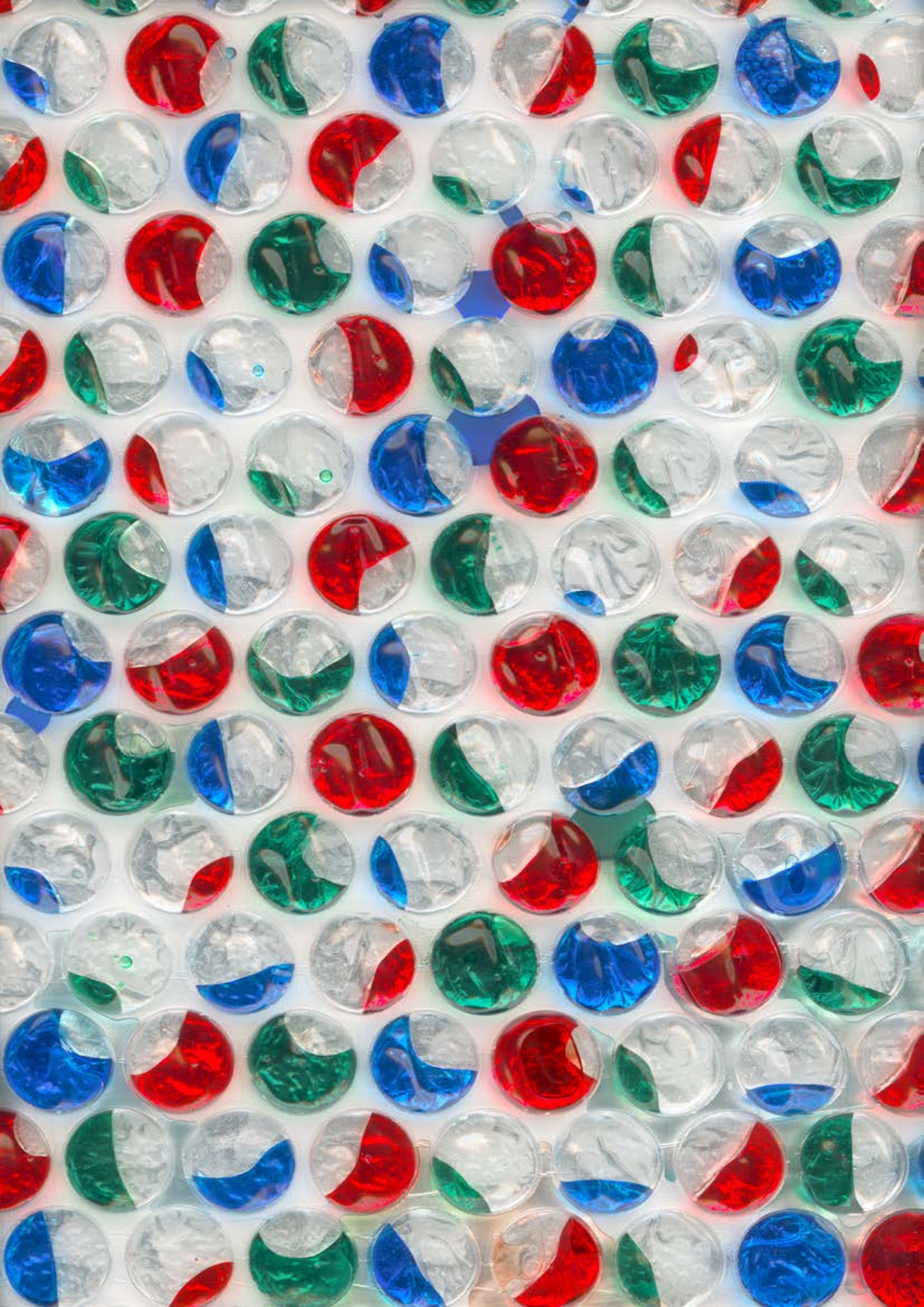
Step 8

Pixel by pixel, line by line, the bubble wrap is colored in accordance with the underlying SSTV image.

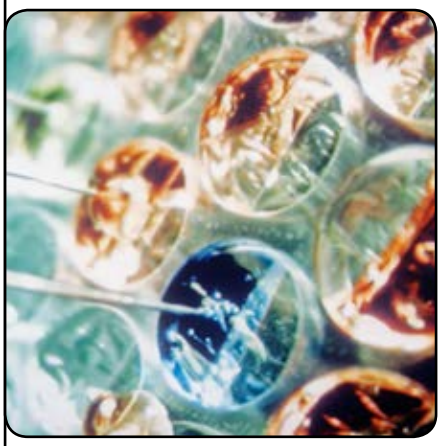
Assuming 10 seconds per pixel, this will result in a new VSSTV display every 20 hours (75 lines per image).

Viewed from an appropriate distance (approx. 5 meters), the individual dots of ink resolve into distinct colors. An overall image emerges and becomes visible:

Very Slow Scan Television

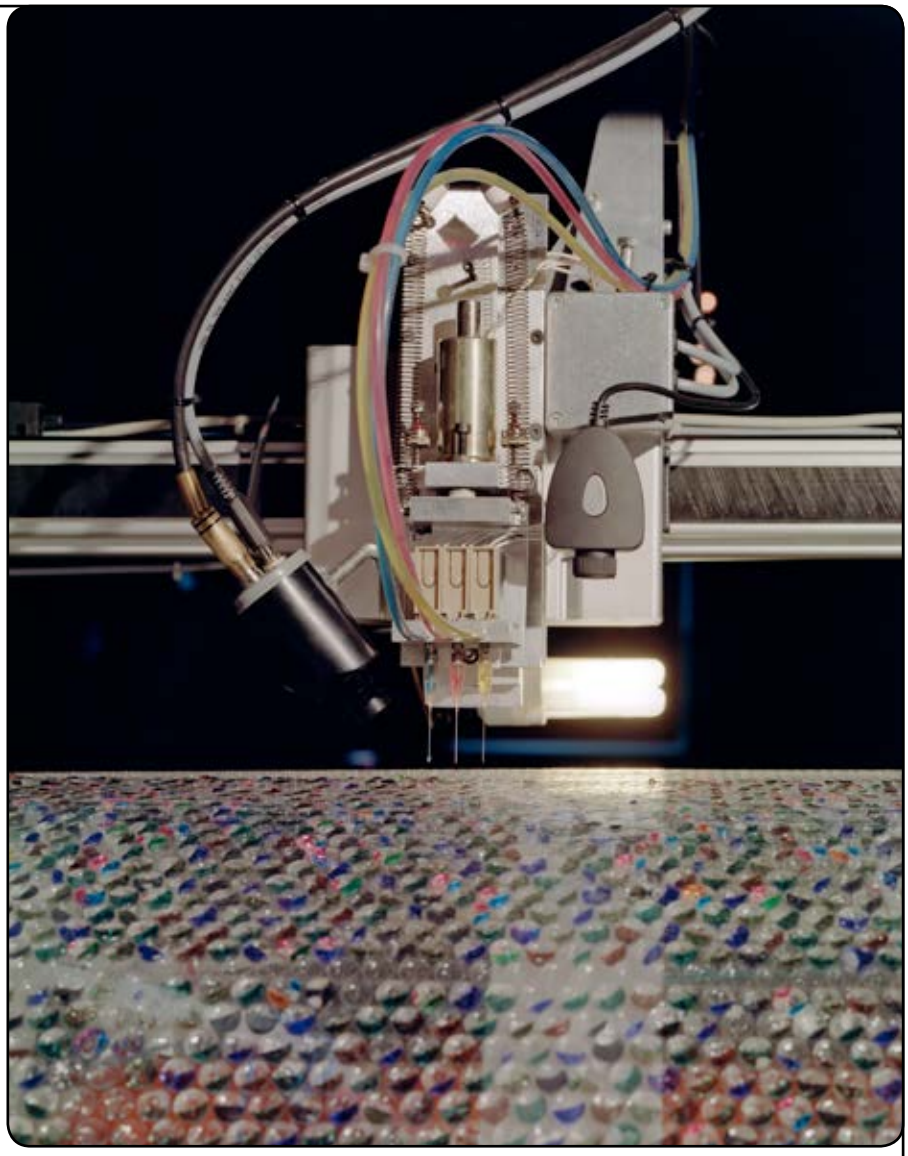


VSSTV at Transitio_mx, Mexico City 2005-12



control rack monitor: print head camera

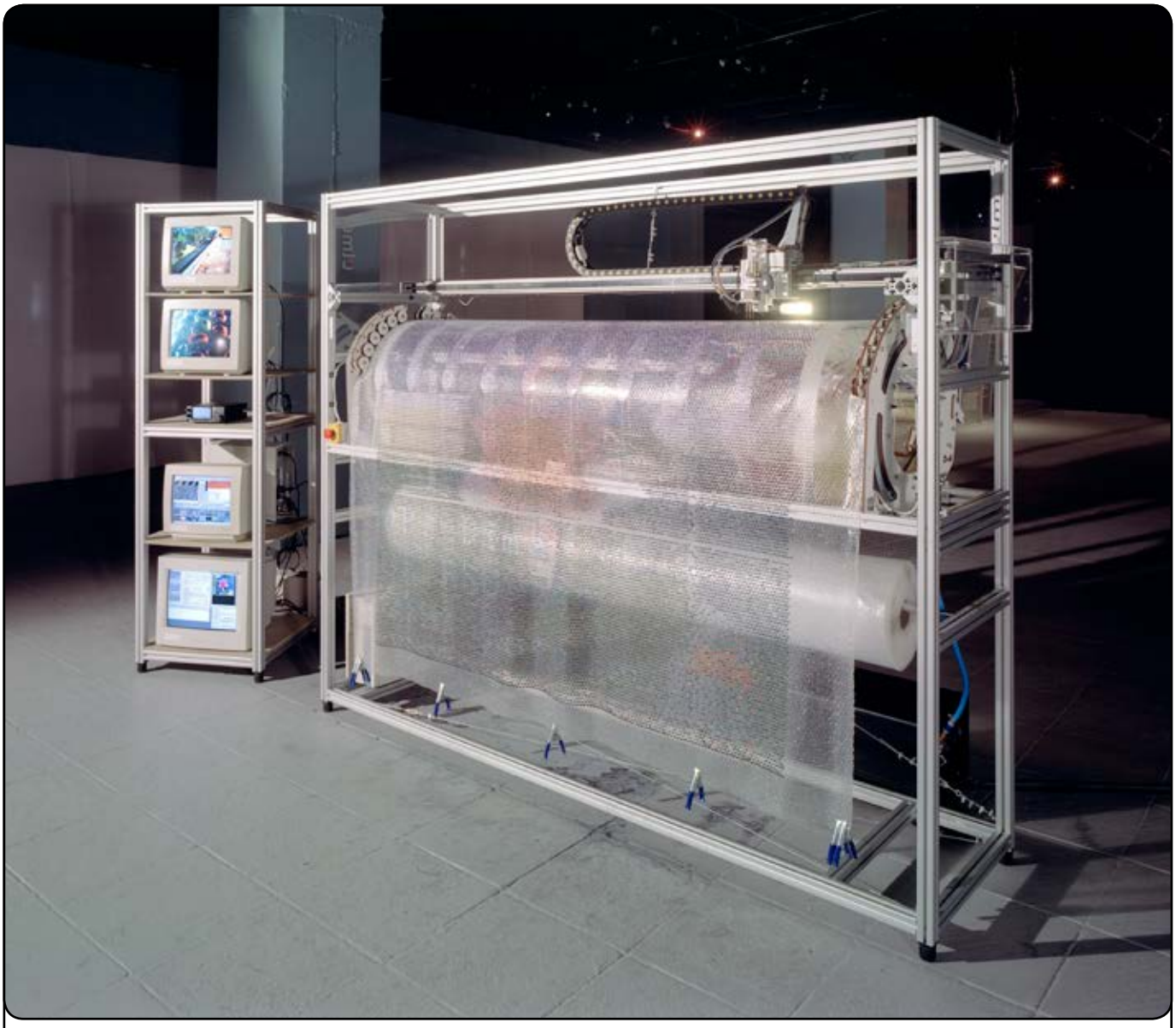
SSTV shortwave antenna (on roof)



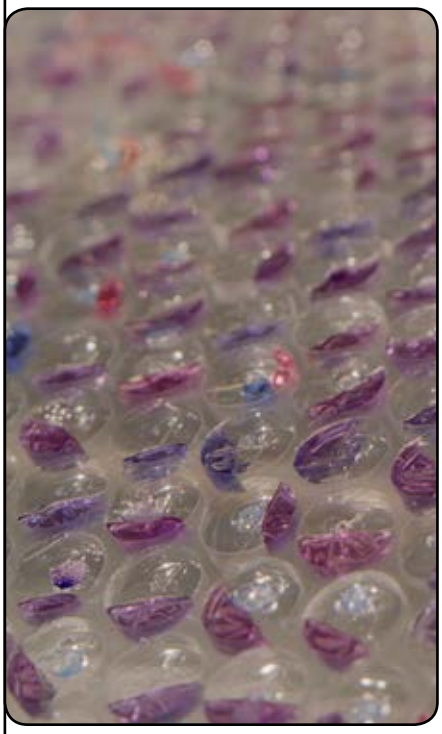
print head

VSSTV printout detail (black ink)

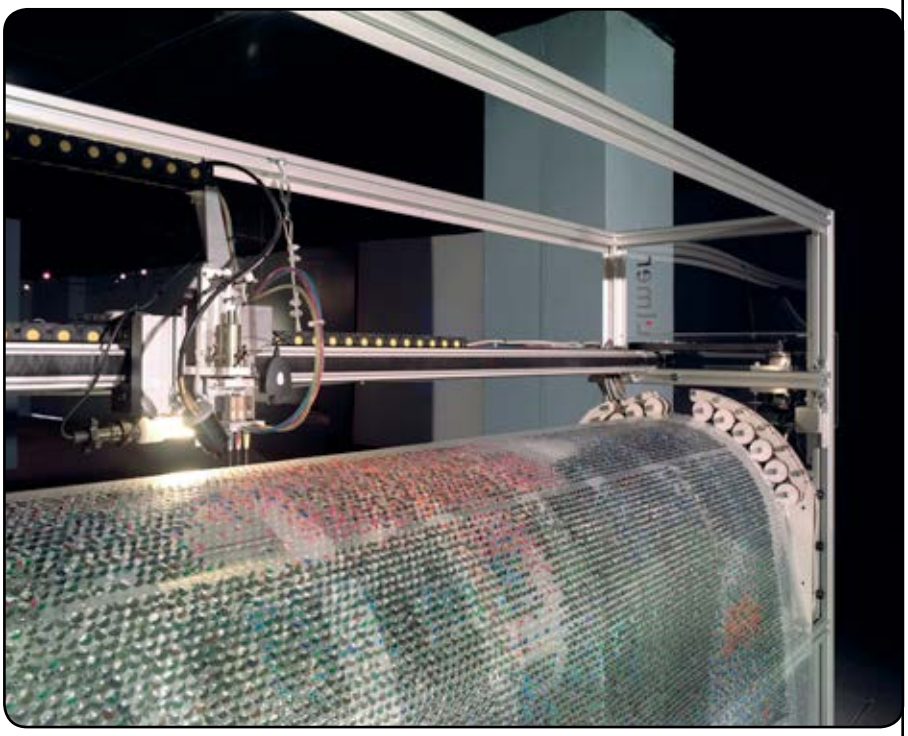
VSSTV printout (color ink)



VSSTV plotter and control rack

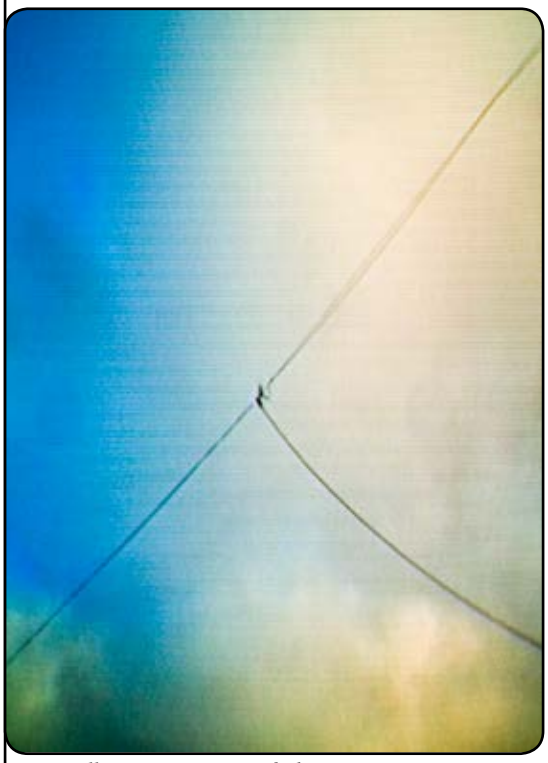


bubble wrap detail

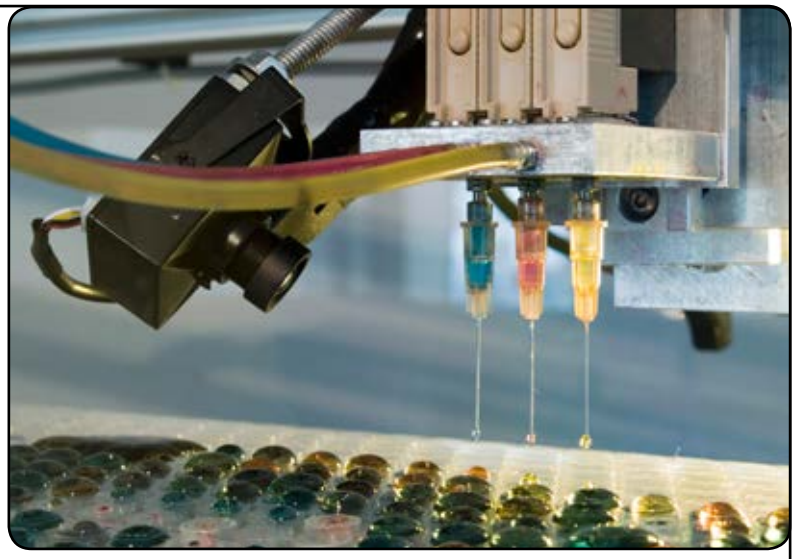


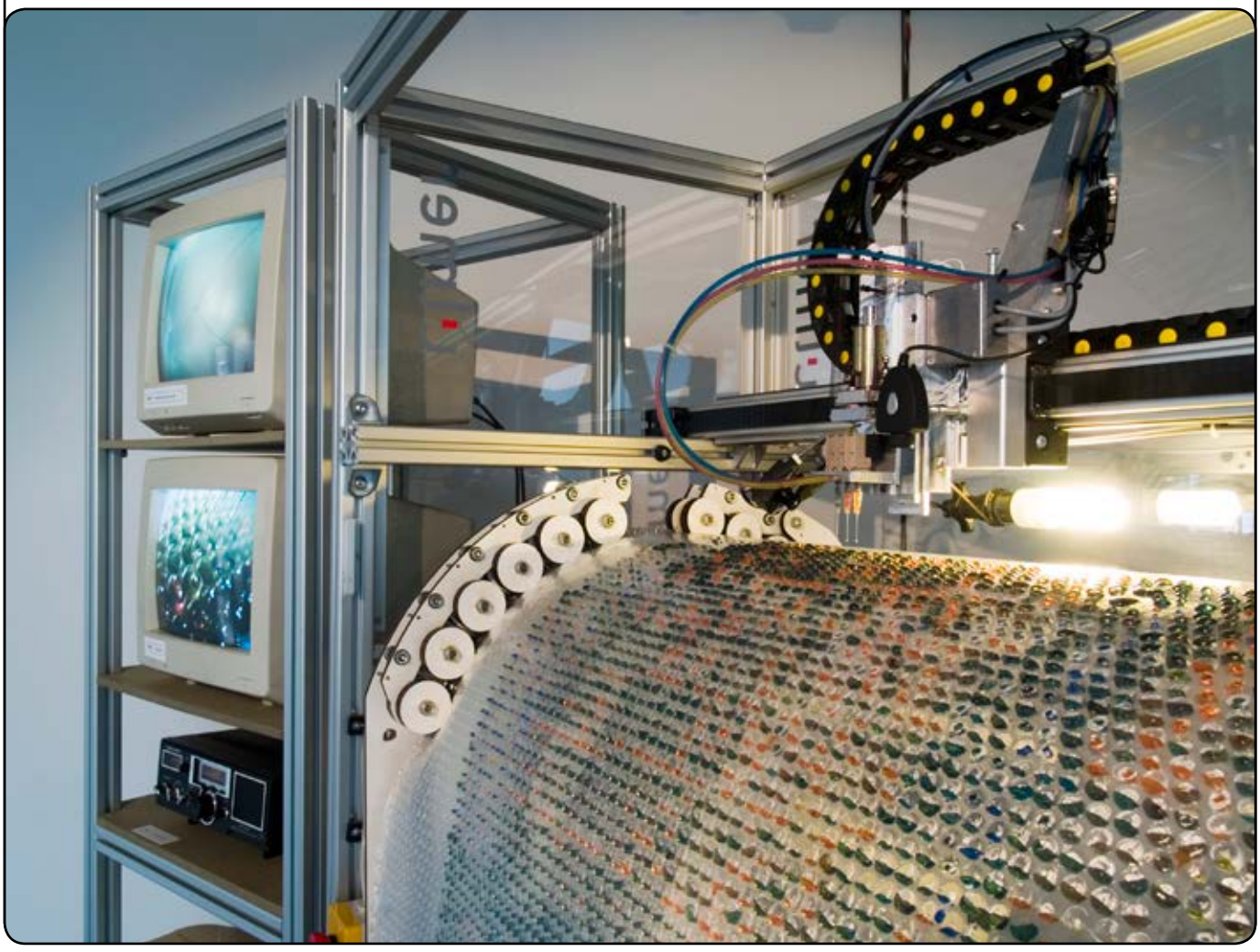
plotter detail

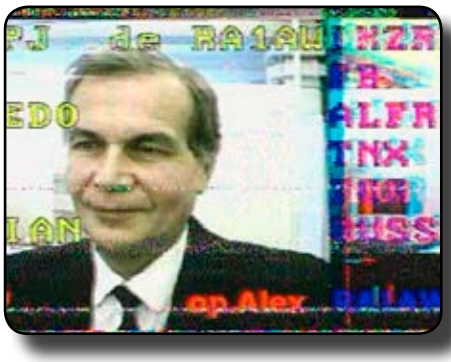
VSSTV at Electrohype
Malmö, Sweden 2006-12



surveillance camera view of shortwave antenna on museum roof







Please visit our Website Vsstv.com for print quality Images, Video clips and other Information about Vsstv.

VSSTV is a project by Gebhard Sengmüller, in collaboration with Jakob Edlbacher (technical design), Johannes Obermayr (control engineering) and Ludwig Ertl (programming).

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Supported by:

Kultur Land Salzburg

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Special thanks to:

Ulmer GmbH Profil- und Fördertechnik: Stefan Schauer, Andreas Liebminger
ÖVSV - Gregor Wagner, Othmar Seidner
Matthias Hammer
Charles Gute (editing)
Familie Sengmüller
Paul Sengmüller
Hans Schlager
Josef Hubinka