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'An Element of Perfection': The Transductive Art of Robert Mallary

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Abstract: In 1969, American artist Robert Mallary (1917–1997) coined the term 'transductive art' to describe an approach to art based on the notion of receiving energy from one system and retransmitting it, often in a different form, to another. Long before the realm of techno-art became a recognizable construct, Mallary was interested in a system of relationships, seeking in his words, 'an element of perfection' in combinations of materials and technologies to make 'a beautiful whole'. From his experiments with the Mexican Muralists to assemblage and Neo-Dada sculpture, and finally, his synergistic relationship with the computer, Mallary's work addressed the place of the human in a technological world. He instigated one of the first American computer art curriculums within a fine art department, developing early examples of software created by artists for use by artists. His espousal of the digital to become a 'Supermedium', led him to conceptualise a 'spatial-synesthetic art', a multi-media immersive environment combining three-dimensional projected visual elements, motion, and sound. Although unrealised, this system anticipated future VR/virtual reality developments such as the 'Cave Automatic Virtual Environment' (CAVE™) system developed at the University of Illinois, Chicago, in 1992. The current review will therefore argue, by example, that Mallary deserves a prominent position in the history of techno-art, and by virtue of both the several emerging influences he had the insight to recognise and bring together and his numerous subsequent contributions as simultaneously an artist, a theorist, and an educator.

Keywords: Robert Mallary; computer art; history of new media; art education; art and technology

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1. Introduction

Long before the realm of techno-art became the recognisable construct that it is today, American artist Robert Mallary (1917–1997) practiced art as a system of relationships, seeking, in his words, 'an element of perfection', combining materials and technologies to make 'a beautiful whole' (Mallary 1992). Mallary began his career as a sculptor exhibiting assemblage, 3D collages, and Neo-Dada art. Health reasons precipitated a change in medium, and he became a pioneer of computer art and computer art education, developing early software for artistic uses. Throughout his career, he was able to move seamlessly between these two, seemingly disparate methodologies, because he saw art as a process, independent of any particular medium.

Shortly after adopting the computer as a medium, in 1969, Mallary suggested the term 'transductive art', which could be used to describe a new approach to art based on the notion of receiving energy from one system and retransmitting it, often in a different form, to another (Mallary 1969). He believed the use of electronics in sculpture would go beyond existing kinetic art to include the cybernetic characteristics of self-organisation, giving such artwork, which he called 'transductive intermedia setups', the 'ability to interact dynamically with their surroundings' (Mallary 1969). Although he made no reference to the work of French philosopher of technology Gilbert Simondon's work on transduction (De Boever et al. 2012), Simondon's key concept referring to a dynamic operation of realising energy movement from one state to another could have been an influence here. Mallary further explained a year later, 'Why should not cybernetic art be experienced variously as

objects, functions, processes—including conceptual process—and combinations of these?' (Mallary 1970b).

Another reference point for Mallary was Kazimir Malevich's groundbreaking essay 'On New Systems in Art', wherein Mallary was introduced to the concept of a 'law for the constructional inter-relationships of forms' (Malevich 1919, p. 100). This provided a theoretical model for Mallary to construct a system for abstract art production initially in assemblage sculpture. Mallary's compositions reference Malevich's discussion of 'mixed' textures with, 'The differences [. . .] constructed in such a way as not to weaken each other, but on the contrary to express each form and texture more clearly' (Malevich 1919, p. 101). Mallary devised his own art as a system of relationships where individual components in a work refer to one another and become sets within the whole system. This system of relationships becomes for him a metaphor for systems of all kinds, which later he was to fully exploit with computing.

Fundamentally a sculptor, Mallary thought deeply about space and how objects and people inhabit space, whether physically or virtually within a computerised system. Seeking a 'fully interactive, synergistic man-machine relationship' (Mallary 1969), the technologies he encountered throughout his career were assembled by him to form a whole artistic process. Toward the end of his career, accordingly, he was led to conceive of a 'spatial-synesthetic art', a multi-media immersive digital environment that combined three-dimensional projected visual elements, motion, and sound (Mallary 1990).

As explored here for the first time, this concept connected with one of Mallary's early formative influences, the Mexican Muralist David Alfaro Siqueiros and his dramatic technical innovation of the 1930s—a 'plastic box', in which the entire architectural space was considered to be artistically vital. Joining a nascent 1980s scientific and engineering community interested in the possibilities of VR, Mallary's proposed artistic/visualisation system anticipated future developments in projection-based systems, and most notably the 'Cave Automatic Virtual Environment' (CAVE™) developed by the Electronic Visualisation Laboratory of the University of Illinois at Chicago, the premier of which was given in 1992.

The current review will therefore argue, by example, that Mallary deserves a prominent position in the history of techno-art, and by virtue of both the several emerging influences he had the insight to recognise and bring together and his various subsequent contributions as simultaneously an artist, a theorist, and an educator. Mallary, in short, has been an important voice in addressing the place of humanity in a technologically driven world.

2. Mexican Murals and Technology

Mallary's eventual involvement with the computer was the consequence of his long-standing interest in art and technology, from the very beginning of his career in the mid-1930s. From 1938, he studied in Mexico City at the Escuela de las Artes Libro for a year and again from 1942 to 1943 at the Academia de San Carlos. Surviving drawings (Figure 1) from this period show anti-war and anti-fascist sentiments. Skeletal, cadaverous, and grotesque figures, some wearing soldiers' helmets and some with swastikas, exude existential angst. The artist, taking his cue about socialist politics from the Mexican mural painters, later explained, 'My first enthusiasm was the Mexican school of mural painting and my model was David Alfaro Siqueiros' (Mallary 1976, p. 4).

At this time, as is well known, monumental mural painting was the major avant-garde art form in Mexico, but what is not so well known is that this seemingly traditional movement incorporated a heavy technological emphasis, not only in terms of its machine iconography but also in terms of its unveiling of new materials and visual schema.



Figure 1. Robert Mallary, a selection of Mexico City drawings, 1936–1943. Photographs courtesy of Mitchell Algus Gallery, New York (drawings are not shown to scale).

The revival of mural painting in Mexico began in the early 1920s from causes that trace back to the Mexican revolution of 1910 and was led by the so-called Big Three—Diego Rivera, José Clemente Orozco, and David Alfaro Siqueiros (Siqueiros 1975). The aim was to develop a new identity for Mexico, suitable for the working masses, based on the country's historical traditions, as well as a concept of progress, moving forward into the modern age. Creating public art by painting directly onto walls shaped the resulting murals according to the architecture of the designated space and rejected the usual rectangular shape of the (private) canvas that had come to dominate Western art (Edwards 1966). The imagery often blended visions of science and machinery to convey progress, most famously seen in Diego Rivera's Detroit Industry Murals (1932–1933), which contain many examples of workers in harmony with machines, a fusion of human labour and contemporary technology.

Although Mallary professed a preference for the art of Orozco, it was Siqueiros and his calls for a revolution in the technological superstructure of art that was to exert the strongest influence on him (Mallary 1976). Siqueiros (1896–1974) was the youngest and most politically radical of the three and believed that revolutionary art called for revolutionary techniques and materials, writing that 'Art movements should always develop in accordance with the technical possibilities of their age' (Siqueiros 1975, p. 46). According to him, the adoption of the materials, tools, and processes of modern industry was a suitable technical base for the new social function of art.

Additionally, Siqueiros's most dramatic innovation—what he called a 'plastic box', put forward in the 1930s—is of particular relevance to Mallary's later work during the 1980s and 1990s with the bourgeoning concept of VR.

Siqueiros's search for a truly modern ideological expression that would reach his goals of speaking directly to the people led him to devise what he called an 'active composition rather than traditional, academic composition'. He explained,

> The spectator is neither a statue as implied by rectilinear perspective, nor an automation on a fixed axis as implied by curvilinear perspective; he moves over the whole surface of a determined area (Siqueiros 1975, p. 14).

This concept is clearly seen in *Ejercicio Plástico* (Plastic Exercise), 1933 (Hurlburt 1976), (Figure 2).



Figure 2. David Alfaro Siqueiros *Ejercicio Plástico* (Plastic Exercise), 1933. Restored in 2009 and installed at Casa Rosada Museum, Buenos Aires. Photograph courtesy of Walter Raymond. © DACS 2021.

Plastic Exercise, a 200-square meter experimental mural, was painted on a curved surface, a semi-cylindrically shaped basement room of 90-cubic meters, at the Plaza Colon in Buenos Aires, Argentina. In addition to the four walls, the ceiling and floor were also painted, Siqueiros wishing to make 'total use' of the physical room:

> By working out an infinite series of harmonious correlations between all the facets of our architectonic anatomy, and then relating these to each other with interspatial connections, we were able to integrate perfectly balanced reflections, sizes, weights and dimensions (all active) into the total interior air space of a geometric body. Our work could therefore also be called a 'Plastic Box' (Siqueiros 1975, p. 40).

In a completely different approach from that of other Mexican muralists, Siqueiros considered the progress of the spectator as they move through the space. This was achieved through technical innovations including photographic projection used whilst painting to check the positions of pictorial elements from different angles. Additionally, a camera was used to analyse both volume and space and what the artist termed 'movie forms'—movement related to the cinema, with the involvement of a time element (Siqueiros 1975, pp. 14–16). Further, and crucially, 'It is only the active spectator inside the mural concavity who can switch on this rhythmic, architectonic machine. [. . .] when the spectator stands

still, the machine stops moving'. (Siqueiros 1975, p. 126); hence, Siqueiros, as an influence on Mallary, must be considered an early practitioner of optical kinetic art.

A diagram published by Siqueiros for a later mural of 1954 (Figure 3) illustrates this concept. This mural again utilised modern, reinforced plastic materials including pyroxylin and silicones, applied to a curved structure, the whole volume of the space described as an 'air box' (caja de aire), illustrated with a human figure located in the 'Spatial Structure'. This mural was further described in the 1960s as 'a shell binding the space it holds' (Edwards 1966, p. 266).

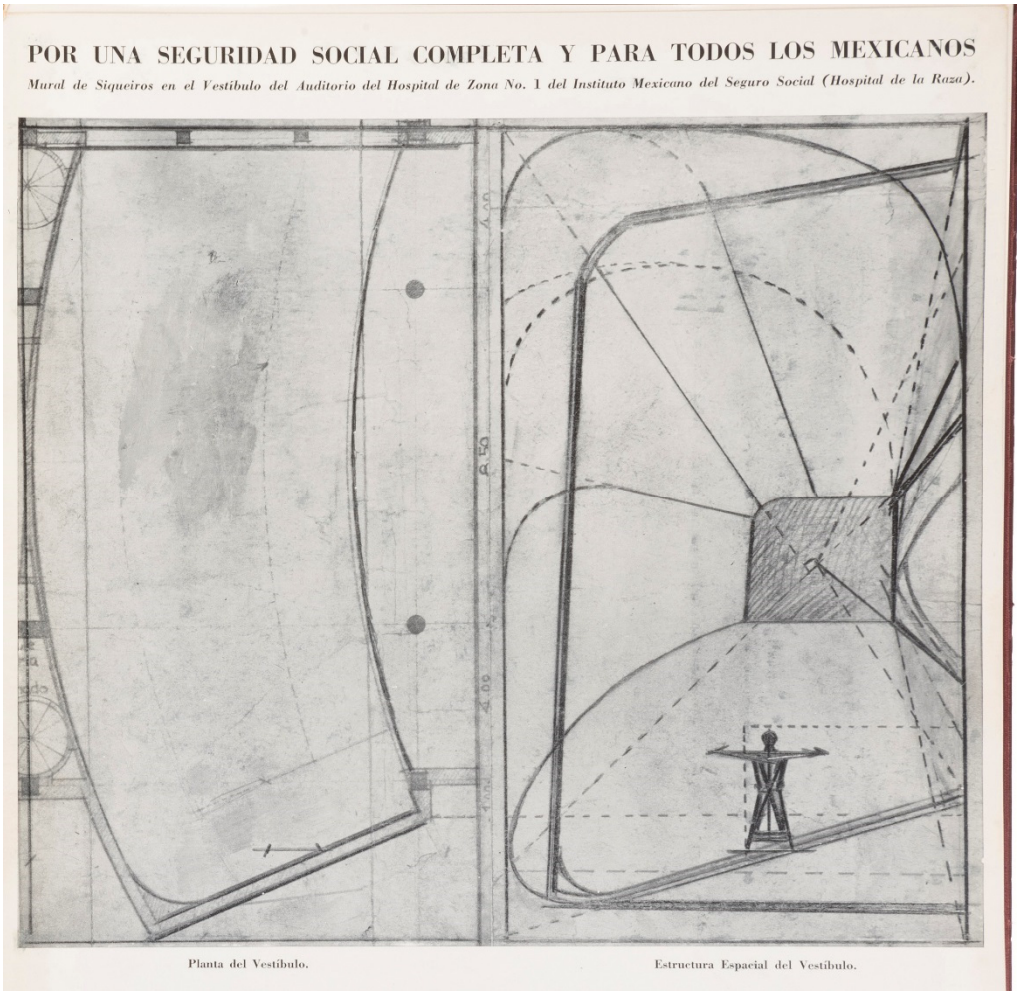

Figure 3. David Alfaro Siqueiros, 'For a complete social security and for all Mexicans', drawings from the book *Alfaro Siqueiros, David. Mural del Hospital de la Raza.* Ocho Láminas, Tres a coloures. México: Public art editions, 1954. Image courtesy of Morton Subastas, México, © DACS 2021.

In short, Siqueiros's emphatic beliefs about technology's power for art subtly influenced the young Mallary, whose interests were already leaning in that direction, and thus eventually allowed these ideas to fully come together in his later 'spatial-synesthetic' proposal.

A more immediate influence on Mallary, however, was the Experimental Workshop founded in New York City in 1936 by Siqueiros. This became for a short time an influential laboratory aiming to 'encourage the artist to seek new forms, new tools, new materials to express himself better in a modern way' (Lehman 1937). New materials included the use of commercial lacquers as commonly used in the automotive industry, for example, pyroxylin, nitrocellulose pigments developed by DuPont in the 1920s. During this period, Siqueiros avoided brushes, applying paint with air-driven spray guns or with dripping techniques

(influencing a young Jackson Pollock who attended the workshop) or cement applicators (McGlinchey et al. 2013). The pyroxylin paint could be thickened with sand, (as seen in Siqueiros's *Cosmos and Disaster*, c.1936 in Tate), where the thickened paint is laid onto a copper mesh on plywood to support the weight and imbedded with splintered wood (Gale 2004).

The evidence of Siqueiros's ideas can be seen in Mallary's work. He conceptualised this technique as 'sculpto-painting'—the transference of painterly qualities and effects from 2D-painted surfaces into a 3D idiom, to create sculptural surfaces combined with reflections of light, causing what he called, 'a fusion of sculptural and illusory-pictorial elements' (Mallary 1990). Similar methods are seen in Mallary's *Head of Bull*, 1958, where sand, gravel, and paint are mixed with polyester onto a fragment of Celotex board (commonly used for household insulation). During the 1940s, he continued to experiment with new materials such as acrylic and polyester plastics, Duco automotive lacquer, and synthetic resins that had been invented for industrial use.

Light also became an important component for Mallary. *Luminous Mobiles*, exhibited in 1952 (Figure 4), was a series of suspended, transparent acetate sculptures painted with fluorescent dyes and pigments that glowed under ultraviolet light and moved with the flow of air (Eliot 1952). Their abstract, spirographic forms prefigured some of his later computer plotter drawings made with his SPGRAF2 graphics program, c. 1983. As part of his research with kinetic sculpture and attempts to create a 'sequential image projection', he also invented in the 1950s what he called a *Stroboplane*, an analogue machine using photographs and electrical components with flashing strobe lights that created images in depth (Mallary 1976). These experiments demonstrate that Mallary was carefully considering how light and 3D forms interact.

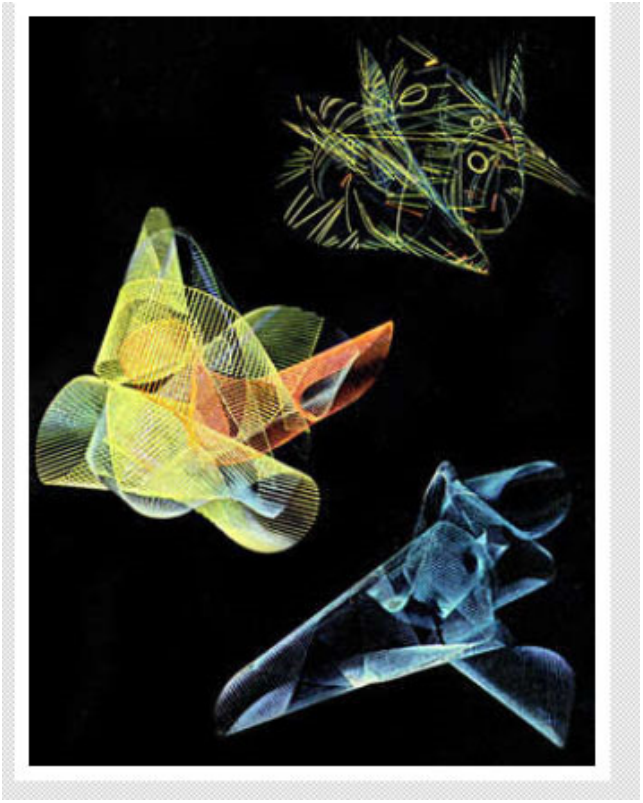

Figure 4. Robert Mallary, *Luminous Mobiles*, 1952. Image courtesy of estate of artist.

3. Assemblage

Mallary's *In Flight*, shown with several of his other works at the famous exhibition *16 Americans* at MoMA, 1959, sits between a sculpture and a painting, a 'sculpto-painting',

an assemblage of blackened wood with fragments of splinters and sawdust seemingly suspended on the painted plywood, the whole held together with a synthetic polymer resin (Slifkin 2019). This and subsequent assemblages (Figure 5) were fabricated with urban detritus, found objects collected by the artist, with the finished works labelled by him as 'junk art' (Mallary 1964).



Figure 5. Robert Mallary, *Jouster*, 1960. Wood, steel, cardboard, tar paper, dirt, resin. Image courtesy of estate of the artist.

Assemblage has been categorised as neither painting nor sculpture, nor architecture, rather a 'complex attitude of ideas' (Seitz 1961). The use of found objects to make a hybrid of sculpture and collage has a history going back to the Dada movement around the time of World War I. Initially associated with Dada and one of the greatest early exponents of assemblage, Kurt Schwitters (1887–1948), aimed to create a *Gesamtkuntswerk* (total work of art). His ideas encompassed the full artistic experience: Painting, collage, sculpture, theatre, architecture, typography, and even sound (through sung poems), combing the principle of assemblage to each of the arts he worked in to blur boundaries (Elderfield 1985). *Merz*, his name given to describe this new universal medium, reached its apogee in his *Merzbau* constructions (Figure 6)—3D sculptural installations, the first created within eight rooms of his studio home in Hanover (1923–1937, destroyed 1943). Made with junk, found objects, recycled materials, and fragments of everyday life, and built onto wood and plaster bases

within the architecture, these installations led to an experience of art that encompassed the whole environment, enveloping the viewer and incorporating an element of interactivity.



Figure 6. Photograph of Kurt Schwitters' *Merzbau* Hannover, 1933. Photo Tate © Wilhelm Redemann, 1933.

The viewer becomes a participant, progressing through the various grotto and cave-like spaces of the *Merzbau,* discovering different vistas, opening secret doors and cupboards, thus incorporating an element of interactivity. Schwitters explained he was not 'constructing interiors for people to live in, [. . .] I am building an abstract sculpture into which people can go'. For him, this was a 'composition without boundaries, each individual part is at the same time a frame for the neighboring parts, all parts are mutually interdependent' (Elderfield 1985, p. 156).

The huge survey exhibition *The Art of Assemblage* at MoMA in 1961 included numerous artists among them many works by Schwitters. Mallary's *Jouster* (Figure 5) was hung next to Robert Rauschenberg's now-famous *Canyon*, 1959, in MoMA. Robert Slifkin has recently argued that the signs of 'violent destruction and ruinous decay' seen in works

such as *In Flight* and *Jouster*, 'were directly informed by the precarious circumstances of the postatomic age in which they were produced'. They both 'imagine the possible demolition of the urban environment and serve as cautionary prophecies against such a fate' (Slifkin 2019, p. 60). Schwitters had written similarly of this, in reference to World War I: 'In the war things were in terrible turmoil. What I had learned at the academy was of no use to me [. . .] Everything had broken down [. . .] and new things had to be made out of the fragments' (Elderfield 1985, p. 12).

Mallary's tuxedo works take this further, held together and formed by impregnated resin, the suits becoming the sculptural medium itself. The empty clothing is suggestive of the human body, or perhaps more specifically, 'an absent occupant' (Andrew 1988, p. 139). This is seen, for example, in the monumental 1964 work *Cliffhangers* (Figure 7), which engages with its architectural setting—the Modernist exterior of the New York State Pavilion, designed by Philip Johnson, for the World's Fair at Flushing Meadows. The falling 'figures' (stiffened tuxedos), seem to prefigure the self-destruction of humanity (Slifkin 2019). Mallary explained, 'it has to do with contemporary man as assailed, harassed, confused, frustrated, befuddled, desperate, and hysterical. As lonely, isolated, afraid, and alienated' (Mallary 1963a).

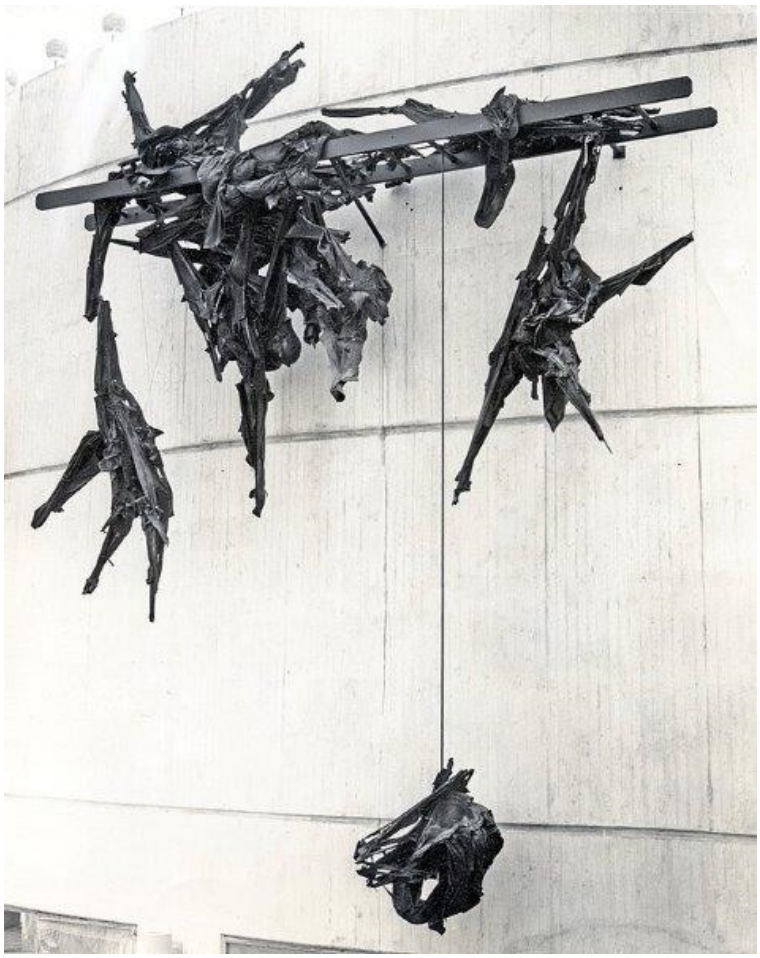

Figure 7. Robert Mallary, *Cliffhangers*, 1964–1965. 20 ft. × 20 ft. Plastic impregnated tuxedoes with wood and welded steel. Installation view exterior New York State Pavilion, New York World's Fair, 1964–1965. Image courtesy of estate of the artist.

Mallary's use of urban detritus and new synthetic resins, and later his embrace of digital technology, become a means through which he is able to assimilate his ambivalence to modern technology, much of the origins of which were developed as a result of war-

orientated projects. The artist said of his tuxedo figures, 'they are resisting the posture in which they have been thrown, they are fighting back' (Mallary 1963a). Likewise, his use of the computer can be seen as an essential means of coming to terms with his concerns about humanity's use of technology under the threat of thermo-nuclear war, through the use of the very materials invented to facilitate such threat.

4. Computer Art

By the early 1960s, Mallary's health had deteriorated, following many years of breathing the toxic fumes of synthetic solvents and plastics without suitable precautions; this was before the time when such dangers were widely known (Mallary 1963b). In response, he moved to the computer, a logical choice given his history: he believed the computer was the future of art, and he wanted to be involved in the early stages (Mallary 1992). This also recalls Malevich's challenge to artists to recognise that, 'not seeing the modern world and its achievements means not participating in the triumph of modern transformations' (Malevich 1919, p. 89). Mallary was able to transform his horror of war by embracing computing technology and putting it to the service of art, and he was thus able to give early expression to what has become a leitmotif of the techno-art movement—the 'vast expansion of the creative sphere' which computing has made possible (Bessette et al. 2019).

Around this time, the idea that art and technology could be a potentially definable art movement was gaining ground. For example, in 1967, the Experiments in Art and Technology (E.A.T) group, centred around Billy Klüver and Rauchenberg, briefly came to prominence in New York. Although Mallary believed this group to be 'technically amateurish' (Mallary 1976, p. 5) and associated it with the Pop Art movement which he considered to be lacking in seriousness, and despite the technical problems that beset E.A.T, it is true that they did garner publicity and possibly even give a name—art and technology—to a loose movement that had been developing somewhat ad hoc in various locations internationally since the 1950s.

In 1967, Mallary took a position teaching sculpture at the University of Massachusetts (UMass). After five years, he implemented one of the first computer arts curriculums for art students in the United States. Such use of computers at this time was highly unusual and a specialised branch of art; using equipment not originally designed for artistic purposes was a difficult task. The major hurdle for artists to first overcome was the challenge of accessing very expensive equipment. Artist Katherine Nash wrote in 1970 of the, 'almost insurmountable problem' of finding a computer that an artist could afford and a situation in a university department that could accommodate their experimental work at the same time as providing employment (Nash and Williams 1970). Due to these specific conditions of access, much of the early artistic work occurred in art departments of larger universities, particularly those that had received federal funding for research and development into engineering applications allied to the Space Race or military applications.

Mallary made his first plotter drawings in 1967, not at UMass, but at the nearby Amherst College, part of the Five College Interchange Program. This co-operative arrangement allowed persons to move between member facilities. He spent five years at what he described as a 'small computer facility [...] developing my art-orientated programs with the help of the bright and obliging Amherst College students, and finally learning to program myself' (Slezak et al. 1988). Mallary was one of the first to consider how computers could be used to produce forms for sculptural works, he devised his own program—TRAN2, assisted by his son Michael Mallary (a physicist and later doctoral student at CalTech), written in Fortran on Amherst's IBM 1130 system (Mallary 1970a). Mallary is essentially converting the computer into a sculptural modelling and shaping tool.

The program used contour sectioning or 'slicing' to produce a series of thin parallel cross-sections of equal thickness. The plotter then produced a set of drawings to be used as templates to cut the 'slices' individually in plastic (later versions were in plywood and marble); these slices were then stacked over a metal rod, laminated together, smoothed

down, and polished by hand. The resulting sculptures became the QUAD series of works, the first one exhibited at *Cybernetic Serendipity* (London 1968) and *QUAD III* (Figure 8) at the Whitney Annual Sculpture show (NY 1968–1969) and *New Tendencies* (Zagreb 1969) (Figure 8). The QUAD works are notable for demonstrating to the art world the arbitrary and almost limitless power of the computer in helping to create new forms, and as eagerly seized upon by later generations of techno-artists. Mallary, continuing into the 1970s, became a contributor to that loosely defined, mutually supportive early community of artists working with computers, and with their members participating in various events, symposiums, and exhibitions, both in the US and abroad.



Figure 8. Robert Mallary, *QUAD III*, 1969. Plywood, metal, and resin on plywood base. Collection of Tate © Estate of the artist. Image courtesy of Mayor Gallery, London.

Mallary did recognise that the TRAN program (Figure 9) was only a beginning and that in the future, computer sculpture, 'will be mainly kinetic, have multi-media features and be based on a cinema type projection system [. . .] with holographic techniques' (Mallary 1970a). This is the beginning of what was to become his 'spatial-synesthetic art' concept.



Figure 9. Robert Mallary, Colour Plotter Graphic, 1972. 8.6 × 11 ins. Image courtesy Mayor Gallery London. Made on the Amherst College IBM system using artist-designed program GRAF/D written in FORTRAN IV. The program stops while the different coloured pens are changed by hand.

By 1972, a large, multi-colour pen plotter had been acquired by the Computer Center at UMass, and Mallary returned there to use the improved university time-sharing system which now had a better setup for creating graphic works. From this date, he began teaching his special course named 'the Computer Graphics Workshop', one of the first in the US. In addition to graduate programs, Mallary also taught at least one undergraduate computer graphics course each semester, making this one of the rare places at this time where undergrad art students could access computing. Initially, students in his workshop wrote programs using batch processing via hand-punched cards. 'Frustrations' with this system were described, due to the possibility of many error problems and the huge learning curve required to even begin. Nevertheless, Mallary wrote 'I am convinced it [programming] can play a role in the education of art students by helping them to think and discuss what they are doing more explicitly and analytically' (Mallary 1976, p. 8). To address such frustrations, in 1978, Mallary created Artfile, a collection of graphics programs and subroutines written in FORTRAN geared specifically to the requirements of the course, developed, he wrote, 'with the help of talented student programmers recruited from the course' (Slezak et al. 1988). Mallary's approach to the computer can be explained as largely one of composition, not surprising given his primary interest in assemblage. His programs allowed users to

specify forms such as squares, circles, or ellipses to make compositions and build these up to create complete artworks.[1]

Other programs followed, collaboratively designed for various artistic purposes; these included BOXES, AUTO2, SPGRAF2, and SHAPE 3D, which used modules to create compositions that could then be constructed physically in Masonite. Again, as per his earlier statement that eventually the computer 'will be more like a collaborator or virtual surrogate for the sculptor himself' (Mallary 1970a), Mallary had anticipated the rallying cry of the techno-art revolution: that the computer can become our creative ally as opposed to a purely calculatory other.

5. A Spatial-Synesthetic Art

Mallary's concept of 'spatial-synesthetic art' was the result of a lifetime of work. He first wrote about 'an ultimate system of 3D projection' in 1969, in which the viewer would not be able to tell the difference between an actual object or scene and a projected one (Mallary 1969). A combination of an understanding of 3D spatial awareness gained from the practice of sculpture, together with the power presented by computing, led the artist to conceive of an expanded form of multi-media art that could generate an integrated experience of both sound and imagery in real space (Russett 1990). Mallary went on to propose that, in the future, the digital would become a 'Supermedium', with illusory, non-static, 3D projection, thus allowing a 'mobile sculpture to realise its full potential by liberating it from its fatal over-dependence on physical materials and mechanical contrivances' (Mallary 1986).

Although he did accept that the technological equipment was not yet developed, and the software to run such a system would be massive and the cost enormous, he set out proposals for how such a type of inter-media, computer-driven system utilising cybernetic principles of control and feedback, would function (Figure 10). This system would assimilate and aesthetically integrate features from many forms of art and, in any conceivable style with no constraints, save those self-imposed. The artist would work interactively with this system, writing code, or via what he called the 'robotic mode'—that is, self-generating material utilising collected datasets from a diverse community of artists and styles, to become itself a virtually autonomous artist. Further, Mallary proposed that network arrangements could link users–creators remotely. This immersive environment would occur in what he called the 'event space'—a large-scale 'transparent cube of space' (Mallary 1990).

Here, without doubt, we must credit the influence of Siqueiros, with his own 'plastic box', which can be considered a prototype of the virtual environment, and hence the connection, via Mallary, to developments of the 1970s and 1980s in VR art. Mallary's proposal acknowledged, continued, and expanded an interest within the art and technology community that had been around since the mid-1960s, that is, in an immersive art that could be fully interactive in three dimensions—what would later be termed VR. Indeed, his 'event space' recalls Ivan Sutherland's proposal for an 'Ultimate Display'. Although unrealised, due to limitations of the available technology, Sutherland conceived of a room 'within which the computer can control the existence of matter' (Sutherland 1965). Venturing even further—and perhaps to the fringes of AR/artificial reality—is Myron Krueger's example from the mid-1970s *Videoplace*, considered to be the first human interface to perceive and incorporate the participant's full body in a shared communication space, where real-time performance and interaction could be experienced (Krueger 2021).

Therefore, an art historical trajectory can be traced through the middle decades of the 20th century of a 3D immersive and interactive type of art that occurs in a specific defined environment. Mallary's proposal took elements from Siqueiros's mural innovations (the plastic box) and Schwitters's architectural installations (the *Merzbau*), and combined them with his own expertise in sculptural assemblage and, eventually, computing (the event space).

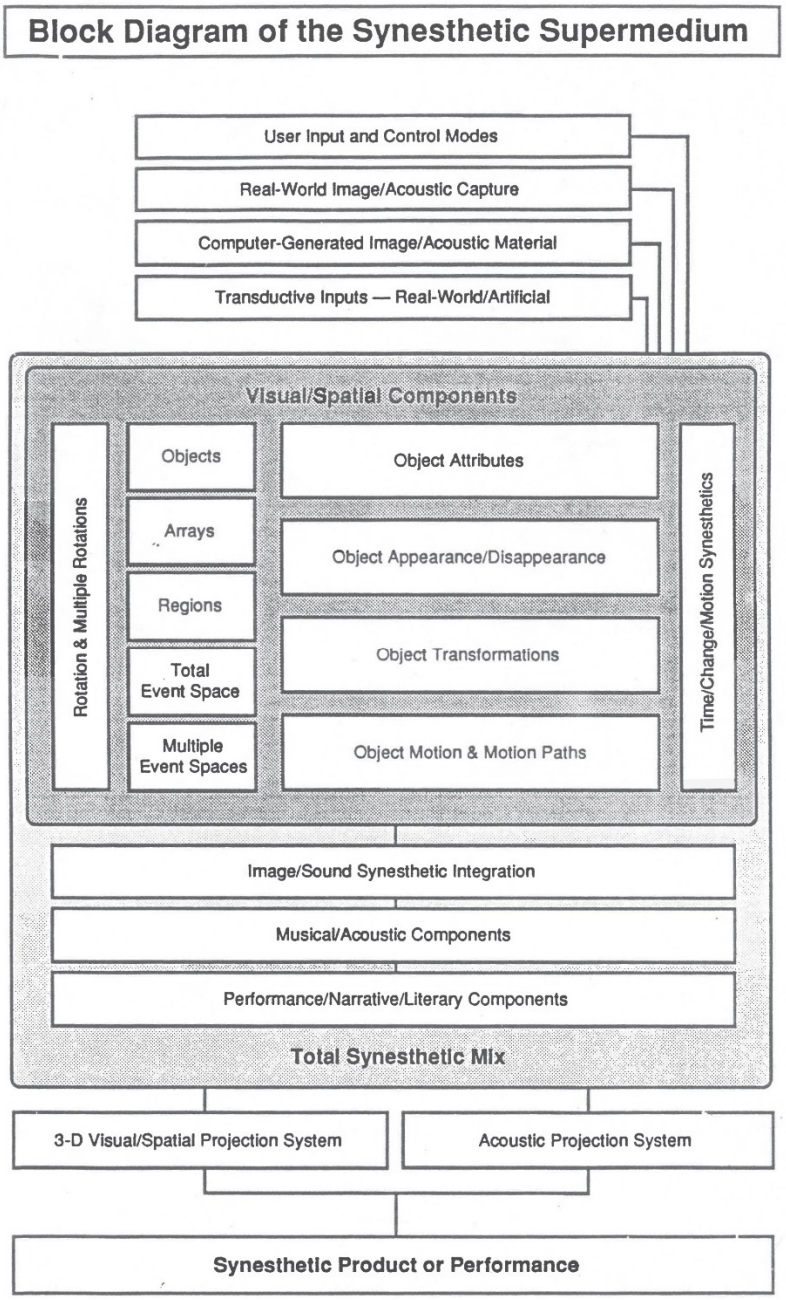

Figure 10. Robert Mallary, block diagram of the synesthetic Supermedium system, published 1990. © Estate of the artist.

Arguably, the ultimate realisation of VR in this context came a few years later with the CAVE™, a walk-in, cube-shaped room (Figure 11) and included here as an important example of an end-point towards which Mallary's efforts were leading. Created at the Electronic Visualisation Lab at the University of Illinois, Chicago, and premiered at the SIGGRAPH 1992 conference, CAVE™ was initially created as a tool primarily for scientific visualisation. It was envisioned 'from the outset as a device to enable distance collaboration among viewers immersed in shared 3D computer-generated scenes' (DeFanti et al. 2010). In time, five- and six-sided systems evolved, and higher resolution projection and then flat panel displays increased the illusion of being surrounded, allowing artists and participants to 'enter' virtual space, interact with each other, and manipulate artworks.

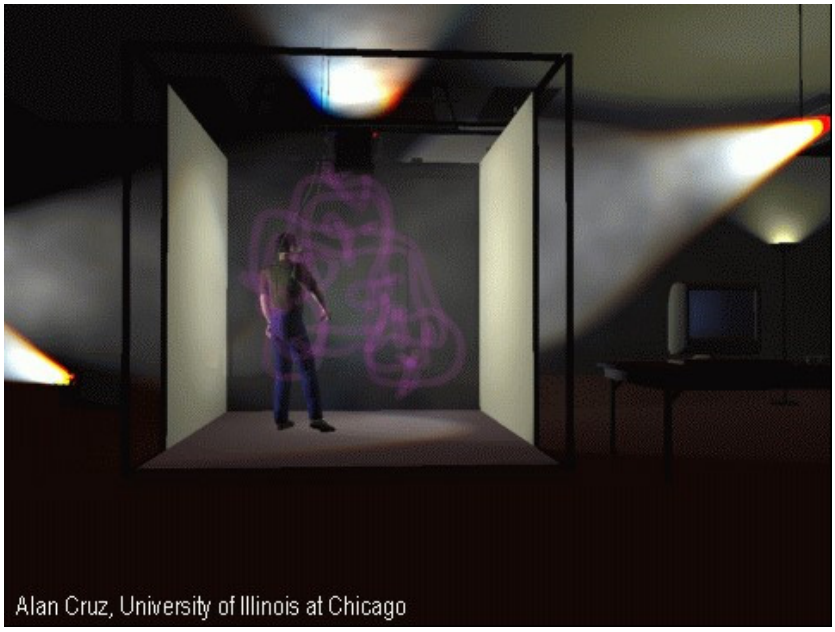

Figure 11. The 1992 CAVE™ illustration, courtesy of the Electronic Visualisation Laboratory (EVL), University of Illinois, Chicago (CAVE is a trademark of the University of Illinois Board of Trustees).

VR continues to be a rapidly expanding field. Today, the artistic use of such immersive, augmented, and extended technologies is also increasing and becoming more common in mainstream museums and galleries, hastened and intensified by challenges presented by the COVID-19 pandemic.

Responding to Mallary's original concept in the pages of *Leonardo* in 1990, Kathleen Forsythe hailed spatial-synesthetic art as a break from that of the past, presaging 'an advanced sociotechnic culture where people and their machines are in mutually supportive relation' (Forsythe 1990). Further, the participants themselves could become the Supermedium, an extension of ourselves as observers and creators in a space generated by ourselves, interacting with one another and sharing meaning. Perhaps this leads towards the resolution that Mallary had been searching for in his art, what he called the 'Element of perfection. An impeccable organisation, [the] perfect thing' (Mallary 1992).

In summary, and as yet again evident with this example of his many critical involvements, Mallary was an early prophet of the techno-art revolution. He considered the computer an intelligence and information amplification device that could be linked synergistically with the unique, creative capabilities of the human mind for artistic output and surpassing that of either the human or machine capabilities functioning separately.

6. Reception and Conclusions

Historically, computer art was difficult to categorise, tending to fall between the two camps of art and science and not fitting comfortably within either of the traditional categories of painting or sculpture, thus posing a threat to the art world status quo. Mallary recognised this, writing, 'I do not think I fall entirely into any one category [. . .] I would like to remain mobile, to change direction many more times, if I feel there is a reason to do so' (Mallary 1963a). Likewise finding suitable exhibition opportunities could be an issue, with such work often 'hidden' in small-scale and or specialist exhibitions. Thus, computer art also subverted the traditional economic structure of dealers, galleries, auctions houses, and museums. Although Mallary said that he was more interested in the quality than the quantity of his audience (Mallary 1963a), computer art, being limited in physical size to the often small plotting machine surfaces of that time, did not necessarily fit in with the large scale of much contemporary work in other media (such as Pop Art). Mallary discovered this when NYC commercial dealer Leo Castelli complained that his new computer drawings

were too small to sell (Figure 9), asking what he had that was 'big', as only work of a certain scale was hung in the gallery. Castelli represented Andy Warhol, one of whose *Mao Tse-Tung* paintings exhibited there in 1972 was 13 feet tall. Mallary referred to this scale problem, common to all early plotter art, as 'the Castelli factor' (Prince 1988).

Curator Klaus Postler believed that 'while [Mallary's] influence on his colleagues was profound, his later work did not always receive the critical attention it deserved' (Claveloux 2020). Recently, his shift toward the computer was described by a critic as an 'aesthetic swerve' and blamed for 'driving him off the map' (Hatfield 2020). The result is that Mallary's computer art has tended to be somewhat overlooked by mainstream art history. His work, however—along with other 20th century stirrings of the art and technology movement—is now being re-evaluated; and as a shining example, the Tate made a 2019 acquisition of his *QUAD III* (Figure 8).

The fraught relationship between humankind and the machine was frequently explored by artists of the 20th century. Mallary's contribution was to demonstrate a means of assimilating some of these concerns through a dynamic role—an 'artist as technologist', a positive relationship with the machine, for both creator and viewer. Over the course of his career, he moved from a direct, visceral response to the war in his youth (seen in the Mexico drawings), to a more subtle consideration of life in the Anthropocene, via the use of digital technologies through which interaction and connection with others are possible.

It is clear that Mallary, in common with other pioneering computer artists of his generation, was able to accomplish highly innovative and creative things within the very limited palette that early computer technology allowed. His educational initiatives laid the groundwork for subsequent generations, inspiring fellow artists and students alike, and are among the forerunners of numerous inter-disciplinary digital art programs attracting millions of students to art schools around the world today.

Mallary's contribution has been called 'profound' by his peers[2] (Friedman 1997). His activities and artwork are visionary examples of the artist in a synergistic alliance with the machine. They provide inspiration as humanity continues to debate the role and function of technology in all aspects of contemporary life, and what it means to be human in a rapidly changing world.

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Notes

1 Friedman, Michael. Personal communication, 27 August 2020.

2 Ferraro, Michael. Personal communication, 27 May 2021; Scholl, Laura. Personal communication, 4 January 2022.

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