AN ENQUIRY INTO THE SIMULTANEOUS EXPOSURE OF THE INTERIOR AND THE EXTERIOR OF SCULPTURAL FORM

JANE GLEDHILL

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ABSTRACT

This research was a practical investigation into the simultaneous exposure of the interior and exterior of sculptural form. Opaque materials were used to examine the apparent opposition between the terms 'interior' and 'exterior' within a sculptural context. The research was divided into five sections: I first carried out a survey of selected sculpture produced over the last century that had been specifically concerned with interior and exterior. There then followed an introduction to my studio-based work that located my area of research within the context of this survey. The last three sections were in the form of a diary and recorded my studio practice.

In the first section of the studio diary small-scale studies, using planar and volumetric materials, were made and resulted in establishing a taxonomy that provided a structure for further investigation. The taxonomy covered six categories, each with sub-categories, such as the moment of transition between the interior and exterior achieved through the manipulation of surface; the influence of implied rotation that investigated the effect of symmetry; and the role of stratification and correlation, which introduced space into the studies and sculptures. I concluded from the first section of the studio diary that the division of interior and exterior was almost exclusively concerned with 'edge' or 'corner', but became more ambiguous when a continuous surface was introduced.

In the next section of the studio diary radiography provided an opportunity to see hidden information and simultaneous views that could not normally be seen within an opaque form. The two-dimensional radiograph revealed a continuation of line from exterior to interior, which I extended into three-dimensions resulting in line becoming surface. In the final section of the research the transition between interior and exterior became ambiguous as a result of using a curved continuous surface. Combining the investigations into the significance of surface, space and symmetry resulted in full-scale sculptures in which the exposure of the interior and the exterior of the forms were in equilibrium and simultaneous.

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Cheltenham and Gloucester College of Higher Education and is original except where indicated by specific reference in the text. No part of the thesis has been submitted as part of any other academic award. The thesis has not been presented to any other education institution in the United Kingdom or overseas.

The views expressed in the thesis are those of the author and in no way represent those of the College.

Jane Gledhill
24.9. 01

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INTRODUCTION

The approach chosen for the research was in the proportion of 60% studio based practice and 40% theory. The objective was to explore the apparent opposition between interior and exterior surfaces in sculpture and attempt to expose them simultaneously. The Introduction of the thesis below is a discussion of some of the existing work involving interior/exterior and the remaining sections are a record of my studio practice.

The Introduction served to identify the work of artists, which explored the interior and exterior of form. I selected specific twentieth century artists and architects that I was already familiar with who provided diverse examples and contrasting ways in which interior and exterior were explored. Within the wide range of explorations, artists had begun from the interior and worked outwards, begun from the exterior and worked inwards, or worked on the interior and the exterior simultaneously. It was possible to place their explorations into broad categories, such as: investigations that opened up mass to give continuity of space, investigations that enclosed space within the interior to create volume or investigations that used ambiguity surrounding the interior and the exterior to question the boundaries between them. Other factors, such as, the use of edge and the use of transparent materials also affected the artists' investigations into the interior and exterior of form.

At the beginning of the twentieth century, artists' explorations into the interior and the exterior of sculptural form began to challenge the traditional concept of space displacement. Central to this challenge was the development of Cubism, which became concerned with an analysis of the interior and exterior structure of form. One of the first significant sculptures, and it was indebted to Cubism, that questioned the concept of sculpture displacing space was Umberto Boccioni's *Development of a Bottle in Space*, 1912, which was a

bottle in the process of apparent disintegration, planes moved out eccentrically from the centre of the bottle into the space beyond. In contrast to this eccentrically outward movement of planes, space itself moved in to occupy the centre of the bottle. In this way space became an integral element in defining the interior of the composition as well as the exterior. In the *Technical Manifesto of Futurist Sculpture, 1912*, he announced,

'We must take the object which we wish to create and begin with its central core. In this way we shall uncover new laws and new forms which link it invisibly but mathematically to an EXTERNAL PLASTIC INFINITY and to an INTERNAL PLASTIC INFINITY.' *The Futurist Manifestos*, ed. by Umberto Apollonio (London: Thames and Hudson, 1973), p. 52

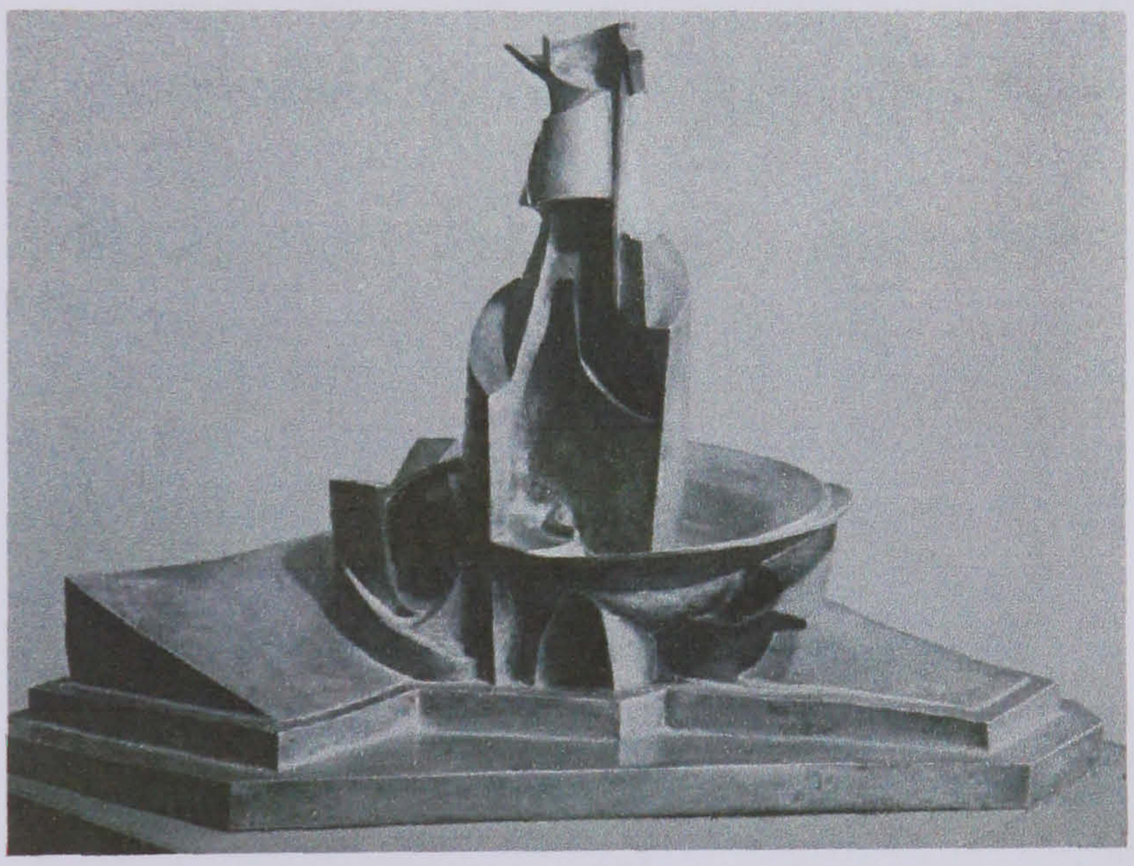


Fig. i-1
Boccioni: *Development of a Bottle in Space*, 1912.
Bronze, 15 x 24 in.

In the bronze sculpture, *Development of a Bottle in Space* Boccioni fused the two aspects he had previously explored: notions of transparency and the 'interpenetration of planes', in his search for 'continuity in space'. [1] This sculpture was in the exhibition, 'Objects of Desire', October 1997- January 1998, at the Hayward Gallery, London and from the central position at the front Boccioni's use of the displacement of space achieved a sense of transparency he had earlier sought through diverse materials and which was demonstrated in his paintings and drawings such as *Table, Bottle and Block of Houses*, 1912. Although significant at the time, the sense of transparency

Boccioni sought was achieved in the sculpture ultimately through the most obvious means: cutting into the object. [2] Instead of continuing to use the unfolding planes, which would have rotated the section of the bottle to another position to reveal the interior, Boccioni simply cut and removed the section. The logic that the neck of the bottle exhibited was, therefore, lost at the centre of the composition. Since Boccioni's ultimate aim was the achievement of 'continuity in space' he was inevitably concerned with the role of the contour, profile or edge in his sculpture, which could be clearly seen in *The Development of a Bottle in Space*. [3] In the Galerie La Boetie catalogue preface, 1913, he noted,

> 'My sculptural ensemble evolves in the space created by the depths of the volumes, while showing the thickness of each profile. Therefore my sculptural ensemble does not offer a series of rigid profiles, immobile silhouettes. Each profile carries in itself a clue to the other profiles, both those that precede and those that follow, forming altogether the sculptural whole'. Raffaele Carrieri, 'Futurism' (Milan: 1961, pp 77-78 (repr. In Boccioni: Futurist Sculpture Robert L. Herbert, ed., *Modern Artists on Art: Ten Unabridged Essays* (Englewood Cliffs N J: Prentice Hall, Inc., 1964), p. 48

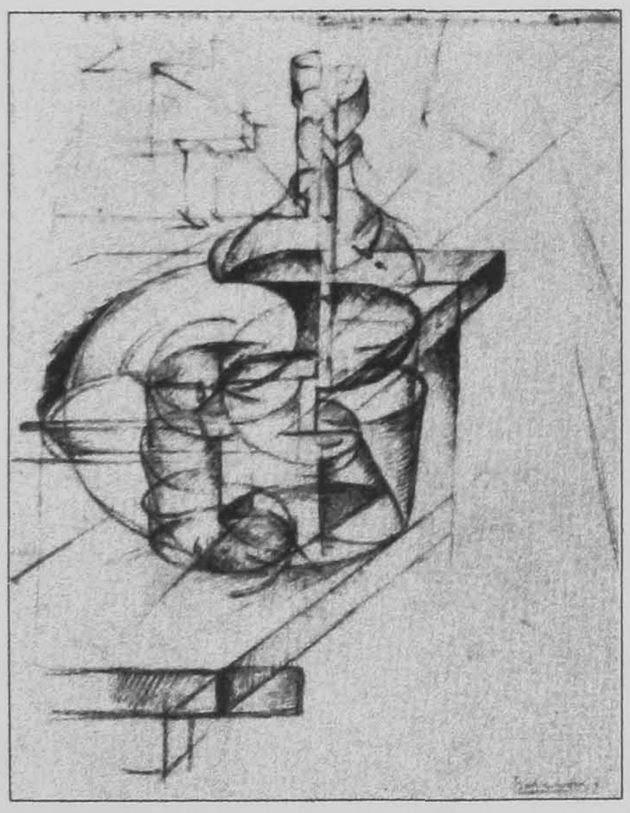


Fig. i-2
Boccioni: *Table and Bottle and Block of Houses*, 1912.
Charcoal drawing, 13 in. x 9⅓ in.

A uniting factor amongst the Futurists was their interest in depicting dynamism through explorations such as the 'interpenetration of planes' Apollonio, 1973, p. 52. In this aspect Boccioni's investigations championed

the advent of new technologies and materials, glass, steel, artificial light, etc., as was clear in his paintings of the period such as *Simultaneous Visions* of 1911. Further to this, a direct reference to transparency, a quality considered important to both painting and sculpture for its ability to reveal the interior of form, was described in the following from the Futurist Painting Technical Manifesto of 1910.

> 'Who can still believe in the opacity of bodies, since our sharpened and multiplied sensitiveness has already penetrated the obscure manifestations of the medium? Why should we forget in our creations the doubled power of our sight capable of giving results analogous to those of x-rays.' Herschel B. Chipp, *Theories of Modern Art: A Source Book by Artists and Critics* (Berkley, Los Angeles and London: University of California Press, 1968), p. 290.

Another group formed in the same decade as the Futurists and also concerned with continuity and with the relationship between interior and exterior, was the Dutch De Stijl group. The Dutchman Theo Van Doesberg was the self-appointed chair of the group and developed their aesthetic. The difference, however, between the aims of this group and those of the Futurists was, whereas the Futurists championed dynamism, the De Stijl artists considered dynamic equilibrium to be one of the most important aesthetic aims of the group. The latter refuted notions of centrality and the need for a composition to have a centre, in favour of continuity. The essential difference between Futurism and De Stijl was that the former relied heavily on the inference of circular movement or rotation, whilst the latter was almost exclusively concerned with the articulation of the horizontal and vertical using black, white, grey and primary colours only.

Fig. i-3
Rietveld: *Schröder House*, 1924:
flexible room arrangement
on top floor.

The approach of De Stijl to three-dimensions, and by inference sculpture, was exemplified by the Schröder House, built in Utrecht in 1924 by Gerrit Rietveld, in collaboration with Van Doesberg and the commissioner of the project, Madame Schröder Schrader. The *Schröder House* differed from previous architecture in the method of construction as the exterior appearance was initiated by the interior structure. The vertical and horizontal planes of varying size, which made up the exterior of the house, originated from the interior and were extended or projected to the exterior and by implication, beyond. These projections allowed planes, such as the balconies, to appear displaced, creating an emphasis on their outward projection, a factor that appeared to open up or deconstruct the original cube form the house was based on. [4] Yet, all the planes that made up the exterior of the *Schröder House* had complementary relationships to one another, creating the typical De Stijl equilibrium without being symmetrical. As the *House* was on the end of a terrace the sense of equilibrium was further enhanced by the lack of a main view, giving the three visible sides equal visual importance. This added to the sense of three-dimensionality, but at the same time the interaction between the planes, broke up the volume.

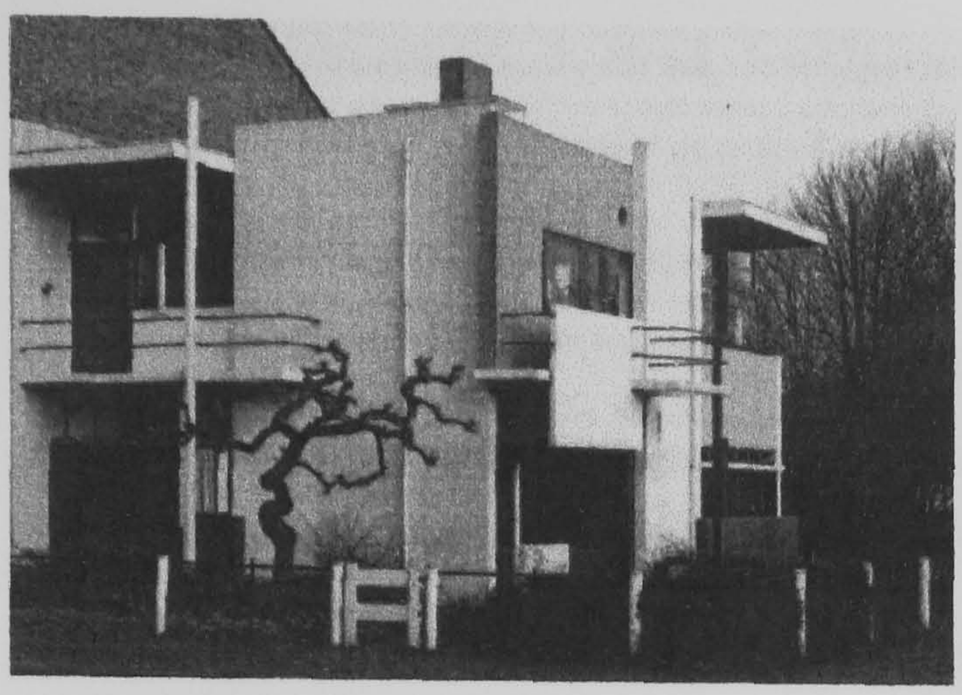


Fig. i-4
Rietveld: *Schröder House*, 1924: view from the street and looking towards the entrance at side.

One of the most notable uses of material and the way spatial continuation was achieved from the interior to the exterior of the *Schröder House* was the Eastern corner first floor window. When the windows were opened outwards the corner appeared to completely disappear: due to the corner being made out of two large glass windows at 90 degrees to each other. As a result, the closed cubic nature of the house disappeared and the interior and exterior appeared continuous. Additionally, if the windows were open and the partitions folded back, there was an increased perception of continuous space throughout the floor. [5] This had the effect of making the interior appear much larger than the actual physical dimensions. Also, because of the expanse of transparency when the windows were closed, reflections were projected: the garden and surroundings from the outside combined with views of the interior or, conversely, from the inside the exterior seen through the glass overlapped with reflections of the interior, creating a sense of continuity with the result that the separate states of interior and exterior were concurrently present.

Whilst these developments were becoming apparent in Western Europe, in Russia, the sculptor Naum Gabo and other Constructivists were involved in the use of new materials, initially, in a similar way to the Futurists. In 1915, Gabo made *Constructed Head No. 1* from plywood and used intersecting planes in which space entered the interior of the form and was defined and redefined by the articulation of planes. [6] One of the essential aims in this sculpture and

Constructed Head No. 2, 1916, for Gabo was to create volume rather than mass. In the latter sculpture, made from galvanized iron and originally painted yellow ochre, the planes projected to define the exterior whilst receding into the interior to reveal the innermost recesses. Space, as a consequence, was not displaced in the traditional sense with these sculptures but instead became a form-defining element that was essential to the existence of the sculpture, as were the planes. With the introduction of space came light and shadow, which emphasised both the planes and space, but Gabo used the edge in a different way to Boccioni. The vital but thin, uniform edge in Gabo's *Head* was used to describe the outline or boundary of the form into which space was introduced, whereas Boccioni used it to accentuate a cut or to promote a sense of movement outward, away from the centre.

Fig. i-5
Gabo: *Constructed Head, No. 2.*
1916
Metal. H 45 cm

The early work Gabo suggested he may initially have been influenced by Cubist explorations into flattening of space and the faceting of solids. It is also known that Gabo was acquainted with Futurism and both groups used stereometry in their work. One of the first examples of this was in his *Heads* of 1915 and 1916 where the organisation of the planes began to achieve what he was to describe as the Stereometric Principle. He described the principle as follows:

'...there are photographs of two cubes which illustrate the main distinction between the two kinds of representation of the same object, one corresponding to carving and the other to construction. The main points that distinguish them lie in the different methods of execution and in the different centres of interest. The first represents a volume of mass; the second represents the space in which the mass exists made visible. Volume and mass and volume and space are sculpturally not the same thing. Indeed, they are two different materials.' Naum Gabo, *Circle*: *International Survey of Constructive Art*, ed. by J. L. Martin, Ben Nicholson and Naum Gabo (London: Faber and Faber, 1937), p. 106.

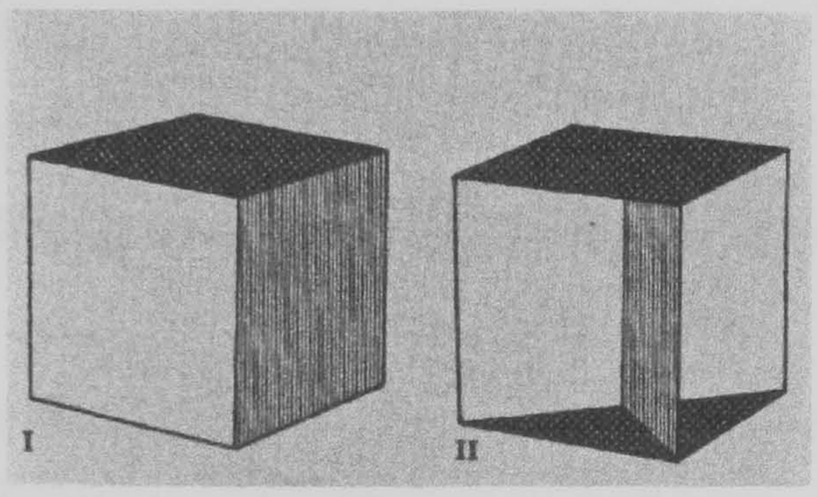


Fig. i-6
Gabo: Diagram showing volumetric (i) and stereometric (ii) cubes.

By the late 1920's Gabo was using curved planes and a series of models and sculptures on a 'Spheric Theme' were begun in the mid 1930's. The result of these sculptures was comparable with the Stereometric Principle in that a sphere was described through a continuous curved plane, whilst the incorporated space created volume. Of these sculptures, Burnham notes, with interest, that the edge is topologically continuous and follows the pattern of the seams of a baseball. *Beyond Modern Sculpture* (London: Allen Lane the Penguin Press, 1968), p. 141. The first of this series was *Model for a Spheric Theme*, made around 1937, and consisted of two broad discs with their centres removed. They were cut along their radii, bent and joined to become a continuous strip. As I walked around the model, gaps could be seen between the curved planes: at the top in the 'front' view and at the bottom in the 'side' view, which allowed space to flow uninterrupted around the sculpture and describe the sphere. Of this series Gabo stated:

> 'I felt that the visual character of space is not angular: that to transfer the perception of space in sculptural terms, it has to be spheric... I consider that in this work of mine

there is a satisfactory solution to the problem. Instead of indicating space by an angular interaction of planes, I enclose the space in one curved continuous surface.' *Naum Gabo: Sixty Years of Constructivism*, ed by Steven Nash and Jörn Merkert, (Munich: Dallas Museum of Art and Prestel-Verlag,1985), p.36.

By the early 1920's the Constuctivists were using materials, which had previously been considered non-traditional, for example, steel, wire and mirror. By using glass and with the development of modern plastics, such as celluloid, Plexiglass and Perspex, the internal composition of many of Gabo's sculptures were revealed through the transparency of the materials. Without cutting through or displacing the exterior the transparent sculptures operated in a similar way to x-rays, in that it was possible to see through the exterior surface to the interior. Although Boccioni had listed glass in the *Futurist Manifesto* and artists such as Tatlin and Archipenko had used it, it was Gabo who extended the sculptural possibilities of transparency. Through the introduction of planar materials and using the Stereometric Principle, Gabo had introduced volume, but by using transparent materials, the sculptures could be less reliant on stereometry. In *Translucent Variation on a Spheric Theme*, also made around 1937, it was not only the composition that was continuous, but the translucency of the material made both the inside surfaces and the exterior surfaces visible simultaneously.

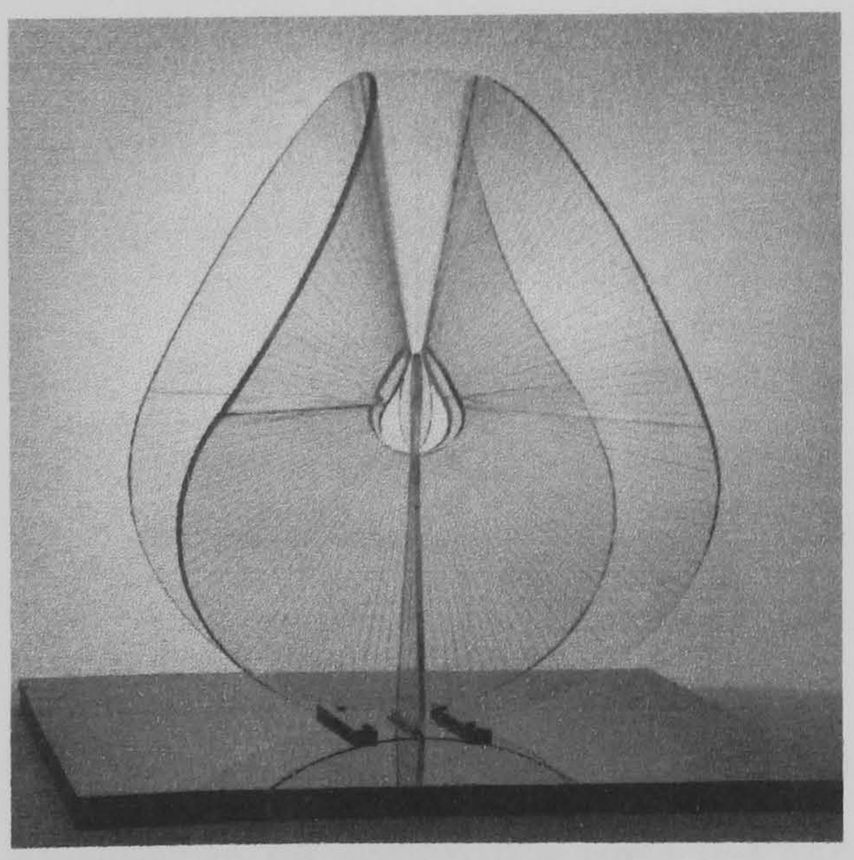


Fig. i-7
Gabo: *Translucent Variation on a Spheric Theme*, 1951 version of a 1937 original.
Plastic, 22 ⅜ in.

In 1920, Gabo used kinetics to introduce volume into a form and constructed one of the first significant kinetic sculptures of the last century, *Kinetic Construction*. This was his only three-dimensional kinetic work, and it involved a weighted sprung wire rod, which was vibrated at its base by a bell motor from a Moscow tram. When the rod vibrated, space became volume as described by the oscillations of the wire. Kenneth Martin described the sculpture in unpublished notes in 1967, although he referred to it by another, more descriptive name,

> 'The early motorised kinetic work of Gabo's 'Virtual Volume' when working correctly has the appearance of stillness. A line has become the contour of volume. Movement has engendered stillness. The work in motion becomes changeless, only when the speed of the motor changes does the work change.' *Kenneth Martin [an Exhibition at the] Tate Gallery*, [14 May – 29 June], I, (London: Tate Gallery Publications, 1975), p. 31.

Whilst Gabo's scientific and mathematical interests and his engineering skills were evident in his work, there was always, as he admitted, a strong intuitive drive in his work. Max Bill, in contrast, made the concepts of mathematics crucial to his approach to sculpture and stated 'I am of the opinion that it is possible to develop an art largely on the basis of mathematical thinking.' Eduard Hüttinger, *Max Bill* (Zurich: ABC Edition, 1978) p. 7. [7] An obvious example of his use of mathematics, and particularly topology, in his work was his series of 'Endless Ribbons', which he made between 1935 and 1995. These sculptures were based on a Möbius Strip or Band.

> 'The Möbius band is constructed by giving a strip of paper a single half-twist and then attaching the two free ends to form a closed loop. It is popularly described as a surface with just one side and one edge.' Keith Devlin, *The Language of Mathematics: Making the Invisible Visible* (New York: W. H. Freeman and Co. 1998, repr. 2000), p. 229.

During the development of the first of the series, *Endless Ribbon*, 1935, Bill claimed to be unfamiliar with the Möbius Strip and of his sculpture he said,

'… I had succeeded in giving spatial form to the mathematical symbol for infinity, the horizontal 8'. *Max Bill: Endless Ribbon 1935-95 and the Single-Sided Surfaces*, ed., by Chantal and Jakob Bill, (Wabern-Bern: Benteli Verlag, 2000) p. 13. Once acquainted with what he referred to as the Möbius Ribbon, however, he redefined it as: '… delimited by a line which runs parallel to itself.' *Max Bill: Endless Ribbon 1935-95 and the Single-Sided Surfaces*, p. 73.

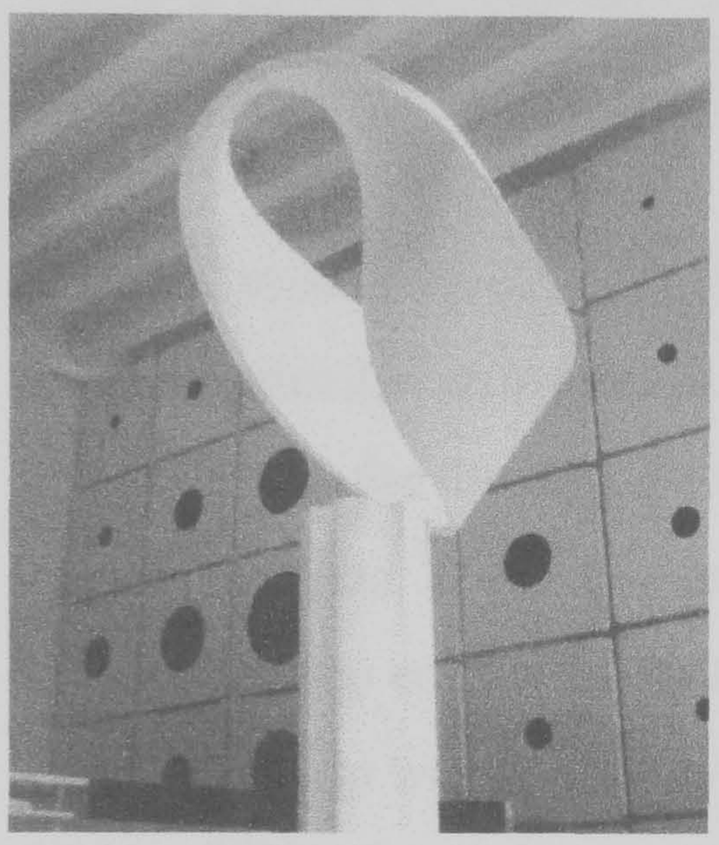


Fig. i-8
Bill: *Endless Ribbon, Version I,* 1936
Plaster. W. 50 cm, Material thickness 4 cm.

Within the series of 'Endless Ribbons', the sculptures varied in dimensions and were made of a range of materials including plaster, bronze and various types of stone. These single-sided, endless surfaces were used to create volume and enclose space. In for example, *Endless Ribbon, Version IV*, 1955, it was the nature of the curves that created a sense of the exterior space flowing in and around the sculpture. Through his work Bill identified his interest in topology as being two-fold:

> '1) The idea of an infinite surface – which nevertheless is finite – the idea of finite infinity;
>
> 2) The possibility of developing surface which – as a consequence of the intrinsic laws which underlie them – almost inevitably leads, without interpretation, to formations which prove the existence of aesthetic reality'. *Max Bill: Endless Ribbon 1935-95 and the single-sided surfaces*, p. 87

Fig. i-9
Max Bill: *Endless Ribbon, Version IV*. 1955.
Bronze. 150 x 100 x 120 cm

Although mathematical surfaces do not have sides or thickness, Devlin, p. 230, the main principle of a Möbius Strip is that it has the appearance of having one surface, but in the majority of Bill's 'Endless Ribbons' the surfaces remained visually separate. This was due to the plane having a significant thickness and a distinct, sharp edge between the two surfaces. This was no accident as Bill noted, 'the strip was limited by a narrow, flat "edge".' *Max Bill: Endless Ribbon 1935-95 and the single-sided surfaces*, p. 53. The distinction could possibly be ascribed to the materials Bill chose for these sculptures, although even in the versions made from copper or brass, in which the thickness were greatly reduced, the distinct edge was maintained. However, the stone 'Endless Ribbons', such as the largest one, *Endless Ribbon, Version V*, 1994/5, made from red Aswan granite, did achieve the introduction of space into what had previously been a solid mass of stone.

Another artist who was interested in introducing space into materials that were traditionally used to express mass was Barbara Hepworth. Like Gabo and Bill, Hepworth was also familiar with mathematical models but her approach to sculpture was similar to Gabo's in that it was more intuitive. Much of Hepworth's mature work was organic in its conception and appearance, but her interest in sculptural issues of space displacement: space volume, internal structure and equilibrium were recurrent and consistent issues in her work. The

piercing of material to produce a hole right through the sculpture was present in many of her sculptures made after her first *Pierced Form*, 1931. There were, however, two sorts of holes that Hepworth made in her work suggesting she used them for fundamentally different reasons. The first type of hole was one with a soft or graduated edge, which gave the appearance of the exterior being sucked through the hole and connecting to the opposite side of the sculpture. This sort of hole did not seem to reveal anything of the interior of the sculpture but was concerned with introducing space into mass. These types of holes usually appeared in sculptures made of stone, such as the alabaster *Pierced Form*, 1931. The other sort of hole Hepworth used in her work could be categorised as a sharp edged one, which deliberately delineated the interior from the exterior. This type of hole was where the exterior surface was cut into and the interior of the form was revealed and emphasised. Examples of this type of hole were found in works such as, *Oval Sculpture*, 1943, *Pierced Form (Epidauros)*, 1960 and *River Form*, 1965.

The large central hole in *Pierced Form*, 1931, was not perfectly circular and in this way was consistent with the amorphous organic nature of the form but somehow still appeared at odds with the sculpture. Looking at an image of the sculpture, the hole gave the impression that it was made after the form was finished, as it was incongruous with the clearly closed form. Of the hole in this sculpture Hepworth commented, 'I had the most intense pleasure in piercing the stone in order to make an abstract form and space; quite a different sensation from that of doing it for the purpose of realism.' Herbert Read, *A Concise History of Modern Sculpture* (London: Thames and Hudson, 1990, repr. 1995), p. 39. It would seem from this statement that Hepworth was indeed preoccupied with opening up the form and allowing exterior space to flow through it. It was purely due to the soft, graduated edge that the shadow created by the hole did not make a clear demarcation of where the exterior stopped and the interior began. For this reason alone, the form did not appear

to reveal its interior but gave the sense of the exterior continuing through the hole to connect with the other side of the sculpture.

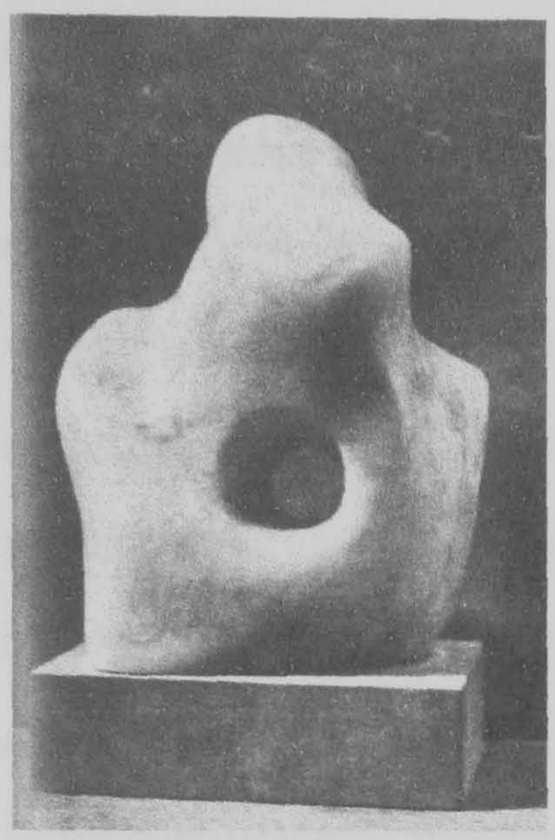


Fig. i-10
Hepworth: *Pierced Form*, 1931.
Pink alabaster, 25 cm
Destroyed (war)

In contrast to the graduated edge of the hole in *Pierced Form* was the sharp edge, which could be found in numerous subsequent works, such as *Oval Sculpture*, 1943, at the Barbara Hepworth Museum, St. Ives. In the majority of sculptures with sharp edges the exterior of the form was smooth and less complex than the elaborate interior that was disclosed through differing shaped larger holes or penetrations. This implied in the sculpture a shell-like protective outer casing, which was emphasised, particularly in this example, because of its egg-shaped exterior. The delineation between the exterior and the interior was accentuated in many of these examples, not only by the sharp edge but also by colour or texture. Originally *Oval Sculpture* was made of wood but subsequently cast in bronze due to cracking in the wood. The exterior of the bronze was painted in a darker colour to differentiate the exterior from the interior but in order to cast the bronze version, first, a plaster copy had to be cast. In the plaster version, without colour, the demarcation was still clearly visible, due, entirely to the sharp edges of the penetrations in the exterior of the sculpture.

In *Oval Sculpture*, 1943, Hepworth was not primarily concerned with opening up the form to allow space and light to flow through the form, but more with keeping the space and light within the form to accentuate the interior. Obviously the form had to be initially opened up to allow the interior to be seen, but here Hepworth was more preoccupied with revealing interior complexities. The exterior penetrations had more of a feeling of windows, which allowed the structure of the interior to be seen. The treatment of the interior of the form was softer and more flowing and had an emphasis on connecting interior surfaces to one another. The structural nature of the interior appeared to trap light and space within the form, giving it visual precedence over the exterior, reducing it to a boundary. Of this work Hepworth stated, 'The carving and piercing of such a form seems to open up an infinite variety of continuous curves in the third dimension, changing in accordance with the contours of the original ovoid and with the degree of penetration of the material.' Matthew Gale and Chris Stephens, *Barbara Hepworth: Works in the Tate Gallery and the Barbara Hepworth Museum, St. Ives* (London: Tate Gallery Publishing, 1999), p.87. There was, therefore a difference between the role of the holes in *Pierced Form* and *Oval Sculpture* with the former allowing space to travel through the sculpture and the latter appearing to trap space so that it defined the interior.

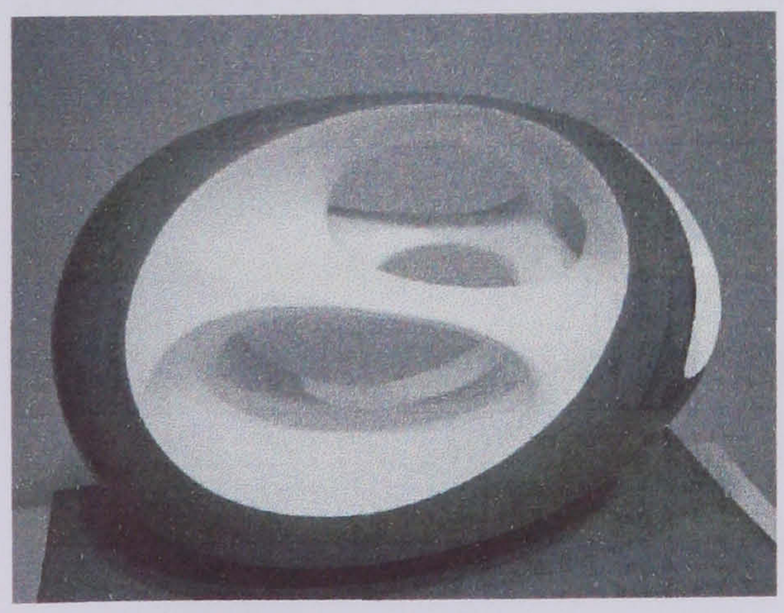


Fig. i-11
Hepworth: *Oval Sculpture*, 1943.
Painted wood
Base length 42 cm

Fig. i-12
Hepworth: *Oval Sculpture (No. 2)*, 1943, cast 1953
Plaster
29.3 x 40 x 25.5 cm

Sphere With Inner Form, 1963 may be a key to the differing role that holes played in the work of Hepworth. This work dealt with a theme also favoured by Moore, and treated in a similar way, that of enclosure and protection. In this sculpture the interior form was separate from the protective exterior shell and the treatment of the two elements was very different. The exterior element, although retaining some organic traces, was much smoother in appearance and had sharp edges to the holes, which penetrated the outer shell. In contrast, the inner form was amorphous and soft in appearance. The inner form also had a hole, which ran through its centre. As the exterior form was hollow the penetrations appeared to be cuts into a sphere and, again, gave the appearance of windows, through which the interior of the form was revealed. In contrast the hole in the inner form merely revealed the form that appeared to be solid and gave visual access through the centre of the sculpture to the space beyond it. As this sculpture was made of bronze, and bronze is generally cast hollow, there was a difference between the final form and the original. It could be assumed that the original was probably made of plaster and the inner form could have been solid. This suggested that Hepworth not only used different types of holes in her work but also their use also changed depending on whether the material which was penetrated was hollow or solid. Returning to *Oval Sculpture*, 1943, and following the previous argument, the fact that Hepworth started with a solid block of wood, one would expect the exterior penetrations to merely open up the form to allow space to travel through the form. Instead, because of the labyrinth of holes carved into the block, it no longer appeared solid and these interconnecting holes and the surfaces they produced captured the space and light within the sculpture. It would seem, therefore, that the two types of holes Hepworth used for differing functions were ultimately only distinguished by their edge.

Fig. i-13
Hepworth: *Sphere with Inner Form*, 1963
Bronze, 90 x 90 x 88.5 cm

Around the same time Hepworth made *Pierced Form*, Julio González was also investigating opening up form and introducing space into sculpture. Instead of attempting to open up the mass of solid form as Hepworth had done, González, and also Picasso, were exploring the use of line to define space within their sculptures. A sense of transparency was introduced as the linearity allowed space to continue from the exterior through the sculpture. In for example, the linear construction of Gonzalez's *Maternity*, *(Maternité)*, 1934, a sense of volume was also created. By attaching a vertical loop to a central rod a head was suggested whilst horizontal loops at the centre and the base inferred a body.

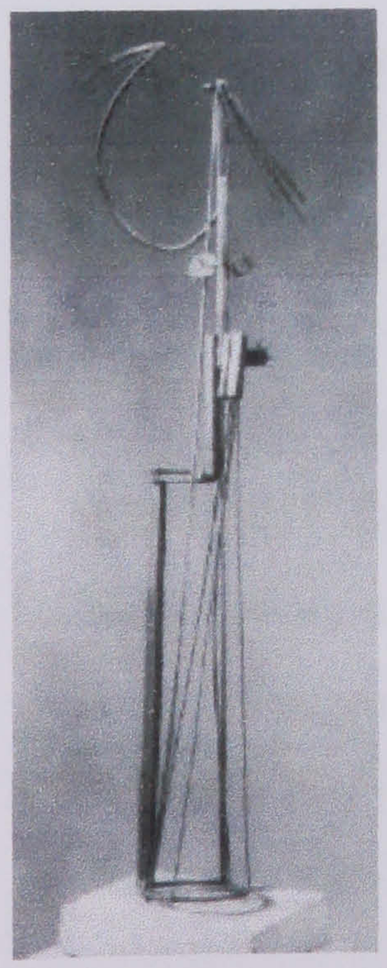


Fig. i-14
González: *Maternity (Maternité)*, 1934.
Steel
130.5 x 40.6 x 23.5 cm

Fig. i-15
González: *Head*, 1935
Wrought Iron
17¾ in.

This sculpture, and much of González's work at this time, was heavily reliant on stereometry. In his sculpture, *Head*, 1935, the circular volume of the face was described by the large crescent supporting the hair and mouth and the rough disc fixed on it at right-angles. The use of stereometry was emphasised by the base, which was made up of three planes projecting from the centre. It was reminiscent of Gabo's cube representing 'space in which mass exists made visible'. Naum Gabo, *Circle*: *International Survey of Constructive Art*, ed. by J. L. Martin, Ben Nicholson and Naum Gabo (London: Faber and Faber, 1937), p.106.

Another artist working with the same material as González and also using line to define space was the American artist, David Smith. The crucial difference between González's *Head* and Smith's use of line was the lack of stereometry in the latter. A clear example of this in Smith's work can be found in *Blackburn: Song of an Irish Blacksmith*, 1949-50. Perhaps because *Head* incorporated aspects of Expressionism and Surrealism the central core was necessary for coherence of form. Smith, in contrast appeared to have dispensed with the central core in *Blackburn* for exactly the same reason: to introduce incoherence. In this sculpture Smith accentuated the different viewpoints of a three-dimensional form by making them radically contrasting, in the information they conveyed. Although *Blackburn* conformed to a central axis, the two viewpoints did not add up to a cohesive whole. Stereometry as used by Gabo and González involved reducing the components of a sculpture to an edge or plane but the differing viewpoints conveyed the same information and suggested volume. Smith, however, was interested in questioning apparent volume. From one view, *Blackburn* had stereometric qualities, but by moving round 90 degrees the sense of three-dimensionality was immediately lost. Instead of a form describing volume in the first view, one was faced with a

predominance of space, which appeared merely to pass through the open structure.

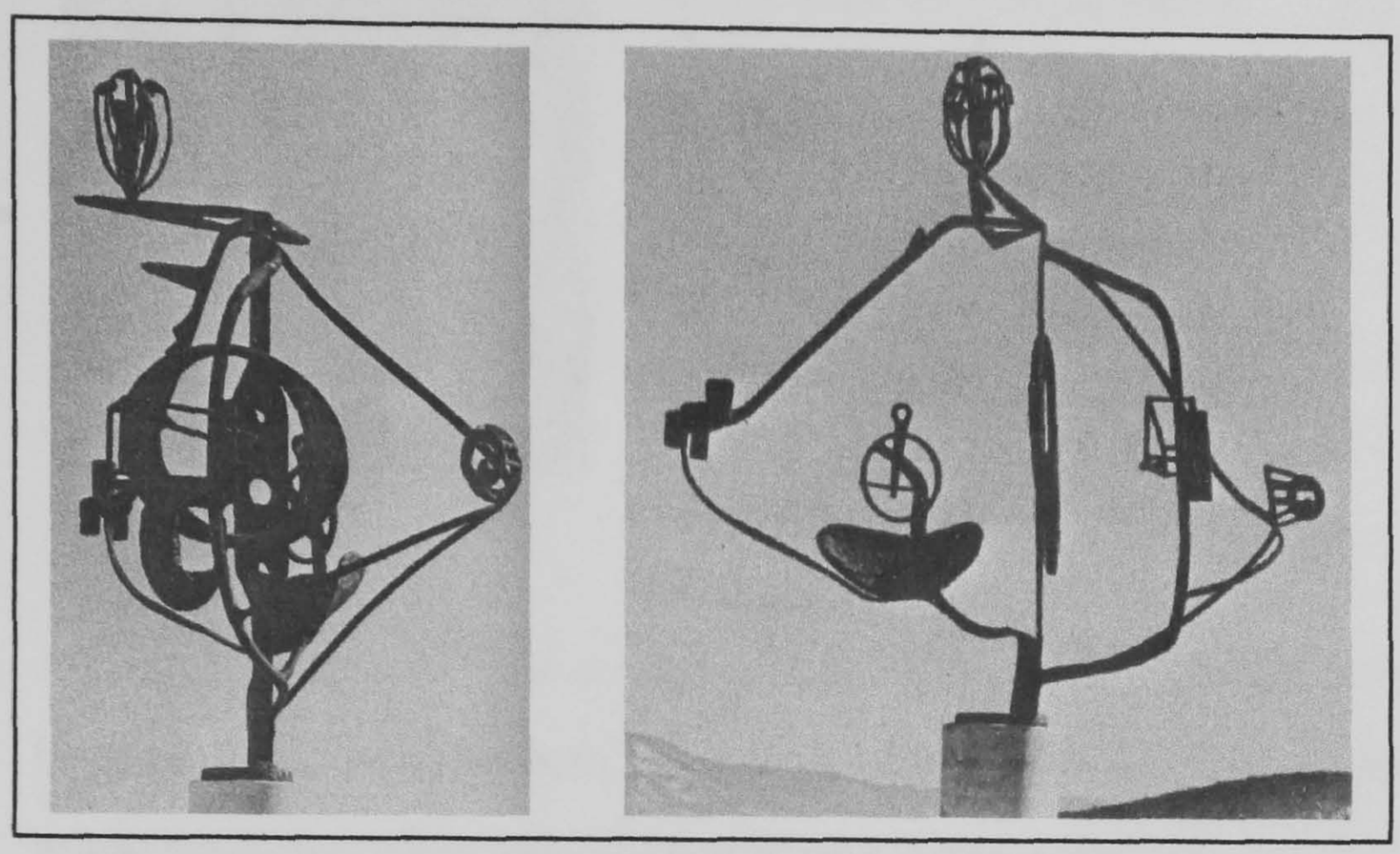


Fig. I-16
Smith: Blackburn: Song of an Irish Blacksmith, 1949-50
Steel and Bronze. 46 ¼ x 40¾ x 24 in.
Two Views

The subversion of the notion of the revealed core relating to the coherent reading of an object and a questioning of apparent volume could be seen again in a later example of Smith's work, *Zig IV*, 1961, as was noted by Krauss in *Terminal Iron Works: The Sculpture of David Smith*, (Cambridge, MA and London: MIT Press, 1971), pp. 12-16. The yellow ochre painted steel sculpture consisted of separate cylindrical sections, which were sited on a raised, sloping flat plane. The front view was predominant, which provoked a feeling that half of the sculpture was hidden. The flat plane on which the cylinder sections were sited seemed to refer to sculptural relief although this was undermined by small elements that extended from the underside of the plane or appeared to puncture the surface. Although *Zig IV* is made up of planes they do not enclose space. The fundamental difference in these two sculptures to other works discussed so far was the boundaries that Smith used in these two sculptures did not work in the conventional way of describing volume. The lack of volume in these examples of Smith's work could be traced, particularly in *Zig IV*, to the denial of a central core.

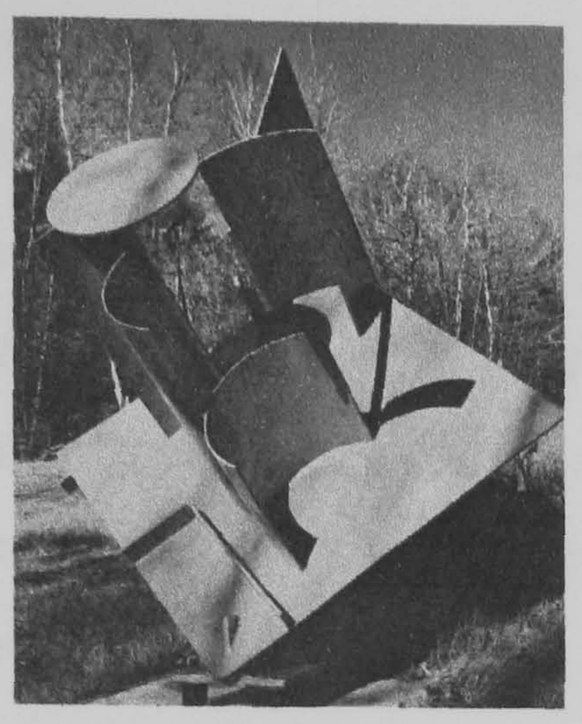


Fig. i-17
Smith: *Zig IV*, 1961
Steel painted yellow-ochre
95⅜ x 84¼ x 76 in.

A clear example of how a central core could achieve an apparent volume could be seen in Kenneth Martin's series of *Screw Mobiles* and *Variable Screws* made between 1953 and 1974 of which some were kinetic: activated by hand or motors. The series explored the creation of virtual form through change or movement and stillness and included sub-groups investigating differing aspects of both form and types of movement, such as translations, rotations or twists. There were at least two types of movement in Martin's work: physical movement through rotation and the virtual movement created by the helical arrangement of elements around a central axis. Further types of movement were introduced in later work through additional elements, increasing the complexity of the form and developing secondary forms around the primary one, resulting in virtual volumes in space. Diversity of movement, both virtual and physical, was created through varying the width or length of the rods used and by also varying the angles at which they were attached to the axis. The width of rod was not arbitrary but conformed to organised patterns originating from, for example, the Fibonacci series, which was then developed by Martin to accomplish the resultant rhythm.

In his notes about his work each term has a specific meaning, for example, 'Change is considered as structure making.' Kenneth Martin [an Exhibition at the] Tate Gallery, [14 May – 29 June] 1975, I, (London: Tate Gallery

Publications, 1975), p. 31. In a lecture called *Invention* given in 1956, Martin described how a line in motion, or change, could appear to create a plane and how the movement of the plane could appear to create a solid. He noted in that it was the space that was enclosed within the movement of the lines or planes around a central axis, which gave the sense of form. (Martin, *Tate Gallery*, I, p. 9). The use of symmetry and asymmetry could be seen in Martin's plan and elevation drawings of the *Screw Mobiles*. An example of symmetry could be seen in both the drawing and the sculpture of *Screw Mobile 1953*. An example of asymmetry could be seen in *Variable Screw 1967* in which four elements were arranged on a screw thread. The sculpture consisted of parabolic brass bars of differing width, which were attached to washers that rotated on a threaded rod in a clockwise or anti-clockwise direction to move up or down. The washers that attached the bars to the rod were either on the inside or the outside of the parabola and were placed at differing positions along its length. The type of form the movement a single bar created depended upon the position of the washer in relation to the parabola. Although the underlying structure remained the same, the viewer could create numerous variations of form by the movement of individual elements around the central rod, which became a fixed point of reference. As the mobile was suspended, the bars had to be positioned to balance in order to retain the verticality of the central rod and, in this instance: it was asymmetry that balanced the mobile.

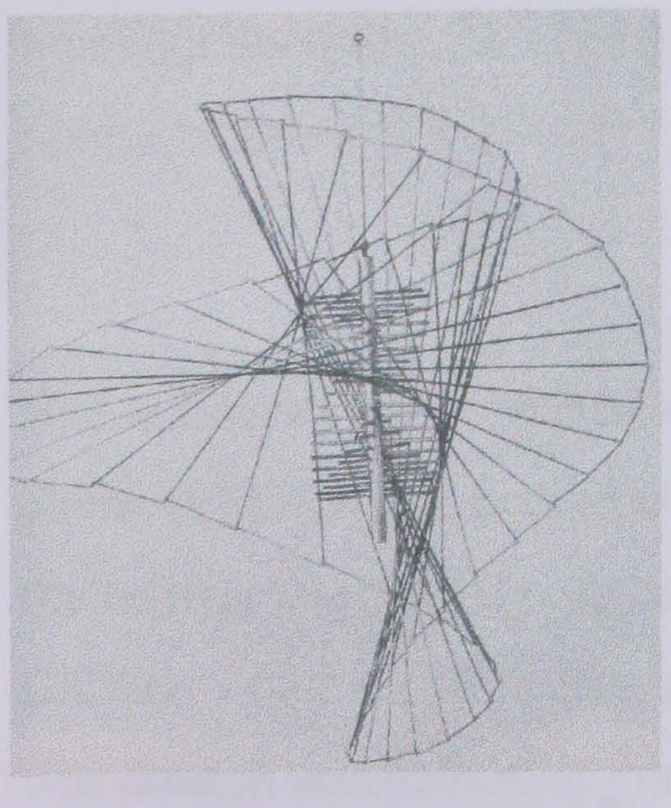


Fig. i-18
Martin: *Screw Mobile*, 1959
Phosphor –bronze
H 24⅞ in.

In *Screw Mobile 1959* a core was centred round a cylindrical axis and asymmetrical secondary elements created virtual volume or solid form when rotating. Martin was referring to the apparent volume created by symmetrical movement of Gabo's *Kinetic Construction*, 1920 when he wrote in 1967,

> 'The hyperboloid of revolution is a ruled surface and is generated by a straight line which revolves about an axis not in the same plane with it. This solid of revolution will seem as still and as symmetrical as the work by Gabo or a Greek urn. If a succession of linear rods are set around the axis in circular fashion and also set in rhythmically different angles to each other, then a solid of revolution can be created by movement which is not symmetrical but asymmetrical and in which a sequence of fluid changes can take place. In such instances contour is the result of internal forming.' Martin, *Tate Gallery*, I. p. 26

It would seem that although Martin used a central axis he was not limited to creating symmetrical sculptures through its use. In fact, from a simple device he could create complex structures. In *Screw Mobile 1959* the secondary elements were connected to each other at their extremities, not only creating a profile with which to enclose space but also enhance fluid movement. The resultant edge could be described as topologically continuous and used the mathematical principles of topology in a similar way to Gabo in his *Spheric Theme Series*. In contrast to the apparent volume created by internal forming of his kinetic work, Martin also used topology involving the edge of form in his static work, as in for example, *Line with Black Box 1961*.

Just as interior space created apparent volume, as in the *Screw Mobiles* of Kenneth Martin, so it could also be used to make spatial relationships between the interior and exterior of sculptural form, as in the example of Eduardo Chillida's *Our Father's House* of 1988. In the two works, the interior space was created and defined in completely contrasting ways. *Our Father's House*

was a solid cast concrete sculpture, over nine metres high, sited in a park on the outskirts of the Basque town of Gernika. The structure, which had a substantial thickness, was made from two straight planes that were at approximately 90 degrees to each other but connected by a gentle curve. The combinations of straight and curved elements were echoed in the penetrations made through the structure at the top edges of the straight planes and at the curve or apex of the sculpture. The penetrations of the curve took the form of segmented roughly circular sections, which were joined together but retained the smooth curve of the exterior surface. The asymmetric arrangement of these sections gave the sense that the surface was broken through rather than holes being incorporated into the structure, as with the two perfectly round and symmetrical penetrations at the top corners. Instead of actual or virtual movement of the material encapsulating space, as in Martin's mobiles, it was the apparent movement of space through penetrations in the static and solid material of *Our Father's House,* which allowed space into the interior.

Fig. i-19
Chillida: *Our Father's House*,
1988
Concrete
Over 30 ft high

The sculpture in no terms could be described as a closed form, as there was a large opening between the two straight ends but, despite this, the form did have a sense of having a clear delineation between interior and exterior. The interior and exterior surface of the form were identical and if the sculpture were made of an elastic material, there would be no reason why the sculpture could not be inverted and the interior surface become the exterior surface and

vice versa. The presence of an interior in *Our Father's House* may have been due to the scale and the obvious materiality of the sculpture but equally it could have been due to its relationship with space. The concave nature of the form provided an inner space, but it was not only the ability to hold space that provided the sculpture with a sense of interiority. The penetration of the material also created a sense of interiority, as the continuation of exterior space appeared to pass through a boundary. The sense of space flowing from the exterior to the interior was felt more strongly when it passed through a boundary than if no boundary existed, as with the open end of the sculpture. It was the separate elements emanating from a central axis in Martin's *Screw Mobiles* that enclosed space during movement to create an apparent volume and therefore a sense of an interior. In *Our Father's House*, Chillida neither used a central axis nor enclosed space, but instead used the penetration of the exterior surface to achieve a sense of interior.

With the exception of Smith, in the sculpture and architecture discussed so far there have been two predominant aims. There has been either an attempt to open up solid form to create space within and provide a continuation of space from the exterior to the interior or, secondly, there had been an attempt to create forms, which enclosed space within their interior to imply volume. In order to achieve the aims in both instances there has been a significant relationship between the interior and the exterior. In the work of Rachel Whiteread, however, although she used the interior and exterior it was in neither of these ways. Instead, in works such as *Ghost*, 1990, and *House*, 1993, she created solid form from space. In these works the space that existed within the object was given precedence over the actual object through becoming solid, opaque and apparently impenetrable, while the original object was discarded.

Fig. i-20
Whiteread: *House*, 1993
Concrete

In *Ghost*, 1990, the interior surface of a room was cast in plaster sections and the sections were reassembled to produce a solid representation of the space within the room. What also occurred during the casting process was the interior surface of the room was transformed into the exterior surface of the sculpture. By the inclusion of details within the cast, for example, the fireplace in negative, I was able to see that the exterior of the sculpture was a cast of the interior of a room. A similar procedure was used on a larger scale with *House*, 1993, where the interior of a whole house, apart from the attic, was cast in concrete and the exterior subsequently removed. Out of the two aims outlined, which explored interior and exterior, Whiteread's transformations were most similar to the second aim, in which space was enclosed within form, but unlike this aim she did not create virtual volume but actual volume. What Whiteread did not do in either of these sculptures was to offer a new interior within the transposed interior. In *House* particularly, the apparent solidity of the cast interior produced only an exterior surface. Although she transformed the interior into the exterior there was no new significant interior apart from during the demolition of *House*. Through the 'dematerialisation' of the original object into a positive manifestation of space, Whiteread's sculpture was more concerned with questioning the artistic object than with concepts of interior and exterior. Stuart Morgan in *Rachel Whiteread: Shedding Life* (London: Tate

Gallery Publishing, 1996) p. 19. She was not, therefore, primarily concerned with the interchange of interior and exterior in sculptural form but more with presence and absence.

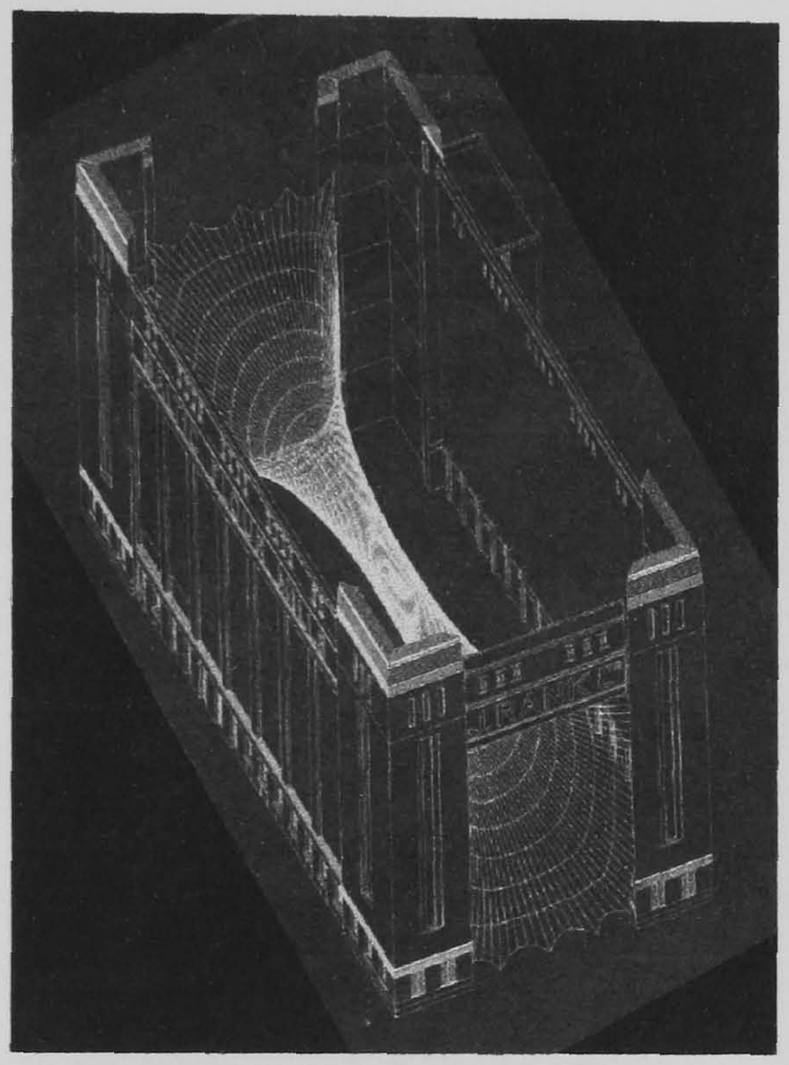


Fig. i-21
Kapoor: Bird's-eye projection of *Taratantara*, 1999.

As with Whiteread's *Ghost* and *House*, Anish Kapoor's installation, *Taratantara*, 1999, also used architectural space. In *Taratantara*, however, instead of using interior space as a given and merely transforming space into mass, Kapoor questioned the whole notion of what constituted interior space. Although, *Ghost* and *House*, to some extent, challenged the boundaries of interior and exterior, through transposition, the result was easily comprehensible. In contrast, Kapoor's installation created ambiguity between the notions of interior and exterior and raised questions of boundary, which were much less easily answered. During the interim period of a disused flour mill in Gateshead becoming the Arts Centre: Baltic, Kapoor had the opportunity to make a site-specific installation. Only the North and South facades remained and the building was scaffolded externally. This left an internal floor space 50 metres long and 25 metres wide and Kapoor's installation stretched the full length of the building. The installation was a

double, open-ended 'trumpet form', made from three tonnes of semi-transparent crimson PVC, which was welded together using high frequency radio waves. The resulting 'trumpet form' was attached to the inside of the building and made taut by ratchet straps. Kapoor questioned notions of interior and exterior by the way in which information about the installation was revealed.

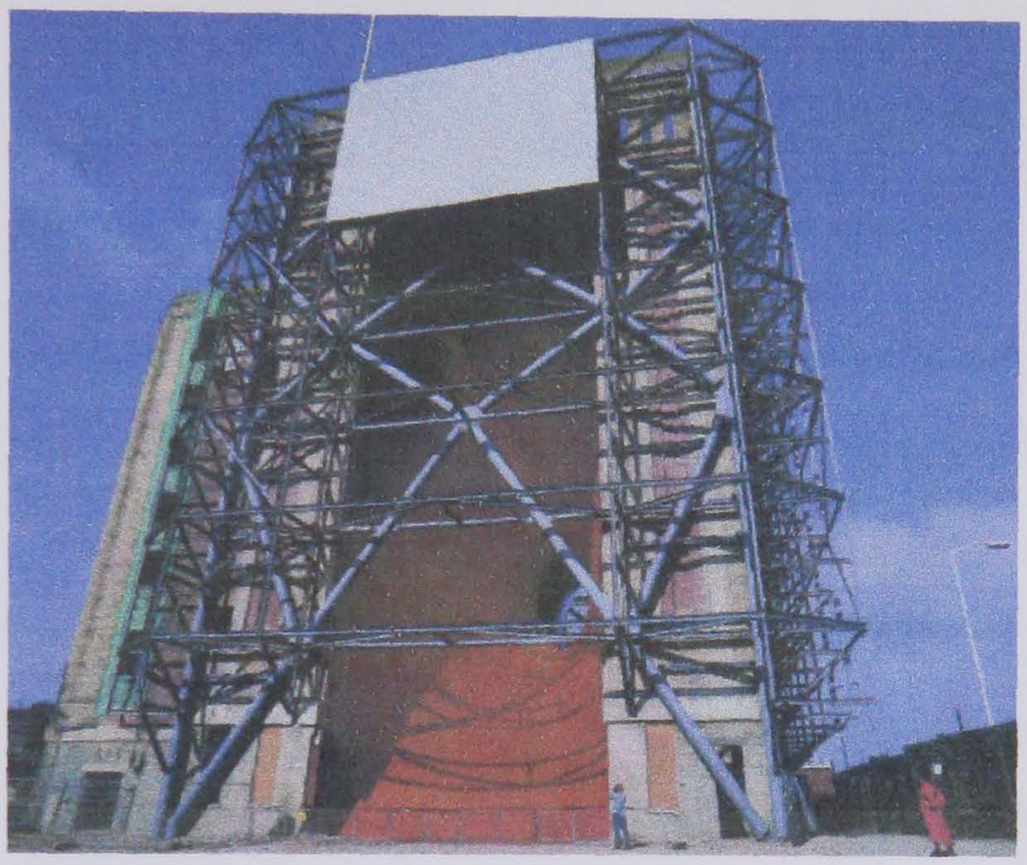


Fig. i-22
Kapoor:
Taratantara, 1999
PVC
Length 50 m

There was no one viewpoint from which the whole installation could be seen, and to fully understand the structure as seen from the outside of the building, one needed information from the inside view. The innovative use of interior and exterior in *Taratantara* came from the reversal of the position in which information was disclosed. From the outside of the building I could only see the exterior facades and the interior of the PVC structure. Conversely, when standing inside the walls, on the interior of the building, only the exterior of the PVC structure could be seen. The two views of the PVC structure, therefore, evoked very different responses.

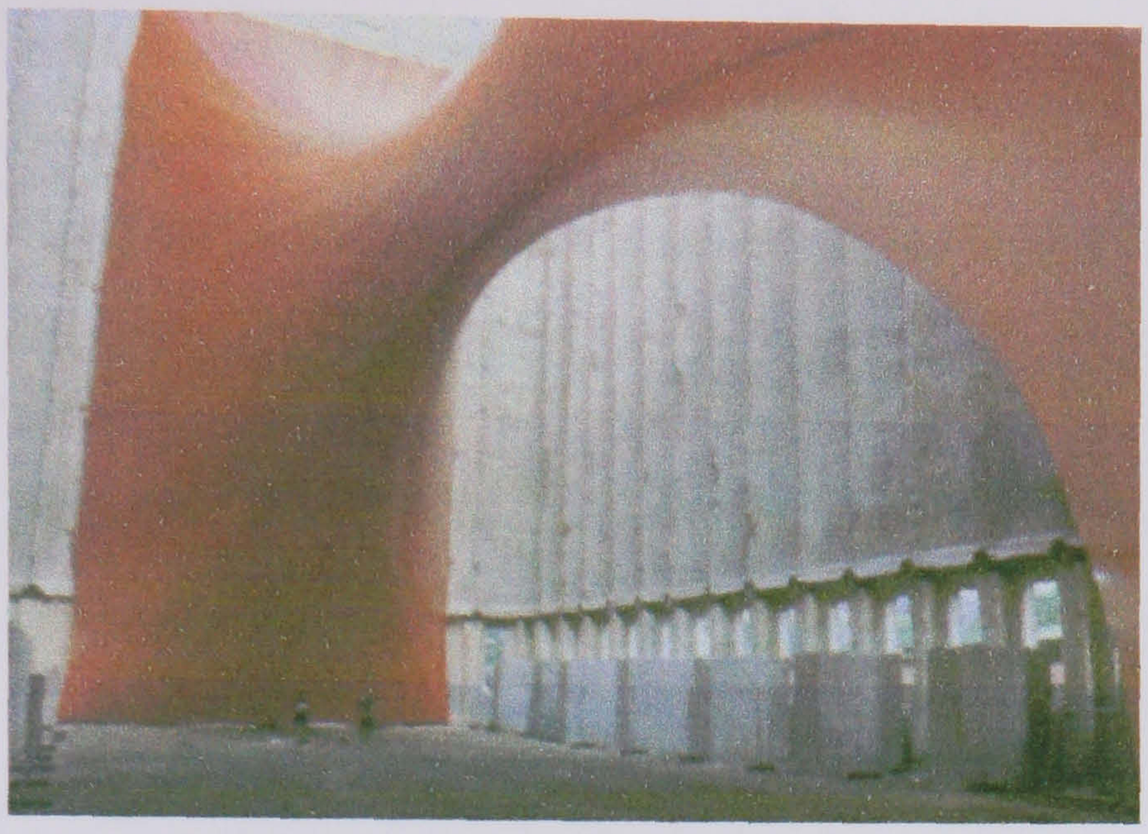


Fig. i-23
Kapoor:
Taratantara, 1999
PVC
Length 50 m
View from inside
the building.

From outside the building and at a distance, the most notable feature of the installation was the central hole, flanked by red, which framed and accentuated the blue of the sky, in a similar way to a Turrell sculpture or installation. [8] In *Taratantara* there appeared to be a foreshortening and it was impossible to discern the shape or length of the hole. Kapoor's wish for the structure to be seen in terms of the body was realized by standing close to the structure and looking into it, as one's whole vista was immersed by a crimson, pulsating expanse. The structure moved because of a through-flow of wind and as the building did not have a roof, the light and clouds affected the colour of the structure. The sense of being drawn into the interior was enhanced by the curved edge of the structure, which was reminiscent of the way Hepworth used a graduated edge. Of this view Kapoor stated, 'I am thinking of a very simple, primal experience: look at the sun and put your fingers over your eyes, that after-glow of red, eyes so to speak, turned inwards.' 'Anish Kapoor in Conversation with Sune Nordgren', *BALTIC Newsletter*, No. 5, 7 July – 1 September 1999. [no page]. [9] Partly due to the scale and partly by standing both outside the sculpture and also in the open air the evocation of interiority was disconcerting.

Expecting a similar but more intimate experience from viewing the structure from the inside of the building, one was confronted instead with the sense of

scale, tension and texture of the material. The view from inside the building described the shape, size and true colour of the structure and explained all that could not be deduced from only seeing its interior. The one issue that was not explained by the structure, however, was where the boundaries lay between the interior and exterior, in relation to the whole installation. There were no clear distinctions between the boundaries of interior and exterior and because of this the terms were challenged and became significant through their ambiguity. Further ambiguity arose from the involvement of a building, with generally accepted usage of the terms interior and exterior.

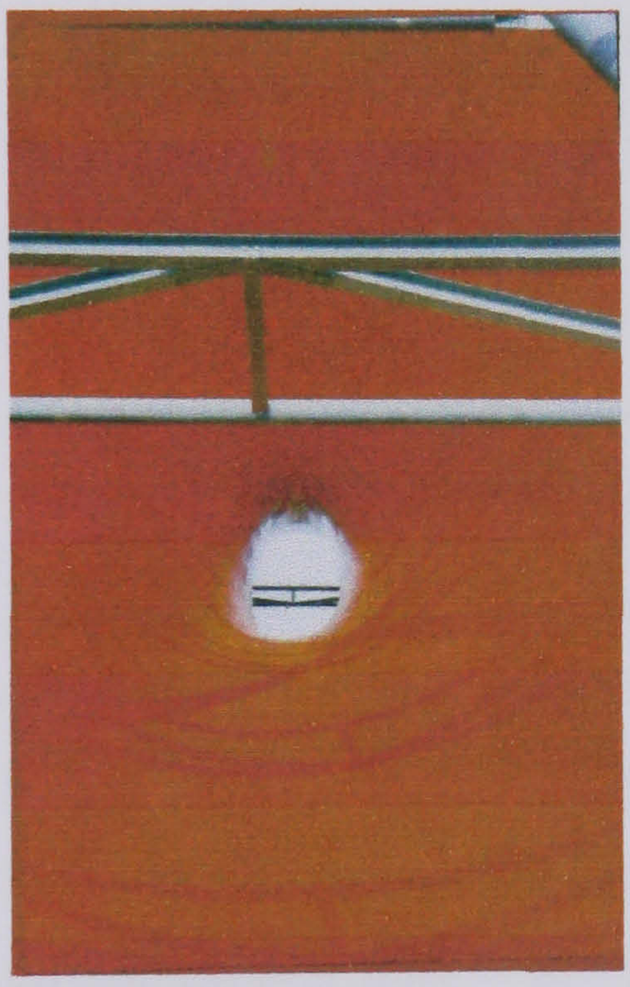


Fig. i-24
Kapoor: *Taratantara*, 1999
PVC
Length 50 m
View from outside the building and looking into the interior of the sculpture.

If the installation was simply the PVC structure then the boundaries of interior and exterior would be clear, but Kapoor did include the building as part of the installation, as he commented, 'I like the idea that the architecture is a reflection or a substitution, if you like for the self. It is a surrogate body. *BALTIC Newsletter*, No. 5, 1999. [no page]. It would seem from this statement then, that the building constituted the exterior of the installation but, in the same interview, he also referred to the 'external structure' of the material. Kapoor commented, 'It's as if the building is kind of irrelevant. It's the external structure and the internal structure that are operating against each

other. Except that the building has enormous presence.' *BALTIC Newsletter*, No. 5, 1999, [no page]. If the outside of the building and the outside of the structure were both exteriors, then the question was raised as to how to define the place within the building but on the exterior of the structure. If this place were part of the interior of the installation, as would be consistent with architectural terminology, instead, there would be two interiors. The second interior was formed by the structure, which was also what separated the two and allowed it only to be viewed from outside the building.

It would seem as though the interior of the work was the starting point for Kapoor's sculpture, with the exterior surface used to create ambiguity or to accommodate the interior void. For instance, sculptures and installations, such as *Suck*, 1998, were, in a similar way, predominantly concerned with creating an interior space with the site of the installation becoming the exterior. [10] The ambiguity between the interior and the exterior boundaries in *Taratantara* may have been due, in contrast with previous installations, to the interior not being inset into solid mass. It was the fact that one could stand in the space between the structure and the building, which prompted questions concerning boundaries. This opportunity to physically experience the installation differentiated it from other of Kapoor's works in which questions of boundaries were provoked by an altered sense of perception arising from, for example, dark voids, plays of light or an apparent disparity in size between interior and exterior.

Richard Serra deliberately utilises the boundaries of interior and exterior in sculptural form in his series of 'Double Torqued Ellipses'. In these works Serra questioned interiority and exteriority and what was between these two states. The whole series, of eight to date, included single and double ellipses and both types used materiality to articulate space and create a sense of motion

and flux. Fundamentally associated with their material presence was Serra's use of space as a material with which to create volume. Within his inquiries into the dislocation and articulation of space he spoke of the material as being a 'skin' between the interior and the exterior. In previous work Serra acknowledged starting from the material and enclosing space, but in the 'Torqued Ellipses' he spoke of beginning from the void and forming the object from emptiness. These sculptures differed from previous work because, as the 'Ellipses' enclosed space, he began from the inside and worked outwards.

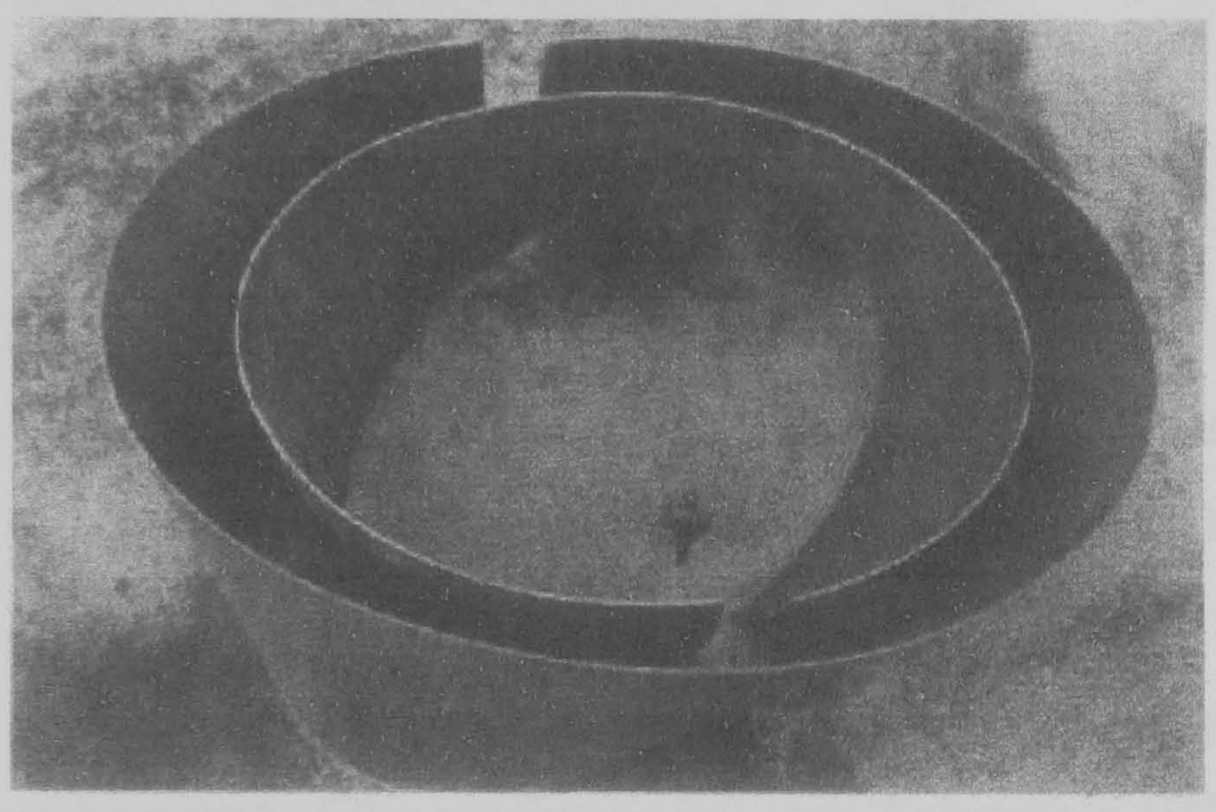


Fig. i-25
Serra: *Double Torqued Ellipse II*, 1998
Weatherproof steel
Exterior Ellipse 3.58 x 7.67 x 11.64 m
Interior Ellipse 3.58 x 6.05 x 8.85 m
Plate thickness 5.1 cm

The series of 'Torqued Ellipses' were made from 5 cm thick Cor-Ten steel plates and ranged in height from 3.65 metres to 4.18 metres. Rotating parallel ellipses in such a way that the base and the top were at different angles to each other created the forms. The variations between the pieces were due to changes in the relationship between the major and minor axes and by changing the angle of rotation the gradient of the sides of the plates also altered. Each ellipse was made of two or three plates, with each plate weighing approximately twenty tons, which were butted together. The 'Double Ellipses' were two ellipses with differing angles of torque placed one inside the other which created a corridor space between them. Apart from whether a sculpture had one or two ellipses they also varied from one another in height, angle of torque, colour and in the placement of the entrances. Each ellipse could be accessed through a space in the wall.

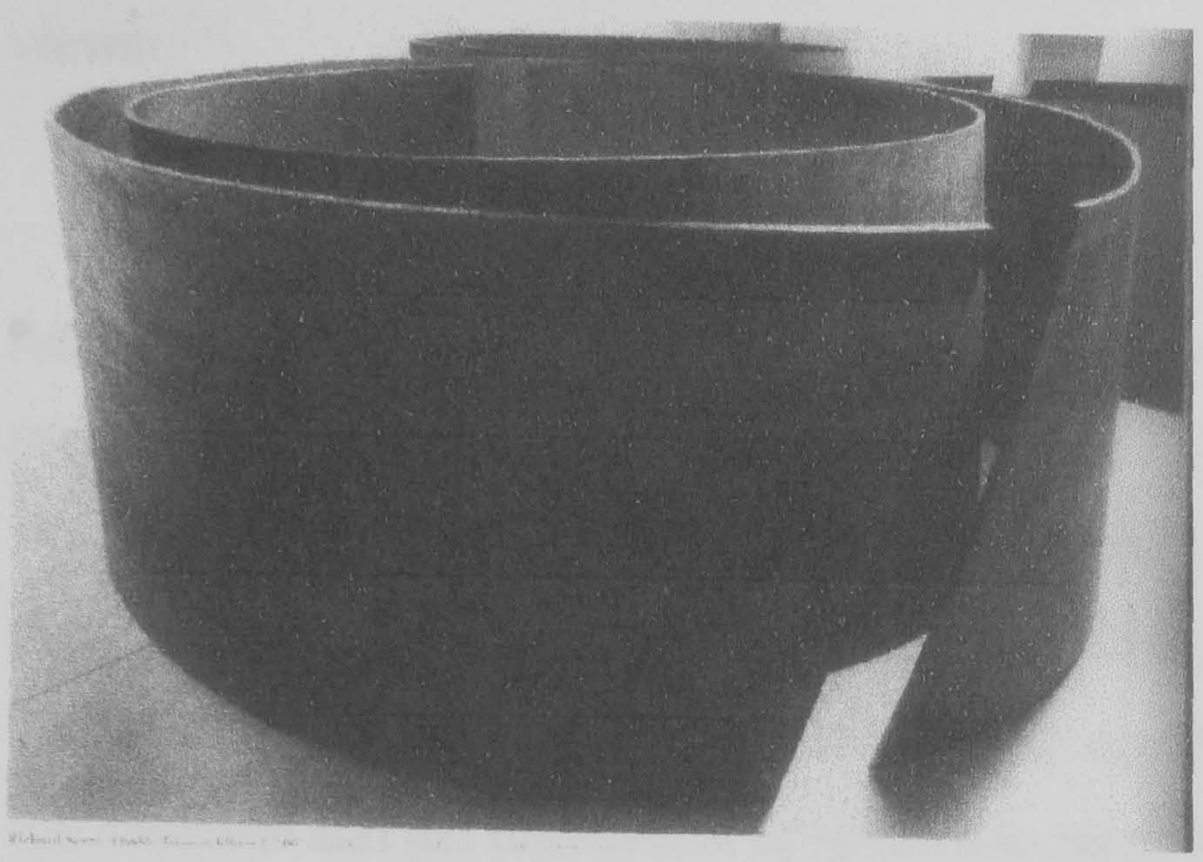


Fig. i-26
Serra: *Double Torqued Ellipse I*, 1997
Weatherproof steel
Exterior Ellipse 3.98 x 10.20 x 8.24 m
Interior Ellipse 3.98 x 7.90 x 6.37 m
Plate thickness 5 cm

Standing in the gallery and looking at the exterior of the 'Torqued Ellipses' the overwhelming sensation I had was one of volume and materiality as the huge steel walls, pitted from their making process and in differing states of weathering, stood in close proximity to one another. Serra particularly wanted the pieces shown in an enclosed space in order to experience this volume and as he noted of the exhibition between September 1997 to June 1998 at Dia, New York, where three of the Ellipses had previously been shown, 'When you walk into a room, you're not in a room with pieces in it, you're in the space of the pieces' *Richard Serra: Torqued Ellipses*, ed by L. Cooke and K, Kelly, (New York: Dia Arts Centre for the Arts, Enterprise Press, 1997) p. 20. Specifically with the 'Torqued Ellipses' the manipulation of material was for the purpose of encapsulating and articulating space within and around a sculpture. The space was the volume and the material held the space. Referring to the 'Torqued Ellipses' Serra explained they 'define a spatial continuum, interior and exterior to their volume, where space in and of itself is the content of the work' (Audiotape of the artist accompanying the Bilbao Exhibition, 1999). The 'Fish' Gallery in which the Ellipses were shown in Bilbao added to the vertiginous feeling due to the lack of verticality with which to orientate

oneself, and as one neared the sculptures they appeared to loom over the viewer. [11]

Reading and grasping the making process of the 'Torqued Ellipses' could not prepare the viewer for the actual experience, as the space within the 'Ellipses' was understood physically rather than optically. As there was no single viewpoint, due to the scale, from which each sculpture could be understood, the viewer had to walk around the outside and into the sculpture. In this way the structure and the dislocation of space was sensed rather than seen. Not only did the viewer have to move around the sculpture but, as one walked, the space also seemed to change with the movement of the body. Because of the scale of the work, when one moved around the sculptures there was never a point when the outside and the inside could be seen at the same time and it was very difficult, therefore, to prove anything one experienced by cross-reference. For example, in *Double Torqued Ellipse I*, 1997, the outside edge, which allowed access, disturbed the eye as it leant in the opposite direction to the inner and outer walls. After exploring a single ellipse, such as, *Torqued Ellipse II*, 1996, which, of the series, seemed to be the most simple to comprehend, the sense of disorientation was still present even if the form was more clearly understood.

The manipulation of the steel seemed to cause an inherent movement within the sculpture. The apparent movement of the sculpture, coupled with the actual movement of the viewer, created a feeling of vertigo. Seen from the outside, compared to the others, *Double Torqued Ellipse II,* 1998, was low and squat and the surface appeared both flat and curved at the same time. As I walked into the sculpture and looked in both directions there was a feeling of disorientation as the two ellipses leant in opposite directions. The space in the corridor between the two ellipses was disconcerting and one's speed of walking altered as the width varied. The maximum width of any of the

corridors was 91.5 cm and in this example the widest point was at the change over point of angles and narrowed to 70 cm. The narrowness and the steep angles of the walls forced one to lean inwards. As Serra was interested in the relationship of the inside of one ellipse to the outside of the other the maximum angle of torque was seventy degrees, otherwise the overhang caused the ellipses to be too far apart to interact with each other. If the exterior of *Double Torqued Ellipse II* was the part of the sculpture experienced before going through the space in the outer ellipse and the interior was the space at the centre of the of the inner ellipse, then the boundaries between interior and exterior were called into question by the corridor space. Serra called the corridors 'a space in between'. The relatively dark space, in comparison to the lighter space of the interior of a 'Double Ellipse' added to the feeling of it being an in-between space.

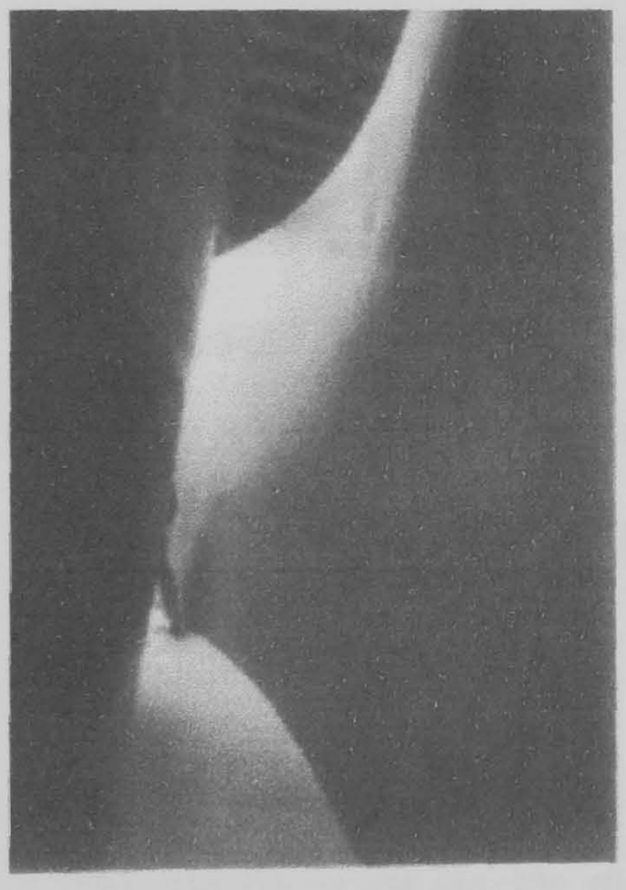


Fig. i-27
Serra
Inside a Double Torqued Ellipse

One interesting contrast between Kapoor and Serra was the use of the edge in their work. Although Kapoor had numerously acknowledged his interest in opposite states and employed them in his work there was often a blurring of the edge between the interior and the exterior in his work. In *Taratantara*, Kapoor did not employ a hard edge, which would have signified a change from the exterior to the interior, although he talked about them as being very distinct places. The blurring of the edge in the work of Kapoor was used to

destabilize the viewer and to suggest the possibility of being sucked into the void. Serra, on the other hand, questioned the place between interior and exterior in the 'Torqued Ellipses' but at the same time employed a hard edge that clearly demarcated the exterior from the interior. What Serra did instead, was to make a place - the corridor - that was neither part of the exterior nor the interior. To emphasize this point the corridor was made up of the inside wall of the outer ellipse and the outside wall of the inner ellipse. This corridor space or 'space in between' was reminiscent of the space in *Taratantara,* which was inside the building but viewed the outside of the structure. In both instances this was the most interesting place within the work.

The entrance to an ellipse was the only point where the thickness of the steel can be ascertained and these entrances bore the marks of the torch used to cut them. The entrance allowing the viewer access to the sculpture had been cut into the ellipse at the expense of the integrity of the whole. Each ellipse was made of two sections butted together with a smooth join; the cut marks at the entrance reinforced the sense that the entirety of the ellipse had been interrupted. Due to the cuts and gaps, Serra's remarks about the ellipses being topologically continuous appeared to be evocative of topology rather than a literal representation of it.

> 'In the ellipses you have the outside of the outside, and then you have the inside of the outside on the outside, and then you have the inside of the inside, and then again you have the outside of the inside on the inside. These pieces continuously ask you to pay attention to their surface as it moves from what you would think of as an interior form to an exterior form. In some way they are topologically continuous' Cooke and Kelly, 1997, pp. 27-28.

The thickness of plate used in the ellipses was such that the pieces did not need any internal structure and, therefore, the 'skin' was all that separated the exterior from the interior. Through the exploration of interior and exterior

Serra focused on his primary concern: the physicality of space. 'Whereas in previous works, I started with materials to create the space between, in these works, I start from the void and form the object from this emptiness. In this way, the material becomes the skin of the void' Taylor from conversation with the artist 23 June 1997, Cooke and Kelly, 1997, p.55. Serra used an enormous exterior presence in the 'Torqued Ellipses' but as he was also interested in the interior space he'd opened up closed form to allow the interior to be experienced. Once on the interior of, for example, *Double Torqued Ellipse II*, 1998, the articulation of space was still felt. In the space encapsulated by the ellipses the middle seemed to be off-centre but by adjusting position the reverse seemed to be the case. Standing at one edge of the centre where the top was overhanging, the sense of being contained was very strong, despite the large area of open space above, it was the feeling of being underneath the ellipse that dominated. Although Serra was concerned with the interior, exterior and the state in-between the two, their presence must be experienced rather than seen. In the gallery with the 'Torqued Ellipses', at any one time one was experiencing one of the three states, interior, exterior and in-between, but there was no position one could take, other than above the sculptures, where the interior and exterior could be viewed simultaneously.

Through close examination of the sculpture, installations and architecture discussed above I identified numerous ways in which they had explored the relationship between interior and exterior of form. These included: the introduction of space into mass, the articulation of space and the enclosure of space, etc. The tables shown in the Appendix, Figs a-1 and a-2, summarise the methods. Out of this survey several methods excited me more than others. For example: Gabo's use of transparency as a way of seeing through the exterior to the interior of form in *Translucent Variation on a Spheric Theme*, of around 1939, the use of the edge of form by Hepworth in *Oval Sculpture*, 1943, to delineate between the exterior and the creation of ambiguity surrounding the

boundaries of interior and exterior as was seen in the corridor space of Serra's *Double Torqued Ellipse II*, 1998. These and other ways of affecting the relationship between the interior and exterior were used to inform my own studio practice within the research and place myself within a context of existing practitioners.

INTRODUCTION TO STUDIO PRACTICE

Before beginning the PhD research my sculpture practice was concerned with still life compositions using forms that referenced domestic objects, such as ladles or bowls, placed on specifically made wooden tables. The table, initially chosen for its anthropomorphic qualities became increasingly used as a device to divide space. Through the familiarity of the table there was a readily acknowledged space above and below the plane of the tabletop. (Caro used this device in his series of table sculptures, for instance, *Table Piece XCVIII*, 1970.) My work developed by establishing an interaction between the table and the specific placement of objects: above, below or by intersecting the actual table surface. During my MA at the Royal College of Art, as the table became more of a focus, an interest in the manipulation of space around the table replaced the objects. An example of a sculpture made during this period was one that transformed space into mass through casting the space between the table legs. This was revealed by cutting through the table surface and its underlying structure and incorporating the cast into the table.

The sculptures developed by moving away from the imagery of a table to the predominance of the horizontal plane. One such sculpture is shown in Fig. i-28, whereby boxing in the space below the horizontal surface, the opposite terms, interior and exterior became of increasing interest to me. [12] Subsequently, the focus of the investigations turned to the surface that separated the inside from the outside, or the interior from the exterior. This involved methods, such as trying to establish what was the thinnest possible divide between the interior and the exterior. During these investigations a metal structure became a mould and tissue paper was cast over the exterior surface. The realisation that the cast exterior surface of the structure became the interior surface of the tissue paper form was significant for future work. Instead of constructing sculpture using wood, material and welded metal, which had been my usual working process, I now decided to investigate the casting process to explore the transformation of an exterior surface into an interior surface.

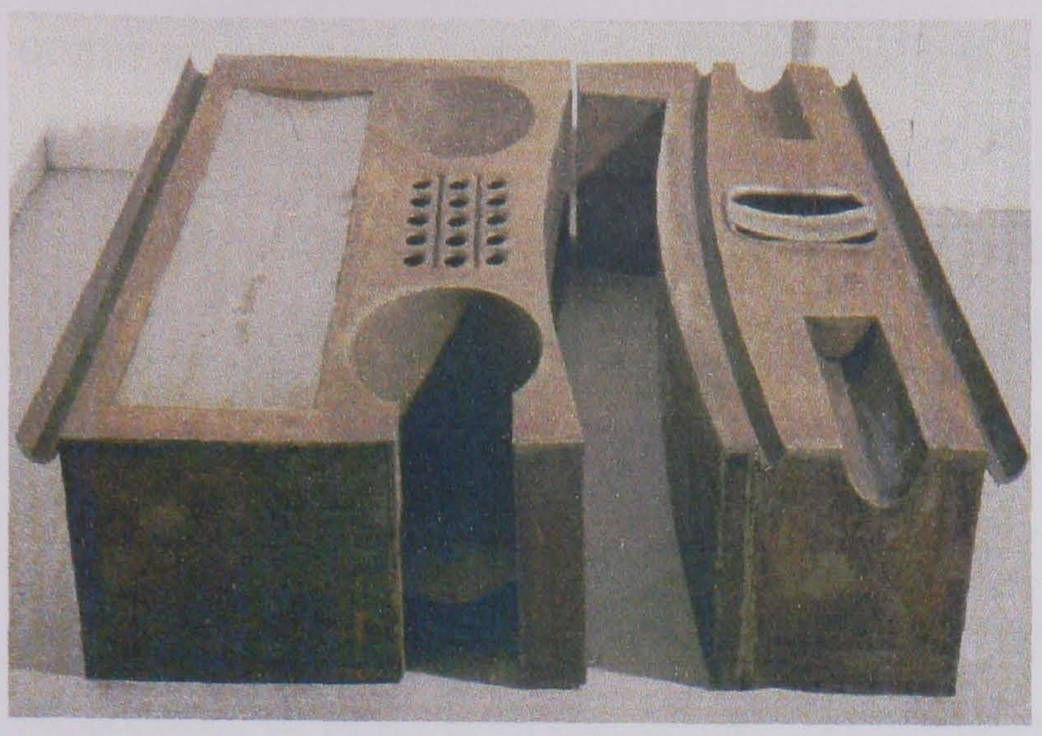


Fig. i-28

Recipient, 1996

Steel

261 x 200 x 47 cm

A sculpture made during my MA which was investigating contained and open space below a plane. [13]

It was at this point that I wrote the proposal for my research project. Looking at objects in common usage, it became apparent that in the majority of opaque forms, the exterior was the dominant feature. My interest was in the possibility of using opaque materials to simultaneously expose the interior and the exterior of sculpture. This required the articulation of sculptural form with particular attention to material and surface. This, of course, was a different approach to that of Gabo, where for instance, in a sculpture such as, *Translucent Variation on a Spheric Theme*, 1937, the transparency of the Plastic and the disposition of the planes, made it not only possible to see right into the interior, but through the sculpture itself and out to the other side.

The objective of my research practice was to explore the dichotomy [14] between the interior and exterior surfaces of a sculptural form and expose them simultaneously. By simultaneous exposure, I meant achieving equilibrium between the interior and exterior so that neither was dominant. My research concerned two questions pertaining to the simultaneous exposure of the interior and the exterior of sculptural form. Firstly, could the interior and the exterior form of a sculpture be exposed simultaneously using opaque materials? Secondly, what relevance did materials and techniques have in determining the simultaneous exposure of the interior and the exterior of sculptural form? From the outset of the research project, I realised that 'interior' and 'exterior' are opposites and were usually conceived as single conditions, making, in literal terms, their simultaneous exposure impossible. However, in reality there were instances where these states were less clearly defined. Within the objects in

common use and in artworks there were places or areas that were not distinctly either within the interior or on the exterior. [15] In-between spaces, such as the thickness of the material of an earthenware cup, allowed at least the possibility of challenging the terms of reference. I decided from the outset to restrict the subject matter of my investigations to what I would term the formal aesthetic, as this was a continuation of the type of imagery I had used in my later MA work. Therefore, the sculptural forms I used were not intended to have any direct references to objects in the so-called outside world, but instead were to emphasise the relationship between interior and exterior.

The initial research involved closer examination of already familiar artists who were relevant to the investigations. The diversity of this literature survey and the complex nature of the topic suggested a need for a taxonomy. By taxonomy, I meant the introduction of clarity and definition into the research to create a coherent language that relied on classification. This stage also involved the selection of three-dimensional forms that were sufficiently versatile to provide consistency throughout the research. I wanted to understand the possible relationships between the interior and the exterior of a basic three-dimensional geometric form, such as, sphere, a cube, and a cylinder. These geometric forms also did not have a specific front or back and seemed to be a neutral and non-referential starting point. Although a sphere was the simplest geometric three-dimensional form, it only had one orientation and lost its identity when cut into or bisected. I did not use a cube as Gabo had previously used one in relation to the interior and the exterior of form to demonstrate the Stereometric Principle and I wanted to avoid this reference. Instead, I chose a cylinder because it appears to be able to retain its identity under more transformations than the other figures and could be solid, hollow, closed or open-ended, of any length and diameter and orientated in different ways.

During the initial literature survey the only artist I found who specifically investigated the simultaneous exposure of the interior and exterior of sculptural form was Max Bill through his 'Endless Ribbons'. As these forms were

derivatives of Möbius Strips it was predictable that Bill would examine their topological properties. However, it seemed from his notes, cited on pages 11-12, it was more the 'finite infinity' aspect of the Strips that fascinated Bill rather than solely the simultaneous exposure of the interior and exterior. The other main difference between Bill's work and my own research was that Bill used an edge to limit the strip, whereas I eventually used it create ambiguity between the interior and the exterior. It was through the investigation of Bill's work that I realised the importance of using an edge as a delineating device and, therefore, began my investigations by examining the artists previously mentioned who used interior and exterior in their work, with particular attention to artists who used the edge in their work.

At the time of the initial survey Kapoor had not made *Taratantara* nor Serra, the *Double Torqued Ellipses*, which questioned the boundaries between the interior and the exterior. Through examining sculptures, such as, Boccioni's *Development of a Bottle in Space*, 1912, Hepworth's *Oval Sculpture*, 1943 and Martin's *Screw Mobile*, 1959, I began to identify categories in relation to the interior and exterior of sculptural form that could be of use to my research. At the same time as the initial literature survey, practical investigations in the studio involved the production of small-scale studies in card, plaster, clay, etc. Through the literature survey and the studies, my research began to suggest that the particular relationships sculptors had used with reference to interior and exterior represented a very diverse range of sculptural activity. It was, therefore, necessary for the purposes of my research to develop some clarity, a classification of what was, and what could be, possible and hence the need for a taxonomy. The taxonomy involved the following, each of which was to be examined through practice: [16]

A. The role of positive and negative reversal in the simultaneous exposure of the interior and the exterior of sculptural form.
B. The moment of transition between the interior and the exterior of sculptural form.

C. The use of holes, penetrations and openings in the simultaneous exposure of the interior and the exterior of sculptural form.
D. The influence of implied rotation on the simultaneous exposure of the interior and the exterior of sculptural form.
E. The role of stratification and correlation to achieve the simultaneous exposure of the interior and the exterior of sculptural form.
F. Contrasts between space and mass in relation to the simultaneous exposure of the interior and the exterior of sculptural form.

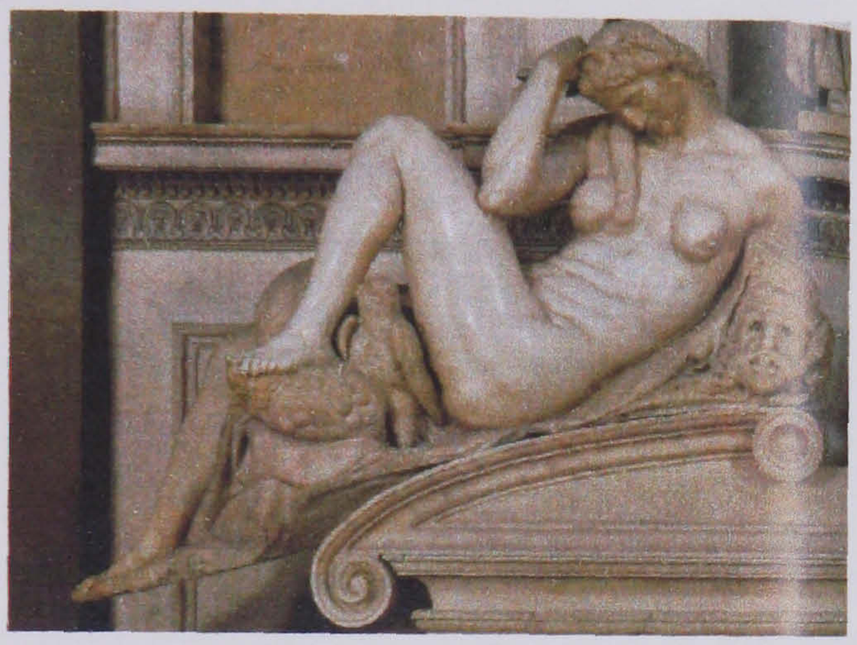


Fig. i-29
Michelangelo: *Night, Tomb Of Guiliano de'Medici*, 1526-34, Marble, 76⅜ in.

Fig. i-30
Michelangelo: *Night, Tomb of Guiliano de'Medici*, 1521-34, Marble, 76⅜ in.
Alternative view

Obviously the categories had antecedents in sculpture, some for instance, such as Category B, involving the moment of transition between the interior and the exterior of sculptural form, had prominence in such well known sculptures as Michelangelo's *Night*, 1526-34, where the distinct twist in the pose gave the sense of simultaneously revealing and concealing the figure. However, because of the so-called non-referential direction of this research, the majority of these categories were more easily linked with developments in sculptures that have occurred over the last hundred years, as noted in the introduction. For instance, Boccioni's *Development of a Bottle in Space*, 1912, demonstrated positive and negative reversal, as the positive form of the bottle became a negative form as one walked around to the front of the sculpture. An example of the contrast between space and mass could be clearly seen in Gabo's series of sculptures that used stereometry, such as *Constructed Head No 1*, 1915. The work of Hepworth,

for instance, *Oval Sculpture*, 1943, demonstrated an example of the use of holes, penetrations and openings with regard to the interior and exterior of sculptural form.

The research commenced with small-scale studies and concluded with full-scale sculptures. The small-scale studies, concerning the taxonomy, were done within the framework of investigating the interior and exterior of sculptural form and, therefore, enabled a detailed understanding of sculptural language associated with these terms. Initially, before the taxonomy had been established, I explored the role of holes and penetrations although these studies lacked a systematic approach, which was more successfully achieved after the taxonomy had been established. When the taxonomy was in place, the first category of the taxonomy I explored through practice was Category C, the influence of implied rotation. I began with this because of all the categories it appeared to be the most direct way of exposing the interior. As the research progressed two or more categories were combined within one study, such as, Category F, contrasts between space and mass and Category A, positive and negative reversal. However, due to the breadth of categories I was investigating within one study it often became difficult to separate out the achievement of each category, which would have furthered the research. To enable a clearer assessment, I returned to investigating single categories within each study to discover which categories fulfilled the aims. Only, in much later studies, when I had established the possibilities attainable from a category could I combine them successfully. Interestingly, the most successful studies and sculptures, in terms of working towards simultaneously exposing the interior and exterior of form, usually involved a single main category from the outset.

STUDIO DIARY – Section One

This section of the research investigated, through practice, the function and displacement of the exterior boundary of a cylindrical form and the penetration of its interior volume. The research involved the first research question; can the interior and the exterior of a sculpture be exposed simultaneously using opaque materials? As previously mentioned, at this stage of the research, I had not established the taxonomy, but the initial investigations used what would become Category C of the taxonomy: the use of holes, penetrations and openings to attempt to simultaneously expose the interior and the exterior of form. After the taxonomy was established, this first section of the studio diary investigated the role of symmetry within the research. This stage explored Category D of the taxonomy, the influence of implied rotation on the interior and exterior of sculptural form. The next stage combined methods from the taxonomy, such as implied rotation, the role of positive and negative reversal and the use of space and mass. The diary is a record of each stage of the investigations, which are identified by numbered studies. [17]

Study No. 1

The aim of this study was to assess what happened to a cylindrical form when the exterior surface or boundary was penetrated to displace up to half of the interior volume. Studies were made that were no larger than 50 cm in diameter and concave formers of various sizes were incorporated into the top of cylindrical moulds. A series of solid plaster casts were produced. The studies varied in height and in the size of the concavity that interrupted the top surface. The series ranged from studies in which the cylinder could still be identified, to those in which some of the properties of a cylinder were lost. [18] The studies that retained the predominant properties of a cylinder had small concavities, which only partly interrupted the top horizontal surface. The concavities used in the studies were shallow to minimize references associated with a vessel, such as a bowl-shaped interior.

Fig. 1
Study No. 1
Example of a study made to explore the affect of displacing part of the interior.
Plaster
H 10 cm, D, 30 cm.

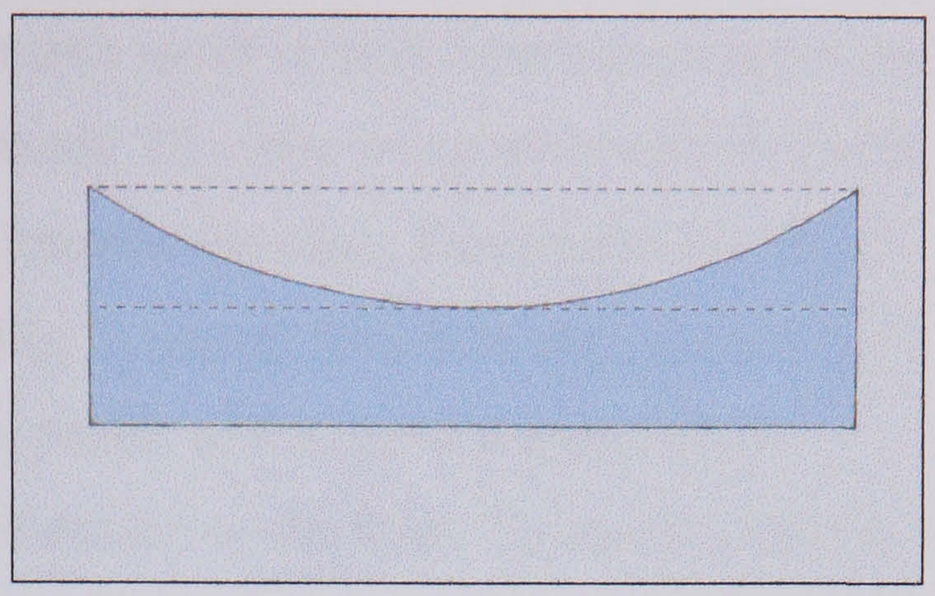


Fig. 2
Cross-section drawing of Study No. 1

Observations

The studies that lost some of the properties were those in which the concavity was extended to become the whole of the top surface. For example, *Study No. 1*, Fig. 1, no longer retained the 'uniform cross-section' of the top surface and, therefore, lost one of the properties of a cylinder. (See endnote No. 18). One of the aims of *Study No. 1* was to penetrate and displace up to half of the solid interior of the cylinder by moving the top exterior surface inwards to half the height of the cylinder, as shown in Fig. 2. In order to achieve this aim, the height of the cylinder had to be reduced and the proportions of the resultant form resembled a lateral segment of a cylinder. Although the example shown in Fig. 1 moved the top exterior surface inwards to displace part of the interior volume, and in this way began to show the interior, it was not sufficiently pronounced. Instead, the concavity could be read as being part of the exterior boundary or surface of the new form. In the next study my aim was to repeat *Study No. 1*, but to allow more of the interior to be seen, by making the penetration deeper.

Study No. 2

The aim of this study was to assess the effect of using a vertical hole to penetrate the interior of a solid form identical to the one used in *Study No. 1*. This was

done by repeating *Study No. 1*, except that a small vertical tube was incorporated at the casting stage and removed afterwards. The tube was positioned off-centre to avoid a direct relationship with the centre or the edge. This resulted in *Study No. 2*, Fig. 3, resembling *Study No. 1*, Fig. 1, except for a hole that penetrated all the way through the solid cylinder. The profile of the top of the hole on the interior followed the concave surface of the top of the form. To assess the effect of light and shadow on the hole, the study retained the same horizontal position as *Study No. 1*, Fig 1.

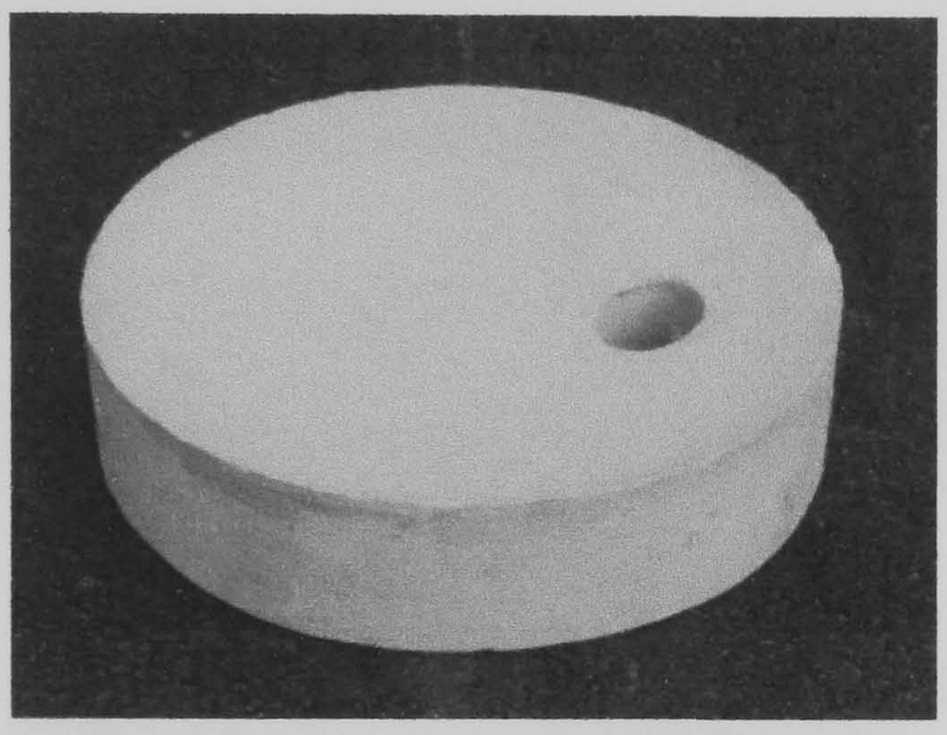


Fig. 3
Study No. 2
A study made to explore the effectiveness of a hole in revealing part of the interior.
Plaster
H 10 cm, D 30 cm.

Observations

The hole in *Study No. 2*, Fig. 3, appeared to displace part of the interior volume in a more effective way than the concavity in *Study No. 1* and inevitably became the focal point of the study because it physically penetrated the larger form. The proportions of the hole to the form were also very different and these were further emphasised by the reflected light on the top horizontal surface, which contrasted with the dark shadow in the hole. The studies were made on a workbench and this was their intended viewing height, as shown in Fig. 3. From this viewpoint the hole darkened as the penetration deepened. It was the shadow that created the delineation between the interior and the exterior of the form.

Shadow also emphasised the change in direction of the planes within the study, from predominantly horizontal to vertical. Ambiguity arose within the study, although the hole did extend from the top to the bottom surface, this could not be seen from most viewpoints. The next study, therefore, aimed to make a form, which allowed both ends of a hole to be visible.

Study No. 3

The aim of this study was to show both ends of a hole that penetrated the interior of a cylinder whilst keeping it in the same orientation as the previous two studies. This was achieved by incorporating a curved piece of metal tubing into a cylindrical mould and plaster being poured around the tubing. This resulted in a cylinder, 15 cm in height and 30 cm in diameter. As the tube was curved, both ends of the hole that penetrated the solid interior were visible, one on the top surface and the other on the side.

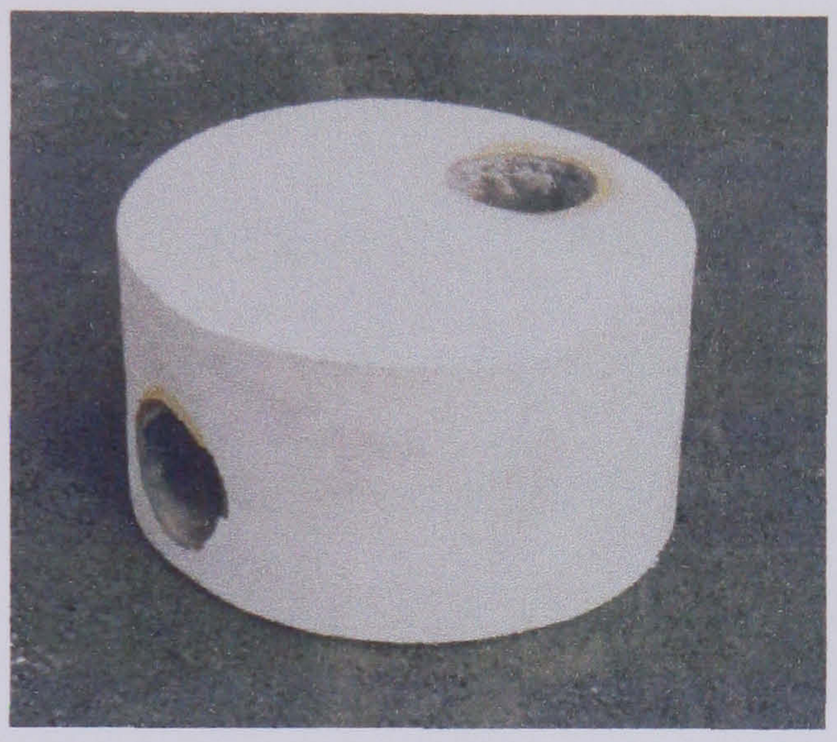


Fig. 4
Study No. 3
A study showing both ends of a tube incorporated into a form. Plaster
H 15 cm, D 30 cm.

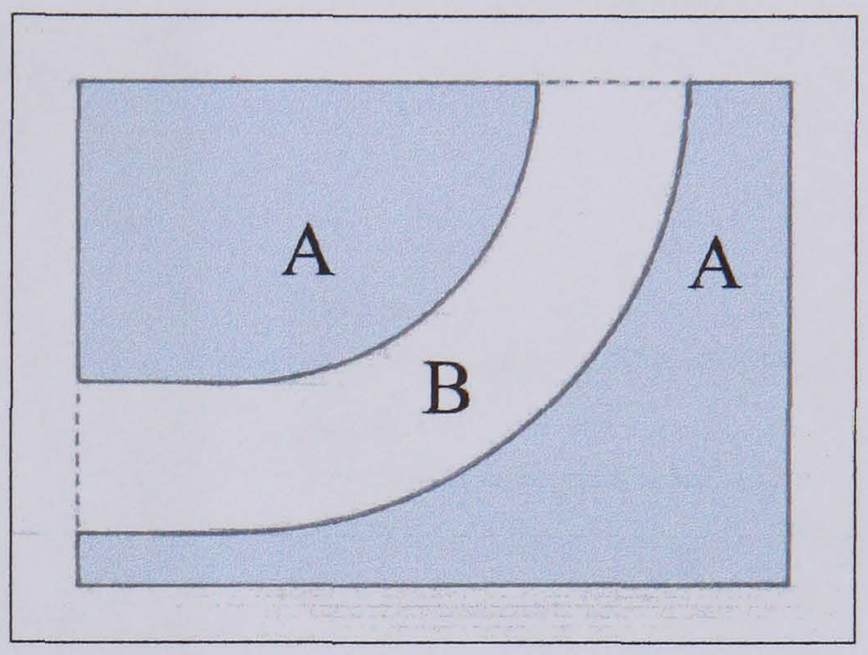


Fig. 5
Cross-section drawing of
Study No. 3
Key to Fig. 5
A: Solid plaster cylinder.
B: Interior of tube.

Observations

As the tube was left in the form it was the interior of the tube that was visible, rather than the interior of the cylinder and this resulted in a grey colourless hole that destroyed the tonal subtlety of the plaster, as shown in Fig. 4. [19] However, without needing to re-make the study, it could be assumed that if the tube were removed it would have allowed one to see into the interior of the cylinder. As the hole did not have a direct engagement with the geometry of the cylinder, I did not pursue this method of penetrating the interior. Instead, in the next studies I used cast hollow forms so that the interior space and exterior surface had a more direct relationship to one another. Through using a hollow form, I could also investigate the relevance of the exterior wall in respect to the interior and exterior.

Study No. 4

Instead of introducing an object into the cylinder to reveal the interior, as with the previous study, *No. 3*, Fig. 4, this study used a hollow cylinder. By doing this I could also aim to establish the relevance of an exterior wall in relation to the interior and exterior of a three-dimensional form. Two mould cases were made from Hot-Melt Vinyl, one making the exterior surface of the form, the other the interior surface. From this, studies were made in which the exterior wall thickness varied.

Fig. 6
The Hot-Melt Vinyl rubber cases.
The left one was used to cast the exterior wall surface and the right, the interior.

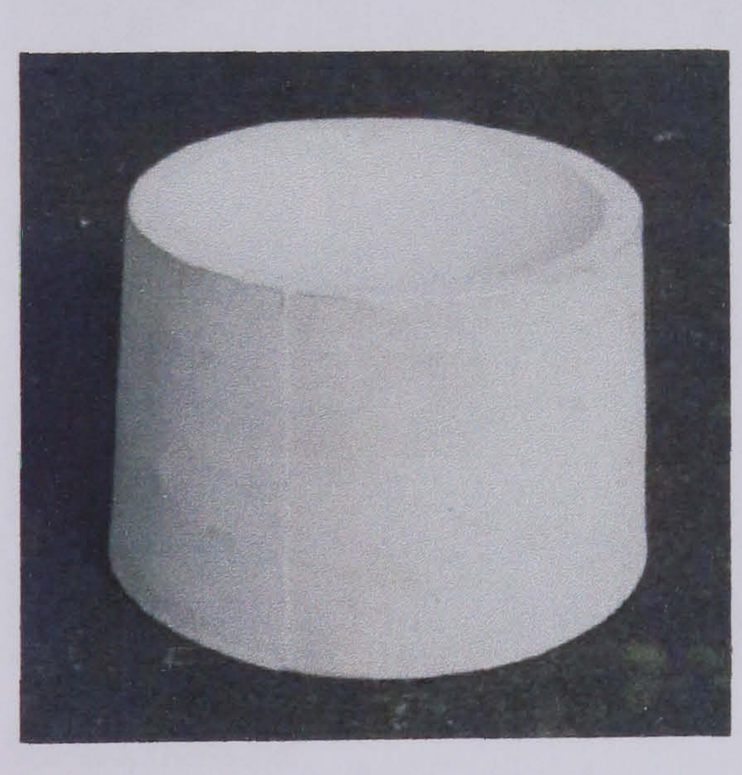


Fig. 7
Study No. 4. A cast with walls of equal thickness.
Plaster. H 36 cm, D 50 cm,
Wall thickness 2 cm.

Observations

As the walls of *Study No. 4*, Fig. 7, were 2 cm thick, a space was enclosed when the form was in its intended upright position. Therefore, the exterior wall became a boundary that separated the interior space from the exterior space. In the next study the same form was used to investigate the affect of varying the wall thickness.

Study No. 5

Using the moulds made in *Study No. 4*, as shown in Fig. 6, the aim of this study was to establish the relevance of a change in the width of the exterior wall of *Study No. 4*. The mould on the right in Fig. 6, which created the interior surface of the form, was positioned to make the walls 1 cm thick on one side and 3 cm on the other. To enable the wall thickness to be seen the top of the form was removed as shown in Fig. 8.

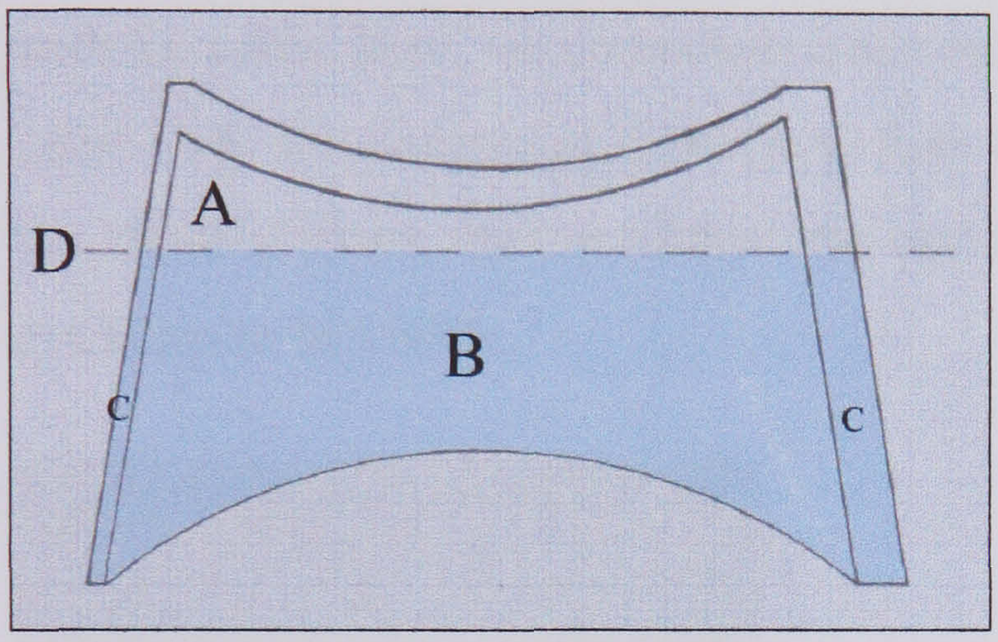


Fig. 8
Cross-section drawing of Study No. 5, to reveal the wall thickness.
Key to Fig. 8
A: Removed part of form.
B: Part which was Study No. 5.
C: Differing wall thickness.
D: Dividing line.

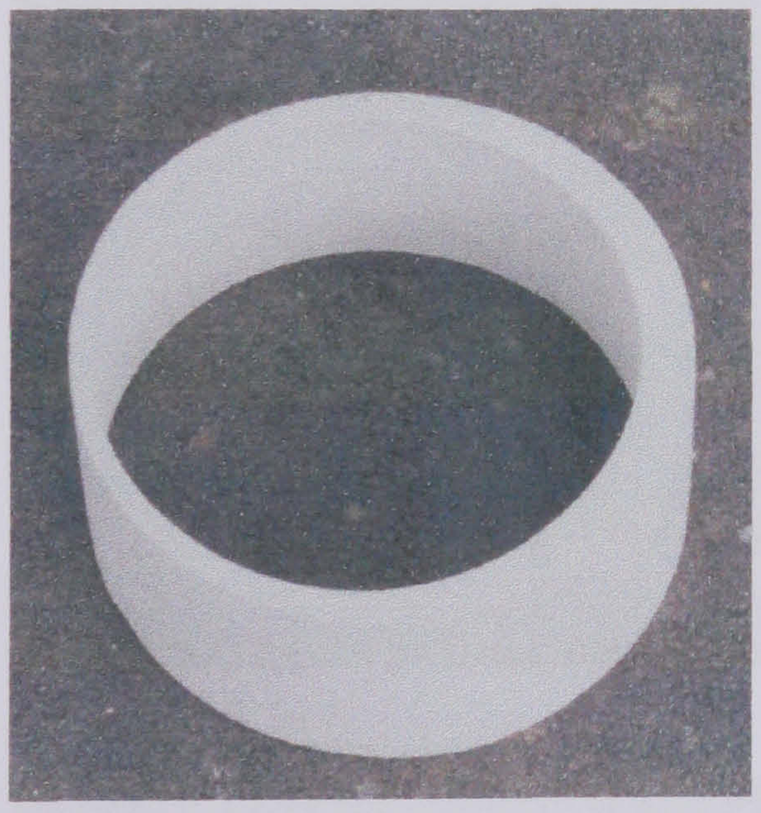


Fig. 9
Study No. 5
A study showing a form with walls of unequal thickness.
Plaster
H 30 cm, D 50 cm,
Wall thickness 1-3 cm.

Observations

Consideration was given to the height of the study. If made to full scale it would have been approximately the same height from the floor as the workbench it was made on, which is 90 cm. Fig. 9 is an approximation of this viewpoint, with the study placed on the floor and viewed from above. [20] The importance of the exterior being a boundary between the interior and exterior space was evident in this study and the change in thickness of the walls placed the focus on this boundary. The significant result in this study was the realisation that a hollow form produced a distinct interior space instead of the less distinguishable interior that was produced by a solid form. This interior space appeared to be more

pertinent to the investigations at this stage, than wall thickness, which I had intended to explore in this study, shown in Fig. 9. In the next series, therefore, I used a planar material, cardboard, to make forms that incorporated space.

Study No. 6

In this study, shown in Fig. 10, two cylinders were contained in a cubic form to introduce space around them, as the aim of this study was to use cardboard to investigate the affect of space within a study. The cylindrical forms contrasted with the cubic form, which became a surrounding frame. The side walls of the cubic form were extended in height to fully contain the cylinders and, to explore the affect of space, the top surface was omitted to allow both surfaces of the cylinders to be visible.

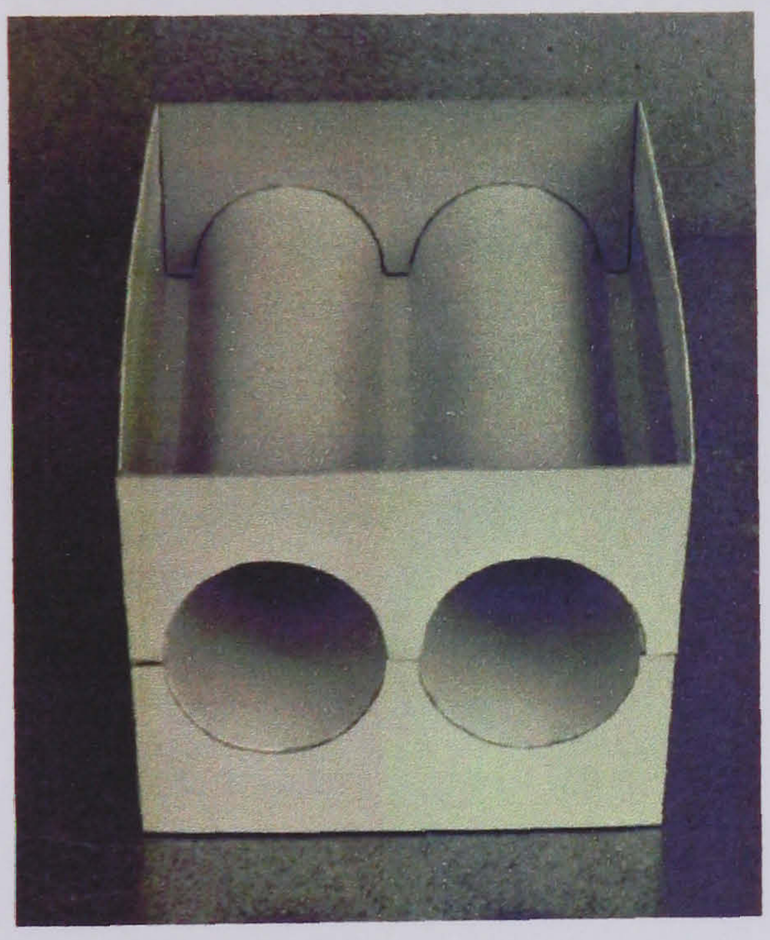


Fig. 10
Study No. 6.
A study made to explore the affect of introducing space into a form.
Cardboard
H 15 cm, L 20 cm, W 15 cm.

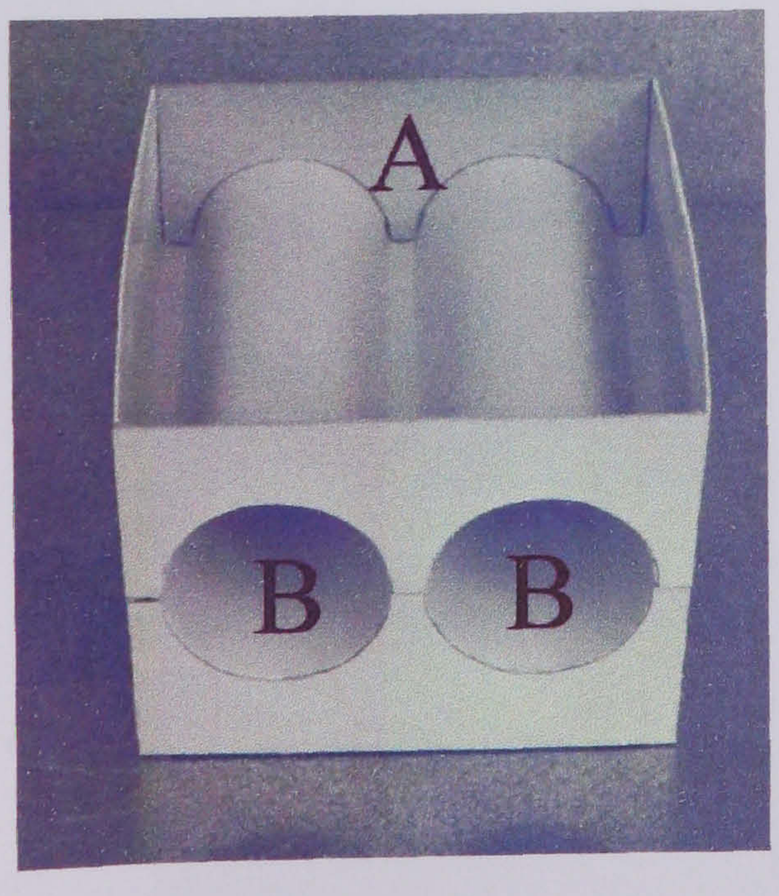


Fig. 11
Key to Study No. 6:
A: Interior of cubic form and exterior of cylinders, leading to an ambiguous interior.
B: Interior of cylinders and the form.

Observations

Through the omission of the top surface of the cubic form, ambiguity was created within the study as to what constituted interior space. Together with the intended interior, shown as 'B' in Fig. 11, the walls of the cubic form created a second possible interior, shown as area 'A' in Fig. 11. As with *Study No. 2*, Fig 3, light and shadow assisted in delineating between the interior horizontal holes and the exterior surface. In area 'A' in Fig. 11 both the surrounding frame and also shadow suggested that this was also part of the interior of the form, despite it including the exterior surface of the cylinders. The study, therefore, began to question what constituted an interior space or the interior of the form.

Throughout studies *Nos. 1-6,* issues began to arise, such as, what constituted an exterior and an interior, and I realised I needed a vocabulary within which the investigations could progress more coherently. The next series of studies, *Nos. 7-12*, were developed to identify categories that demonstrated some degree of potential for simultaneously exposing the interior and the exterior of form. Cardboard had proved to be a quick and versatile material and was used to make the series. These studies led to the taxonomy, which was initially outlined on page 41.

Study No. 7

In this study I continued to investigate how the surrounding frame could create ambiguity concerning the interior or interiors of a form. Using cardboard, I made a form with half-cylinders and partially enclosed them with planes.

Fig. 12
Study No. 7.
A form made to explore the use of a surrounding frame to create ambiguous interiors.
Cardboard
H 40 cm, L 20 cm, W 20 cm.

Observations

Using half-cylinders and only partially enclosing them, the study demonstrated positive and negative reversal, which later became the first category of the taxonomy. Due to the frame, the partially contained area appeared to be more in shadow and therefore, was more suggestive of an interior than the open area of the form. However, in both this study and *Study No. 6*, Fig. 10, the partially contained areas were not enclosed to the same degree as the cylindrical interiors marked 'B' in Fig. 11. Also, as with the previous study, it was the exterior surfaces of the cylinders that were contained, creating further questions concerning interior and exterior. The next stage was to investigate other ways in which ambiguity could be created between the interior and exterior. In *Study No. 8* a cardboard cylinder was cut horizontally and the half of the cylinder was reversed so that the interior surface became an exterior surface.

Study No. 8

The aim of this study, shown in Figs. 13 and 14, was to transpose the interior of a cylinder so that it became part of the exterior surface. I constructed a cardboard cylinder, which was 10 cm in height, and cut it horizontally at the centre, leaving a thin joining strip. The top half of the cylinder was unfastened, reversed and rejoined.

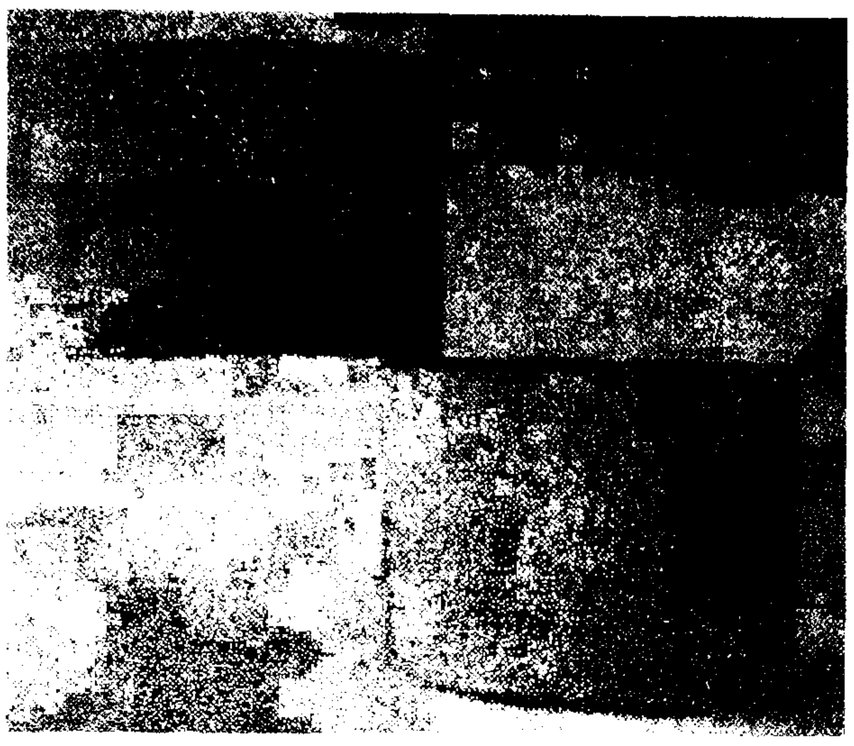


Fig. 13
Study No. 8
A study made to explore the affect of reversing the interior surface so it became an exterior one.
Cardboard
H 10 cm, W 12 cm.

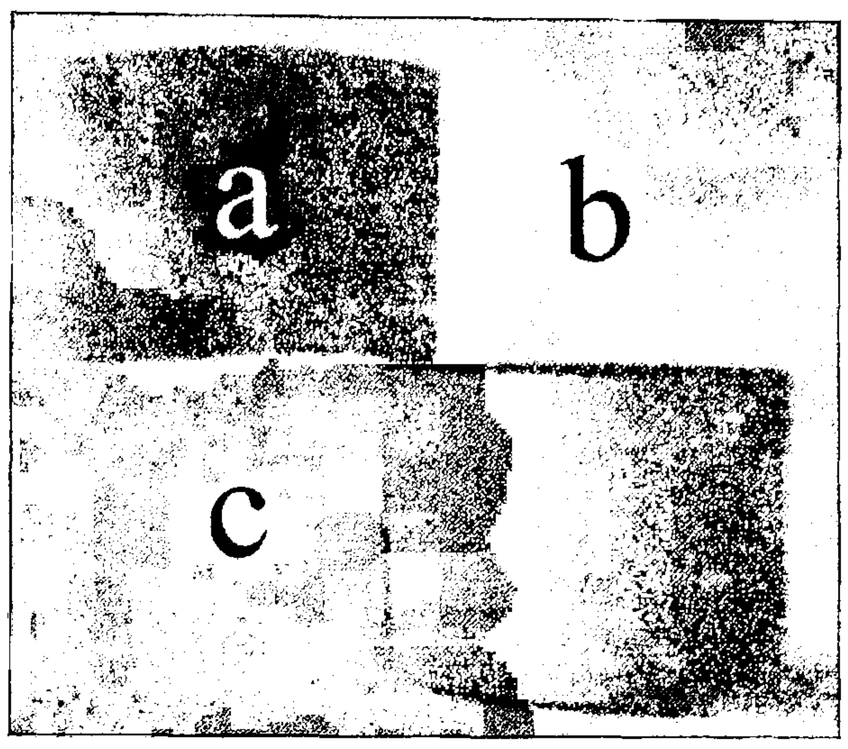


Fig. 14
Study No. 8 with key.
a: Top half of the cylinder revealing the interior surface of the original cylinder.
b: Originally occupied by the cylinder, now space.
c: Originally exterior space, now implicated into the form.
d: Lower half of the cylinder in its original position.

Observations

Although only the top half of the cylinder had been reversed, both the cylinder and the surrounding space were affected by the change. The area 'b' in Fig. 14, which had previously been occupied by 'a', was now space and the exterior space was now form. The area 'c' was now implicated within the form and it had equal significance to area 'b'. The lower half of the cylinder maintained its original position and was not reversed. In the study, through the reversal of a positive form, its position was changed and by implication a negative space was produced. By turning the surface of 'a' inside out the interior surface was transposed to an exterior surface. In the next study, the aim was to create ambiguity between the interior and the exterior by rearranging the surfaces in other ways, such as, continuing the exterior surface to the interior of the form.

Study No. 9

This study aimed to create ambiguity between the interior and the exterior by making the same surface continue from the exterior to the interior of the form. This was done by cutting a 10 cm high cylinder in half and intersecting the two halves of the cylinder using slots cut into the sides.

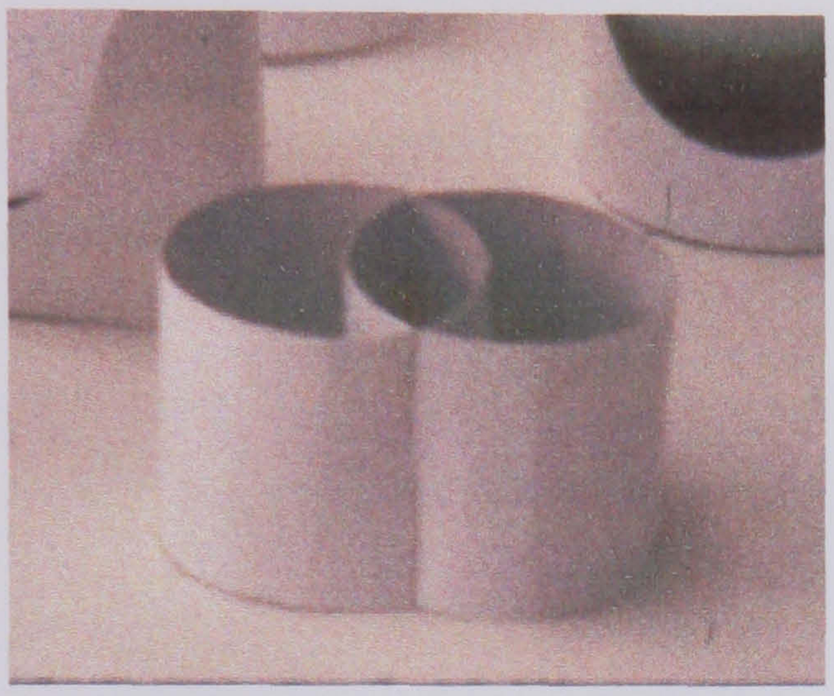


Fig. 15
Study No. 9
A study made by intersecting two cylinders to investigate a surface that is partly on the exterior and partly on the interior of a form.
Cardboard
H 5 cm.

Observations

This was the first study made to date in which the same surface continued from the exterior to the interior and in doing so created another interior within the form. In *Study No. 8*, Fig. 13, ambiguity between interior and exterior was created through exposing the interior surface. However, in contrast, in this study, Fig. 15, the ambiguity concerned the continuation of the exterior surface to a position on the interior of the form. This point of transition warranted further investigation in later studies, such as *No. 23*, Fig. 53. Another effect of the intersecting cylinders was that the interior was divided into three and begged the question, what was the interior? [21] The next study explored another way to create ambiguity between the interior and the exterior by investigating the affect of cutting through the exterior surface and also extending the interior so that it projected beyond the exterior.

Study No. 10

In the previous study, shown in Fig. 15, the exterior moved to the interior of the form. The aim of this study, shown in Fig. 16, was to do the opposite and make the interior project to the exterior and in this way question the point where the interior became the exterior. This study also aimed to explore revealing the interior of a form by penetrating the exterior surface. [22] Three tapered cylinders were made that fitted inside each other and a hole was made in each one. The cylinders were turned so that the holes were offset. The top's of the inner tapered cylinders could be seen, as they were made progressively taller than the exterior.

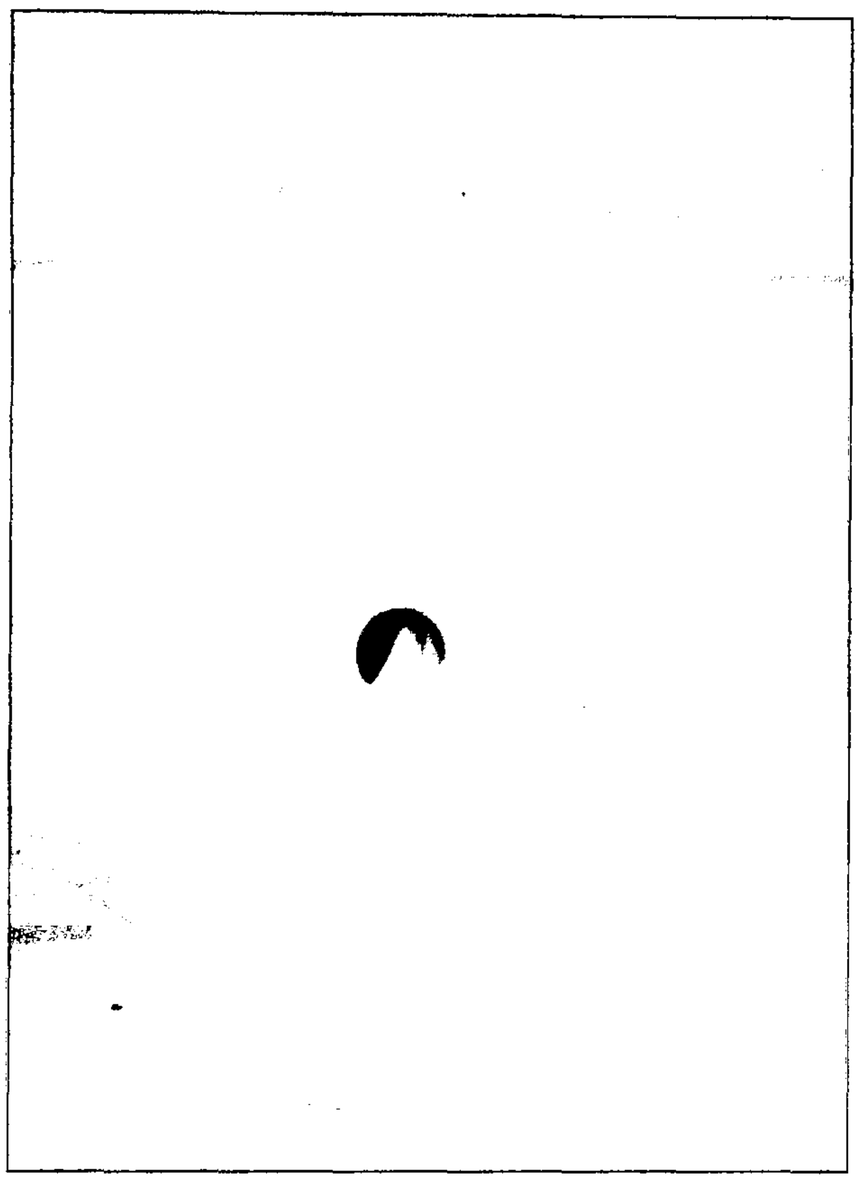


Fig. 16
Study No. 10
A study made to explore the effect of cutting through the exterior surface of a form. Ambiguity was also created between the interior and the exterior where the interior could be seen projecting above the exterior
Cardboard
H 27 cm

Observations

Through the holes in *Study No. 10*, Fig. 16, each tapered cylinder could be partially seen and also the dark interior of the form. In this study ambiguity arose at the top of the form where the interior cylinders projected to become exterior and, therefore, involved a different aspect of the moment of transition between the interior and the exterior than the previous study, Fig. 15. Of all the cardboard studies made during the explorations into different ways of investigating the interior and the exterior, this study was the most successful: this form began to move away from being merely demonstrating an idea. As penetrating the exterior surface and rotating the cylinders had succeeded in revealing the inner cylinders and the interior of the form, this was continued in the next study but used a single surface.

Study No. 11.

The aim of this study was to reveal the interior of a form by using implied rotation. A box was made and cut horizontally into equal sections, leaving a small joining strip on each section. The sections were then rotated by equal degrees. The sections were made square to enable the axis to be visible.

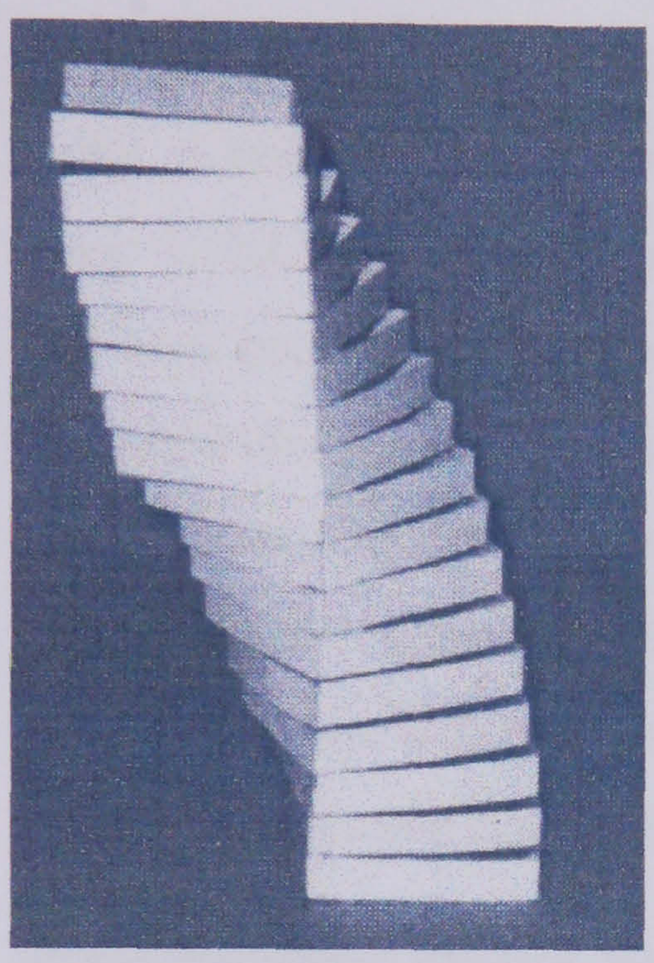


Fig. 17
Study No. 11.
Example from Category D.
A study exploring implied concentric rotation around a single axis.
Cardboard
H 15 cm, W 9 cm.

Observations

Cutting the exterior surface of the form at equal intervals and then rotating the sections revealed the interior of the form. I was beginning to realise that revealing the interior could be initiated from either the interior or the exterior. In the previous study, as shown in Fig. 16, it was the projection and rotation of the inner elements, which revealed the interior, whereas, in this study, as shown in the Fig. 17, it was due to the implied rotation of the exterior. Although this study did reveal the interior there was little ambiguity between what was the interior and what was the exterior. The next study, therefore, returned to revealing the interior whilst questioning what constituted the interior by investigating the use of layers, which had been suggested by *Study No. 10*.

Studies No. 12 (i-iv)

The aim of these studies was to question what was the interior of a form. To allow the strata to be seen, holes were made in some of the studies. The four studies shown in Fig. 18 were part of the series that constituted *Studies No. 12(i-iv)*.

Study 12(i), Fig. 18, was made by making a cylinder and attaching layers of card of increasing length to its mid point, which transformed the cylinder into an ovoid. A hole was drilled through each of the layers.

Study 12(ii), Fig. 18, was made by making a curved section and attaching layers that were progressively reduced in length, the form was then cut diagonally.

Making a closed cylinder and attaching a second layer to its mid point made *Study 12(iii)*, Fig. 18. Successive layers of the same length were added. A hole was drilled through each of the layers.

Study 12(iv) was made by gluing pieces of card in the centre to form a cylinder. These then radiated outwards to form a larger surrounding cylinder.

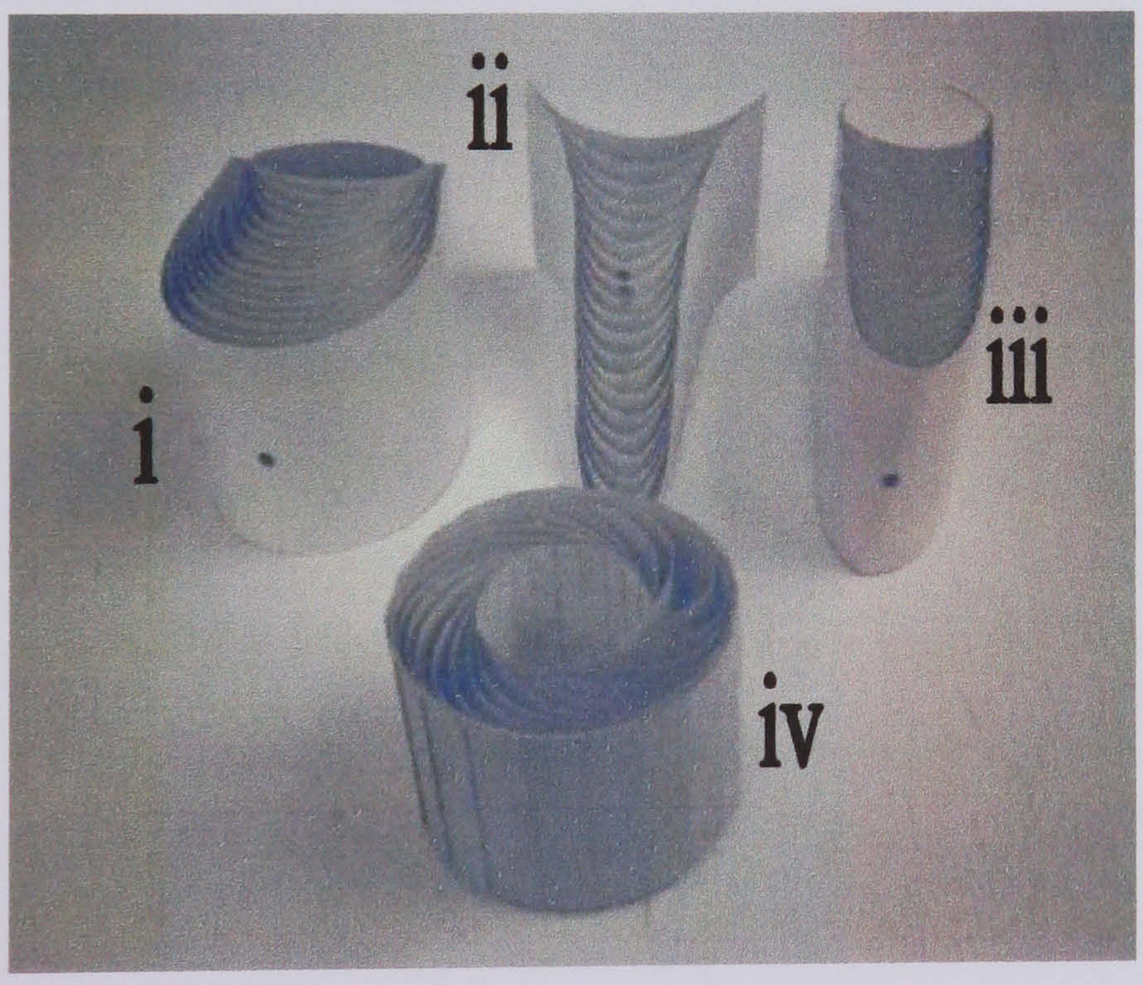


Fig. 18
Studies No. 12(i-iv).
Examples of studies that were made to explore stratification as a way of questioning the interior and exterior of a form.
Cardboard
Height range 10 – 15 cm.

Observations

The photograph, Fig. 18, shows the studies from above so that the reader can see the disposition of the strongly geometrical composition. However, if built to full-scale, i.e. approximately 2 metres high, then the holes would have become more important and assumed a more dynamic focal point for the observer. My intention in enclosing the cylinder in *Study 12(iii)* was that its interior would only be visible by viewing it through the holes in the layers. However, as it was closed

and inaccessible to light this was not possible. As the cylinder in *Study 12(i)* was open, light entered and the inside was illuminated.

The layers in *Study 12(ii)*, Fig. 18, were cut diagonally to allow them to be fully revealed and the spaces between the layers became the interior of the form.

Study 12(iv), Fig. 18, which investigated symmetrical stratification, was intended to be viewed from the top. The study resulted in forming a number of interior spaces, which together defined the central interior.

In all of the *Studies 12 (i-iv)*, shown in Fig. 18 the exterior was clear and acted as a boundary that surrounded the interior and it was separate from the interior. The interior, however, was ambiguous because of the stratification of the interior created multiple interiors. I realised that the stratification in *Study No. 10*, as shown in Fig. 16, was more effective in creating ambiguity between the interior and the exterior than in these examples because the interior strata projected to the exterior, creating a relationship between the two.

Studies Nos. 7-12(i-iv) were examples from a larger series of studies, which after their completion were grouped into categories. They were grouped by their similarities and according to the different ways they demonstrated the potential for simultaneously exposing the interior and the exterior of a form. Of the possibilities explored, six categories were established and these formed the basis for the taxonomy. A brief description of the categories in the taxonomy was mentioned earlier and the full taxonomy is listed below. This taxonomy subsequently had a role in informing the remainder of the investigations, and an example of a study made, which explored a specific aspect, is listed next to it.

Taxonomy

Through the investigation of form and the use of appropriate techniques and materials the research sought to establish;

Category A

The role of positive and negative reversal in the simultaneous exposure of the interior and the exterior in sculptural form, through a sequence of three-dimensional studies which investigated:

(i) Juxtaposition, for example, *Study No. 17*, Fig. 33, where part of the space around the form made positive was shown.

(ii) Intersection, for example, *Study No. 34*, Fig. 102.

(iii) Cutting through the exterior surface, for example, *Study No. 18*, Fig. 35.

Category B

The moment of transition between the interior and the exterior of sculptural form through a sequence of three-dimensional studies, which explored:

(i) The emergence of the interior to the exterior, for example, *Study No. 39* and the sculpture *No. 40, Hollow*, Figs. 114-118.

(ii) The entrance of the exterior to the interior, for example, *Study No. 23*, Fig. 53.

(iii) Manipulation of the exterior or the interior surface i.e., folding, bending, wrapping, distortion etc, for example, *No. 33, Simply Connected*, Figs 97-99.

(iv) The intersection of the interior and the exterior, for example, *Study No. 30*, Fig. 87.

(v) Cutting through the exterior to reveal the interior, for example, *No. 36, Loop*, Fig. 107-108.

(vi) Emphasis on a section of structure between the interior and the exterior, for example, *Study No. 37*, Fig. 110.

Category C

The role of holes, penetrations and openings in achieving the simultaneous exposure of the interior and the exterior of sculptural form through a sequence of

three-dimensional studies, which explored:

(i) Size variance, for example, *Studies Nos. 29* and *30*, Figs. 84 and 87.

(ii) Sequencing, *Study No. 12*(i), Fig. 18.

(iii) Off-setting, for example, *Study No. 26*, Fig. 74.

Category D

The influence of implied rotation on the simultaneous exposure of the interior and the exterior of sculptural form through a sequence of three-dimensional studies, which:

(i) Incrementally exposed the interior using concentric rotation, for example, *Study No. 14(iii)*, Fig. 29.

(ii) Incrementally exposed the interior using eccentric rotation, for example, *Study No. 14 (i)*, Fig. 27.

(iii) Rotated by unequal degrees, for example, *Study No. 21(i)*, Fig. 47.

(iv) Revealed the interior and concealed the exterior using concentric rotation, for example, *Study No. 23*, Fig. 53.

(v) Revealed the interior and concealed the exterior using eccentric rotation, for example, *Study No. 21(ii)*, Fig. 49.

Category E

The role of stratification and correlation to achieve the simultaneous exposure of the interior and the exterior of sculptural form through a sequence of three-dimensional studies investigating:

(i) The interrelation of identical and equidistant layers or strata, for example, *Study No. 12(iii)*, Fig. 18.

(ii) The stratification of surfaces of differing heights, for example, *Study No. 10*, Fig. 16.

(iii) The stratification of surfaces placed at unequal distances, for example, *Study No. 20*, Fig. 43.

(iv) The stratification revealing the interior as mass, for example, *Study No. 2*, Fig. 3.

(v) The stratification revealing the interior as space, for example, *No. 36, Loop, Figs 107-8*

Category F

The effect of contrasts between mass and space in relation to interior and exterior through a sequence of three-dimensional studies, which explored:

(i) A change in viewpoint, for example, *Study No. 27*, Figs 77-78.

(ii) Exposure of the interior as space and the exterior as mass, for example, *Study No. 19*, Fig. 41.

(iii) Exposure of the interior as mass and the exterior as space. (No example).

Through the taxonomy both the manipulation of the exterior surface and the effect of revealing the interior was investigated. The former through, for example, the investigations into the moment of transition between the interior and the exterior and the latter through, for example, investigations to establish the role of holes, penetrations and openings. Having established the categories for investigation their effectiveness was evaluated throughout the remainder of the research.

The majority of *Studies Nos. 7-12(i-iv)* had a definite exterior and interior and this series investigated an exchange between the interior and exterior. In the next series I used implied rotation, which was Category D of the taxonomy, to investigate forms that had an implied exterior and the interior of the original form became the exterior. As these aims concentrated on the exterior, a solid form was used to simplify the investigations and, later, planar materials and other variants were reintroduced.

Studies No 13

In these studies I investigated Category D of the taxonomy, which was to establish the influence of implied rotation on the simultaneous exposure of the interior and the exterior of sculptural form. [23] The aim of the studies was to rotate one or both of a divided cylinder and assess what happened to the interior and the exterior. To do this a solid cylinder was divided into two equal parts and one or both of the sections were rotated or moved in straight lines. Fig. 19 shows the complete cylinder and Fig. 20, the cylinder in two equal parts.

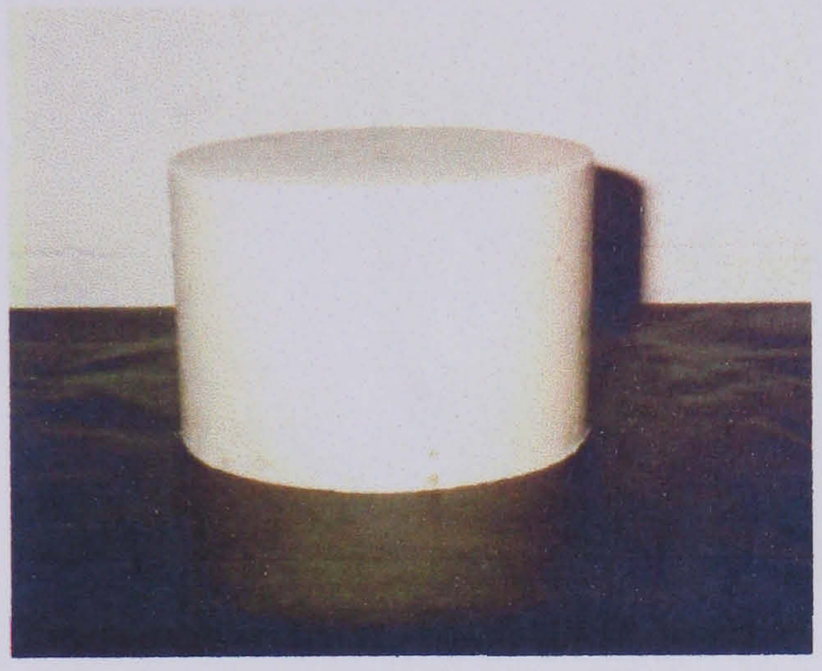


Fig. 19
Study No. 13. The original cylinder.
Plaster. H 15 cm, D 20 cm.

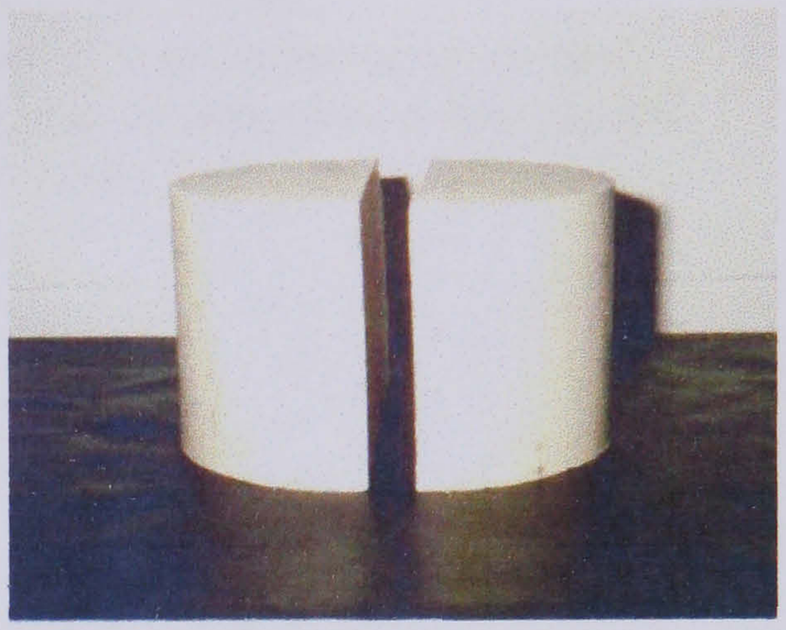


Fig. 20
Study No 13(i). Bisection and equal movement of both sections of the original cylinder.

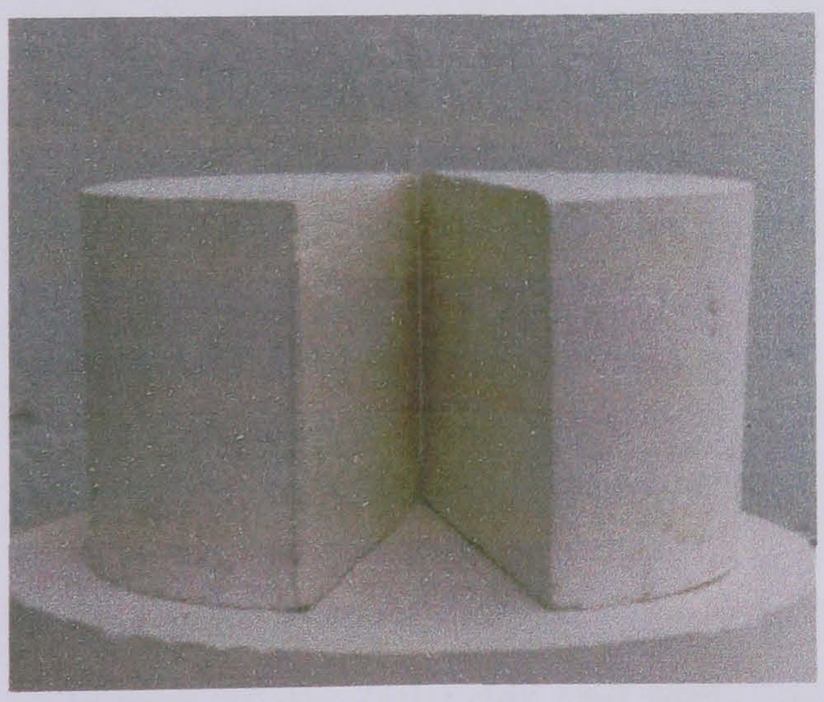


Fig. 21
Study No. 13(ii). Bisected parts of the original cylinder subjected to concentric rotation in opposite directions.

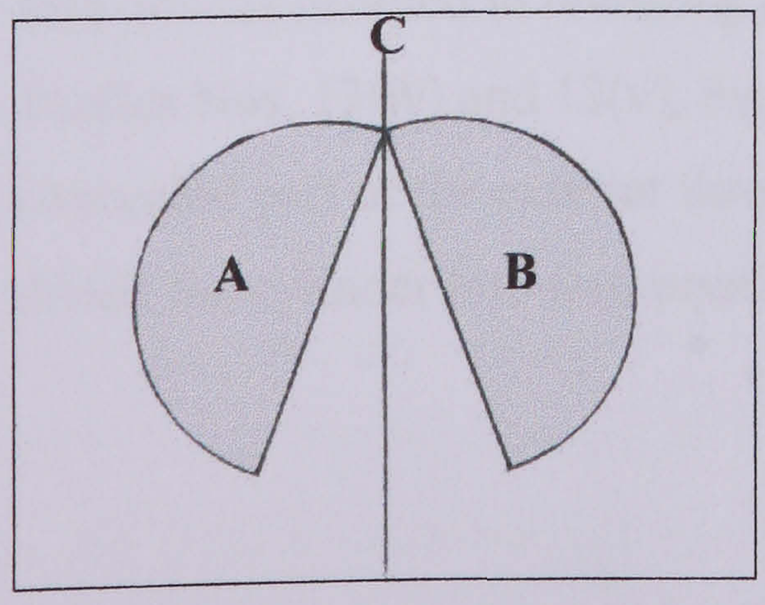


Fig. 22
Plan view drawing of Study No. 13(ii)

Key to Figure 22

A: Rotated 20 degrees in a clockwise direction around 'C'.
B: Rotated 20 degrees in an anticlockwise direction around 'C'.
C: Horizontal axis.

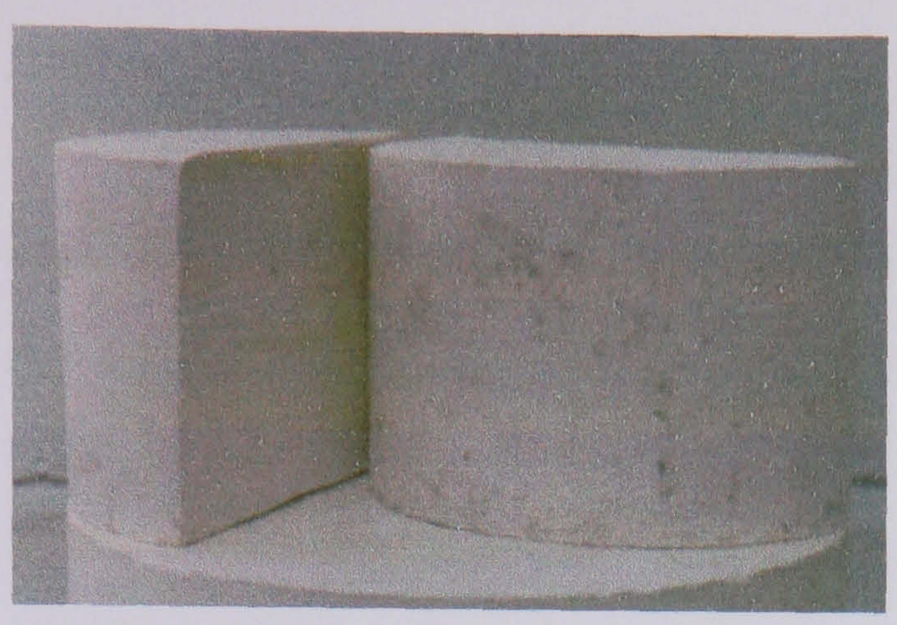


Fig. 23
Study No. 13(iii)
Bisection and concentric rotation of one of the parts of the original cylinder.

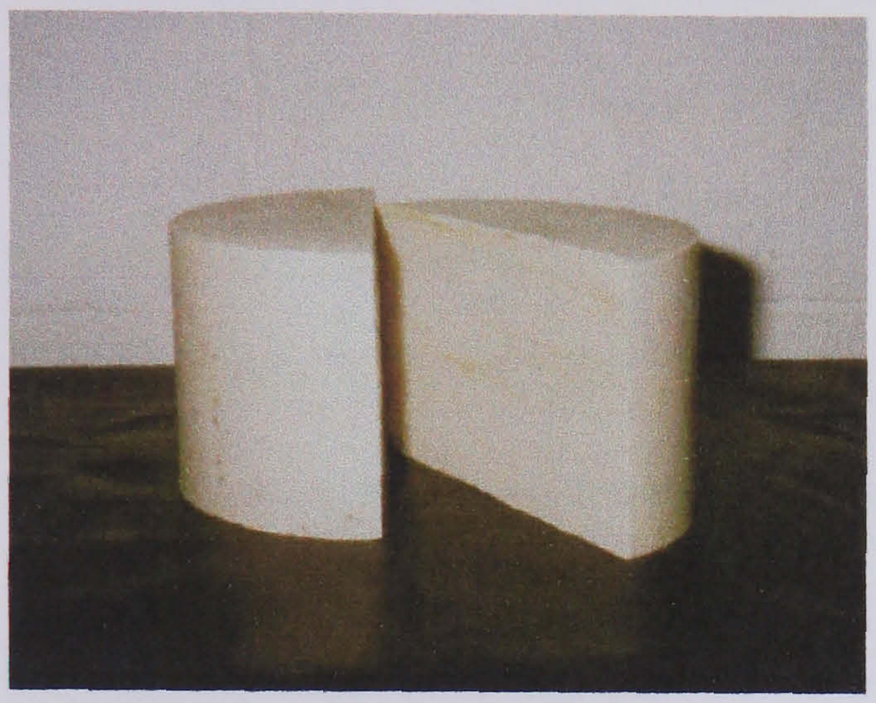


Fig. 24
Study No. 13(iv).
Bisection and rotation by unequal degrees of both parts of the original cylinder.

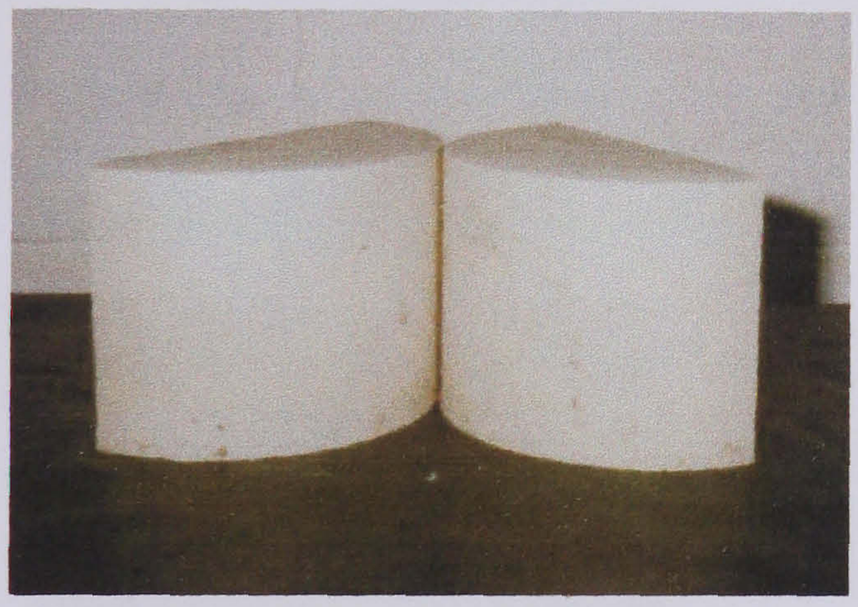


Fig. 25
Study No. 13(v).
Bisection and concentric rotation in opposite directions of both parts of the original cylinder.

Observations

The studies demonstrated that the interior could be revealed within a form when parts of the original form were moved to imply rotation or simply moved apart. Division of the cylinder and rotation of the parts of Studies Nos. 13(i) – 13(iii), Figs 20 - 23 resulted in revealing the interior but did not affect the exterior. Studies Nos. 13(iv) and 13(v), Figs 24 and 25 revealed the interior but also concealed part of the exterior through implied rotation. The next stage was to divide the cylinder into four equal parts.

Studies No. 14

The aim of these studies was to increase the number of elements that made up the cylinder to four, and compare the possible types of implied rotation with *Study No. 13*, Figs 21-25. A cylinder was divided vertically into four equal parts and some or all of the parts were rotated or moved apart in specific sequences. Fig. 26 shows the cylinder divided into four equal parts, in Fig. 27, one part was rotated through 180 degrees and part of the interior of the study became part of the exterior. In Fig. 28, one part of the cylinder was eccentrically rotated and in Fig. 29, all the sections were concentrically rotated.

Fig. 26
Study No. 14. The original cylinder divided vertically into four equal parts.

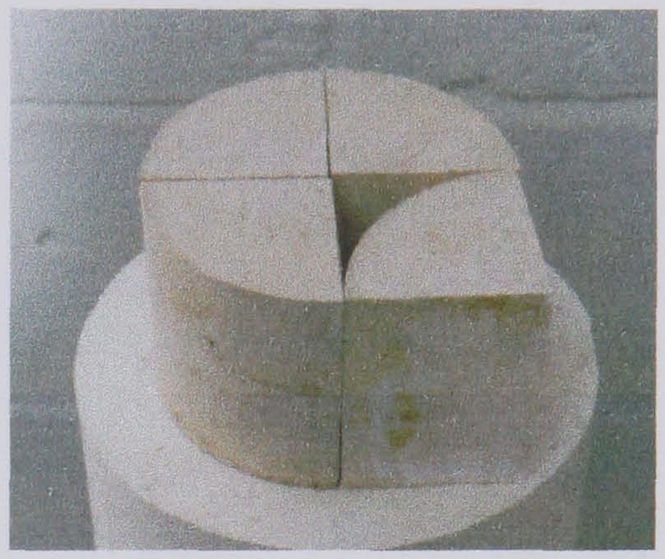


Fig. 27
Study No. 14(i). The original cylinder with one part rotated concentrically.

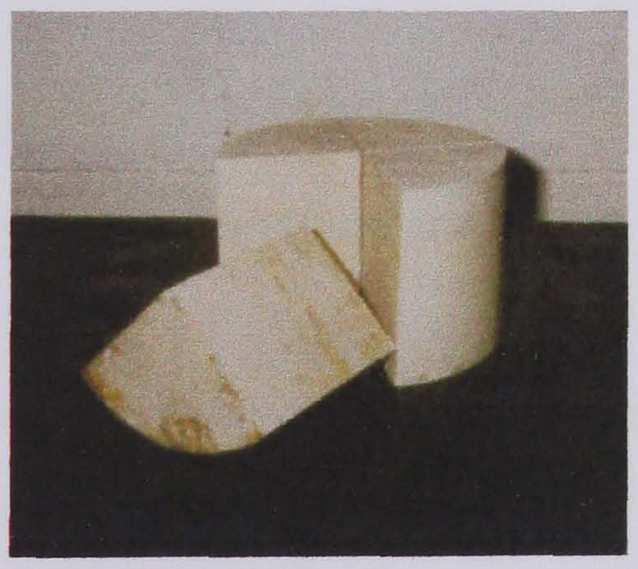


Fig. 28
Study No. 14(ii). The original cylinder with one part eccentrically rotated.

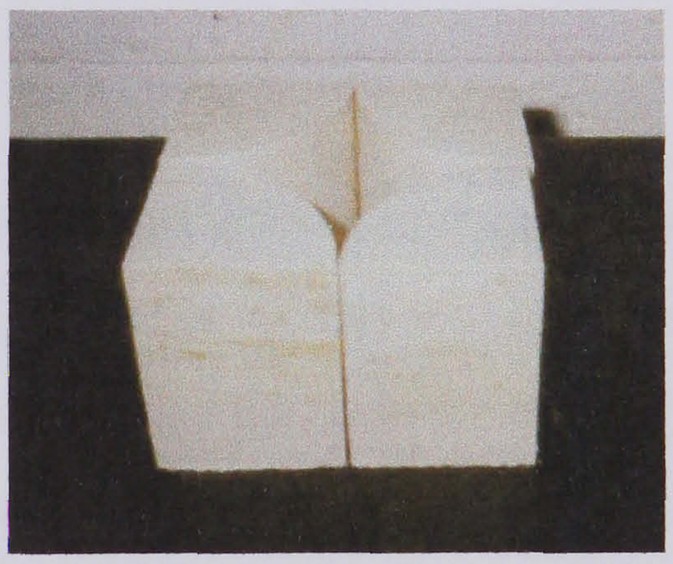


Fig. 29
Study No. 14(iii). All four of the parts of the original cylinder rotated concentrically. Original exterior becomes interior and vice versa.

Observations

Again the studies demonstrated that the interior could be revealed within a form when sections of the original form were moved to imply rotation. *Study No. 14(i)*, Fig. 27, concealed part of the exterior whilst disclosing part of the interior and *(ii)*, Fig. 29 repositioned the exterior to the inside of the form. Both these

studies introduced space into the form. Therefore, if the original state of the form was clearly defined, the interior and the exterior could appear to be repositioned through rotation and space can be introduced. *Study No. 14(ii)*, Fig. 28, intimated a more dynamic way to reveal the interior of a form and in the next study the cylinder was divided vertically, then off-set by repositioning. [24]

Study No. 15

The aim of this study was to investigate the influence of a splayed axis on the cylinder, as shown in Fig. 30.

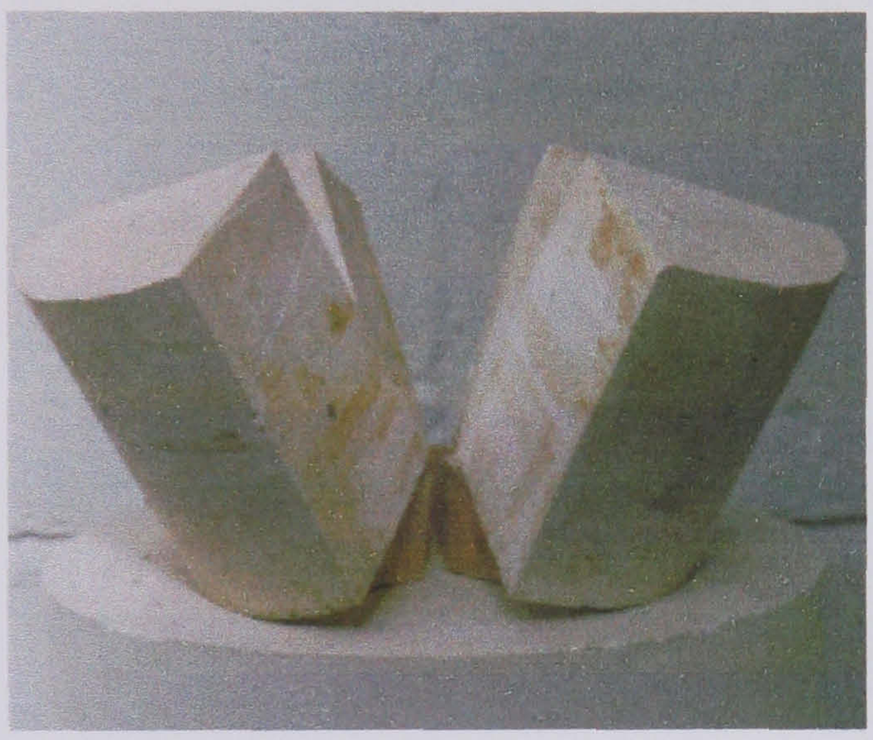


Fig. 30
Study No.15. The original cylinder subdivided into four sections and splayed from a central axis.

Observations

Through upsetting the parts within a form the interior became more prominent, as shown in Fig. 30. Although in *Study No. 15*, the interior was revealed and became more prominent, there was no interchange between the interior and the exterior as with several of the previous studies in this section, such as *Study No. 14(iii)*, Fig. 29. It was also a departure from orthogonality and, therefore, was a major shift of emphasis in the research and I felt at this stage the parameters needed to be restricted. Instead, in the next study I explored whether casting the original form furthered the research.

Study No.16

The aim was to investigate the influence of re-forming a divided cylinder after part of it had been moved. A solid cylinder was divided into four equal parts, shown in Fig. 31, and one part was raised by a quarter of its height. This new position was then cast to create one form, without cuts, shown in Fig. 32.

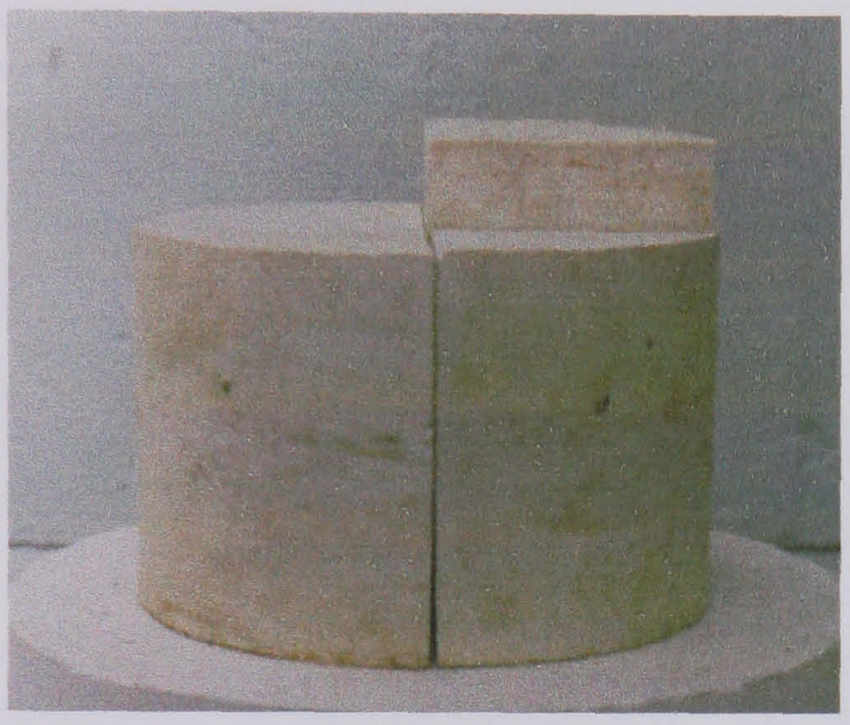


Fig. 31
Study No. 16 before casting.
Plaster
H 15 cm D 15 cm.

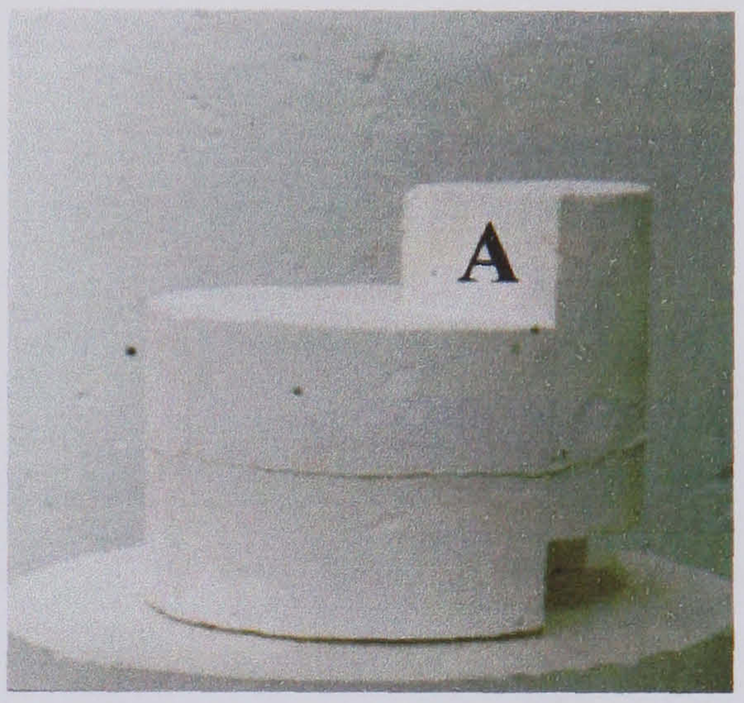


Fig. 32
Study No. 16 after casting.
Plaster
H 15 cm D 15 cm.

Observations

By casting the divided and reorganised parts of the original cylinder the form became one element. Space was introduced into the form through raising one of the parts. The casting process transformed part of the interior surface into part of the exterior surface, shown as 'A' in Fig. 32, which up until this point had only been implied through the disclosure of the interior. I decided in the next study to cast part of the space which was introduced though the reorganisation of the parts of a form.

Study No. 17

The aim of this study was to investigate reconnecting parts of a divided cylinder by casting part of the space, which was introduced through reorganising a divided cylinder. This study explored the role of positive and negative reversal by making part of the space around the form positive. A solid cylinder was divided and rotated and part of the space created by the rotation was cast, shown in Fig. 33 and as 'D' in Fig 34.

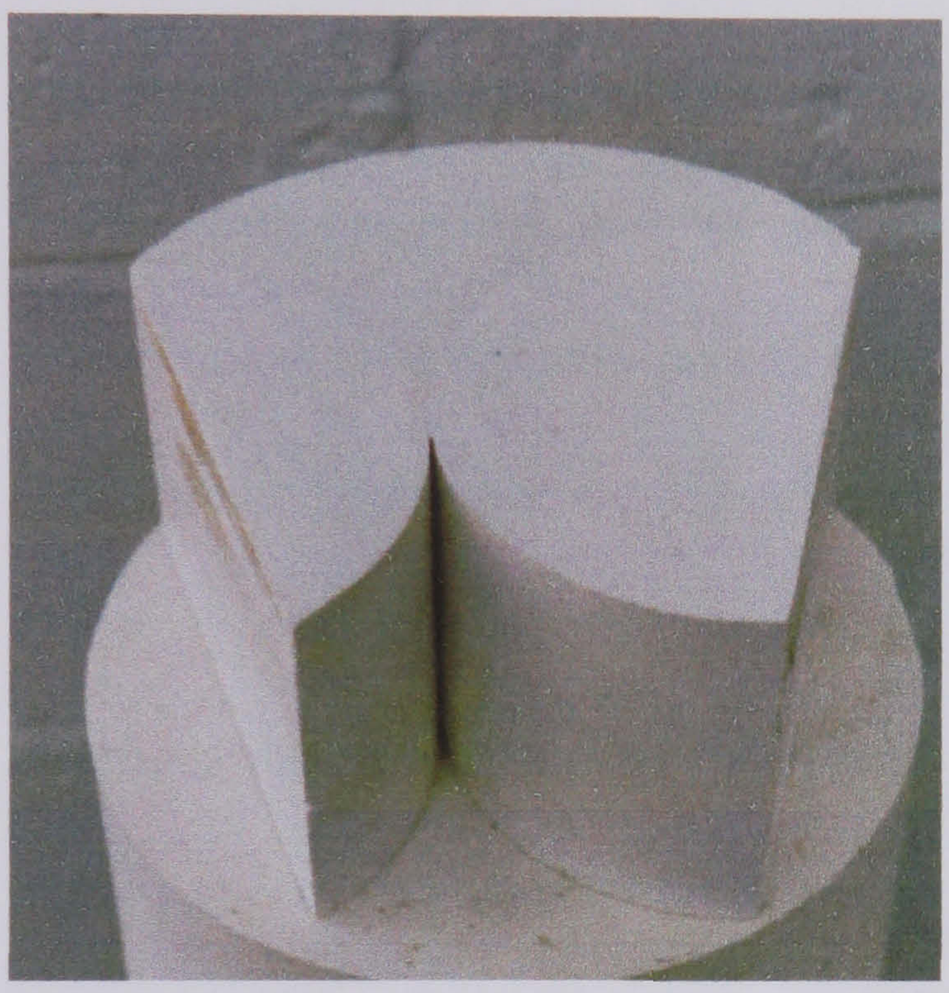


Fig. 33
Study No. 17
The two parts of a divided cylinder were reconnected by casting part of the space around the form.
Plaster
H 15 cm

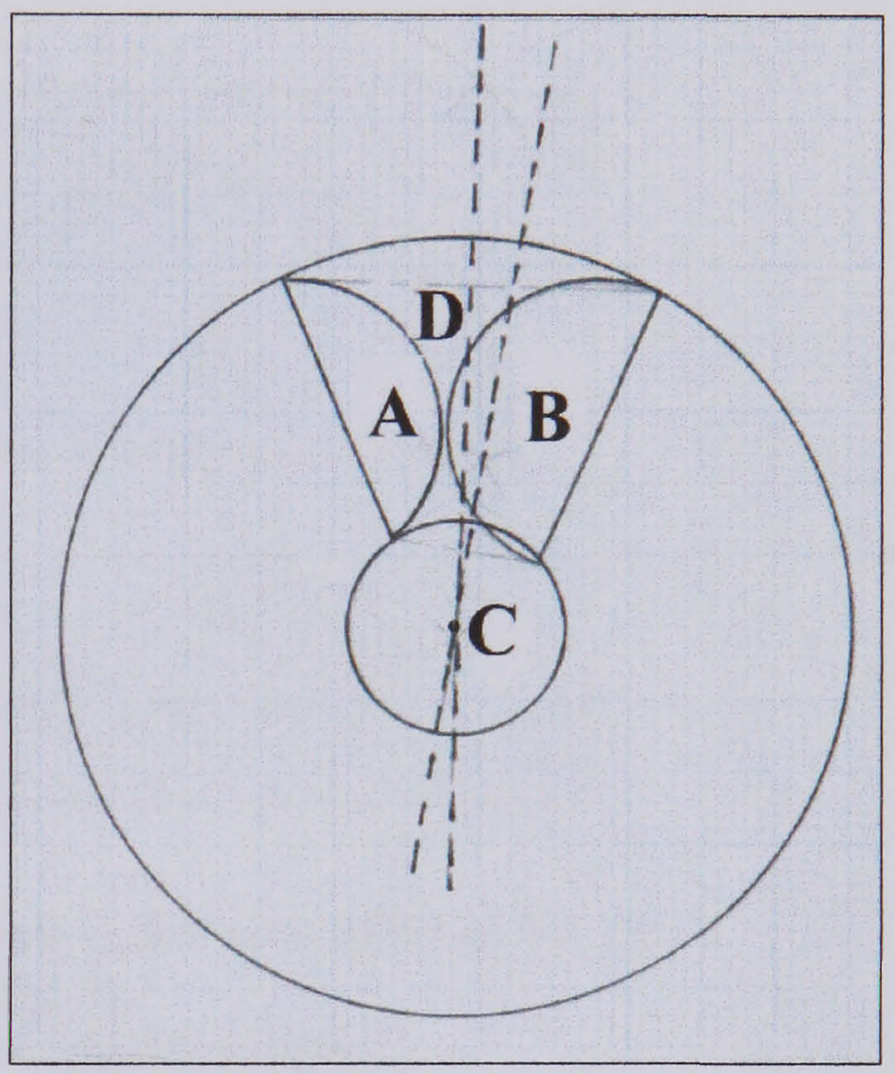


Fig. 34
Drawing of Study No. 17
Key to Fig. 34
A and **B**: Parts of the original cylinder.
C: The point of rotation outside the original form due to the asymmetry of the division.
D: An element of the secondary cylinder scribed by rotation point 'C'.

Observations

The original parts of the divided cylinder, shown as 'A' and 'B' in Fig. 34, were reconnected by casting the space, 'D' and limited by a second cylindrical former. The introduction of a second, outer cylinder was a new departure in the research and I found that it began to imply a cylindrical exterior, despite the original parts being rotated. This second cylinder brought new possibilities into the research, which I explored in the following studies.

Study No. 18

The aim of this study was to introduce as much of a cylindrical form as possible and still rotate the original cylinder. The original divided cylinder, shown in Fig. 35 was cast into a second (outer) cylinder, which was 2 cm greater in diameter and twice the height of the original. The composition was divided off-centre and the smaller part was removed. Half of the original cylinder was also removed. The remaining half of the original cylinder was rotated around the central axis, shown as 'A' in Fig. 36.

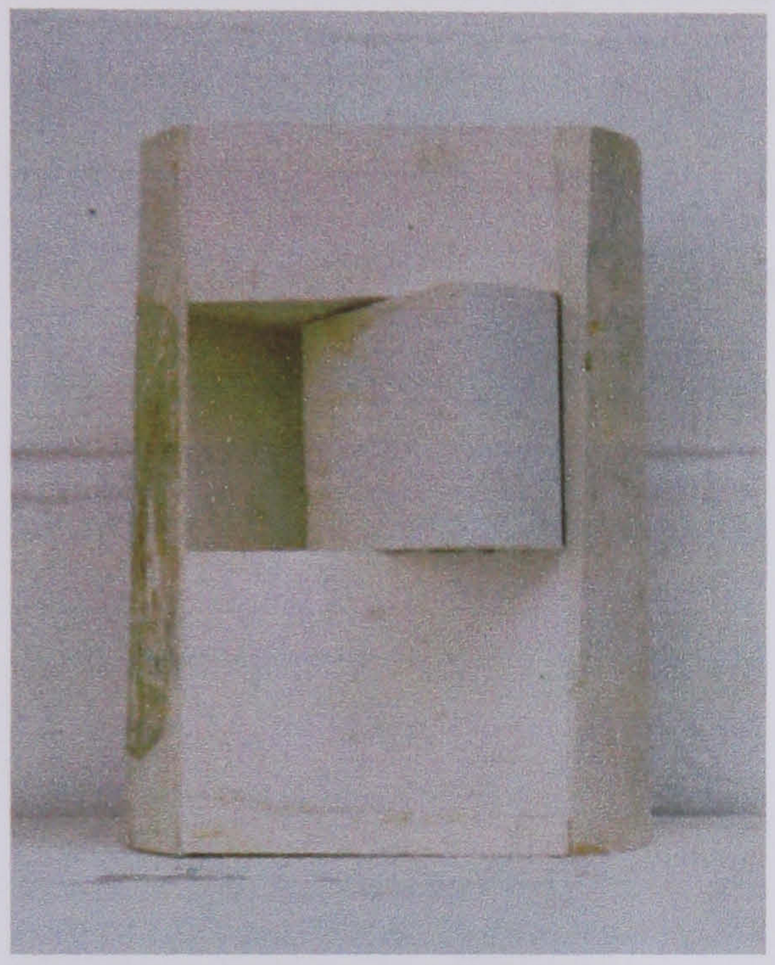


Fig. 35
Study No. 18
Plaster
H 30 cm, D 22 cm.

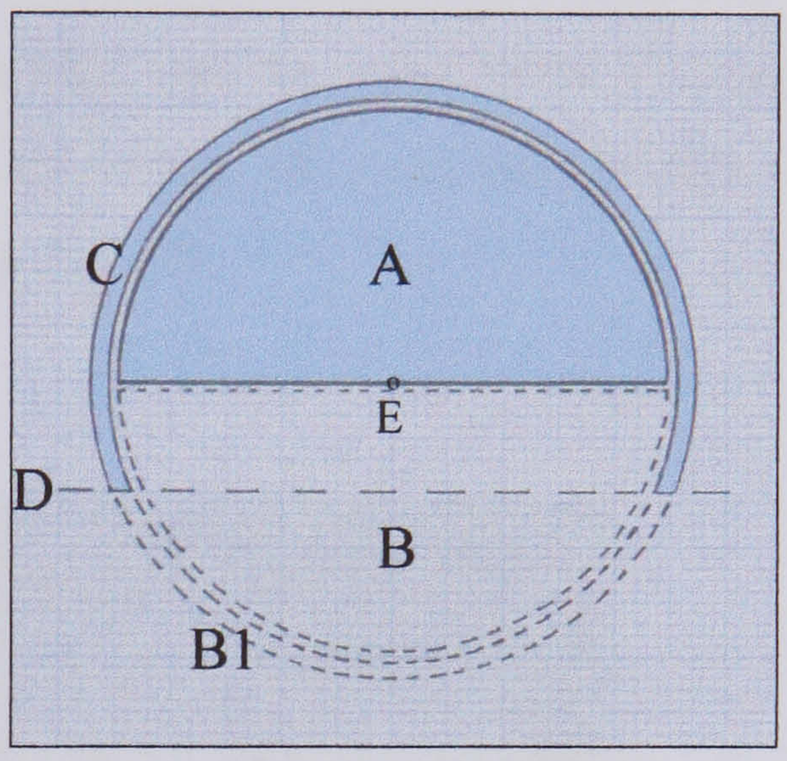


Fig. 36
Cross-section plan view of Study No. 18.
Key to Fig. 36
A: Part of original cylinder.
B: Discarded part of original cylinder.
B1: Discarded part of outer cylinder.
C: Outer cylinder.
D: Dividing line for outer cylinder.
E: Point of rotation for original cylinder.

Observations

As shown in Fig. 35, part of the exterior (outer) cylinder had to be removed, shown as 'B' in Fig. 36, to disclose the original half cylinder. Removing one half of the original cylinder and rotating the remaining half introduced interior space into the form. Light and shadow emphasised the interior space. Through the introduction of a second cylinder, implied rotation was more clearly defined. This was because the second cylinder provided an exterior boundary within which the implied movement could occur. In Fig. 35, due to a part of the form being removed, it did not have the same level of completeness as previous studies, such as, *Study No. 17*, Fig. 33, and I found this weakened the study. It was also less successful because of the association with slots in post boxes, for

example, which gave an inference that the rotated part was not originally a part of the whole form. The next study moved away from this imagery but continued to explore a secondary cylinder using both implied rotation and the interaction between mass and space. Before this study, a form was made, which could be then be used to investigate the influence of implied rotation.

The aim of *Study No. 19(i)*, Fig. 37 was to produce an appropriate form for the investigation of both implied rotation and the use of space and mass. The original cylinder was increased in height and divided into two equal parts. The parts were rotated 180 degrees, shown as 'A' and 'B' in Fig. 38. A second cylinder was cast around the rotated sections, as shown in Fig. 37.

Fig. 37
Study No. 19(i)
A form made to investigate the influence of implied rotation.
Plaster
H 40 cm, D 20 cm

Fig. 38
Study No. 19(i)
A and **B**: Divided and rotated parts of the original cylinder.
C, D, E, F: Parts of the new cylindrical exterior after the rotation of 'A' and 'B'.

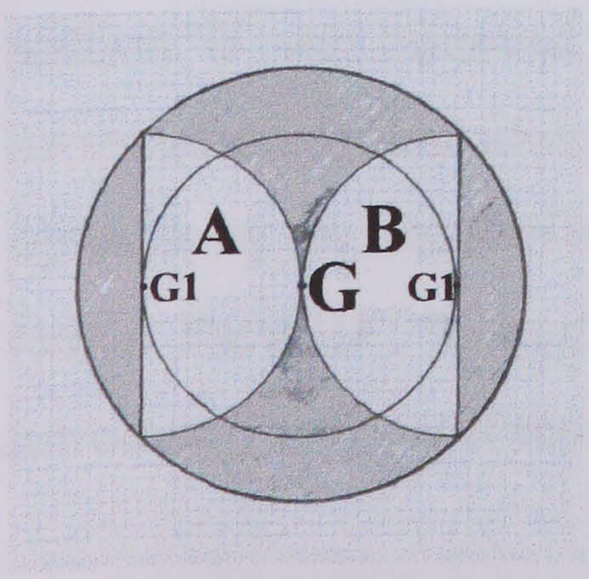


Fig. 39
Drawing of Study No. 19(i)
Key to Fig. 37
A and **B**: Divided and rotated parts of the original cylinder.
G: Centre point of rotation of the original cylinder.
G1: Position of the original centre point after rotation.

Observations

A cylindrical exterior had been restored after the implied rotation of the original parts of the cylinder. Fig. 38 shows the contrast between the straight surfaces, for example, between 'A' and 'D' and the curved surfaces between 'A' and 'E'. A limitation of this study was that all the parts were the same height. In *Study No. 10*, Fig. 16 ambiguity was introduced through a height difference in the cylinders, making the interior project upwards to become part of the exterior. To further investigate the possibility of height differences I then made *Study 19(ii)*, shown in Fig. 40.

Sections of *Study 19(i)*, Fig. 37, were cast and cut to varying sizes. The parts were placed back together in their original format. Height differentiation clarified the separate parts within a form and revealed otherwise hidden information, for example, the inside face of the taller part, as shown in Fig. 40.

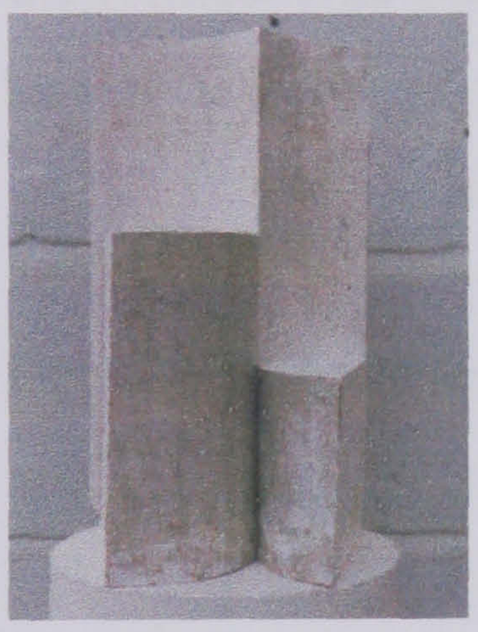


Fig. 40
Study No. 19(ii)
A form investigating height differences
Plaster
H 40 cm, W 20 cm

Study No. 19(iii)

The aim of this study was to investigate the effect of height differences and the influence of implied rotation. The form, shown in Fig. 42, was repeated and section 'B' was removed, as shown in Fig. 41. By removing 'B' the study also investigated the introduction of space into the interior. Part 'A' was moved upwards by one third of its height. Part 'C' was reduced by one seventh of its height. Parts 'D', 'E' and 'F' were as cast. A third outer cylinder had to be introduced to support the sections. All the measurements were by eye.

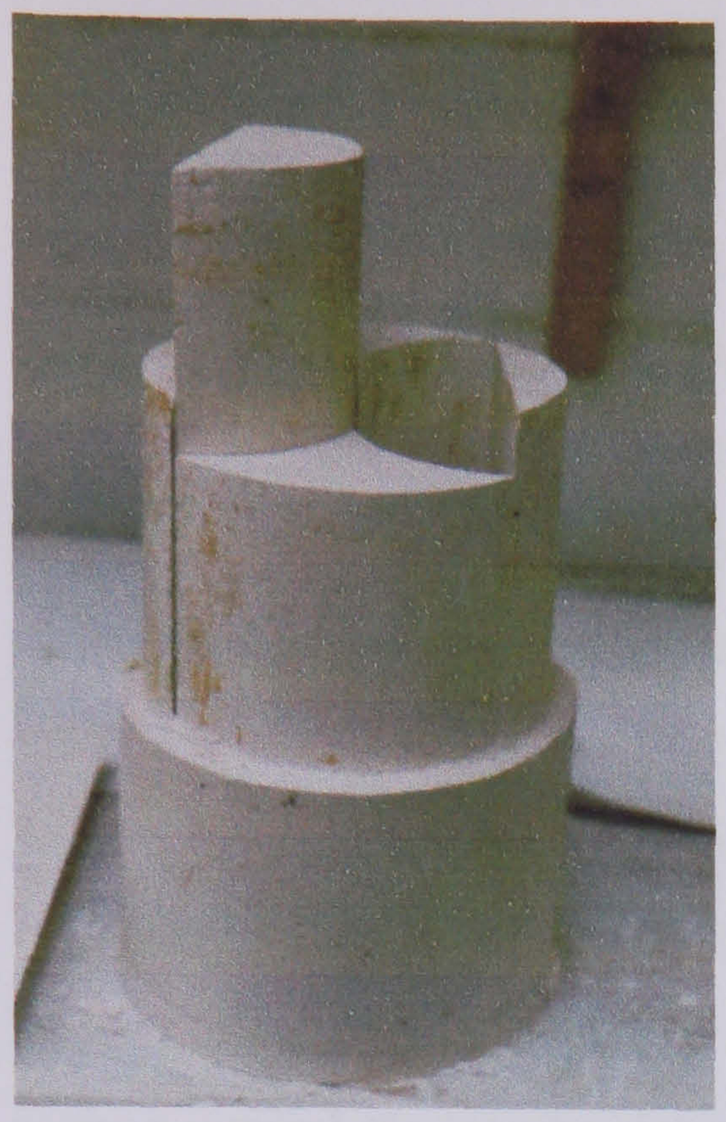


Fig. 41
Study No. 19(iii)
A study investigating the influence of height difference and implied rotation.
Plaster
H 53 cm, D 22 cm

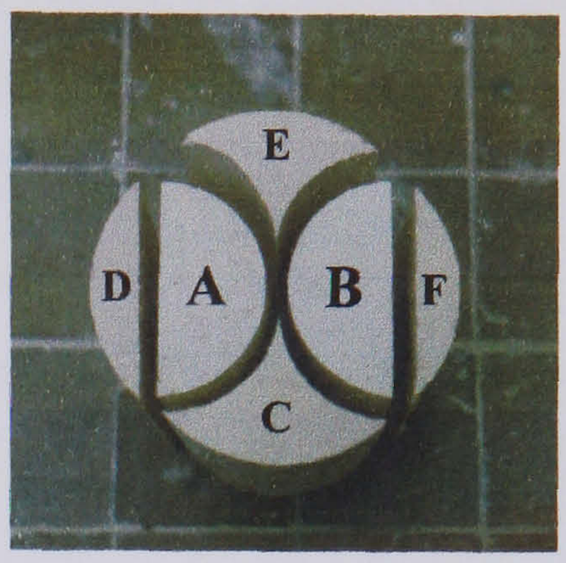


Fig. 42
Repeat of Study No. 19(i)

Observations

The study revealed the space previously occupied by one of the original parts of the cylinder after casting. The base, shown in Fig. 41, had initially been used to hold the separate parts of the cylinder in the correct position, but it served to reaffirm a cylinder as the basis for the study. Through the introduction of the base, there was stepping within the form, which created a feeling of movement. Fig. 41 shows the interior and exterior in this study were beginning to be ambiguous through the reorganisation of the original parts of the cylinder. As part 'A' of the original cylinder protruded above the surrounding parts it became part of the exterior in a similar way to the interior cylinders in *Study No. 10*, Fig. 16. Also, section 'A' was both part of the exterior and the interior of the form. However, the contrast between the straight edges and the curved edges emphasised the original interior of the cylinder, which was now on the exterior.

By removing one of the original parts, 'B', an interior space was created within the composition, emphasised by shadow, shown in Fig. 41. In the next study I extended the device of using an outer cylinder by further enclosing the original cylinder. Through enclosing the form, but still retaining the space created by removing the section shown as 'B', the next study investigated Category F(ii) of the taxonomy, the exterior as mass and the interior as space.

Study No. 20

The aim of this study was to create a more enclosed interior space than the previous study, *No. 19(iii)*, Fig. 41. This was done to reaffirm a cylinder for the basis for the study and also investigate a clearly defined interior space. I was aware that I did not want to create an interior that was merely the inside surface of the exterior. I did not want to present the viewer with a box, lift the lid and show the empty inside of the box. Instead my aim was make an interior that related to the exterior, but interestingly different to it. To make the study, shown in Fig. 43, *Study No. 19(iii)* was repeated and cast a second time but in reverse with part 'A' removed and part 'B' extended in length. The two casts were placed one on top of the other, as shown in Fig. 43. Part 'C' was reduced in both casts to reveal the interior space.

Fig. 43
Study No. 20
A form with interior space.
Plaster
H 80 cm, D 22 cm

Fig. 44
Detail of Study No. 20

Observations

Through the repetition of form, the study had a strongly geometric composition. The repeated use of cylinders was reminiscent of the layering seen in studies such as *No. 12*, Fig. 18. In *Study No. 20*, the interior spaces were emphasised by shadow to a greater degree than the previous study due to being more fully enclosed. It was confined by the limits of the cylinders, one at the base and the other at the top. Together they also reaffirmed the cylinder as the basis of the study.

In this study the interchange between the interior and the exterior were distinct. Fig. 44 shows a detail of part 'C', where the edge delineates between the interior and the exterior through the abrupt change of angle. Therefore, although interior space was created to a greater extent than in the other studies to date, the interior and the exterior remained separate. The enclosed nature of the composition, which assisted in creating this interior space, made the exterior dominant and so they were not exposed simultaneously. Although the composition originated from investigations into implied rotation, it was through the removal and reduction of elements that the interior space was revealed. Spaces were created through positive and negative reversal. The next study further explored the influence of implied rotation by rotating an interior element to meet the exterior boundary.

Studies No. 21

The aim of the forms in this study was to create an interchange between the interior and the exterior using implied rotation. In *Study No. 21(i)*, as shown in Fig. 47, the part, shown as 'B' in Fig 45, was rotated to meet the exterior surface. It was made by re-casting *Study No. 20*, Fig. 43, except part 'B' of the top cast was rotated beyond the original boundary of the outer cylinder. A third cylinder was cast around the new position so that the rotated part 'B' just touched the exterior surface. In *Study No. 21(ii)*, as shown in Fig. 49, only part of one of the interior cylinders was rotated. To show this a different form was used to that of the previous two studies.

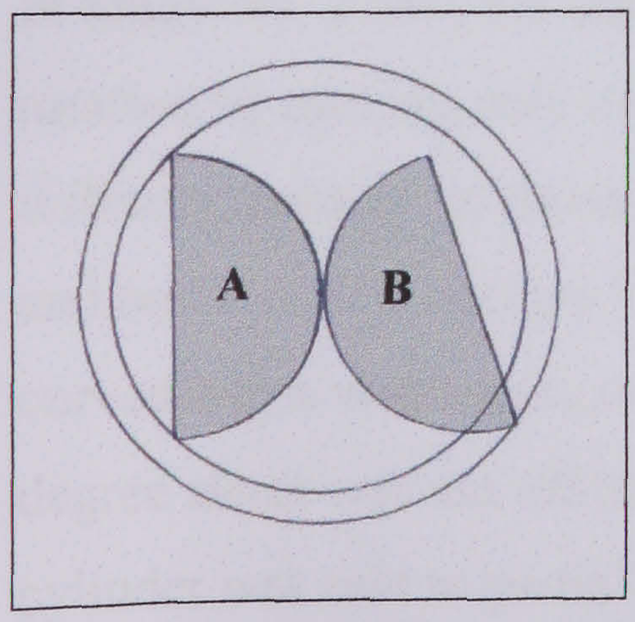


Fig. 45
Drawing of Study No. 21
showing the diameter of the movement of part 'B' of the original cylinder and the diameter of the capital.

Fig. 46
The original position of part 'B'.

Fig. 47
Study No. 21(i)
A study made to investigate the influence of part of the interior rotated to meet the exterior boundary.
Plaster
H 70 cm, D 23 cm

Observations

In *Study No. 20*, Fig 43, the top and bottom cylinders that resembled a base and a capital were made to a diameter that merely supported the separate parts. In this study, shown in Fig. 47, however, the capital was a specific diameter, which was dictated by the rotation of part 'B' in the top section. I realised, at this stage, that if the interior parts were moved and the exterior was to contain them, the size of the exterior was governed by the interior. Through the implied rotation of part of the interior an interaction began to occur between the interior and the exterior. In this study the rotation had been eccentric and this asymmetry was explored further in the Study No. 21(ii).

In Study No. 21(ii), the aim of this study was to clarify the influence of implied rotation by moving only one section of a divided cylinder. A cylinder of a different diameter to those previously used was cast and divided both vertically and horizontally. Section 'C', shown in Fig. 48, was rotated 180 degrees and the curved edges were made to touch the circumference of the inner cylinder. A 15 degree sliver was cut off the inside edge of sections 'A', 'B' and 'D'. A second cylinder was cast to partially encase the top and the bottom of the inner cylinder, to hold it in place, as shown in Fig 49.

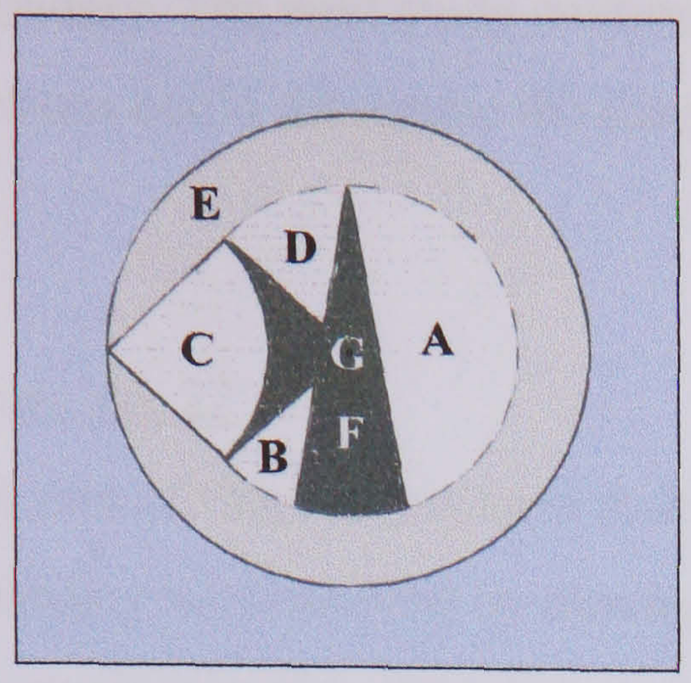


Fig 48.
Horizontal cross-section drawing of Study No. 21(ii).
A, **B** and **D**: Sections of inner cylinder in their original position.
C: Section of inner cylinder rotated by 180 degrees.
E: Outer cylinder, which held the inner cylinder in position.
F: The space in the form after a 15 degree section had been removed from 'A', 'B' and 'D'. Also the space created by rotating section 'C'.
G: the centre of the two cylinders.

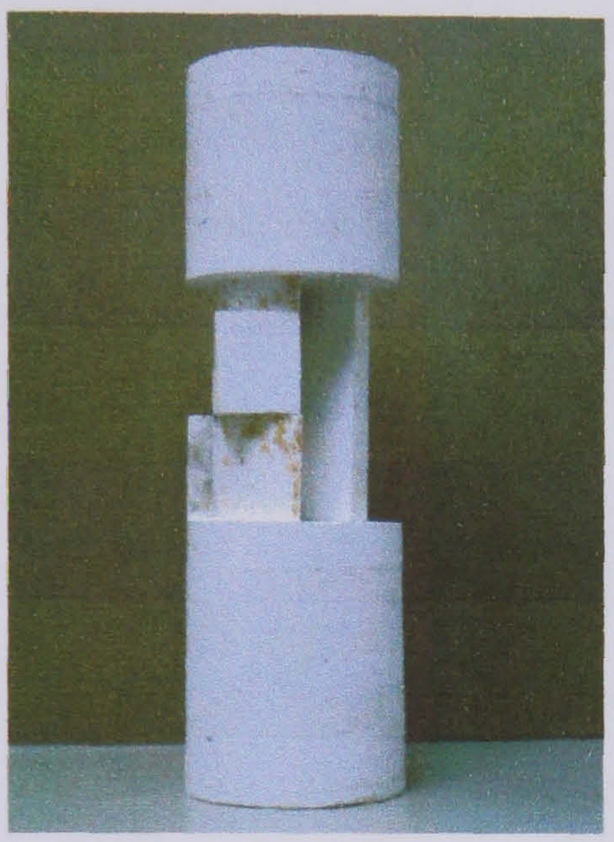


Fig. 49
Study No. 21(ii)
A form in which the central axis was moved to the exterior.
Plaster
H 60 cm, D 20 cm

Observations

Study No. 21(ii), as shown in Fig. 49, served to reaffirm the importance of the central axis as the centre could be used as a point of reference within a form to indicate the interior. Implied rotation was clearer in this form than in the other in this study, shown in Fig. 47, because only a small section was rotated. The area shown as 'F' in Fig. 48 had been removed to reveal the interior of the form and allow the exterior of section 'C' to be seen on the interior, (although in retrospect, it would have been preferable to leave it in place) By removing section 'F' the central axis had also been taken away and the only remaining part of it was the outside edge of section 'C'.

Although Studies Nos. 18 –21 originated from the use of implied rotation, the inclusion of other categories of the taxonomy, such as positive and negative reversal, resulted in findings that were difficult to separate. The investigations, therefore, focused on the results of *Study No. 21(i)*, Fig. 47, in which implied rotation of the interior sections was used to establish the diameter of the exterior

boundary. The next study continued to explore how movement of interior sections could determine the diameter of the exterior.

Study No. 22

The aim of this study was to make a form in which the exterior diameter and boundary was initiated by moving the interior sections. Two half cylinders were reorganised so that their exterior surfaces touched. A drawing was made to find the centre of rotation of the new arrangement, shown in Fig. 50. Two circles were drawn, each of which touched one point of each half cylinder. These two circles became the exterior boundary of the form, shown as 'G' in Fig. 50. The drawing was used to make *Study No. 22*, Fig. 51.

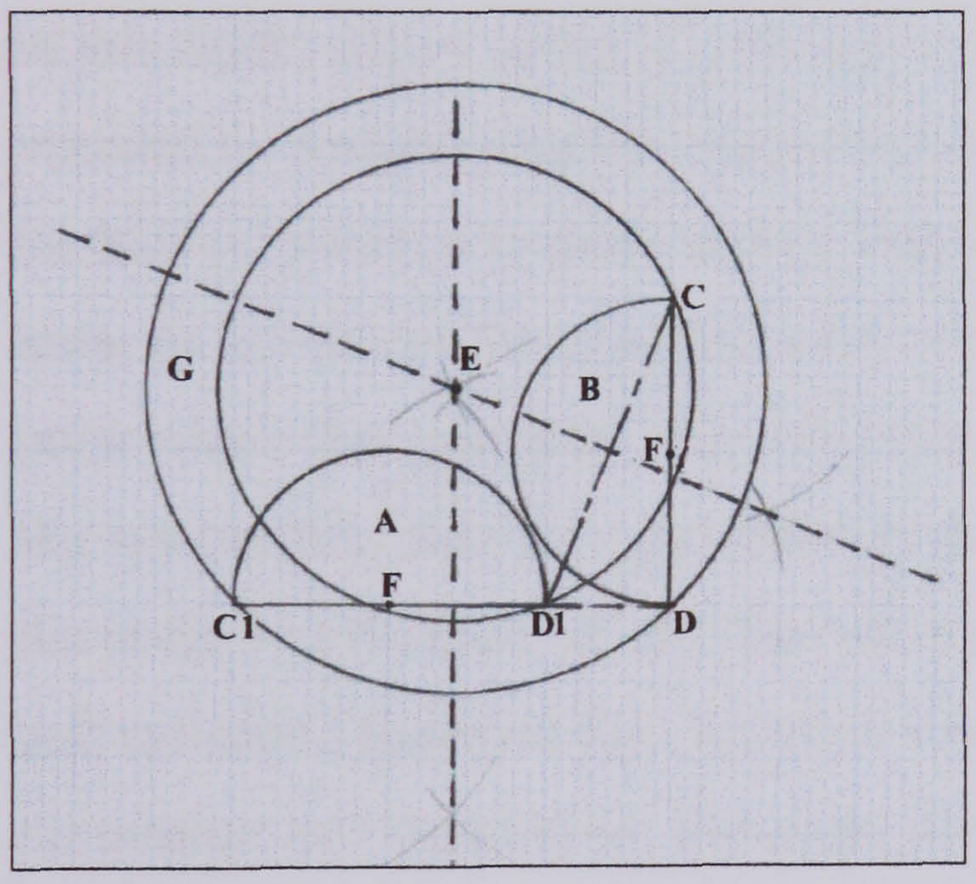


Fig. 50
Drawing for Study No. 22
Key to Figure 50
A and **B**: The two halves of the original cylinder.
C, **D**, and **C1**, **D1**: Bisection lines of the original cylinder.
E: The centre of the new form.
F: The centre of the original cylinder.
G: The exterior of the new form dictated by the points 'C', 'C1', 'D' and 'D1'.

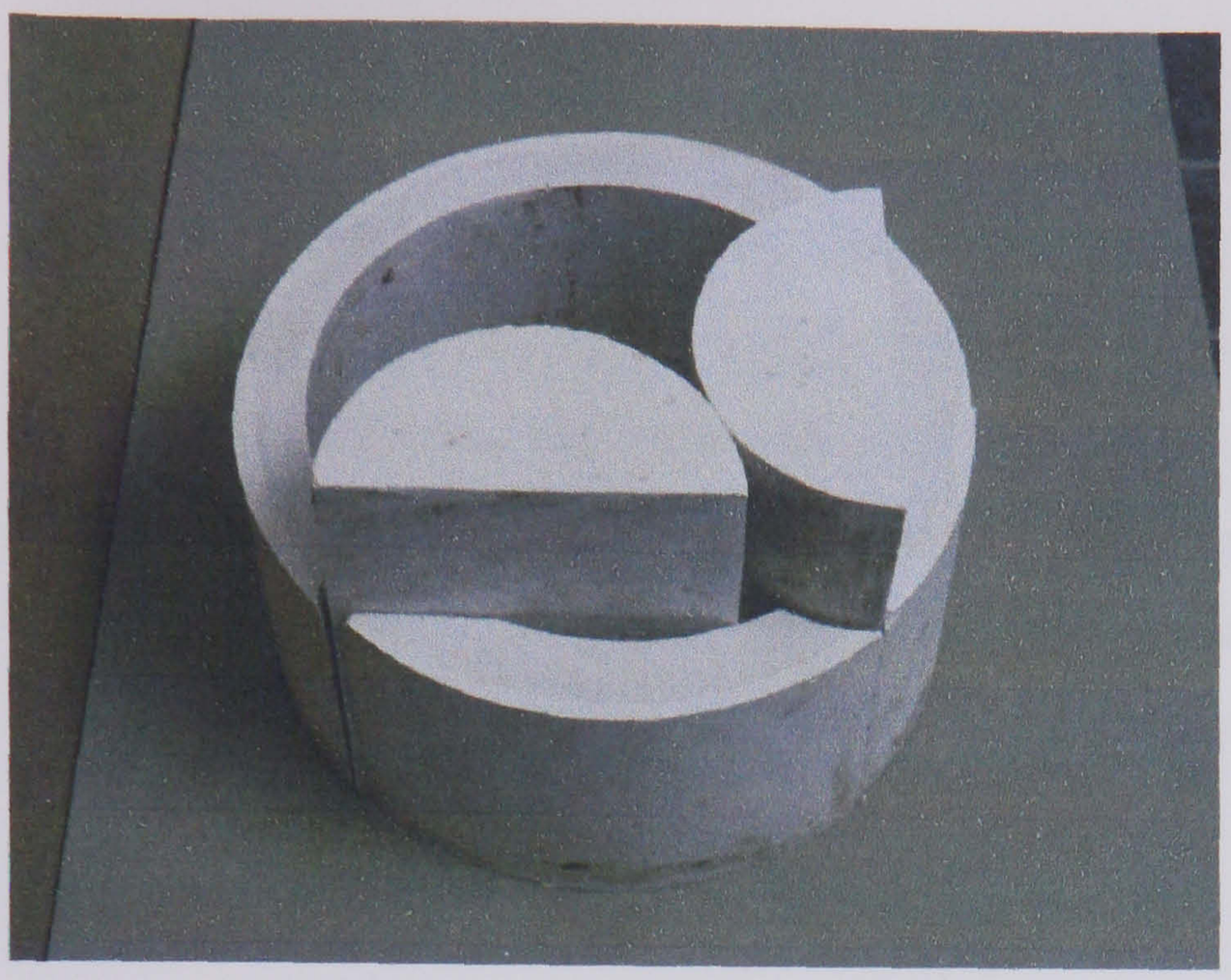


Fig. 51
Study No. 22
Plaster
H 30 cm
A form in which the diameter of exterior boundary was determined by the implied rotation of the interior sections

Observations

In this study, shown in Fig. 51, the diameter and thickness of the exterior was initiated by reorganising the interior forms. The exterior cylinder, which framed the half cylinders, was made shorter than the interior forms so that ambiguity arose as to whether the cylinders were in the interior or part of the exterior at the point where they protruded above the frame. By the half cylinders interrupting the exterior boundary this also questioned their position in relation to being on the interior or the exterior. By intersecting the exterior frame with the interior half cylinders, shown in Fig. 51, I had hoped to achieve an interchange between the interior and the exterior. However, due to the interior and the exterior forms being separate elements, rather than being physically connected, this interchange was not achieved. In the next study I, therefore, aimed to integrate the interior and exterior to a greater degree to see if an interchange could be achieved.

Study No. 23

The aim of this study was to make a form in which the interior and exterior were more integrated than in *Study No. 22*, Fig. 51, whilst still initiating the exterior diameter from the movement of the interior elements. Fig. 52 shows a drawing in which two semi-circles represented the original half cylinders ' A' and 'B' of Fig. 37. When the two half cylinders were whole their centre of rotation was at the centre of the cylinder. When they were halved and rotated their new centre was outside them. The drawing, Fig. 52, shows the geometry used to find the new centre of rotation. *Study No. 23*, Figs 53 and 54 was made from this drawing. To differentiate between 'G' and the two half cylinders, 'G' was made shorter in height by a third.

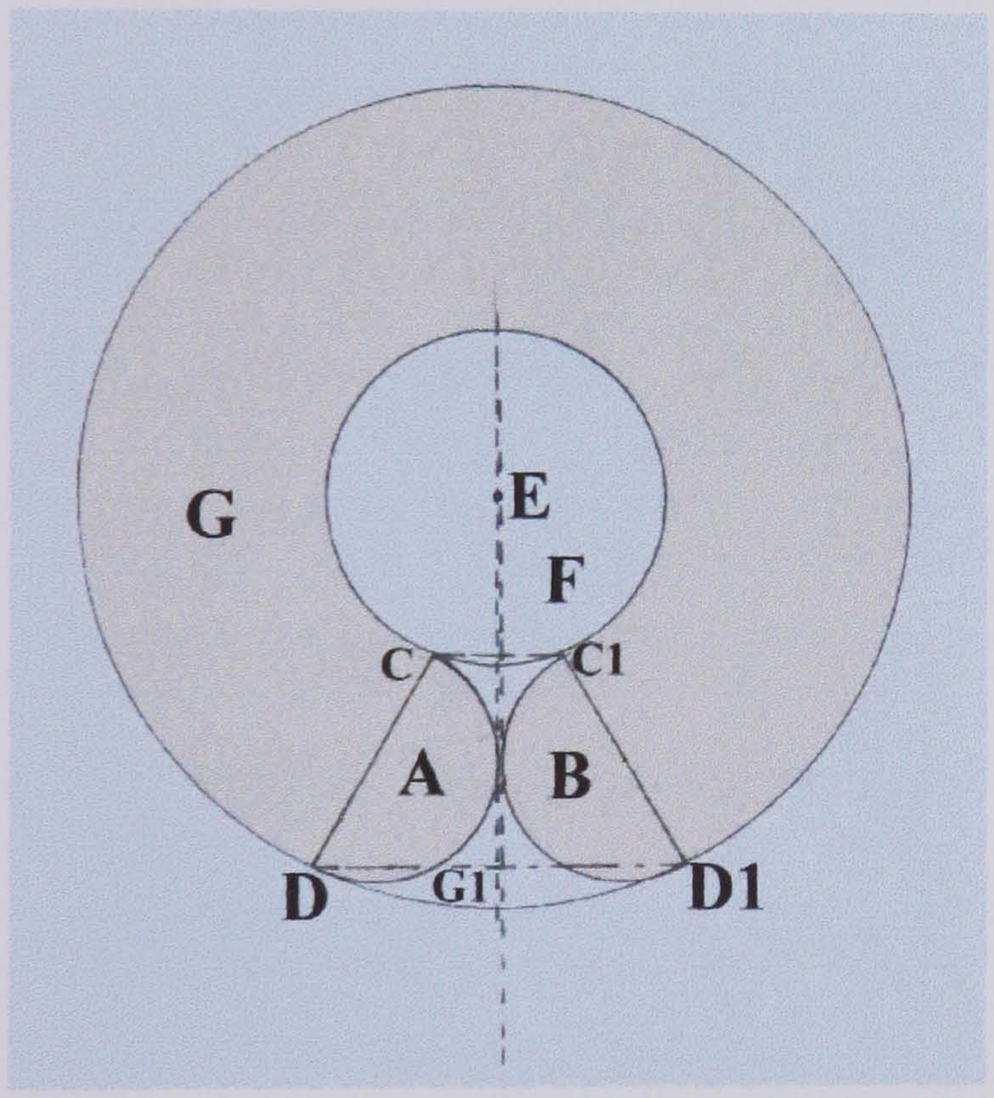


Fig. 52
Drawing which initiated Study No. 23

Key to Fig. 52

Line 'CD': Bisection line of 'A' which was rotated 60 degrees from the central axis or reflection line.
B: Reflection of part 'A'.
E: The centre of rotation of the new form.
F: Circle whose diameter was dictated by the new centre of rotation of 'A' and 'B' so that it touched 'C' and 'C1'. The circle contained the centre of rotation 'E' of the new form.
G and **G1**: A circle whose diameter was dictated by the new centre of rotation of 'A' and 'B' so that it touched 'D' and 'D1'.

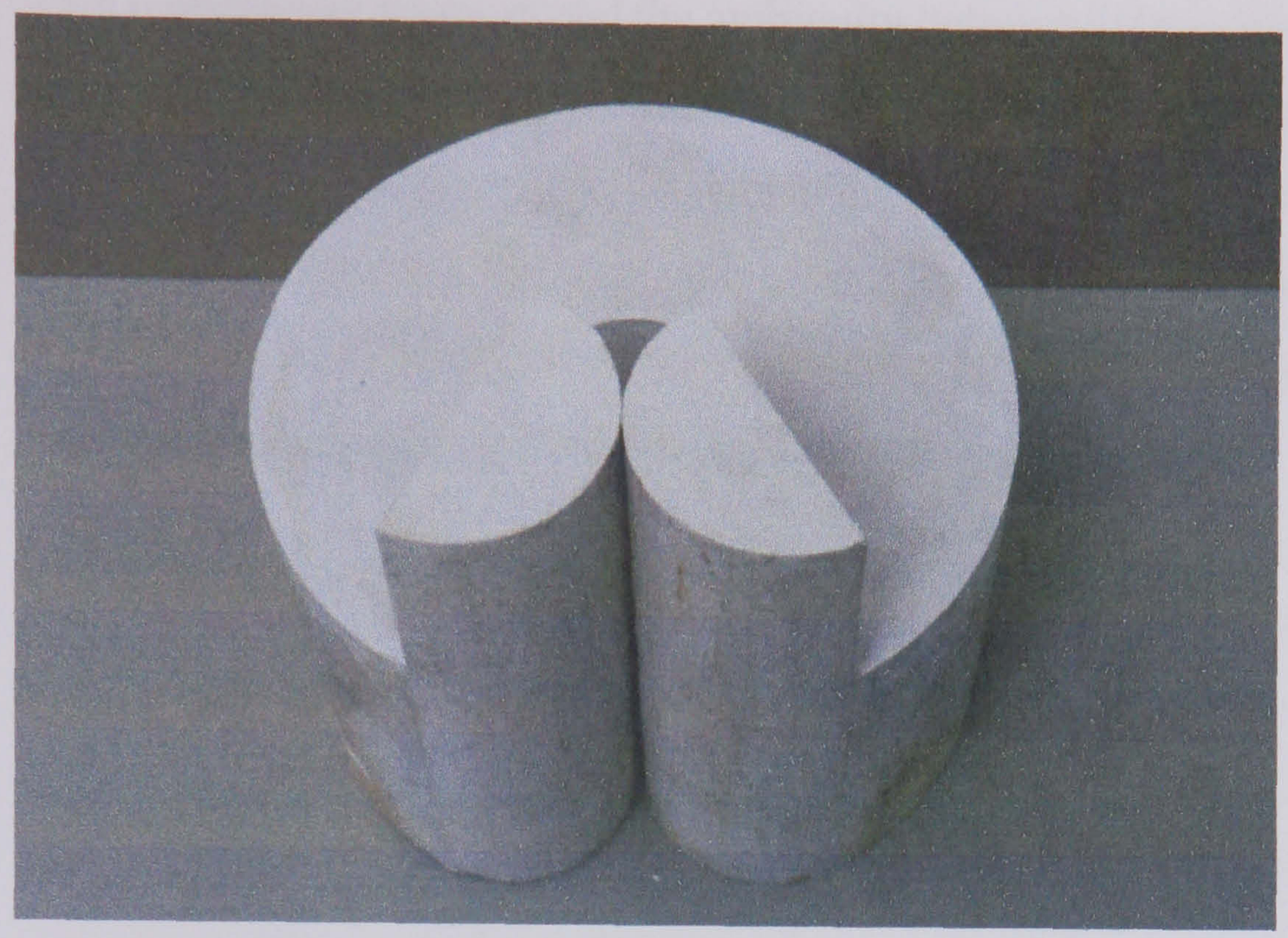


Fig. 53
Study No. 23
A form in which the exterior surface continued to the interior.
Plaster
H 35 cm

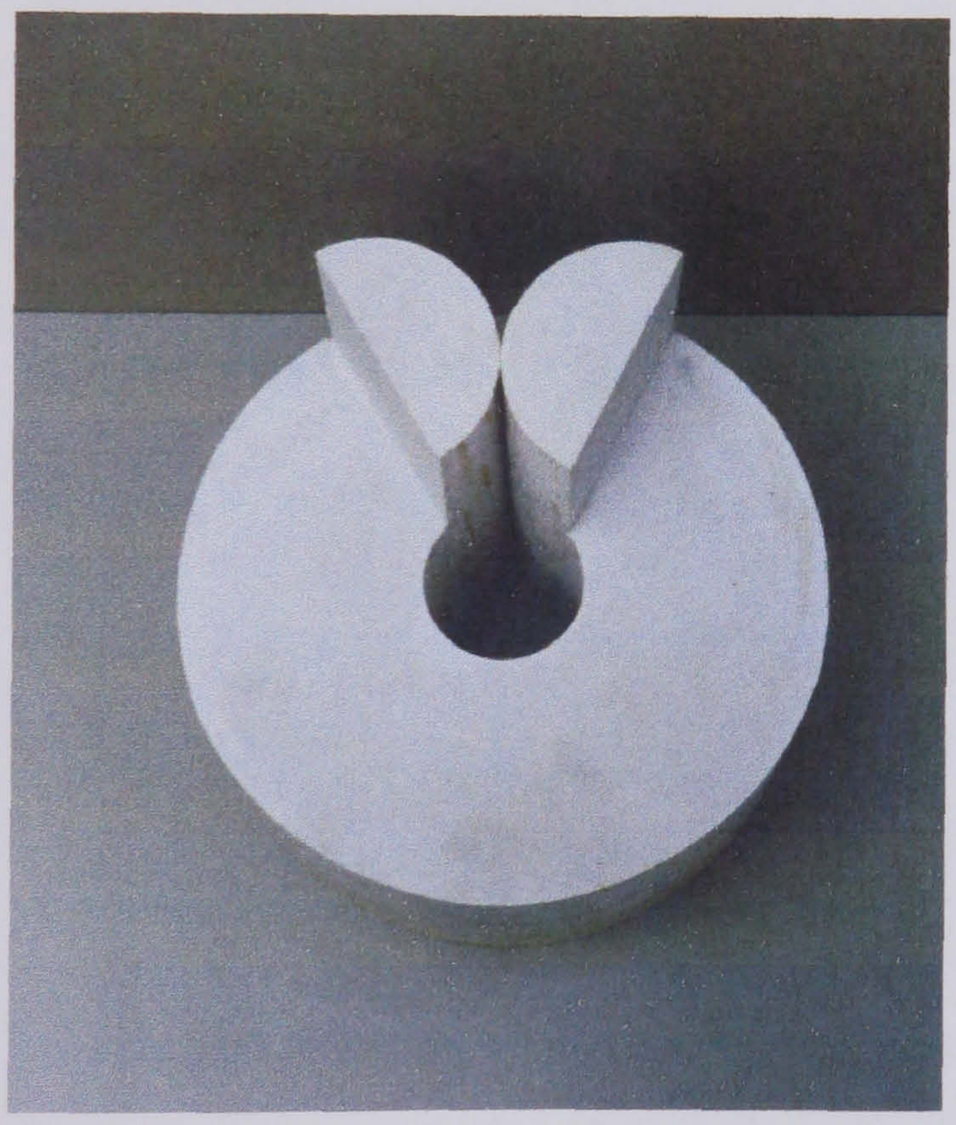


Fig. 54
Study No. 23
Alternative view

Observations

In *Study No. 23*, Figs 53 and 54, joining the two original half cylinders with a connecting cylinder created a new interior and some of this new interior consisted of parts of the exterior surfaces of the original half cylinders. The exterior of the original half cylinders were, therefore, part on the interior, part obscured and part on the exterior of the form. Through the positioning of the half cylinders there was much more of an interchange between the interior and the exterior than had been achieved in the previous study, No. 22, shown in Fig. 51.

This interchange reintroduced the ambiguity between interior and exterior first seen in *Study No. 10*, Fig. 16. Although the new form was connected, through casting the form into a whole, the height difference still allowed the origins and the implied rotation in the study to be seen. The straight edges of the divided cylinder were still visible and again ambiguity arose as to whether these interior surfaces were now on the interior or the exterior.

Study No. 23, Figs 53 and 54 showed the moment of transition between the interior and the exterior, which was Category B of the taxonomy, although this ambiguity had arisen from combining implied rotation and height difference. The exterior in this study had been initiated from the rotation of the half cylinders and became integral to the form instead of being imposed on it as in earlier studies, such as, *Study No. 18*, Fig. 35.

The most important aspect of this study was that the curved surfaces of the half cylinders and the exterior cylindrical form were connected through the casting process and through the positioning of the elements, this connected surface continued from the exterior to the interior. Although this only affected the curved surfaces of the study, this was very important to the research. I realised that although the form was solid and did not twist there was a connection between it and a Möbius strip. The link was that a Möbius strip has apparently one continuous surface, and a single edge, and one cannot point to a specific place where the exterior surface becomes the interior surface. The next stage of the investigations considered these implications.

Conclusion of Section One

Initial studio investigations began with general explorations of what constituted the interior and exterior of sculptural form. As the research progressed and became more focused, strategies and methods of working began to develop. Initial investigations demonstrated that implied rotation applied to a divided cylinder, revealed its interior. At this stage of the research I was concerned with

identifying what constituted an exterior boundary. In *Study No. 17*, Fig. 33, a second cylinder was introduced in an attempt to retain this boundary. This introduced other issues, such as the role of space and mass and positive and negative reversal. It was not until *Study No. 21(i)*, Fig. 47, that it became clear to me, through the potential of the introduction of a second and third cylinder, that the investigations had been initiated from the exterior. *Study No. 21(ii)*, Fig. 49, was also important, with respect to this issue, as it established the importance of the central axis as a reference point for the interior of a form. Once *Studies No. 22* and *23*, had been made the research progressed through the realisation that some of the methods identified in the taxonomy were initiated from the exterior and worked inwards while others began from the interior and worked outwards. The two main categories were firstly, the manipulation of the exterior surface to reveal the interior and the second was the exposure of the interior through its emergence to the exterior.

It became apparent as the research progressed that clear and consistent definitions of the terms 'interior' and 'exterior' were required. As early as *Study No. 6*, Fig. 10, questions were raised about the term 'interior', for example, a space within a composition that is only partially enclosed had different aesthetic properties to an interior space delineated from the exterior by light and shadow. The terms 'interior' and 'inside' were explored more fully in the next section of the studio diary in, for example, *Study No. 31*, Fig. 65 and *Study No. 47*, Fig. 87. Differences had also emerged, in for example, *Study No. 8*, Fig. 14 between an interior and an exterior and their surfaces, which needed further investigation and definition.

The investigations of Section One did, however, define what is meant in the research by the term 'exterior'. The term 'exterior' and 'exterior surface' are interchangeable as it is the surface of the exterior, which defines its boundary. The dictionary definition of surface is 'the exterior face of an object or one such face.' (OED, 1989). The initial studies began with attempting to establish the importance of knowing the origin of a final form. The reason for this was to

understand how a composition had been altered. As these studies began with a single divided cylinder, the exterior could be easily identified but as the studies became more complicated, in for example, *Study No. 20*, Fig. 43, through the introduction of a second and third cylinder the exterior was no longer necessarily on the outside of the cylinder. The exterior of these more complex compositions might incorporate part of the original interior, as in *Study No. 23*, Figs 52 and 53. It could not be said, simply, that the exterior was always on the outside of the composition. In *Study No. 23*, Fig 53, for example, part of the exterior surface was on the inside of the final composition.

Therefore, for the purposes of this research, the term 'exterior' in relation to a three-dimensional form, came to refer to the exterior boundary or surface of the final form or composition. The form or composition might include an implication that part of the exterior had moved to the interior, but the exterior was still the exterior surface of the final position. The exterior of a form might include parts of the displaced original interior. This ambiguity between interior and exterior was beginning to emerge as a possible way of simultaneously exposing the interior and the exterior of a form. As the research progressed I became aware that by making a clear distinction between interior and exterior, which was necessary to define them, I was moving away from the ambiguity that may expose them simultaneously. This apparent disparity, however, was necessary, as I first wanted to define the terms before using them ambiguously. One of the aims of Section Two was to establish a definition of 'interior' within the context of the research. I began by investigating curved surfaces, which had been introduced in the last study in this section.

STUDIO DIARY - Section Two

I began this section by examining a Möbius strip, after I realised a connection with *Study No. 23*, Figs 53 and 54, which started to suggest a continuation from exterior to interior through its connected curved surfaces. I discussed a Möbius strip in the Introduction, citing some of Max Bill's sculptures, such as *Endless Ribbon*, 1953. [25] During this discussion it was noted that a Möbius strip has only one surface, and one edge, and this surface could create volume and enclose form. Through investigation I hoped to understand the implications and potential of a continuous single surface.

After examining a Möbius strip, I made comparisons with spheres that were solid and hollow and this led to using x –ray technology to explore a hidden interior within the structure of a form. These investigations were consistent with the second research question, which was to explore the relevance of materials and techniques to simultaneously expose the interior and exterior of form. Material exploration, at this time, involved discovering those materials that were translucent under x-ray, such as, plaster, wax, wood, rubber etc. [26] The x-rays and resulting radiographic study, shown in Fig. 65, had a significant impact on the remainder of the research. [27] One of the results of the radiograph was the disclosure of a hidden interior, which was explored in the six studies at the end of this section.

The form used in the radiograph was the result of questioning the continuity of surfaces found in a Möbius strip and the spheres. Making a Möbius strip out of a piece of card was a necessary starting point to understand exactly what happened in this apparently simple form and is explained in Figs. 55 and 56. [28] As the strip was made into a three-dimensional form, which contains apparent volume, in Fig. 56 shows the surface continuing from the exterior to the interior. I observed two properties of the Möbius strip, one being reliant on the other. Firstly, the Möbius strip had an apparently single continuous surface and a single edge and secondly, I became aware of the ambiguity surrounding the point at which that

surface changed from exterior to interior and vice versa. I then considered another surface that appeared to be continuous: a sphere.

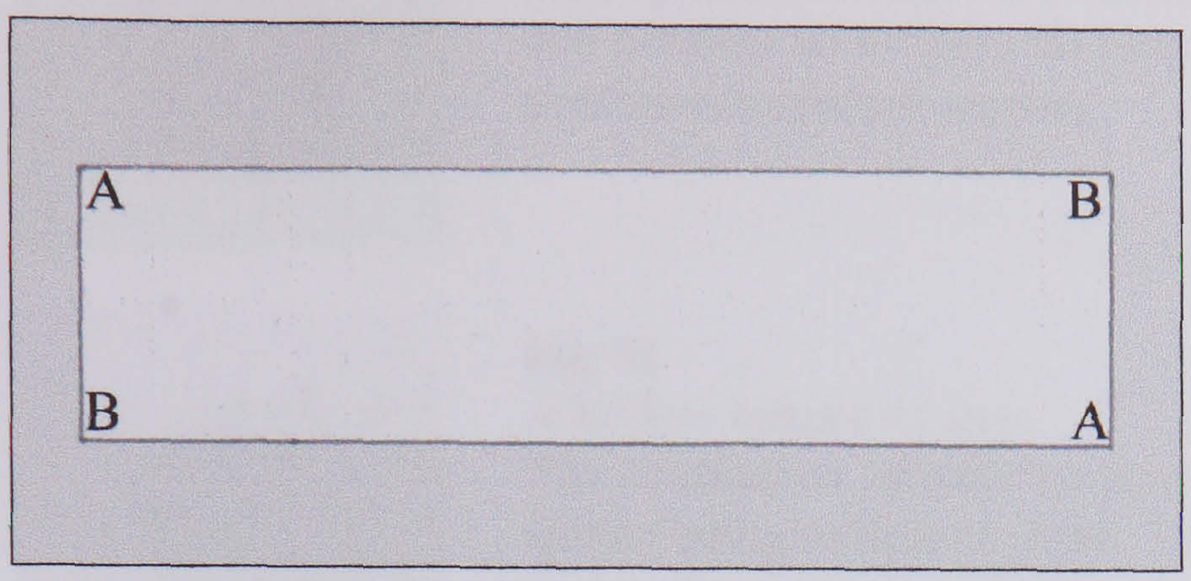


Fig. 55
The card used to make a Möbius strip.
The card was given a single twist of 180 degrees and joined 'A' to 'A' and 'B' to 'B'.
Length 70 cm, width 8 cm.

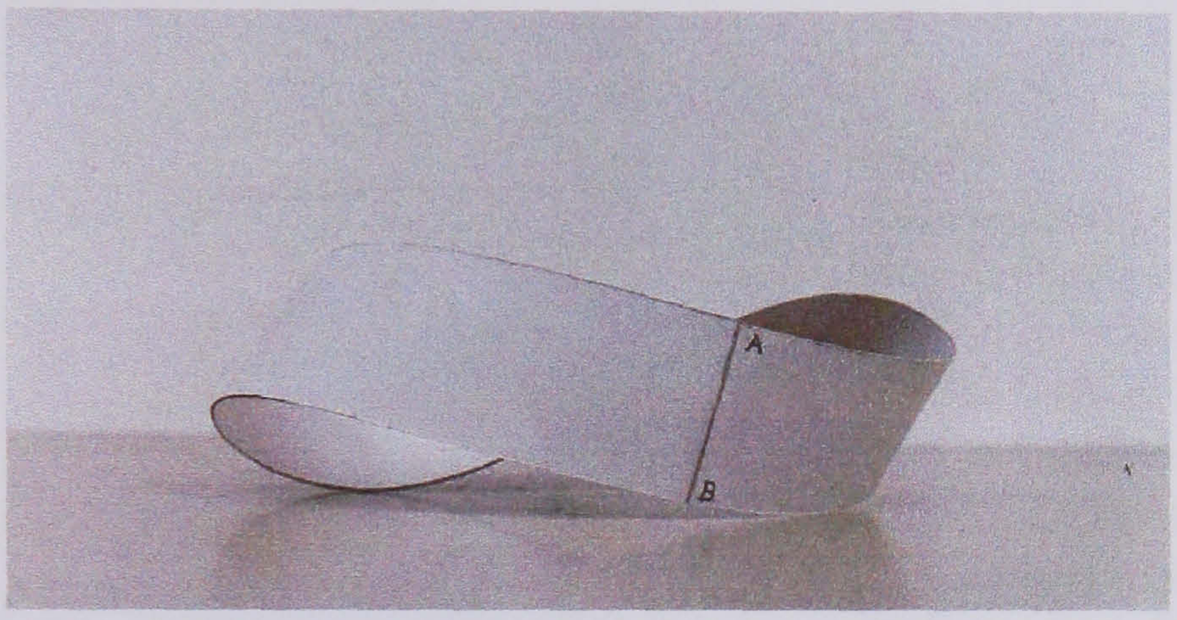


Fig. 56
The completed Möbius Strip demonstrating a single continuous surface and a single edge.

In contrast to the planar continuous surface of a Möbius strip, a solid sphere of clay, shown in Fig. 57, had only one visible continuous surface, the exterior. The interior of the sphere could not be seen as it was within the exterior surface. The difference between a solid and a hollow sphere would only become apparent when the interior was revealed. To explore the surfaces of a hollow sphere of clay and investigate the influence of the thickness of a material, I made a diagram, Fig. 59. [29] As shown in Figs 58 and 59 a hollow sphere might have two interiors, one between the interior and exterior surfaces, shown as 'B' in Fig. 59 and the second, the space 'D' enclosed by the interior surface, 'C'. [30]

Fig. 57
A solid clay sphere of clay.
As a sphere does not have corners it can be seen to have one continuous exterior surface. The interior was within the continuous exterior surface.

Fig. 58
A hollow sphere of clay.
The continuous exterior surface was unaffected by the sphere being hollow or solid. The interior was still within the exterior surface.

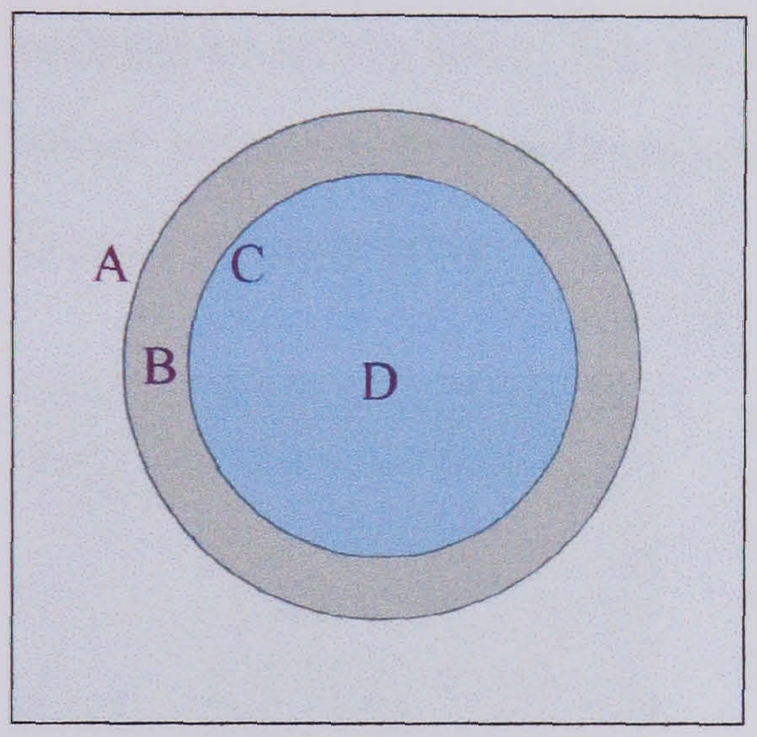


Fig. 59
Cross-section diagram of a hollow sphere.
Key to Figure 59
A: The exterior surface.
B: The interior of the material. Clay.
C: The interior surface.
D: Interior space.
A hollow sphere could be said to have two surfaces, one on the exterior shown as 'A' and a second, unconnected to it due to the thickness of the material, shown as 'C'. If there were two surfaces in a hollow sphere it could suggest that it had two interiors, which were separated by the surfaces. The first would be within the clay and between surfaces 'A' and 'C', shown as 'B'. The second, enclosed by surface 'C', was the space within the hollow sphere, shown as 'D'

For visual reference I made a cylindrical form with a marble within the material, i.e. between the surfaces, as shown in Fig. 61. [31] I had specified that the research would investigate opaque materials, therefore, x-rays were used in these demonstrations so that the form did not have to be cut to expose the interiors. Fig. 60 shows the form before being x-rayed and Fig. 61 shows the radiograph of the form after being x-rayed.

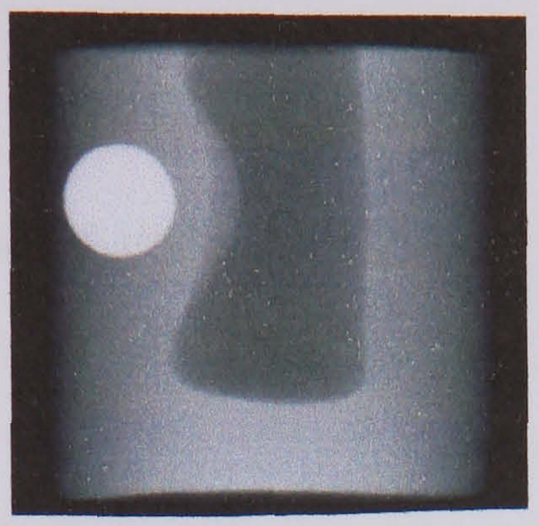


Fig 60
Open opaque wax form before x-ray.
Wax, a glass marble. H 8 cm.

Fig 61
Radiograph of Fig. 60 showing a marble between the exterior and the interior surfaces of an open form. (In previous tests a marble had been found to be less transparent than wax under x-ray.)

My interest in radiographs was in their ability to reveal otherwise 'hidden' information. The next demonstration, shown in Figs 62 and 63, used radiography to demonstrate the disclosure of the concavity, which was hidden through the orientation of the form. Fig. 63 was initiated by seeing a radiograph of a coin, which appeared to simultaneously reveal the head and the tail of a coin that was face down on a table. [32]

Fig. 62
A cylindrical form 10 cm in height was made, which had one visible concavity and one concealed by the opaque exterior surface. It was then x-rayed, the radiograph is shown in Fig. 63.

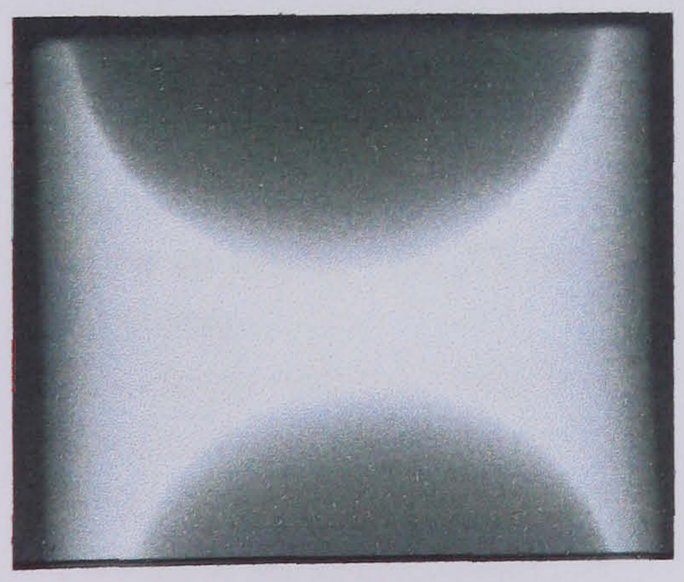


Fig. 63
Radiograph of Fig. 62.
Views which are ordinarily hidden in opaque forms could be revealed through x-rays. In this form the two concave surfaces were revealed simultaneously without the need to turn the form on its side so that one could see inside each end.
In a radiograph it was possible to see part of the exterior surface and the internal structure simultaneously.

The first study of Section Two aimed to investigate the area between the walls of a form, which had been demonstrated in Fig. 59 and 61. My intention was to reveal the area between the walls of a cylindrical form, which was usually hidden in an opaque form and to make this area distinct from the walls I made it hollow.

Study No. 24

The aim of this study was to show an interior space between the exterior and interior surfaces of an open cylindrical form without using transparent materials, and without cutting into the form. The study also aimed to investigate whether an open cylindrical form could have two interiors, which were separated by the interior surface. This study was made from wax, which, through previous experiments had been found to be translucent under x-ray (see endnote 26). Coloured wax, which was opaque, was cast in a cylindrical mould to make cylinder, approximately 14 cm in height and 7.5 cm in diameter. [33] A second cylinder, approximately 12.5 cm high and 4.5 cm in diameter was made in the same way and placed inside the larger one to give a space of approximately 1.5 cm between all the surfaces. A top was melted on to the two cylinders to join the two together and enclose the space, as shown in Fig 64. The cylindrical form was then x-rayed, as shown in the radiograph in Fig. 65.

Fig. 64
View of Study No. 24 before the x-ray.
The sharp corners, which delineated the interior and exterior, can be clearly seen.
The interior and exterior are emphasised by light and shadow.
Wax.
H 14 cm, D 7.5 cm.

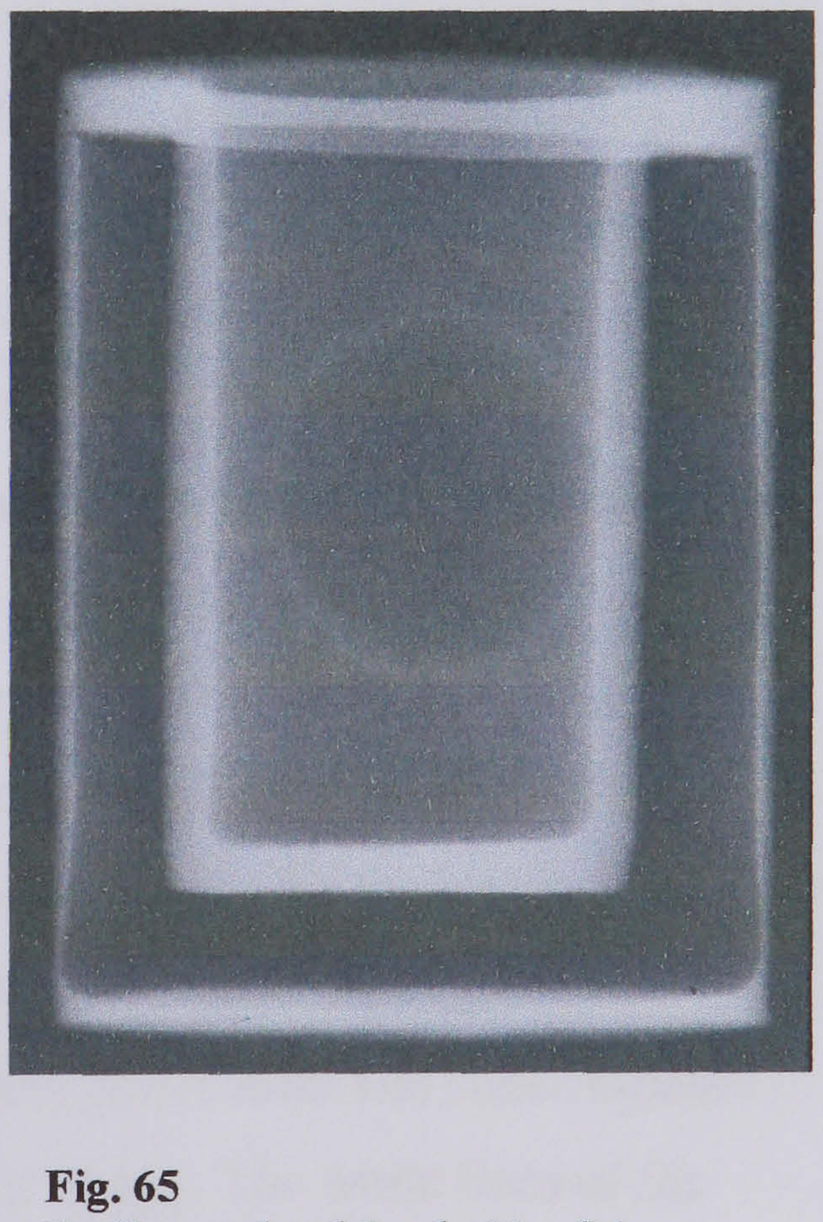


Fig. 65
Radiograph of Study No. 24

Observations

The x-ray image, or radiograph, as shown in Fig. 65, enabled me to observe form very differently to the way it had been seen in previous studies and this had far-reaching ramifications.

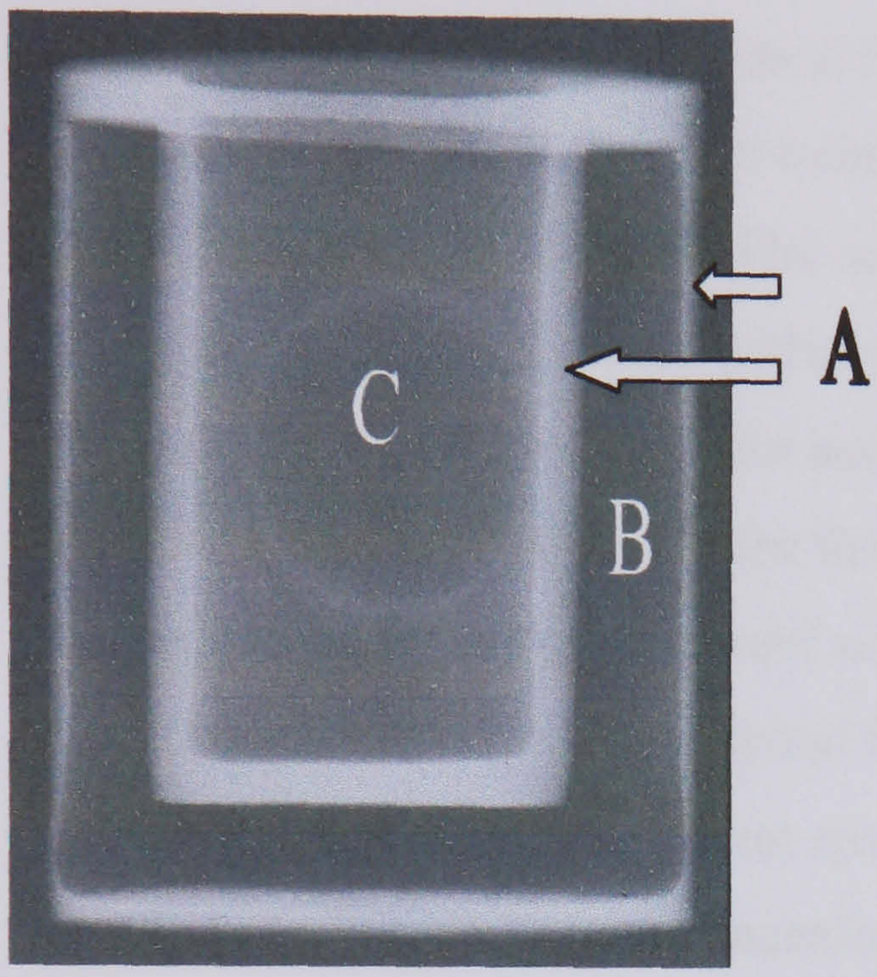


Fig. 66
Key to Study No. 24
A: The white lines created by the superimposition of the depth of the material.
B: The contained interior space between the wall of the cylinder and usually hidden in an opaque form.
C: The interior of the cylinder, which was open.

The form could be said to have two interiors, one 'B', contained and the other, 'C', open.

The radiograph was the result of an x-ray taken of the side of the wax cylinder shown in Fig. 64. The radiograph, shown in Fig. 65, reduced the mass of a hollow cylinder to line, allowing only the essence of the form to be seen. In this way, x-ray technology enabled me to see an opaque, three-dimensional form in a different way and the originality of the image led to a breakthrough in the research. The change in my understanding came from being able to render most of the exterior surface invisible (see endnote 26), whereas, if the form had been transparent I would have been able to see the interior of the cylinder, but only through the exterior surface. As the form was made of one material and, therefore, had a uniform atomic density, the information for the image came from the thickness of the material and the shape of the cylinder. This radiograph contained the information from the whole depth of the form and superimposed this information to produce a two-dimensional image. The white lines of the image, shown as 'A' in Fig. 66, resembled a cross-section drawing. However, this 'cross-section' had radiance, which was not present in the drawn cross-section of the sphere shown in Fig. 59. The studies that followed the radiograph were initiated by cross-section drawings following the realisation that they gave

access to the hidden interior and enabled me to consider more complex forms.

The radiograph revealed the space I'd created between the surfaces of the cylinder, shown as 'B' in Fig. 66. This space would not ordinarily be seen in an opaque form and was only disclosed through the x-ray. It was an enclosed space and was separated from the open interior, shown as 'C' in Fig 66, by the interior wall or surface of the cylinder. The radiograph showed this enclosed space to be an interior as it was contained within the walls of the cylinder. The form, therefore, had a concealed interior and an open interior when viewed in this way and this suggested possibilities for the investigations. For me, an interior being 'hidden' was thoroughly consistent with the idea of it being enclosed and out of sight. A hidden interior went beyond the insides found in a vessel or a room and evoked notions of fabulous, secret spaces. Through x-ray technology I was actually seeing an ordinarily concealed interior space and the prospect of revealing this hidden interior was something I was keen to explore.

Using the information resulting from the radiograph, shown in Fig. 65, the next stage was to find a way of revealing the concealed interior of an opaque form without using x-ray technology. I began by demonstrating it through implication. As visual reference I made a cylinder that had a sphere placed within its surfaces. While the sphere appeared to bulge through the exterior surface, the interior surface in Fig. 67 and 68 was left unaffected by the sphere in order to retain as much of the cylinder as possible. By achieving this, it was implied that the sphere was between the surfaces of the cylinder, even though it was not revealed.

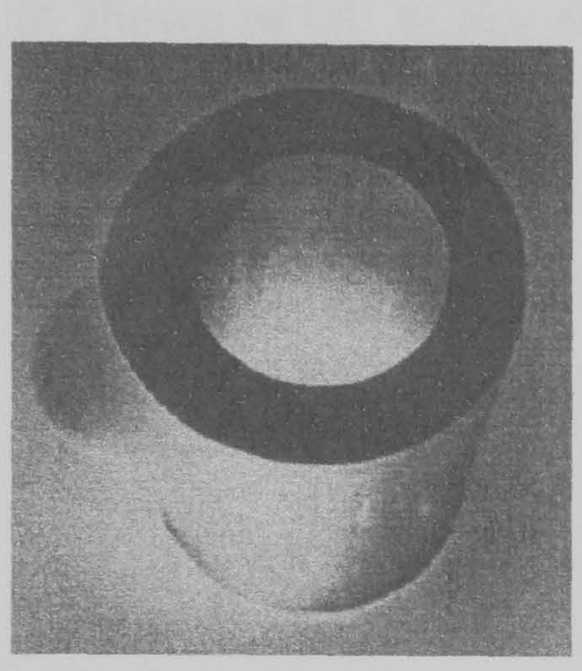


Fig. 67
Plaster. H 20 cm.
A sphere was placed within an elastic cylindrical outer former and a smaller inner cylinder. The space between the two formers was cast.
As the form was an open cylinder, it had an interior, which was accentuated by light and shadow. Due to this interior, the sphere appeared to be within the walls of the cylinder, rather than in its interior. The form, however, did not reveal the sphere but only inferred its presence through the distortion of the exterior surface, as shown in Fig. 68.

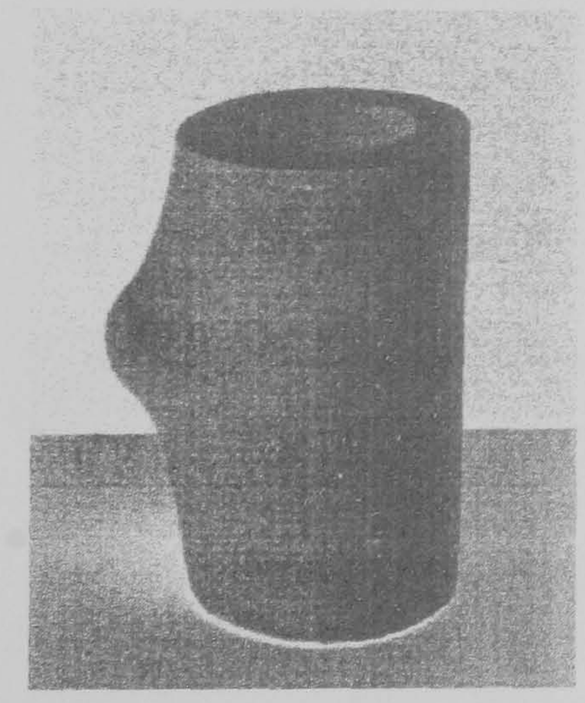


Fig. 68
Side view of Fig. 67.

As implication would not achieve simultaneous exposure of interior and exterior, the first study made after the radiograph aimed to reveal the hidden interior between the surfaces by cutting into the form. The problem I had with revealing a concealed interior within an opaque material was that it would no longer be hidden, as only under the special conditions of the x-rays could a hidden interior be seen. Despite these reservations I felt it was important to at least attempt to reveal this otherwise hidden interior in ways other than x-rays.

Study No. 25

The aim of this study was to imply a sphere had been within the surfaces of a cylinder and by its subsequent removal the interior was revealed. As previously mentioned, the study was initiated from a cross-section drawing of a cylinder with a sphere placed within the walls. The form was made by placing a wax sphere, two-thirds the diameter of a cylindrical mould, into a mould and cut to fit where it intersected the exterior wall. A smaller central wax cylinder was placed in the mould and the smaller cylinder was also cut where the sphere intersected it, shown as 'A' in Fig. 69. Plaster was poured into the mould and around the wax forms and, when it had set, the wax was removed.

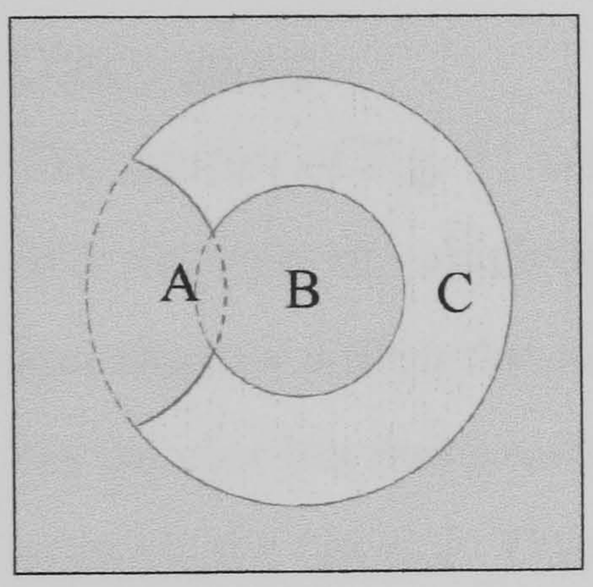


Fig 69
Horizontal cross-section drawing of Study No. 25 with dotted lines showing the points of intersection of the wax sphere and the cylinders.
A: Space left after the removal of the wax sphere.
B: Central space of the wax cylinder connected to the exterior space by 'A'.
C: Plaster cylindrical form.

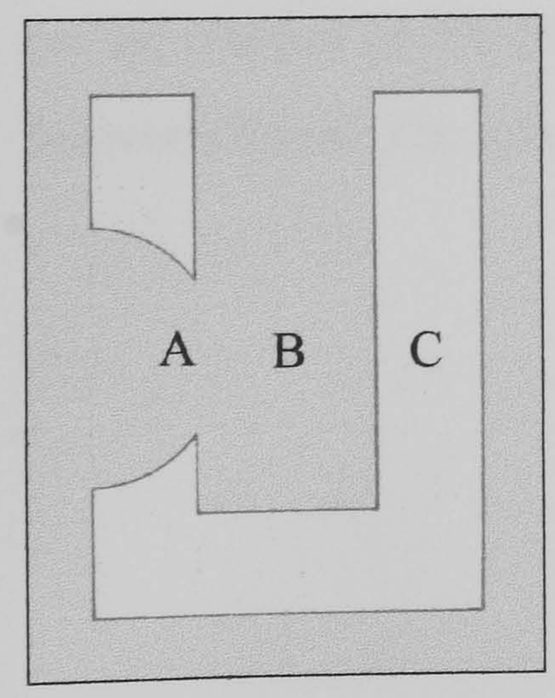


Fig. 70
Vertical cross-section drawing of Study No. 25 after the wax forms had been removed.
A: Space left after the removal of the wax sphere.
B: Central space of the wax cylinder connected to the exterior space by 'A'.
C: Plaster cylindrical form.

Fig 71
Study No. 25
Plaster
H 20 cm, D 15 cm.
Interior seen through the exterior surface after the removal of a sphere that had been placed within the surfaces of the cylinder.

Observations

The interior of Fig. 71 was exposed through the exterior surface by the removal of a wax sphere, which had been positioned in the walls of the cylinder. Light and shadow within the study distinguished between the walls of the cylinder and the interior but there was also a gradation of light to dark from the exterior towards the interior. This gradation was assisted by the smooth but distinct curves of the form. The exterior of the form was lit with reflected light, whereas the interior was in shadow and the aperture, or hole, became the intermediary between the two. This area, shown as 'A' in Figs 69 and 70, was neither clearly on the interior or the exterior of the form, but instead it was a connection between them. The next study placed the sphere in the interior of the cylinder.

Study No. 26

The aim of this study was to place a sphere centrally within the interior of a cylinder so that it interrupted the surfaces of a cylinder. The reason for doing this was to attempt to connect the open interior of the cylinder with the hidden interior within its walls. The study was made by intersecting a wax sphere through its centre with a small solid cylinder. This was done to produce a cylindrical space within the form. The sphere and solid cylinder were then placed within a cylindrical mould and plaster was poured between the inner cylinder and the mould, creating the area shown as 'C' in Fig. 72. When the plaster was set, the small cylinder and the wax sphere were removed. A circular hole was cut, shown as 'A' in Fig 73, into the cylinder wall to reveal the negative space of the sphere and small cylinder, shown as 'B' in Fig. 73.

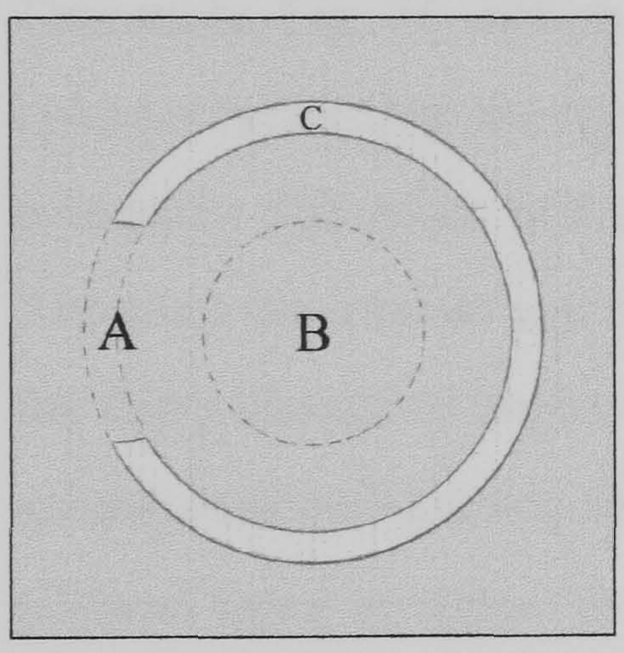


Fig. 72
Horizontal cross-section drawing of Study No. 26 showing a sphere placed centrally within a cylinder.
A: Hole cut into the side of the cylinder revealing the spherical interior.
B: Original cylindrical interior.
C: Plaster form.

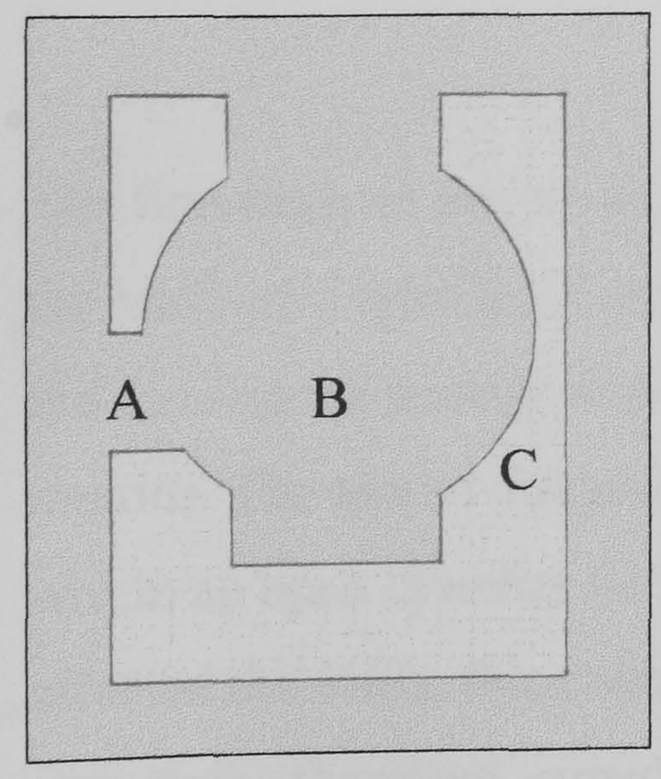


Fig. 73
Vertical cross-section drawing of Study No. 26 after the wax had been removed.
A: Hole cut into the side of the cylinder revealing the spherical interior.
B: Original cylindrical interior and spherical interior interrupting the cylindrical interior.
C: Plaster form.

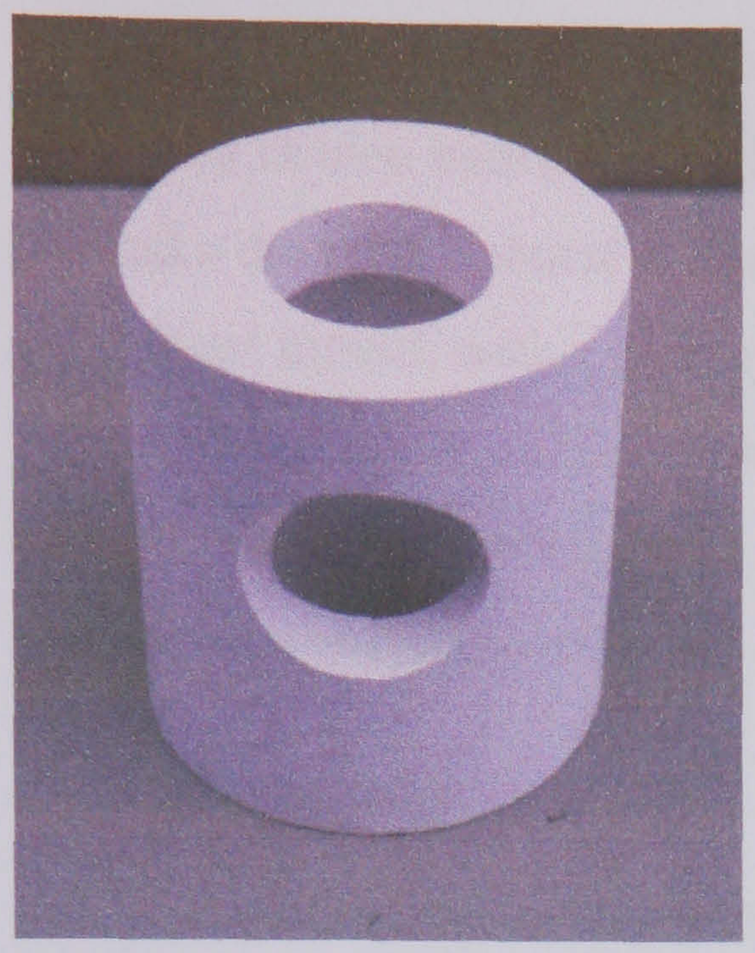


Fig. 74
Study No. 26
Plaster
H 20 cm, D 15 cm
Exterior cut through to reveal the interior.

Observations

This study, Fig. 74, differed from the previous one by having a hole cut into the cylinder rather than the sphere intersecting it. The result was that the hole revealed a difference in the wall thickness of the cylinder, shown in Fig. 73. Although the interior was revealed it remained distinct from the exterior through the sharp change of angles and the wall thickness of the cylinder, which were accentuated by light and shadow. The two holes of the same diameter in the form allowed space to appear to continue through the interior of the cylinder and connect to the exterior space.

The first study in this series, Fig. 71, had attempted to disclose an interior within the walls of a cylinder, first seen in the radiograph, Fig. 65. Although this study did disclose an interior, it did not further the investigations into this hidden interior. The aim of this study had been to connect the already existing interior within an open cylinder with the hidden one within its walls. Although the sphere affected the walls, this connection had compromised the hidden interior. The next study, therefore, aimed to separate the two interiors, which had been identified in the radiograph.

Study No. 27

The aim of this study was to show two interiors of a form but to separate the ordinarily hidden interior from the inside in an attempt to emphasise the former. To make the form I coated a wax sphere, which was two-thirds the diameter of a cylindrical mould, with a thin layer of plaster and cut it to fit where it intersected the exterior wall. A smaller central wax cylinder was placed in the mould and also cut where it intersected the sphere, as shown in Fig. 75. The form was cast and the wax was removed.

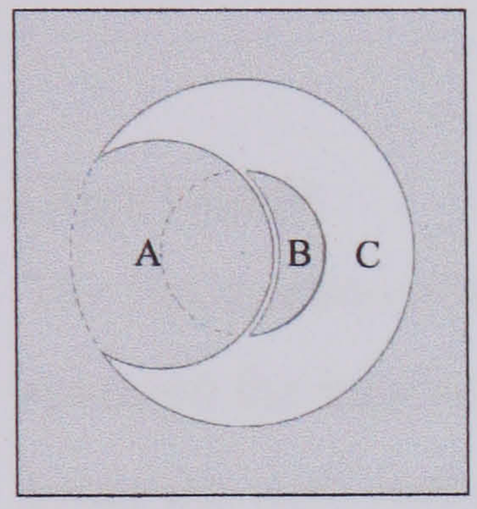


Fig. 75
Horizontal cross-section drawing of Study No. 27.
A: Sphere intersecting the exterior and interior surfaces of the cylinder.
B: The sphere encroaching into the interior space of the original cylinder.
C: The plaster cylindrical form.

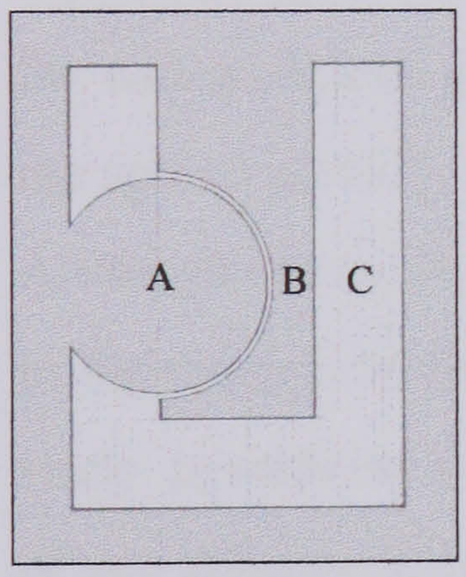


Fig. 76
Vertical cross-section drawing of Study No. 27.
A: Sphere intersecting the exterior and interior surfaces of the cylinder.
B: The sphere encroaching into the interior space of the original cylinder.
C: The plaster cylindrical form.

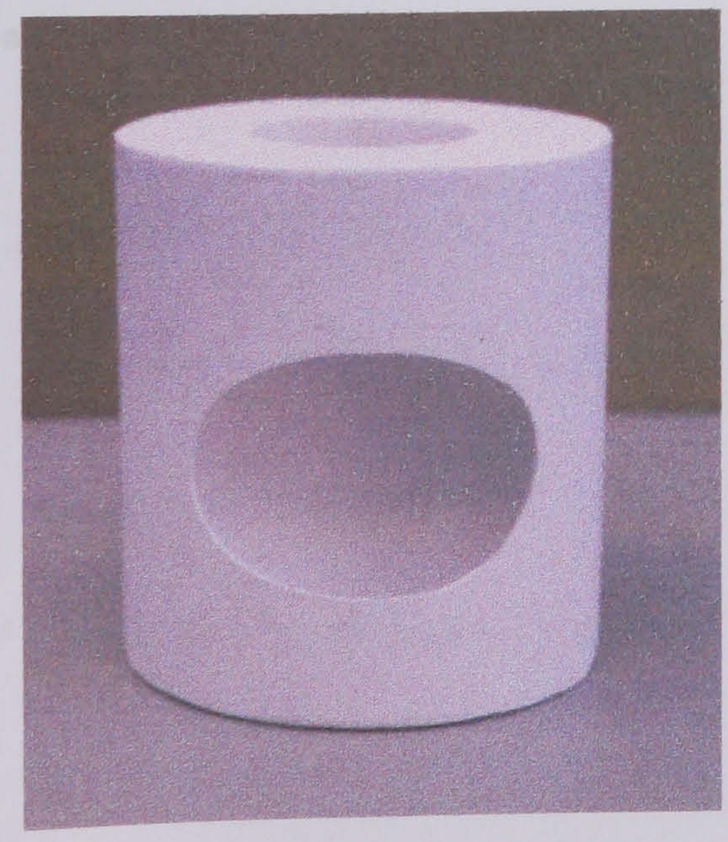


Fig. 77
Study No. 27
Plaster
H 20 cm, D 15 cm
Cylinder with two separate interiors.

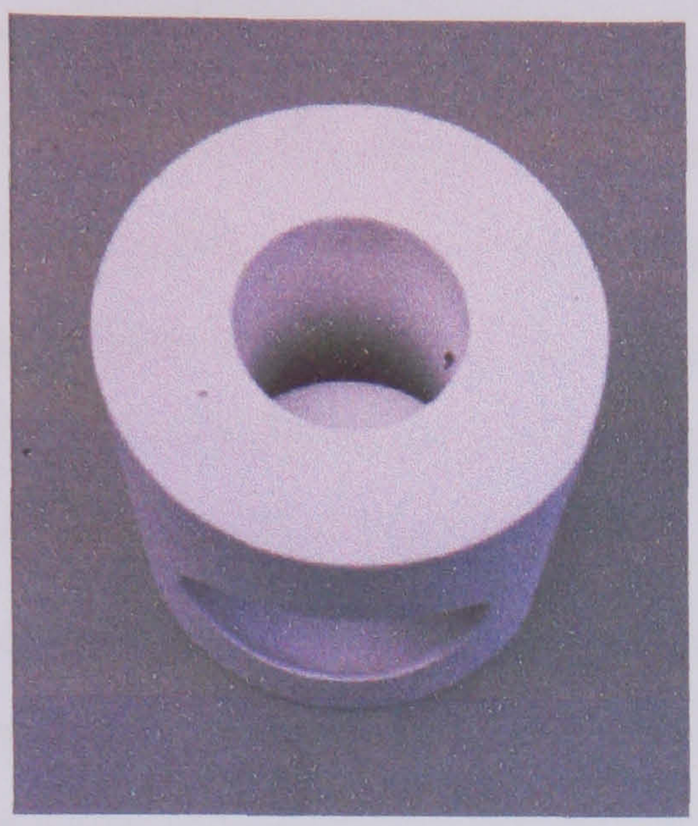


Fig. 78
Alternative view of
Study No. 27

Observations

The intersection of the sphere and the exterior surface created a hole that revealed the interior of the sphere rather than the interior of the cylinder walls. From the view looking into the sphere (Fig. 78), but also being able to see the wall thickness of the cylinder it was possible to deduce that the sphere exceeded the wall thickness and encroached into the interior of the cylinder. This placed the sphere partially in the wall of the cylinder and partially in its interior. Although the study, Figs. 77 and 78, did not disclose the interior within the walls of the cylinder it did create two separate interiors within the form. The next study, in addition to the intersection of the cylinder, investigated the intersection of two spheres. This approach was taken to increase the three-dimensionality of the composition.

Study No. 28

The aim of this study was to reveal the interior of the form through penetrations in the exterior surface of the vertical walls of the cylinder. In contrast to the previous three studies in this series, this cylinder was made without an open interior so that the interior was only revealed through the intersection of the exterior surface by the spheres. Two spheres were used to increase the three-dimensionality of the study. The form was made by coating two intersecting wax spheres, two thirds of the diameter of the cylinder, in plaster and these were placed within a cylindrical mould and cut so that they did not exceed the exterior, as shown in Figs 79. The form was cast and the wax was removed.

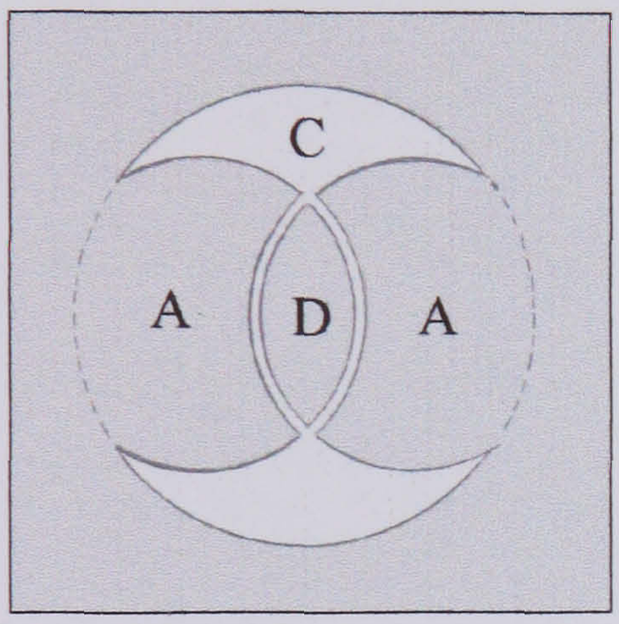


Fig. 79
Horizontal cross-section drawing of Study No. 28.
A: Two spheres intersecting the exterior and interior surfaces of the cylinder.
C: The plaster cylindrical form.
D: An enclosed interior within the spheres.

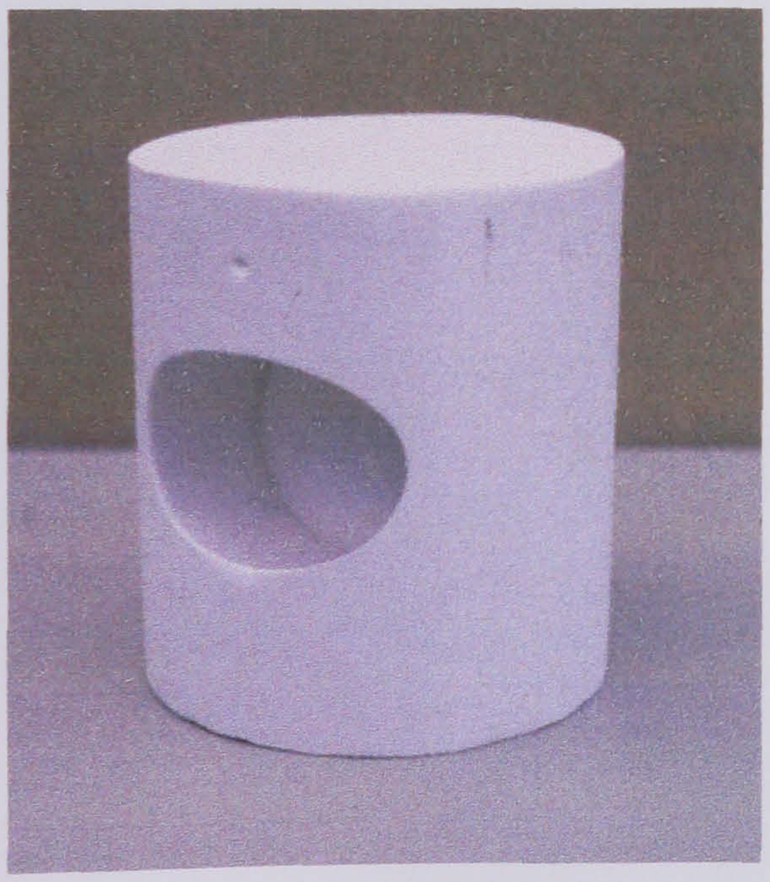


Fig. 80
Study No. 28
Plaster
H 20 cm, D 15 cm.
Two intersecting spheres within a cylinder.

Observations

The spherical intersections in the exterior surface did not read as a continuation of the exterior surface, which had also been the case with previous studies in the series. The reasons for this were identified as the sharp edge of the intersection between the sphere and the cylinder and the change of angle between the exterior of the cylinder and the sphere.

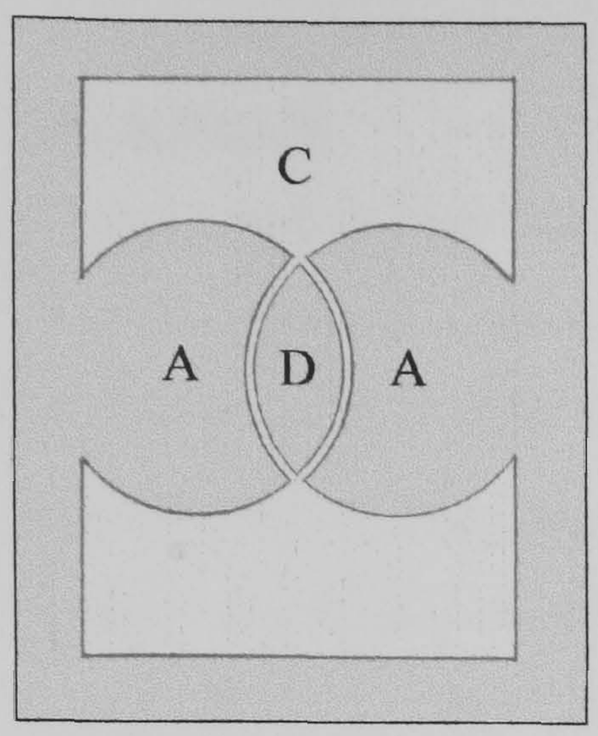


Fig. 81
Vertical cross-section drawing of Study No. 28.
A: Two spheres intersecting the exterior and interior surfaces of the cylinder.
C: The plaster cylindrical form.
D: An enclosed interior within the spheres.

Study No. 28, Fig. 80 created three interior spaces, which were separated by the interior surfaces of the form, two open and one closed. [34] To see the open interiors a change of viewpoint was needed, which did result in a more three-dimensional aspect to the form than the previous study, Fig. 77. However, the main interest in the study was that an enclosed interior had been created, shown as 'D' in Fig. 81. This enclosed space referenced the enclosed interior in the radiograph in Fig. 65, which had initiated the series. Unfortunately this interior was only obvious in the cross-section drawing, Fig. 81 and, therefore, although noted, was not pursued until later in the investigations. Instead, the next study reconsidered how to reveal an interior within the walls of the cylinder, as seen in the radiograph, Fig. 65.

Study No. 29

The aim in this study was to expose the ordinarily hidden interior within the cylinder surfaces. I attempted to emphasise this by keeping the interior surface in its original state, whilst cutting into the exterior surface, shown as area 'A' in Figs 82 and 83. The form was made by cutting a wax sphere to fit between an outer cylindrical mould and a smaller inner one, shown as 'A' in Fig. 82. Plaster was poured into the mould and around the wax forms and when it was set the wax was removed.

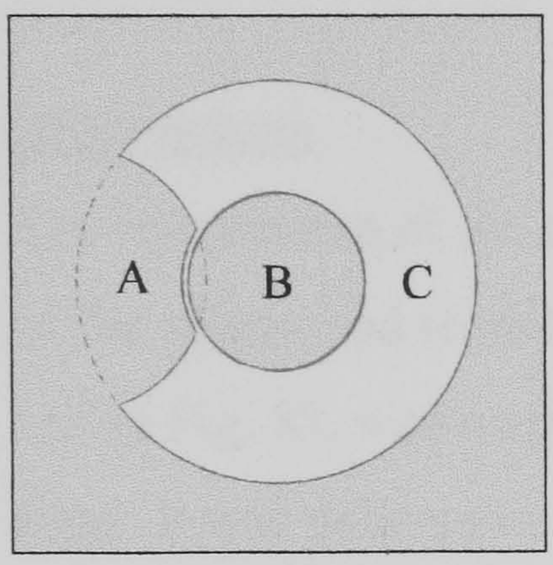


Fig. 82
Horizontal cross-section drawing of Study No. 29.
A: Space where the wax sphere had been removed.
B: The interior space of the original cylinder.
C: The plaster cylindrical form.

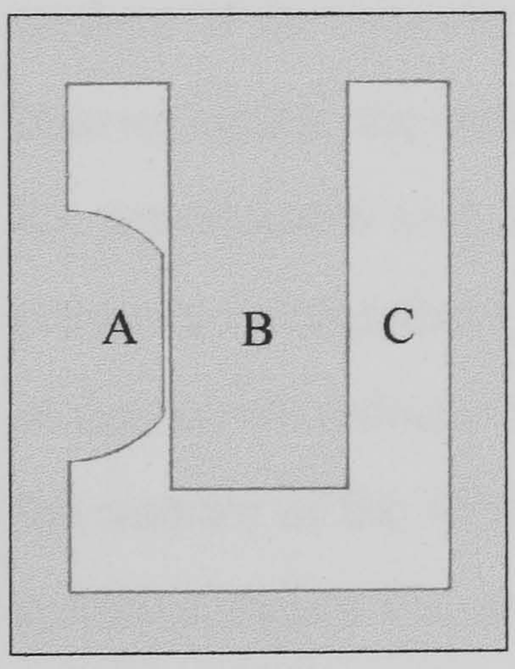


Fig. 83
Vertical cross-section drawing of Study No. 29.
A: A sphere intersecting the exterior but not the interior surfaces of the cylinder.
B: The interior space of the original cylinder.
C: The plaster cylindrical form.

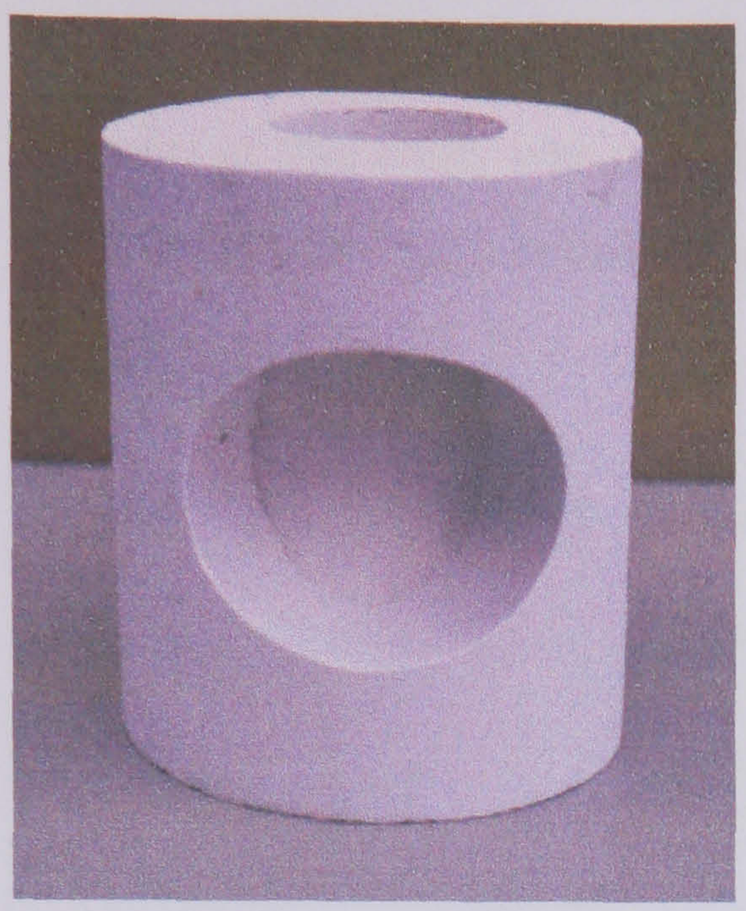


Fig. 84
Study No. 29
Plaster
H 20 cm, D 15 cm
Interior wall visible after wax sphere removed.

Observations

The intersection of the exterior surface was made by the removal of the section of the sphere and revealed the inside surface of the cylinder. This area, marked 'A' in Fig. 83, was neither clearly part of the exterior or on the interior of the form. It was delineated from the exterior by the curved edge of the exterior surface and it was not connected to the interior because of the visible interior surface of the cylinder. The aim of the study, Fig, 84 had been to reveal the interior within the walls of the material. The space revealed, shown as 'A' in Fig. 83, was shallow and, therefore, lighter and was less clearly an interior than previous intersections, such as in *Study, No. 25*, Fig 71. The next and final study in this series reduced the size of the hole by moving the sphere further towards the interior of the form. The reason for this was to attempt to emphasise that the spherical space was an interior contained within the surfaces of the cylinder.

Study No. 30

The aim of this study was to reduce the hole or aperture in the exterior surface so that a spherical space could be seen but which retained the identity of an interior, as shown in Fig. 85. [35]

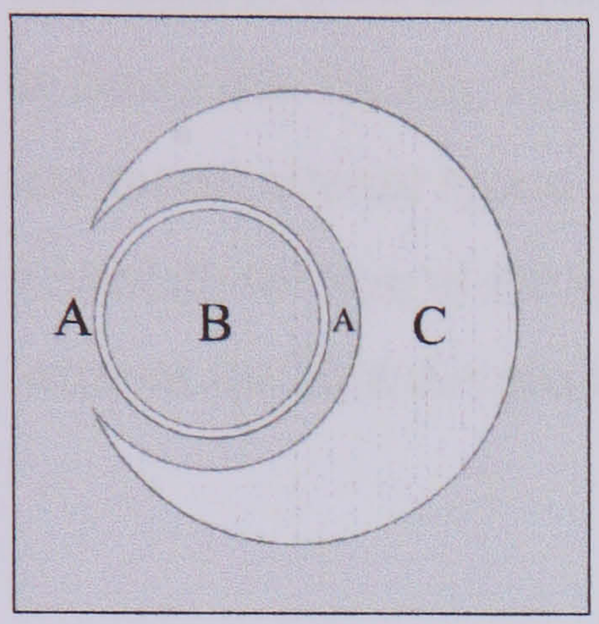


Fig. 85
Horizontal cross-section drawing of Study No. 30.
A: Space where the wax sphere was removed.
B: The interior space of the original cylinder.
C: The plaster cylindrical form.

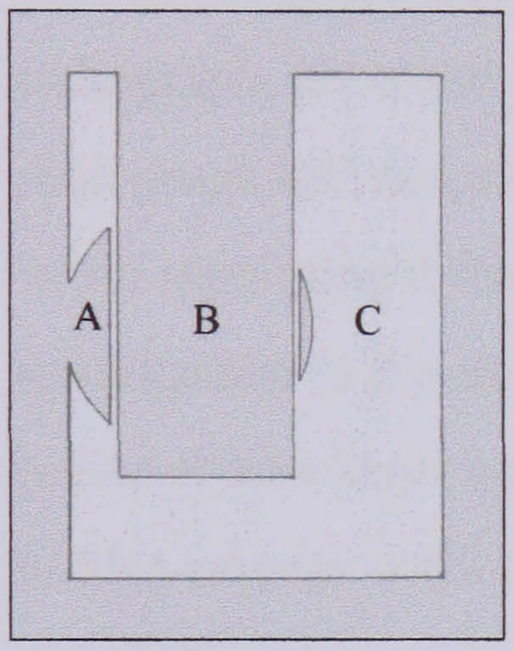


Fig. 86
Vertical cross-section drawing of Study No. 30.
A: Space where the wax sphere was removed.
B: The interior space of the original cylinder.
C: The plaster cylindrical form.

Fig. 87
Study No. 30
Plaster
H 20 cm, D 15 cm
Interior space created by a sphere between the surfaces of the cylinder. The form had two separate interiors.

Observations

As shown in Fig. 87, because the sphere was placed further towards the centre of the cylinder, the intersection of the sphere and the exterior surface produced a smaller hole. This smaller hole, shown as 'A' in Fig. 86, revealed the surface of the smaller cylinder and space. Through the sharp edge of the hole, the

positioning of the smaller cylinder and the dark areas at the side of the smaller cylinder, an interior had been created within the form, shown as 'A' in Fig 85. The revealed interior space appeared to be between the surfaces of the cylinder due to the inclusion of the smaller cylinder. The smaller cylinder also separated this interior from the open interior, shown as 'B' in Fig. 86. This was in contrast to *Study No. 25*, Fig. 71, which did not include the smaller interior cylinder but did reveal interior space. Although the interior between the walls was now revealed, the size of the aperture in relation to the whole form, suggested that without the hole this space would have remained hidden from view.

This series of six studies had been initiated by the hidden interior in the radiograph, shown in Fig. 65 and repeated in Fig. 88. As previously noted, the radiograph had revealed an interior space within the surfaces of the cylinder while separating it from the other interior by the interior wall. Earlier in the introduction to the studio diary I had expressed an inclination to explore the in-between area between the interior and exterior of form and the revelation of the hidden interior within the walls of a form had provided this opportunity. Of the six studies, this study, shown in Fig. 87, was the closest to achieving a suggestion of an interior within the surfaces of a form.

<u>Conclusions of Section Two</u>

The radiograph, shown in Fig. 65, revealed an otherwise hidden interior that was within the walls of a form. *Studies Nos. 25- 30* explored this interior within the walls of a form through investigations involving Category C of the taxonomy: the use of holes, penetrations and openings. The last of these, *Study No. 30*, Fig. 87, was similar to the radiograph in that the form had two interiors, one open and the other hidden. The hidden interior was revealed through a penetration of the exterior surface, but it would still have been present if it had not been revealed in this way. Within the context of the research to date, therefore, the term 'interior' was either an area or surface within a form and could be either revealed or concealed.

A distinction between the exterior and the interior had been necessary in *Studies Nos. 25-30* to investigate the hidden interior within the surfaces of the form and understand the interior. It had also been established, in *Study No. 30*, Fig. 87 that the distinction between the interior and exterior was due to the sharp edges of the exterior surface and a small hole creating shadow within the form. I had succeeded in creating an interior that was distinct from the exterior, which enabled me to define 'interior' within the research, but through this distinction, I had lost the interchange between interior and exterior that had been present in earlier studies, such as, *No. 23*, Fig. 53. In this earlier study ambiguity had been introduced through the exterior surface curving inwards and becoming part of the interior surface. This interchange was also found in the Möbius strip. Having realised that I could not achieve the simultaneous exposure of the interior and exterior whilst they remained distinct I re-examined the studies, looking for a possible solution.

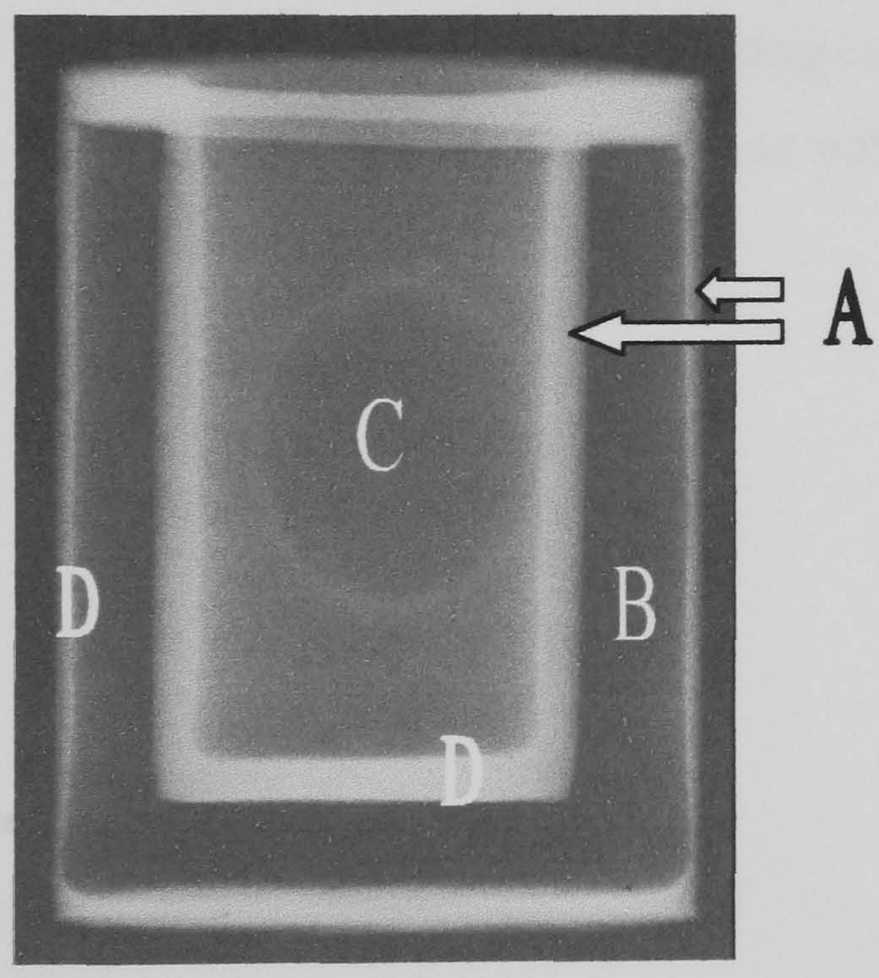


Fig. 88
Key to Study No. 24
A: The white lines created by the superimposition of the depth of the material.
B: The contained interior space between the wall of the cylinder and usually hidden in an opaque form.
C: The interior of the cylinder, which is open.
D: The surfaces of the cylinders, which is seen as a continuous line in the radiograph, the continuity being given emphasis by the rounded corners.

On re-examination of the radiograph, Fig. 65 and repeated in Fig. 88, I realised that not only did the image appear to be in cross-section, but that by reducing a form into a flat image form became line. Once I recognised the importance of the lines in the image I began to understand a connection between the interior and exterior. Due to the space between the interior and exterior surface, shown as 'B' in Fig. 88, the same line could be traced from the outside to the inside and back again. The second important point about the line, shown as 'D' in Fig. 88, was the radiograph appeared to radius all the corners and these curved corners

emphasised the appearance of a single continuous line travelling around the form. Through the x-ray this form had a direct relationship with the Möbius strip. Although the form was three-dimensional and made of an opaque material, the radiograph produced a continuous line, which moved from the exterior to the interior. This continuous line and the curved corners were in contrast to the study before it was x-rayed, as shown in Fig. 64, where the interior and the exterior were delineated by sharp edges. The radiograph, Figs 65 and 88, therefore, was a good example of the simultaneous exposure of interior and the exterior but in two-dimensions.

X-ray technology enabled me to see an opaque, three-dimensional form in a different way and the originality of the image led to a breakthrough in the research. Besides the significance of exposing the interior without cutting into the form and the information this radiograph revealed: it was the aesthetic the image itself that suggested a possible way to connect the interior and exterior. The next section investigated using curved edges to imply a continuous exterior surface and an interior or interiors within that surface.

STUDIO DIARY – Section Three

As stated in the introduction, the objective of this research was to explore the apparent opposition between interior and exterior surfaces in sculpture and attempt to expose them simultaneously. For their simultaneous exposure there had to be equilibrium between interior and exterior so that neither was dominant. While the exterior had been defined as 'exterior surface or boundary', the definition of interior was more complex. Interior could be a surface within a form that could be revealed or hidden or an area within a form that could be revealed or hidden. However, in the studies the exterior often included parts of the displaced interior, such as in *Study No. 23*, Fig 54 and 89. This immediately gave rise to an ambiguity between interior and exterior where it became impossible to define the exact point at which interior became exterior, and vice versa, in the sculpture. This ambiguity was subsequently given increased emphasis in the radiograph, which suggested the possibilities of a continuous line, leading to a continuous surface. This could be seen in Fig. 65, where the line became gently curved at every corner and the transition from one plane to another became smooth. The ambiguity between interior and exterior gained prominence in *Study No. 23*, Fig. 54, because of the circular configuration of the sculpture caused a smooth transition from interior to exterior in the vertical plane. This smooth transition that was at odds with *Study No. 30*, Fig. 87, where a sharp contrast between interior and exterior was emphasised.

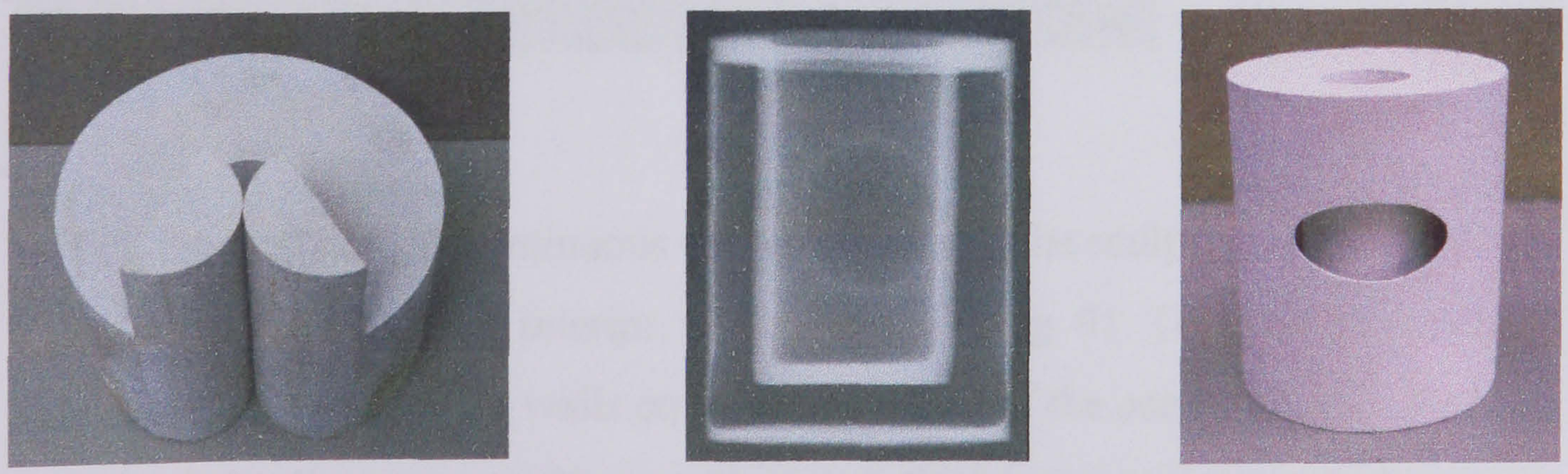


Fig 89
Study No. 23 (repeated from Fig. 54)
Study No. 24 (repeated from Figs 65 and 88)
Study No. 30 (repeated from Fig. 87)

On the basis of the previous studies, research in this section, therefore, became increasingly focused on two issues. The first concerned the need for an apparent equilibrium between interior and exterior along at least one of the main axes of the sculpture. The second concerned the ambiguities that existed in that region of the sculpture where interior became exterior.

No. 31. Continuous Surface

I aimed in this sculpture, Fig. 90, to concentrate on the transition of the exterior to the interior, (Category B(ii) of the taxonomy) by making a cylindrical form with curved edges that implied a continuous surface. [36] The cylindrical form was open at one end to reveal an interior, shown as 'B' in Fig. 91, and closed at the other to retain a cylinder as the basis for the sculpture.

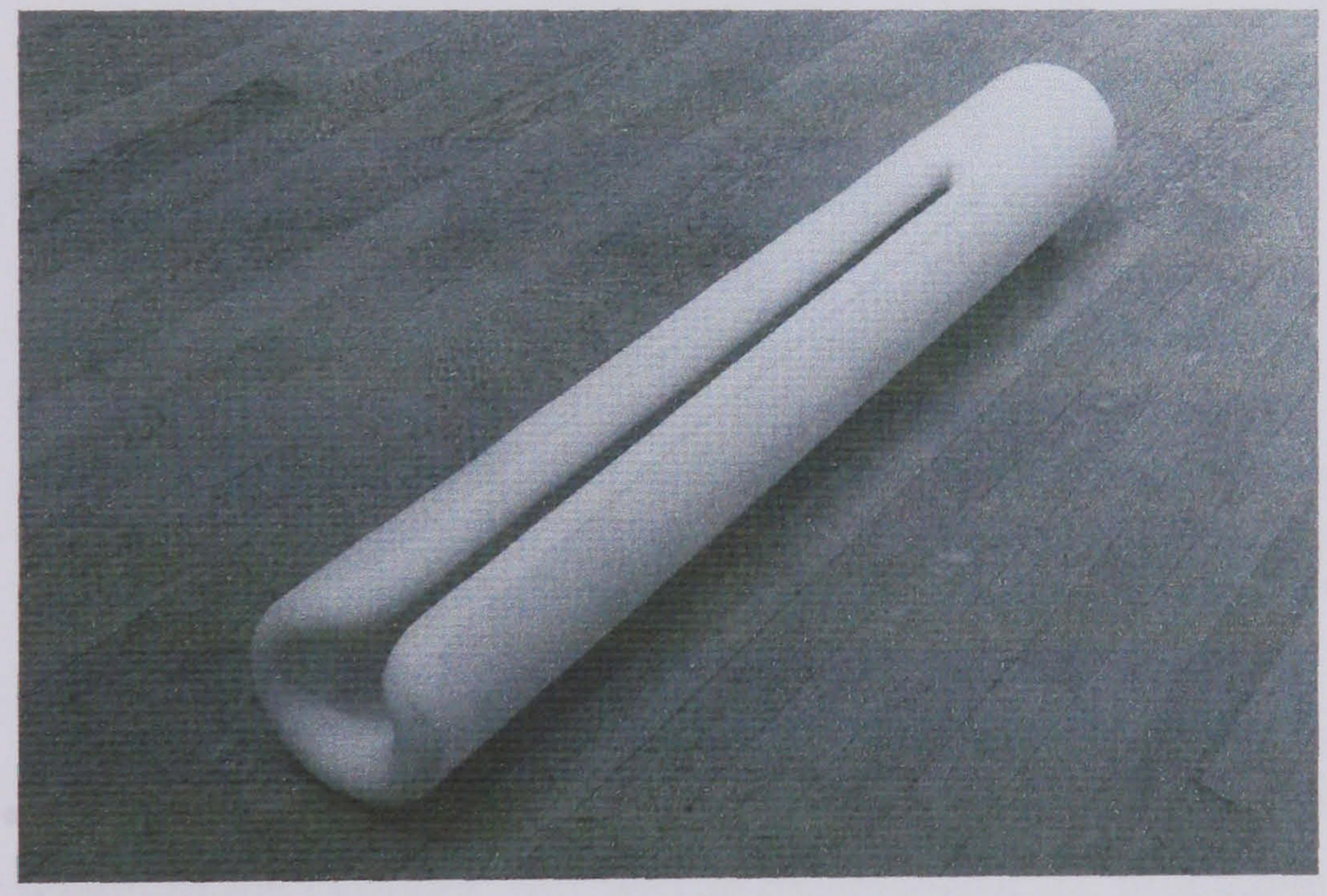


Fig. 90
No. 31.
Continuous Surface
Feb. 1999
Plaster and Jesmonite
H 20 x L 100 x W 20 cm
A form with curved edges to infer a continuous surface.

Within the walls of the continuous curved surface of the sculpture, I intended to imply a contained, hidden interior, shown as 'C' in Fig. 91. To make this evident, the combined width of the walls equalled the width of the central interior they contained. Its diameter was 20 cm and its wall thickness was 5 cm, which resulted in the form having a ratio of wall thickness to interior space of 1:2:1.

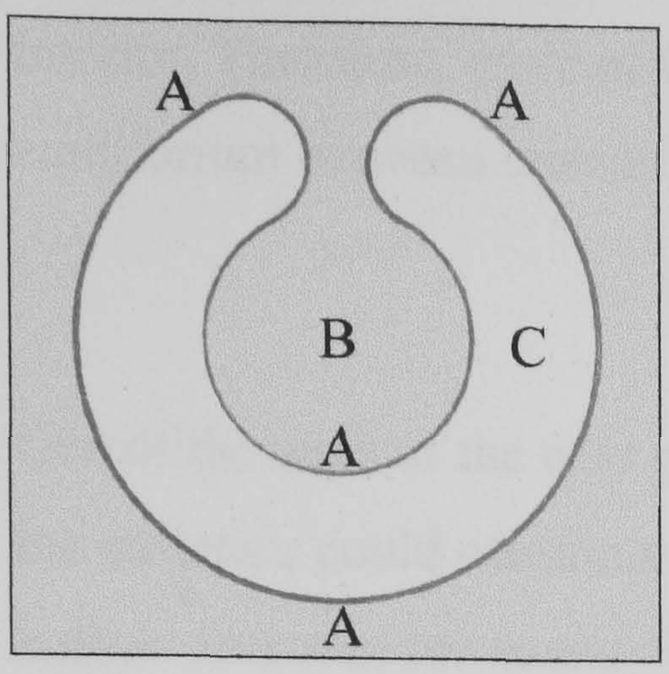


Fig. 91
Vertical cross-section drawing of Sculpture No. 31, Continuous Surface
A: The continuous surface travelling from the exterior to the interior and back to the exterior.
B: The interior space within the form.
C: The concealed interior within the form.

Observations

The curved edges at the end and along the opening of the cylindrical form enabled a gradual transition from the exterior to the interior, with the result that the surface appeared continuous. It was, therefore, difficult, if not impossible to point to a line or edge where the surface, shown as 'A' in Fig. 91, changed from exterior to interior. By curving the edges, light and shadow, which would have emphasised the edge became more diffused, the gradations from reflection to shadow had a subtlety that was not evident in the previous studies. [37]

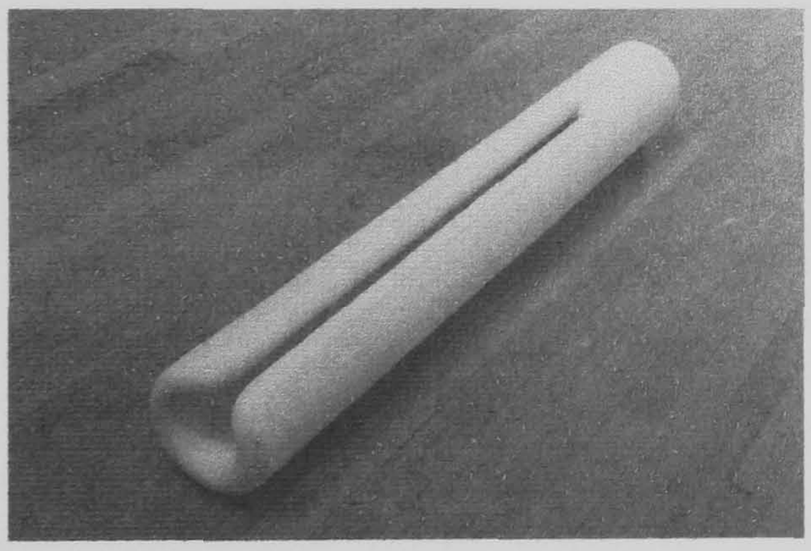


Fig. 92 (repeat of Fig. 90)
No. 31.
Continuous Surface
Feb. 1999
Plaster and Jesmonite
H 20 x L 100 x W 20 cm
A form with curved edges to infer a continuous surface.

The interior space, 'B' in Fig. 91, was revealed through the opening along the length of the cylinder: this was an extension of the procedure in the previous study, *No. 30*, Fig. 87. The difference between the two was in this latest sculpture (Fig. 90 and 92), there was an ambiguity between the interior and the exterior, whereas in the previous study, the opening had assisted their differentiation. Without the distinction created by edge it was possible to read the surface as one, irrespective of it being on the outside or the inside of the sculpture. As mentioned earlier, the walls of the sculpture, shown in Fig 92, were made half the width of the interior space in an attempt to imply a hidden interior within the walls. This caused attention to be drawn to the surfaces, but not specifically to the hidden

interior. Therefore, more of the interior needed to be seen if there was to be equilibrium between interior and exterior.

One of the aims of the next piece was to make a hollow sculpture to show that the structure could contain a concealed interior. (If one taps the surface of a hollow structure the sound it produces indicates a contained space within.) Plaster had been the predominant material used to date but when cast in thin sheets it became very fragile. In order to further the research by the reintroduction of planar materials and hollow forms, an acrylic composite, Jesmonite was used. [38]

No. 32. Inverted Cylinder

The aim of this sculpture was to reveal more of the interior than in the previous one. Meanwhile, transposition of the exterior to interior depended on achieving a coherent continuous surface. I also aimed to imply a concealed interior within the surfaces of the form by making the sculpture hollow and increasing the width of the walls to 10 cm. The total width was 40 cm, which resulted in the walls making up half the width of the form. [39] The increase in wall width also resulted in the hidden interior and the visible interior space being the same diameter, shown in Fig. 95 and as 'B' in Fig. 93. This was an attempt to give the hidden and revealed interiors, 'B' and 'C', equal significance within the sculpture.

In the planning stage a cylinder the same length and width as *No. 31, Continuous Surface* was used. The composition attempted to imply that the original cylinder had been folded back on itself at 'D' in Fig. 93. I prefabricated the parts using plastic tubes and modelled clay sections and these were cast to make a hollow form.

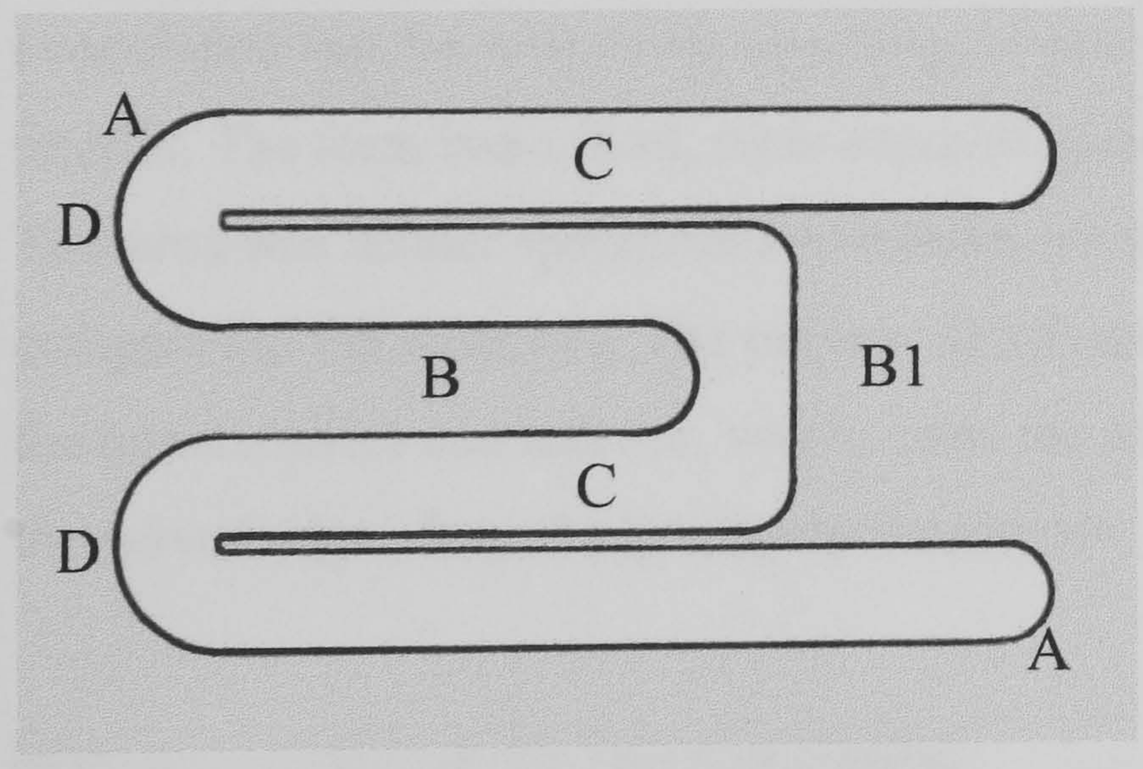


Fig. 93
Cross-section drawing of No. 32, Inverted Cylinder.
A: The continuous surface.
B: An interior space within the form.
B1: A second interior space within the form.
C: The concealed interior within the form.
D: The curves that implied the folding back of the cylinder walls.

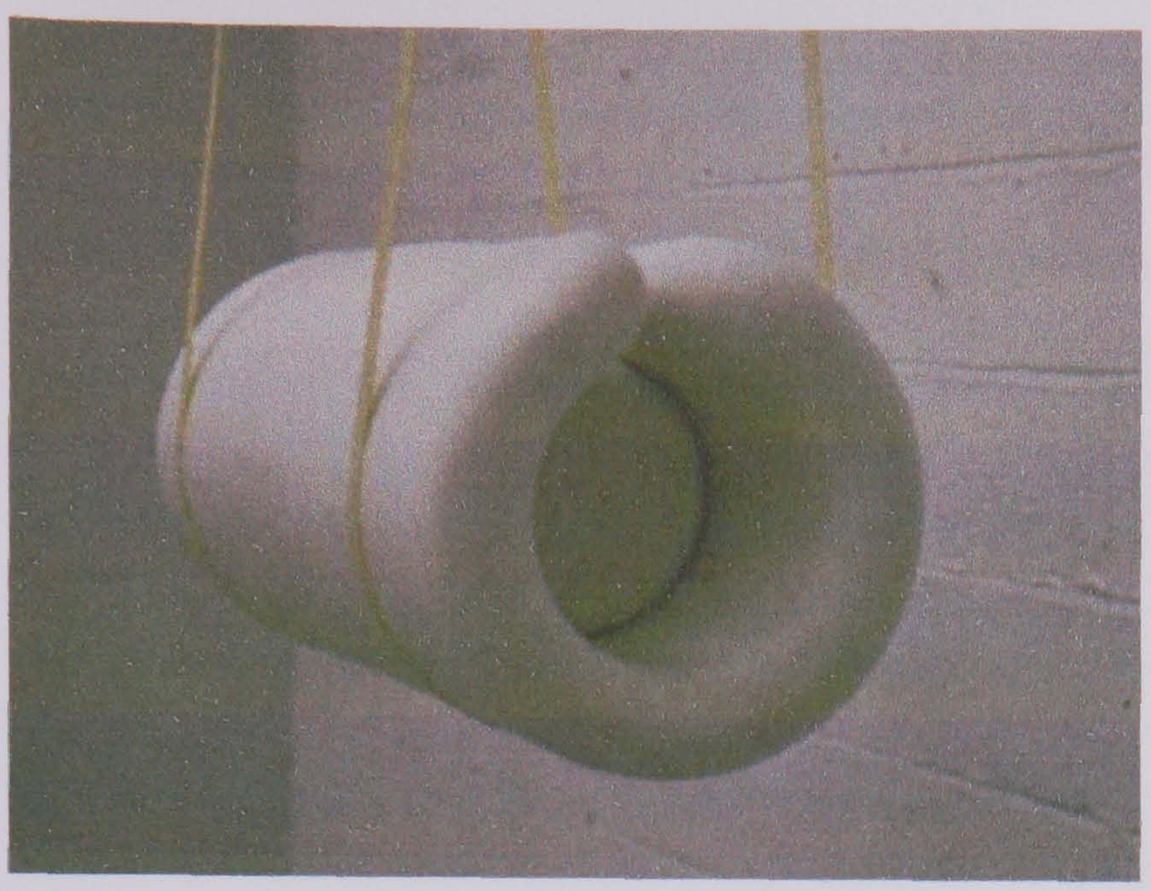


Fig. 94
No. 32, Inverted Cylinder
March/April 1999
Jesmonite.
H 40 x L 100 x W 40 cm
Wall thickness 10 cm
A cylinder implying it had been folded back on itself to show a continuous surface.

Observations

At the area where it was implied that the cylinder folded back on itself the wall width doubled and curved. This increased the implication of the surface continuing from the interior to the exterior, as shown as 'D' in Fig. 93. The suggestion of a continuous surface was more successful here than elsewhere in the form because the curve was more gradual.

I concluded that the wall width equalling the interior space 'B' implied a hidden interior. The form had a third, more exposed space, shown, as 'B1' in Fig. 93. This area was neither specifically an interior nor an exterior space when compared to the other two. The purpose of this area, in addition to it questioning the terms interior and exterior, was to show the same surface continuing around the curved edges from the exterior to the interior.

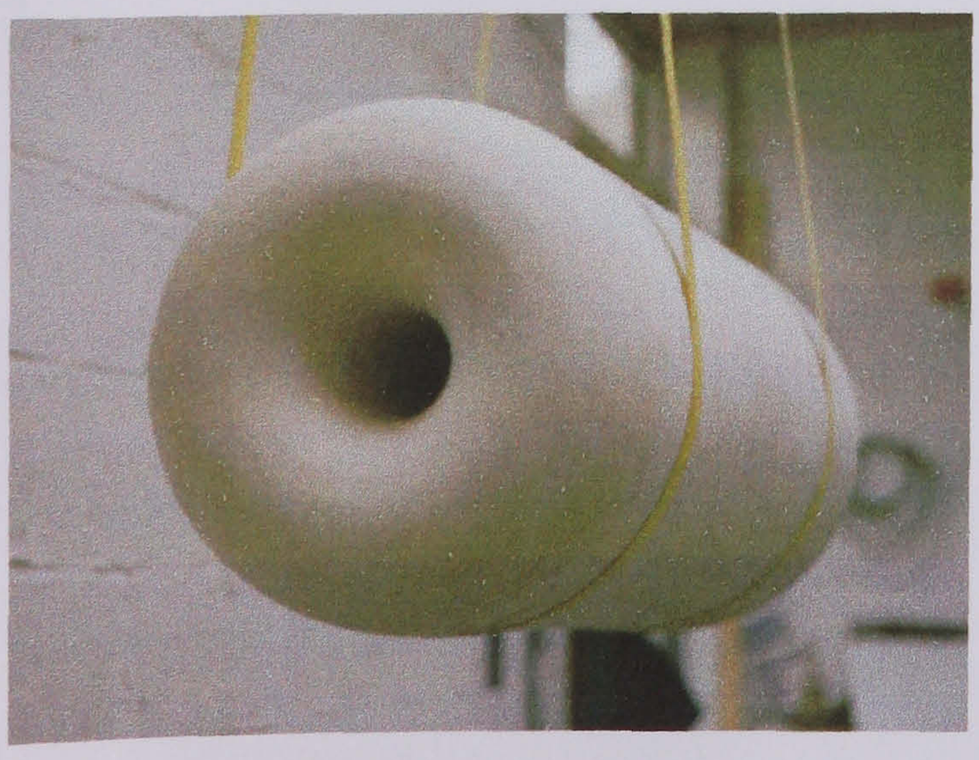


Fig. 95
No. 32, Inverted Cylinder
March/April 1999
Jesmonite.
H 40 x L100 x W 40 cm
Alternative view

Showing this sculpture at an appropriate height was difficult, because I wanted the entire exterior surface to be seen to continue to the interior. If it had been placed on a plinth or the floor it would have been partially covered, and, therefore this continuity would have diminished because contact with another surface would interrupt the geometry of the sculpture. The solution was to hang it at head height by straps.

The important result of this sculpture was learning that through folding back the material an interior surface became an exterior surface. Unfortunately the suggestion of the cylinder being folded back was not immediately clear: due to the compact nature of the interior. Consequently, I decided that the composition needed to be opened out and less compressed, so that the folding back of a continuous surface was evident. My intention, therefore, in the next sculpture was to introduce space into the form so that a continuous surface became a more significant sculptural element.

No. 33. Simply Connected [40]

As previously stated, to simultaneously expose the interior and the exterior of a form, there should be equilibrium between the interior and exterior so that neither was dominant. I aimed, in the sculpture, to investigate this statement in four ways. Firstly, by making a sculpture in which an interior part of the form projected beyond the exterior and, therefore, became exterior. [41] The interior and exterior surfaces would be connected and allowed the possibility of interchange between the two. Secondly, by attempting to make a form in which a cylinder was folded back on itself so that the interior surface became an exterior surface and vice versa. Thirdly, by using a curved continuous surface to create a less specific region where the exterior became the interior and vice versa. Fourthly, by making a form with multiple interiors, both seen and concealed. This aim, again, attempted to redress the balance between a dominant exterior and the less exposed interior.

The form of the sculpture was based on the previous, *No. 32, Inverted Cylinder*, as shown in Figs 94 and 95. However, in this sculpture, space was introduced between the inner and outer cylinder to increase the implication that the cylinder had been folded back on itself. This space is shown as 'F' in Fig. 96. This introduction of space also assisted in simultaneously exposing the interior and exterior as all the surfaces could be seen assisting in the appearance of a continuous surface. It also created another interior within the form.

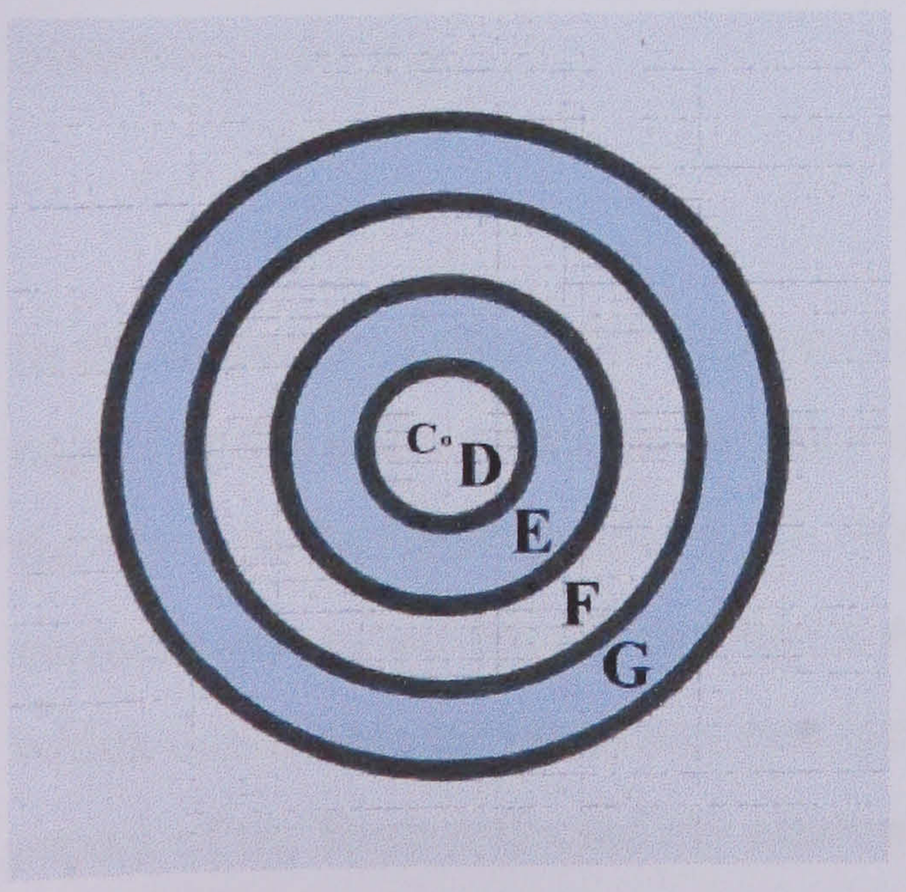


Fig. 96
Vertical cross-section drawing of No. 33: Simply Connected
C: Centre of rotation within the form.
D: Central interior space within the form.
E and **G**: Concealed interior space within the walls of the material.
F: A second revealed interior space.

The proportions of the form were carefully considered and related specifically to the space incorporated within the sculpture when seen from the view shown in Fig. 97. The central space, 'D' was the same diameter, 30 cm, as the combined width of the walls of 'E' in Fig. 96, which created the inner cylinder. Apart from the central space, there was a second space, shown as 'F'' (mentioned in the previous paragraph). This space was the same width as the wall thickness of the cylindrical forms (15 cm). This made the concealed interior space within the walls of the cylinder the same width as the visible space, 'F', in an attempt to create equality between the seen and unseen space.

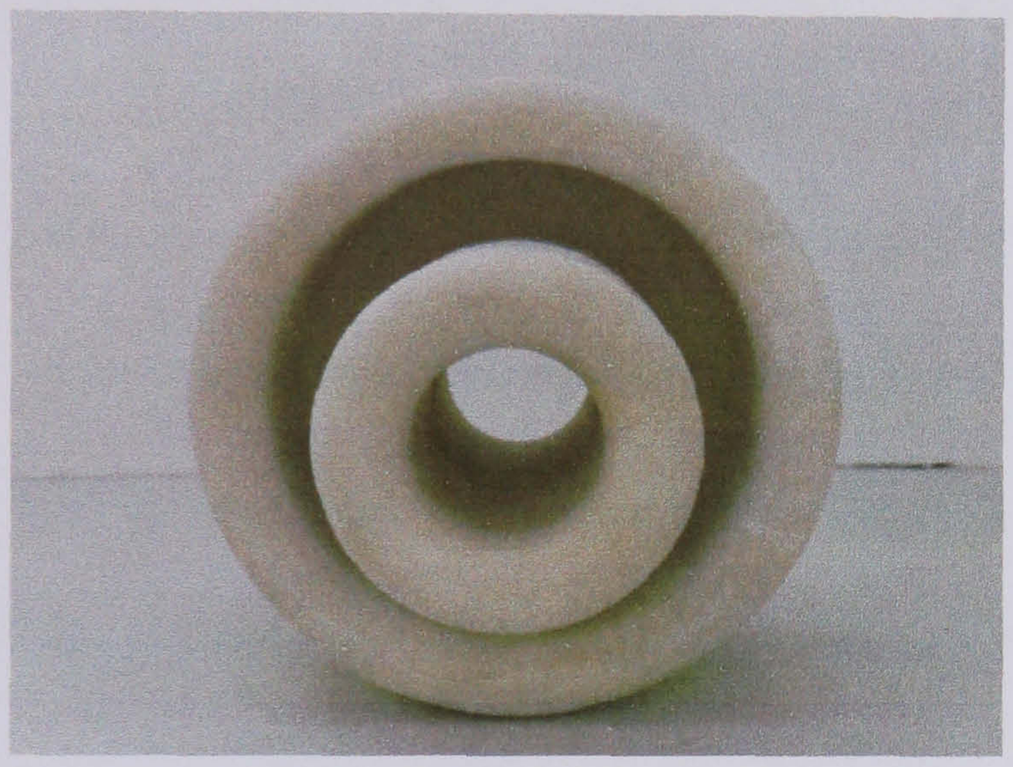


Fig. 97
No. 33. Simply Connected
May/June 1999
Jesmonite
H 120 x L 135 x W 120 cm
'Front' view
A form with a continuous surface, two revealed interiors and a concealed one between the walls of the material.

Observations

This sculpture had very significant results for the research. At the beginning of the research I had not anticipated being able to achieve the simultaneous exposure of the interior and exterior of form in a sculpture. However, through the introduction of a continuous surface, ambiguity and equilibrium, it was now becoming possible.

In the majority of the earlier studies the area concerned with simultaneously exposing the interior and the exterior had been limited to a particular portion of the form. In for example, *Study No. 30*, shown in Fig. 87, the interior between the surfaces was revealed only through a small hole cut into the exterior surface, which could only be seen from one viewpoint. However, in this sculpture every aspect of the form reflected my attempts to simultaneously expose the interior and the exterior. By this I do not mean that every view in this sculpture

demonstrated equilibrium, but rather that the combined viewpoints added together to make a cohesive whole. The viewpoints that displayed equilibrium were the 'side' and 'front', where the main axis of the sculpture could be seen, shown in Figs 98 and 97 respectively. The 'back' view, as shown in Fig. 99, did not display equilibrium to the same extent, but was still concerned with transposing interior to exterior.

I had found it necessary in the previous sculpture, *No. 32*, as shown in Figs 94 and 95, to suspend the form to avoid the loss of continuity of the surfaces. In this sculpture, due to the increase in size and the introduction of the space shown as 'F' in Fig. 96, I realised that the inner cylinder of the form already appeared to be suspended and sufficiently revealed all the connected surfaces. [42] The second difference between this sculpture and the previous one, *No. 32*, Figs 94 and 95, was that the starting point for *Simply Connected* was a cylinder that was open at both ends. This created a central space, shown as 'D' in Fig. 96. The space 'D' encompassed the centre of rotation, shown as 'C' in Fig. 96, which emphasised it as the interior of the form, even though as a hole it was less contained than the other visible space in the form, shown as 'F'. From the 'back' view shown in Fig. 99, it was only the central interior space with its enveloping exterior that was visible. My intention was that the viewer would interpret this dominating exterior expanse as a splayed out continuation of that interior.

From a 'side' view, shown partially in Fig. 98, the inner cylinder could be seen to project further than the outer cylinder. The surface of the inner cylinder, shown as 'E' in Fig. 96, therefore, was part interior and part exterior. The point at which interior became exterior became difficult to determine as the edges of the outside cylinder were curved. Therefore, in this sculpture, the points of transition between the visible interior and the exterior were the most ambiguous of any form made to date. The curved edges and the creation of space between the walls of the material resulted in a comprehensible continuous surface. With the visible interiors and exterior approaching simultaneous exposure I returned to explore

the hidden interior, first discovered in the radiograph in *Study No. 24*, as shown in Fig. 65.

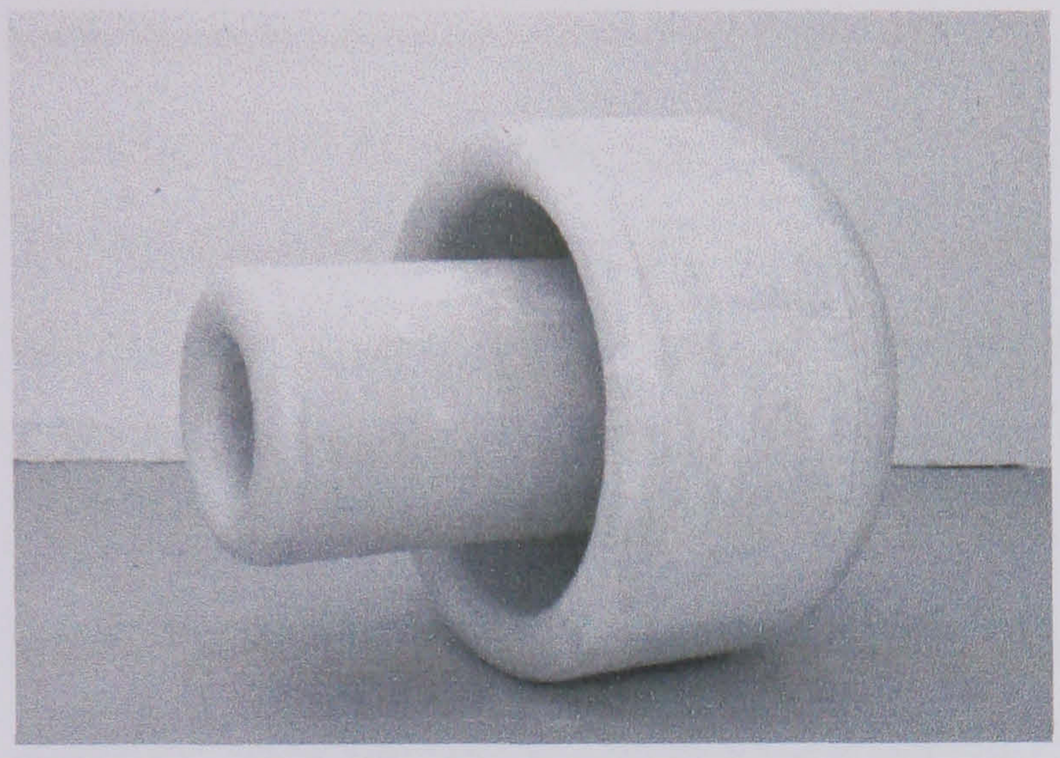


Fig. 98
No. 33. Simply Connected
Alternative view – partial 'side' view.
May/June 1999
Jesmonite
H 120 x L 135 x W 120 cm
View showing two visible interiors and one hidden between the walls of the material.

Fig. 99
No. 33. Simply Connected
View from the 'back' showing one interior.

Study No. 34

As a continuous surface had been used successfully in *No. 33, Simply Connected*, Figs 97-9, it was used in this study with the aim of investigating a 'hidden' interior. By using a continuous surface I aimed to be able to connect this interior with the exterior and avoid the differentiation between them that had been found in earlier studies, such as, *No. 30*, Fig. 87. I used a smaller, but similar, form to *No. 33, Simply Connected*, which had contained a 'hidden' interior with the intention of exposing it to show an interior within the walls of a form. To do this I removed a cake-slice section, shown as 'A' in Fig. 100. The material thickness, now exposed, was made half the thickness of the space between the walls to imply there was still an interior within the material. As before, the edges of the material were curved to emphasise a continuous surface. The cut edges where the section had been removed were rejoined at one side with a curved surface. Revealing the space only at one side of the cut section was an attempt to stress the space now disclosed had previously been on the interior of the material and also created a strong contrast between the two edges shown as 'B' in Fig. 100.

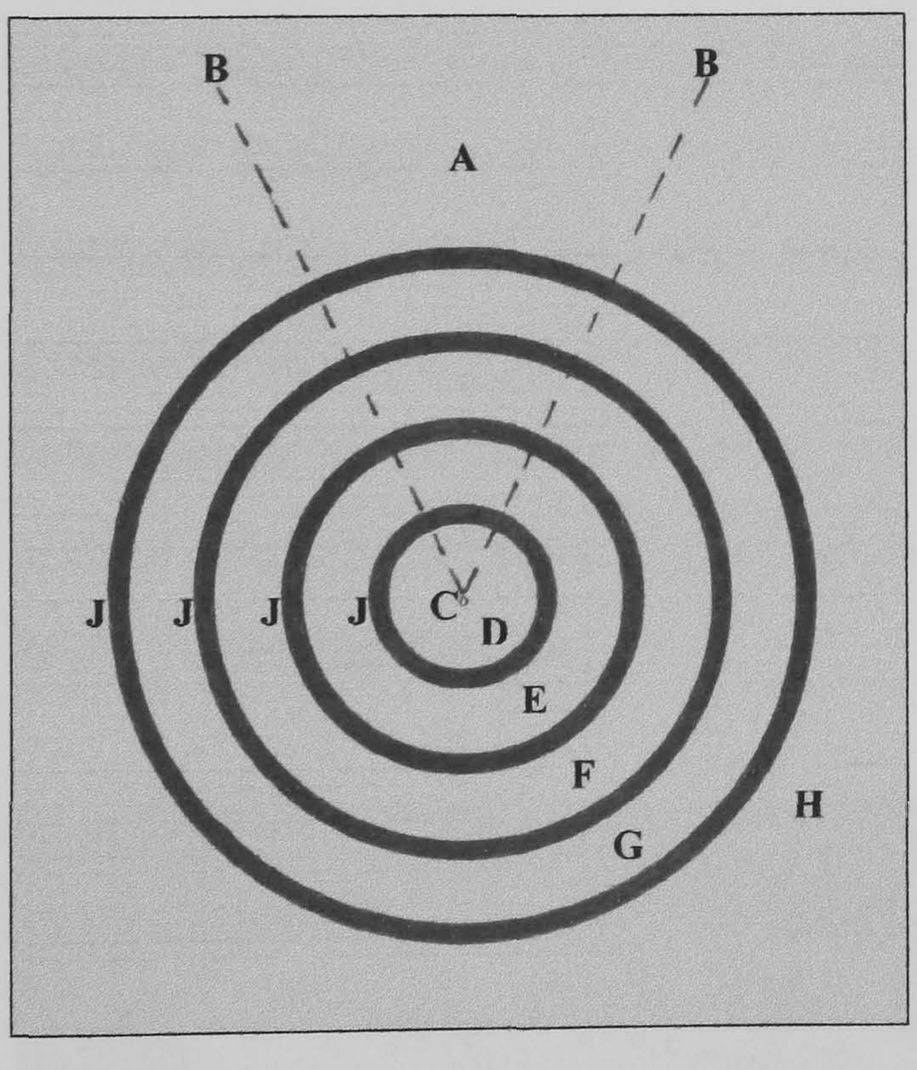


Fig. 100
Cross-section drawing of Study No. 34
A: Section removed from a form similar to the one used in *No. 33, Simply Connected.*
B: Cut marks, 50 degrees apart.
C: Centre point of rotational symmetry within the form.
D: Central interior space.
E and **G**: Interior space within the form, which became visible after the removal of section 'A'.
F: An interior space within the form.
H: The remaining section, which became the study.
J: The walls of the material, which had previously enclosed 'E' and 'G'.

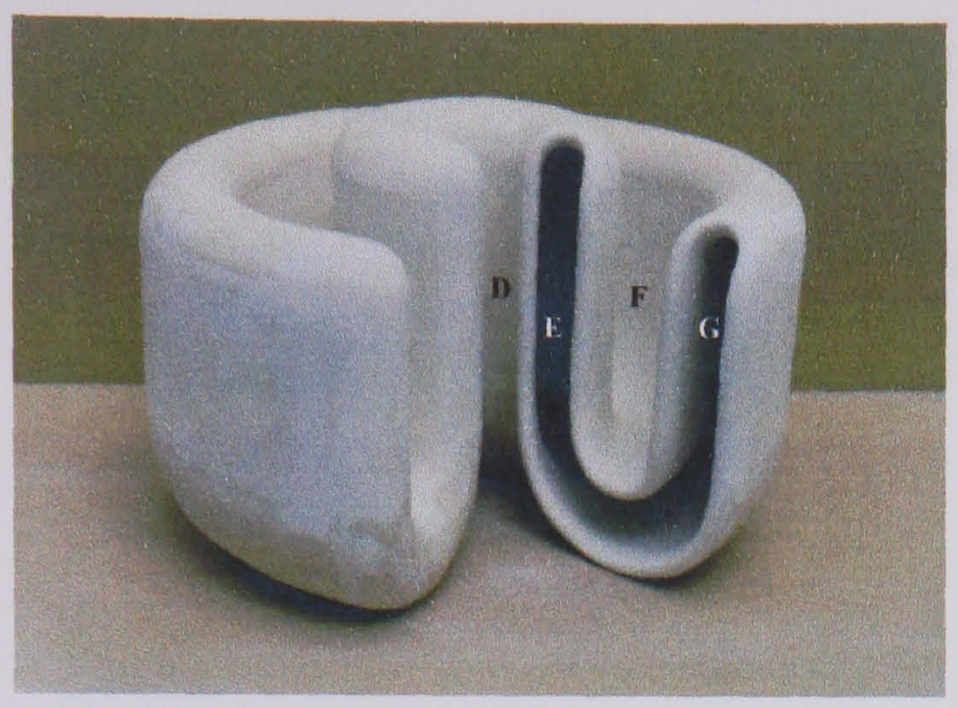


Fig. 101
Study No. 34
D: Central interior space.
E and **G**: Interior space within the form, which became visible after the removal of section 'A'.
F: An interior space within the form.

Observations

With this study I wanted to suggest that however many interiors were revealed there would still be a concealed interior within the walls of the material. By the removal of section 'A', shown in Fig. 100, an interior previously within the material was revealed. This space, shown as 'E' and 'G' in Fig. 101, was more enclosed than the other spaces in the composition, and therefore darker. However, in an effort to maintain the continuous curved edges of the form, at the point of the cut, the edges had to be set back, as shown in Fig. 101. I had also retained a curved surface at one side of the cut to increase the inference of the interior being revealed. Through the attempt to reveal the interior within the material, the right hand side of the study, Fig. 102 showed an incongruous relationship to the left hand side. This gave the study an appearance of a demonstration of a cross-section and therefore, a sense of being incomplete. What began, as the aim became the problem of the study: the removal of a symmetrical section from a symmetrical form inevitably led to a lack of integrity in the remaining portion.

Fig. 102
Study No. 34
August 1999
Jesmonite
20 x 20 x 30 cm

Although the study succeeded in revealing the interior within the walls of the material it was at the expense of the integrity of the form. The study was very obvious, having lost its subtlety. Also, the edge around the cut was too tightly curved to suggest a continuous surface to the same degree that was achieved in *Simply Connected*, Figs 97-99.

Study No. 35

The aim of this study was to investigate the effect of placing the centre point of a form on the exterior, shown as 'C' in Fig. 103ii. To do this I used the discarded section from the previous study. A cylindrical form had been used in the majority of the studies and sculptures to date and the centre of rotation had been within the form. The centre point had been used in the later studies of Section One, such as in *Study No. 23*, Fig 54, as a reference point of the interior of a form.

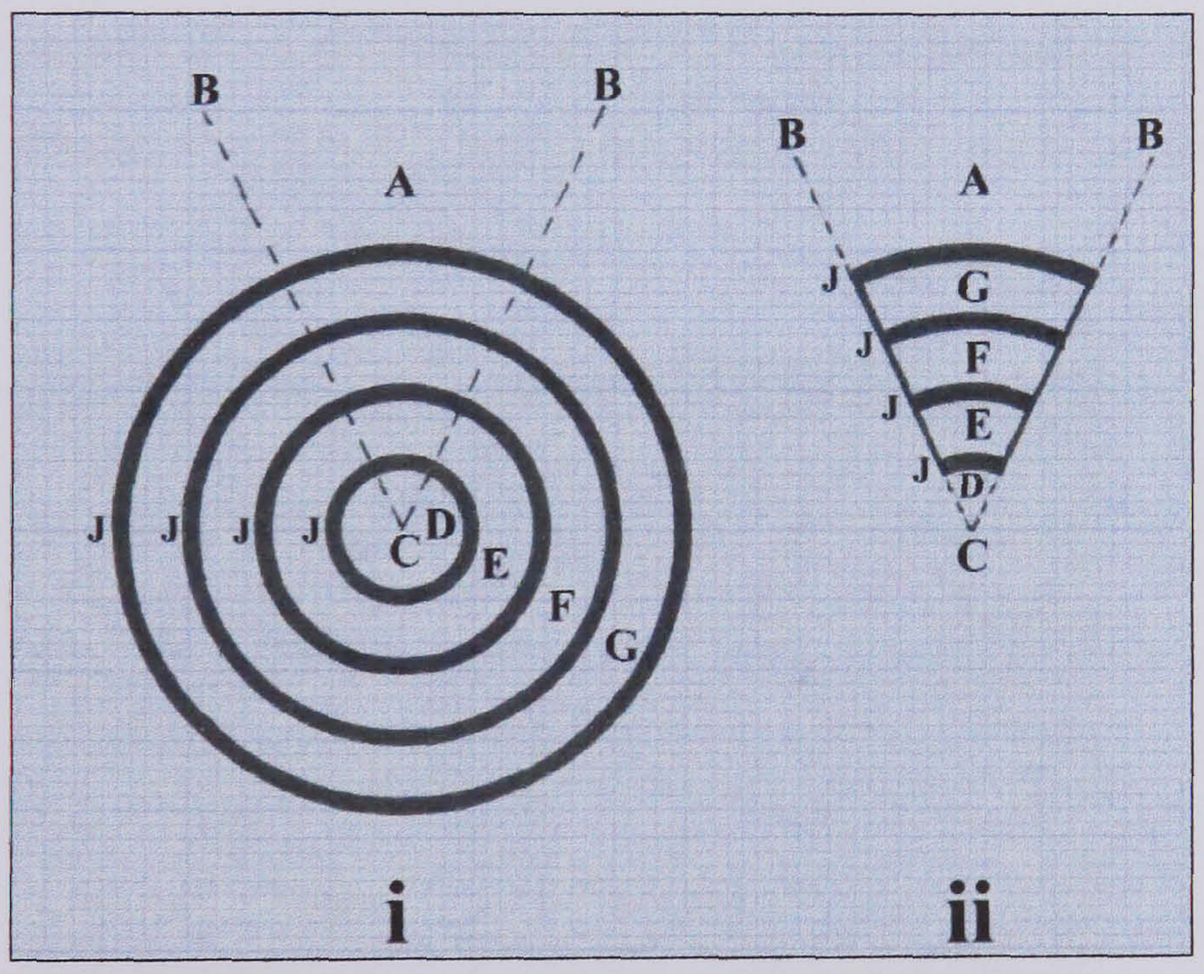


Fig. 103
Cross-section drawing of Study Nos. 34 and 35
i: The cylindrical form similar to *Study No. 33, Simply Connected* from which Study No. 34 was made.
Key to **ii**: The section removed from '**i**', which became Study No. 35.
A: Section removed from a form similar to the one used in *No. 33, Simply Connected.*
B: Cut marks, 50 degrees apart.
C: Centre point of form 'i', situated on the outside of the form in 'ii'.
E and **G**: Interior space within the form, which became visible after the removal of section 'A'.
F: An interior space within the form.
J: The walls of the material, which had previously enclosed 'E' and 'G'.

The study continued to investigate revealing the 'hidden' interior that had been present in *No. 33, Simply Connected*, Figs 97-99. The cut edges were made curved to keep the notion of a continuous surface to investigate its effectiveness of connecting exterior to interior.

Observations

From the view of *Study No. 35* in Fig. 104, the edges, shown as 'J', were predominant and this was due to the study being a small section that had been cut from a larger form. The edges from this view were continuous lengthways but as they were curved they also attempted to connect the different surfaces of the study, such as 'D' and 'E' in Fig. 104, giving the form the implication of a continuous surface. The continuous surface that had been achieved in *No. 33, Simply Connected*, Figs 97-99, was successful because the curves that connected the different planes were of a similar size and in proportion to the whole form. In this study, however, the surfaces appeared to be continuous in places where the curves were proportional to the whole, but where they changed scale, such as the edges, the inconsistency made the continuous surface less convincing.

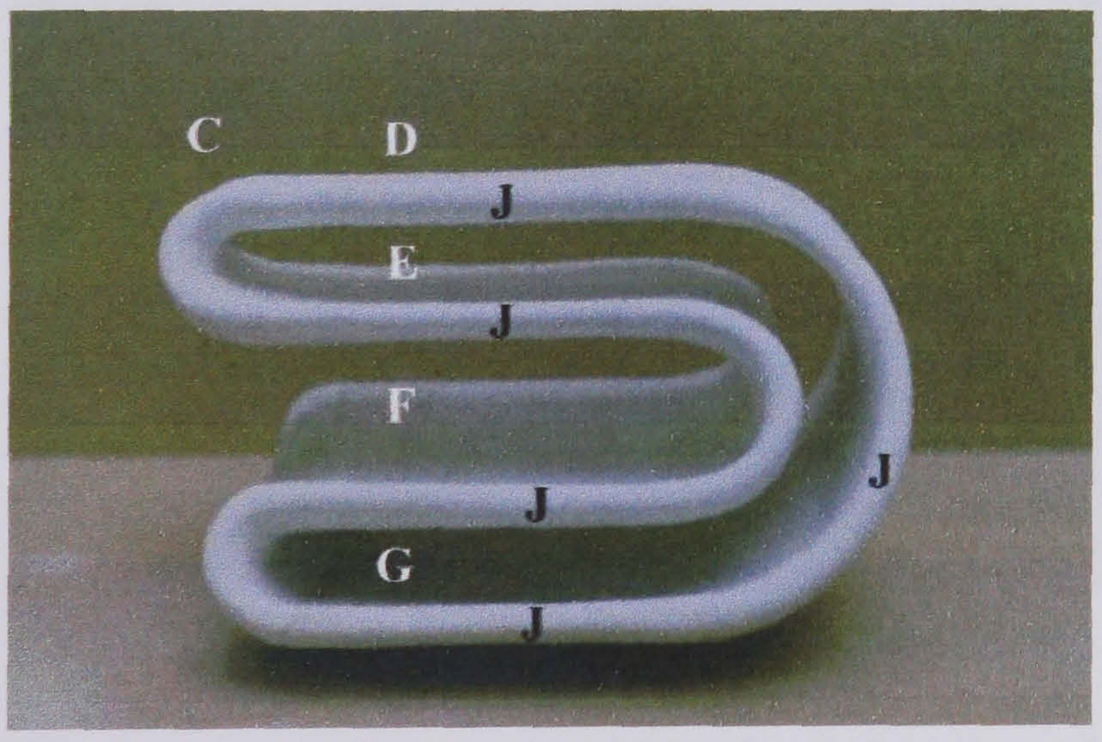


Fig. 104
Study No. 35

C: Point of rotation of the original cylindrical form, which was now on the exterior of the section.
D: The original interior space of *No. 33*, Fig. 97, now exterior space. The curved surface of the material was an arc of the original inner cylinder.
E and G: The connected curved interior surfaces of the form. Also the previously 'hidden' space within the form now connected to the exterior space through the removal of the section.
F: Exterior surface on the interior of the study.
J: The prominent curved continuous edge of the study.

As the form was not cylindrical, but rather a small portion of a cylinder, the interior was not contained to the same extent as other studies, such as, *No. 33, Simply Connected*, Fig. 97. This was partly due to the amount of exposed cut planes in relation to the whole form but also as the form was a small section of something larger, the curves were more gentle and less enclosing. Whereas *No. 33, Simply Connected*, Fig. 97, was predominantly concerned with the continuous surface of the material, this study was concerned equally with the continuous surface and the previously hidden space within the form. Space seemed to travel through the form rather than following the curves or being contained within them. Therefore, although the surfaces appeared to continue around the double loop, the space appeared to travel through from one cut edge to the other. This contradiction between the space and the surface within the study brought in a different type of ambiguity concerning the interior and the exterior of the sculpture, which, as yet, had not been investigated.

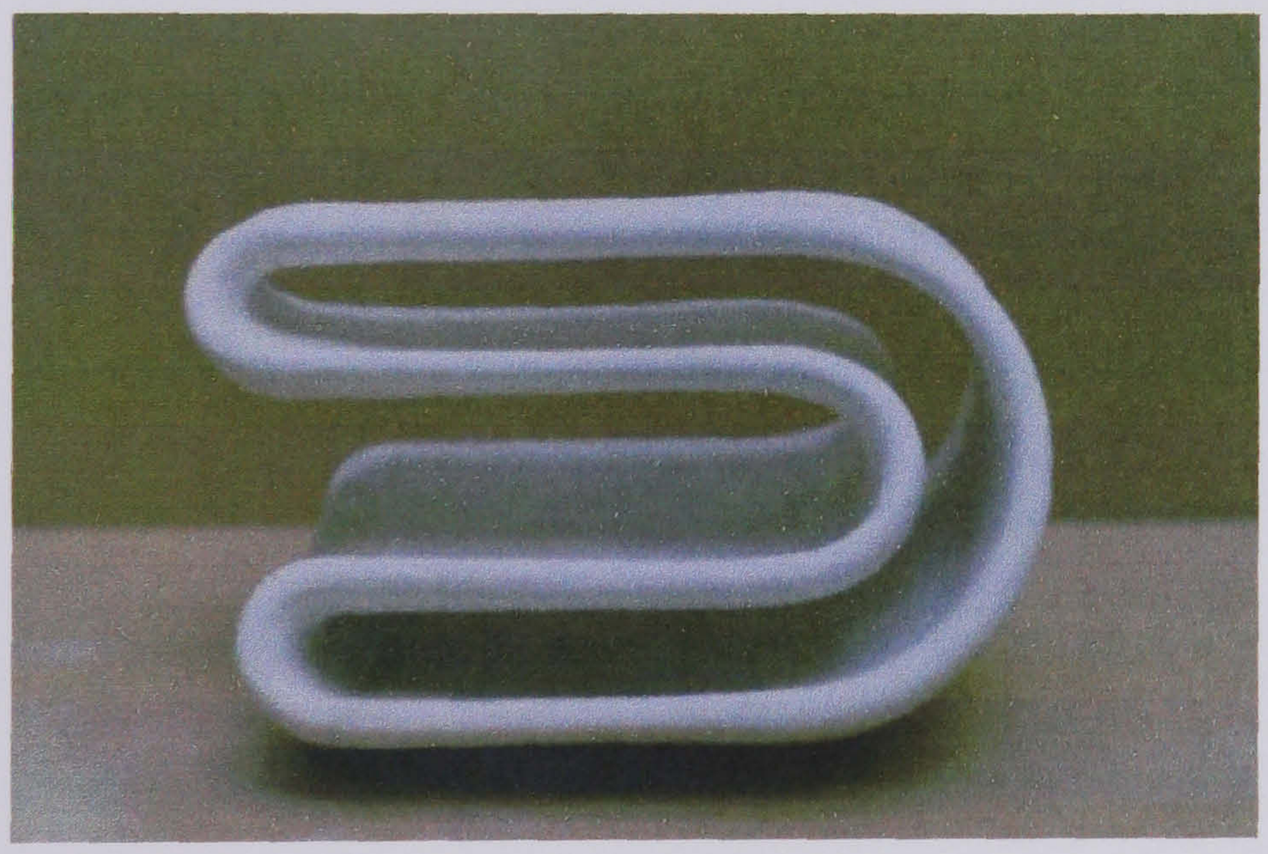


Fig 105
Study No. 35
September 1999
Jesmonite
H 15 x L 30 x W 20 cm
The introduction of space into a form with a continuous surface.

The incorporated space within the form created a much more open structure and, therefore, a more equal disclosure of the interior and the exterior surfaces occurred. Through the combination of space and continuous edge the form began to move away from a distinct interior and exterior and towards their simultaneous exposure. Therefore, although there were disadvantages with the form, such as, the interior not being as contained as the previous two works, these were countered by the introduction of space into the form and warranted further investigation. Other problems were; the scale was not sufficiently large to convey

an implication of a concealed interior within the walls of the form, a discrepancy in the width of the wall lead to a lack of a convincing continuous surface and the orientation of the form did not place the central point of rotation outside the study as convincingly as if it had been vertical.

The next stage, therefore, was to repeat this study and address the problems by making it full scale and changing its position to allow the investigation of following three points that could not be achieved in the maquette. Firstly, imply a rotation point outside the sculpture. Secondly, emphasise a continuous surface through curving the edges of the form and, thirdly, imply a concealed interior within the walls of the material through thickness and hollowness.

No. 36. Loop

The aims of this sculpture were threefold. The first was to imply that the rotation point, shown as 'C', was outside the sculpture, as in (ii) in Fig 106. This was attempted by making a full sized sculpture, similar to *Study No. 35*, Fig. 105, but in upright position. This accentuated the curved surfaces, shown as 'D', 'E', 'F' and 'G' in Fig. 106, as being arcs from cylinders that increased in diameter as they moved away from the axis 'C' and, therefore, emphasised the axis. The second aim was to emphasise a continuous surface throughout the sculpture by curving all the edges of the form. The third aim was to reveal a previously 'hidden' interior space, shown as 'G' and 'E' in Fig. 106.

The form was constructed hollow and made by casting Jesmonite from moulds made of clay sections, plastic tubing and cylindrical formers. As with *No. 33, Simply Connected*, Fig. 97-99, it was hoped that an implication of a concealed interior between the walls could be achieved through hollowness. In turn, the hollowness of the form was attempted through a combination of an increase in the scale of the sculpture and an increase in the width of the walls. The hollowness could be heard if the sculpture was tapped lightly.

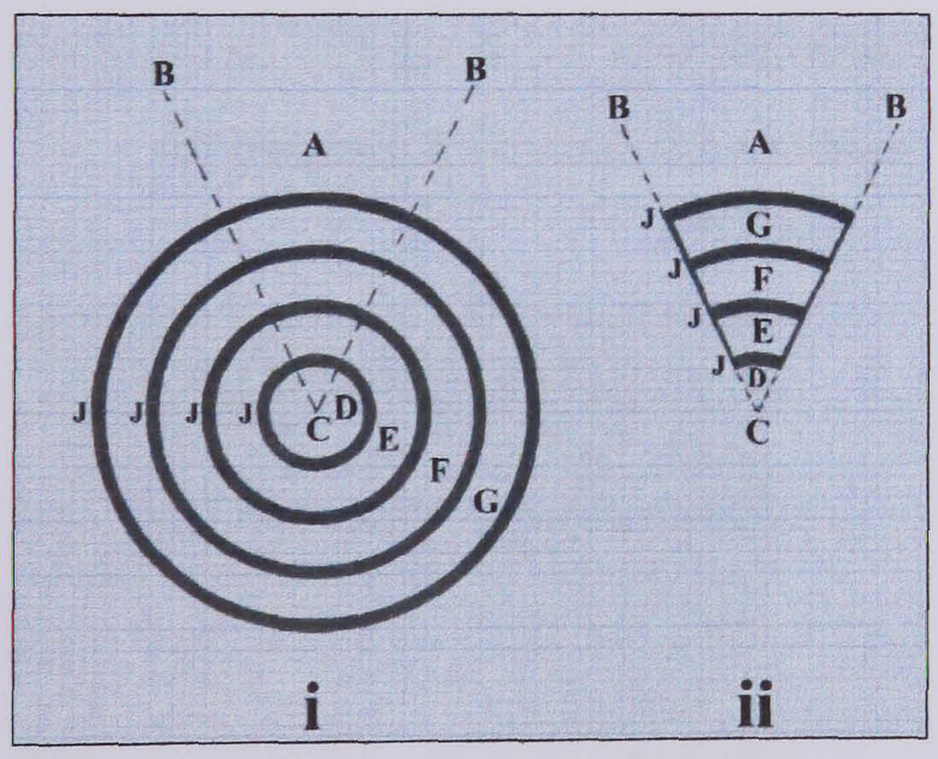


Fig. 106 (repeat from 103)
Cross-section drawing of Study Nos. 34, 35 and No. 36. Loop
i: The cylindrical form similar to *Study No. 33, Simply Connected* from which Study No. 34 was made.
Key to **ii**: The section removed from '**i**', which became *Study No. 35* and *No. 36 Loop*
A: Section removed from a form similar to the one used in *No. 33, Simply Connected.*
B: Cut marks, 50 degrees apart.
C: Centre point of form 'i', now situated on the outside of the form in 'ii'.
E and **G**: Interior space within the form, which became visible after the removal of section 'A'.
F: An open interior space within the form.
J: The walls of the material, which had previously enclosed 'E' and 'G'.

A point of rotational symmetry indicating a central axis had been utilised within the majority of the investigations to date as a reference point for the inside of a form. In this sculpture, Figs 107 and 108 and *Study No. 35*, Fig. 105, one of the aims was to imply the point of rotation of the form was outside the sculpture and, therefore, challenge the reference point usually associated with an interior. This was achieved by using a section of a larger cylindrical whole.

Observations

The sculpture had three contrasting and contradictory viewpoints, which in other sculptures would have been a strength, but in this sculpture created a lack of integrity, particularly from the side and back viewpoints. [43] From the front viewpoint, shown as Fig. 107, however, it was precisely because it was a section of a cylindrical form that a continuous surface could be seen. From this viewpoint the predominant feature of the sculpture was the surface, which included both interior and exterior surfaces. The surface appeared more continuous than in the prototype study, shown in Fig. 105, mainly because the progressively widening arcs could be seen, which in turn made the curves connecting the arcs visible. Also from this viewpoint ambiguity between interior and exterior surface was less reliant on edge than in the previous study. This was because the planes of the interior of the form, shown as 'E2', 'F2' and 'G2' in Fig. 109, projected beyond the exterior 'D' in a similar way to *Study No. 10*, Fig. 16.

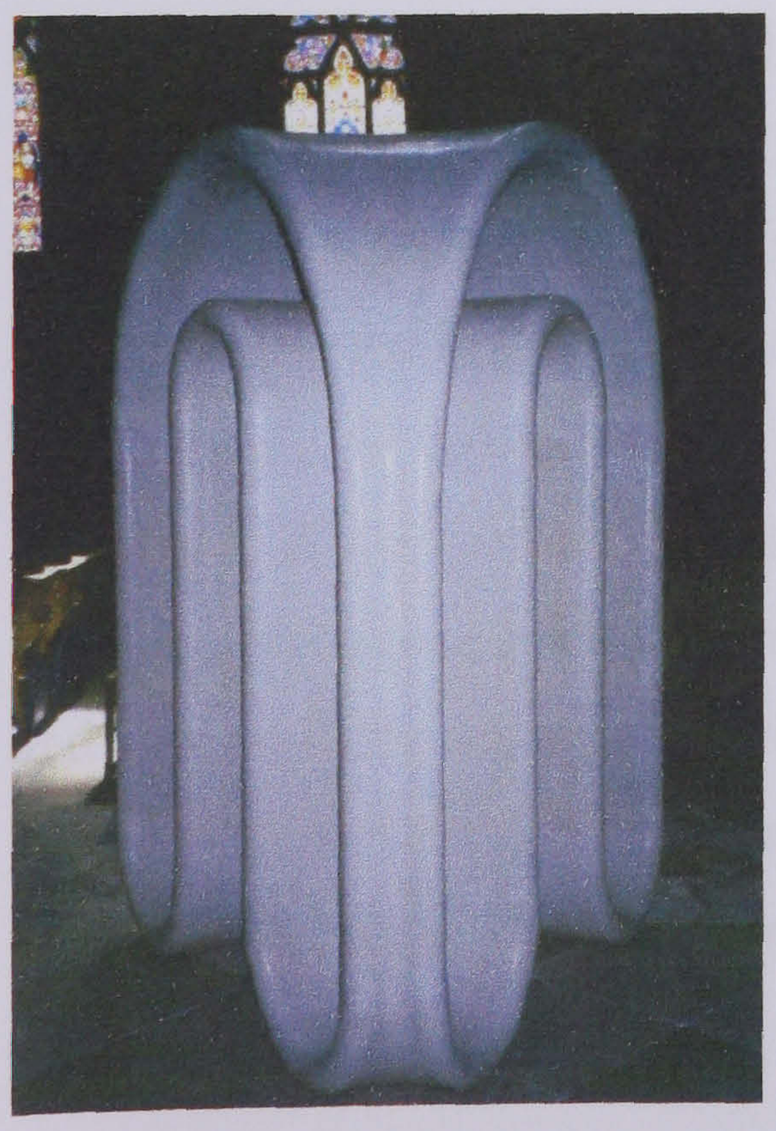


Fig. 107
No. 36, Loop
April/May 2000
Jesmonite
'front' view
H 180 x L 150 x W 20 to 180 cm
View from the front showing the continuous surface

In the study for this sculpture, *No. 35,* shown in Fig. 105, the edges of the material had been the least convincing of all the curves in implying a continuous surface, but in this sculpture, through the increase in scale and the new orientation, it was the edge that emphasised the continuous surface. As the continuous surface was visible from the 'front' view, shown in Fig. 107, the exterior surface could be seen to continue to the interior and back to the exterior and in so doing, avoided the distinct area where the where the exterior stopped and the interior started.

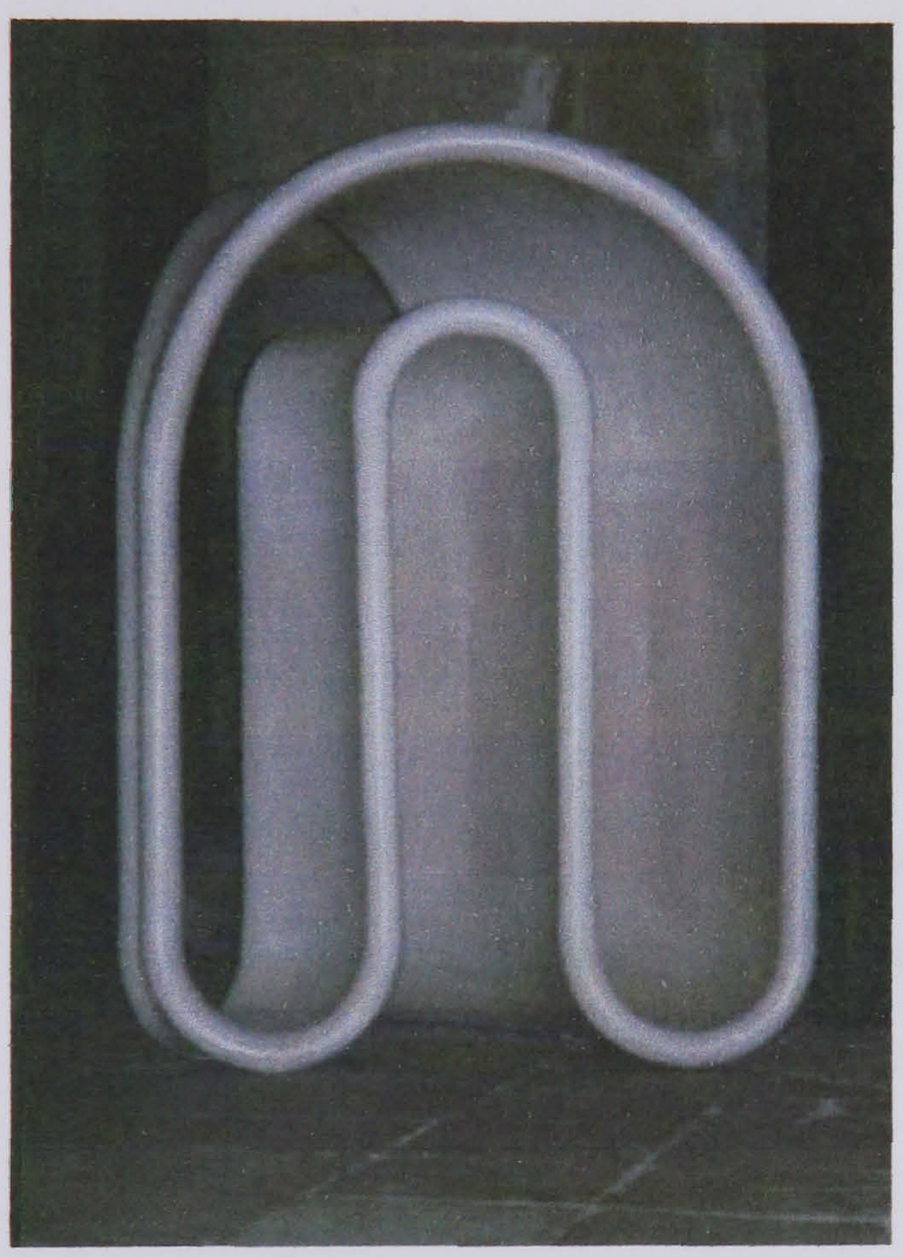


Fig. 108
No. 36, Loop – 'side' view
April/May 2000
Jesmonite
H 180 x L 150 x W 20 to 180 cm
View showing the space between the walls of the form connecting to exterior space.

A continuous surface had been shown to be one method of creating ambiguity, which was a move towards the simultaneous exposure of the interior and the exterior of sculptural form. A second method, the introduction of space to create a more open structure, was shown in the previous study, Fig. 105. This had been the 'hidden' interior space in *No. 33, Simply Connected*, Figs 97-99, but was now revealed in this sculpture. The disclosure of this space between the surfaces was emphasised in the side view of the sculpture, *No. 36, Loop*, shown in Fig. 108 and also made the edge prominent, which appeared as a continuous line. It was because of the introduction of space between the surfaces that the curves were of such a radius that the line became continuous and reminiscent of the line in the radiograph, shown in Fig. 64.

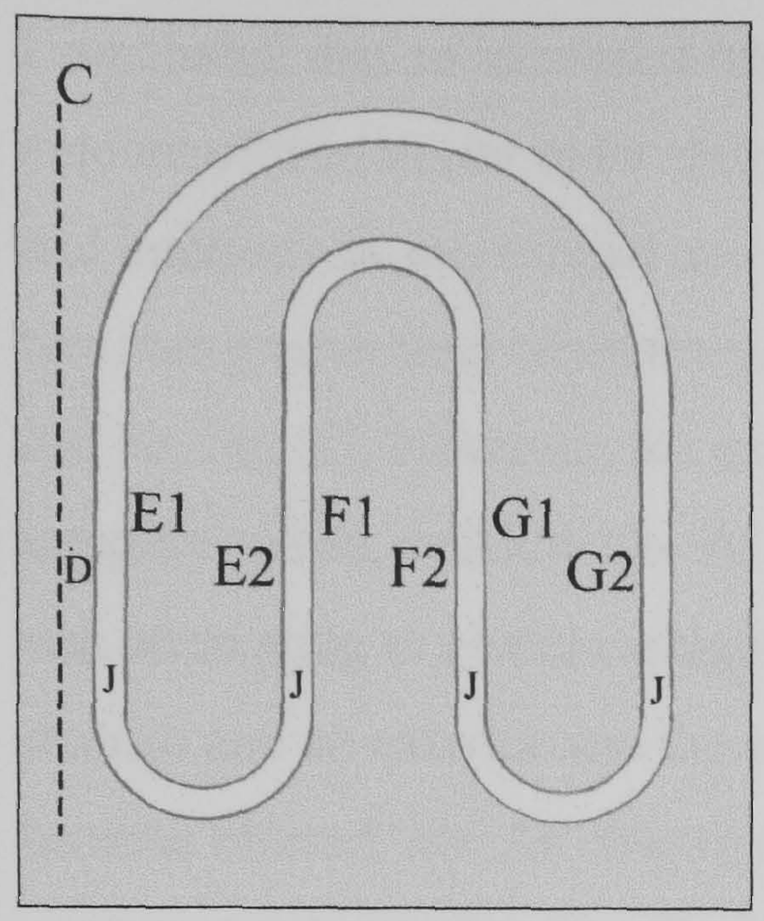


Fig. 109
Diagram of No. 36, Loop.
C: Point of rotation of the original cylindrical form, which was now on the exterior of the sculpture.
D: The original interior space of *No. 34*, Fig. 102, now exterior space. The curved surface of the material was an arc of the original inner cylinder.
E1, E2 and G1, G2: The connected curved interior surfaces of the form. Previously 'hidden' surfaces and space, revealed and connected to the exterior because of the removal of this section from the larger whole.
F1 and F2: Exterior surfaces on the interior of the sculpture.
J: The prominent curved continuous edge of the sculpture containing the 'hidden' interior.

Whilst an open structure allowed visibility, there was a fine balance between the disclosure of the interior by the introduction of space and this space losing its identity as an interior. I had hoped that the reference to an arch, which the viewer could stand within, would counterbalance the openness of the structure and therefore, an interior would be retained. This occurred to some extent in the sculpture, although mostly through the shadow created between the widest two walls.

The front view demonstrated a continuous surface and the side view a continuous line, but where the sculpture lacked continuity was in the connection between the planes along the horizontal axis. For example, in Fig. 109, the surface 'E2' did not appear continuous with the surface 'F1' because the curve at the changeover point was too abrupt as the walls were too thin and resulted in an 'edge'. It would seem that for these surfaces to appear continuous the size of the curve that made the changeover had to relate to the size of the interior space with the proportions of the curve being at least half of the diameter of the interior space, as in *No. 33, Simply Connected*, Figs 97-99.

I concluded that an increased amount of space within a form allowed a greater amount of the interior to be seen and therefore the balance of the visible exterior and interior was more equal and the potential for simultaneously exposing the two was greater than when the exterior was dominant, as it had been in, *Study No. 30*, Fig. 87. However, the exposure of the interior was at the expense of its integrity, while, in *Study No. 30* a distinct interior had been retained. Although I was attempting to create ambiguity within the form, I wanted to retain both an interior and an exterior and the ambiguity to refer to the point at which the two became blurred. *No. 33, Simply Connected*, Figs 97-99, achieved this ambiguity, whilst retaining an interior, for two reasons. Firstly, the form was complete and had a centre as a point of reference for the interior, and secondly, it had a convincing interior within its walls. Whilst already questioning the identity of the interior in *Loop*, placing the centre point outside the form added to the loss of an interior reference.

While the 'side' and 'back' views of *Loop* were not very satisfactory, the 'front' view, shown in Fig. 107, went a long way towards successfully achieving the simultaneous exposure of interior and exterior. Its strong flowing lines created a ribbon-like structure reminiscent of the Möbius Strip, while the steady increment contributed to the revealing of each surface. To address the lack of the integrity of the interior in this sculpture, in the next two studies I concentrated on the concealed interior within the walls of the material. Instead of introducing space into this area to reveal the interior, it was kept enclosed and I attempted to imply its presence by displacing it, which was a device I had attempted in earlier studies, such as *Study No. 30*, Fig. 87. By including the transition of an exterior to an interior and vice versa, which had been shown to be effective in earlier works, such as *No. 33, Simply Connected*, it was hoped to blur the boundaries between the interior and exterior and work towards their simultaneous exposure.

Study No. 37

The aim of this study was to return to a 'hidden' interior space within the surfaces of a form to only imply its presence through displacement. The emphasis of this study was to suggest movement from the inside of a cylinder to the outside and that this was within a continuous exterior surface. To achieve this aim it was necessary to create a convincing exterior surface or skin, in which the implied movement was bound. A cylinder with a continuous exterior surface was made. Several identical rounded objects were cast, cut and attached to the cylinder at regular intervals. At the point where the objects were attached the edges were curved to imply a continuous exterior surface.

Fig. 110
Study No. 37
November 1999
Jesmonite
H 30 x L 30 x W 10 cm
A cylindrical section with elements incrementally changing from the interior to the exterior.

Observations

The final form lacked homogeneity as the elements which moved incrementally did not read as integral to the cylinder, perhaps, because they did not extend to the edge of the cylinder. This had been done to include as many curved surfaces as possible and to maintain the cylindrical shape, but the elements appeared to be grafted on to the form instead of being integral to it. The study appeared to consist of more than one element and, therefore, the aim of creating a continuous exterior surface implying movement was not successful.

The study failed to achieve the aims and this was solely due to the nature of the form, which was too literal, as with the previous sculpture. However, the aims remained valid and were further explored in the next study.

Study No. 38

In this study the previous aims were repeated and the emphasis was placed on a more successful integration of form with a continuous exterior surface and implied movement within this surface. Towards this aim, instead of introducing secondary elements into the hollow cylinder I attempted to manipulate the unseen interior space by altering the thickness of the skin of the exterior surface. The intention was to imply the surface had been pushed in or out beyond the boundary of the cylinder. Through this action the space previously held between the walls of the cylinder would be displaced and the two skins would touch.

Three half spheres, which were smooth on both surfaces were cast, and elongated with a tube of the same circumference. The spheres were integrated into a cylinder, which was open at both ends and had a continuous exterior surface. The spheres were placed at irregular intervals but conformed to the position of an object passing regularly from the outside through equilibrium to the inside of the cylinder. The point of intersection was curved to imply a continuous surface.

Fig. 111
Study No. 38
November 1999
Jesmonite
H 30 x L 30 x W 10 cm
A cylindrical section with elements incrementally changing from the interior to the exterior.

Observations

The elements were more integral to the cylindrical form than in the previous study, shown in Fig. 110, and this was useful in suggesting the need for a more subtle manipulation of the interior and exterior.

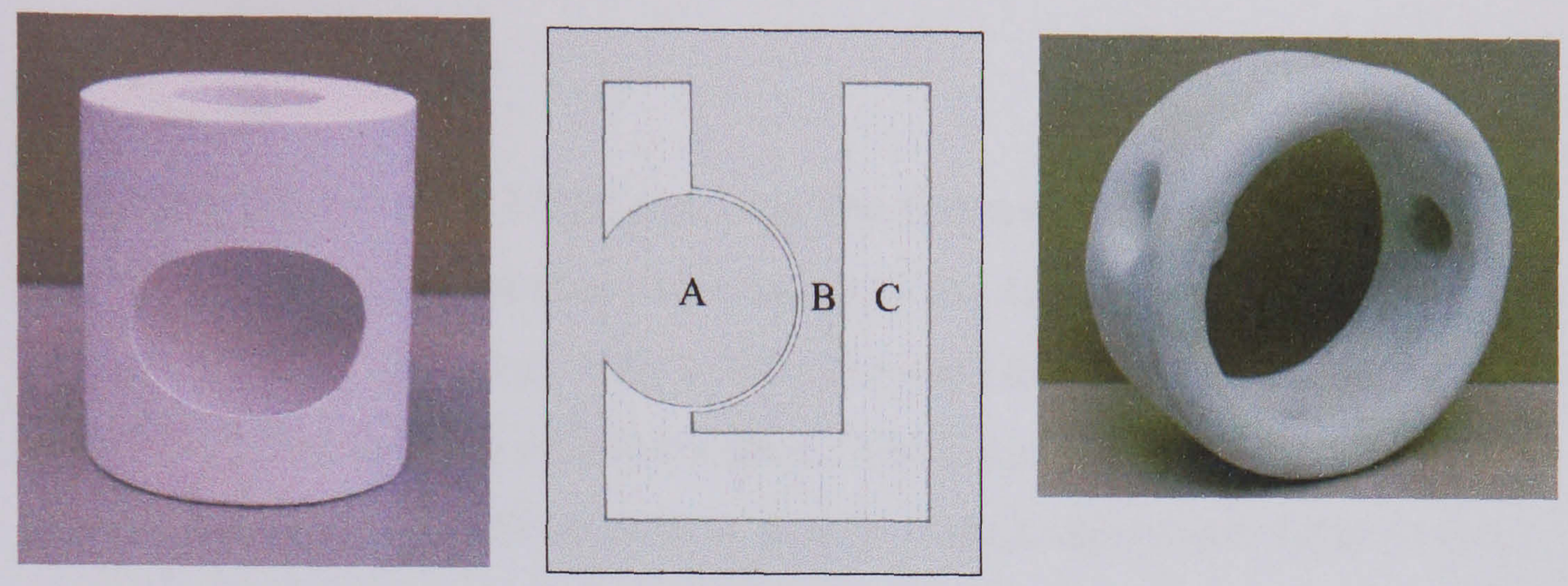


Fig. 112
Repeat of Study No. 27 from Fig. 77.
Repeat of cross-section drawing of Study No. 27 from Fig. 76.
Repeat of this Study, No. 38, from Fig. 111.

During the making of this study I realised that the resulting composition bore some similarities to *Study No. 27*, shown in Fig. 77 and above in Fig. 112, although the aims had been different. In *Study No. 27* the walls of the cylinder were solid and the interior was within the solid material. A hollow sphere with a thin exterior shell, larger than the width of the one of the walls was included at the casting stage. The exterior shell of the sphere remained intact on the inside of the cylinder but was intersected on the outside. Despite the intersection, the form retained its cylindrical appearance, whilst also revealing the space within the sphere. Within the study, *No. 38*, Fig. 111, my intention had been to imply that the revealed space had displaced part of the cylindrical wall. Since the walls of this study were hollow there was no need to introduce a secondary object into the interior of the cylinder. As the cylinder was deformed from the outside it displaced the already present interior space without cutting or intersecting the exterior continuous surface.

The next stage was to repeat a composition similar to *Study No. 38,* but to make a form, which emphasised the continuous surface. If it was the space within the walls that appeared to be displaced, then the continuous surface could stay complete but still imply a movement from interior to exterior, or vice versa.

Study No. 39

Whilst making this study I had four aims. The first was to emphasise the 'hidden' interior without cutting into the continuous exterior surface. Secondly, I aimed to evaluate the effectiveness of using hollow and solid materials in one composition to imply the displacement of interior space, which would also emphasise the 'hidden' interior. The third aim was to simplify the composition to emphasise a continuous exterior surface and the fourth was to attempt to show simultaneous exposure of interior and exterior from all viewpoints.

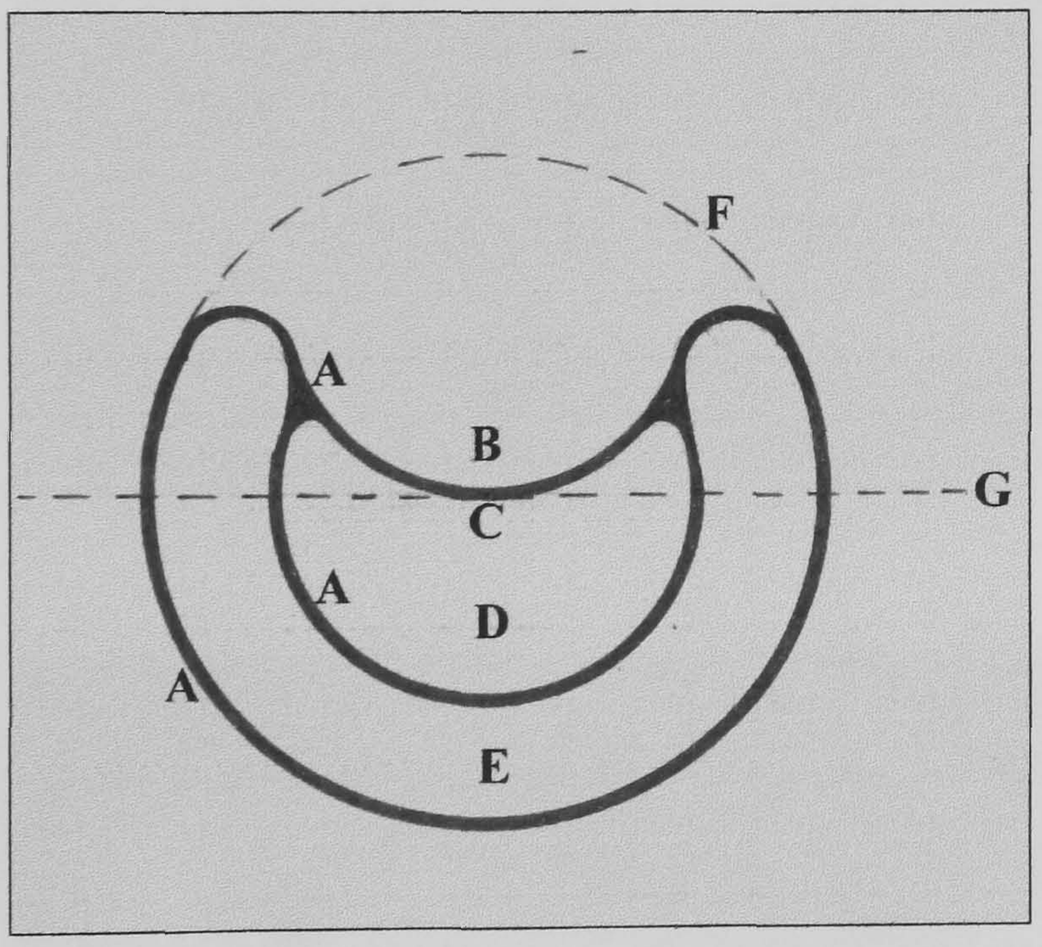


Fig. 113
Vertical cross-section drawing of Study No. 39 with the original cylindrical boundary indicated.
A: The continuous surface.
B: An interior on the exterior of the form.
C: Original centre point of the cylinder.
D: interior space within the form.
E: The concealed interior within the walls of the material.
F: Line showing the original exterior of the cylinder.
G: Original centre line of the cylinder.

A hollow cylinder with both ends open was cast in Jesmonite. The reason for using a hollow cylinder in all the studies and sculpture in this section, shown in Figs 90-118, had been to make it more easily understood that a concealed interior space was within a continuous surface. A solid hemisphere with a diameter the same width as the inside of the cylinder intersected the length of the cylinder, shown as 'B' in Fig. 113. The hemisphere intruded to the centre of the inside of the cylinder. In contrast to the previous two studies, the number of places where this occurred was reduced to one. Curved edges were used where the hemisphere

touched the walls of the cylinder to help make the two objects fuse to become one form with a continuous surface. In order to imply interior space had been displaced by the indentation, it was necessary to reduce the wall thickness of the cylinder at this point. If the wall thickness appeared to have been reduced then it went a long way towards implying that the interior space had been displaced. The main aim of this was to draw attention to the interior within the walls of the material, but in so doing I had also created an interior on the exterior on the study.

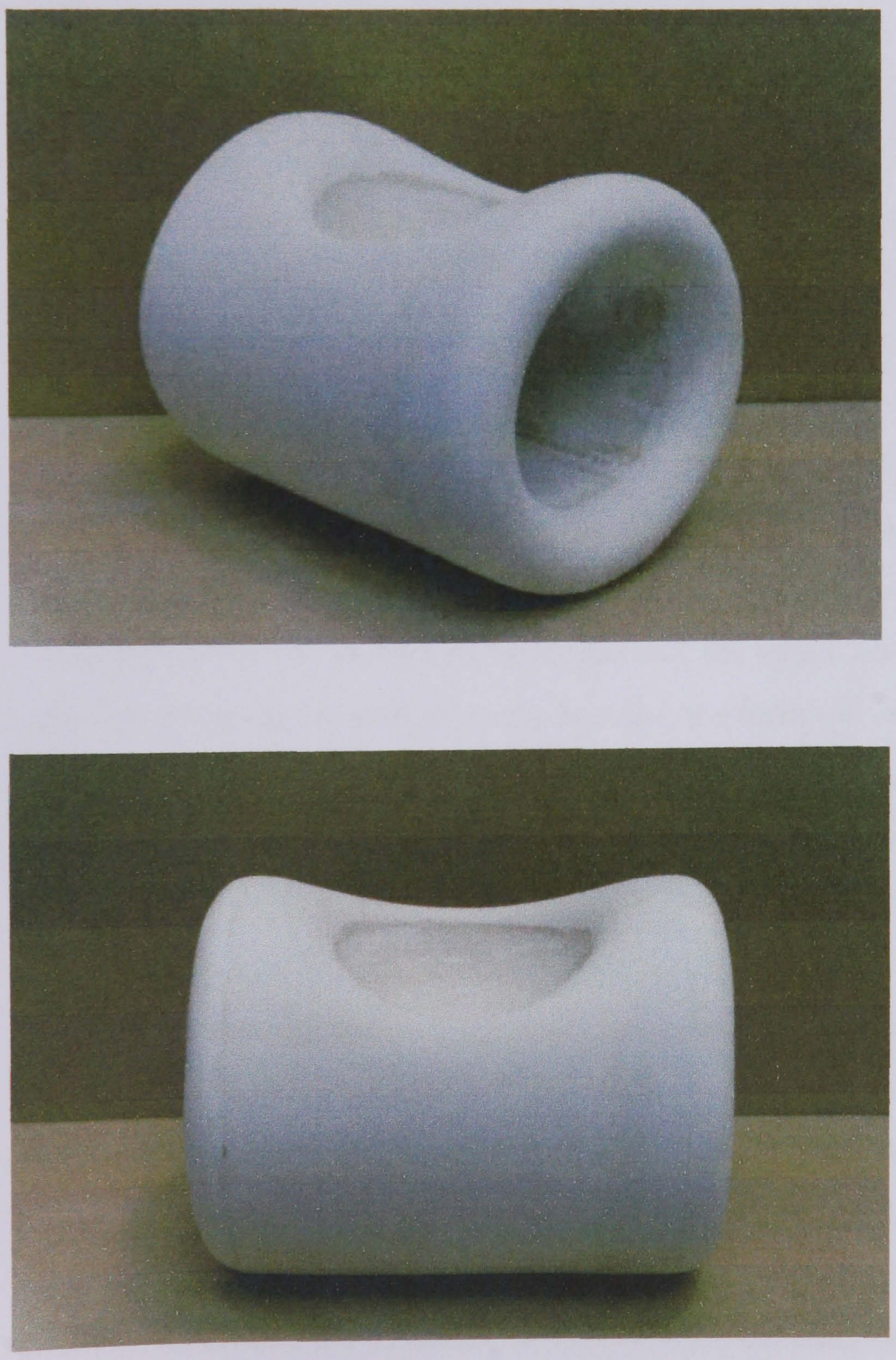


Fig. 114
Different views of Study No. 39
December 1999. Jesmonite. H 20 x L 30 x W 20 cm
A form with three interiors, with one of the interiors on the exterior of the study.

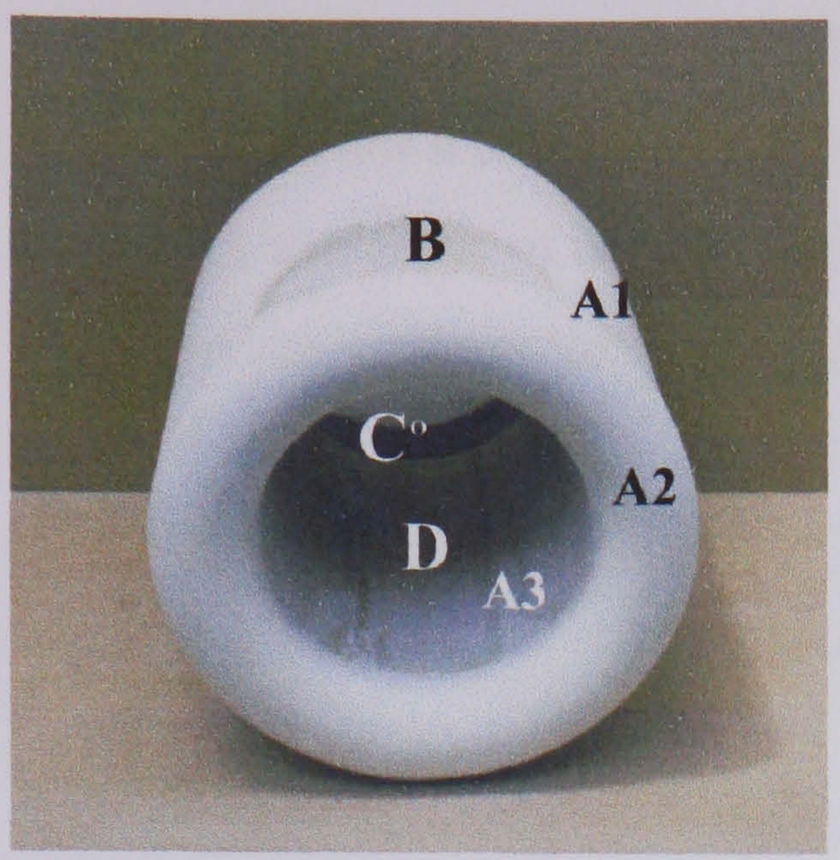


Fig. 115
Study No. 39
A1: The exterior surface.
A2: The curved edge of the continuous surface containing a concealed interior.
A3: The exterior surface 'A1' continuing to the interior.
C: Centre point of the original cylinder.
D: interior space within the form.

Observations

One of the problems I encountered with *No. 36, Loop*, Fig. 106, was the lack of a contained interior. I identified the reasons for this as: the form was only a section of a whole and the centre of rotation was outside the form. The following two studies, shown in Figs 110 and 111, had investigated the displacement of interior space as a method of keeping the integrity of the whole and, because of this, had only been concerned with the concealed interior. This study, as shown in Fig. 114, however, attempted to overcome both problems identified in *No. 36, Loop*. I found that by retaining, for the most part, a cylindrical appearance, the centre line of the form was within the cylinder and in this way emphasised the interior space, shown as 'D' in Fig 115. By displacing the space within the walls of the material, to create an interior on the exterior, the form did not have to be cut. The retention of much of the geometry and integrity of the cylinder, assisted in the simultaneous exposure of the interior and exterior of the form.

The first interior, shown as 'D' in Fig. 116, was within the form as with previous examples, such as, *No. 33, Simply Connected*, Figs 97-99, and this interior was accentuated by shadow. As the wall thickness of the study was half the width of the central interior space, the curves connecting the walls were in proportion to the form, creating the appearance of a continuous surface. The eye, therefore, could travel around the sculpture and move from the exterior to the interior and back again without interruption, which assisted in the simultaneous exposure of the interior and the exterior.

A second interior was produced on the exterior of the cylinder. This new development was achieved by the indentation on the exterior surface moving inwards to the centre of the interior, 'D' resulting in, 'B', shown in Figs 113 and 115. This was made possible through using the centre line or main horizontal axis, shown as 'G' in Fig. 116, as a reference point. With an interior on the exterior of a cylinder and part of the intrusive exterior surface extending to the centre of an open cylinder the established positions of interior and exterior were challenged.

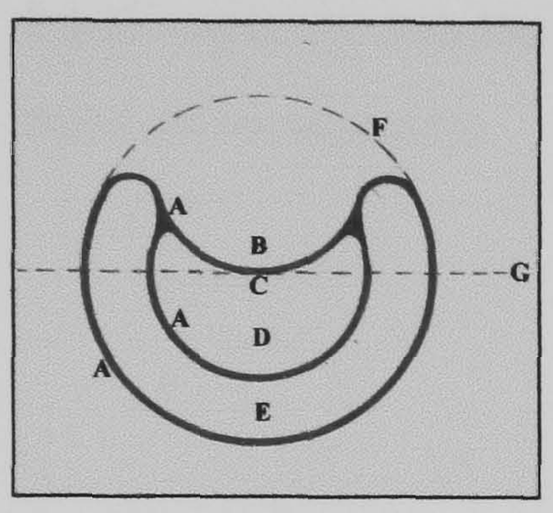


Fig. 116
Repeat of Fig. 113. Cross-section drawing of Study No. 39

The wall width incorporated the third 'hidden' interior space 'E', but where the introduced hemisphere displaced the space, it also separated interior 'B' from interior 'D'. This convex form, which can be seen within the ring at the end of *Study No. 39*, shown in Figs 114 and 115, produced the second significant feature of the sculpture. This convexity was the exterior surface of the interior, 'B'; the area, shown as 'D', was an interior space. Therefore, the study appeared to have a convex exterior surface on the interior of the sculpture. Although the form was less complicated than previous work, it still produced three separate interiors.

In previous sculptures, such as, *No. 33, Simply Connected*, Figs 97-99 and *No. 36, Loop*, Figs 107-108, there were viewpoints where information necessary for simultaneous exposure of interior and exterior was obscured. In this study, *No. 39*, however, from all viewpoints interior and exterior were revealed simultaneously. In the earlier work, the simultaneous exposure was attempted through creating ambiguity between the points where one became the other. While using this approach, this study also succeeded in challenging the accepted placement of an interior within an exterior boundary by exchanging the positions of interior and exterior. This was only possible because the interior and exterior had been clearly defined by retaining the geometry and equilibrium of the

cylinder. Through an exchange in the position of interior and exterior and the connection of the two using a continuous surface they were simultaneously exposed.

This study was successfully submitted as a proposal for a full-scale sculpture for the Millfield Commission. I chose to submit this study rather than any of the previous work because it not only achieved all the aims, but also resulted in a form where the simultaneous exposure of the interior and exterior could be seen from all viewpoints.

No. 40. Hollow. Millfield Commission 2000

The commission gave me the opportunity of making a *Study No. 39* full-scale and to locate it in an outstanding landscape. The main difference between the study and the sculpture was that a person could comfortably sit within either space 'D' or 'B', shown in Fig. 116, in the sculpture, which again emphasised the interiority of these spaces.

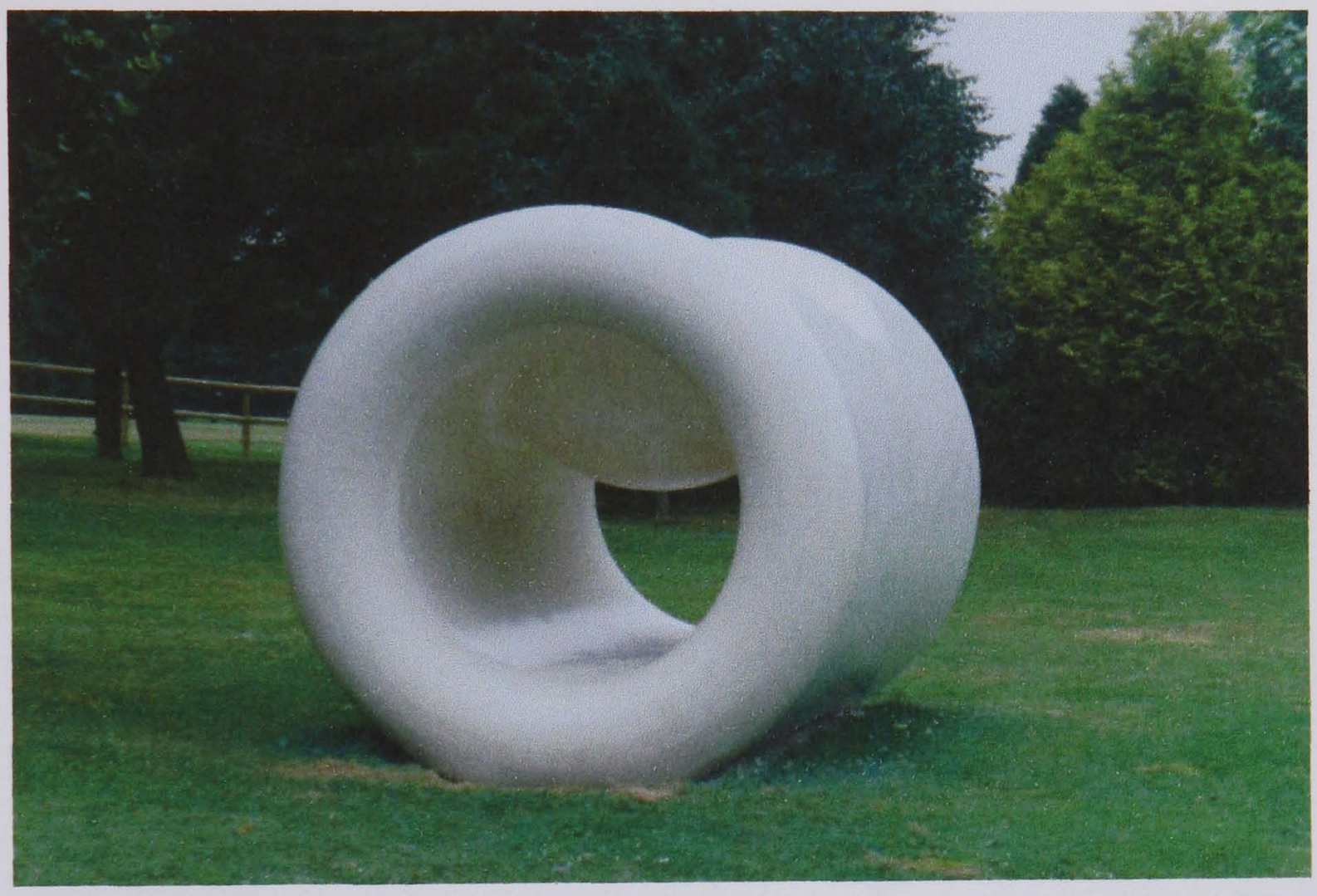


Fig. 117
No. 40, Hollow
May/July 2000
Jesmonite
H 210 x L 315 x W 210 cm
Millfield Sculpture Commission
Full-scale sculpture showing a form with three interiors, with one of the interiors on the exterior.

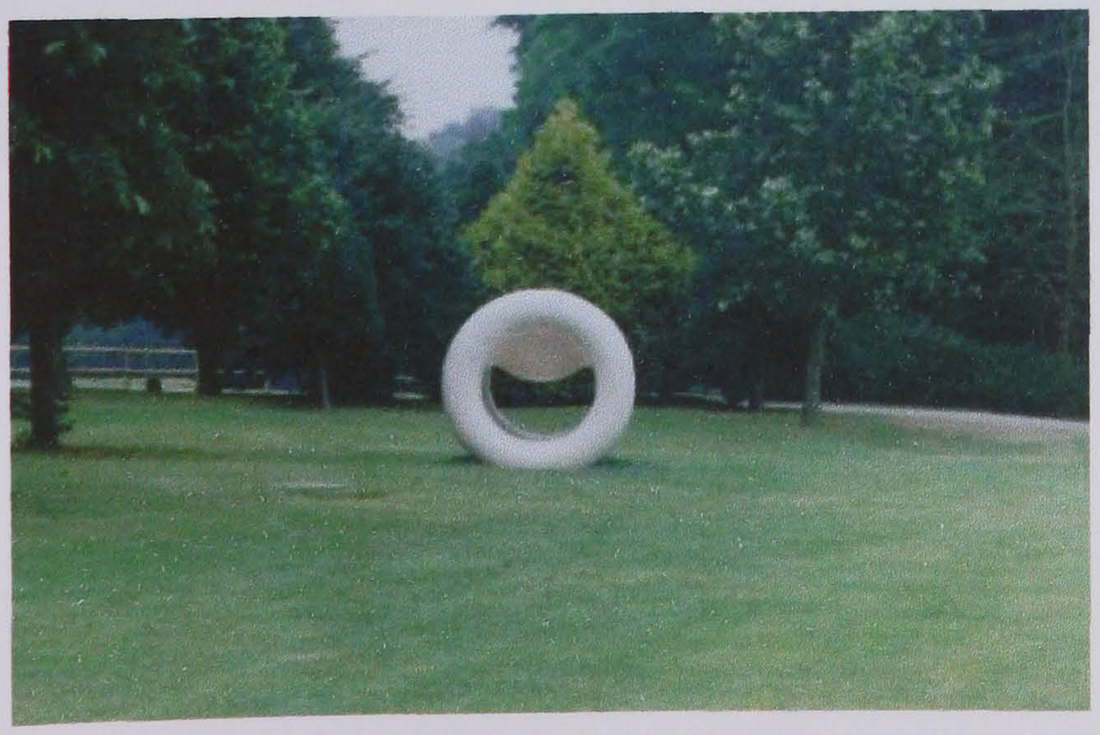


Fig 118
No. 40, Hollow.
Alternative view.
May/July 2000
Jesmonite
H 210 x L 315 x W 210 cm
Front view showing the exterior surface within the interior of the sculpture.

Plate 1
No. 31. Continuous Surface
Feb. 1999
Plaster and Jesmonite. 20 x 100 20 cm.

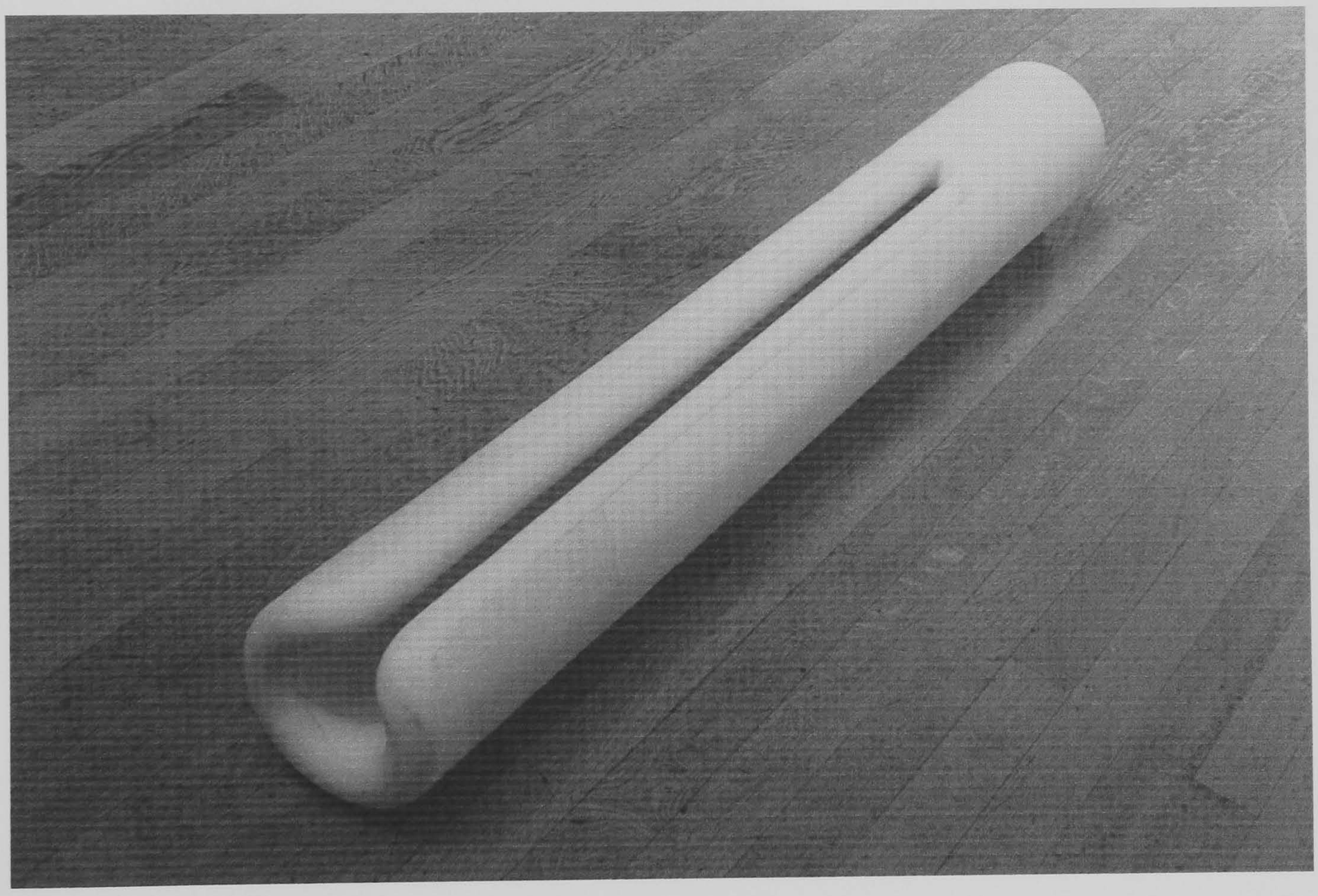


Plate 2
No 32. Inverted Cylinder
March/April 1999
Jesmonite. 40 x 100 x 40 cm.

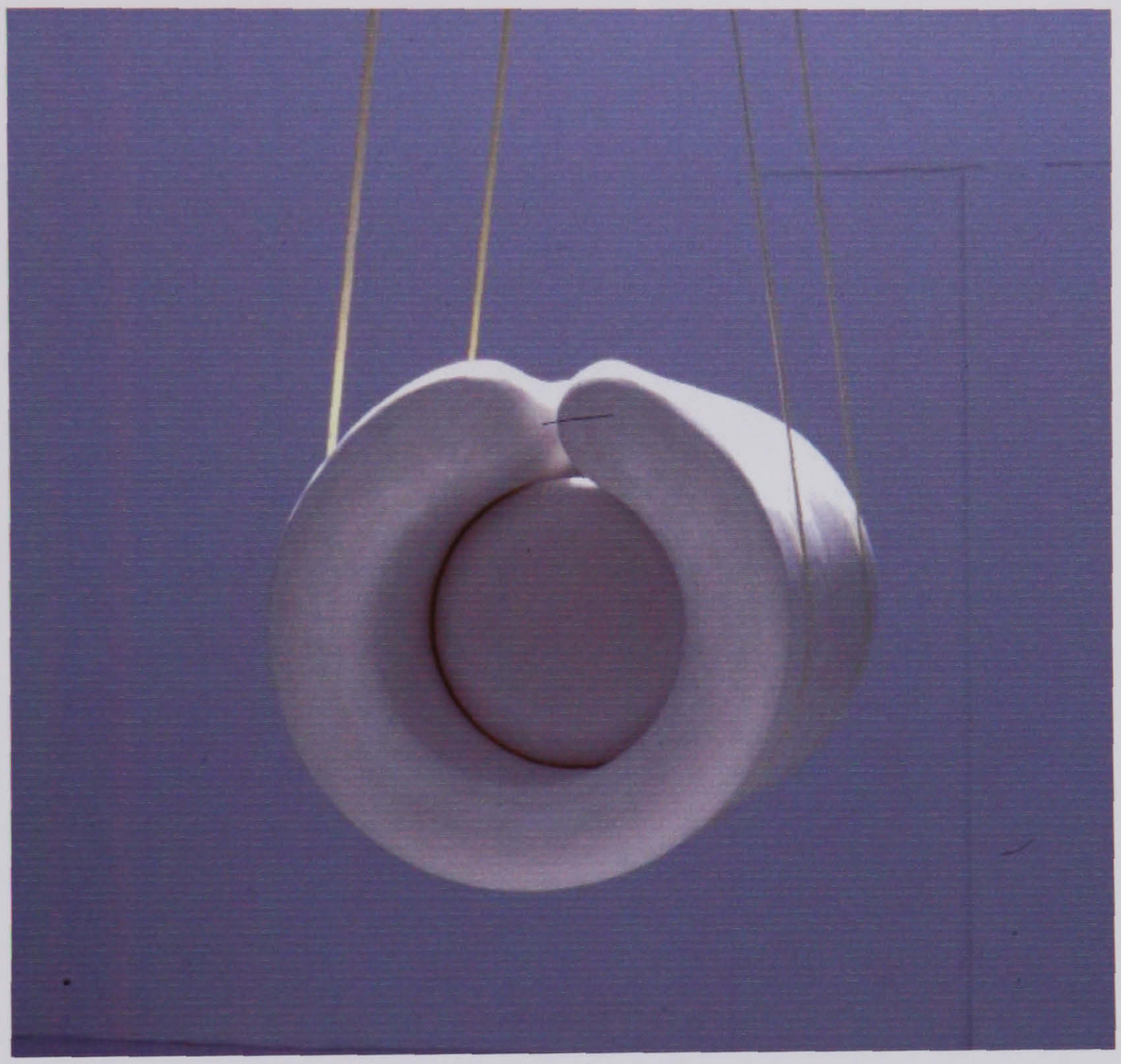
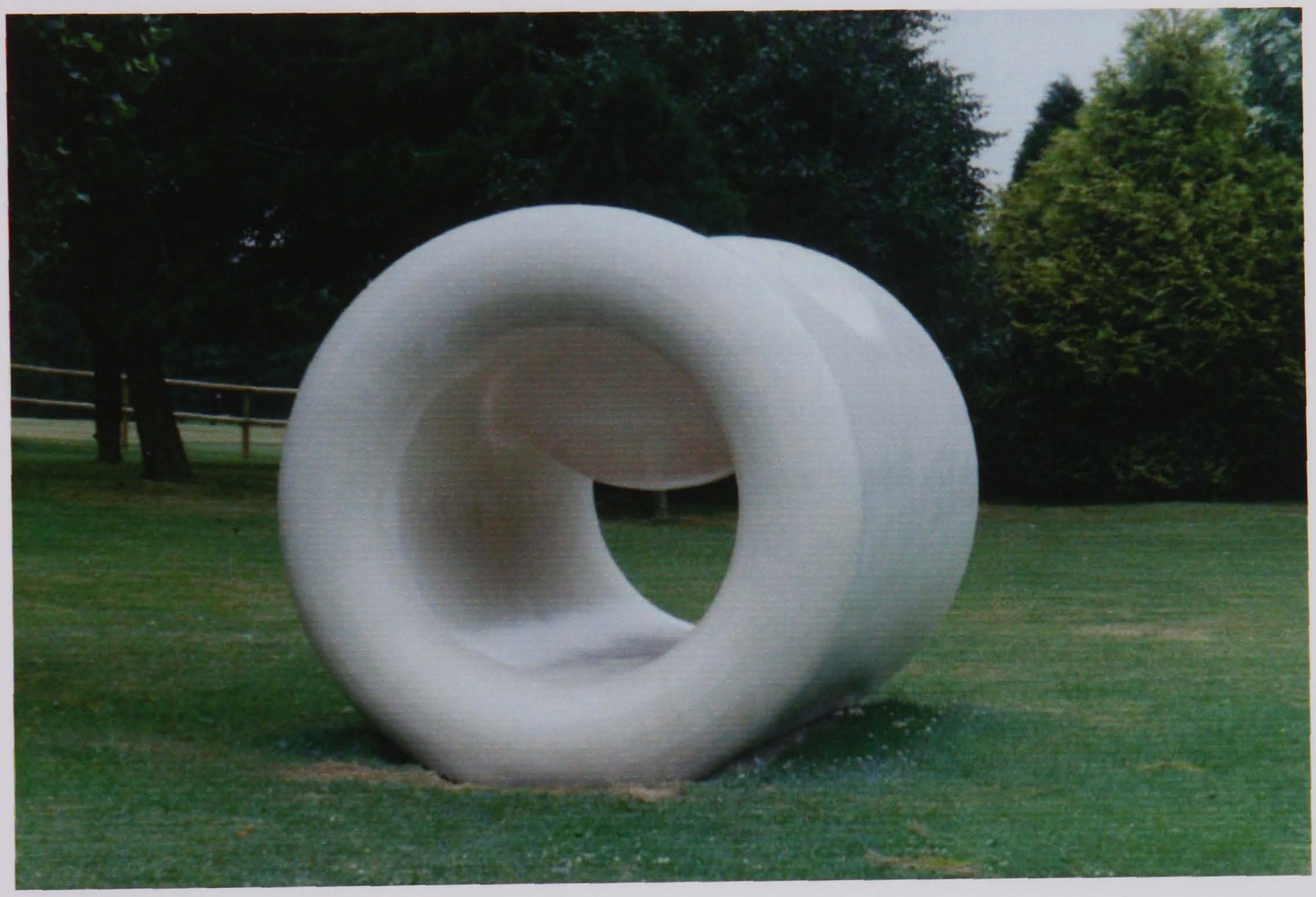


Plate 3
No. 33. Simply Connected
May/June 1999
Jesmonite. 120 x 135 x 120 cm

Plate 4
No. 36. Loop
April/May 2000
Jesmonite. 180 x 150 x 20 to 180 cm

Plate 5
No. 40. Hollow
May/July 2000
Jesmonite. 210 x 315 x 210 cm



CONCLUSION

It has been perfectly legitimate for sculpture to borrow concepts from other fields, mathematics, engineering etc. Indeed, artists who have borrowed in this way have helped shape our definition of sculpture. Concepts such as 'interior/exterior' have been used to different ends by individual artists; Boccioni was interested in portraying dynamism through continuity in space, whereas Kapoor was interested in notions of the void. The specific meanings for each artist have accumulated to produce a tradition of sculpture, particular to art. To say that 'Hepworth pierced the form' would make no literal sense to a mathematician, but it does make sense in the context of sculpture. My research has not been concerned with making works of art alone, neither have they been purely theoretical nor illustrative in the way a mathematical model would be. They were works of art that explored and extended specifically sculptural concepts (albeit informed, as much by modern sculpture as by other fields). The particular aspect of interior and exterior that I have been concerned with in the research was the apparent opposition of the terms and how to make them distinct whilst also exposing them simultaneously.

From the literature survey and through my own practice I recognised the diversity of definitions concerning interior and exterior, and I realised the need for clarification to assist further research. The introduction of a taxonomy provided the rigour necessary for definition and gradual progression. The definitions were essential for my understanding of what constituted interior and exterior in sculptural form, but I also soon realised that to define them I needed to make them separate and distinct. While the exterior had been defined as 'exterior surface or boundary', the definition of interior was more complex. Interior could be an area or a surface within a form and could be either revealed or hidden.

All the categories of the taxonomy were explored during the investigations, but of the six categories, three were found to be particularly pertinent to the

simultaneous exposure of the interior and exterior. The most significant was Category 'B', the moment of transition between the interior and the exterior. The range of possibilities of using the point at which exterior became interior and vice versa was broad and produced numerous constructive results. For example, the sub-category 'B(i)' evolved from making *Study No. 10*, shown again in Fig. 119 and was concerned with the emergence of the interior to the exterior; the tapered interior cylinders projected beyond the exterior cylinder. These investigations were furthered in, for example, *Study No. 23*, shown in Fig. 119 by connecting the interior elements and exterior boundary, making the vertical plane one continuous curved surface that continued from the exterior to the interior. The last sub-category, B(vi) placed emphasis on a section of structure between the interior and exterior and investigations using this criteria produced the radiograph of *Study No. 24*, Fig. 119, which was a key study within the research that had a significant effect on the final sculptures and was responsible for important advances. The radiograph reduced the mass of a hollow cylinder to line allowing only the 'essence' of the form to be seen. Besides the significance of exposing the interior without cutting into the form it was through the 'formal vividness' of the image itself that I was able to realise the possibilities of a continuous surface. The rounded corners produced a continuous line, which moved from the exterior to the interior.

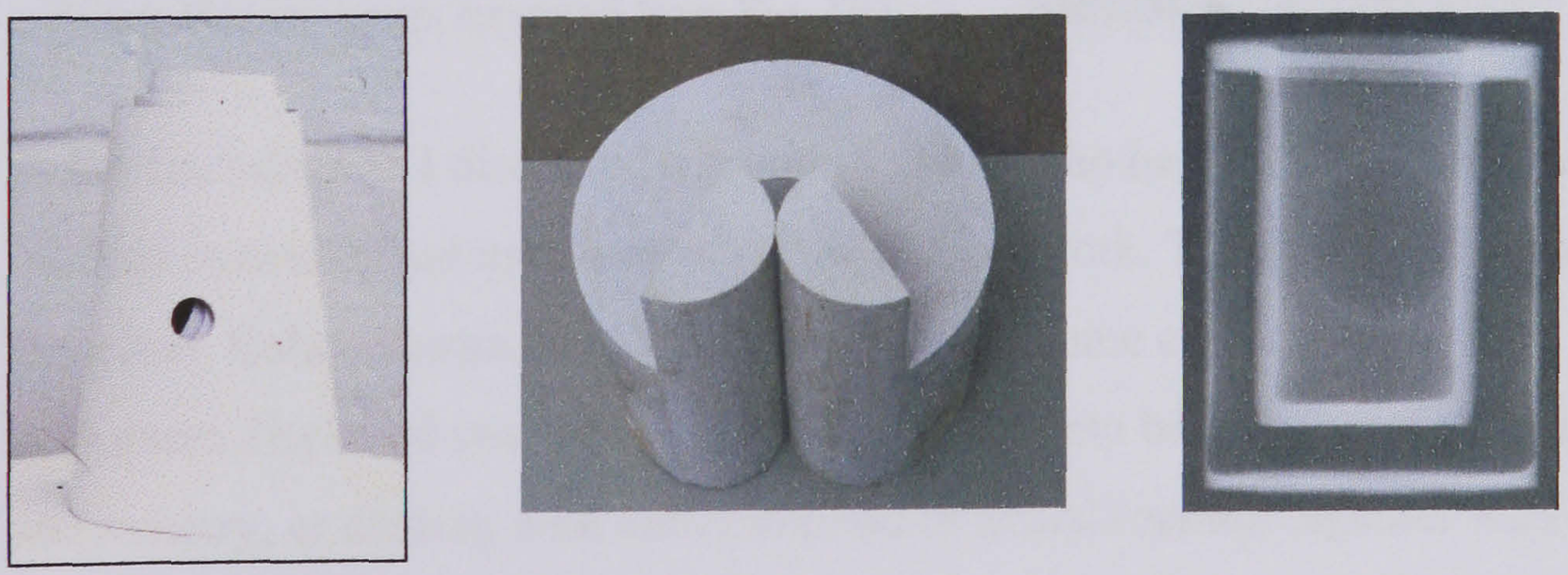


Fig. 119
Left: Study No. 10, repeated from Fig. 16.
Middle: Study No. 23, repeated from Fig. 53 and 89.
Right: Study No. 24, repeated from Fig. 65 and 89.

Category 'C' was the most apparently obvious of the six categories and focused on the role of holes, penetrations and openings. This produced important

conclusions concerning 'edge'. I realised that giving a distinct edge to the opening, in for example, *Study No. 30*, Fig. 120, could separate the interior from the exterior. By contrast, creating a curved edge, as in *Study No. 23*, Fig. 119, merged the interior and exterior and avoided a clear distinction. The merging of the two was used to create a continuous surface. The importance of edge was discovered through observations made in my own practice and by examining the work of artists such as Hepworth, in, for example, *Oval Sculpture*, 1943 and *Pierced Form*, 1931. The use of distinct edge in Bill's sculptures, *Endless Ribbon*, 1935 and *Endless Ribbon, Version IV*, 1955, was a catalyst for my realising that a continuous surface in all directions was necessary if I was to succeed in my research.

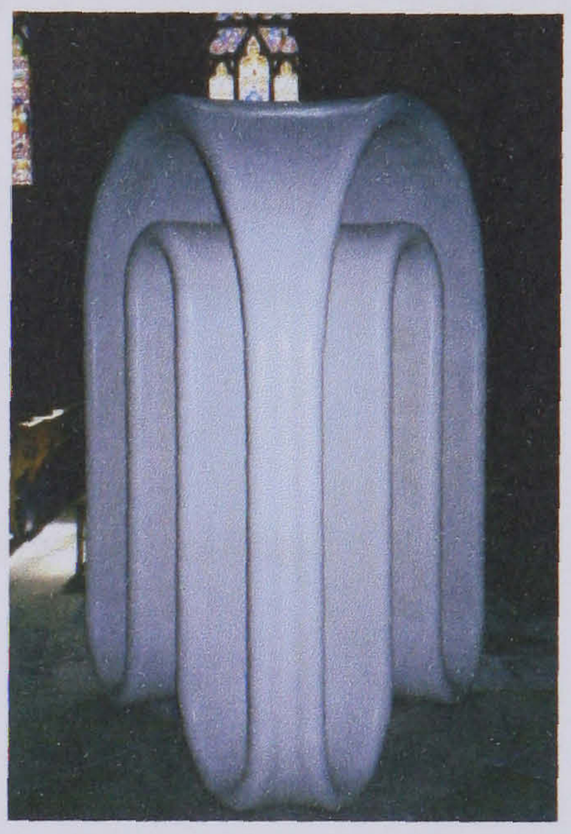


Fig. 120
Above: Study No. 30, repeated from Fig. 87 and 89.
Right: No. 36, Loop, repeated from Fig. 107.

In the Introduction I discussed a group of artists who began from the interior and worked outwards and used a central axis in their work. This group included Boccioni, Gabo, Martin, Serra, Gonzalez and, to some extent, Smith. The sculptures discussed could be further categorised into being concerned with stereometry, or dealing with either implied or actual rotation together with line to imply plane and plane to infer volume. With the exception of Serra, all these artists used the central axis to imply the enclosure or disclosure of interior space. Serra used the central axis to articulate space. The influence of implied rotation was included as Category 'D' of the taxonomy and in the earlier studies, such as, *Study No. 21(i)*, Fig. 47, I investigated the disclosure of the interior through implied rotation. I also experimented with placing the axis point outside the exterior surface in the sculpture, *No. 36, Loop*, shown in Fig.120, but the real

value of this category was to reaffirm the importance of a main axis as a reference point for an interior.

The emphasis in *No. 33, Simply Connected*, Fig. 121, was on making a form that had a continuous surface to create ambiguity surrounding interior and exterior. By introducing space into the sculpture all the surfaces could be seen to continue and the 'edges' were curved to connect interior and exterior without a specific point of transition. Although the form had a continuous surface, from the front and side views, the sculpture appeared to consist of two parts, one within another. This provided an opportunity for the surface of the form to continue from the interior to the exterior. As the sculpture was a cylinder that was apparently folding back on itself, where the interior surface was exposed to become exterior, which in turn masked an exterior surface making it an interior. It was impossible within the sculpture to be precise about the positioning of interior and exterior and this was its potency for simultaneous exposure.

Fig. 121
No. 33, Simply Connected

The final study and sculpture, *No. 40, Hollow*, Fig. 122, brought together all the results discovered throughout the research. The sculpture was a horizontal cylindrical form that was open at both ends, allowing a central interior space to be seen. A continuous surface was achieved by making the ends of the cylinder curved and these curved 'edges' made the transition between interior and exterior ambiguous and avoided a specific region where one became the other. Through carefully considered proportions the combined wall width of the cylinder was half the overall width of the sculpture. This resulted in the curved 'edges' that connected the walls relating to the scale of the sculpture and promoted the appearance of a continuous surface. Space around the surfaces also allowed them

all to be seen and emphasised it as continuous. As the sculpture was hollow and the surface was not cut, there was a 'hidden' interior space within the walls of the cylinder. This hidden interior space was displaced from the outside by a spherical indentation. The indentation created an interior on the exterior surface of the cylinder and this exchange challenged the terms interior and exterior. The curved 'edges' and continuous surface between the cylinder and the indentation again created ambiguity surrounding where exterior became interior. The main central axis was utilised in all three separate interiors and this reference point confirmed their interiority despite their apparent positioning and ambiguity. It also allowed interior and exterior to be seen from all viewpoints.

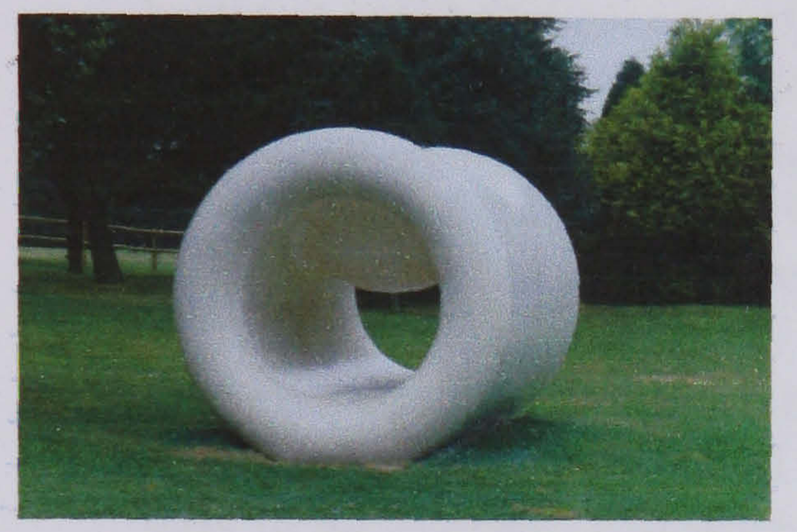


Fig. 122
No. 40, Hollow

Simultaneous exposure of interior and exterior was initially sought through precise definitions, but as the research evolved I realised that this could be more effectively achieved through considered imprecision. Used deliberately, this ambiguity became a strength as a heightened awareness of interior and exterior was brought to the sculptures where no clear transition occurred. Symmetry and a main axis were also used to assist in identifying interior and exterior, and, were used concurrently with a continuous surface and the obliteration of 'edge', to make the demarcation of interior and exterior deliberately vague. True simultaneity of two opposite terms is unavoidably impossible to achieve. In this research, I have been concerned with the fine balance between definition and ambiguity. The result was sculpture that simultaneously defined and questioned interior and exterior.

ENDNOTES

Introduction

[1] The two phrases 'interpenetration of planes' and 'continuity in space' are taken from Apollonio, 1973, p. 52.

[2] What Boccioni appears to be doing in this work is opening up the bottle to connect the exterior space, surrounding the sculpture, to the interior space within it. The opening up takes the form of a series of upwardly spiralling contoured layers, which rotate around the central space and culminate in a tight arrangement of displaced planes at the neck of the bottle, which once again, enclose the bottle's space. Although the interior of the bottle has been disclosed, light and shadow play an important role in continuing to describe interior space within the composition. As the exposed space of the inside of the bottle retains its concave shape, except for the neck of the bottle, it is the darkest area of the sculpture. Due to the shadows created, despite the interior of the bottle being exposed, it retains a sense of having an interior. In this way although the interior and the exterior space is connected and space defines the interior of the bottle, the interior and the exterior of the composition remain distinct.

[3] The edges of the displaced planes accentuate a depiction of dynamism as their uneven thickness added to the sense of eccentric movement. They also vary in the sharpness of edge, with the outside contours of the bottle having the sharpest edges amongst those displaced. This accentuates the sense of the bottle having been cut into and space being revealed. The softer, more curved edges are at the neck of the bottle and infer the planes are folding back on themselves thus depicting the sense of movement Boccioni sought.

[4] The maquette for the *Schröder House* clearly shows it was built from a cube form, in which horizontal and vertical planes predominate, Rietveld used several procedures to achieve his aim of continuity. The first was to open up the closed cube and provide a sense of continuity between the space on the exterior and the space on the interior. The second procedure used to define space without enclosing it was achieved internally by creating a flexible floor plan. The third procedure, which he applied to both the exterior and the interior, was the use of surface including transparency and colour to create a sense of continuity.

[5] The two floors of living space, each of approximately 60 square meters, did not correspond to one another due to the main living area, on the first floor, having one of the first examples of an open-plan space with no set rooms. Using sliding partitions, rooms could be made that were arranged sequentially around a fireplace, which is situated off-centre in the space. The flexible floor plan allowed partitions or walls to be moved or removed completely giving a great range of room arrangements or one continuous room. The partitions followed a precise route indicated by horizontal and vertical coloured surfaces. Where there were rooms in the house, materials and colour were used to provide continuity between them and were chosen

and positioned according to their absorbent or reflective qualities. An example is the blue of the ceiling in the hall, which appears to continue onto the black ceiling of study because of the reflection in the overhead window between the two rooms.

[6] *Constructed Head No. 1*, 1915 can be used to exemplify the whole group of sculptures made around this time: originally from cardboard and then translated into other planar materials such as, in this case, plywood or sheet metal. Slotting together curved or flat planes so that the edge of the plane produced the three-dimensional outline and created the honeycomb structures.

[7] This quote is from an essay entitled 'Die mathematische denkweise in der kunst unserer zeit' (The mathematical approach in contemporary art). The text was first published in Das Werk, no. 3,1949.

[8] An example of James Turrell using the sky in a piece of work is *The Elliptic Ecliptic*, which was a project commissioned by Michael Hue-Williams Fine Art, Tremenheere, Cornwall, August 1999 during the solar eclipse.

[9] The conversation with Sune Nordgren took place in Kapoor's London studio on 19 May 1999.

[10] *Suck*, 1998, was a mirrored steel form that was set into the floor and had a graduated edge. It reflected a distorted view of the surrounding gallery space and the viewer. In essence, it was a deep interior space, made seemingly deeper by the fact that one could not see the bottom of the hole.

[11] The lack of orthoganality was compounded in the Guggenheim, Bilbao by the fact that the 'Fish' Gallery where the Serra exhibition was situated also did not have straight walls. Both Serra and Frank Gehry, the architect of the Guggenheim both used a software programme called CATIA, originally designed for aerospace technology. The programme produced the radial lines on a template for the roller to follow to bend the plates for Serra's Ellipses and the outside plates of the Museum.

Introduction to Studio Practice

[12] In the sculptures made before *Recipient*, as shown in Fig. i-28, the tables were predominant and the opposite terms of reference were 'above' and 'below'. These terms were the subject of my MA thesis, *The table as a strategic tool*, 1995.

[13] This sculpture was exhibited at Chelsea Harbour from 1997 –99 and is now in the grounds of Heathermount School, Sunningdale, Berkshire.

[14] I use the word 'dichotomy' in the sense of 'something paradoxical or ambivalent' OED, 1989.

[15] Part of the reason for wanting to investigate the notion of the interior and the exterior in sculpture was that the terms were also closely associated with, for example, the interior of the body, the interior and the exterior of buildings, vessels, etc. The terms could also involve a wide range of other inferences, such as, mind and body, hidden and overt, protection and exposure, etc.

[16] This description of the taxonomy is a list of the categories included and the full taxonomy can be found on pages 59-61.

Studio Practice – Section One

[17] Although the studies and sculptures were set out in a linear manner in the studio diary, in practice, the studies were not necessarily made individually and often studies with the same aims were made alongside each other. They are numbered and discussed individually to assist the clarity of the diary. Also, within each numbered study, in some cases only a single form was made and in others a number were made and only one was chosen for discussion.

[18] The definition of a cylinder is ' a solid figure in which the two ends are equal and parallel circles, and the intervening curved surface is such as it would be traced out by a straight line moving parallel to itself with its ends in the circumference of these circles'. OED, 1989.

[19] One of the aims of the research was to achieve the simultaneous exposure of the interior and exterior of a form in the simplest way possible. To this end I did not want to introduce any unnecessary elements into the studies or sculpture. This was achieved by restricting the work to one material and a uniform colour.

[20] Studies, which were small scale, were made during the investigations to increase the production of work and to test out ideas. The majority of the studies were not intended to be made full-scale but, nevertheless, consideration was given to the differences that would have occurred had they been made larger.

[21] In *Studies Nos. 7-12* I was investigating ways to reveal the interior and to create ambiguity between interior and the exterior, which could be used in the later stages of the research, rather than pursuing a single approach.

[22] The difference between penetrating the exterior surface of this *Study No. 10*, Fig. 16 and *Study No. 2*, Fig 2, was that in the former, a hollow layered form was used. In this way the interior revealed was the interior surfaces of the form rather than the interior of the material. This was to become a significant factor in later investigations.

[23] As mentioned in the introduction to the studio practice, after the taxonomy had been established, I began by investigating the influence of implied rotation because it appeared to be the most direct way of exposing the interior.

[24] *Study No. 14(ii)*, Fig. 28, intimated a more dynamic way to reveal the interior of a form and I made two cylinders that were divided in directions other than vertical.

As no parts were removed after the cuts made in the studies, as shown in Fig. 123, the only method of revealing the interior was to move one of the parts. As long as a reorganisation of the parts took place, the interior could be revealed, independent of the angle or number of cuts. However, I felt that the diagonal cutting was at odds with the geometry of the cylinder and did not continue with these explorations. I felt that the diagonal cutting was at odds with the geometry of the cylinder and did not continue with these explorations.

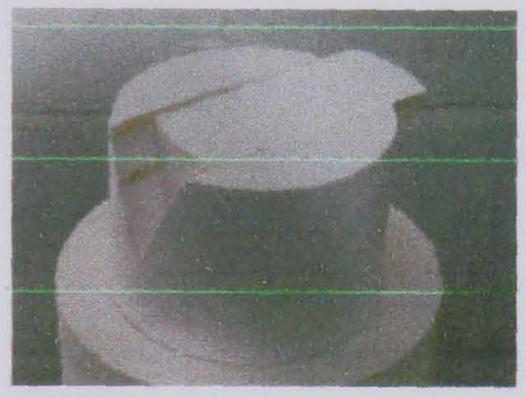


Fig. 123
Plaster. H 10 cm, D 14 cm
An example of a cylinder that was cut at angles other than 90 degrees and a part moved to reveal the interior.

Studio Practice – Section Two

[25] The Möbius Strip was named after August F. Möbius (1790-1868), a German mathematician.

[26] Vanessa Fell conducted the tests into the opacity and translucency of materials at the Institute of Archaeology in Oxford. I took samples of over thirty different materials, ranging from metal to sponge and these were tested using an x-ray machine set at 70 kilovolts and exposed for different lengths of time: from 30 seconds to a minute. The film to focus distance remained constant and was 0.7 metres. It was the density of a material, as dictated by its atomic number, that was the dominant factor in establishing its opacity or transparency under x-ray technology; the higher the atomic number, the more opaque the material. The thickness of the material also produced the image (see endnote 28). We observed that materials such as steel and clay were opaque and aluminium foil and cardboard were transparent under x-ray. I was looking for a material which was translucent with which I could produce a form that would reveal what was inside the exterior surface. Of the materials tested, wax, wood and aluminium were translucent. The forms in Figs 60-65 were x-rayed at Gloucester Royal Hospital with the assistance of Dr Michael Ward.

[27] In basic terms a radiograph is a photographic documentation of the level of absorption of x-rays that penetrate material. This absorption is affected by the density and thickness of the material that is being exposed to the x-rays. X-rays have the characteristics of travelling in straight lines, at the speed of light and being able to penetrate matter. As they penetrate matter they are more or less absorbed in the process, depending on the material, its density and thickness. They affect photographic films and cause some materials to fluoresce. It is the fluorescence that affects the photographic film and results in the recording of an image. *Radiography of Cultural Material*, ed. by Janet Lang and Andrew Middleton, (Oxford: Butterworth-Heinemann, 1997), p.5

[28] A Möbius strip is a deceptively simple form that perceptually is difficult to understand. Making one and having it as reference helped me observe its perceptual ramifications.

[29] I chose a sphere to compare with a Möbius strip as a sphere does not have corners to change the plane and, therefore, the continuous surface could be more easily understood.

[30] Also as previously noted, in some of the Möbius strips in Bill's work the surface did not always appear to be a single surface. This was due to the sharp edges in, for example, *Endless Ribbon*, 1953, where the surface appeared to be separated into two by a distinct edge and the thickness of the material.

[31] Diagrams and other images were used instead of studies where it was felt that the information revealed was already understood. They acted merely as a visual reference.

[32] With the example of a radiograph of a coin it is not actually the top and the underneath that is revealed, but the depth of the coin. Due to the variation in thickness, the x-ray reveals an image, which appears to be the head and the tail of the coin.

[33] In an attempt to draw a parallel between this study, *No. 24*, shown in Fig. 65, and the cylinder with a marble in the material, shown in Fig. 61, I had inserted part of a hollow sphere to make a convexity in the inner wall of the cylinder. When the cylinder was x-rayed the convexity was directly facing the front and only appears as a faint ellipse in the radiograph. When I saw the x-ray and the amount of information it revealed I was grateful that the convexity had not shown up, as it was irrelevant. Without needing to remake the cylinder I could see that one with uniformly straight sides would have revealed the same information but just omitted the ellipse. Therefore, from this point on I disregarded the convexity.

[34] *Study, No. 28*, as shown in Fig. 80, had a similarity to *Study No. 9*, shown in Fig. 15, and this was particularly evident in the vertical cross-section drawing of *Study, No. 28*, as shown in Fig. 81. In the earlier study there had

been an ambiguity as to what was an interior space but in the later study there was little doubt that the contained space was an interior.

[35] I wanted *Studies Nos. 25-30,* Figs 71-87, to have a link with the radiograph in Fig. 65, which is why I used an open cylinder. I did not, however, merely want to repeat the form and make a hole in the side to reveal a space between the walls. For this reason I chose the sphere, which apart from introducing another geometric form into the cylinders, was used to intersect the exterior walls.

[36] In an attempt to emphasise the edges of the form I cast a long cylinder in plaster, which had curved ends and a curved opening down part of its length. The cylinder was made through a combination of casting plastic tubes with modelled clay sections. The majority of the form was made from plaster but I also experimented with a new material to me, Jesmonite, which is described in endnote 38.

[37] To successfully attain a surface that continued in and out of the form I especially wanted to move away from any reference to a vessel whose primary purpose is to contain. For this reason the form was longer, in comparison to others made in the research to date, and it was laid on its side. The final sculpture, which in part had 'organic integrity', was at odds with the intentional visible cast marks of the making process. The joins of the sections of the cast, although smooth, were visible and brought attention to the surface of the form. The sculpture could have been painted to unify the surface, but I preferred the contradiction of the apparent continuous surface with the truth that it was made in sections. I was also interested in the inherent qualities of the materials I was using. One reason for using plaster (and later Jesmonite) in the work was that I liked the coolness of the white and the subtle changes in tone that could be achieved. They also had connotations of being prototype materials making the forms potentially in a state of transition. I found this appropriate, with the research investigating the change from one state to another, i.e. interior to exterior.

[38] Jesmonite is a water-based acrylic composite, which is made by mixing two parts powder to one part liquid. It can be used as a solid material or cast in layers. Jesmonite has properties similar to glass reinforced polyester resin, allowing strong skins as thin as 6-8 mm to be cast. It is recommended that for added strength, Jesmonite is used with quadaxial matting, which is a glass matting that is sewn together rather than woven. Jesmonite was developed for architectural reconstruction as it takes detailed casts, has little shrinkage and takes additives, such as pigments and stone powder. It also comes in three grades: carvable, castable and machinable. A clear top coat can be applied to help with weather resistance.

In my work I used the middle density Jesmonite (castable) and used it in its natural state, without additional pigment or stone powder. It is recommended by Jesmonite Technologies Ltd that moulds be made from silicon rubber as the strength in the Jesmonite comes when it is dry and, therefore, is still green and brittle during de-moulding. As I was making

often large, one-off moulds silicon rubber moulds were prohibitively expensive. However, after experimentation I did find that if care was taken, successful moulds could be taken from Hot-Melt Vinyl, flexible metal and plastic moulds and even plaster waste moulds. To make a cast, a mould is first waxed and a gel coat applied. Two more coats of Jesmonite are then applied. A layer of matting is then laid onto wet Jesmonite and painted over. The next layer is Jesmonite mixed with chopped strand and should be approximately 6-8 mm thick. This is a spacer layer, which gives the strength, before the last layer of matting is applied, in the same way as the first.

Jesmonite can be obtained from:
Jesmonite Technologies Ltd. The Old School, Stanton Lacy, Ludlow, Shropshire, SY8 2AE.

[39] The wall width to whole form in *No. 32, Inverted cylinder*, Fig. 94, was the same ratio as the previous sculpture, *No. 31, Continuous Surface*, Fig. 90. However, as *No. 32* was based on the diameter of the cylinder in *No. 31*, the wall width had actually been doubled by comparison.

[40] The name of the sculpture, Simply Connected, referred to a term used in topology, which is the 'branch of geometry concerned with continuity in geometric figures, i.e. with those properties of a figure that remain unchanged (topologically equivalent) when a figure is bent, stretched, or shrunk, but when it is not torn or deformed by the fusion of points on it.' Dictionary of Physics, 1990. The term 'simple' means that the curve does not intersect itself. Dr Sankaran, a mathematician from Bath University, explained the terms to me during conversations about topology and surfaces.

[41] The projection of an interior beyond the exterior surface was first explored in *Study No. 10*, Fig. 16 where it was found to create ambiguity surrounding interior and exterior.

[42] The sculpture had succeeded in losing its reference to vessels or receptacles, which were present in earlier studies, such as, *No. 26*, Fig. 74. Along with my own intentions the form began to take on other references, both organic and man-made, for example, the appearance of a mushroom or the aerodynamic nature of an engine cowling for a jumbo jet.

[43] There were similarities between this sculpture, *No. 36, Loop*, and Smith's *Blackburn: Song of an Irish Blacksmith*, 1949-50, where he dispensed with a central core to introduce incoherent viewpoints.

APPENDIX

Fig. a-1. Diagram demonstrating the methods used to investigate interior and exterior of form by artists discussed in the introduction

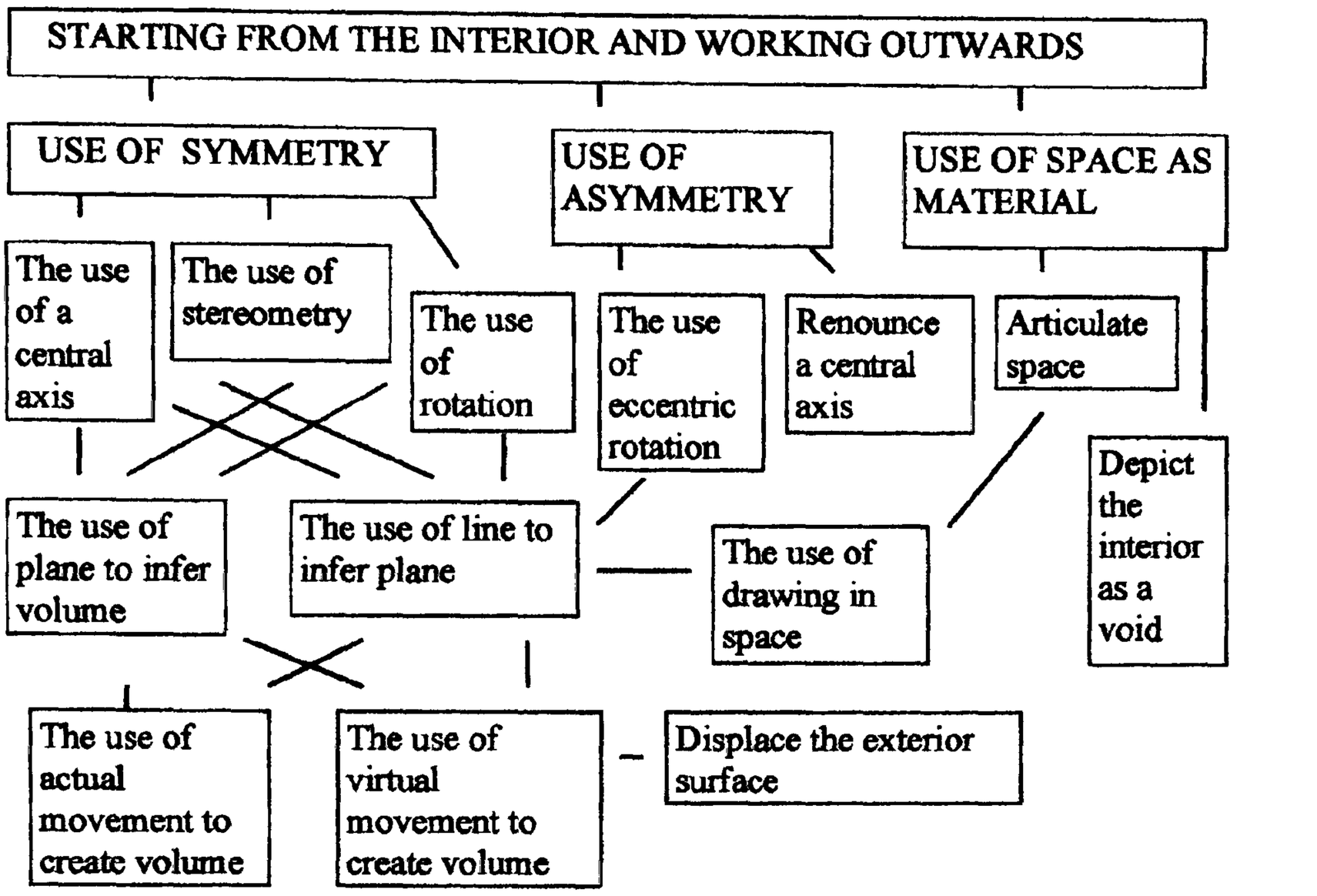


Fig. a-2.
The methods of working used to achieve the aims of the selected examples of artworks discussed in the introduction

AIM	Start from the interior and work outwards.	Start from the exterior and work outwards.	Work on interior and exterior simultaneously.
Introduce space into mass.	Stereometry. Symmetry or asymmetry + line to infer plane. Symmetry or asymmetry + plane to imply volume. Displace the exterior surface.	The use of holes, penetrations and openings.	
Continuity in space.	Eccentric rotation-virtual movement-displace the exterior surface. Project or extend from the interior.	Penetrate the exterior surface.	Topology. Transparency
Define space	Stereometry + draw in space with line.	Use the exterior as a boundary.	
Question the boundaries between the interior and the exterior.		The use of stratification. Use the exterior as a boundary.	Restrict information revealed from a given viewpoint. The use of topology.
Creation of apparent volume.	Central axis-line to infer plane-virtual or actual movement. Central axis-plane to infer volume-virtual or actual movement.		
Use notions of the void.	Central axis	Use the exterior as a boundary. Use holes, openings and penetrations. Use of the edge of the exterior surface.	Use of light and shadow.
Articulate space.	Use space as a material. Symmetry. Eccentric rotation. The use of virtual or actual movement.	Allow physical access to the interior of form.	Use of topology. Restriction of information revealed making viewer move around the work.
Undermine apparent volume.	Renounce the use of a central axis.		

GLOSSARY

Some terms have specific meanings within the context of the research and are listed below:

Ambiguity: This term was used to describe the lack of distinction surrounding the exact region where interior becomes exterior or vice versa.

Anthropometric: Relating to the measurement of the body.

Arc: Usually part of the circumference of a circle or other curve and in the context of the research relates to a section from a cylinder.

Asymmetry: A lack of symmetry.

Axis: 'The straight line about which the parts of a body or system are symmetrically arranged.' OED, 1989

Closed form: A form that is enclosed by an exterior boundary.

Closed material: A material or surface, which is not cut or penetrated.

Concentric movement: Movement from a common centre.

Continuity of space: A situation where space within an object appears to continue without interruption to the surrounding space

Continuous exterior surface: An exterior surface, which extends without apparent interruption.

Curved continuous surface: A surface, which is apparently continuous irrespective of whether it is on the interior or exterior of a form. It is also uninterrupted by corners or edge.

Cylinder: 'A solid figure of which the two ends are equal and parallel circles, and the intervening curved surface is such as would be traced out by a straight line moving parallel to itself with its ends in the circumference of these circles.' OED, 1989

Cylindrical form: A form that has some semblance of a cylinder.

Dichotomy: I use the word in the sense of 'something paradoxical or ambivalent' OED, 1989

Dynamic equilibrium: The phrase was taken on by the De Stijl group from Mondrian's idea of composition, which was complex and developed throughout his career. His notion of dynamic equilibrium was significantly different from classicism.

Dynamism: Used in context to mean demonstrating apparent movement.

Eccentric movement: Movement that occurs when an axis is not placed centrally.

Edge: Used to denote a difference in state, i.e. a change in plane or a change from exterior to interior.

Equilibrium: The state of equal balance. Used specifically in my own practice to mean that neither the interior nor the exterior dominate.

Exterior surface: The tangible exterior boundary of an object.

Exterior: In relation to my sculpture came to refer to the exterior boundary or surface of a final form or composition. The form may include an implication that part of the exterior has moved to the interior, but the exterior was still the exterior surface of the final form. More succinctly, an exterior boundary or surface.

Fibonacci series: A series in which successive pairs of numbers are added together to form the next number. (Scholfield, 1958, p. 11) Named after 'Leonardo Fibonacci, also called Leonardo Pisano (Fl. 1200). Tuscan Mathematician.' OED,1989.

Formal aesthetic: The appearance of the object or form in an artistic context.

Former: A device used as a mould to cast a specific shape.

Graduated edge: An edge that does not have a specific point at which the plane changes.

Hidden/concealed interior: An interior area or space that is within a closed exterior boundary and cannot ordinarily be seen in an opaque material.

Hollow form: A cast form that contains space.

Hot-Melt Vinyl: A vinyl moulding compound, which can be melted down and re-used numerous times. Available in hard or soft grades and particularly suited for use with plaster.

Implied rotation: That which appears to encapsulate a sense of concentric movement.

Incremental movement: Either actual or apparent movement that moves in measured amounts.

Incrementally exposed: Disclosure by either actual or apparent movement that moves in measured amounts.

Inside: A term used within the research when inexactness is needed during a description of something within an exterior boundary.

Interchange: Used in the research to mean a relationship between interior and exterior.

Interior surface: The surface of a form that is within an exterior boundary.

Interior: An area or surface within a form that may be revealed or concealed.

Jesmonite: A water-based acrylic composite, which is made by mixing two parts powder to one part liquid. It has properties that are similar to glass reinforced polyester resin.

Mass: A volume of substance that occupies space.

Möbius strip: A strip with one apparent surface due to a twist of 180 degrees in the material before joining the two ends together. Created by a German mathematician, August F. Möbius (1790-1868).

Opaque: That which cannot be seen through.

Open form:	A form that has some part of it drawn aside to allow free access to the interior.
Orthoganality:	Right-angled.
Outside:	A term used within the research when inexactness is needed during a description of something beyond an exterior boundary.
Parabola:	'One of the conic sections; The plane curve formed by the intersection of a cone with a plane parallel to a side of the cone.' OED, 1989.
Plane:	A surface.
Positive/negative reversal	The exchange of space for mass or vice versa.
Radiograph:	A photographic documentation of the level of absorption of x-rays that penetrate matter. (See endnote 27)
Rotational symmetry:	Symmetry that occurs around a fixed point.
Solid:	Full of matter, that which is not hollow.
Space displacement:	Used specifically to mean the movement of interior space through a change in the exterior or interior surface, which surrounds it.
Splayed axis:	The upsetting of sections from a central axis.
Stereometry:	The use of a central plane to imply volume.
Stratification:	The use of layers.
Surface:	The visible and outermost boundary of anything.
Symmetry:	Symmetry is firstly used to mean the 'equable distribution of parts about a dividing line or centre' (OED, 1989), but is also used in a looser way to imply balance.
Taxonomy:	The introduction of clarity and definition into the research to create a coherent language.
Topology:	'branch of geometry concerned with continuity in geometric figures, i.e. with those properties of a figure than remain unchanged (topologically equivalent) when a figure is bent, stretched, or shrunk, but when it is not torn or deformed by the fusion of points on it.' (Dictionary of Physics, 1990)
Translucent:	Neither transparent nor opaque and has the property of being seen through under certain circumstances.
Transparency:	That which can be seen through.
Transpose:	To change the order of position.
Vertiginous:	A sense of vertigo
Virtual movement:	Demonstrating apparent movement, but with no actual movement.
Walls:	Specifically referring to the surfaces of the forms used in the research, which surround the 'hidden' or concealed interior space.
X-ray:	'A form of radiation discovered by Prof. W.C. Röntgen of Würzburg in 1895, capable of passing in various degrees through many substances impervious to light, and of affecting a sensitised plate and thus producing shadow-photographs of objects inclosed within opaque receptacles and bodies... Now known to be a form of electromagnetic

radiation of wavelength less than that of short-wave ultraviolet light. OED, 1989. Also see endnote 27.

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