

Geometries of Hope and Fear: the Iconography of Atomic Science and Nuclear Anxiety in the Modern Sculpture of World War and Cold War Britain

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In the 1952 monograph of the sculptor Barbara Hepworth, her friend and apologist Herbert Read observed that her work since 1934/1935 had developed ‘a dialectic . . . between the antitheses of Geometry and Grace’. For Read, the geometrical aspect was especially evident in her drawings, above all those from 1936 to 1942 (Colour plate 3). He identified the origin of her formal geometries in the Constructive art of Naum Gabo and her former husband Ben Nicholson, which aimed to create a ‘new reality’ where art would ‘enhance life, assert it and assist its further development’.¹ Like them, Hepworth signalled her desire for a new social and political order by alluding to the geometrical forms associated with modern science and mathematics. The reintegration of artistic and scientific endeavour that they imagined was exemplified by their friendship with the atomic physicist John Desmond Bernal. In common with many in the late 1930s and early 1940s they presumed that the advance of science, especially of the new field in which Bernal worked, would bring about a more enlightened, equitable and peaceful world. By the time Read’s monograph was published, the geometric imagery of simplified atomic diagrams had become a ubiquitous symbol of cultural and social progress, conspicuously appropriated by advertising and interior decoration at the 1951 Festival of Britain.²

Just as the optimistic symbolism of atomic geometry acquired popular currency, Read provocatively redeployed the term to characterize a very different kind of modern sculpture. In the summer of 1952 – between the Hepworth monograph going to press and publication – he published an introduction to the eight ‘young’ British sculptors representing Britain at that year’s Venice Biennale in which he famously described their sculpture as embodying ‘the geometry of fear’.³ His metaphorical phrase responded to their invention of new expressive forms that had ‘a linear, cursive quality’, exemplified by Reg Butler’s *Woman* (1949; Figure 2.1). Coming at a moment when the ideological conflict of the Cold War had been transformed into military confrontation in Korea and increased risk of nuclear warfare, Read’s memorable phrase slipped into the discourse of post-war British sculpture, shifting the semantic associations of ‘geometry’ away from the Constructive art of utopian Socialism (familiar to regular Biennale visitors from Hepworth’s 1950 exhibit) toward an Expressionist art of dystopian anxiety. Given the former associations of geometry with proportion, perfection and purity, Read’s application of the term to an art of deformation, despair and hybridity had the gloomy implication that formal, social and political unities were no longer imaginable, let alone attainable. Although Hepworth and Gabo – the most committed Constructive sculptors – continued to make geometrical works that represented their positive vision of the future, contemporary fears of Cold War enmity and global catastrophe ensured that ‘the geometry of fear’ overshadowed the geometry of hope.

Unlike the corresponding literature of American and continental European art,⁴ comparatively little has been published on modern British sculpture’s complex and changing relation to the ‘atomic’ or ‘nuclear’ age. In tracing their relation from the mid-1930s to the mid-1960s, this chapter takes Read’s provocative allusion to

‘geometry’ in 1952 as a pivotal moment of recognition. The first half of the chapter draws on recent research into the influence of science and mathematics on Hepworth’s and Gabo’s optimistic Constructive art of the later 1930s and early 1940s, investigating the far-reaching but little recognized impact on them both of Bernal’s atomic research. The second half of the chapter examines the more familiar association of British post-war ‘humanist’ sculpture with anxieties over nuclear warfare in the early years of the Cold War. It demonstrates that some sculptors, such as Henry Moore and the naturalized Hungarian émigré ‘Peter’ (Laszlo) Peri, made works that both overtly celebrated atomic science and opposed nuclear weaponry, while those now routinely identified as ‘Geometry of Fear sculptors’⁵ invented a more coded sculptural language to address the perils of the nuclear age. Throughout the chapter, a premium is put on Read’s influential writings as they were critical to shaping the meaning of modern British sculpture, both during the period and after. The chapter concludes with an analysis of how Read himself and others have understood his seminal description of post-war sculpture.

Hope: Constructive Sculptors and Atomic Science (c.1936-1945)

The friendship between Hepworth, Gabo and Bernal was characteristic of the London Constructivist circle, which brought artists, architects, designers and writers on art and design into contact with scientists and writers on science. Encouraged by Socialist convictions, they devised a Modernist programme for art and design that sought to reintegrate art and science, and to challenge the intellectual compartmentalizations of bourgeois culture. As the architect and co-editor of their ‘manifesto’ publication *Circle: International Survey of Constructive Art*, Leslie Martin observed: ‘In science as in art, “appearance” has been jettisoned in favour of a world discovered only through the penetration of appearances.’⁶ Among their scientific friends were zoologist Julian Huxley, anatomist Solly Zuckerman, biologist C.H. Waddington, geneticist C.D. Darlington, and science-journalist Jim Crowther. But as other art historians have demonstrated, it was the brilliant, charismatic polymath Bernal who most encouraged Hepworth’s and Gabo’s dialogue with science and mathematics.⁷ In 1937 Bernal became Professor of Physics at Birkbeck College, University of London, having established his reputation as a leading crystallographer at the Royal Institution and Cavendish Laboratory. Known to many friends and colleagues as ‘Sage’, Bernal refined the practice and theory of X-ray crystallography pioneered by William Henry Bragg and his son William Lawrence Bragg, inventing cameras and photographic methods to analyse the sub-microscopic arrangement of atoms in complex molecules. As a Marxist, a pacifist, and an admirer of modern art and architecture, he was especially interested in the social function of art and science.⁸ In 1937, he lectured on ‘Architecture and the Scientist’ at the Royal Institute of British Architects and, at Hepworth’s invitation, contributed an essay on ‘Art and the Scientist’ to the sculpture section of *Circle* and the foreword to an exhibition catalogue of her own work.⁹ His enthusiasm for modern art deviated from the official Communist Party doctrine of ‘socialist realism’, and he argued for the social utility of Hepworth’s sculptures by likening them, paradoxically and prophetically, to Neolithic menhirs.¹⁰ By 1952, he owned two works by Hepworth and at least one by Gabo.¹¹

Hepworth was introduced to Bernal in the early 1930s by their mutual friend, the writer and collector Margaret Gardiner (then Bernal’s lover), who witnessed their

fascination with each other's professional work.¹² Bernal's biographer, Maurice Goldsmith, records that Hepworth 'loved the visits of Bernal, who would examine her works and explain their mathematical and geometrical forms'.¹³ According to their mutual friend Marcus Brumwell and Hepworth herself, they exchanged ideas excitedly and drew things for one other on the studio floor, while Bernal occasionally wrote mathematical equations in delible pencil on her sculpture (rather as mathematical models were sometimes inscribed).¹⁴ Sculptor and crystallographer shared a common interest in the nature of matter and three-dimensional form. A few years after meeting Bernal, Hepworth's interest in crystal structures led her to accompany a mineralogist to the National Geology Museum.¹⁵ Meanwhile, Bernal became sensitive to parallels between abstract geometric sculpture and crystallography, noting in his writing on Hepworth that 'By reducing the traditional forms of sculpture it is possible to see the geometry which underlies it.'¹⁶ His understanding of formal structure, including characteristics such as reflection and symmetry, is evident in his essay in *Circle*, where he likens a sculpture's internal formal relationships to the forces of attraction and repulsion between atoms, comparing Hepworth's *Two Forms* (1935) to a scientific illustration of the 'equi-potential surface of two like charges'.¹⁷ In their fruitful correspondence, Hepworth addresses him respectfully, even deferentially, accepting his 'scientific' criticisms of her sculpture. While she acknowledges important differences between art and science, she assumes they share a rational, Constructive search for aesthetic and political truth:

...science, surely, does not work as emotionally as ptg or sculpture. You always seem to me to be searching for, discovering + applying basic laws + principles....I know no one more fitted to make these laws clear to other people. Your criticism is most stimulating because you know exactly where a law has been broken + can apply the principle so that you can make the solution clear. It seems to me that we know those laws emotionally + intuitively, learning by our experience + trying to live the sort of life that will most easily enable us to express the laws – that is construction.¹⁸

Hepworth was deeply attracted to Bernal's political ideas: she joined the Hampstead-based anti-Fascist group, *For Intellectual Liberty*, in which Bernal and Gardiner played leading roles, and considered joining the Communist Party.¹⁹ As Hepworth confided to Gardiner, his intellectual and humanitarian ideals seemed to offer a solution to the growing threat of Fascism:

I can't see how science and the human spirit can be reconciled unless there is a clear majority of men of the calibre of Desmond.... I think there will be a new form of ethics – social and political – very *much* to the good and what we had hoped for... I cannot see any hope of stopping this suicidal impulse unless Art and Science stand firm together.²⁰

Hepworth's admiration for and contact with Bernal remained strong until the end of the Second World War, during which time the influence of crystallography grew from a means of understanding her work into an initiating subject.

Gabo's relationship with Bernal was never as close as Hepworth's, tempered no doubt by his own unfavourable first-hand experience of post-Revolutionary Russia.²¹ He and Bernal became acquainted after Gabo's move from Paris to London in 1936, meeting in London and later St Ives.²² Yet, as Martin Hammer and Christina Lodder have shown, Gabo's knowledge of science and mathematics was considerable, far greater than Hepworth's, following his early study of physics and chemistry at Munich University and his continuing appetite for scientific literature.²³ In his 1949 essay 'On Constructive Realism', Gabo used his knowledge of atomic science and

relativity to defend the right of the artist to produce innovative responses to ‘a world which is pictured to us as a conglomeration of oscillating electrons, protons, [and] neutrons’, reasoning:

... If the scientist is permitted to picture to us an image of an electron which under certain conditions has less than zero energy . . . and if he is permitted to see behind this simple common table, an image of a curvature of space – why, I ask, is not the contemporary artist to be permitted to search for and bring forward an image of the world more in accordance with the achievements of our developed mind . . .²⁴

His awareness that atomic physics undermined simplistic distinctions between solids and space has been compared to his method of constructing sculpture in sheets of clear plastic to render its form open and transparent.²⁵ Of Gabo’s *Construction in Space: Crystal* (1937-1939), for example, Jacky Klein observes that its ‘sense of dynamic forces and centrifugal energies relates to his interest in modern physics, in particular to discoveries which pictured the physical universe as a continuous field of forces.’²⁶ It was only after his arrival in London and meeting with Bernal that his aim of expressing ‘the dynamic interior of objects’ was fully realized by fabricating sculpture entirely from transparent planes.²⁷

As sculptors in diverse materials, Hepworth and Gabo were understandably interested in the atomic structure of matter, which determines many of its most important characteristics, such as hardness, texture, strength and colour. But their interest in Bernal’s research went beyond a mutual fascination with the parallels between cutting-edge science and art, and the shaping of their philosophical views of ‘reality’. Their frequent use of crystalline forms and of the term ‘crystal’ in the titles of their works, together with a recognition of this in contemporary criticism, confirms that the science of crystallography had a more specific influence on their work in this period.

Gabo’s awareness of crystallography is widely acknowledged in the literature of the artist.²⁸ Despite his disavowals of its influence, it manifested itself in the forms and titles of several works produced in the later 1930s and early 1940s, most overtly in the multiple versions of *Construction in Space: Crystal* and *Construction in Space with Crystalline Centre* (c.1938-40; Figure 2.2). Of the latter, Hammer and Lodder declare that it ‘evokes a scientific imagery of crystalline or atomic structure’.²⁹ But its connection to crystallography may go deeper: the basic formal structure – a curvaceous shallow ‘tunnel’ enclosing a central octahedral crystal, which several commentators note appears to have the potential to rotate³⁰ – bears a conceptual affinity with the apparatus Bernal invented and used in his analytical technique of ‘single crystal rotation’. The X-ray goniometer – a staple of laboratory practice from the 1930s to the 1950s – directs a beam of rays at a pinhead-sized crystal mounted on a rotating spindle inside a cylindrical camera, enabling its atomic structure to be calculated from the photographic diffraction pattern obtained.³¹ Small wonder that Hepworth, who particularly admired Gabo’s construction, specifically recommended Bernal to view it, and that Gardiner subsequently purchased it.³² Another work from this period which may have some relation to Bernal’s crystallographic methods is the entirely transparent plastic construction *Spiral Theme* (1941), commissioned by Gardiner as a birthday present for Bernal.³³ Hammer and Lodder suggest it was partly inspired by the artist’s own photographs of reflected light patterns,³⁴ connecting its genesis to a source similar to the goniometer’s photographic diffraction patterns.

The influence of crystallography on Hepworth's art has been shown by Anne J. Barlow to be widely acknowledged, though its exact nature is disputed.³⁵ Each of the 20 or so pencil and gouache drawings of 1936-1942 that Read identified as exemplary of the geometrical tendency in her work, depicts one or more irregular-shaped, polygonal figures on an orthogonally divided ground. The majority are traversed by converging and crossing straight lines, some of which intersect to create parabolic curves, giving an overall impression of spatially ambiguous figures that resemble multi-faceted, crystalline forms. Hepworth's biographer A.H. Hammacher observed that the crystal is their 'leading motif' and that 'the poetry of the crystal' marks '[t]his episode of her career',³⁶ having previously noted her understanding of 'mathematics and geometry'.³⁷ The poet Kathleen Raine, who commissioned four of the drawings for her poetry collection *Stone and Flower* (1943)³⁸ – the frontispiece, *Crystal*, and three others entitled with variations of the book's title – believed 'Barbara's hard crystals and solid geometry' expressed their shared understanding of the natural world and 'sense of the interior landscape of contemporary science'.³⁹ Although curator and critic Alan Bowness (Hepworth's son-in-law) has asserted that the drawings are 'an examination of crystal structure',⁴⁰ Barlow is sceptical of 'superficial comparisons between "scientific" form and Hepworth's work', reiterating Hammacher's view that the drawings emerged 'emotionally, not mathematically'.⁴¹ Even if not 'scientific', the visual and circumstantial evidence confirms that Hepworth's drawings from this period and, as we shall see, her sculpture, were informed, like Gabo's constructions, by crystallographic science. That Bernal owned one of Hepworth's crystal drawings confirms their interest to him.⁴²

While we should not expect to find exact sources for Hepworth's drawings in crystallographic imagery, her contact with Bernal makes it likely that she was familiar with his method of drawing crystal structure diagrams and may have seen published examples. Indeed, her drawings bear some resemblance to diagrams of hydrogen-related molecules that Bernal co-published with his doctoral research student Helen Megaw in the *Proceedings of the Royal Society* in 1935, notably to the individual unit cells within the atomic lattices of naturally-occurring minerals such as aluminium hydroxide (Figure 2.3).⁴³ Hepworth's fascination with Bernal's crystallographic ideas raises the possibility that she may have seen other published sources or attended public lectures on the subject by other crystallographers, such as the British pioneer of X-ray crystallography (and Bernal's former research director at the Royal Institution), William L. Bragg. Unlike Bernal's and Megaw's lattice diagrams, Bragg's *Atomic Structure of Minerals* (1937) contains illustrations of single, multi-faceted crystals drawn in three-dimensions, which especially resemble some of Hepworth's drawings (Figure 2.4).⁴⁴ While neither Bernal's nor Bragg's publications were necessarily known to the sculptor, they contain the types of crystalline diagram she is likely to have known. And just as the parabolic curves seem to derive from, but not copy, the mathematical models she (and Gabo) had studied in science museums, so the geometric networks of straight lines seem to allude to crystal diagrams, without exactly imitating them.⁴⁵ This fusion imbued Hepworth's work with a scientific resonance, evoking the complex modern experience of the natural world.

In Hepworth's 1952 monograph, Read acknowledged the connection between these drawings and her contemporary sculpture and Hepworth herself described them as 'my sculptures born in the guise of two dimensions'.⁴⁶ Both this monograph and William Gibson's earlier one juxtapose reproductions of one of the crystal drawings

with a version of *Sculpture with Colour* (Colour plate 4),⁴⁷ suggesting that this work exemplifies Hepworth's increasingly self-conscious engagement with crystallography in the early 1940s. Forced by wartime restrictions to work on a smaller scale than usual, what more fitting subject than the crystal? The first and smallest version of the sculpture was the only sculpture Hepworth took with her when she moved from London to St Ives in 1939 and during the following three years she made five larger versions. Collectively, they transform the converging lines, parabolic curves and bright colours of the crystal drawings into plaster or wood, introducing two significant innovations in Hepworth's *oeuvre*, painted colour and string. The external form of the five later versions, with their more sharply abutting planes, recall the simple octahedral crystals pictured in some of Hepworth's drawings. If read as a hollowed-out crystal, the stringing may be taken to signify the internal atomic lattice. Given that one version was mounted on a turntable, the sculpture invites comparison with Gabo's almost concurrent *Construction in Space with Crystalline Centre*, and in turn with Bernal's technique of rotating a crystal to expose its atomic 'interior'.⁴⁸

Hepworth's and Gabo's enthusiasm for X-ray crystallography extended their circle's longstanding interest in the structure of natural form, which had previously attracted it to a genre of micro-photography found in books such as D'Arcy Wentworth Thompson's *On Growth and Form* (1916 and 1941) and Karl Blossfeldt's *Art Forms in Nature* (English edition, 1929).⁴⁹ Yet however fascinated they were by atomic science, their purpose and understanding were aesthetic and imaginative rather than analytical and 'scientific'. Above all, as Hammacher noted, it was the symbolism of the crystal that mattered most to them:

The geometry of the crystal, the laws it obeys, its clarity – all satisfy the requirements as to form which the anti-surrealists demanded during these years. Crystals were almost symbols of the ideal they pursued.⁵⁰

As Hammacher hints, the formal perfection of the crystal – its order, precision, predictability, universality, and so on – could be taken to symbolize their utopian social ideals. The molecular organization of atoms invited comparison with the strength and coherence of a unified society composed of a mass of equal and interconnected members. Likewise, crystallography and atomic physics were associated with the 'red science' movement of the 1930s,⁵¹ through figures such as Bernal and his predecessor as Birkbeck Professor of Physics, Patrick Blackett.

The symbolic value attached to the crystal by British Constructivists is made clear in the final chapter of Herbert Read's only novel, *The Green Child* (1935), written in the summer of 1934 when Read is almost certain to have been aware of Bernal's crystallographic work. His fantasy novel traces the journey of a former political dictator to an apolitical, peace-loving society which lives in an underground network of crystalline grottoes. Read's narrator comments that: 'The science which we call crystallography . . . was the most esteemed of all sciences in this subterrestrial country; indeed, it might be regarded as science itself, for on it were based, not only all notions of the structure of the universe, but equally all notions of beauty, truth and destiny.'⁵² For the 'workmen' in this harmonious community, the highest 'stages of existence' are to be first a maker of crystals – 'suggested' by natural forms but 'not exact imitations' of them – and then, when judged to have 'constructed' five perfectly formed crystals, a 'crystal-polisher' or 'sage' (Bernal's nickname, as it happens). The elite group of sages spend their final days engaged in what is regarded as 'the most

difficult problem in their philosophy', contemplating the precision, perfection and order of artificial crystals. With flattering implications for the practitioners and theorists of Constructive art, Read's utopian allegory identifies the artistic construction and philosophical contemplation of crystalline sculptural forms as the path to absolute sensual and intellectual enlightenment.⁵³

When Constructive art enjoyed a critical resurgence in the 1940s, its crystalline forms came to embody the hope of post-war social transformation. Hepworth's *Sculpture with Colour*, Gabo's *Spiral Theme* and several of their related drawings were selected by curators Margot Eates and Hartley Ramsden for inclusion in the London Museum's wartime exhibition *New Movements in Art: Contemporary Work in England*.⁵⁴ According to Gabo, the exhibition received about 10,000 visitors and his own work a very positive critical response.⁵⁵ As Chris Stephens has noted, *Spiral Theme* acquired a particularly high status among Constructive artists and their supporters: Read, who had not previously reviewed Gabo's work, hailed it as 'the highest point ever reached by the aesthetic intuition of man'. Two years later it was reproduced alongside a Constructivist work by Hepworth in *This Changing World* (1944), an influential collection of essays edited by Marcus Brumwell, who had become a friend of Gabo, Hepworth and Read through their work for the Design Research Unit (DRU), which he directed, or for his advertising agency. Many of the essays were written by supporters of Constructive art (two of them former contributors to *Circle*), including Bernal, Crowther, Darlington, Raine, Ramsden, Read and Waddington.⁵⁶ Drawn from articles published in *World Review* – a journal edited by Brumwell and owned by the liberal-leftist publisher Edward Hulton – the anthology laid out a progressive post-war programme for art, architecture, science, education, politics, and so forth, applying the utopian spirit of Constructivism to plans for the physical and social reconstruction of Britain.⁵⁷

That crystal structure patterns featured extensively in post-war 'Festival-style' designs for fabrics, wallpaper, products and interiors, is a direct consequence of the influence of Bernal and Hepworth. Lesley Jackson has shown that the Festival Pattern Group's promotion of 'crystal design' had its origins in a proposal made by Brumwell in 1946 for the DRU to publish a book on the subject by Bernal's former doctoral student Helen Megaw. Brumwell had met Bernal through Read, and witnessed Bernal's enthusiasm for Hepworth's sculpture at first hand.⁵⁸ Revealingly, he sought an opinion on the proposed book from Hepworth, who had responded enthusiastically:

I think it's a marvellous idea to use these 'designs' for fabrics . . . The main point seems to me to produce them as suggested in series – with their proper names – exactly as they really are. To me they are more beautiful than any man-made pattern [emphasis in original].⁵⁹

When the idea was taken forward in 1949 by the recently founded Council of Industrial Design, it was because its Chief Industrial Officer, Mark Hartland Thomas, attended a lecture on crystallography given to the Society of Industrial Artists by Bernal's former colleague Kathleen Lonsdale (using slides prepared by Megaw).⁶⁰ With Megaw acting as scientific advisor to the Festival Pattern Group, the pre-war utopian symbolism of Constructivism's crystalline geometries was pressed into post-war service to signify the coming of a progressive, cooperative and equitable, social-democratic new age.

Fear: Humanist Sculpture and Nuclear Warfare (c.1945-1970)

In the year that the imagery of atomic science achieved ubiquity at the Festival of Britain, the Nobel Prize in Physics was belatedly awarded to J.D. Cockcroft and Ernest Walton, who had famously ‘split’ the atom in 1932 while working alongside Bernal at the Cavendish Laboratory under Ernest Rutherford.⁶¹ Following their momentous breakthrough, the technology of the atom bomb was developed during the Second World War by the joint Anglo-American-Canadian Manhattan Project and deployed to devastating effect at Hiroshima and Nagasaki. The Soviet Union achieved atomic capability in 1949 and Britain followed in 1952. As the world fractured into ideologically antagonistic spheres of American and Soviet influence, the likelihood of Cold War escalating into nuclear warfare was increased by a series of international political crises and military interventions, most notably the Korean War of 1950-1953, when Chinese and Soviet-backed forces supported the Communist North against the UN-backed South. From 1953 to 1958, Britain joined the nuclear arms race by conducting H-bomb tests in the Pacific region.⁶²

The proliferation of nuclear weapons and growing risk of their use meant that the positive and optimistic attitudes toward atomic science of the pre-war era were increasingly eclipsed by anxiety and pessimism. Distinguished scientists in the United States – most famously Albert Einstein, Linus Pauling and veterans of the Manhattan Project, Robert Oppenheimer, Hans Bethe and Joseph Rotblat – opposed the development of nuclear arms by founding the Emergency Committee of Atomic Scientists and initiating the international Pugwash conferences. Eminent scientists in Britain, such as Huxley, Waddington and Zuckerman, expressed public concern and joined campaign groups for peace and disarmament. Among them were atomic physicists and crystallographers, including Bernal, Blackett and another of Bernal’s former research students, Dorothy Crowfoot Hodgkin. They supported British protest organizations that emerged in the 1950s, including the Christian, pacifist Toldas group and the larger, non-aligned National Campaign for the Abolition of Nuclear Weapons Tests (NCANWT) and its successor, the Campaign for Nuclear Disarmament (CND). Bernal and Zuckerman were especially vocal, driven by longstanding concern for the social responsibility of science and perhaps by the findings of their wartime military research into the impact of explosive blasts on people and buildings. Bernal brought Communist and non-Communist campaigners together in Scientists for Peace and the Cambridge Scientists Anti-War Group, and joined the CND’s Easter marches to London from the government’s Atomic Weapons Research Establishment at Aldermaston.⁶³

Just as many of the scientists associated with British Constructive art became opponents of nuclear weapons, so did many of the artists. As early as 1950, Henry Moore signed a letter to *The Times* opposing the use of atomic weapons in Korea.⁶⁴ By 1958, he and Hepworth had become sponsors of the CND,⁶⁵ and its forerunner the NCANWT.⁶⁶ They were among the 300 artists and writers who publicly supported the Marxist critic John Berger’s call for an immediate end to the ‘testing, storing and manufacture of nuclear weapons’.⁶⁷ Like many on the Left, Hepworth had felt compelled by the events of 1956 – the Soviet invasion of Hungary and the Suez Crisis – to re-examine her political conscience. Having distanced herself from Bernal and

his politics,⁶⁸ her political sympathies now focused on pacifism, disarmament and internationalism. As she told Read:

I became a pacifist two years ago but all this has pushed me into trying to do more by joining the Labour Party, the Toldas Group & United Nations Association of Great Britain and Northern Ireland], etc. One can scarcely look 'earlier sculptures' in the face if one remains politically and socially inactive now.⁶⁹

Her commitments are likely to have been galvanized by the loss of her first son, an RAF pilot, in the Korean War, while her troubled sense of personal responsibility may have been heightened by her own pre-war fascination with atomic science. That her optimism endured, however, is evident from her continued commitment to a broadly Constructivist aesthetic: her former secretary David Lewis recalls that 'in the post-war years of nuclear arms and the Cold War, she once again sought to make a counter-statement of serenity'.⁷⁰

Unlike Hepworth, Henry Moore produced sculpture in the 1950s and 1960s that was widely seen as a direct response to the prevailing climate of nuclear anxiety. Even Berger, an unlikely champion of Moore, proposed that his *Falling Warrior* (1956-1957) become an emblem for the CND and the preliminary studies the subject of a CND-sponsored exhibition.⁷¹ However, it was Moore's ambiguously entitled *Atom Piece* (1964-1967) that was to become the best-known British sculpture to confront the twin subjects of atomic science and nuclear warfare (Figure 2.5). Commissioned by the University of Chicago, it was intended to commemorate Enrico Fermi's contribution to the Manhattan Project by marking the site of the nuclear pile where, in 1942, the Italian physicist initiated the first self-sustaining nuclear chain reaction. The commissioners hoped it would be 'a monument to man's triumphs, charged with high hope and profound fear'.⁷² On Moore's own account, his proposal provocatively conflated the forbidding forms of 'a mushroom cloud' and 'a skull – a death's head'.⁷³ Given its resemblance to his helmet-head sculptures (conceived in the Second World War and developed during the Korean War) and to a contemporaneous CND poster, Iain A. Boal concludes that Moore's monument deliberately undermined his patrons' nuclear triumphalism, leading them to rename it *Nuclear Energy* so as to distance it from the military purpose of Fermi's experiment.⁷⁴ But Moore's intentions remain unclear and his later efforts to associate the work with organic forms and cathedral architecture have been cited to suggest that he had developed a more ambivalent stance to nuclear arms by the later 1960s.⁷⁵ Such equivocation was certainly characteristic of the time, as nuclear power became commonplace, the Windscale accident faded from memory and other radical causes increasingly preoccupied the Left. It may also have been a response to the commissioners' ambivalent desire for a monument that would instil both hope and fear.

The same dichotomy between the benefits and dangers of atomic science was clearly manifest in two works by the sculptor 'Peter' Peri. In 1960, he completed a wall-sculpture for a Leicestershire school of a celebratory symbolic figure holding an atomic ball-and-spoke structure, entitled *Man's Mastery of the Atom = Self Mastery* (1959-1960).⁷⁶ In the same year, he made a small sculptural group in his characteristic social-realist style, entitled *Aldermaston Marchers* (1960; Figure 2.6), which, according to Helga László, was 'inspired by an actual peace march'.⁷⁷ As a Quaker (and Communist), Peri was committed to pacifism and disarmament.⁷⁸ The work constituted a rare and belated response to the call from his friend and supporter John

Berger in *Marxist Quarterly* for an art explicitly ‘protesting against the H-bomb’.⁷⁹ A preliminary drawing for the sculpture depicts a line of seven or eight anonymous marchers, with one carrying a CND pennant and another pushing a pram.⁸⁰ The final sculpture simplified and intensified the original conception and reflected the iconography of the burgeoning disarmament campaign by reducing the composition to a single family group: the man now holds the CND symbol more purposefully aloft like a military flag-bearer, while the woman is poignantly held back by a dawdling and uncomprehending child.⁸¹ Peri’s and Moore’s direct engagement with themes of atomic science and nuclear warfare was, however, extremely rare in the 1960s and, paradoxically, even rarer in the preceding decade when Britain had witnessed a more intense period of nuclear testing and disarmament campaigning. In the 1950s, as the possibility of nuclear apocalypse increasingly haunted the popular imagination, British sculptors developed a subtler, metaphorical repertoire of forms, materials and subjects to express the collective unease.

Read’s identification of the work of a younger generation of sculptors with ‘the geometry of fear’ signalled his recognition of the transformation that British sculpture was undergoing. He aligned the work of the eight represented at Venice – Robert Adams, Kenneth Armitage, Reg Butler, Lynn Chadwick, Geoffrey Clarke, Bernard Meadows, Eduardo Paolozzi and William Turnbull – with the Surrealism of Moore, Picasso, Calder and Giacometti (and, in Butler’s case, Lam and Masson), claiming it was ‘close to the nerves, nervous, wiry’. Contrasting their purposes with the ‘transcendental values’ of Hepworth and the Constructivists, he revealed a new scepticism toward the earlier movement’s attempt ‘to create the images of a civilisation not yet born, perhaps never to be born.’ Employing ideas derived from nineteenth-century German aesthetics, he insisted that: ‘They are all involved in some wider manifestation of the creative will, some general extension of consciousness.’ He used the timing of the sculptors’ birth – ‘for the most part . . . during or immediately after the First World War’ – to explain their lack of classical calm and serenity, and to associate them with the bleak and disturbing imagery of T.S. Eliot’s Modernist poetry of those years: ‘They have seized Eliot’s image of the Hollow Men and given it an isomorphic materiality. They have peopled the Waste Land with their iron waifs.’ In the most striking and most frequently cited passage, Read described their work in terms of psychological repression and Surrealist fantasy, still drawing his foreboding imagery from Eliot’s poetry:

These new images belong to the iconography of despair, or of defiance; and the more innocent the artist, the more effectively he transmits the collective guilt. Here are images of flight, of ragged claws ‘scuttling across the floors of silent seas’, of excoriated flesh, frustrated sex, the geometry of fear.⁸²

His metaphorical imagery hinted at the horrors of the Bomb – the ultimate symbol of the alienated technological civilization that Read increasingly lamented. It conjured a vision of post-war Man as desperate, culpable, vulnerable, injured and impotent. Read wrote these words in March or April of 1952,⁸³ less than a year after the US had tested a hydrogen bomb and as a tense military stalemate held in Korea. Although the hawkish General MacArthur had been relieved as UN Supreme Commander, the US had made preparations for the possible use of atomic weapons. With the rise of the disarmament movement, Read’s pacifism and abhorrence of nuclear arms would soon lead him, like Hepworth and Moore, to support the NCANWT and Berger’s protest, and later, as an anarchist, to sponsor the radical Direct Action Committee Against

Nuclear War and its successor, the Committee of 100, which advocated non-violent, civil disobedience.⁸⁴

Read's view of the new sculpture derived from an eclectic mix of cultural, psychological and political theory. As I have argued elsewhere, his conception of 'the geometry of fear' owes much to his longstanding attachment to the ideas of Wilhelm Worringer, whose 'psychology of style' associated geometric abstraction with the art produced in hostile environments where Man is alienated from nature.⁸⁵ (The crystallographers' discoveries of the geometry underlying natural materials did not deter Read's commitment to the paradigm.⁸⁶) While the new sculpture was neither fully abstract nor literally 'geometric', Read's defining phrase effectively aligned it with the art of alienation. Although he ascribed a unity to it that was clearly an over-simplification and less obviously suited to the work of Adams, Paolozzi and Turnbull, its longstanding identification with his soubriquet reveals how well the language used in his introduction – which he described himself as 'a bit poetic'⁸⁷ – matched the metaphorical character of their sculpture. In 1963, he acknowledged that his earlier account of these sculptors had been over-generalized but once again asserted their unity, writing that 'with one or two exceptions, such as Robert Adams, they are all expressionists'.⁸⁸ His new characterization demonstrates the stylistic eclecticism of this sculpture which combines features of Expressionist art with those more typical of Surrealism (as he had emphasized in 1952) and of contemporaneous 'modernist realism'.⁸⁹ The amalgamation of emotionally-charged content and figurative imagery has led many commentators to describe it as 'humanistic'.⁹⁰

Among the formal tendencies that distinguished the new sculpture from the Modernist sculpture that preceded it were its open assembled forms and metamorphic imagery, which abandoned both Constructive geometry and Surrealist biomorphism. Sculptors favoured forged and welded metal over carved stone and wood, and casting from directly carved plaster rather than from the malleable forms of clay or wax. Instead of massiveness and volume, its forms are often skeletal, planar and spiky. An effect of weightlessness and suspension is produced by slender legs and open-form bases, conveying a sense of frailty and immateriality. In place of smoothly polished forms, surfaces tend to be pitted, scarred or scorched. Their battered and ruined 'skin' has been associated with post-war perceptions of the political or existential human predicament,⁹¹ and in retrospect may remind us of the charred bodies of the victims of atomic and napalm bombing in Japan and Korea. As sculptors used these innovative and evocative materials and forms to create an imagery of attenuated and deformed bodies, insubstantial limbs and diminutive heads, it implied the fragility and insignificance of the individual, and a permanent loss of the social cohesion and natural harmony that underpinned idealist and organicist abstraction.

The subject matter of this sculpture is dominated by birds, animals, insects, crustaceans and humans. There are animals that have been startled, injured and killed, like Meadows' cockerels, birds and crabs (Figure 2.7), and humans who have been blasted by strong winds, felled, impaled, mutilated and martyred. Of the many winged creatures – some drawn from myth, others from pre-history – most have been deprived of the power of flight. Numerous 'hybrids', as Read described them in 1952,⁹² surrealistically metamorphose animal, human and sometimes vegetal forms. Margaret Garlake has compared them to the genetically mutated victims of irradiation featured in contemporaneous science fiction literature and film, and plausibly

suggested that they represent ‘the negation of identity, of selfhood’.⁹³ By contrast, there are symbols and personifications of cruel and domineering methods of persuasion and oppression. Among the animals are predatory beasts, insects and crustaceans armed with menacing beaks, teeth, claws or pincers, and protective shells or armour (Colour plate 5). Among the human figures, invariably male, are works entitled Politician, Orator, Director, Inquisitor, Dictator, Tyrant and Big Brother, sometimes equipped with armour and threatening weapons or ‘machines’. Butler and Meadows, who were responsible for many such figures, frequently drew their subjects from history and science fiction, but their relevance to the adversarial politics and propaganda of the Cold War is self-evident.⁹⁴ Butler, a pacifist and wartime conscientious objector who was active in the disarmament campaign as an Aldermaston marcher and member of the Committee of 100, created the menacing *Manipulator* (1954), who controls the skies with a sinister apparatus.⁹⁵ Whether animal, human or hybrid, these creatures are often animated by prominent and vigilant eyes (or by a single cyclopean eye) that suggest, in Garlake’s words, a ‘control mechanism’,⁹⁶ enforcing their role as a ‘watcher’ or ‘sentinel’.

Much of the allegorical iconography deployed in this sculpture, from archaic helmet heads and fallen warriors to dominant and distressed animals possessed respectively of unfeeling or fearful eyes, recalls the prototypical Modernist image of aerial bombardment and civilian massacre, Picasso’s *Guernica* (1937). This huge and renowned mural painting had toured London and several British cities before the war to enthusiastic acclaim from Modernist artists and critics.⁹⁷ Using the language of the bullfight, its juxtaposition of the overbearing bull and injured horse had long been interpreted as representing the brutality of the Spanish dictator and the suffering of his people.⁹⁸ Attuned by *Guernica*, contemporary critics recognized the unhappy creatures which populated British sculpture in the Cold War as ‘visual metaphors’:⁹⁹ albeit aggressor or victim, hunter or hunted, oppressor or oppressed, here were competitors in a vicious struggle for power.

As I have observed before,¹⁰⁰ many of these creatures embody within themselves a strange ambiguity, being predatory, threatening and aggressive but also vulnerable, anguished and frightened. This internalized dialectic denies them any simplistic identification with either good or evil, virtue or vice, just as Moore’s doubly titled *Atom Piece/Nuclear Energy* monument possesses a ‘duality’ which enables it to evoke both the benefits and dangers of atomic science.¹⁰¹ The origin of this ‘ambiguity, or duality of meaning’ has been plausibly located by Chris Stephens in Moore’s helmet-head sculptures.¹⁰² It was certainly consistent with Read’s belief in the dialectical nature of great art, which he reasserted in an essay of 1950 by quoting Schelling’s observation that: ‘To be drunk and sober not in different moments but at one and the same moment – this is the secret of true poetry.’¹⁰³ The dialectic may even be found in those sculptures representing figures of authority, which also invariably possess an implicit weakness. Meadows’ armed figures may have a commanding presence, with helmets, shields, armour and extended blades, but their top-heavy bodies, spindly legs and exposed flesh suggest their possible downfall through the vanities of high office – pomposity, hubris, narcissism, and so forth (Figure 2.8). This duality may also be applied to the fixed and penetrating stares of these creatures, which are equally the hallmark of predator or prey; they may gaze imperiously or peek timidly, just as the piercing eyes of Moore’s helmet heads may be those of binocular observer or frightened casualty. Similarly, the many sculptures

of Armitage, Butler and Chadwick that allude to surveillance technology – from primitive observation towers to modern radio and radar masts, detectors, listeners, monitors, and so on – are neither simply defensive nor offensive. Butler combined the watchfulness of the oppressed with the shadowing methods of the Cold War oppressor in his design for a Monument to the Unknown Political Prisoner (1952-1953) by placing anxious female ‘Watchers’ at the foot of a menacing communications tower.¹⁰⁴ In short, the new sculpture transfigured the imperatives of Cold-War enmity – strength, alertness, deterrence, defence, surveillance, dissemblance, and so on – in a metaphorical and de-historicized language of anthropomorphic and zoomorphic forms. As with *Guernica*, Surrealist symbolism transformed specific political fears into broader psychological anguish. The duality and ambivalence of the imagery confounded a simple apportioning of rights and wrongs, reflecting the difficult moral choices facing Western liberals and leftists in the ideological battle between capitalism and Communism.

In the decade after Read coined the ‘geometry of fear’ phrase it established itself in the critical lexicon of modern sculpture, repeated many times by Read himself and by those sympathetic to his views.¹⁰⁵ In reviewing Chadwick’s solo exhibition at the Venice Biennale in 1956, Bernard Denvir proclaimed it ‘one of the happiest phrases coined by an English critic during the past twenty-five years’; however, ignoring Read’s emphasis on the historical conditions that had shaped the new sculpture, Denvir argued that: ‘Fear is no new thing in art, and it would be tedious to try to relate Chadwick’s sculpture to any anxiety about the atom bomb.’¹⁰⁶ When Read himself later reiterated the phrase, he also attempted to reinterpret its meaning. In 1958, in a survey of post-war British art, he aligned the sculpture and phrase more explicitly with existentialist philosophy.¹⁰⁷ Elsewhere, in the same year, he reworked it in light of his growing allegiance to Jungian ideas, explaining that he had not intended to refer to fear of ‘physical peril (in a battle or an air-raid, for example)’ but to ‘metaphysical’ or ‘unconscious fear’, the ‘demonic force that is pent in the unconscious’ as the ‘primary source of creative activity’, ‘released’ when it enters an ‘archetypal form’.¹⁰⁸ Six years later, writing in *A Concise History of Modern Sculpture*, he expanded further:

It is temptingly easy to interpret the diverse phenomena of modern art as expressions of an ‘Angst’ or despair induced by the alienation prevailing in our technological civilisation – a ‘geometry of fear’, as I once expressed it. . . Anxiety [however] . . . is seldom unmixed with hope. . . The artist unconsciously projects the anxieties of his age, but he would have no creative energy if he were completely filled with despair.¹⁰⁹

His backtracking was prompted by an exhibition in Darmstadt entitled *Evidences of Anxiety in Modern Art*, which included Armitage, Butler, Chadwick and Moore, and elaborated the meaning of their work in relation to his 1952 catalogue introduction.¹¹⁰ Read’s retrospective efforts to re-shape his interpretation of this sculpture was accepted by at least one commentator, his friend, the Arts Council’s Director of Art, Philip James, who advised visitors to an exhibition in 1960 that these sculptors ‘express the *ecstatic* [my emphasis] “*Angst*” of our age in what has been aptly called a “geometry of fear”’.¹¹¹

More recently, David Hulks has coaxed more positive meanings from this sculpture and Read’s evocative phrase by subjecting them to psychoanalytical examination. He argues that the sculpture ‘*acknowledged* psychic fragmentation under Cold War

conditions, but . . . showed a way of turning despair into exaltation.¹¹² For Hulks, images of affirmation were allowed to prevail over those of despondency by achieving a ‘double inflection’, exemplified in the work of Armitage and Meadows. Although his argument rightly acknowledges the duality of this sculpture and shows how Read’s later reinterpretation of the phrase allowed him to invest it with optimistic associations similar to those surrounding Constructive art, it accords less well with Read’s original text, which attributes emphatically negative meanings to the sculpture – Armitage’s figures are described as ‘a sardonic commentary on the stretched agony of human relationships’, while the ‘virtue’ of Meadows’ cockerels and crabs is ‘caught as in a snare’.¹¹³ Notwithstanding Hulks’ and Read’s own attempts to bring a more nuanced psychological dimension to this sculpture and Read’s account of it, most commentators who have connected them over the years have done so to assert the sculpture’s troubled mood.

Almost from the moment that Read ascribed a unity to this sculpture focused on its ‘iconography of despair’, more formalist-minded critics voiced their criticisms of it. When in January 1953 the painter and critic Patrick Heron reviewed an exhibition of maquettes by British entrants to the Unknown Political Prisoner competition, including five of the sculptors shown in Venice and others working in a similar style, he dismissed them (with a few exceptions) as ‘emptily expressionist’ and devoid of ‘any genuine, compelling *Angst*’, concluding that ‘the repetitive spikiness of all these iron thorns and cacti . . . are a thin cliché by now’.¹¹⁴ By the mid-1960s, when Read’s critical authority had waned, formalist and phenomenological methods of criticism were ascendant, and new forms of colourful abstract sculpture were emergent, a younger generation of sculptors and critics – many of them former students of Anthony Caro at St Martin’s School of Art – increasingly denigrated the sculpture of the 1950s.¹¹⁵ Reflecting on ‘A Decade of British Sculpture’ in 1964, David Thompson reiterated Heron’s accusations that the ‘*Angst*-ridden’ new sculpture ‘that Read in a much repeated phrase called “the geometry of fear” [had] degenerated almost flagrantly into cliché’.¹¹⁶ In 1971, the critic Charles Spencer wrote still more scathingly:

These sculptors were part of what might be called the ‘mutilated’ or ‘tortured’ school. They were humanists, concerned both with the human body and the human situation and expressed their tragic understanding of life in emotional clichés which amounted to a kind of blackmail – headless torsos, torn limbs, scabrous, pitted skin surfaces. . . .¹¹⁷

In the changing aesthetic and political landscape of the 1960s, which saw the peaceful outcome of the Cuban missile crisis, the implementation of the first Nuclear Test Ban Treaty and US involvement in Vietnam, younger artists expressed their opposition to nuclear weapons more often through a satirical Pop aesthetic, resembling the black humour of Stanley Kubrick’s 1963 film, *Dr Strangelove or How I Learned to Stop Worrying and Love the Bomb*. That year Colin Self created his *Leopardskin Nuclear Bomber No.2* (1963), which conflated military and sexual bravado by ‘tarting-up’ the phallic fuselage of a model US fighter-plane with tight-fitting leopard-skin fabric.¹¹⁸ At the turn of the next decade, Eduardo Paolozzi wryly associated napalm and nuclear warfare with the excesses of capitalist production and consumption by exhibiting stock-piled *Bombs* (1971) – which he described as ‘my answer to [Warhol’s] Brillo Boxes’¹¹⁹ – and a replica skip entitled *Waste (Cloud Atomic Laboratory)* (1971). Unlike the sculpture of the 1950s, such works were marked by an overt anti-Americanism. With the emergence of this new aesthetic, ‘geometry of fear’ sculpture

and Read's commentary on it received scant historical or critical attention for nearly two decades, until interest was reawakened in 1981 by the Whitechapel Art Gallery's landmark exhibition, *British Sculpture in the Twentieth Century*.¹²⁰

For more than two decades in the middle of the century, some of the most critically acclaimed modern sculpture produced in Britain had expressed social ideas related to developments in atomic physics. Before 1945, the mathematical geometry of crystal structures supplied Constructive sculptors with a recognizable signifier of the utopian hopes accompanying scientific advance. Gabo and Hepworth introduced formal and technical innovations to their work inspired by the pure research of the crystallographers. After 1945, new forms of humanist sculpture expressed the anxieties created by the deadly inventions of the nuclear technologists through a metamorphic, metaphorical and dialectical language pioneered by Moore and given meaning by Read. The 'geometry of fear' sculpture adopted new images, forms and materials to confront themes of oppressive power, intense surveillance, and identity erasure. Despite Read's retrospective efforts to reconcile the fear that he identified in this sculpture with timeless and universal aspects of the human condition and collective unconscious, the poetic resonance of his original insightful description ensured its indissoluble tie to the historical realities of the Cold War and the Bomb.

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¹ Herbert Read, 'Introduction', in *Barbara Hepworth: Carvings and Drawings* (London: Lund Humphries, 1952), ix-x. Hepworth's drawings are reproduced in large numbers in the monograph.

² See Lesley Jackson, *From Atoms to Patterns: Crystal Structure Designs from the 1951 Festival of Britain* (Shepton Beauchamp: Richard Dennis in association with the Wellcome Collection, 2008).

³ Herbert Read, 'New Aspects of British Sculpture', in *The XXVIth Venice Biennale: The British Pavilion*, exhibition catalogue (London: British Council, 1952), np.

⁴ See, for example, Mona Hadler, 'The Bomb in the Postwar Era: From the Sublime to Red Hot Candy', *Source: Notes in the History of Art*, vol. 21, no. 1 (Fall 2001): 38-43; Brooke Kamin Rapaport and Kevin Stayton, eds, *Vital Forms: American Art and Design in the Atomic Age, 1940-1960* (New York: Brooklyn Museum of Art in association with H.N. Abrams, 2001); Stephen Petersen, 'Explosive Propositions: Artists React to the Atomic Age', *Science in Context*, vol. 17, no. 4 (2004): 579-609; *Be-Bomb: The Transatlantic War of Images and all that Jazz, 1946-1956*, exhibition catalogue (Barcelona: Museu d'Art Contemporani de Barcelona; Madrid: Centro de Arte Reina Sofia, 2007). Some rare but over-generalized comments on British sculpture appear in Darrell D. Davisson, *Art After the Bomb: Iconographies of Trauma in Late Modern Art* (Bloomington, IN: Authorhouse, 2008).

⁵ See, for example, Ann Jones, in *Geometry of Fear: Works from the Arts Council Collection*, exhibition guide (London: South Bank Centre, 2007), np. This exhibition demonstrates how the group has been enlarged since 1952 to include others who worked in a similar manner and who had often been taught by one of the original eight, such as Robert Clatworthy, Elisabeth Frink, John Hoskin, and Leslie Thornton.

⁶ J. Leslie Martin, 'The State of Transition', in *Circle: International Survey of Constructive Art*, ed. J.L. Martin, Ben Nicholson and Naum Gabo (London: Faber and Faber, 1971 [1937]), 217.

⁷ See Anne J. Barlow, 'Barbara Hepworth and Science', in *Barbara Hepworth Reconsidered*, ed. David Thistlewood (Liverpool: Tate Gallery, 1996), 95-107; Martin Hammer and Christina Lodder, 'Hepworth and Gabo: A Constructive Dialogue', in *Barbara Hepworth Reconsidered*, 109-133; Martin Hammer and Christina Lodder, *Constructing Modernity: The Art and Career of Naum Gabo* (New Haven and London: Yale University Press, 2000), 379-381.

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- ⁸ On Bernal, see Maurice Goldsmith, *Sage: A Life of J.D. Bernal* (London: Hutchinson, 1980); Brenda Swann and Francis Aprahamian, eds, *J.D. Bernal: A Life in Science and Politics* (London: Verso, 1999); Andrew Brown, *J.D. Bernal: The Sage of Science* (Oxford: Oxford University Press, 2005).
- ⁹ J.D. Bernal, 'Architecture and the Scientist', *RIBA Journal*, 3rd series, vol. 44, no. 16 (June 1937), 805-812; J.D. Bernal, 'Art and the Scientist,' in *Circle*, 119-123; J.D. Bernal, Foreword to *Barbara Hepworth*, exhibition catalogue, Alex Reid and Lefevre Gallery, London, 1937, np. According to Hepworth, Bernal planned to write a book on art and science (Margaret Gardiner, *Barbara Hepworth: A Memoir* (London: Lund Humphries, 1994; Edinburgh: Salamander, 1982), 28).
- ¹⁰ Bernal, Foreword, to *Barbara Hepworth*, np.
- ¹¹ See *Barbara Hepworth: Carvings and Drawings*, xvi; and Hammer and Lodder, *Constructing Modernity*, 280 and 401.
- ¹² Gardiner, *Barbara Hepworth: A Memoir*, 27.
- ¹³ Goldsmith, *Sage*, 87.
- ¹⁴ See Goldsmith, *Sage*, 225; and Brown, *J.D. Bernal*, 154. On the inscription of mathematical models, see Michael Compton, 'Gabo, Mathematics and Science', in *Naum Gabo: Sixty Years of Constructivism*, exhibition catalogue (London: Tate Gallery, 1987), 16.
- ¹⁵ Sally Festing, *Barbara Hepworth: A Life of Forms* (London: Viking, 1995), 148.
- ¹⁶ Bernal, Foreword, to *Barbara Hepworth*, np.
- ¹⁷ Bernal, 'Art and the Scientist', 121, and Figures 5a and 5b.
- ¹⁸ Hepworth, letter to Bernal, no date [c.1936/1937], University Library (Add. 8287/J84 [Box 83]), University of Cambridge.
- ¹⁹ Gardiner, *Barbara Hepworth: A Memoir*, 48-51.
- ²⁰ Hepworth, letter to Gardiner, nd. [late 1930s], quoted in Gardiner, *Barbara Hepworth: A Memoir*, 28.
- ²¹ Gardiner, *Barbara Hepworth: A Memoir*, 44.
- ²² Hammer and Lodder, *Constructing Modernity*, 233 and 270.
- ²³ For their fullest account, see Hammer and Lodder, *Constructing Modernity*, 379-401.
- ²⁴ Naum Gabo, 'On Constructive Realism', in Katherine S. Dreier, James Johnson Sweeney and N. Gabo, *Three Lectures on Modern Art* (New York and London: Kennikat, 1971 [1949]), 76-77.
- ²⁵ Martin Hammer and Christina Lodder, 'Naum Gabo and the Constructive Idea of Sculpture', in *Naum Gabo: The Constructive Idea*, exhibition catalogue (London: South Bank Centre, 1987), 42-45; Compton, 'Gabo: Mathematics and Science', 26.
- ²⁶ Jacky Klein, 'Naum Gabo: Construction in Space (Crystal)', Tate Gallery, September 2002 (<http://www.tate.org/art/artworks/gabo-construction-in-space-crystal-t06978>, Tate website, accessed 19 December 2012).
- ²⁷ Klein, 'Naum Gabo: Construction in Space (Crystal)', accessed 19 December 2012.
- ²⁸ For example, Hammer and Lodder, *Constructing Modernity*, 385.
- ²⁹ Hammer and Lodder, 'Hepworth and Gabo', 128.
- ³⁰ For example, Hammer and Lodder, *Constructing Modernity*, 262; Jacky Klein, 'Naum Gabo: Construction in Space with Crystalline Centre', Tate Gallery, September 2002 (<http://www.tate.org/art/artworks/gabo-construction-in-space-with-crystalline-centre-t06977>, accessed 19 December 2012).
- ³¹ See Brown, *J.D. Bernal*, 61; and J.D. Bernal, 'My Time at the Royal Institution, 1923-27', International Union of Crystallography (<http://www.iucr.org/people/crystallaphers/bernal2>, accessed 12 December 2012).
- ³² For Hepworth's recommendation, see Hepworth, letter to Bernal, 2 May 1939; cited in Hammer and Lodder, *Constructing Modernity*, 261, n. 251. Gardiner recalled purchasing the first completed version before September 1939, Hammer and Lodder, *Constructing Modernity*, 261, n. 253. Gardiner still owned it in 1978, see *Tate Gallery 1976-8: Illustrated Catalogue of Acquisitions* (London: Tate, 1979), 64, although it was not among the works gifted to the Pier Arts Centre, Stromness, Orkney, in 1979.
- ³³ See Hammer and Lodder, *Constructing Modernity*, 280, nn. 79 and 80.
- ³⁴ Hammer and Lodder, *Constructing Modernity*, 281 and plates 188-90.
- ³⁵ Barlow, 'Barbara Hepworth and Science', 95-107.
- ³⁶ A.H. Hammacher, *Barbara Hepworth* (London: Thames and Hudson, 1968), 89 and 86.
- ³⁷ Quoted in Barlow, 'Barbara Hepworth and Science', 103.
- ³⁸ Kathleen Raine, *Stone and Flower: Poems, 1935-43* (London: Nicholson & Watson, 1943).
- ³⁹ Kathleen Raine, *Autobiographies* (London: Skoob, 1991), 266 and 224.
- ⁴⁰ Alan Bowness, 'The Drawings of Barbara Hepworth', in *Barbara Hepworth: Drawings from a Sculptor's Landscape* (London: Cory Adams & Mackay, 1966), 17.

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- ⁴¹ Barlow, 'Barbara Hepworth and Science', 106 and 103.
- ⁴² Goldsmith, *Sage*, 87.
- ⁴³ J.D. Bernal and Helen Megaw, 'The Function of Hydrogen in Intermolecular Forces', *Proceedings of the Royal Society*, Series A, 151: 873 (2 September 1935): 384-420. See also boric acid, brucite, lepidocrocite and zinc hydroxide.
- ⁴⁴ William L. Bragg, *Atomic Structure of Minerals* (Ithaca, NY: Cornell University Press; London: Humphrey Milford; Oxford: Oxford University Press, 1937), 249, fig. 136. See also blende (64, fig. 30), pyrites (72, fig. 39), 'octahedral' variants of spinel and magnetite (99, fig. 58), feldspar (244, fig. 132), mica (207, figs. 116 & 117) and orthoclase (236, fig. 131).
- ⁴⁵ Hammer and Lodder, 'Hepworth and Gabo', 115-116.
- ⁴⁶ Read, 'Introduction', in *Barbara Hepworth: Carvings and Drawings*, x; Hepworth, quoted in Chris Stephens, 'Drawings for Sculpture with Colour', in *Barbara Hepworth Centenary*, ed. Chris Stephens (London: Tate, 2003), 71.
- ⁴⁷ For reproductions, see *Barbara Hepworth: Sculptress*, introduction by William Gibson (London: Faber & Faber for Shenvall, 1946), 42-43; *Barbara Hepworth: Carvings and Drawings*, figs 61a and 61b.
- ⁴⁸ Information on this sculpture is drawn from Matthew Gale and Chris Stephens, *Barbara Hepworth: Works in the Tate Gallery Collection and the Barbara Hepworth Museum St Ives* (London: Tate Gallery, 1999), 74-78, and Stephens, 'Drawings for Sculpture with Colour', 71.
- ⁴⁹ See Barlow, 'Barbara Hepworth and Science', 102; Hammer and Lodder, 'Hepworth and Gabo', 128.
- ⁵⁰ Hammacher, *Barbara Hepworth*, 85.
- ⁵¹ See Eric Hobsbawm, 'Preface', to Swann and Aprahamian, *J.D. Bernal: A Life in Science and Politics*, ix-xx.
- ⁵² Herbert Read, *The Green Child* (London: Robin Clark, 1989 [Heinemann, 1935]), 174. I am grateful to David Hulks for drawing my attention to this chapter of Read's novel.
- ⁵³ See Read, *The Green Child*, 175-195.
- ⁵⁴ Lancaster House, 18 March – 9 May 1942. A version of the exhibition with a different catalogue toured seven British cities.
- ⁵⁵ Hammer and Lodder, *Constructing Modernity*, 279-280. They note that Gabo's *Construction in Space with Crystalline Centre* may also have been exhibited.
- ⁵⁶ Chris Stephens, "'The morrow we left behind": Landscape and the Rethinking of Modernism, 1939-53', *Art History*, vol. 35, no. 2 (April 2012): 219, 221, 224 and 232.
- ⁵⁷ J.R.M. Brumwell, ed., *This Changing World: A Series of Contributions by Some of our Leading Thinkers, to Cast Light upon the Pattern of the Modern World* (London: Routledge, 1944).
- ⁵⁸ Goldsmith, *Sage*, 87.
- ⁵⁹ Jackson, *From Atoms to Patterns*, 5.
- ⁶⁰ See Jackson, *From Atoms to Patterns*, 8-10.
- ⁶¹ Brown, *J.D. Bernal*, 111.
- ⁶² See Lorna Arnold and Katherine Pyne, *Britain and the H-Bomb* (Basingstoke: Palgrave Macmillan, 2001).
- ⁶³ Brown, *J.D. Bernal*, 414 and 454. The first march, in 1958, reversed the route.
- ⁶⁴ B. Britten, E.M. Forster, H. Moore, *et al.*, 'Use of Atomic Weapons', *The Times*, 14 December 1950; cited in Chris Stephens, 'Henry Moore's *Atom Piece*: The 1930s Generation Comes of Age', in *Henry Moore: Critical Essays*, ed. Jane Beckett and Fiona Russell (Aldershot: Ashgate, 2003), 247, n. 9.
- ⁶⁵ James Hyman, *The Battle for Realism: Figurative Art in Britain During the Cold War, 1945-1960* (New Haven and London: Yale University Press, 2001), 244, n. 76.
- ⁶⁶ Richard Taylor, *Against the Bomb: The British Peace Movement, 1958-65* (Oxford: Clarendon, 1988), 9, n.15.
- ⁶⁷ John Berger, 'Artists and the H-Bomb', *Art News and Review*, vol. 10, no. 9 (24 May 1958): 2; for letters of response, see *Art News and Review*, vol. 10, no. 15 (16 August 1958): 2; cited in Hyman, *The Battle for Realism*, 244, nn. 76 and 79.
- ⁶⁸ See Gardiner, *Barbara Hepworth: A Memoir*, 52-56.
- ⁶⁹ Hepworth, letter to Read, 4 December [1956]; quoted in Gale and Stephens, *Barbara Hepworth*, 20; and Stephens, *Barbara Hepworth Centenary*, 246.
- ⁷⁰ 'Barbara Hepworth: A Memoir', in Stephens, *Barbara Hepworth Centenary*, 12.
- ⁷¹ John Berger, 'Round London'. *New Statesman*, vol. 56, no. 1245 (July 1958): 15; cited in Hyman, *The Battle for Realism*, 171 and fig. 178.

- ⁷² William H. McNeill (University of Chicago), letter to Moore, nd [November 1963]; reprinted in David H. Katzive, 'Henry Moore's *Nuclear Energy*: The Genesis of a Monument', *Art Journal*, vol. 32, no. 3 (Spring 1973): 285.
- ⁷³ Interview with Franz Schulze, *Chicago Daily News*, 2 December 1967: 10; quoted in Iain A. Boal, 'Ground Zero: Henry Moore's *Atom Piece* at the University of Chicago', in Beckett and Russell, *Henry Moore*, 228.
- ⁷⁴ Boal, 'Ground Zero', 228 and 235, and figs 10.4 and 10.5.
- ⁷⁵ Stephens, 'Henry Moore's *Atom Piece*', 250-251.
- ⁷⁶ See Terry Cavanagh and Alison Yarrington, *Public Sculpture of Leicestershire and Rutland* (Liverpool: Liverpool University Press, 2000), 11-12.
- ⁷⁷ Helga Laszlo, 'The Realistic Sculpture of Laszlo Peter Peri' (MA dissertation, trans. John Lloyd, University of Budapest, 1990), vol. 1 (text), 83, and vol. 2 (plates), figs. 66 and 99.
- ⁷⁸ John Lloyd, 'Correspondence: Peter Peri's Politics', *Art Monthly*, no. 104 (March 1987): 25.
- ⁷⁹ John Berger, 'The Necessity for Uncertainty', *Marxist Quarterly*, vol. 3, no. 3 (July 1956): 168-177; cited in Hyman, *The Battle for Realism*, 171.
- ⁸⁰ Laszlo, 'The Realistic Sculpture of Laszlo Peter Peri', vol. 1, 'Supplement 6: sketches for the sculptures'.
- ⁸¹ On Moore's family groups and CND imagery, see Stephens, 'Henry Moore's *Atom Piece*', 248.
- ⁸² Read, 'New Aspects of British Sculpture', np. Read's introduction refers to three of Eliot's poems: 'The Lovesong of Alfred J. Prufrock' (1915), 'The Wasteland' (1922) and 'The Hollow Men' (1925).
- ⁸³ Read sent the text to Lilian Somerville (British Council) on 2 April 1952, Margaret Garlake, 'Revisiting the Geometry of Fear', in *Rereading Read: New Views on Herbert Read*, ed. Michael Paraskos (London: Freedom Press, 2007), 135.
- ⁸⁴ See Taylor, *Against the Bomb*, 9, n.15, and 196, n.20. On Read's support for Berger, see Hyman, *The Battle for Realism*, 244, n. 76.
- ⁸⁵ Robert Burstow, 'The Geometry of Fear: Herbert Read and British Modern Sculpture', in *Herbert Read: A British Vision of World Art*, ed. Ben Read and David Thistlewood (Leeds: Leeds City Art Galleries in association with The Henry Moore Foundation and Lund Humphries, 1993), 123-125.
- ⁸⁶ See, for example, Herbert Read, 'Great Britain', in Marcel Brion, *et al.*, *Art Since 1945* (London: Thames and Hudson, 1958), 243.
- ⁸⁷ Herbert Read, letter to Somerville, 2 April 1952; quoted in Garlake, 'Revisiting the Geometry of Fear', 135.
- ⁸⁸ Herbert Read, 'Introduction', to *Sculpture in the Open Air*, exhibition catalogue (London: London County Council, 1963), np. The exhibition included all of those presented at Venice in 1952 except Paolozzi.
- ⁸⁹ See James Hyman, 'Henry Moore and the Geometry of Fear', in *Henry Moore and the Geometry of Fear*, exhibition catalogue, James Hyman Fine Art, London, 2003, 6-11.
- ⁹⁰ For example, Philip Hendy on Butler's work of 1949, cited in Hyman, 'Henry Moore and the Geometry of Fear', 8.
- ⁹¹ Hyman, 'Henry Moore and the Geometry of Fear', 10.
- ⁹² Read, 'New Aspects of British Sculpture', np.
- ⁹³ Margaret Garlake, *New Art, New World: British Art in Postwar Society* (New Haven and London: Yale University Press, 1998), 194-200; Margaret Garlake, 'Identifying the Geometry of Fear', in *Henry Moore and the Geometry of Fear*, 5; and Garlake, 'Revisiting the Geometry of Fear', 143.
- ⁹⁴ See Margaret Garlake, *The Sculpture of Reg Butler* (Much Hadham and Aldershot: Henry Moore Foundation in association with Lund Humphries, 2006); Robert Burstow, 'Bernard Meadows', in *Sculpture in 20th Century Britain: Vol. 2: A Guide to Sculptors in the Leeds Collections*, ed. Penelope Curtis (Leeds: Henry Moore Institute, 2003), 232-235.
- ⁹⁵ See Garlake, *The Sculpture of Reg Butler*, 16 and 25; Taylor, *Against the Bomb*, 197, n. 20.
- ⁹⁶ Garlake, *New Art, New World*, 195.
- ⁹⁷ See *Picasso and Modern British Art*, exhibition catalogue (London: Tate, 2012).
- ⁹⁸ See Carla Gottlieb, 'The Meaning of the Bull and Horse in *Guernica*', *Art Journal*, vol. XXIV, no. 2 (Winter 1964-1965): 106. (This interpretation of the bull was available in English by 1956.)
- ⁹⁹ For example, David Thompson, 'A Decade of British Sculpture', *Cambridge Opinion*, no. 37 (January 1964): 24-32.
- ¹⁰⁰ Robert Burstow, 'Aesthetics, 1950-75', in *Sculpture in 20th Century Britain: Vol. 1: Identity, Infrastructure, Aesthetics, Display, Reception*, ed. Penelope Curtis (Leeds: Henry Moore Institute, 2003), 170.
- ¹⁰¹ Katzive, 'Henry Moore's *Nuclear Energy*', 288.

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- ¹⁰² Stephens, 'Henry Moore's *Atom Piece*', 251.
- ¹⁰³ Herbert Read, 'Realism and Abstraction: A Footnote to the Preceding Essay', in Herbert Read, *The Philosophy of Modern Art* (London: Faber and Faber, 1982 [1951]), 104.
- ¹⁰⁴ See Robert Burstow, 'Butler's Competition Project for a Monument to "The Unknown Political Prisoner": Abstraction and Cold War Politics', *Art History*, vol. 12, no. 4 (December 1989): 472-496; Robert Burstow, 'The Limits of Modernist Art as a "Weapon of the Cold War": Reassessing the Unknown Patron of the Monument to the Unknown Political Prisoner', *Oxford Art Journal*, vol. 20, no. 1 (Spring 1997): 68-80.
- ¹⁰⁵ Read's introduction was given a new lease of life in 1956 when the British Council circulated the 1952 sculpture exhibition as an international touring exhibition. Among others who cited his phrase, was Robert Melville in his introduction to the Lynn Chadwick exhibition at the British Pavilion of the XXVIIIth Venice Biennale in 1956.
- ¹⁰⁶ Bernard Denvir, 'The Geometry of Fear', *Art*, 29 June 1956: 3.
- ¹⁰⁷ Read, 'Great Britain', 232-235.
- ¹⁰⁸ Herbert Read, *Lynn Chadwick* (Amriswil: Bodensee-Verlag, 1958), 9-10.
- ¹⁰⁹ Herbert Read, *A Concise History of Modern Sculpture* (London: Thames and Husdon, 1964), 218-225.
- ¹¹⁰ *Zeugnisse der Angst in der modernen Kunst*, exhibition catalogue, Mathildenhöhe Darmstadt, 1963.
- ¹¹¹ Philip James, 'Sculpture Today', in *Sculpture in the Open Air*, exhibition catalogue (London: London County Council, 1960), np.
- ¹¹² David Hulks, 'Despair, or Defiance: the Double Inflection in Herbert Read's Geometry of Fear', in Paraskos, *Rereading Read*, 144 and 151.
- ¹¹³ Read, 'New Aspects of British Sculpture', np.
- ¹¹⁴ Patrick Heron, 'Fruit or Thorn?', *New Statesman and Nation* (24 January 1953): 92.
- ¹¹⁵ See Burstow, 'Aesthetics, 1950-75', 171-175.
- ¹¹⁶ David Thompson, 'A Decade of British Sculpture', 25.
- ¹¹⁷ Charles Spencer, 'Robert Adams', in *Robert Adams: Retrospective Exhibition*, exhibition catalogue (London: Arts Council, 1971), np.
- ¹¹⁸ See the artist's account of the work cited in Simon Martin, 'Art on the Eve of Destruction: Colin Self and the Nuclear Age', in *Colin Self: Art in the Nuclear Age*, exhibition catalogue (Chichester: Pallant House Gallery, 2008), 22.
- ¹¹⁹ 'Speculative Illustrations: Eduardo Paolozzi in conversation with J.G. Ballard and Frank Whitford', *Studio International*, 193 (October 1971), reprinted in *Eduardo Paolozzi: Writings and Interviews*, ed. Robin Spencer (Oxford and New York: Oxford University Press, 2000), 202.
- ¹²⁰ See especially, Richard Calvocoressi, 'Public Sculpture in the 1950s', in *British Sculpture in the Twentieth Century*, ed. Sandy Nairne and Nicholas Serota, exhibition catalogue (London: Whitechapel Art Gallery, 1981), 134-153. The author quotes Read's catalogue introduction (143, n. 35).