77 Peter Smithson, 'Contributions to a Fragmentary Utopia', *Architectural Design* 36 (February 1966), 64–67.

78 Smithson, 'The Pavilion and the Route', 143–6.

79 'A Clip-On Architecture', 535.

80 For an instance of this contemporary argument, see Raymond Wilson, 'Mobility', *Architectural Design* (May 1967), 217–23.

81 Glass fiber saturated with a liquid polyester mix formed a coated mold.

82 Chalk, 'Architecture as Consumer Product', 230.

83 This freestanding bathroom tower was designed as an appendage to an existing block of housing which was being converted into a student hostel. A continuous corridor spiraled around the tower and linked it to each floor of the old building. 'Anyone needing a bath will spiral effortlessly (or at least with a minimum of effort) until they find one empty rather than rushing from corridor end to end' ('Bathroom Tower, Paddington', *Architectural Design* (November 1966), 577).

84 Chalk, 'Architecture as Consumer Product'. The first Archigram catalogue of 1972 claimed that (a) Chalk started to use the word capsule around 1964, and (b) the Capsule Homes and Plug-In City were at first being developed separately (p. 44).

85 Peder Anker, 'The Ecological Colonization of Space', *Environmental History* 10 (April 2005), 239–68.

86 David Greene, 'Living Pod', *Architectural Design* (November 1966), 570.

87 Ibid.

88 Warren Chalk, 'Living, 1990', *Architectural Design* (March 1967), 146.

89 Ibid.

90 Drusilla Beyfus, '1990: Flexible Space', *Weekend Telegraph Magazine* 126 (3 March 1967), 23.

91 Chalk, 'Living, 1990', 146.

92 Beyfus, '1990: Flexible Space', *Weekend Telegraph Magazine* 126 (3 March 1967), p.27.

93 Ibid., Drusilla Beyfus, with Anne Edwards, was best known for her manual *Lady Behave: A Guide To Modern Manners*, London: Cassell & Company Ltd, London, 1956.

94 Ibid., Beyfus, '1990: Flexible Space', 27.

95 Chalk, 'Living, 1990', 147.

96 Ibid.

97 Greene, 'Living Pod', 570.

98 Reyner Banham, 'Monumental Windbags', *New Society* 11(290), 569. Reprinted in Marc Dessauce (ed.), *Inflatable Moment: Pneumatics and Protest in '68*, NY: Princeton Architectural Press, 1999, p. 31.

99 As he was described in the IDEA pamphlet for the Folkestone conference and exhibition (unpaginated). Otto, a mason by training, had become the leader in the field of lightweight structures as a result of his experience with the destruction of stone structures during the war.

100 Frei Otto's *Tensile Structures* was perhaps the most influential work on minimal structures. Otto was an avid promoter of structural obsolescence, objecting to the clutter of the earth with long-lasting buildings.

101 Materials were developed for spacesuits and lightweight structures easily assembled in space. See R. Sziland, 'Structures for the Moon', *Civil Engineering* (October 1959), or Frei Otto, *Tensile Structures*, vol. 1, Cambridge, MA: MIT Press, 1967, pp. 26–9.

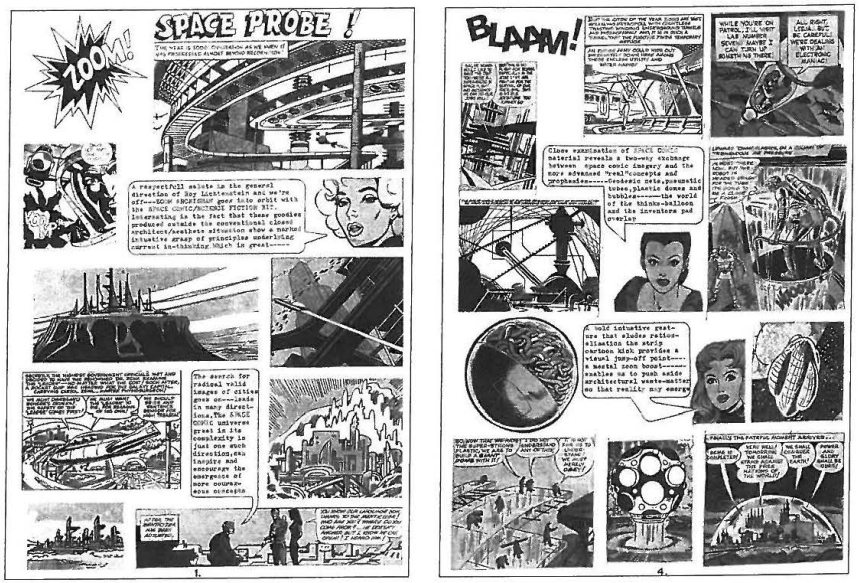
102 Space exploration, right down to the pneumatic spacesuit, relied on high-performance synthetics and was rapidly producing these fabrics, as well as the high-frequency welding processes for joining them and the miniaturization of technology necessary.

> And to me too, who loves life, it seems that butterflies and soap-bubbles, and whatever is like them among men, know most about happiness.
> Nietzsche, *Thus Spake Zarathustra*, 1883-85

BUBBLES
THE TRIUMPH OF SOFTWARE

Amazing Archigram 4: *Zoom* (1964) moved from transience through duration, or expendability, to the implications of speed. It was designed in form and spirit to resemble an issue of a magazine such as *Amazing Stories* or *Astounding Science Fiction*, right down to font and visual sound effects.[1] Sheets of 8 by 13 inch paper, folded and stapled along the spine, gave the issue the coherence of a booklet, a sense which was reinforced further by the rigidity of the card used for the silk-screened cover and the hand-cut 'pop-up' centerfold of communication towers.[2] The cover portrayed a superhero dressed in Superman reds and blues against a bright yellow background hovering over a metropolitan skyline of vertical, interconnected structures that resembled the towers featured in the centerfold. On the first four pages, comic strip frames culled from various sources for their active, flexing and whooshing architectural landscapes were reconfigured into a new storyline. Between the frames, female visages of a 'pop' sensibility spoke in bubbles of (misspelled and ungrammatical) editorial opinion: 'A bold intuitive gesture that eludes rationalisation the strip cartoon kick provides a visual jump-off point – a mental boost – enables us to push aside architectural waste-matter so that reality may emerge.'[3] Together with the provocative nature, promotional effort and publication quantity increased with this issue, which made this the most familiar of the *Archigrams*. The project had achieved significant momentum at this juncture, as reflected in the notes provided on the final page which stated that 1,000 copies of *Archigram* had been printed and that (though this was not to be) future issues would appear two or three times a year.

'Our document is the Space-Comic,' stated *Archigram* 4, and the choice was tactical.[4] Firstly, counter-cultural associations came along with this literature since the Children and Young Persons (Harmful



4.1
Warren Chalk, comic pages 1 and 4 from *Archigram* 4, 1964.

Publications) Act had banned the importation of American comics in 1955.[5] The comic also had the tools to turn the static page into a vital surface built right into its medium. There were visual cues for invisible things, such as sounds, and for aspects that were difficult to represent, like speed. Speech balloons demarcated the subjective worlds of thought and speech. A continuous narrative was generated through a series of discrete frames: a process of time that unfolded in space. Everything was bound together through the conventions by which the comic combines text and image. Words had no position in space; they were not within the picture or outside of it. Yet the balloon functioned as part of the image, and the image could not be separated from the text, rendering the two modes of representation intimately connected. The comic unified a panoply of parts into a coherent narrative while maintaining a sense of speed and dynamism. Through its graphic strategies, the comic book overcame what

Archigram 4 declared to be the 'greatest weaknesses of our immediate urban architecture': 'the inability to contain the fast-moving object as part of the total aesthetic.'[6]

Though they tended to reiterate all the familiar social hierarchies, space comics were replete with architectural conditions that complemented the quest, reprinted here from the Situation Gloop of Living City, for 'something to stand alongside the space capsules'.[7] 'Is it possible for the [space-comic's] future to relate once again with buildings-as-built? Can the near-reality of the rocket-object and hovercraft-object, which virtually cease to be cartoons carry the dynamic (but also non-cartoon) building with them into life as it is? Or shall we be riding in these crafts amongst an environment made of CLASP?'[8] The juxtaposition of everyday, government-sponsored mass production with the technology portrayed in comic books highlighted the gap between the imagery of the future and the present-continuous of the architectural proposal. The inspiration of imaginary representations of space was, for some, a foregone conclusion:

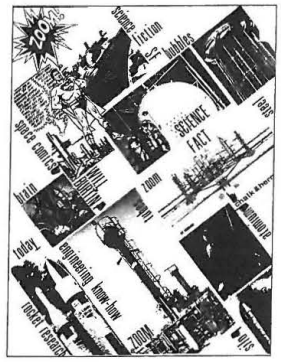
4.2
Warren Chalk, 'Situation Architecture', *Archigram* 4, 1964.

> [Science fiction] is the history of towns and cities yet unbuilt, ghosting our imaginations and lifting us to rise up and find hammers and nails to build our dreams before they blow away. I dare suggest some architects who, if you asked, would say the same: that a Frank R. Paul cover painting on an October 1929 issue of *Amazing Stories* caused them to buy pens, pencils, rulers, and drawing boards to paper up a concept and create a living world. If you bombarded an audience with three minutes' worth of covers from the old science fiction magazines, each screened for just two or three seconds, the effect would be stunning. For city after city, wall after wall, avenue after avenue, would strike the retina and stimulate the brain . . . Science fiction remains the architecture of our dreams, and science fiction illustration will continue to inspire our next generation of dreamers.[9]

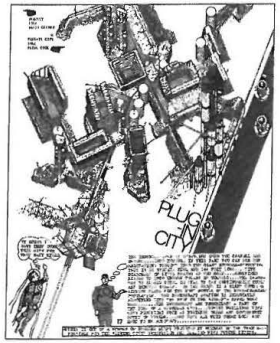
Science fiction assimilated emergent disciplines and the most advanced technological developments into the cultural spectrum; it identified social attitudes toward change and placed new ideas in traditional contexts; and, significantly for a visually driven discipline, it provided a memorable image where there was none. In *Archigram* 4, the speech

balloons spoke of a 'search for radical valid images of cities' that involved a constant dialogue between scientific fiction and discovery.[10] In the hunt for solutions 'outside the conventional closed architect/aesthete situation', *Archigram* 4 drew on the popular imagery of extraterrestrial exploration.[11] The interplay of fantasy and fact was featured on the eighth page as a rotated grid of engineered and sci-fi structures, also to be exemplified on later pages by 'first generation' avant-garde gestures, ranging from the circle of Bruno Taut to contemporary projects by Cedric Price and Han Hollein.[12] A high-profile Archigram proposal – the iconic axonometric of Cook's Plug-In City with its pensive superheroes – brought the issue to a close. By way of contrast with the high technology offered up, the issue was heavily crafted: beyond the basic assembly, the silkscreen, the pop-up center-folds and glued-in additions all had to be done individually and by hand.

The 'Zoom Wave' was fascinated by the promise of mobile technologies that had advanced outside of the discipline's domain.[13] Some of the developments, like those of *Archigram* 3, were simple forms of motorized shelter that were not considered architecture. Other structures, like the ones featured in this issue, had evolved for inhabitation in places untouched by architects or planners. In particular, *Archigram* 4 was dedicated to the productive overlap of the 'world of the thinks-balloon and the inventors pad'.[14] Containers generated by space travel, such as the Apollo crafts, the complex of Cape Canaveral and the spacesuit, demanded structural solutions that were (in theory) pure technology. Similar extreme conditions applied to the seabed, a theme that would continue in other *Archigrams*, also illustrated through comic strips.[15] The 'Zoom Wave' architects, as Banham described them, were looking for an 'alternative architecture that would be perfectly possible tomorrow if only the Universe (and especially the Law of Gravity) were differently organized'.[16] Ulrich Conrads and Hans Sperlich had only just declared the conquest of gravity to be 'one of the great utopian dreams of architecture in our century'.[17] Situations where the laws of gravity did not function conventionally provided insight into alternative modes of shelter, as in the autonomy and integrative system of the capsule model.[18] Such a counter-thesis to the norms of conventional construction was offered by the example of the bubble, which, already having been positioned as the second stage of the groundwork toward transience in *Archigram* 3, was evoked repeatedly in this issue.

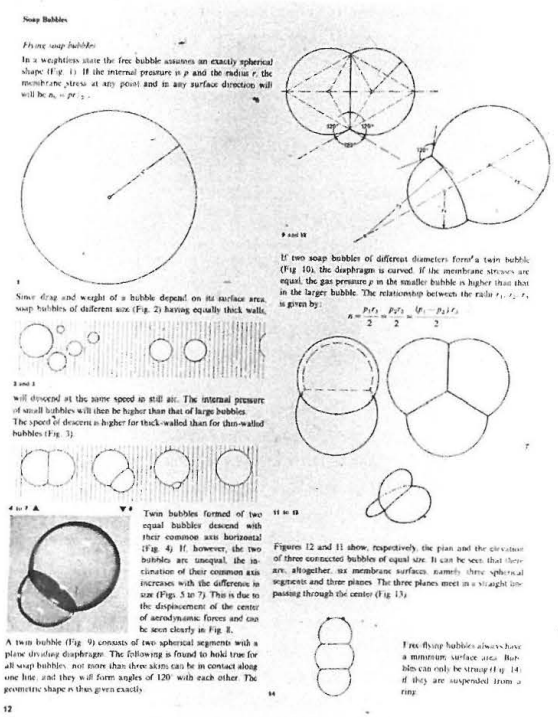


4.3
Ron Herron, 'Science Fiction Science Fact', *Archigram* 4, 1964.



4.4
Peter Cook, axonometric of Plug-In City, *Archigram* 4, 1964.

4.5
Warren Chalk, 'Underwater Zoom', *Archigram* 4, 1964. Because the comic strip at the top of the page became unstuck from the mock-up at the printing shop, each issue had to have the section glued in.



4.6
'Soap Bubbles', Frei Otto, from *Tensile Structures*, vol. 1, 1967 (English translation of *Zugbeanspruchte Konstruktionen*).

Pneumatic forms

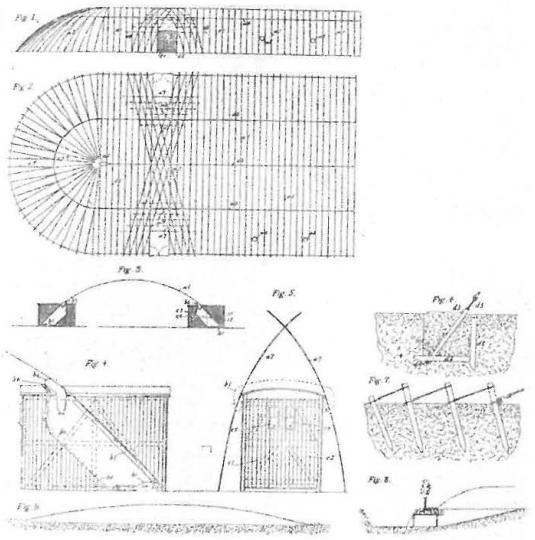
Bubbles, particularly thick in the worlds of science fiction, had by now gained some credibility on the ground through developments in the field of pneumatic structures. Texts dedicated to the properties of air-supported structures demonstrated their unique structural characteristics by diagramming those of soap bubbles, which they technically resembled. Bubbles had served as a symbol of the fleeting quality of material things in *vanitas* paintings and supplied ideal models for scientific studies long before their applicability to pneumatic structures, from the dioptrical experiments of Robert Hooke and Isaac

Newton to the microphysical ones of James Clerk Maxwell and Michael Faraday.[19] Scientists and architects were fascinated by bubbles because, given the boundary conditions, they always enclosed the maximum volume with the minimum surface area. Under 'A Plan Proceeds From Within to Without', Le Corbusier wrote: 'A building is like a soap bubble. This bubble is perfect and harmonious if the breath has been evenly distributed and regulated from the inside. The exterior is the result of an interior.'[20] In *Notes on the Synthesis of Form* (1964), Christopher Alexander cited the bubble as the ideal instance where form and function are one and the same.[21] These merits were routinely cited in the pneumatic literature.[22]

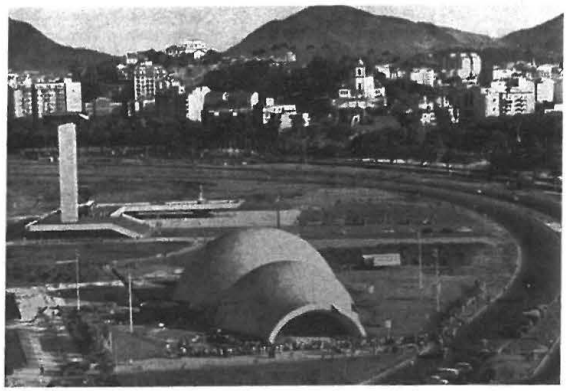
In addition to the formal virtues, the dynamics of the skin were a source of fascination. Following the paradigmatic research of Joseph Plateau in the mid-nineteenth century into long-lived soap films, the study of the resilience of the fragile envelope was added to the structural investigation of bubbles.[23] Mixing wonder with physics as they did, lasting bubbles made an excellent centerpiece for popular demonstrations of scientific principles.[24] 'On the Forces of Matter', the series of lectures delivered by Faraday himself 'before a juvenile auditory' at the Royal Institution over the Christmas holidays in 1859, included the soap bubble as demonstration of chemical cohesion. Faraday asked: 'Why does it hold together in this manner? Why, because the water of which it is composed has an attraction of particle for particle – so great, indeed, that it gives to this bubble the very power of an India-rubber ball.'[25] Faraday's investigations into the structure of Nature inspired other works, including D'Arcy Wentworth Thompson's *On Growth and Form* (1917), which familiarized postwar architects with the utility of a form 'so pure and simple that we come to look on it as well nigh a mathematical abstraction'.[26] 'The particular beauty of the soap bubble, solitary or in collocation,' wrote Thompson, 'depends on the absence (to all intents and purposes) of these alien forces [of gravity, mechanical pressure, osmosis] from the field.'[27] It was on the strength of the soap film and its economy of form that the technology of pneumatic structures hoped to draw.

The Handbook of the British Compressed Air Society (1947) traced pneumatics back to the magical technologies of Hero and Ctesibius in the second century BC who used air pressure to make statues moan and to open temple doors mysteriously.[28] The roots of pneumatics in such theatrics embedded it, as Vitruvius described,

4.7
Patent filed by Federick William Lanchester for 'Improved Construction of Tent for Field Hospitals, Depots and like purposes', 1918.



in an architectural type that was notoriously subject to alteration and illusion. More recently, the technique had been applied to the mundane, for example in the tire, the drill and the hovercraft. Spurred on by the need for quick construction during World War I, Frederick William Lanchester patented a technique in 1918 for supporting temporary enclosures with a continuous supply of low-pressure air.[29] The development of components for use in World War II provided the necessary materials for the realization of pneumatic structures.[30] After the success of the Radome, an inflatable weather shield to protect military equipment, Walter Bird extended the practice of his firm, Birdair, to the civilian arena during the mid-1950s.[31] Despite their cost-effectiveness, however, pneumatic structures were rarely seen in the street.[32] When conventionally trained architects turned to inflatable design in the late 1950s,[33] the structures tended to be



4.8
Victor Lundy with Walter Bird, 'Atoms for Peace' Pavilion, US Atomic Energy Commission, 1960.

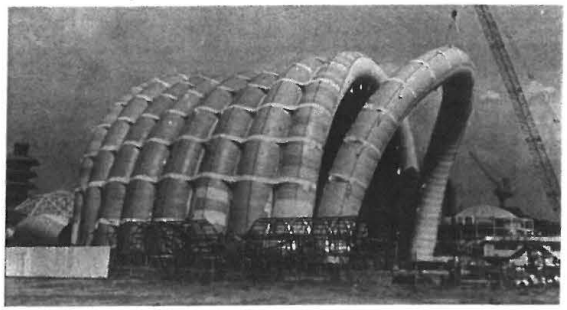
exiled to the arena of the Exposition where they efficiently provided coverage for large areas.[34] Owing to their novelty and suggestion of transience, inflatables would, for many, continue to exhibit a lack of rigidity that was disturbing even for use at temporary sites.[35] Bubbles might have been perfect pneumatic forms in the abstract space of science, but on the ground there are all sorts of forces that destabilize the skin held in place by air.

In some quarters, though, the very nature of this shifting architecture was met with enthusiasm. 'I believe that pneumatics are the most important discovery ever made in architecture,' wrote Arthur Quarmby. The technique, he was convinced, had the potential to 'free the living environment from the constraints which have bound it since history began'.[36] To the sphere that was also a staple of utopian thought, pneumatics added the coveted dimension of transience.[37] Not only did the inflatable structure document the fluctuation in ambient conditions, but the construction process required a minimum of time and expertise. An inflatable was simple to put up and, crucially, easy to take down. For those who wished to transform the environments in which people lived to accompany the pace of contemporary cultural change, air-supported architecture had particular significance. Alternative experiments with inflatable DIY would abound in the sixties, offered as possible antidote to the legacy of pollution, suburban sprawl and bleak estates.[38] The political aspect was most

4.9
Company brochure demonstrating the inflation sequence of a Cid Air structure that was reproduced as part of the 'Making the Airhouse' section in *Archigram* 6.

blatant in the work of the French group *Utopie*, which was active in Paris during the momentous time of student unrest in the late sixties that never would erupt in London.[39] As a genre, pneumatics tended to flourish in the domain of visionary sorts.[40] It was the conscious avoidance of finitude that would differentiate standard practice from the inventive use of pneumatics. The air-supported structure was in a constant process of actively enclosing – the fans continuously churned to maintain the pressure supporting the building's form, and changes arose from variations in this artificial breath. In themselves, the buildings were also subject to environmental forces, sensitive and visibly responding to 'minute variations in climactic parameters and loading conditions'.[41] Again the tension between form and formlessness was manifest, this time with the added component of never reaching a point where architecture was a finished object; it was always in a stage of adaptation, from its inception to its dissolution. It was in this intrinsic ephemerality, this thematization of transience, that the virtues of pneumatics lay. Everything about responsive, air-supported structure spoke of continuous change.

A method for overcoming the conventional limitations of building technology was precisely what the bubble suggested. The air-supported envelope combined the intrinsic strength of materials used in tension with the structural efficiency of the shell, with no concern for bending or buckling. In the inflatable, as in the bubble, material was pushed to its limits to enclose the maximum space with the minimum boundary and with no need for any rigid infrastructure of columns or beams. By removing the remaining supports, the pneumatic structure tended even more toward the limits of materiality. Pneumatic structures promoted conditioned air from ambient condition to structural element.[42] Though by now lightness of materials and truth to structure were routine aspirations in the architectural discipline, the skeleton wrapped in glass still had a defined parameter and constant dimensions. With the availability of components far lighter than those of the industrial revolution, the young architects aspired to an architecture as portable as a suitcase, or even as a suit. A transparent hemisphere in which the boundary between inside and outside was as thin as possible approximated an ideal.[43] At the same time, the skin spoke to the transience of those very limits. Brought together in this lightweight enclosure, a resilience prone to transience



4.10
Yutaka Murata with Mamoru Kawaguchi, Fuji Pavilion, Expo '70, Osaka, 1970. This dramatic structure made of sixteen Vinylon arched tubes of compressed air was the site for the debut of the rolling loop IMAX projector.

trod the same territory as the desire for structural impermanence faced with the need for shelter, and embodied the tension of a world of static objects versus one in a state of constant flux, of form and formlessness. The tension between the formal perfection encapsulated in the suspended bubble and the appealing formlessness of the pneumatic structure remained a pervasive feature of the translation from bubble to building.

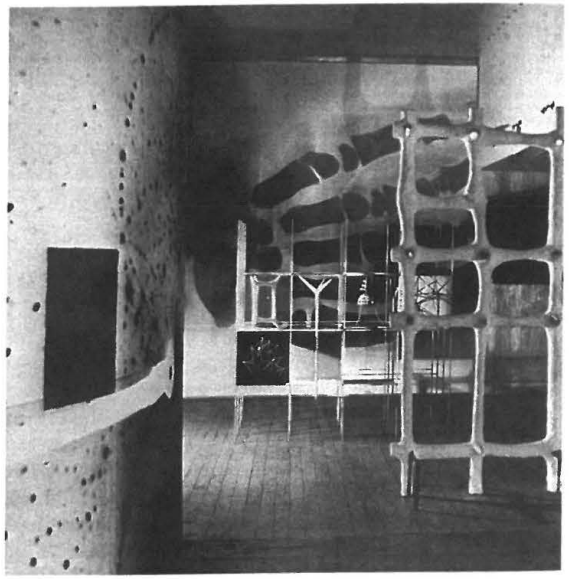
Broadly speaking, there are two types of air-stabilized architectures that are sometimes used as hybrids and often mixed with conventional building techniques. The less innovative and more common of these, the inflated structure, functions much like other building systems, using inflatable ribs or vertical supports. The inflated structure is easier to control than the moody membrane that is supported mostly by air pressure. Owing to the use of air as a structural component, the inflatable was always in the act of enfolding. In themselves, the buildings were also subject to ambient forces, sensitive and responding to 'minute variations in climactic parameters and loading conditions.'[44] As it visibly and audibly adjusted to climactic conditions from within or without, the self-regulating skin strained against the pull of gravity. Far from exerting force on the ground, the air-supported structure, if not firmly anchored, floats away.[45]

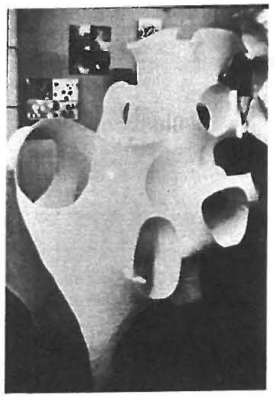
On growth and form

The problem of a building drifting and how it might be moored raised unique issues and required the contemplation of an alternate notion of what constituted architectural soundness. Fuller, who had been advocating such a conceptual shift for some time, built on Thompson's

methodology. Thompson had criticized the tendency to explain the natural world exclusively 'by the teleological concept of end, of purpose or of "design"':[46] 'In Aristotle's parable,' Thompson explained, 'the house is there so that men may live in it; but it is also there,' he continued, 'because the builders have laid one stone upon another.'[47] Aristotle believed that while things appeared to transform as they developed – from child to adult, for example – in essence they stayed the same. Thompson, on the other hand, was looking at the process of that growth and change, not the outcome of the process. Objects, then, were not just forms that had reached completion, but diagrams of the forces that had molded them. Underlying Thompson's vision of nature was a conception that viewed change and motion, 'the ephemeral and the accidental', as essential elements for understanding the world, 'not eternal or universal things'.[48] In turn, Fuller's extension of the claim that organic evolution was driven by the requirements of structure to technological production sparked a trend of curious texts published after World War II linking design according to these principles to the improvement of the human condition.[49] As it had for Thompson and Fuller, the bubble retained its ideal status throughout this unsystematic chain of transmission. 'In the soap film, the material achieves its "moment of truth",' wrote Michael Burt in *Spatial Arrangement and Polyhedra With Curved Surfaces*, a typical example of these texts.[50] Less overtly, the emphasis on development over formal results had influenced the methodology of Sigfried Giedion, notably in *Mechanization Takes Command*, and the art-historical approach of Ernst Gombrich.

This notion of process, natural and technological, captivated the intellectual attention of members of the assorted artists of the Independent Group.[51] The debt to Thompson was overt in the (minimally attended) On Growth and Form exhibition of 1951 organized by Richard Hamilton at the ICA.[52] Two years later, Parallel of Life and Art demonstrated the structural similarity of biological and engineered things.[53] In 1956, among the twelve pavilions at This is Tomorrow was an installation by James Stirling, Richard Matthews and Michael Pine that centered on a sculpture extrapolated from photographic studies of soap bubbles.[54] The sculpture, in other words, assimilated the process of documenting the procedure of making bubbles. An additional text on the Independent Group reading list further underscored the methodological agenda: the eccentric *Science and*





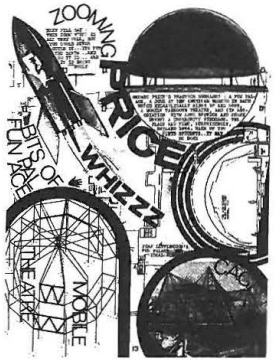
4.11
Installation view of the Growth and Form exhibition at the Institute of Contemporary Arts, London, 1951.

4.12
Photograph of the bubble sculpture taken by David Wagner at This is Tomorrow, Whitechapel Gallery, London, 1956.

Sanity (1933) by Alfred Korzybski, or rather the translation of this anti-Aristotelian polemic into popular terms by A.E. van Vogt in his science fiction *The World of Null-A* (1948).[55] An invited lecturer spoke on the notion of Dada as an anti-Aristotelian art. Korzybski had critiqued the legacy of Aristotelian logic in language – the 'either-or' construction of day or night, land or water, life or death – arguing, like Thompson, in favor of a dynamic, process-oriented model. Faith in such a dynamic model was at the root of the rejection of the curatorial policy that had shaped the visual practice promoted at the ICA under the leadership of Herbert Read. Read had modeled his strategy on the ethos of the Purist manifesto: 'But what strikes me,' Ozenfant had written, 'is not how ephemeral all this is, but particularly how prodigiously stable . . . These vast "constants".'[56] It was in Thompson's drive to study local relations rather than an ideal final cause that the Independent Group saw its reflection. In short, the

struggle of ICA modernism with the values of the Independent Group was the struggle of the universal with the ephemeral, the teleological view of a world versus a world of constant change.

Enclosure and time



4.13
'Zooming Price', *Archigram* 4, 1964.

Banham, himself a formative part of this alternative scene, helped to define an agenda for the loosely knit and variegated members of the Independent Group, especially after its demise. He continued to privilege work that prioritized changing environmental or social conditions through a methodological focus on process. Those engaged in the development of technologically enabled ephemera were for the same reasons those drawn to experiment with pneumatic structures. Over the course of the 1960s, such temporary structures would be combined with information-processing systems and their devices, building on the cybernetic philosophy of technology. *Archigram* 4 dedicated a page to 'Zooming Price', the local role model in this regard, among its other zooming images. While two additional pages of other examples intended to show that architects could be 'as wild, and as dynamic as the cartoonists', it was Price's work, some of it even realized, that *Archigram* declared to have 'particular relevance to this "connection" with reality'.[57] Compared with the featured projects by Price – a hydraulic dome, a fun palace, a mobile theater and a triangulated birdcage – the other schemes, including Hans Hollein's Architectural Form, were like backdrops for whizzing things rather than flexible in themselves.

As was not the case for most of his contemporaries, Price's involvement with the technical aspects of pneumatics was thorough.[58] His surveys of pneumatic structures conducted in collaboration with Frank Newby for the British Standards Institution and the Department of Environment were also unique in that they did not feature the standard idealism of the bubble analogy.[59] The interest that Price exhibited in air structures was consistent with his aversion to the notion of formal perfection and ambition to introduce temporality into the finished architectural product.[60] Price actively integrated adaptive pneumatic techniques into his projects, combining them with electronic mechanisms, computerization and other structural systems to incorporate what he called a 'precise time factor into the process of enclosure'.[61] With the integration of time, and thus speed, into the building process, there was the potential for a model of becoming, of passage, which would not merely be an inversion of

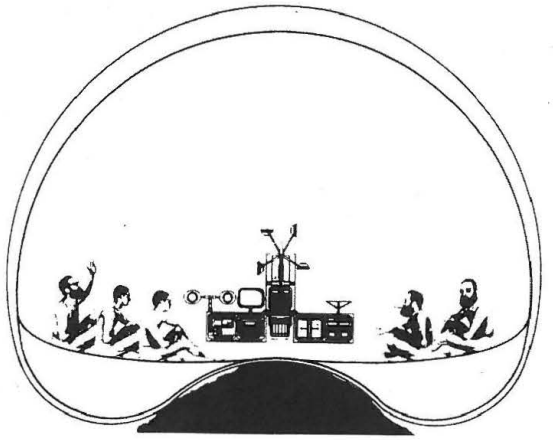
the stable.[62] Once the element of time was added to the equation, the bubble as a paradigm of static form would be replaced with a paradigm of a dynamic system. This inclination also took the flip side of the bubble's structural properties into account: the possibility of sudden and dramatic collapse.[63]

In *Archigram* 3 bubbles had been represented as rigid forms, nestled between the molded plastic capsules of the prefabricated bathroom and the urbanism of the system. The added component of an active relationship between container and contents made capsules, even Dymaxion ones, seem heavy. As the catalogue for Utopie's Structures Gonflables exhibition explained, 'At each instant every non-rigid container exemplifies, in its form, the dialectical relationship between container and contents. On the contrary, the rigid container is indifferent to its state of repletion.'[64] Less abstractly, Banham reported on his experience of a pneumatic structure:

> Every slight change of state inside or out – even a heated conversation – brought compensating movement in the skin, not through the expensive intervention of a computer, but by direct variation of curvature under balance of pressures. For the human occupant it was a kind of partnership relation with the enclosing membrane, each going independently but sympathetically about its business. Quite unlike the relationship with the static shell of a traditional building where you can beat your fists on the walls and scream and get no more than an echo for response: here a blow directed at the enclosing skin would produce a flurry of reproachful quivering and creaking, quickly dying away as the even tenor of its normal breathing ways was resumed. I *like* that.[65]

Human behavior was one element among the others that supplied feedback to the overall pneumatic system. Though Banham acknowledged that inflatables could only ever be a low-tech approximation of an actual cybernetic environment, responsive structures, like inflatable ones, worked well with the language of reflexive technology; at the ICA, the discussion of 'The Unstable Environment: The Use of Pneumatics in Art and the Environment' in 1967 was followed by the celebrated exhibition on systems technology and artistic practice, Cybernetic Serendipity: The Computer and the Arts (1968).[66]

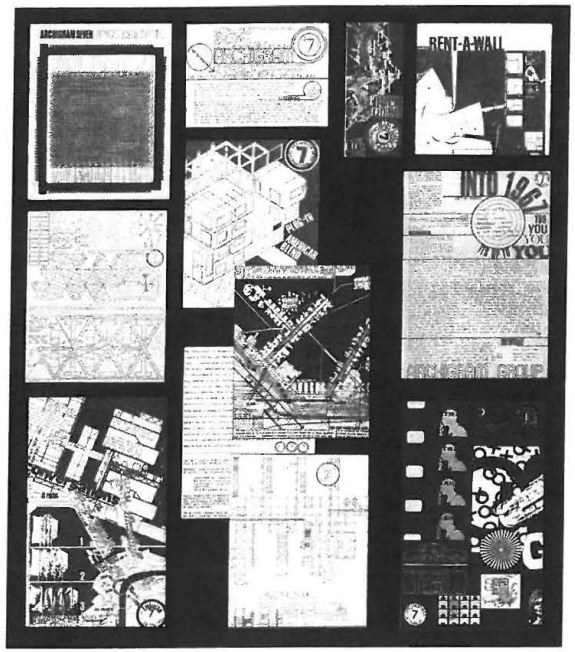
4.14
Adrian George, cover of *Architectural Design*, October 1970.



4.15
François Dallegret, 'Environbubble', 1965.

Hard and soft

As familiarity with information systems and their mechanisms grew, neither the language of comic graphics used in *Archigram* 4, nor that of the urban infrastructural system that would persist in *Archigram*s 5 and 6, would be sustained. *Archigram*, following the trajectory of consumer consciousness, would borrow as the decade progressed more and more heavily on the terminology of computing and communications theory. From City Synthesis on, computer-based technology had been referenced, but with *Archigram* 7: *Beyond Architecture* (1966) the language became more pervasive, and with *Archigram* 8: *Popular Pak* (1968), dominant. As ever, this shift was reflected in form as well as content. *Archigram*s 7 and 8 were unbound and unpaginated, confronting the reader with an abundance of information that shifted in organization with each shuffle. A kind of low-tech version of an information system replaced the coherent, narrative artifact of the leaflet or comic book. *Archigram* 7 introduced 'the ARCHIGRAM NETWORK. THE PRINTED PAGE IS NO LONGER ENOUGH: Ideas and situations now involve movement and sequences that need film, colour, magnification and explanation in length: Magazines will dissolve into hybrid networks of all media at once.' Fifteen loose pages of varying sizes printed in red, green, blue, brown or black came sheathed in plastic.[67] Also included in the 'pak' was an electronic



4.16
Spread of loose pages from *Archigram* 7, 1966.

resistor, chosen at random from a large mixed bag of components purchased on the Tottenham Court Road. Besides the title words running along the top, the cover page (8 inches by 10 inches) was an intricately woven black-and-white pattern representing circuitry. The contents, however, included a lot of architecture, including Barry Snowdon's inflatable inventions, Greene's Living Pod and numerous variations on the Plug-In model, but also the promise that 'there may be no buildings at all in *Archigram* 8'.

Cook wrote in the editorial of *Archigram* 8: 'In seven years the discussion has shifted: first from a search for form to the throwaway building. From this to the notion of the all-happening city and from this, inevitably to the future of the "building" as such. In *Archigram* seven the notion of assemblies programmed or designed objects was

4.17
Spread of loose pages from *Archigram* 8, 1968.

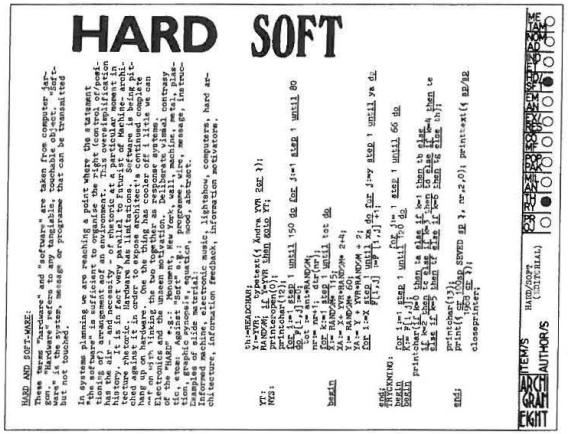
beginning to loosen-up so that it is no surprise to us that *Archigram* 8 is entirely concerned with the problem of direct personal provision: of comfort, facility, satisfaction, enquiry, and above all the effect of all kinds of phenomena upon each other.' Nineteen pages, this time of a more consistent size, were bundled in a mailing envelope of yellow card (8.375 inches by 6.25 inches). These leaves were described as a

pack of cards to which other contributions could be added. The font used for the titles throughout had an art nouveau, not futuristic, sensibility. *Archigram* 8 was focused around eight terms – specified as metamorphosis, nomad, indeterminacy, hard/soft, emancipation, exchange, response and comfort – and their redefinitions.[68] Each of the nineteen double-sided pages had a legend along the left margin that indicated which of the themes its contents emphasized.[69] For the first time, the balance was clearly weighted toward text at the expense of imagery. A prototype for an audio-visual helmet by Charles Colbert accompanied the details for a community of reactive, adaptive and gendered mobiles by the prominent British cyberneticist Gordon Pask.[70] The pneumatic 'mobile exhibition hall' by Antoine Stinco of Utopie was on the flip side of the editorial discussion of 'The Nomad' which explicitly stated: 'Time is a factor.'[71] Price also discussed the introduction of time, or a fourth dimension, in order to describe the 'location of the nomad': 'in planning architecture and design – the POSSIBLE must become more important than the PROBABLE. The NOMAD is literally NOWHERE until the most valid non locational system is designed.' The discussion of the nomadic process in which every juncture is reached only to be left behind was contemplated in terms of the other featured themes of indeterminacy, exchange and response.[72] The language through which the interface of the humans and machines was debated spilled over into that of biological change, or 'metamorphosis', defined in Archigram usage as the 'Continuous evolution from one state (or arrangement of forms, values, etc.), to another. Always alive but never the same. Always in a transient state.'[73] *Archigram* 8 also made the distinction, 'taken from computer jargon', between hardware and software for the first time, further reinforcing the blurred boundaries of mechanical and biological systems.[74]

Since programs still came bundled with computers as a package, the interwoven aspects of hard and soft technology resulted in a conceptual fuzziness in the amateur realm.[75] Among architects, rigid materials, such as steel and concrete and glass, tended to be referred to as 'hardware', while flexible ones passed as 'software', although, in the manner of Oldenburg's soft sculpture, transpositions did occur.[76] Because these terms were applied materiality, the metaphors were quickly assimilated in architectural discourse. As was the case in *Archigram* 8, hard- and software tended to be treated in sensory

terms: '"Hardware" refers to any tangiable [*sic*], touchable object. "Software" is the system, message or programme that can be transmitted but not touched.'[77] 'Hardware has its limitations,' the *Archigram* text continued. 'Software is being pitched against it in order to expose architect's continued complete hang up on hardware.' Such dichotomies enabled the group to clarify its agenda, using the term 'hardware' to speak of traditional definitions of architecture, such as the monument and the city, but also of contemporary metals and plastics. Programs, wires and information stood on the software

4.18
'Hard/Soft', *Archigram* 8, 1968.



side of the equation. In a structure that was essentially an aggregate of these components, the receivers were attuned to the subtleties of indeterminate use patterns, enabling the hardware of the entire unit to adapt without the aid of an architect. The snippet of ALGOL code that accompanied the Hard/Soft editorial reinforced the message with the operational language of random generation.

The use of the term 'software' as a shorthand for any vehicle of adaptation was demonstrated in 'The Triumph of Software', where Banham contrasted the hardware imagery of *Space Odyssey 2001* (1968) with the inflatables of *Barbarella* (1967).[78] Banham compared Kubrick's constructions to a 'Pompeii re-excavated': 'All that grey

plastic and crackle-finish metal, and knobs and switches, all that . . . yech . . . *hardware*!' By contrast, he wrote, the bubbles of *Barbarella* were 'responsive environments . . . curved, pliable, continuous, breathing, adaptable surfaces'.[79] The architectural difficulties of *Barbarella* stem from the contradiction that 'a lump of hardware like the city of Sogo could co-exist with the living, breathing vision of a friendly . . . adaptable personal environment'.[80] In other words, inflatable furniture did little to combat an urbanism which, even mediated through the lens of the megastructure, was essentially unyielding. The way out of a lingering archetype was exemplified by a vision, as in *Barbarella*, where 'hardware is fallible, and software (animate or otherwise) usually wins. *Barbarella*'s spaceship is more often broken down than not. The electronic gadgetry in David Hemmings' revolutionary HQ always goes on the blink when he needs it.' Software, it seemed, was bringing about the destruction of artifacts; for the landmark exhibition, Software, Information Technology: Its New Meaning for Art, John Baldessari cremated his accumulated artwork – all of his hardware – in a mortuary.[81]

In the technical literature on pneumatics, hardness also assumed a negative connotation. Thomas Herzog's handbook on pneumatic architecture, for a prominent example, deviated from its factual voice to critique the 'orthogonal forms with hard, cold, machine-produced surfaces' that had dominated architecture until now.[82] On the other hand, softness connoted the contemporary climate. Soft indicated 'flexible, movable, roundly spanned, "organic" shapes, which can be of great sensuous beauty'.[83] With the malleability of the inflatable, the language of the organism took over. As Banham wrote of the Nova dome, it carried on

> like a neurotic bullfrog puffing itself up, straining, creaking, wrinkling along the seams, trying to lift itself off the floor . . . Unlike conventional architecture which stands rigidly to attention and deteriorates (like a guardsman with moths in the busby) inflatables (and tents, to a lesser extent) move and are so nearly living and breathing that it is no surprise that they have to be fed (with amps, if not oats) . . . As an adjustable and largely self-regulating membrane it is more truly like the skin of a living creature than the metaphorical 'skin' of, say, a glass-walled office block.[84]

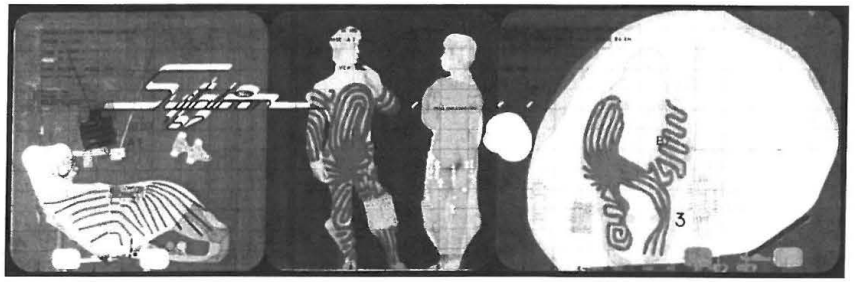
4.19
Haus-Rucker-Co, 'Pneumacosm', 1967.

Structures that seemed alive, Herzog wrote, offered a unique alloy of the organic world and built form that did not negate the structural dimension of architecture: '[P]revious attempts to oppose this with a sensuous plastic world have meant a negation of the technical/structural dimension of architecture, building with pneumatic structures offers the possibility of synthesis.'[85] Thus Fuller treated the Polyvinyl Chloride (PVC) from which these structures were made as an 'inherently natural' material because it was based on 'complex structural behaviors permitted by Nature'.[86] In short, pneumatics suggested a blend of the organic world and of built form that would not undo the primary role of architecture.

Herzog's organicism was predominantly a formal metaphor. Frei Otto's guide to pneumatics was more concerned with how architecture emulated plant and animal life than the analogical rhetoric of curvaceous sensuality:

> We find [pneumatic principles] not only in fruits, air bubbles, and blood vessels, but also in the skin kept taut by muscle tissue and blood pressure, and largely supported, in addition, by a skeleton resistant to bending and compression. Animal and man exhibit the essential features of a lightweight structure . . . Pneumatic structures, developed along lines dictated by purely technical considerations, are meeting the justified and growing demand that technology abandon its abstract, antiorganic-mathematical conception, though not its scientific basis, in favor of a conception nearer to organic life.[87]

4.20
Michelangelo's David has been dressed in a Suitaloon to demonstrate his recliner/transportation device, as well as his inflatable home, 1967.

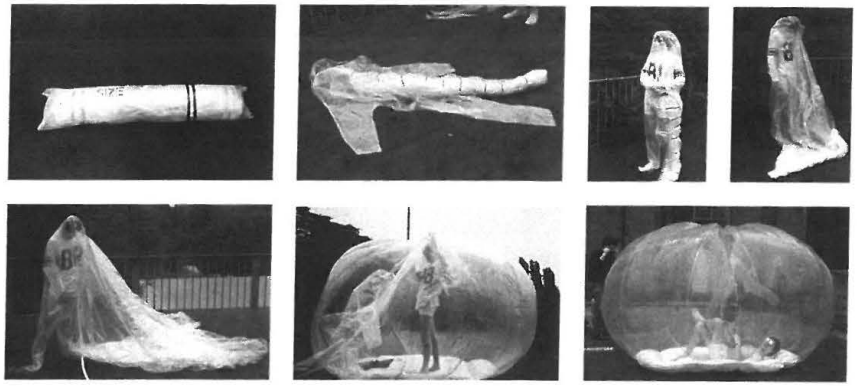


Otto's biologically based pneumatics emphasized the dynamics of the skin over the physics of structure. Once the characteristics of skin were attained, the aspiration was for the absolute limit of that thinness. 'There is a strong link between [Otto's] work,' Cook wrote, 'and the notion of an ultimate in skins: a membrane which is not there. The skin which can be seen through; the skin which can be parent to all within; the skin which can be regularized; the skin which can be treated as an environmental totality.'[88] Marshall McLuhan described the ideal of architecture as skin as the logical outcome of the experimentation with space capsules, air jet walls, and buildings with walls and floors that can be moved at will. 'Such flexibility,' McLuhan wrote, 'naturally tends towards the organic. Human sensitivity seems once more to be attuned to the universal currents that made of tribal man a cosmic skin-diver.'[89]

The cosmic wet suit

When Otto drew a detail of the pneumatic spacesuit, he included human skin as a layer of the outfit. Sure enough, an Archigram project included in *Archigram* 8 wrapped a combination of a 'soft', inflatable form with responsive technology architecture around the body. The notion of the suit as the most basic form of housing was at the heart of Mike Webb's design for the Suitaloon: Comfort for Two (1967). The project experimented with the McLuhanesque view of clothing as housing, but while even a spacesuit was still a suit, the Suitaloon blurred the boundaries between different kinds of bodily enclosures, of buildings and clothes, of inside and outside. The difference between the flexibility of the capsule and that of the inflatable suit was that when you wanted to be home, your suit inflated to enclose you. The biological organism (the inhabitant) and its enclosing mechanism (the Suitaloon) interacted with other physical systems, such as the compatible Cushicle, for further programmatic elasticity. The supply of basic services was 'refined down into a system of pipes worn around the body that heat and protect it.'[90]

In Muthesius's description of household mechanicals, technology had taken on a human metaphor. At the heart of the Suitaloon system, the body meshed with the core. This approximation of an integrative system implied a different outcome than would the analogy of the conduit to be sustained in the aesthetics of High Tech. In the first instance the technology was hidden within, an infrastructure sustaining the life of the house; in the end the roles were reversed –



4.21
Greene in the inflated trial Suitaloon at the Milan Triennale of 1968.

technology as the superstructure with a neurologically perceptive infrastructure. Webb combined what Price called the 'time factor' and the capacity to integrate change with structure to overcome the 'either-or' dichotomies of permanence and instability, hard and soft, technological and natural – as Archigram perceived them. With the possibilities of lightweight materials, Webb proposed an enclosure that was fully transportable, exploited the speed of expansion and deflation, constituted and reconstituted itself at will, like a lung. It was a house that was only as durable as clothing and as natural as a second skin.

The biological model had made the unity of the body and machine more complete than it had been in the production method of scientific management, where human motion conformed to that of the machine. The centrality of human-machine integration was made explicit in Norbert Wiener's *Cybernetics: Or Control and Communication in the Animal and the Machine* (1948).[91] Wiener's research, initiated for defensive purposes during World War II, had defined cybernetics as 'the set of problems centered about communication, control, and statistical mechanics, whether in the machine or in living tissue'.[92] British cyberneticists, following W. Ross Ashby's homeostatic emphasis in *Design for a Brain: The Origin of Adaptive Behavior* (1952) also interpreted communications systems along these lines.[93] In 1960, as part of the research conducted in the

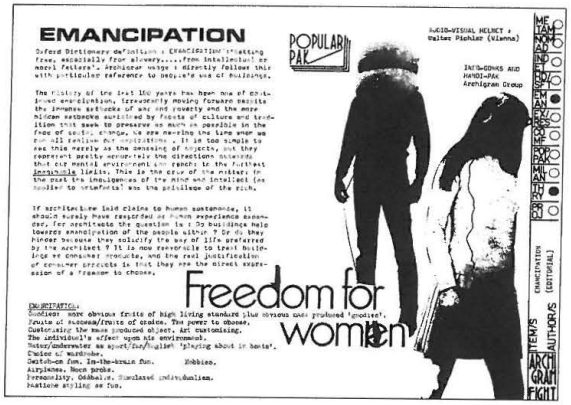
course of pursuing the space race, the term 'cyborg' was coined to describe an organism that was part animal, part machine.[94] Within architectural confines, Moholy-Nagy had evoked the body throughout the text of *Vision in Motion*, using the terms 'biological' and 'organic' to describe machine-made form. Technology, he thought, had 'become as much a part of life as metabolism'.[95]

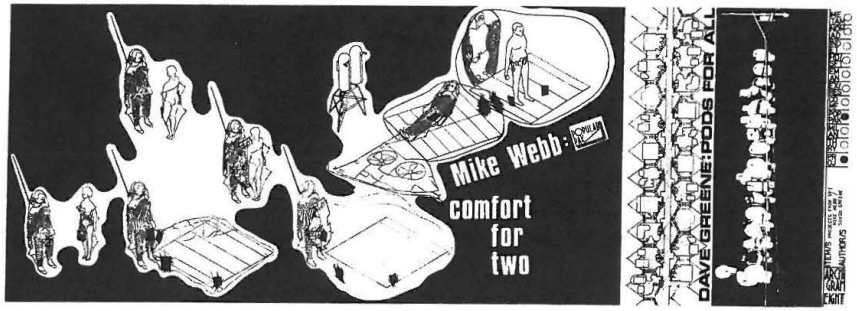
With the model of the Suitaloon, biology was not technology's unifying principle as Moholy-Nagy conceived, but rather its primary motivator. The Suitaloon, with its view into the autonomous bubble for one, occasionally two, offered a glimpse at technology, not as the machine-for-living cliché, but as adapting to the biological exigencies of life. The images of a meditative David Greene at the Milan Triennale of 1968, wearing Infogonk spectacles, a prototype of a virtual reality headset, inside a trial Suitaloon made by Nottingham art students demonstrate this well. The goggles completed the introversion by providing a view – architecture for the inside of the head – that was entirely perceptual. Reduction of spatial experience on the outside was all about opening up the world of subjectivity, like the contemporaneous promise of drug culture. No other appliances vied with the activity of introspective exploration in the Suitaloon. On offer was an alternative domestic experience, or model of the private sphere, mediated through the mind via a bodily appendage. This architecture for the inside of the head more completely meshed perception and technology, presenting virtual space as technology's inevitable destination: 'If developed, the extension of personality might become the central reason for the environment.'[96] Desire and privacy was a form of virtual reality to be created through the head.

Privacy, subjectivity, bodies: *Archigram* 8, with the obvious sexual politics of its conjoined Suitaloons and male/female analogies of Pask's communicating mobiles, grappled both with input and feedback on the one hand, and with the prevalent rhetoric of liberation and comfort on the other. On the page dedicated to 'Emancipation', and alongside the byline of 'Freedom for Women', images of a woman wearing Info-Gonks and a man sporting Walter Pichler's Audio-Visual Helmet (1966–90) linked social emancipation to expanding the limits of the imagination made possible through technology. On the 'Exchange and Response' page, a suited woman is linked via a dotted line to a vaguely insect-like mechanical organism. The bolded words 'WOMAN-INTERFACE-MACHINE' evoked the later hopes that the integration of

4.22
Peter Cook, Info Gonk educational TV glasses and headgear, 1968.

4.23
'Emancipation', *Archigram* 8, 1968.





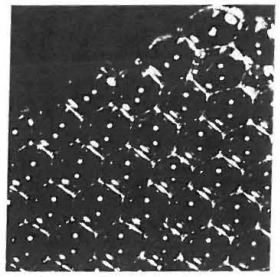
4.24
Mike Webb: a sequence demonstrating how a couple dressed in 'Suitaloons' could join together into a single enclosure, 1968 – note the relative states of dress/undress of the pair. Pod/Suitaloon page from *Archigram* 8, 1968.

human and machine would have emancipatory potential.[97] Whether the technological freedom of the mind was to be followed by the sexual autonomy of the body can only be a matter of speculation. Perhaps Archigram's Living 1990 built on the communal kitchens and washrooms of earlier utopias, eliminating chores with the flick of a switch. The purpose of this response to the user, however, as Cook's domestic 'Metamorphosis' included in *Archigram* 8 demonstrated, was to exemplify how structure would come to resemble the human systems within it: 'And the parts slowly but continuously evolving –

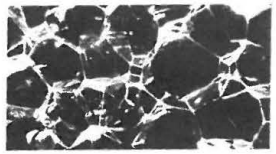
a sensory and responsive role and it all gets clearer as it gets nearer the minds within.'[98]

The relationship of the body, the home and the outside world dramatized the change in the dialectic of privacy and publicity in the technologically responsive environment. Such self-containment conflicted with the communal nexus of the stem and web that had been entrenched in the discourse since the fifties. 'I have nothing against discontinuous domes,' Philip Johnson quipped, 'but for goodness sake, let's not call it architecture.'[99] As if to emphasize the concerns raised for the issue of community, Greene's Pods for All, a neighborhood of Living Pods, occupied the margin of the folded sheet with the Suitaloon. To circumvent enforced isolation in an autonomous envelope, the Suitaloon was provided with a plug to connect it with other like envelopes;[100] in the handbooks, meticulous attention was paid to how bubbles clung together in groups. The automatic adjustments made by the whole each time a bubble joined the collocation displaced the emphasis from the reclusive realm of the individual bubble to the interaction of these self-contained units in a responsive system. The inter-connections of the system, 120-degree angles at which bubbles converge, the curvature of their shared walls, provided insight into how to overcome the exclusivity of interiority and exteriority. In the cluster, each individual bubble, a closed system in itself, adapted to the conditions of the neighborhood. The automatic adjustments made by the whole each time a bubble joined the collocation displaced the emphasis from the introverted realm of the individual bubble to the interaction of these self-contained units in a responsive system. More than the ordered cluster of bubbles, an agglomeration made up of a multitude of compressed bubble sizes and shapes, as in a foam, was an even better example of what emerged when competing forces were at work. Add a dose of responsive technology to the adaptive ways of the cluster and the results could not be more compliant.

A notable consequence of using the material limit as an energy interface was that the surface plane assumed an importance belied by its negligible width. Modern architectural tenets had proscribed thinness to de-emphasize the perimeter in keeping with its diminished structural role. The ultra-thin membrane, however, commanded the attention that was its due. Even the simplest of inflatables has a skin in dynamic equilibrium. 'All architecture has to mediate between an



4.25
Organized cluster of floating bubbles of equal volume.

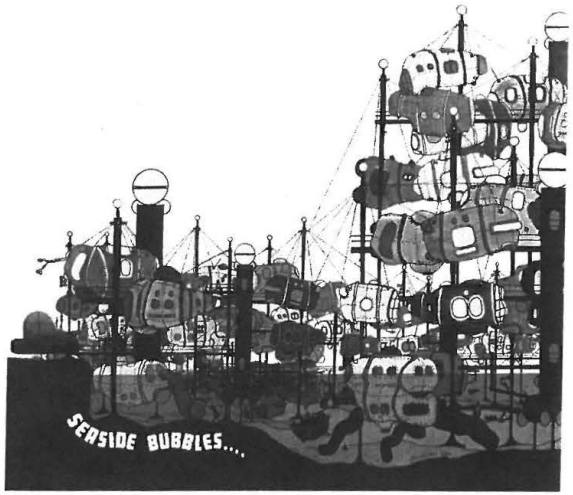


4.26
Agglomeration of bubble shapes, or foam.

outer and an inner environment in some way,' wrote Banham, 'but if you can sense a rigid structure actually doing it (dripping sounds, tiles flying off, windows rattling) it usually means a malfunction. An inflatable, on the other hand, in its state of active homeostasis, trimming, adjusting and taking up strains, is malfunctioning if it *doesn't* squirm and creak.'[101] Compounded by the status of the surface in the realm of complex technology, attitudes toward surface and volume hung in the balance. The celebration of that which had been associated with superficiality became a bromide of the 'new' technology and post-modernism:

> In this new environment, the surface is no longer constrained to pretend that it just does not exist, and almost as if in vindication of the obscurity to which it was relegated for so long it is now taking on a dramatic role that upstages the third dimension. Indeed, the emblematical images of the present-day world reveal an environment tendentially dematerialized, as fluid as the flow of information that passes across and through it, flattened down into the two-dimensionality of printed paper and the television screen . . . This prevalence of the two-dimensional (and the dematerialisation that it implies) seems to go much further than just the boundaries of the world of information and information science. Physical objects seem to have come under the same influence, as if by some strange drag effect; it's not just the numerous family of objects that have been transformed by electronics and miniaturisation in the normal course of their evolution, but also those objects that by necessity and by their nature keep to their three-dimensional character that are now entrusting a greater part of their expressive capacity and their performance to their surface area.[102]

The move from the celebration of the two-dimensional to the disintegration of the three-dimensional has obvious importance for a discipline concerned primarily with the design and construction of objects. With the friction between physicality and dematerialization, the set of contradictions introduced by the polarity of the mobile and the fixed had reached full capacity. The inside/outside tension of the individual bubble, which was already a stand-in for the hard/soft divide, itself a substitute for the structure/infrastructure dichotomy, shifted to an opposition tension between the surface and the frame



4.27
Ron Herron, 'Seaside Bubbles', 1966.

at the urban scale with the added conflict of conviction over open and closed systems.

To face the outcome of such interiors, the group had to negotiate the interface between the outside and the inside. How would the conglomeration of individual components with their scenic views of the unconscious amount to the social interactions that engendered an Archigram city? Ron Herron's 'Seaside Bubbles' (1966), in which a scoop of blue, green and yellow soft spheroids, touched with white, purple, orange and red, hung from a dark blue frame, aptly demonstrated the state of the dialectic. The components bobbed against each other, contrasting with the orthogonals from which they were suspended. Cluster was tethered to infrastructure. The group soon had an answer for this: 'Coming together and independence are compatible if we use time. The effect of hybrid assemblies that are at once mass-produced and private world already exist.'[103] So it is to the system that we must turn.

1 These magazines had been key for a segment of the Independent Group. See 'Science Fiction', in D. Robbins (ed.), *The Independent Group*, Cambridge, MA: MIT Press, 1990, pp. 61–2.

2 Peter Cook reports that each pop-up insert was cut by hand using a Stanley knife by participants working inside the Taylor Woodrow site hut for the Euston Station project.

3 'Space Probe!', *Archigram* 4 (1964), 4.

4 'Zoom and Real Architecture', *Archigram* 4 (1964), 18.

5 American comics were argued in the Act to be harmful to 'impressionable minds'. This fear was perpetuated by the publication of Frederic Wertham's *The Seduction of the Innocent* in 1964 (Martin Barker, *A Haunt of Fears: the Strange History of the British Horror Comics Campaign*, London: Pluto Press, 1984).

6 'Zoom and Real Architecture', *Archigram* 4, 18.

7 'Science Fiction Situation Architecture', *Archigram* 4, 6.

8 'Zoom and Real Architecture', *Archigram* 4, 18.

9 Ray Bradbury, 'Art and Science Fiction: Unbuilt Cities/Realized Dreams', *Yestermorrow: Obvious Answers to Impossible Futures*, Santa Barbara, CA: Joshua Odell Editions/Capra Press, 1991, pp. 18–29.

10 'Space Probe!', *Archigram* 4, 1.

11 Ibid.

12 'There is the same consistency in an "Adventure Comics" city of the 1962–3 period and Taut's projects for Alpine Architecture of 1917 with the same force of prediction and style' ('Zoom and Real Architecture', *Archigram* 4, 18). Some of these same images and more had appeared in the 'Architectures Fantastiques' issue of *L'architecture d'aujourd'hui*.

13 In the premiere issue of *Megascope*, the students of Bristol wrote, 'We must rocket ourselves so high that even when the paralysing missiles of regulation are shot at us our satellite is still orbiting, transmitting data of potential workable solutions . . . count down for Utopia.' This excerpt was quoted in Denise Scott Brown, 'Little Magazines in Architecture and Urbanism', *Journal of the American Institute of Planners* 34(4), 225.

14 'Space Probe!', *Archigram* 4, 4.

15 *Archigram* 4 included the underwater villages of Cousteau, the Aluminaut submarine, the Alvin ocean explorer, and Buckminster Fuller's Undersea Island. The idea of underwater exploration would continue to fascinate Chalk in particular: 'Oceanographers have long realized the untapped sources of wealth to be found in the sea and under the sea bed. Underwater resources appear fantastic, a storehouse for harvesting petroleum, natural gas, minerals and sulphates; even gold and diamonds are to be found, and commercial fish-farming is a theoretical possibility. These activities will give rise, eventually, to on-surface and undersea marine settlements as unexceptional communities . . . besides the great commercial implications of marine cities there also may be an equal leisure potential – a potential that may make the line, "We all live in a yellow submarine", more prophetic than even the Beatles might have imagined' (Warren Chalk, 'Hardware of a New World', *Architectural Forum* 125(3), 50–1).

16 Reyner Banham, 'Zoom Wave Meets Architecture', *New Society* 7(179), 21 (reprinted in Penny Sparke (ed.), *Design by Choice*, London, Academy Editions, 1981, p. 64).

17 Ulrich Conrads and Hans Sperlich, *The Architecture of Fantasy*, tr. C. Crasemann Collins and G.R. Collins, NY: Frederick A. Praeger, 1962, p. 19.

18 'Even a cursory look shows that in the conventional environment, that is, in the field of gravity, certain difficulties exist in space occupation which, in the case of space travel, are eliminated by a single enormous expenditure of energy. However, achieving the conditions for human life – climate control, suitable pressure, and the other requirements – outside the earth's atmosphere, underwater, or underground will, in the foreseeable future, involve such colossal difficulties and costs and such extreme modifications of our basic life pattern that these environments can probably not be considered as living spaces for large numbers of people for extended periods in the near future, and so are irrelevant to present-day urban planning. I am therefore resisting the temptation to sketch an utopian ideal which depends on conceivable but not presently available inventions and techniques or which disregards biological and psychological obstacles, such as, for example, space occupancy based on the manipulation of gravity, telekinesis, tele-delivery (without conductors), food-waste recycling, total climate control . . . and all the other attractive ideas which presently fall in the realm of science fiction' (Eckhard Schulze-Fielitz, *Stadtsysteme I*, Stuttgart: Karl Kramer Verlag, 1971, p. 19).

19 For detail on the mass science of soap bubbles and commodity culture, see Simon Schaffer, 'A Science Whose Business is Bursting', in Lorraine Daston (ed.), *Things That Talk: Object Lessons from Art and Science*, NY: Zone Books, 2004, pp. 147–92.

20 Le Corbusier, *Towards a New Architecture*, tr. F. Etchells, London: Architectural Press, 1946, p.167.

21 Christopher Alexander, *Notes on the Synthesis of Form*, Cambridge, MA: Harvard University Press, 1964, p. 90.

22 'With regard to their surface all shapes produced with soap bubbles can be thought of as "ideal" pneumatic forms . . . Within the prescribed boundary conditions the largest possible volumes and the smallest possible surface areas always form . . . Thus an optimisation of form in relation to use of material takes place' (Thomas Herzog, *Pneumatic Structures: A Handbook of Inflatable Architecture*, NY: Oxford University Press, 1976, p. 8).

23 Joseph Plateau, *Statique Experimentale et Theorique des Liquides soumis aux Seules Forces Moleculaires*, Paris: Gauthier-Villars, 1873.

24 The best-known and most cited of these lectures delivered to juvenile and popular audiences at the Society for Promoting Christian Knowledge was *Soap Bubbles, Their Colours and the*

Forces which Mould Them by Charles Vernon Boys (London: SPCK 1890). Another example, *Soap Bubbles*, was delivered at the Hulme Town Hall in Manchester on Wednesday, 3 November 1875, by Arthur Rücker (*Science Lectures for the People: Seventh Series*, Manchester: John Heywood, 1876, pp. 33–48).

25 Faraday had isolated the isoprene molecule – the flammable, liquid, unsaturated hydrocarbon C_5H_8 used to make synthetic rubber – in 1826. 'Lecture III: Cohesion – Chemical Affinity', *Scientific Papers: Physics, Chemistry, Astronomy, Geology, with Introductions, Notes and Illustrations*, New York, P. F. Collier & son [c. 1910], Harvard Classics no. 30, Charles W. Eliot (ed.), pp. 36–49. This lecture was cited by others such as Thomas Williams whose own popular lecture was published as *Soap Bubbles* (Liverpool, 1890).

26 D'Arcy Wentworth Thompson, *On Growth and Form*, Cambridge: Cambridge University Press, volume 1, 1917, p. 351. Thompson was a staple of pneumatic literature.

27 Ibid.

28 Sigfried Giedion also cited *The Pneumatics of Hero of Alexandria* to illustrate the 'magical' use of technology by the ancients versus our own 'progressive' view (Sigfried Giedion, *Mechanization Takes Command*, NY: Oxford University Press, 1948, p. 32).

29 Lanchester, an aeronautical engineer, submitted his patent (#119,339) for 'An Improved Construction of Tent for Field Hospitals, Depots and like purposes' in 1917: 'The present invention has for its object to provide a means of constructing and erecting a tent of large size without the use of poles or supports of any kind. The present invention consists in brief in a construction of tent in which balloon fabric or other material of low air permeability is employed and maintained in an erected state by air pressure and in which ingress and egress is provided for by one or more air locks' (John Fletcher (ed.), *The Lanchester Legacy: A Celebration of Genius*, vol. 3, Coventry: Coventry University Enterprise Ltd, 1996; also reproduced in Herzog, *Pneumatic Structures*, 34–5).

30 These include barrage balloons, temporary shelters, dummy buildings and lifeboats.

31 *Archigram* 6 featured three 'domes' by Birdair, alongside Victor Lundy's inflatable Atomic Energy Commission pavilion, noted below, which had been featured in the 'Architectures Fantastiques' issue of *L'architecture d'aujourd'hui*. The photographs were stamped 'FACT'. The construction sequence of the CID Air 'Airhouse' was also reproduced from that company's promotional literature.

32 The spherical forms lent themselves to Picturesque scatter in non-urban situations. Simple inflatables proliferated during the fifties – by 1957, there were about fifty manufacturers in the US making portable air structures: Birdair, Schjeldall, Irving, US Rubber, Goodyear, Texair, Stromeyer, Krupp, Seattle Tent & Awning, and CID Air Structures, to name a prominent few.

33 Roger N. Dent listed the Boston Arts Center Theater (Woods Hole, MA, 1959), by Carl Koch and Margaret Ross with Paul Weidhinger of Birdair, as the first pneumatic construction designed by architects (*Principles of Pneumatic Architecture*, London, Architectural Press, 1971, pp. 39–40). Victor Lundy's hybrid pneumatic exhibition hall for the US Atomic Energy Commission (Santiago, Chile, 1960), with Walter Bird, was noted for its innovation at the architectural level (Dent, *Principles of Pneumatic Architecture*, pp. 41–4; Reyner Banham, *The Architecture of the Well-Tempered Environment*, Chicago: University of Chicago Press, 1969, pp. 270–4).

34 The Irving Air Chute Company exhibited a two-room inflatable air house – two inflatable domes connected by a tube – at the International Home Exposition in NYC, June 1957. Pneumatics enclosures were extensively used at Expo 67, Montreal and Expo 70, Osaka.

35 Reyner Banham mocked these concerns: 'But . . . surely this is not a home, you can't bring up a family in a polythene bag? This can never replace the time-honoured ranch-style tri-level standing proudly in a landscape of five defeated shrubs, flanked on one side by a ranch-style tri-level with six shrubs and on the other by a ranch-style tri-level with four small boys and a private dust bowl' (Reyner Banham, 'A Home is Not a House', *Art in America*, April 1965, vol. 53, no. 2, p. 76 (reprinted in *Design by Choice*, 59).

36 Arthur Quarmby, *Plastics in Architecture*, NY: Praeger Press, 1974, p. 114.

37 Some examples are Laurent Vaudoyer's Design for a Spherical House (1784), Bouleé's Cenotaph for Newton, J.J. Leonidov's Design for the Lenin Library (1927–8). Hemispheres, such as Ralph Tubb's Dome of Discovery (1951) for the Commonwealth Exposition or Geodesic, were a subset of this category. See Conrads and Sperlich, *The Architecture of Fantasy*, pp. 88–93.

38 Pneumatic contraptions had a prehistory within utopian thought, particularly in relation to dreams of transformation through pure air. The connection between the problem of ambient air and architectural designs for social improvement got an early start in Britain with John Evelyn's environmental tract about industrial pollution in London, *Fumifigium* (1661), and accompanying program for a city cased in glass. London's air remained notoriously deadly for centuries: in one week in December 1952, around 5,000 people were left dead by a poisonous mist that settled on the city.

39 Utopie actively engaged in the design of inflatables and presented their projects in a notable exhibition, Structures Gonflables (March 1968), at the Musée d'Art Moderne de la Ville de Paris. Utopie saw pneumatics in explicit political terms of the kind from which Archigram distanced itself. Like Archigram, Utopie subverted the text of comic books to present their pneumatic plans. Jean Aubert recalls: 'We pushed the research rather far on the permanence of materials. Working as architects and not as stylists, we controlled the limits of the ephemeral and mobile aspect of those constructions, whereas others – some with real graphic talent, like Archigram in London – turned it into a flag for theoretical discourses and advertising movements . . .Our inflatable structures, accurate instruments of technology and aesthetic in the service of daily life, appeared to us as an exercise set back from the social and political context, cultivated in order to perpetuate an art and a knowledge that would have otherwise disappeared under "normal" living conditions' (Marc Dessauce (ed.), *The Inflatable Moment: Pneumatics and Protest* in '68, NY: Princeton Architectural Press, 1999, p. 65).

40 In addition to Cedric Price and Archigram, Coop Himmelblau, Hans Hollein and Haus Rücker Co. in Vienna are prominent examples. In Paris, where social unrest was pronounced, Utopie focused exclusively on inflatables as a form of agitative practice.

41 Dent, *Principles of Pneumatic Architecture*, 21.

42 Banham, *The Architecture of the Well-Tempered Environment*, 276.

43 The language of invisibility borrowed heavily from Fuller's aspiration to do 'vastly more with vastly and invisibly less'. Buckminster Fuller, *Utopia or Oblivion*, London: Allen Lane, 1970, pp. 184–5.

44 Dent, *Principles of Pneumatic Architecture*, 21.

45 'Unlike conventional structures which exert a positive loading on the ground, the pressure differential across the membrane of an air supported structure causes up-lift forces, and these must be resisted by firmly anchoring the air supported structure to the ground' (ibid., p.19).

46 Thompson, *On Growth*, 4.

47 Ibid., 6. In addition to his own groundbreaking work in the field, Thompson was known for his translations of Aristotle's biological works on *Greek Birds* and *Greek Fishes*.

48 Thompson, *On Growth*, 3–4.

49 The archetypal example was Matila Ghyka's *The Geometry of Art and Life* (New York: Sheed & Ward, 1946), which had a cult following. The text made connections between geometrical form as found in nature, art and mysticism.

50 Other examples would be M.A. Guran's *Change in Space Defining Systems*, R.K. Thomas's *Three Dimensional Design*, J. Borrego's *Space Grid Structure*, D.G. Wood's *Space Enclosure System*, Steve Baer's *Dome Cook Book* and M. Safdie's *New Environmental Requirements for Urban Building*.

51 Anne Massey, *The Independent Group: Modernism and Mass Culture in Britain 1945–1959*, Manchester: Manchester University Press, 1995, p. 44.

52 Massey recounts how this exhibition came to be part of the ICA's contribution to the Festival of Britain (ibid., 42–4). Hamilton told of being introduced to Thompson's *On Growth and Form* by fellow Slade student Nigel Henderson, in *Collected Words 1953–1982*, London: Thames & Hudson, p. 10.

53 This exhibition was held at the ICA, as was On Growth and Form.

54 This is described in by Graham Whitham, in David Robbins (ed.), *The Independent Group: Postwar Britain and the Aesthetics of Plenty*, Cambridge, MA: MIT Press, 1990, p. 143: 'Pine,' the catalogue quotes, 'recalls the photographs as "great fun to do"' and then cites from a letter that he wrote to Jacquelyn Baas on 20 August 1988: 'An enlarger was focused through an aspirin bottle containing soapy water onto photosensitive paper on the wall. This was all set up using a red filter, and when we had a good bubble image, the red filter was removed for about four seconds, and the paper immediately developed. The problem with this was the tendency of the bubbles to burst during the four seconds of exposure. However, we got enough prints for our purpose.' Pine and Stirling discounted any influence of Hamilton's *On Growth and Form*.

55 *The World of Null-A* imagined a society in which no rules of Aristotelian logic applied. Each chapter of the book (which originally appeared as a series in *Astounding Science Fiction*) began with a quote from Korzybski. In Frank Cordell's view, none of the IG members had read Korzybski in the original (Massey, *The Independent Group*, 85–9; Robbins, *The Independent Group*, 61). An invited speaker also lectured the group on the notion of Dada as an anti-Aristotelian art.

56 Quoted in Massey, *The Independent Group*, 87. The full text of the manifesto, 'After Cubism', is translated by John Goodman in Carol S. Eliel (ed.), *L'esprit Nouveau: Purism in Paris, 1918–1925*, Los Angeles: Los Angeles County Museum of Art in association with Harry N. Abrams, 2001, pp. 129–67.

57 'Price is almost the only architect in England actually building tensegrity structures, pop-up domes and disposable buildings' (Cook, 'Zoom and Real Architecture', *Archigram* 4, 18).

58 Price actively engaged in professional meetings, including the 'First International Colloquium on Pneumatic Structures' in Stuttgart in 1967, and delivered the keynote address at the National Conference of Air Structures in Education that was held in an inflatable at Antioch College, Maryland, in 1973.

59 *Air Structure Research Report*, Department of the Environment, London: HMSO, 1971, and *Air Supported Structures: Draft for Development*, London: British Standards Institution, 1976.

60 *Archigram* 6 would include a small section of Price's 'air-structure projects', all of which demonstrated his integrative approach.

61 Cedric Price, 'Pneumatics – a key to variable hybrid structuring', in *Cedric Price, Works II*, London: Architectural Association, 1984, p. 31.

62 As Deleuze and Guattari described their nomadology, fluids are not a special case of a theory of solids: 'From turba to turbo: in other words, from bands or packs of atoms to the great vortical organizations. The model is a vortical one; it operates in an open space throughout which thing-flows are distributed, rather than plotting out a closed space for linear and solid things' ('Treatise on Nomadology – The War Machine', in *A Thousand Plateaus: Capitalism & Schizophrenia*, tr. B Massumi, Minneapolis: University of Minnesota Press, 1987, p. 361).

63 Quarmby tells a precautionary tale of his three dramatic mishaps with inflatables (Arthur Quarmby, *Plastics and Architecture*, NY: Praeger, 1973, pp. 98–100). As Banham put it, 'an airdome is not the sort of thing that the kids, or a distracted Pumpkin-eater could run in and out of when the fit took them – believe me, fighting your way out of an airdome can be worse than trying to get out of a collapsed rain-soaked tent if you make the wrong first move' (Banham, 'A Home is not a House', 76).

64 Claude and Léon Gaignebet, in Dessauce, *The Inflatable Moment*, 29.

65 Banham, 'Monumental Windbags', *New Society* 11(290), 570 (reprinted in Dessauce, *The Inflatable Moment*, 33).

66 Jasia Reichardt organized the exhibition in collaboration with Mark Dowson and Peter Schmidt. It was held at the ICA from 2 August–20 October 1968. The Computer Arts Society (CAS) was founded in Britain as a result of this exhibition. From 1969 onwards, CAS published a bulletin entitled *Page*.

67 There was also an accompanying exhibition, 'Beyond Architecture: a Projection of 640 Images', held at the Museum of Modern Art, Oxford, which opened on 22 February 1967.

68 The themes of *Archigram* 8 were introduced on 30 November 1967 in the Terry Hamilton Memorial Lecture, 'Current Archigram Preoccupations: Eight Non-Fictions', at the ICA. Cook's lecture notes, 'Preliminary Workout for the Eight Notional Titles: Metamorphosis, the Nomad, Indeterminacy, Emancipation, Exchange, Comfort, Response', remark under 'Hard-Soft': 'These terms aren't yet in the Oxford dictionary.'

69 It also indicated whether the page belonged to the category of 'popular pak', theory or project, or whether it was part of their plans for the 1968 Milan *Triennale*.

70 Gordon Pask, 'A Plan for an Aesthetically Potent Social Environment', *Archigram* 8, unpaginated. This was the same project included in *Cybernetic Serendipity* (1968).

71 *Archigram* 7, 1966, unpaginated. For more on Utopie, see Dessauce, *The Inflatable Moment*.

72 The architectural project to be included in *Cybernetic Serendipity* was an example of 'indeterminate' planning, demonstrated by the hospital building at Northwick Park, North London by John Weeks et al.

73 'Metamorphosis', *Archigram* 8, 1968, unpaginated.

74 'Hard/Soft', *Archigram* 8, unpaginated.

75 In computer technology, software designated changeable programs and procedures, whereas hardware referred to components such as processors, memory, display devices, and other – tangible – equipment. The software industry was initiated in the late 1950s when individuals who had programmed for computer manufacturers, such as IBM or Univac, or the government agencies and corporations who were the early users of such machines began to set up shop on their own. In the 1960s, the major hardware manufacturers would bundle the operating systems, utility programs, language compilers and other application into their machines in response to each customer's needs. Over the course of the decade, however, some companies began to offer software directly to the consumers as stand-alone products. Finally, on 30 June 1969, IBM announced that it would unbundle hardware and software with its System/3 minicomputer line.

76 'One of the ways in which Pop expressed itself was through the mass-produced material culture of the day and, in this context, it presented the possibility of things incorporating "expendable" values, whether literally or metaphorically. This was in line with what had come to be called the "throwaway" culture. In physical terms the new soft plastics – PVC and polyurethane foam – were ideal exponents of this new system of values and they were used extensively as signs of a new relationship between consumer/user and the physical envirogment' Penny Sparke (ed.), *The Plastics Age: From Bakelite to Beanbags and Beyond*, Woodstock, NY: Overlook Press, 1993, p. 88.

77 'Hard/Soft', *Archigram* 8.

78 'The Triumph of Software', *New Society* 12(318), 629–30 (reprinted in *Design by Choice*, pp. 133–6).

79 Ibid., 629.

80 Ibid., 630.

81 The exhibition was curated by Jack Burnham and opened in September 1970 at the Jewish Museum, NY (*Software Information Technology: Its New Meaning for Art*, New York: Jewish Museum, 1970, p. 30–1). *Architectural Design* also reported on Baldessari's decision in November 1970, p. 548.

82 Herzog, *Pneumatic Structures*, 7.

83 Ibid. Also see Jeffrey L. Meikle, *American Plastic*, NJ: Rutgers University Press, 1995, pp. 217–18.

84 Banham, 'Monumental Windbags', 570. Peter Murray and Tony Gwilliam designed this dome in 1967 for a spread in *Nova* magazine.

85 Herzog, *Pneumatic Structures*, 7.

86 Meikle, *American Plastic*, 215–16. Baudrillard explained this understanding of synthetic materials: 'In the contemporary environment, all the organic or natural materials have, in practice, found their functional equivalents in plastic or compound substances . . . Objectively speaking, materials are what they are: there are no true or false ones, natural or artificial ones. Why should concrete be less "authentic" than stone? We experience old synthetic materials, such as paper, as completely natural, and glass is one of the richest materials in existence. In essence, the inherent nobility of materials forms part of a cultural ideology which is analogous to that of the aristocratic myth in the human domain, and even this cultural prejudice evaporates with time' (Baudrillard, 'Natural Wood, Cultural Wood', *The System of Objects*, Editions Gallimard, 1968, reprinted in Sparke, *The Plastics Age*, 112).

87 Frei Otto, *Tensile Structures*, vol. 1, Cambridge, MA: MIT Press, 1967, p. 10.

88 Peter Cook, *Experimental Architecture*, London: Studio Vista Ltd, 1970, pp. 51–5.

89 Marshall McLuhan, 'Housing: New Look and New Outlook', in *Understanding Media*, New York: McGraw Hill, 1964, p. 128.

90 Cook, *Experimental Architecture*, 117.

91 Cybernetic theory, developed in the 1940s by Nobert Wiener, was much elaborated by thinkers in fields right across the academic map, from computing to sociology. See Peter Galison, 'The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision', *Critical Inquiry* 21(1), 228–66.

92 Norbert Wiener, *Cybernetics*, New York, Paris: Technology Press, 1948, p. 11.

93 For an outline of the trajectory of British cybernetics, see Andrew Pickering, 'Cybernetics and the Mangle: Ashby, Beer and Pask', in A. Dahan and D. Pestre (eds.), *La reconfiguration des sciences pour l'action dans les années 1950*, Paris: Presses de l'EHESS.

94 Manfred Clynes, Nathan S. Cline, 'Cyborgs and Space', *Astronautics* (September 1960).

95 László Moholy-Nagy, *Vision In Motion*, Chicago: Paul Theobald & Co., 1947, p. 64.

96 'Nomad', *Archigram* 7, unpaginated.

97 Donna J. Haraway, 'A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century', *Simians, Cyborgs, and Women: the Reinvention of Nature*, NY: Routledge, 1991, pp. 149–81.

98 Peter Cook, 'Metamorphosis', *Archigram* 8, unpaginated.

99 'Where We Are At', *Architectural Review* (September 1960) (reprinted in *Architecture Culture 1943–1968*, NY: Rizzoli, 1993, p.191).

100 'Each suit has a plug serving a similar function to the key to your front door. You can plug into your friend and you will both be in one envelope, or you can plug into any envelope, stepping out of your suit which is left clipped on to the outside ready to step into when you leave. The plug also serves as a means of connecting envelopes together to form larger spaces' ('Comfort For Two', *A Guide to Archigram 1961–74*, London: Academy Editions, 1994, p. 207).

101 'Monumental Windbags', 570.

102 Ezio Manzini, 'Objects and Their Skin', in Sparke, *The Plastics Age*, 115–16.

103 'Nomad', *Archigram* 7, unpaginated.