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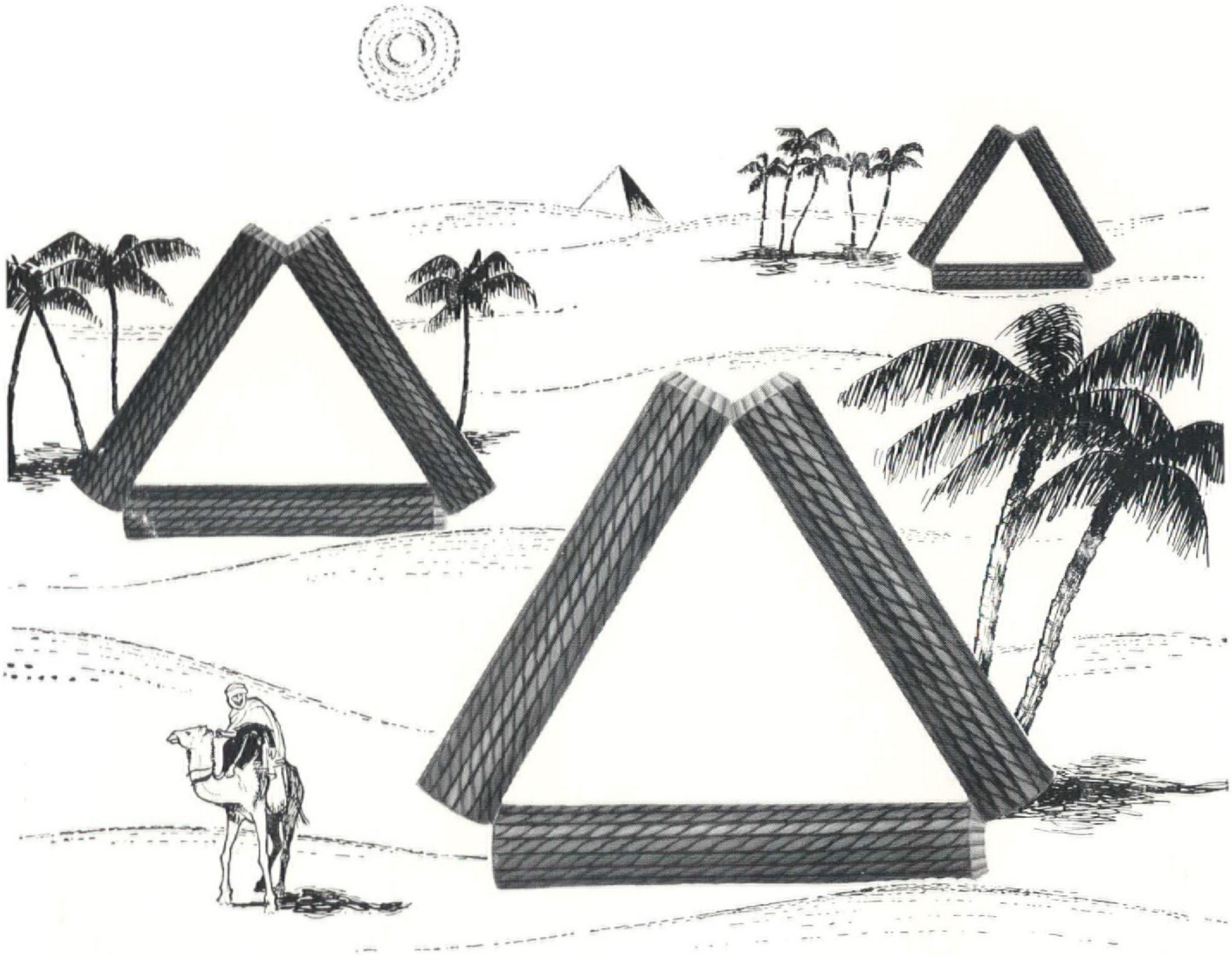

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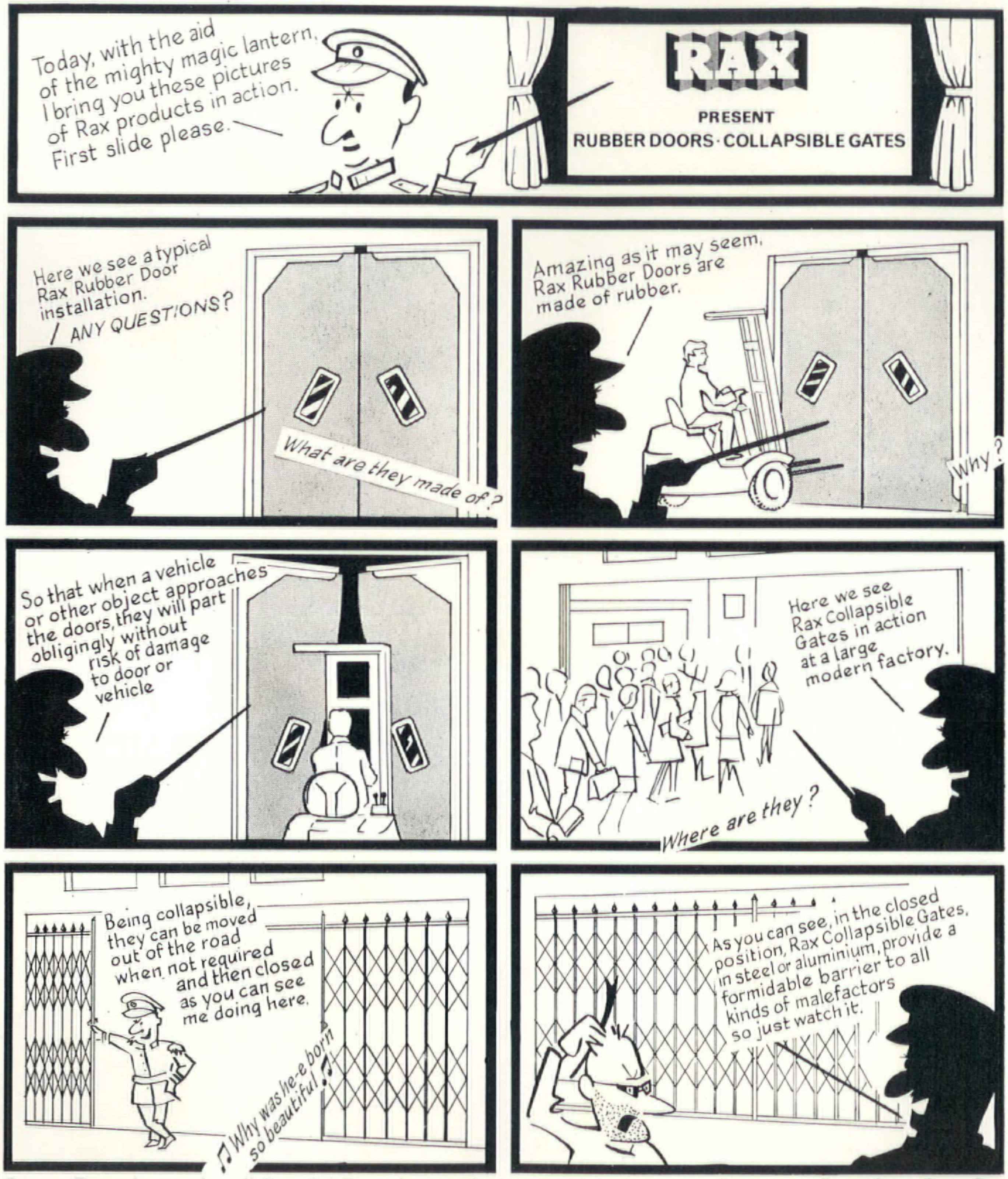

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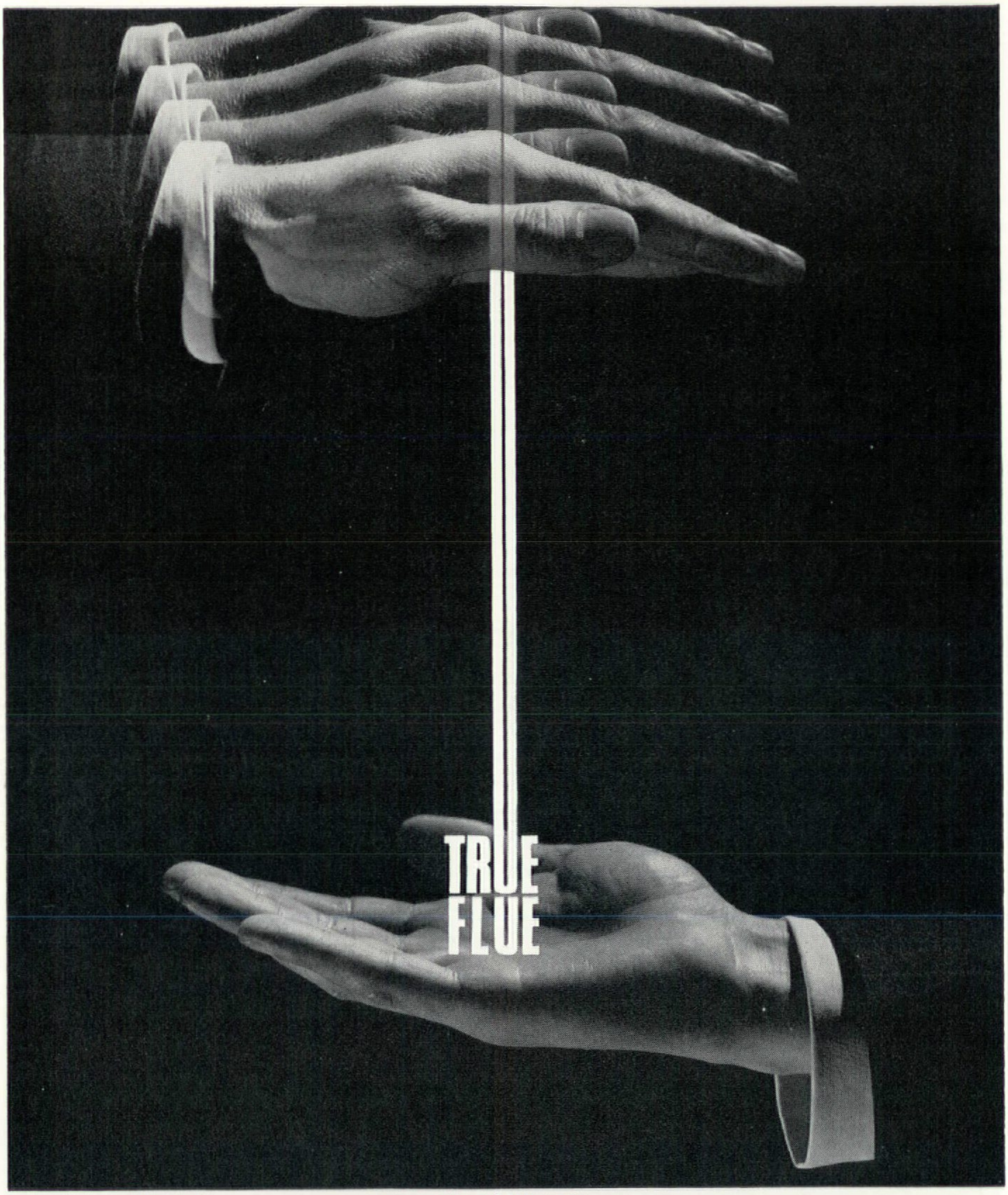

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SfB(85)

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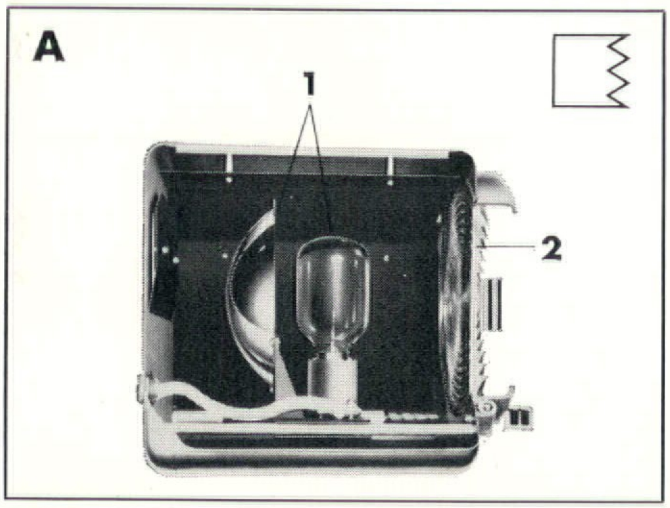
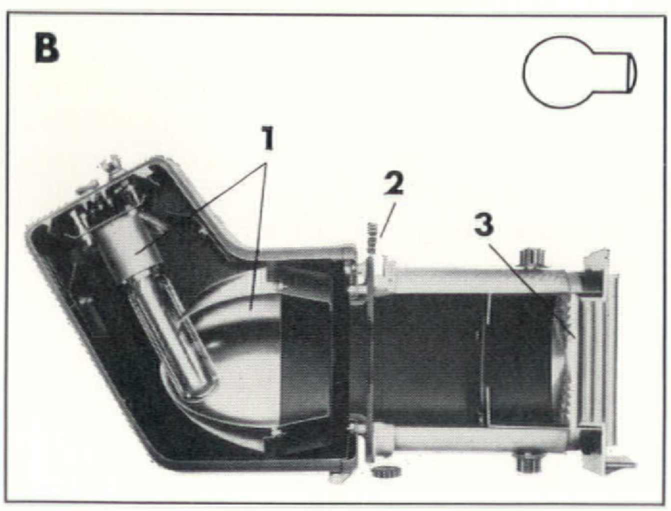
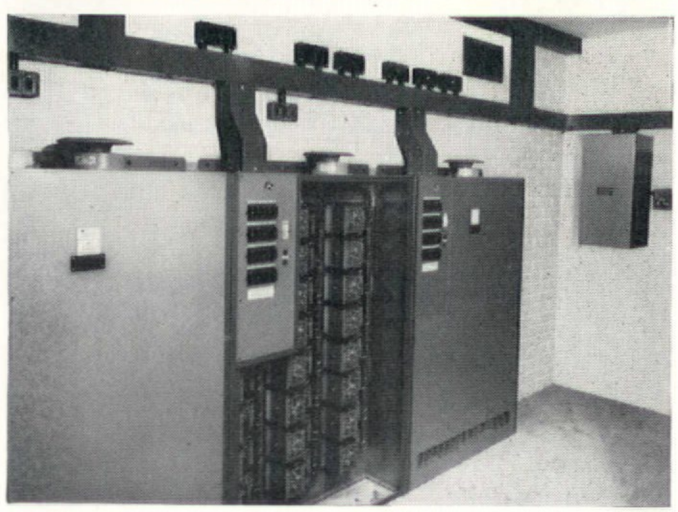
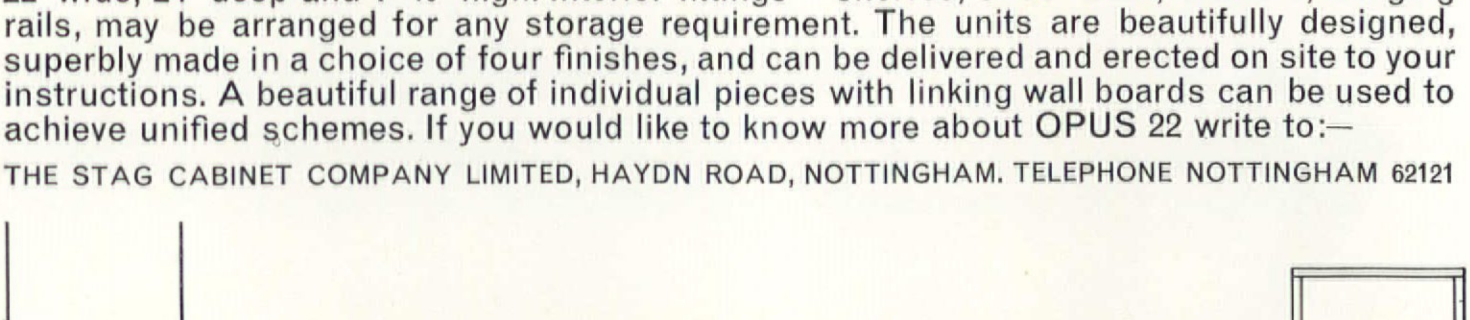
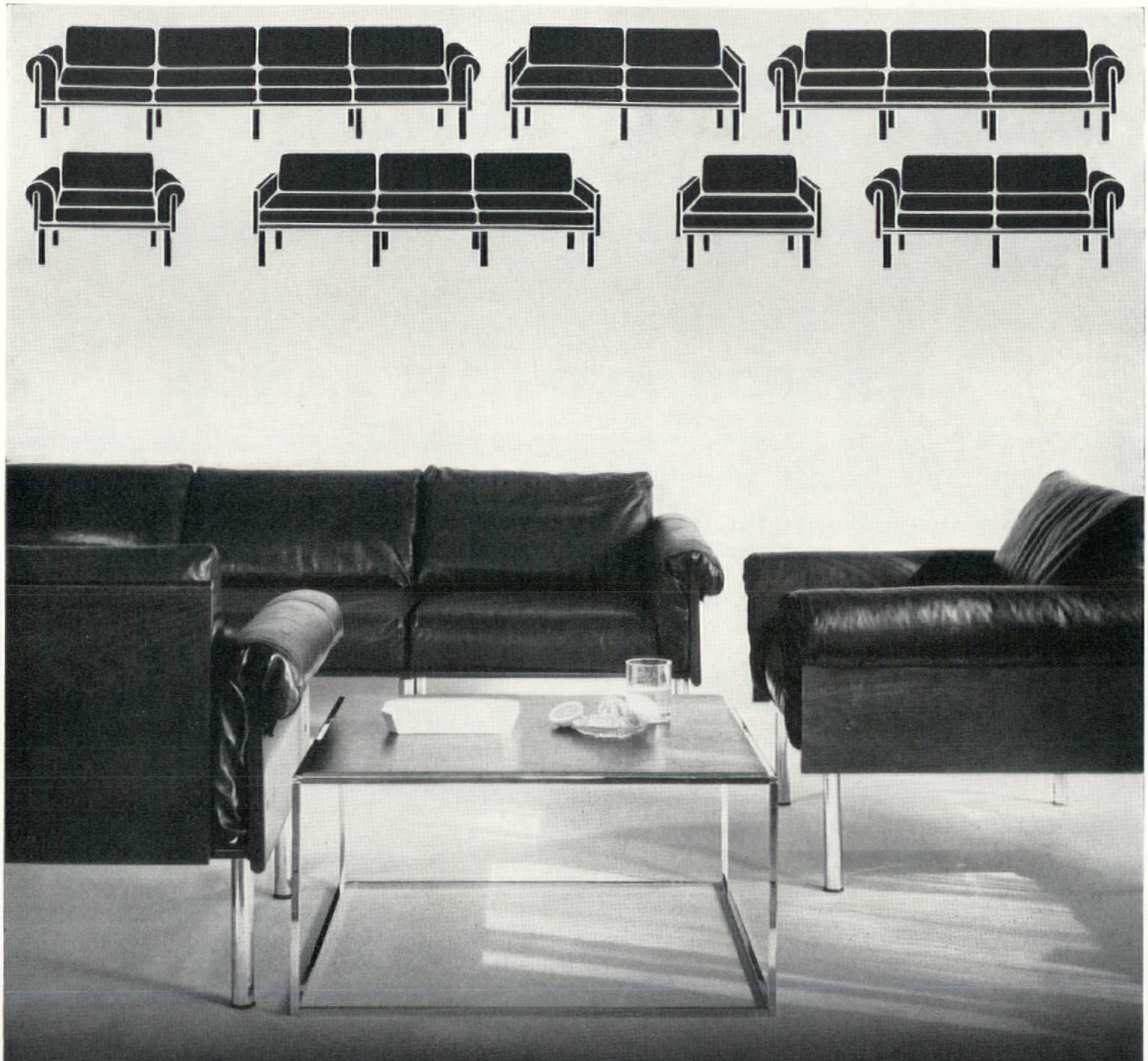






The Strand Electric & Engineering Co. Ltd., 29 King Street, Covent Garden, London, W.C.2. Telephone: Temple Bar 4444





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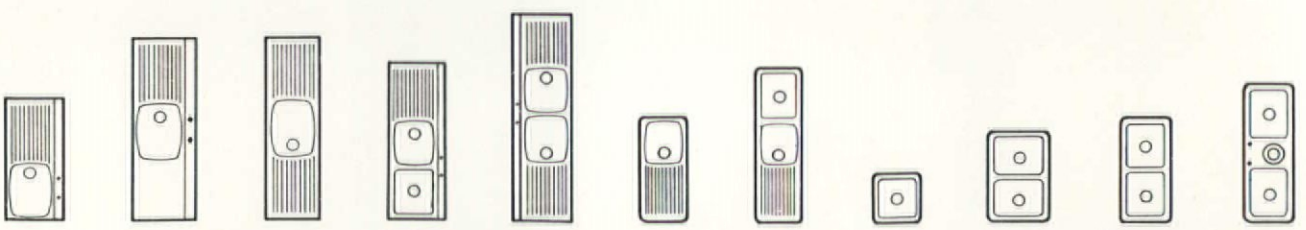

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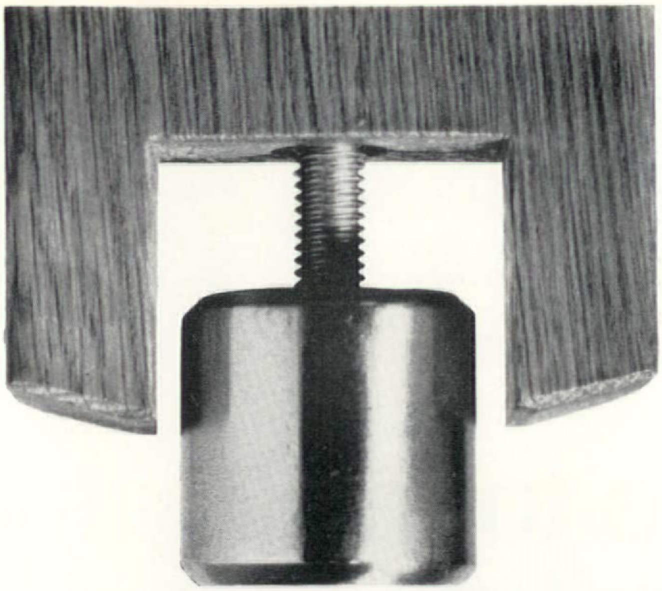

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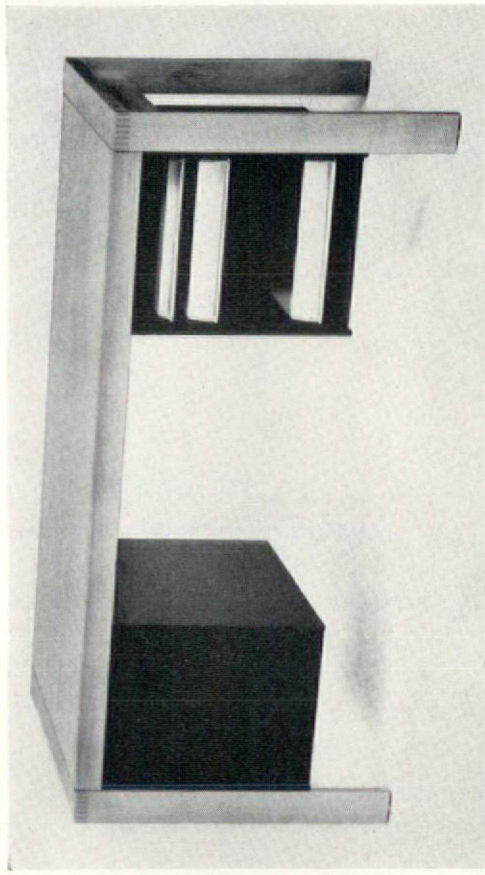

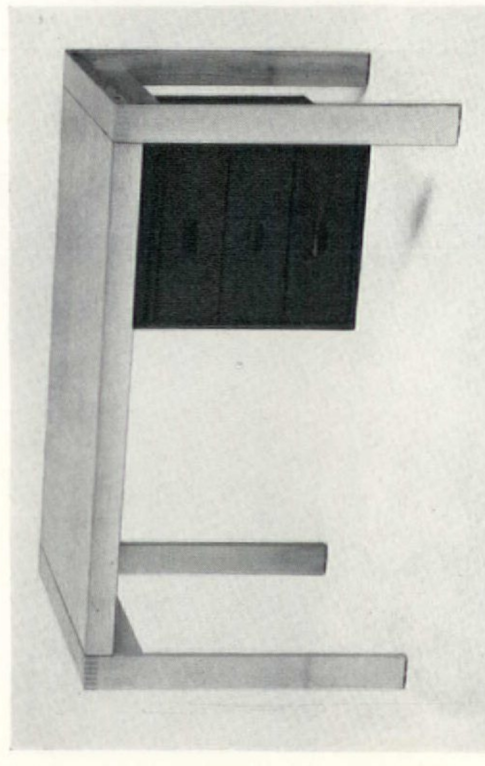

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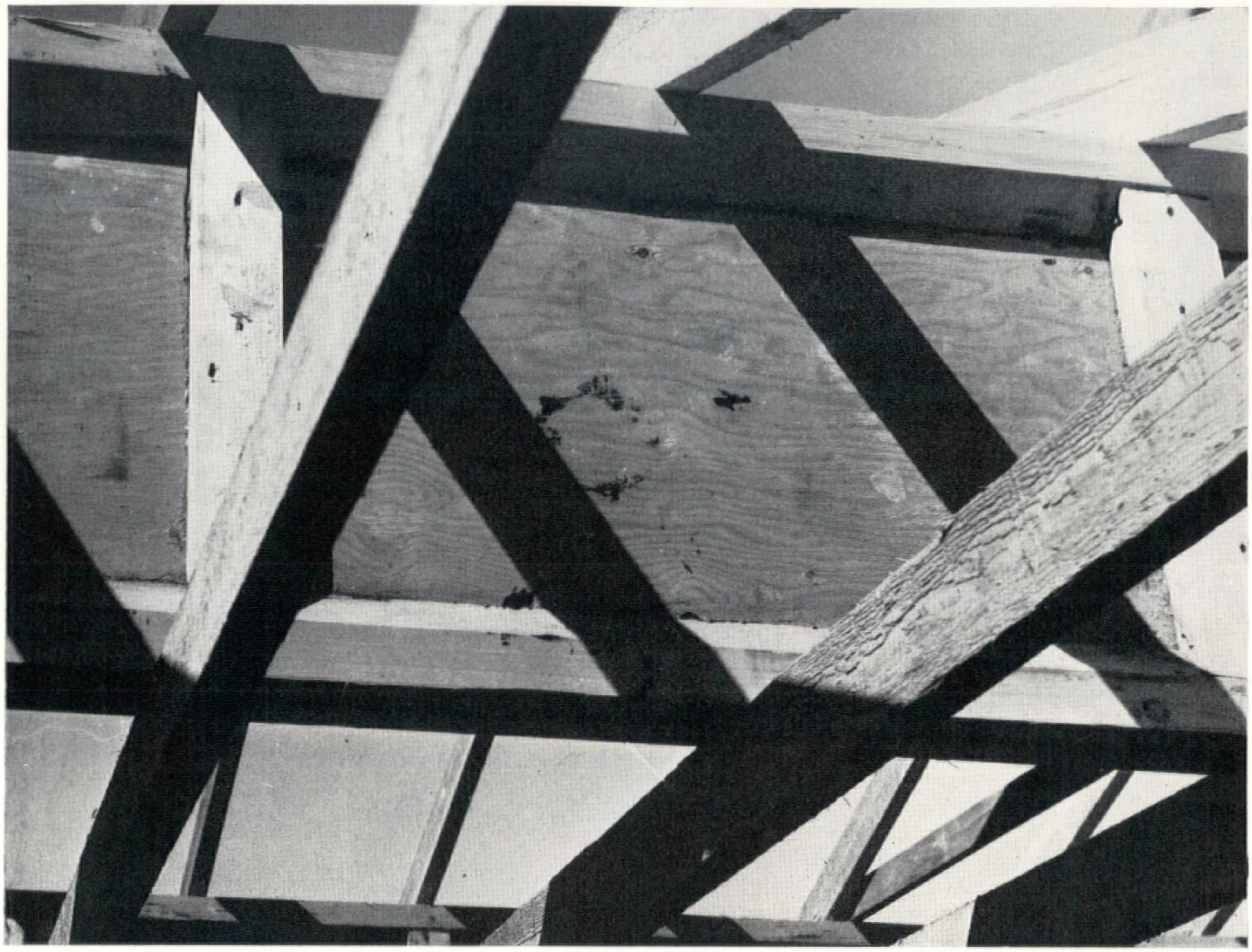

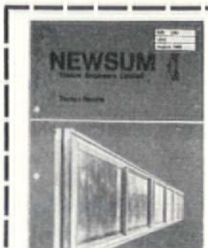

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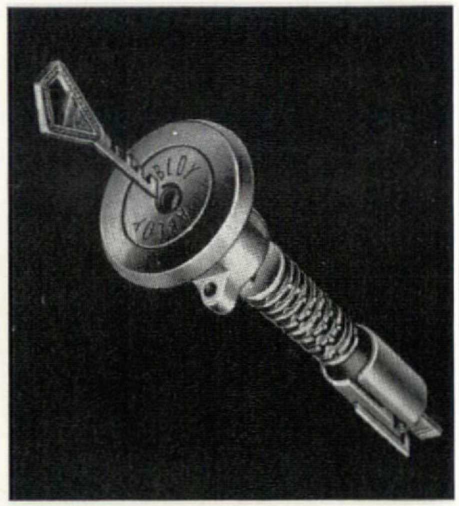

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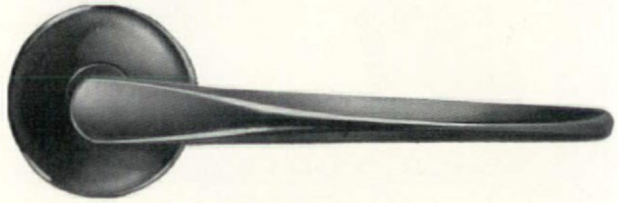

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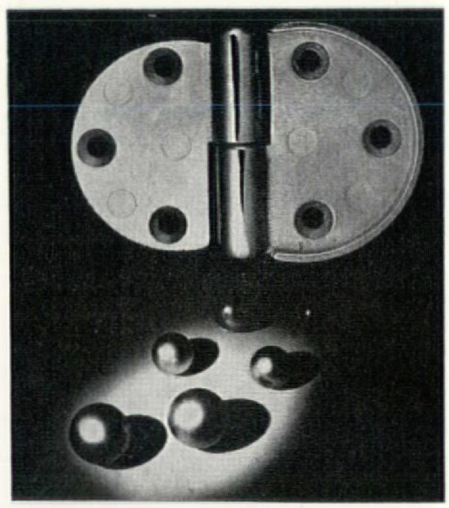

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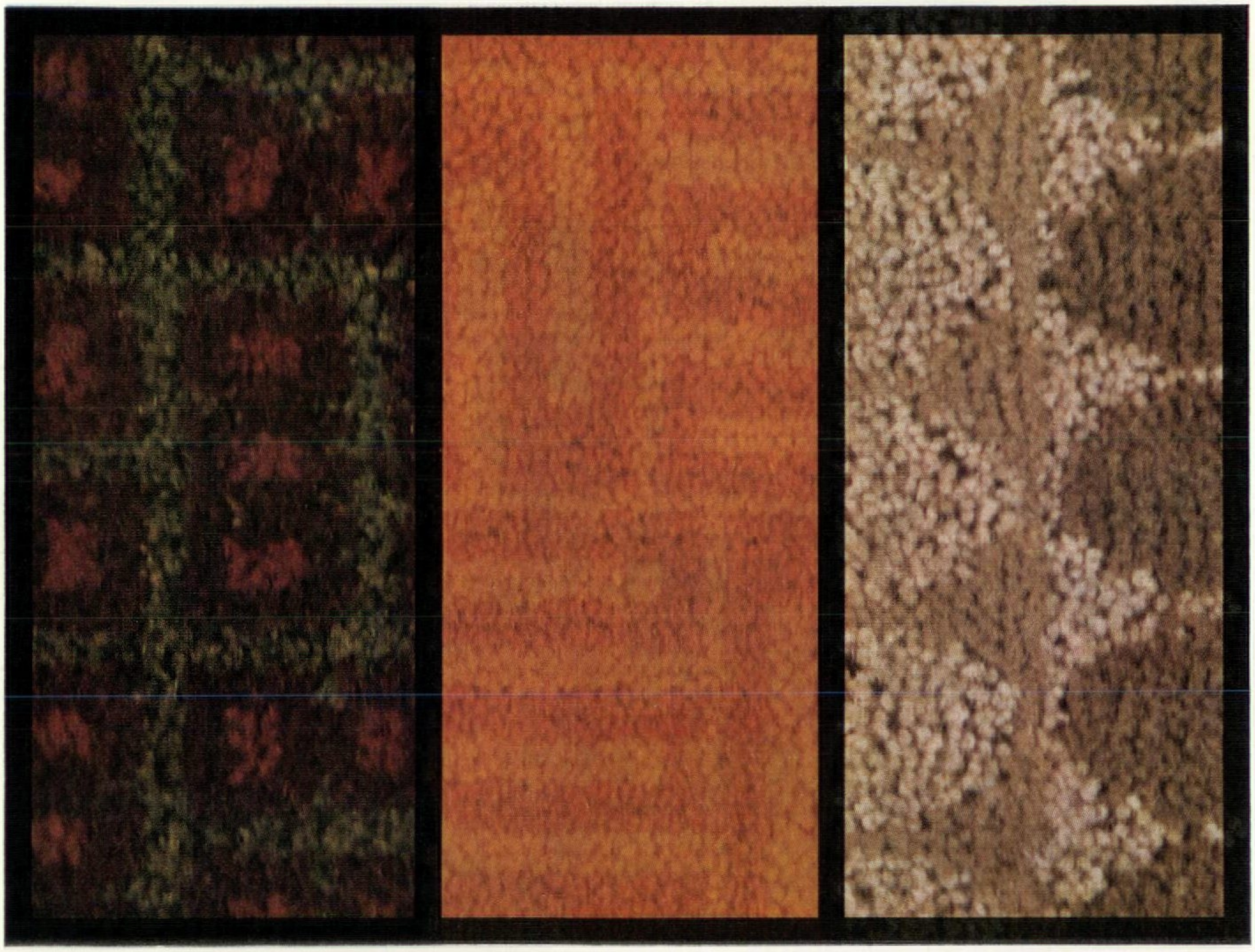

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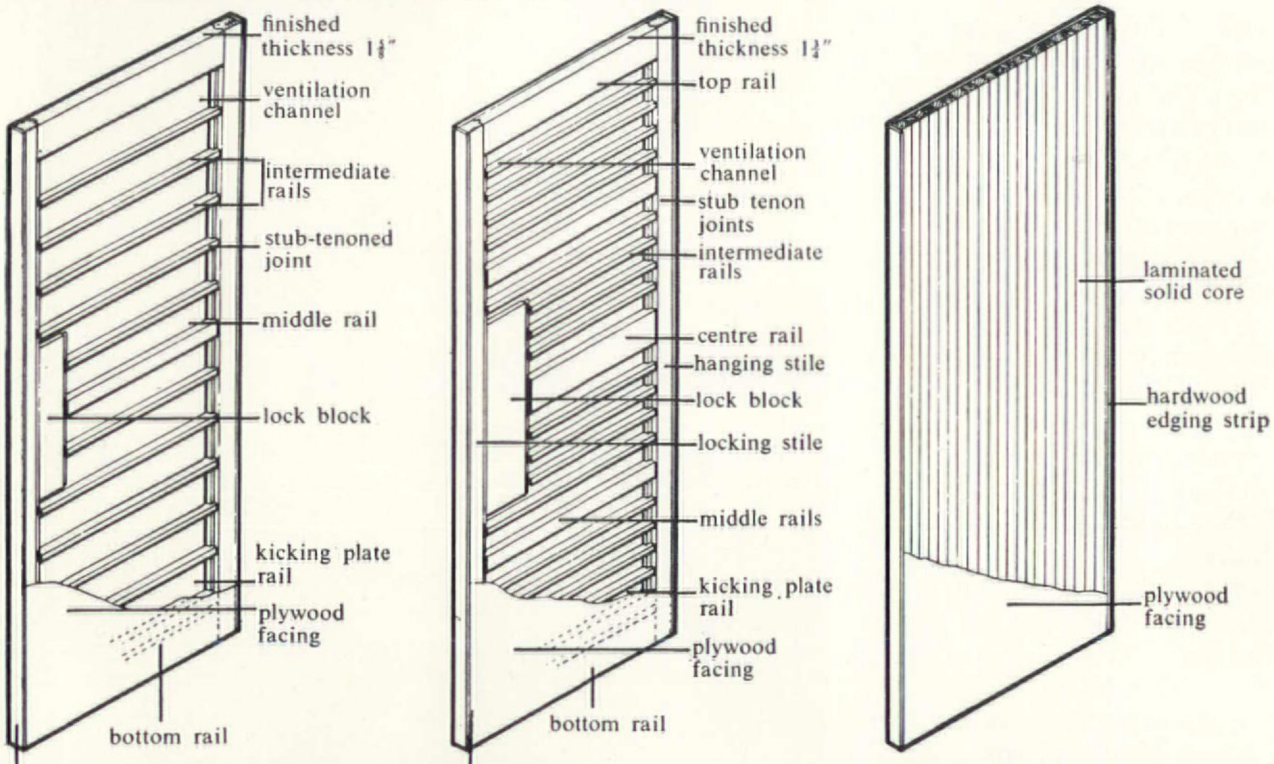
The Leaderflush range includes all the main types of flush doors; solid, semi-solid, timber-cored and asbestos lined fire check doors.



MATERIALS Canadian Western Red Cedar is used exclusively for all cores. Its low coefficient of expansion virtually eliminates the risk of distortion even when subjected to changing temperature and humidity. Facings are beech for interiors and West African mahoganies for exterior work. Veneers may be specially selected, book matched and laid to order, or can be supplied from stock laid at the time of manufacture of the plywood. All timber is subjected to electronic checking for correct moisture content before it is permitted to be incorporated in a Leaderflush door.

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FIRE CHECK DOORS The standard solid core Leaderflush door has been tested and approved by the Fire Research Station as a ½ hour fire check door. Where a 1 hour fire check door is called for, a special asbestos lined solid core door is available. This door has been tested and approved by the Fire Research Station as a 1 hour fire check door.

Although the four types of door illustrated above form the basis of the Leaderflush range, a substantial part of our business is in purpose-made doors to individual requirements. For complete details, write or telephone

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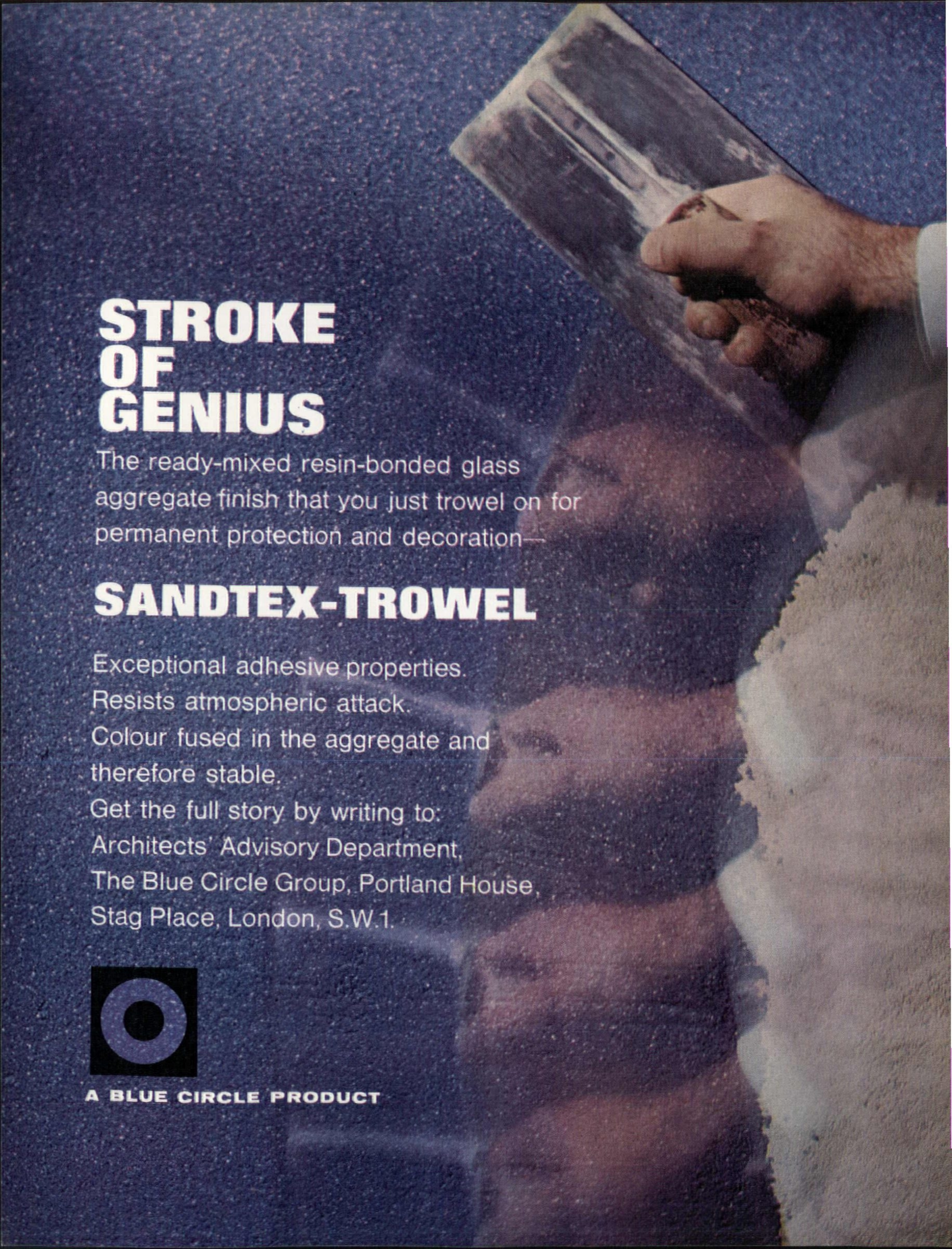
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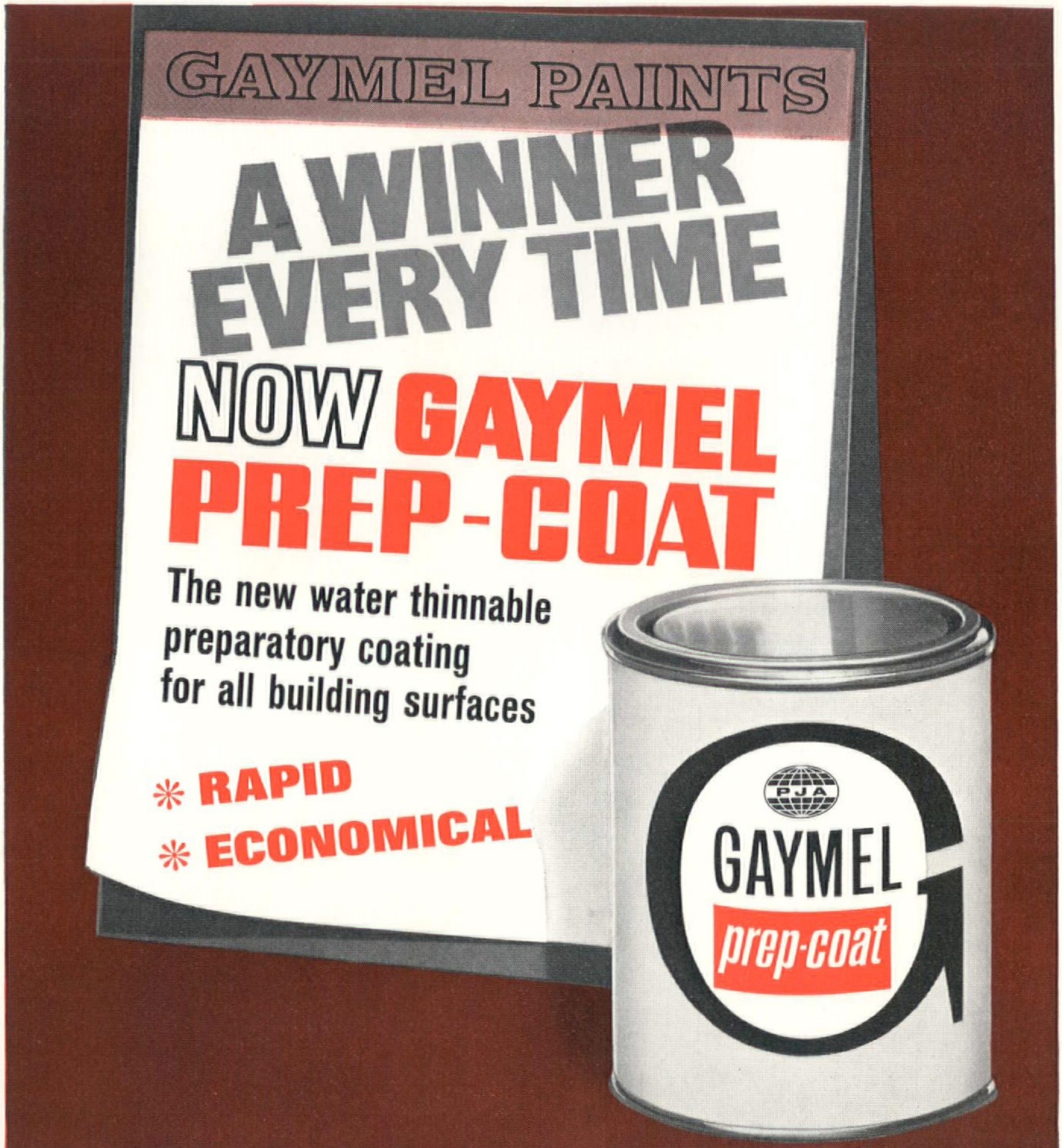
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The month in Britain

Michael Manser

In many ways December was a notable month. The Council of British Ceramic Sanitaryware Manufacturers warned that if we enter the Common Market a rapid expansion of the bidet in Britain may be expected. They also sent a questionnaire to local authorities in Britain concerning the specification of sanitary ware in new houses, and Looe UDC replied that they could see no useful purpose in answering

Lord Kennet, Parliamentary Secretary to the Minister of Housing, replying to a question about the future of St Pancras, said that the Minister would 'be unlikely to agree to demolition unless convinced that preservation was incompatible with imperative operational requirements, and that there was no possible alternative use for the building'.

Lord Robens said High Speed Gas is just an old flame tarted up, and the personal column of *The Times* contained a 'squeeze' excuse for no Christmas Cards from a couple also unable to answer Christmas correspondence from their yacht cruising the Mediterranean.

John Grant replaced Mrs Tomalin as manager of the COID's record of designers; Polyplan Ltd announced a second course on Plastics in Building Design and Construction for senior architects on 10th to 13th April; The RIBA gave its Royal Gold Medal for Architecture to Professor Pevsner, found 65 per cent of offices were using SfB, and published a new-look pamphlet, 'Architect-designed: value for money in new houses.' Christmas came like a string of cold Sundays and London's Regent Street decorations were made silly by the dramatic simplicity of plain white bulbs in Paris's Boulevard Haussman. The festivity ended with a record number of road deaths and the Road Research Laboratory published Technical Paper No. 56 on traffic signals.

Brick stocks increased by about 40 millions. Taylor Woodrow-Anglian Ltd, achieved erection times of 14–15 flats a week by industrialization, and Turner & Newall Ltd, announced that the Rhodesian crisis would push up the price of asbestos goods.

The Minister of Housing and Local Government approved plans for a new quarter-million-people town in N. Buckinghamshire, (see p. 57) and Cumbernauld new town was announced to be in a short list of three for the new Reynolds Metal Company $25,000 award for Community Architecture.

The trustees of the Tate Gallery acquired a painting by Roy Lichtenstein entitled 'Whaam', art thieves temporarily acquired £2 million worth of paintings from the trustees of the Dulwich Gallery, the new Agrément Board acquired its first certificate holder (Hyload Pitch Polymer Dampcourse), and Placed Concrete Limited demonstrated a new system of pumped concrete 300ft horizontally or 100ft vertically.

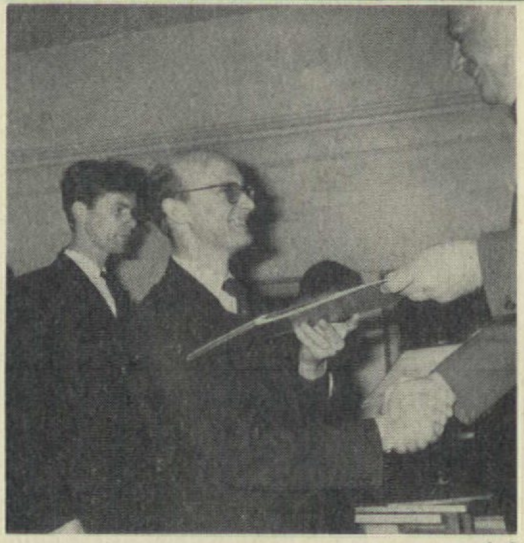
The Architectural Association published a prospectus for mid-career courses in 1967.

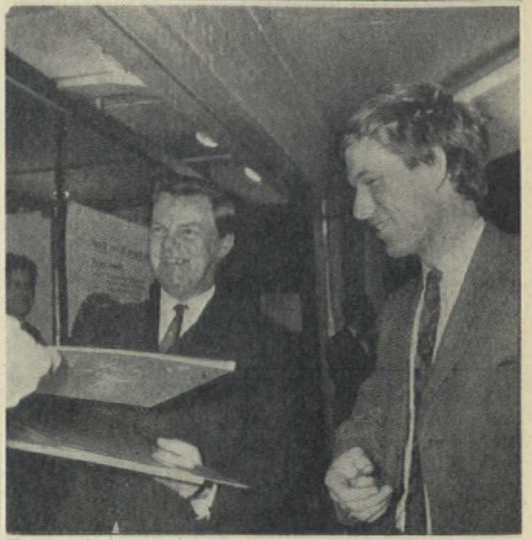
Water resources over England and Wales were found to be sufficient, if properly managed, to meet forseeable demands until the end of the century. A new flyover in Derby collapsed during erection and the Ministry of Public Building & Works held a conference on 'Keeping building work going in winter'.

From an analysis made by the BRS it was found that a fourth bedroom puts £2693 on the price of a new house.

BBC Television repeated their programme *Cathy Come Home* that highlighted the housing shortage more clearly than all the statistics.

To celebrate the New Year Mr Reg Prentice promised the building industry a period of greater stability, while a former NFBTO research officer prepared a plan to cut down the 'appallingly high' rates of bankruptcy in the building industry; and *AD* held a party to fête their Project Awards winners **1, 2**; while London's Borough of Camden prepared two Finnish exhibitions designed by Tapio Wirkala for their Arts Festival this month—one on architecture and design and one about books.





1, 2

1 & 2
Left to right: F. K. Colam and J. D. Richards (Sir Robert Matthew, Johnson-Marshall & Partners), and F. D. Williamson and Martyn Evans, receiving their Project Award certificates from Ernö Goldfinger

Project Awards 1968

It has been decided to limit the *AD* 1968 Project Awards programme to one category only, HOUSING (in the sense of *habitat*). The last date for entries will be October 31st, 1967. However, full details will be announced in due course.

Funds required urgently

At least £100 is urgently required by the students' Centre of Activity at the AA, which is actively engaged in assembling the British Students' exhibition for the UIA Congress in Prague in July. This is a sequel to the one shown in Paris 1965* and develops the theme for the next stage of the World Design Science Decade as proposed by R. Buckminster Fuller. It will deal with the available energy sources and the harnessing of 'prime movers'.

Funds are required for photography, construction, transport of exhibition to Prague, etc. Donations should be addressed to the AA Coordination Centre (Sec. Michael Ben-Eli), 34 Bedford Square, London, WC1.

*See AD 10/65, p.484

UIA/Prague

The last day for registration for the 9th World Congress of the International Union of Architects, Prague, 3rd–7th July 1967, has been changed from Feb. 28th to March 15th. Full particulars from Kathleen Hall, RIBA, 66 Portland Place, London W.1.

Industrialized housing and the architect

Michael Manser

At the NBA/RIBA two-day conference in London last month delegates were excellently organized, fed and instructed, but no clear conclusions were reached. Oliver Cox gave the best exposition of his paper and the Minister made a more than adequate summary. Several times analogies were drawn between industrialized housing and Georgian domestic architecture, and emphasis was laid on the need for improved layouts and broader planning. No parallels were made with Victorian row houses or 1930 semi d's which are even more similar in number and repetitiveness.

The immobility of concrete systems was mentioned, and for me this is the biggest doubt. We are matching the fastest period of obsolescence with some of the most durable houses that have ever been built. What could be more absurd? Concrete must be recognized as a clumsy expedient until a lighter, better insulated material with better surface finishes is available. The cost of handling the concrete systems during erection is formidable; the cost for the next generation of clearing them will be ruinous.

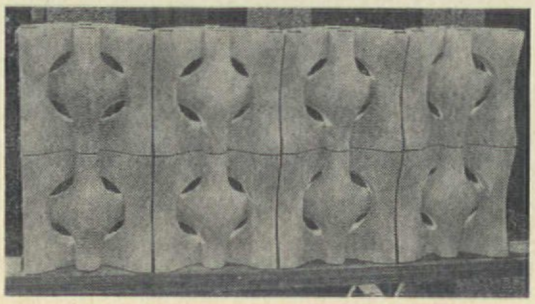
Sculpture by the yard

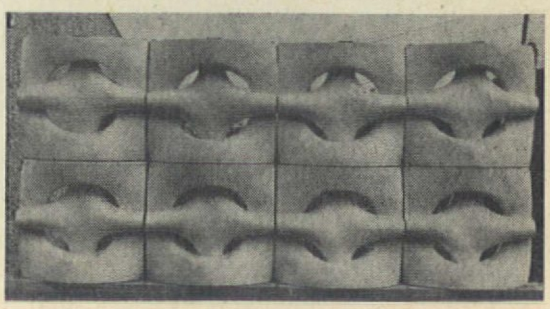
Jasia Reichardt

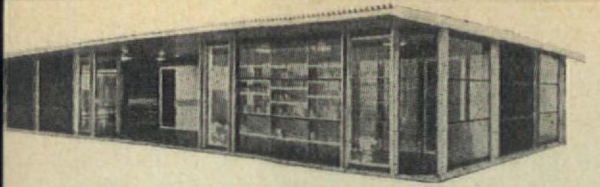
Mitzi Cunliffe's 'sculpture by the yard' is based on a module system of units which are either in relief or in the round. Its function fundamentally is a decorative one, the articulation of architectural space—interior or exterior walls and partitions. The units are mass-produced, and materials include fibreglass, concrete and anodized aluminium. This is an attempt at integration of creative three-dimensional design and architecture, and the fact that Mitzi Cunliffe has had numerous commissions including those for Cement & Concrete Association (front and back views below), universities and various company buildings, serves to prove that her venture has met with considerable success. Her methods have no spatial limitations—the largest work so far occupying 1750 square feet—and the designs are flexible enough stylistically to integrate into any surroundings.

Although the title of the exhibition 'sculpture by the yard', is not very apt in the context in which the term 'sculpture' is generally used, her aims are more realistic. Mrs Cunliffe is basically involved with design within the confines of industrial or public architecture, and her methods are so ingenious and simple that after seeing examples of the work one wonders why they have not been widely explored before.

After the current showing at USIS, London, the exhibition can be seen at Brunel University, University of Sussex, Brighton Art Gallery and University of Leeds.



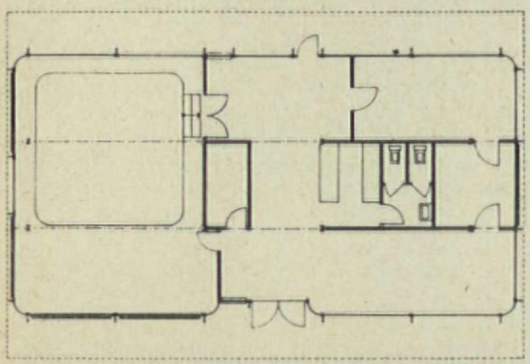


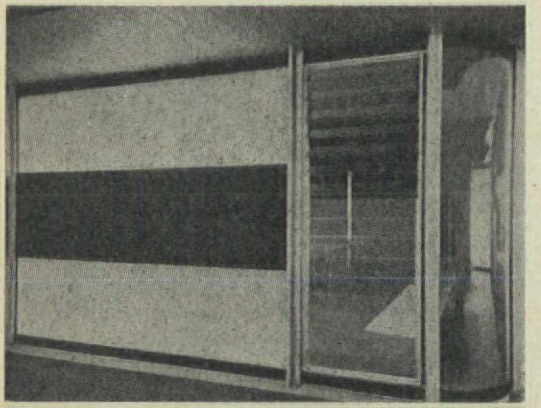


Prouvé

Efficiency, precision and elegance of detailing are not enough in the pursuit of architectural success, some flair for coordinating and giving form to an initial generating concept is required. Jean Prouvé's prototype for a youth club, first shown at the Salon de la Société des Artistes Décorateurs in October 1965, has all the poise and polish of detail that one has come to expect from this master of prefabrication. The base is of poured concrete, but all the superstructure, from the parallel spine beams, supporting roof panels of plywood and aluminium, to the infilling panels and curved plexiglass corners, are standard elements, manufactured and marketed by CIMT, designed to be handled and erected by the unskilled members of youth clubs. The precision of the whole is not easily to be matched, it offers some of the satisfaction of a mathematical theorem finely worked out. But not enough of this satisfaction. The formula seems too simple—banal even—unencumbered by the complexities of finding an architectural language appropriate to the real needs of people to-day.

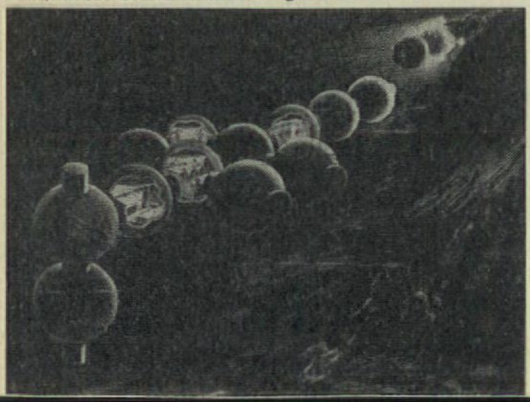
Techniques et architecture, November 1966

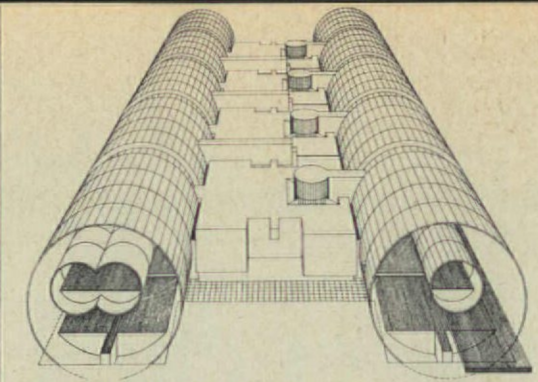




Project bottom fix

O. Klima and F. S. Burrell of the General Electric Company, USA, have designed this manned habitat for eventual occupation of the mid-Atlantic Ridge (the rift, with mounts as shallow as 6000ft, running midway between Europe and America and continuing into the South Atlantic). The habitat is made up of bottom moored dwellings, each 12ft inner diameter, interconnected in three directions if need be. A pile or 'anchor' is located on the ocean floor by explosive embedment or mechanical means; at the top of each pile is the 'ball' module designed like a universal joint. When internal chambers are brought to sea-surface pressures the hatchways are opened and mating completed. The structure is glass or ceramic.





Formalized movement

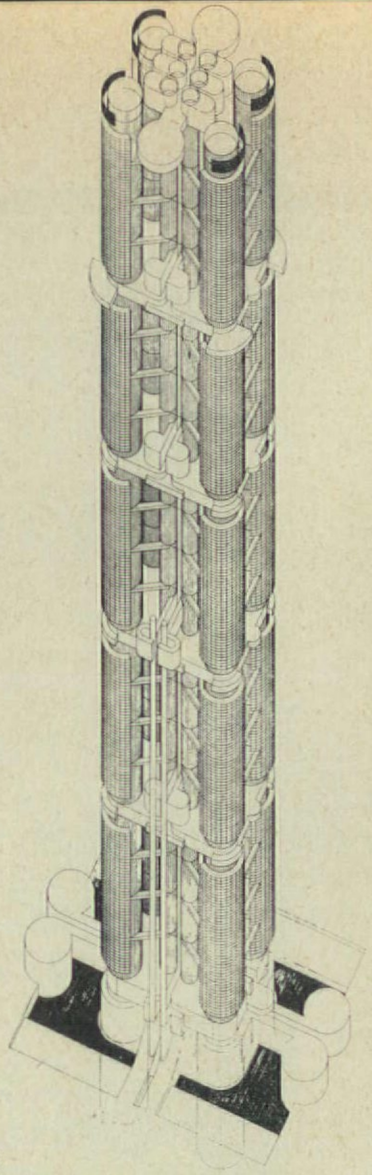
1

Routes of communication have long been regarded as the prime generators of form in our urban complexes and cities. The sprawl of roads that enmeshes Los Angeles is no longer a source of wonderment and pilgrimage, it has been taken for granted. Planners start off their new towns with hover-trains nowadays, though the actual revolution in means of communication might soon render all such fixed, large-scale systems redundant. Walkie-talkies, Television telephones and other more dramatic inventions may make us less keen to move about so much.

But if transportation and movement are still accepted as a vital catalyst by designers, certain static and formal ideals of composition emanating from the old Ecole des Beaux Arts, have a stronger hold even on the most fanciful of modernists. Hans Hollein's curious adherence to strictly symmetrical, mock-monumental methods of composition is notorious.

In America, Fredrich Saint-Florian, teacher at Rhode Island School of Design, has produced two designs, one a competition entry for the Berlin-Tegel airport, **1** done in association with R. J. Abraham, the other a vertical city for Boston **2**, both of which are advisedly designed with modes of transportation uppermost in mind. The airport is conceived as a staging post only, between air and rail transport; the vertical city is no more than a vast interchange—cars enter at the bottom and are stacked in circular silos, people move at high speed, vertically through the complex to a heliport on the roof. Residential units are organized into four columnar units on the periphery. Both designs are stiff and symmetrical. They give no hint of the drama and the thrill of movement that is supposed to generate them.

l'Architecture Aujourd'hui, October–November 1966



2

Guggenheim

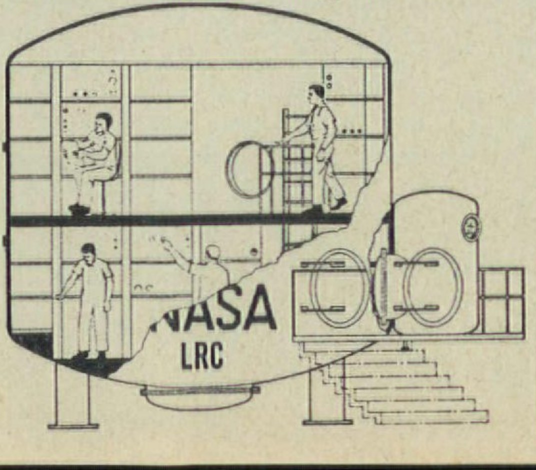
Frank Lloyd Wright's Museum is to be enlarged. His pupil William Wesley Peters is to add a drum-shaped gallery and administrative building, slightly lower than that shown in the illustration.

Progressive Architecture, December, 1966

NASA living pod

The Nasa-Langley space station simulator, of which only the mock-up and individual components have so far been made, will provide capacity for a four-man crew for missions of one to five years, assuming food re-supply at 90-day intervals. Similar to the Douglas life-support system (see page 70), it includes in addition a Bosch reactor, to reduce CO_2, and a water hydrolysis unit, and makes use of waste heat from a simulated radioactive-decay power source to desorb CO_2 and evaporate urine.

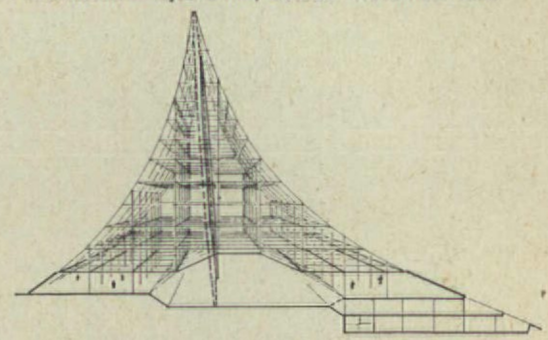
International Science and Technology June 1966

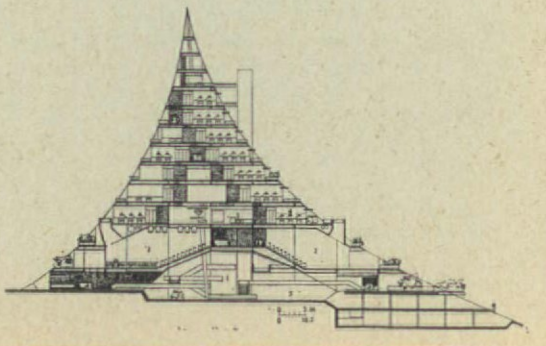


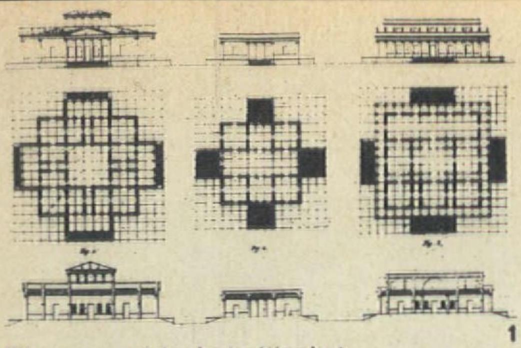
Filigree framework

With Georg Neddjkov, Frei Otto has prepared a design for the University Hospital Centre in Berlin that would permit walls, floors and all internal organization to be changed for experimentation. The structure, similar to that of the West German pavilion in Montreal, consists of a network of steel cables supported on nine steel masts. Floor panels slotted into this filigree framework would be of reinforced concrete for stiffening, but they could be moved and differently disposed. The whole structure, in fact, could be adjusted to allow for new floor to ceiling heights or depths of ductwork—a building in constant flux.

l'Architecture Aujourd'hui, October–November 1966







1

The geometrical straitjacket

Robin Middleton

The great advantage of the Gothic Revival was that it restored common sense to architecture. By the end of the eighteenth century the disciplines imposed by the Classical style had become so rigid and codified and so restrictive that all ease of organization, all convenience of planning was impossible. The height, the breadth and the width of any room of any pretension was determined by rules; even the sizes of the door and window openings were controlled by these rules. Symmetry was *de rigueur*, so that one opening had to be balanced by another of the same size and each had to relate to a symmetrical scheme in adjoining rooms. Planning, at best, was an affair of geometric ordering. The grid came into its own. J. N. L. Durand, the greatest grammarian of Neo-classicism, reduced architecture to a geometric pattern **1**. He started, whenever possible, with a square, equally sub-divided in both directions. On this he arranged first his plan—strictly symmetrical in all its parts—then, projecting the grid vertically, he composed the section and elevation. There is a play of rationality in this method, but clearly, the logic has little to do with the objectives of architecture. Durand's vaunted logic is disingenuous. There was no question of convenience prompting an ideal.

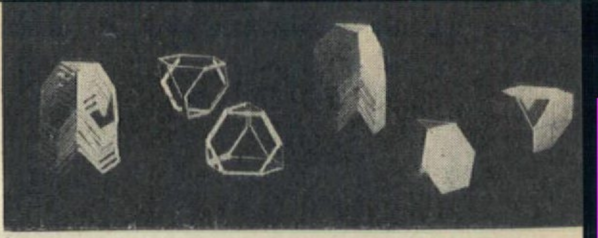
When it came to detail, the formulas of the Neo-classical movement were even more inhibiting. The height of a column and all its related mouldings were fixed by its diameter, and the application of such Greek and Roman temple details was so unsuited to the complexities even of early nineteenth century planning that a crisis ensued every time a corner had to be turned or a junction effected. Very few architects could stand the strain. Sir John Soane determined to think out a new vocabulary for himself. But the Gothic Revival swept away these barriers. Henceforth, all arrangements, all plans, all mouldings even, could follow the apparently wayward pattern imposed by external limitations and—most important—by use. Rooms could be of the size and shape required, they could be set in relation one to another according to convenience, and openings could be placed exactly where they were needed. The particular and appropriate success of Alfred Waterhouse's vast and complex public buildings would have been impossible before the Gothic Revival.

The other inestimable contribution that the Gothic Revival made to architecture was freedom and honesty of structural arrangement. Structure could be designed as and where it was needed, and it was allowed, —indeed encouraged—to show. There was to be no more dissimulation. Viollet le Duc was the prophet of this movement; small wonder that the pupils of the Ecole des Beaux Arts swore *haine à Viollet le Duc* on their *Grand Durand*.

Viollet le Duc's theories largely conditioned the modern movement—Le Corbusier's *Vers une architecture* is little more than a paraphase of his ideas; Frank Lloyd Wright thought him a perfervid prodigy, while Mies van der Rohe continues still to lean heavily on verities that he propounded. Functionalism and structural honesty as ideals are a legacy of the Gothic Revival. The architects of the Heroic Period took full advantage of the freedom afforded by these commonsense goals. 'Free planning' is a phrase we associate still with the masterpieces of the twentieth century masters. But during the last twenty years there has not been much time for inventive experimentation. An architecture bathed in the concealed light of modernity has long been accepted. Most architects have been forced to build continuously, endlessly and at great pace in a known idiom. Formulas have had to be devised for architecture. And one of the most pervasive is that of space enclosed by planes at right angles to one another. The rectangle is taken for granted. Architects are scarcely conscious of it as a decisive and limiting factor in planning. Rather it appears a convenience. Certainly it simplifies problems of detailing, junctions and setting out and relates closely to the standard shapes and sizes of manufactured sheet materials and of furniture. There is no difficulty in making things fit

But, of course, the rectangle has been found a constraint. Hans Scharoun has therefore continued serenely to design in exactly the same dynamic manner as in the twenties. Since the completion of the Berlin Philarmonie many architects in Germany have attempted to imitate the urgent angular lines of his plans. But uncontrolled by the master, they are rarely satisfying. Some less exacting and more certain method of achieving success has long been sought by architects tired of the rectangle; some planning formula not based on the right-angle. There is a range of other regular geometric figures—the triangle, the hexagon and the octagon are some of these—and one by one they have been adapted as an organizing motif. Frank Lloyd Wright was one of the first to use them with any degree of persistence. He drew and even built a number of houses based on these figures. But he soon found faults. Not only was the architecture unbearably self-conscious, but inconvenient. How was one to live in these spaces, how to arrange the furniture and relate it to the architecture. He was forced to re-design all furniture to the same insistent geometric pattern—to ludicrous resultant effect. Until a new mode of living was devised appropriate to the new geometric formula it was simply an embarrassment.

But the triangle, the hexagon and the octagon still seem to offer to restive architects a modicum of planning freedom withheld by the ubiquitous rectangle. Recently, Noel Moffet, stacking up an array of hexagonal boxes for an old age home in White City **9** (conceived as an occasional building between lumbering slabs of rectangular housing) demonstrated yet again how awkward that figure could be as a plan form. But there have been more sophisticated essays. For it has seemed to many inquisitive architects that a new planning formula might be linked inseparably to that other twentieth century dogma, the ideal of structural economy and honesty. Buckminster Fuller has proclaimed the static supremacy of the tetrahedron, the icosahedron and what-have-you. A new geometry seems to be upon us. One that could unite the desired planning formula and the refinements of structure. Alfred Neumann, Zvi Hecker and Eldar Sharon have constituted themselves the most determined exponents of this new architecture. During the past five years they have designed a spate of buildings in Israel based on polyhedral solids—rhomboid, hyperbolic paraboloids, truncated tetrahedra and octahedra, these are the words they used to describe the architecture **2**. First was the Bat Yam civic centre (*AD*, November, 1964), then a series of elegant, light-hearted holiday camps at Arhziv (*AD*, April, 1965), Michmoret and Kiriat Yam **3**, but they took up thereafter the ponderous administrative mode; the Faculty of Mechanical Engineering at Haifa **7** the Natania Civic Centre **4, 5, 6** and the El Al terminal building in Tel Aviv **8**. They have also designed housing in the new geometrical style at Ramat Gan, outside Tel Aviv. The buildings are not without felicities of climatic control and dramatic internal lighting effects, but these are secondary to and in any case not dependent upon the rigid adherence to a simple three-dimensional structural and spatial unit. The adventurousness and the spirit of intellectual honesty that must first have conditioned their use has been dissipated. The geometry has taken over and has the architects in thrall—indeed, in a stranglehold. They have abrogated all freedom and all common sense. Their planning has become progressively more rigid and their composition more hieratic. The later buildings have miserable pretentions to monumentality. Durand even, with all the formulae of Neo-classical composition at his command, offered more freedom of design. For Durand at least retained the rectangle as the basis of his design (the circle was an ideal only, not a seriously considered practical possibility) and the rectangle can, within its limits, be adjusted in size. Moreover it is neither obtrusive nor inconvenient. The truncated tetrahedron as adapted for use in Israel is not only grossly inconvenient for planning, but obsessive—an opinion with which Buckminster Fuller would certainly agree. The architecture has the quality of hallucination, far removed from the sanity needed to build in this teeming twentieth century.



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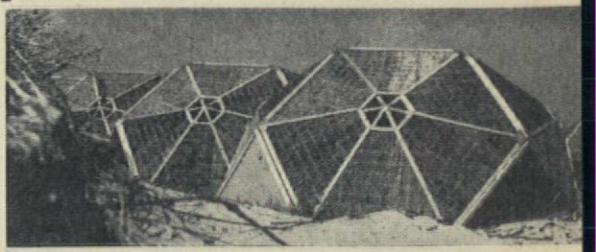

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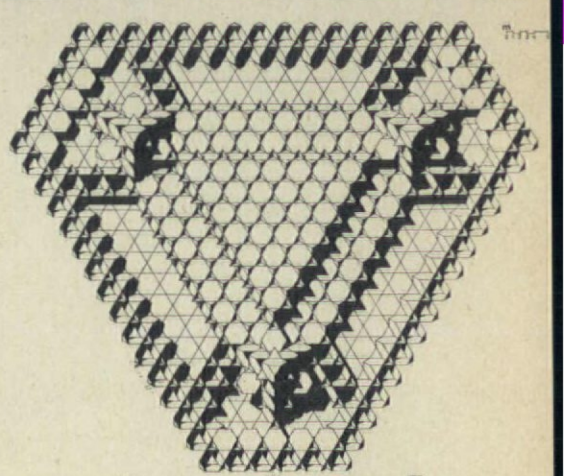

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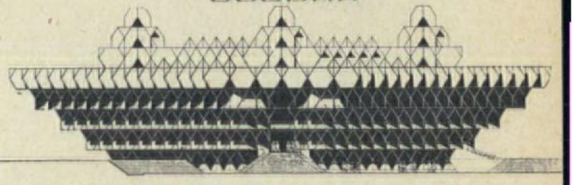

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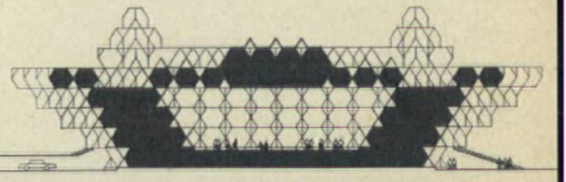

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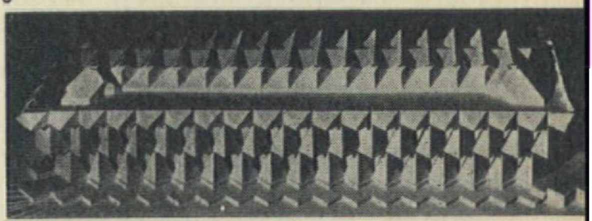

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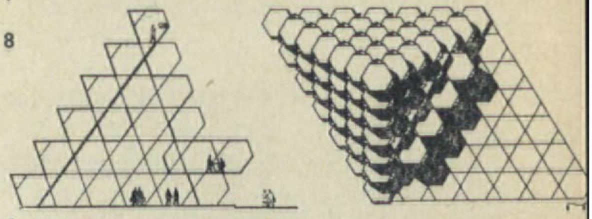

9


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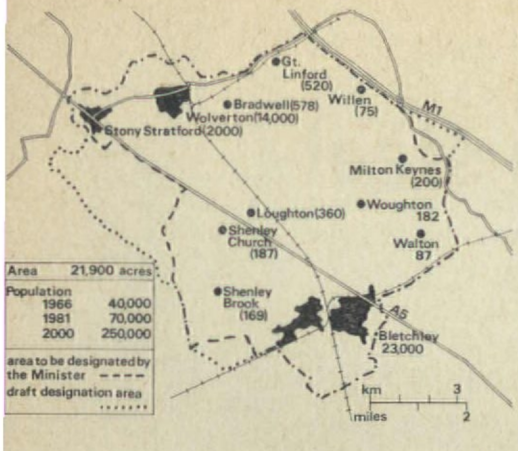
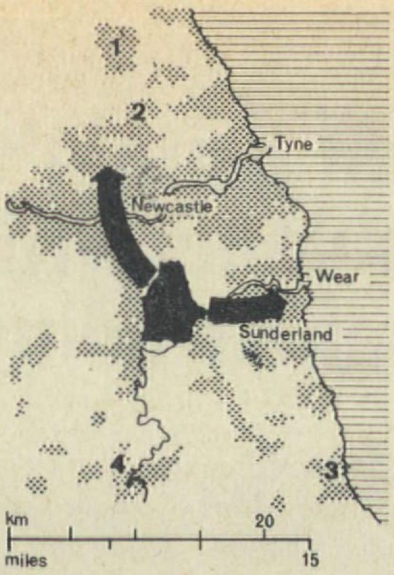
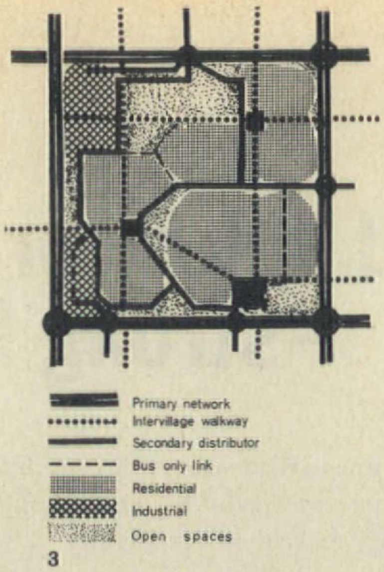
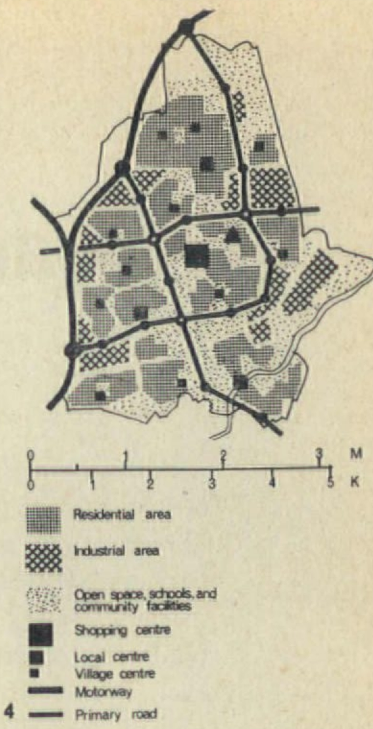








1
North Buckinghamshire New Town (Milton Keynes) designated area
2
Washington New Town—regional situation: 1 Cramlington New Town, 2 Killingworth New Town, 3 Peterlee New Town, 4 Durham

3
Diagram of a Washington 'village' group
4
Washington New Town—master plan

Villages for all

Milton Keynes (*Bucks*), pop. 200, has been chosen by Anthony Greenwood, MoHLG as the name for the proposed new city for 250,000 people between Bletchley and Wolverton, south-east of the M1. Ever since the LCC played with Bletchley as an overspill area it has seemed a natural for expansion, then Fred Pooley, Bucks County Architect and Planner, dreamed up his 'butterfly monorail' city for north Bucks in '64, followed by the Ministry's appointment of Wilson and Womersley to look into expansion in the area as a whole[1]. Their report clinched the idea. Just under 22,000 acres have been designated, including Bletchley, Wolverton and Stony Stratford, and a further nine villages, with a present population of 40,000, to rise to 70,000 by 1971, thereafter to 250,000. The density—88 acres per 1000—is very much lower than the average north of England town, but as the city is for Londoners mainly, lower densities are asked for. At a town density of 11 persons per acre it is still lower than the average Mark 1 New Town. Before the County Landowners Society takes to arms, however, it should be remembered that the intention here is to create a new kind of city—a miniature city region—having a number of quite separate 'towns', so that the existing settlements will still retain their sense of identity. Could it be that when the consultants are appointed and their development Plan is presented, Milton Keynes appears as an undisturbed village within a green wedge?

Washington New Town (*Co. Durham*) is very much part of the Tyneside conurbation within which it is intended as an attractive growth area. Gateshead is only two miles to the north and Sunderland half a mile east at one point, while within seven miles over a million people already have their homes and work. Its role is clearly understood by the consultants[2] who have produced a Report that in itself is a beautiful propaganda piece to come and enjoy living in a new town, as well as being a useful analysis of the design process. Going back on their earlier interim idea for an even roadway network at one mile intervals on a gridiron, further studies have led to a primary net at two mile spacing and a secondary net at one mile which divides the area into 23 units within half-mile rectangles which form the basic 'village' of the plan.

Five thousand three hundred acres of designated area include both interesting scenery, such as part of the River Wear, but also some rough old settlements, which, like the coal mining, must be phased out as the present population of 20,000 grows to 80,000. The village units are really a breakdown from the old neighbourhood, and for the moment, just as convincing. Each would have about 4500 people—at 3·3 persons per household that would be 1350 dwellings, a convenient number to give identity, capable of being built as a single unity within 15 months—supports one 2FE Primary School and a few local shops and a pub, and maximum walking distances of a quarter of a mile from edge to centres. In fact, most journeys are not like that, but it is a reasonable base for 'Radburn type' housing areas. Densities are low, being designed to attract people here rather than send them south, and even to act as a magnet for southerners persuaded to move to the north-east. There would therefore be all types of housing—for sale as well as rent, and possibly private as well as public development. It is a two-storey house town, maximum densities about 50 persons per acre, but many will be very much lower since the overall density is about 15 persons per acre. At 66 acres per thousand, it is less than Skelmersdale and Cumbernauld, but greater than the earlier new towns. Industry is dispersed in 15 units—four exist now—along the outer primary road; commuting in and out of the town for work is regarded as reasonable; and the whole basis of the highway network is to expect high car usage but to allow for local and regional bus services. No special routes are suggested nor alternatives to the bus. This may be timid, but the plan seems flexible enough to allow modifications as it proceeds—surely the real test.

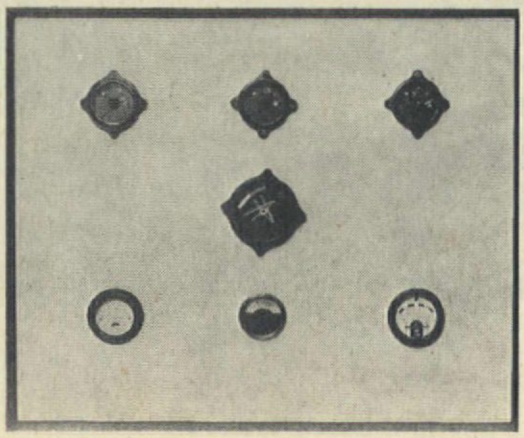
[1] *Northampton, Bedford & North Bucks study*—HMSO for MoHGL, 25s. See *AD*, March 1966, p. 109.
[2] *Washington New Town Master Plan and Report*—Dec. 1966. Llewelyn-Davies, Weeks, Forrestier-Walker and Bor in association with: Sylvia Crowe & Associates: landscape and recreation Freeman Fox, Wilbur Smith & Associates: traffic engineering Nathaniel Lichfield & Associates: economic planning.

Thought forms of metal

Jasia Reichardt

In his constructions and assemblages Takis uses motors, electromagnets, cathode ray tubes, compasses, dials and lights, apart from the more common sculpturing materials like prefabricated iron elements. William Burroughs said that Takis 'is working with and expressing in his sculpture thought forms of metal'. As a description of Takis's work of the past ten years this is accurate enough, but more important still is the fact that this statement is evocative of the artist's intention as well as its realization. Takis explores the possibilities inherent in the technological properties of ready-made objects and forms. In terms of sculpture, these forms appear bare and minimal—metal balls suspended from the ceiling and held precariously in position by a magnetic force emanating from a cylindrical object mounted on a flat horizontal disc; small coloured lights in flat frames surmounting long thin rods up to 10 feet high; or dials fixed to a vertical board which at the turn of a switch launch into a hiatus of motion.

Since his work involves the element of movement as an integral part of the structural framework, Takis has been placed under the inevitable and rather uncomfortable aegis of kinetic art. Kineticism as such means very little. It is not a style, trend or movement, but a technique. As an umbrella term it admits such varied possibilities as divergences exist in the entire field of the visual arts. Kinetic art, too, has its expressionists, constructivists and realists. The work of Takis is not so easy to classify. He could be compared to an inventor who associates things according to their intrinsic function rather than for their visual possibilities. For this reason it is perhaps more apt to describe these crudely mechanical constructs as poetic, often significant and usually surprising, rather than aesthetic.



There is nothing about these works that shows evidence of the sort of aesthetic criteria that have been manifested in the history of Western art since the Renaissance. Those seeking a sense of historical continuity in the context of the visual arts, will not find it in the work of Takis, because the principles involved in his mechanical and electronic objects have more in common with recent developments in science, music and literature than with the visual arts. His works are neither pictorial nor sensuous. Their impressiveness relies less on the appearance of the individual work than the idea behind it. A typical Takis electromagnetic sculpture with sound amplification is visually sparse; as an arrangement of three needles, three pieces of wire, alternately attracted and repelled by a small magnet, might suggest. He is not operating with chords of colour, volumes, textures, embellishments, or visual ambiguities, but ideas which are not essentially visual although they are displayed visually. Takis's recent London exhibition at Indica Gallery had the character of an inventory of mysterious and fragile articles related to some unspecified scientific operation. Occasionally one comes across artists whose work seems unpalatable in terms of what we expect and demand that art should be. These artists help to stretch the boundaries which are built and protected to satisfy our sense of order and facility of identification. Takis is one of them.

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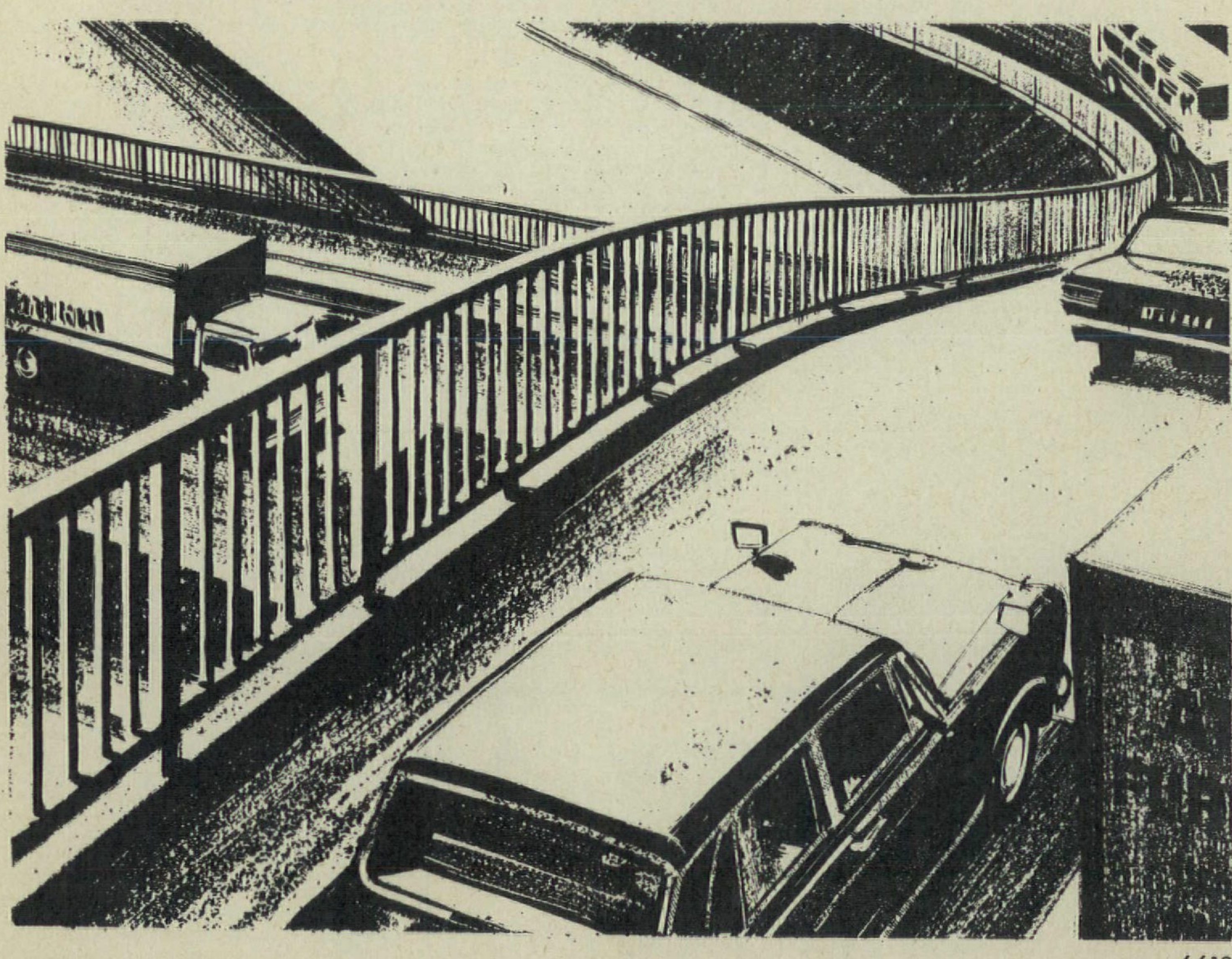


6613

Around Britain

Glasgow and the west of Scotland

Frank A. Walker

You need not be an economist to appreciate the fundamental relationship between work and home—nor a politician to realize that something has to be done to put right a situation where the two have become no longer compatible. But for the regional planner whose task it is to attempt a practicable and viable resolution of the problem, JOB and HOUSE must loom large as bogeys in a recurrent nightmare. West Scotland presents such a case—a classic example of what political journalists used to call 'an agonizing re-appraisal'.

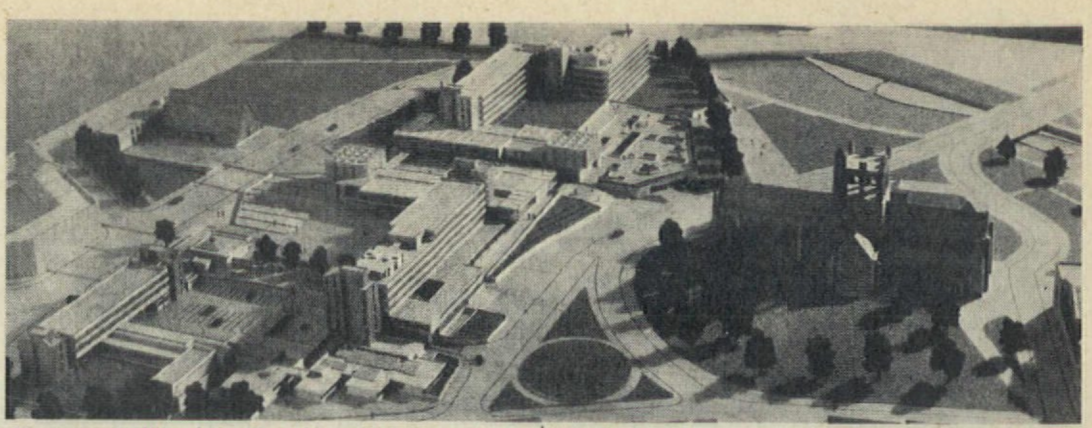
The coal mines, steelworks and shipyards of north Lanarkshire have lost their pre-eminence. Strip mill, Q4 and all forms of shipyard consortia there may be, but West Scotland's future is now more surely tied up with the fortunes of firms like Burroughs, IBM, Honeywell, Chemstrand, ICI—all of whom now have a big stake in the region. In place of the old expertise in heavy engineering—still something the area does better than most—a fund of new skills has grown up based on electronics, miniaturization and computers, backed up by the research facilities at the National Engineering Laboratory and fed from the technological University of Strathclyde.

The older concentrated centres shrink. The new lighter industries, less demanding of location, imply dispersal. Nineteenth century housing in Glasgow and Clydeside crumbles. New houses are needed to replace the slums and alongside the new factories. Glasgow, at the heart of the change, has had to think in terms not only of extensive rehousing within the city limits, but also of overspill. Existing towns have been able to absorb part of this excess, often temporarily redundant population, but entirely new communities had to be created. New jobs and new houses—this is the emergent pattern in West Scotland—a development whose success can be gauged on the one hand in the viability of the new and expanding old towns and on the other in Glasgow's own housing struggle.

East Kilbride, first of the new towns, has an industrial boom dangerously out-pacing residential growth. By the end of 1967, 7000 new jobs will have been created but only 3000 new houses will be built. At this rate the Development Corporation will find it hard to complete the town as scheduled by 1970. The place itself, however, once little more than factories, trad-tidy houses, roads, roundabouts and more roads, has at last begun to establish some identity. Its familiar newtown-centre may be visually undistinguished, but it *is* coming alive. After the shops and offices, have come bowling alley, hotel and cinema (all developers' dull) and a more promising swimming pool **4** by A. Buchanan-Campbell. Even the RIBA has larded the town's prestige with bronze medal kudos for Gillespie, Kidd and Coia's St Bride's Church—pilgrimage for architects and enigma for the locals.

At Cumbernauld, industrial development is still well short of East Kilbride's achievement. Nevertheless housing moves on apace. Last year the highest annual total so far was reached and by 1970 it is expected that 1900 houses will be being built as a consequence of what is described as 'an ambitious programme of industrialized system building'. The first signs of this programme are encouraging—several 12-storey blocks looking for all their mechanized simplicity remarkably at home on the town's still rural hillsides. But the most interesting 'happening' is undoubtedly the recently completed first stage of the town's multi-level centre (*AD*, Nov. 66). At one moment the whole place seems more like a vast adult play area—at another like nothing so much as a huge luxury liner anchored somewhat incongruously on a windswept ridge above the town. Perhaps these two sensations account for the initial seduction of the place. It will take longer to arrive at a valid sociological assessment of what amounts to putting all the community's eggs in one concrete basket.

Central Development is not confined to new towns. At Dumbarton, Motherwell and Wishaw and at Paisley **1** there are administrative centres built or building, each the result of open competition and (significantly) each a valuable architectural addition to the heart of these



older communities. Less likely to contribute as much are the commercial centres being developed in several towns throughout the region. Yet it is this type of investment, lured north by the lack of building restrictions and not slow to cash in on the increasing dispersal of industry across the central belt, which will be principally responsible for the reshaping of outworn core areas. In Greenock, Dumbarton and Paisley we must wait and see.

But there is another side to the picture. Emigration, Scotland's perennial tragedy, continues. In the north, a few isolated attempts are being made to stem the drift at its traditional source. But it is the industrial metamorphosis of the central belt which presents the greatest problem. Redundancies tend to swell the emigration figures and unless more planned redevelopment and retraining schemes are provided the trend will continue. At Erskine, there are proposals to claim land for industrial use from the Clyde estuary alongside the road bridge from Dunbartonshire, and expansion of village communities in Renfrewshire is planned. At Irvine, where ICI and Chemstrand have built large plants, a fifth Scottish new town will be built. But with emigration standing at 40,000 annually and unemployment at 70,000 nationally—will all this be enough?

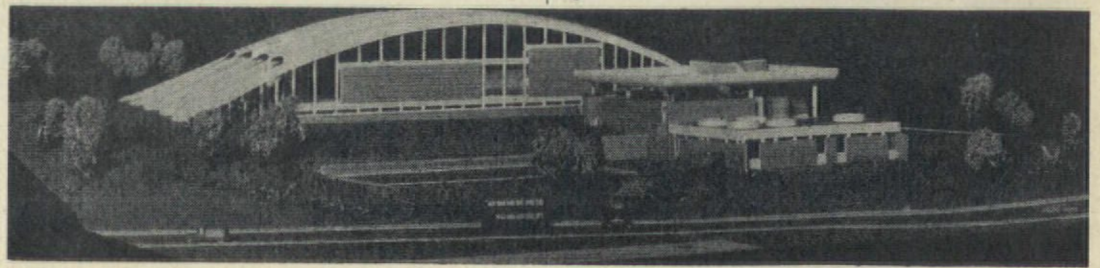
Meanwhile, back in Glasgow, rehousing within the city limits goes on. The old Gorbals has gone. Yet what the word stands for remains true (at any rate in environmental terms) of large parts of the nineteenth-century city which still remain; and true now, too, of a few more recent 'schemes' like Blackhill where no one dares to live in the bottom flat and a rag-and-bone-man's horse was once found stabled in a third floor bathroom. The city has a prodigious job on hand.

Already vast areas have been razed to make way for a new Glasgow. Presumably the bathrooms, refuse chutes and drying cupboards are all there, the exigencies of the building regulations all fulfilled. But do these new terraces, slab and point blocks have the same architectural coherence as the nineteenth-century city? In most cases it seems that even housing is considered fair game for the exhibition of architectural expertise—often at a low level. Fortunately the city has at last begun to consider industrialized building and it is in this field that the most relevant and hopeful work is being done. At Pollokshaws and Woodside (*AD*, Sept. '66), Ibrox **2** and Springburn **3** industrialized building techniques have been employed, and while the unreasonable whims of individual architects can still be detected even in this rigid medium, as for example in the incongruous base structure at Ibrox and the mock striping across storey height panels at Springburn, a controlled logic can be seen appearing. To many the results still seem dull, but if the approach were boldly applied to the city's whole housing problem it might well produce a disciplined visual enviornment comparable in its unaffected rigour to the one that is now being replaced.

1. Model of the competition-winning county and municipal buildings, Paisley, by Hutchison, Locke and Monke; seen from north end of site with Police HQ (1st phase) in foreground, municipal building (3rd phase) and town square beyond, and Renfrew county buildings (2nd phase) at far end of site. The existing church is on the right and the new one on the left are linked by a pedestrian concourse.

2

3



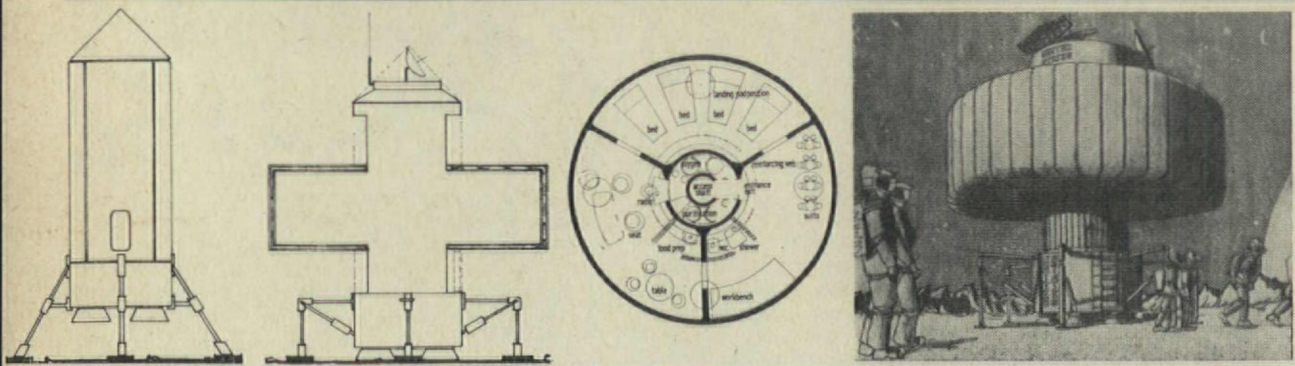
4

Moon shelter ideas

Designs by seventh-year part-time day students at the Northern Polytechnic School of Architecture, London.

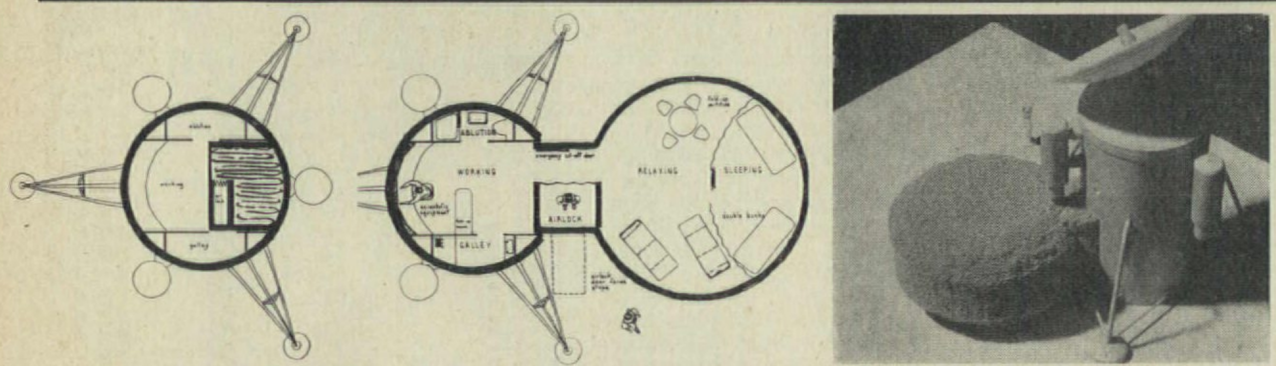
This short-term ideas project, using 'Synectics' (brainstorming) as a preliminary stimulus, was intended to act as a lead-in for a second project, to design a Mobile Arctic research unit.

The brief required an enclosure to house four moon astronauts comfortably for a minimum period of four months, without space suits. It was compiled after preliminary research and communication with John Hodge, Flight Director at Cape Kennedy, who spoke to the teams and answered questions during the programme.



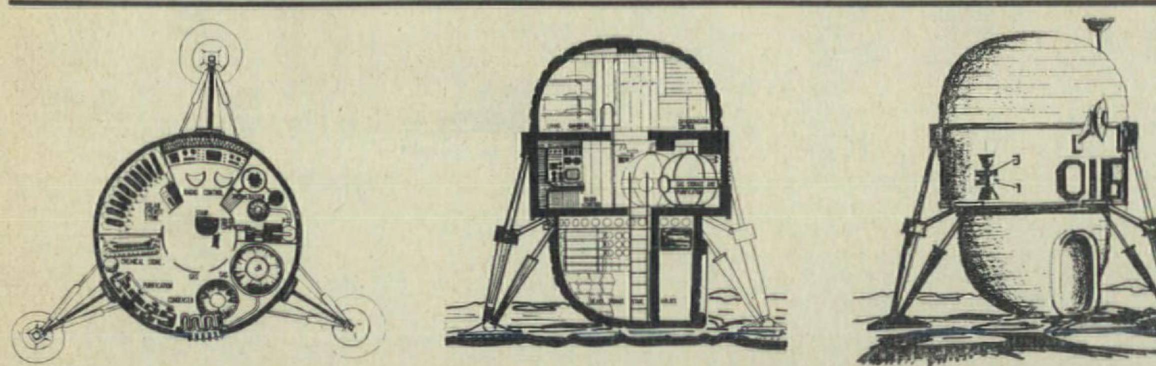
P. Ansell, J. Edwards, K. Hinshelwood, K. Lim, J. Smith, P. Wilson

Final stage, one-way lunar cargo ship precedes personnel capsule, lands at predetermined site. Living compartment inflates automatically, self-hardening foam rigidizes structure. Air lock, storage services within core to provide self-contained, self-sufficient unit.



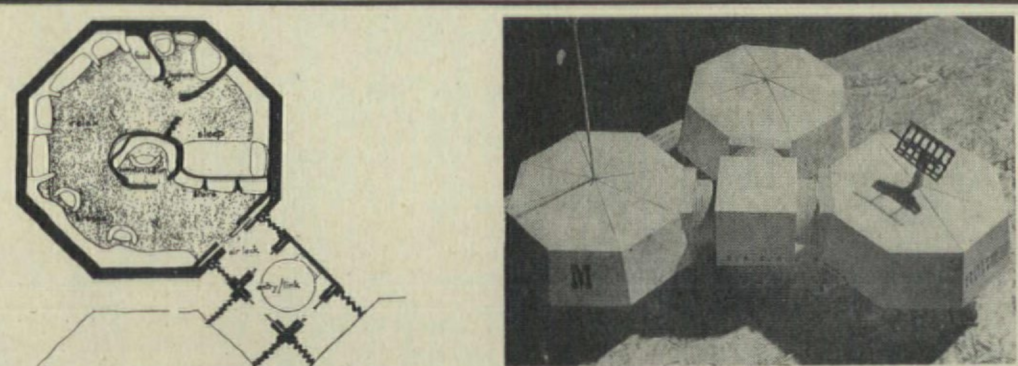
F. Coombs, J. Snoding, H. Latin, B. Arnold, M. Marshall, K. Jones

Unmanned module containing deflated pneumatic structure and equipment lands on moon surface. Hatch ejected, air-lock compartment slides out and multi-skinned pneumatic structure inflates. Foaming agent is pumped between two of the skins rigidizing and insulating the structure. Habitat is now ready for entry.



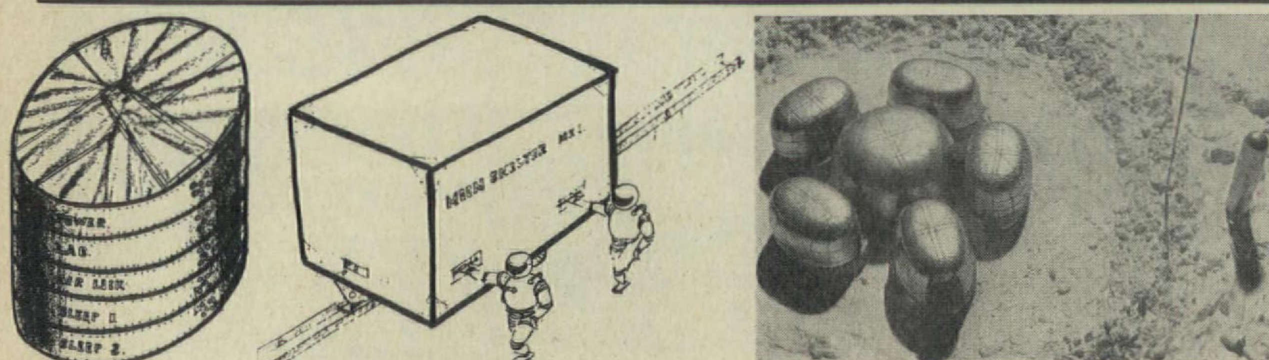
A. Cook, A. Eyles, J. Jones, P. Reynolds S. Shelter, J. Wailling

Final stage rocket lands on stabilizing legs (before manned vehicle arrives). The rocket motor is ejected and the central canister (containing communications and environmental control equipment) expands pneumatically to provide living quarters above and to give space for storage, laboratory and air lock below.



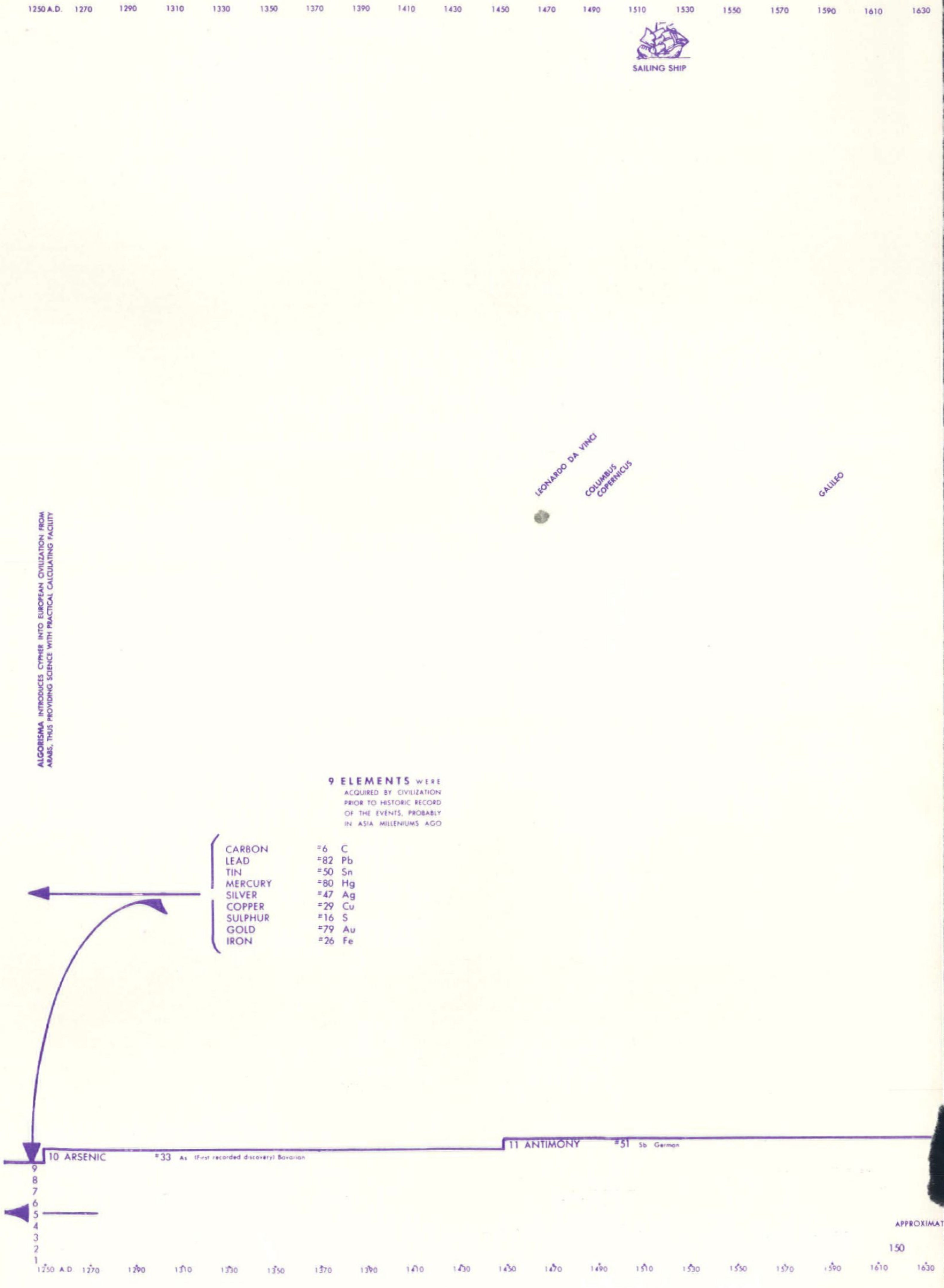
G. Briffa, C. Holt, L. Leeds, G. Waldron, B. Woodcock

Lunar station consisting of three basic modules; living, laboratory and power/storage, delivered as single fully equipped unmanned payloads for 'instant usability' and linked on arrival by means of telescopic airlocks from within storage module. Capable of unlimited colonization.



M. J. P. Davies, D. F. Brealey, N. Southam, W. Longstaff, G. Darrer, J. McMurphy

Two payloads landed; one containing shelter cells, other carrying the ingredients for foamed slag. Each cell consists of base tray, into which furniture and equipment is folded, covered with deflated fabric of a pneumatic superstructure. Trays sited, the superstructures inflated and access links connected. Retaining wall, surrounding the cell complex, inflated and foamed slag pumped in to encase all but the air-lock entrance. Equipment is unpacked inside when the shelter has been tested and conditioned.



1250 A.D. 1270 1290 1310 1330 1350 1370 1390 1410 1430 1450 1470 1490 1510 1530 1550 1570 1590 1610 1630
SAILING SHIP
LEONARDO DA VINCI
COLUMBUS
COPERNICUS
GALILEO
ALGORISMA INTRODUCES CYPHER INTO EUROPEAN CIVILIZATION FROM ARABS, THUS PROVIDING SCIENCE WITH PRACTICAL CALCULATING FACILITY
9 ELEMENTS WERE ACQUIRED BY CIVILIZATION PRIOR TO HISTORIC RECORD OF THE EVENTS, PROBABLY IN ASIA MILLENIUMS AGO
CARBON #6 C
LEAD #82 Pb
TIN #50 Sn
MERCURY #80 Hg
SILVER #47 Ag
COPPER #29 Cu
SULPHUR #16 S
GOLD #79 Au
IRON #26 Fe
10 ARSENIC #33 As (First recorded discovery) Bavarian
11 ANTIMONY #51 Sb German
9 8 7 6 5 4 3 2 1
APPROXIMAT
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1250 A.D. 1270 1290 1310 1330 1350 1370 1390 1410 1430 1450 1470 1490 1510 1530 1550 1570 1590 1610 1630

are futile. They have good convictions and are individually moved as human beings by what they regard a responsibility to 'their' side or 'our' side. But every political ideology and all extant political systems assume that there is not enough to go around—it is either you or me—there can't be enough for both. So we eventually assume war, and that is the cause of the weapons race. The reasoning was once correct. When there is enough available a healthy human will eat three pounds of dry food a day, drink six pounds of water and breathe fifty-four pounds of air or six pounds net of oxygen. For most of the history of man on earth there has not been enough of that dry food and humanity has fought about this, time and again. Many times there has not been enough water, and humanity has fought over this. There has been no time when there has not been enough air. Humanity has so much air available that no one has even thought of putting meters on air and trying to make money out of it. But, there are times, for example in a great theatre fire, when humanity, completely unused to competing for air, finds itself suffocating and goes mad.

It seems perfectly clear that when there is enough to go around man will not fight any more than he now fights for air. When man is successful in doing so much more with so much less than he can take care of everybody at a higher standard, then there will be no fundamental cause for war.

In the years ahead, as man does become successful, the root cause of war will be eliminated. Scientists assure us over and over again that this is feasible. There can be enough energy and organized capability for all men to enjoy the whole earth.

This is the most important prediction I can make: in ten years from now we will have changed so completely that no one will say that you have to demonstrate your right to live, that you have to earn a living. Within ten years it will be normal for man to be successful—just as through all history it has been the norm for more than 99 per cent to be economic and physical failures.

Politics will become obsolete.

At the present moment, we could take all the machinery from all the countries around the world, all the railroad tracks, all the wires, etc., everything we call industrialization—and we could dump this all in the ocean. Within six months, two billion people would die of starvation, having endured great pain. On the other hand, supposing that we take away instead every politician, all the ideologies, all the books on politics—and send them into orbit around the sun. Everybody would keep on eating as before, down will go all the political barriers and we would begin to find ways in which we could send the goods that were in great surplus in one place to another. So people may even begin to eat a little better—in a hurry. This could not be said before.

There are many prognostigations about immediate technology. It seems likely, for example, that there will be considerable advances in transportation, but our present ignorance in handling traffic is appalling. At the bottom of our air-ocean world we are still like flounders and crabs travelling in burrows. In surface travel we restrict ourselves to crowded tubes and lines between buildings and trees when we could go omni-directionally. This is in dramatic contrast to air-travel in which as soon as you go any distance at all you lose sight of other airplanes and can go thousands of miles without seeing another human being. It is only when you slow down that you begin to re-establish close contact. The slower we go, the more crowded we get. Finally, as we leave an airport and get out onto a free-way we have the preposterness of running in lines in opposite directions at 65 miles per hour five feet apart—with everybody practicing steering. A decade from now this will look rather silly. With current technological trending in omni-directional transport we will finish our great highway programmes just in time to turn them into some kind of roller skating rink. It may be fun to roller skate from California to New York—and you will have the time to do it if you like.

It is all Buck Rogers and it will happen. But, such speculation is a waste of time, it is more important to consider what will happen to our relationship one with another.

In its broadest aspect this area must be considered under 'population'. There has been a great debate about the so-called population explosion in recent years. This has been occasioned in part by the fact that we have only recently had accurate census in many countries. Even in Europe population figures only go back a short time.

In the USA, though there was an increase in the post-war birth rate between 1947 and 1954, since then it has declined. This trend is also evident in all the industrialized countries, including Russia. During the last twelve years then the birth rate has been declining in the industrialized countries, yet the main problem is thought to be population increase. The cause of the bulge in census population of these countries is, of course, that more people are living longer. But the underlying reality of the population problem, if there is a problem it is that as we industrialize, the rate of births decrease. We may see this most clearly in, for example, the US, where the early settlers had an average of thirteen children per family and survival rate was very poor. We may then plot the decrease in number of children per family against improvement in technological services, public health, indoor water supply, bathrooms, refrigeration, general improvement in life expectancy, and so on. Clearly, as man industrializes and improves the probability of human survival, whatever the drives or controls of nature are, she does not have to have anywhere as many birth 'starts'. This is one of the fundamental points about industrialization.

We should also consider the rate at which countries become industrialized. England took two hundred years to get industrialization going and up to the present level. The United States 'took off' from England's vantage point and did it in a hundred years. Russia came in and accomplished in fifty what had taken the USA a hundred years, because it was able to start at a more advantageous point. We find that the new countries come in where others left off, not where they started. Japan did not start flying with the Wright Brothers bi-planes, but with the 'Zero' and 'Spitfire' types; China has never flown anything but jets. China came into the world of industrialization after the transistors, computers and atomic fission were available—so she will come to industrial parity with the West in about five years. India will probably be even faster. The acceleration of capabilities coming to bear on India and Africa are of the very highest. As far as one can see, industrialization will be world wide by 1985.

By this date, as the world industrial process is completing, and birth rates reducing, every individual human being will still have about ten acres of dry land and approximately twenty acres of ocean averaging half a mile deep. In terms of a family of five that would be fifty acres of land and 100 acres of ocean —150 acres of acres per family. The amount of food supply would be ample.

We may glimpse in such patterning certain total behaviours in universe that we know little about. We noted, for instance, that as survival rate and life sustaining capability increased, fewer birth starts were 'required'. This may be related to our developing capacities in interchanging our physical parts, of producing mechanical organs, of having progressively fewer human organisms to replenish. The drive in humanity to reproduce as prodigally as possible decreases considerably. This may be reflected in social behaviours—when all the girls begin to look like boys and boys and girls wear the same clothes. This may be part of a discouraging process in the idea of producing more babies.

We shall have to stop looking askance on trends in relation to sex merely as a reproductive capability, i.e. that it is normal to make babies. Society will have to change in its assessment of what the proclivities of humanity may be. Our viewpoints on homosexuality, for example, may have to be reconsidered and more wisely adjusted.

Central to such readjustments will be the concept that man is not alone the physical machine he appears to be. He is not merely the food he consumes, the water he drinks or the air he breathes. His physical processing is only an automated aspect of a total human experience which transcends the physical. As a knot in a series of spliced ropes of manila, cotton, nylon, etc., may be progressively slipped through all the material changes of thickness and texture along the length yet remain an identifiable pattern configuration, so man is an abstract pattern integrity which is sustained through all the physical changes and processing.

We become more aware of this uniqueness of organized and organizing principle in the universe, in science. The long-held myth that science wrests order out of chaos is fast disappearing in due ratio to the extent that all great scientists have found the universe to exhibit an *a priori* orderliness. All the various specialities are discovering that their variously remote studies which seemingly 'ordered' local aspects of nature are converging within progressively simpler and more comprehensive patterns. The 'ordering' is coming together. When we refer to the computer and automation taking over, we refer really to man's externalization of his internal and organic functions into a total organic system which we call industrialization. This metabolic regenerating automated organism is going to be able to support life in an extraordinary way. The machines will increasingly assume various specialized functions. Man who was born spontaneously comprehensive but was focused by survival needs into specialization is now to be broоght back to comprehensivity.

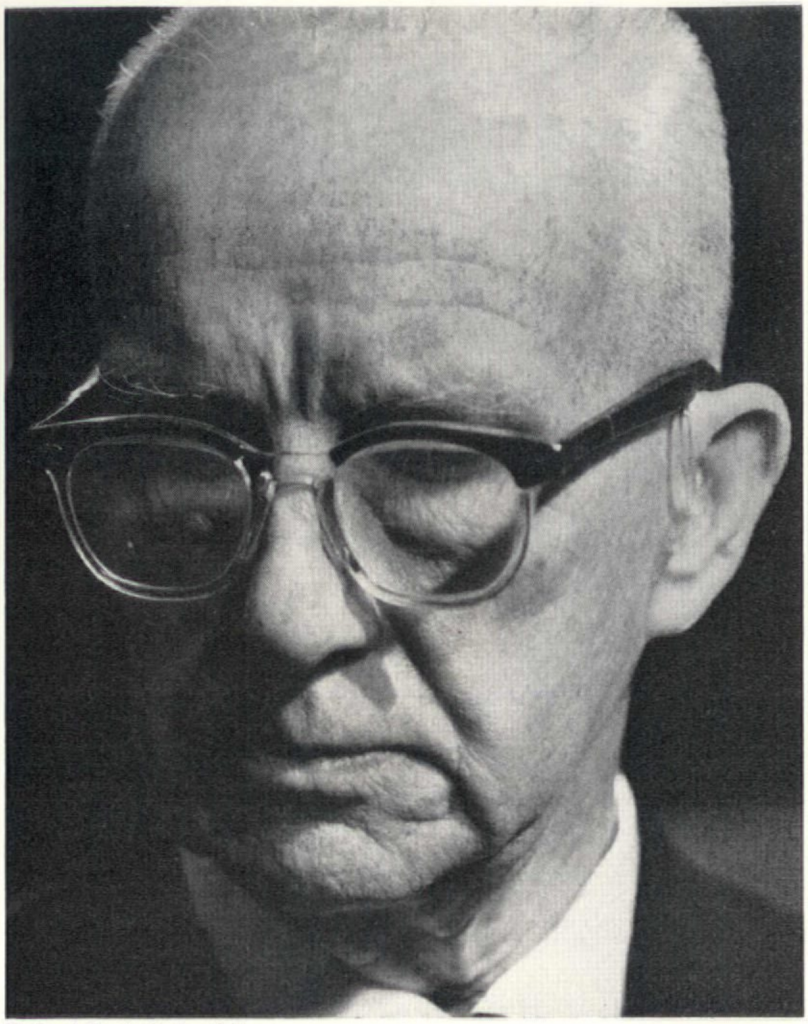
As enormous numbers of men are freed for more education and research and as they become more and more comprehensive in their dealings with nature, there will be engendered a total philosophic awareness of the significance of the whole of human experience. There will be a rediscovery of what Einstein described in 1930, in an article on the 'cosmic religious sense'—the intellectual integrity of the universe and an orderliness that was manifestly *a priori* to man.

We are going to have an increasing number of human beings as scientists and philosophers thinking about the total significance of human experience and realizing that there is an intellect far greater and far more powerful than that of man—and anticipatory of the whole trend of his development. An era of extraordinary integrity might ensue.

This would be for me, the most important and exciting aspect of all the trend curves—that in A.D. 2000, to a marked extent, the integrity of humanity will be of an unbelievably high order. What one human being says to another regarding what he thinks or what he has observed will be reliable. There will be play-acting still, but it will very clearly be play-acting. In looking forward to the year 2000, it is not the 'Buck Rogers' details which are important but whether the world will be a good place for our children and grandchildren. In the past, man had to do many things shortsightedly and we have wasted a great deal of our natural heritage. We have squandered the fossil fuels which represented an extraordinary 'savings' or energy capability account stored up in the earth. The great change now will be in a new type of accounting when we begin to draw more consciously on the fabulous 'income' energies of sun, water, and wind and tidal powers—which if not used will not be 'saved' or impounded on the earth. We will adopt new accountancy standards for all wealth. To account our success in terms of gold and various traditional banking practices is irrelevant. Real wealth is organized capability. One of its important characteristics is that it is irreversible—no matter how much wealth you have, you cannot change one iota of yesterday. Wealth can only be used now and in the future. What we really mean by wealth is how many days forward we have energy available and organized for work to keep the machines running, to keep the foods growing, the refrigeration transportation and so on. The basis for our new accounting system will be—'How many forward days of organized capability do we have available to serve how many men'. We will be able to make the working assumption that it is normal not only for man to be successful but also normal for him to move as freely as he wishes without interfering with any other man. Our overall accounting assumption will be based on whatever amount of organized energy capability is required so as to make it possible for any man to travel around and enjoy the whole earth, and be completely supported in doing so. There will be no such thing as deficit accounting. You cannot live on deficit accounting. You cannot eat deficitly or drink water deficitly. What is to eat is there—as the water is there.

All such negative accounting procedures went along with the need for exploiting others in the 'you or me' phase of man's past struggle for basic survival.

Much of the most exciting and important part about tomorrow is not the technology or the automation at all, but that man is going to come into entirely new relationships with his fellow men. He will retain much more in his everyday relations of what we term the naïvete and idealism of the child. This will be completely justified and not exploited or exploitable in any way. I think then that the way to see what tomorrow is going to look like is just to look at our children.



Richard Buckminster Fuller
Photo: Hans Wild

The Year 2000

R. Buckminster Fuller

This article is a freely edited version of a lecture given at San José State College, California, March 1966.

In relation to increments of time and of prediction, I am confident that I cannot predict for A.D. 2000. Though it is only a little over a generation forward, I do not believe that any human being can foresee with any accuracy as far ahead as that 35 years. What will go on in this next period will be more of a change than has occurred in the whole history of man on the whole earth. All the trend curves which we may examine show rates of acceleration which underline the unprecedented nature of the changes to come. In plotting such trend curves over a period of years, I have sought fundamental information on the experiences of man on earth which might govern the shape of all developments men are experiencing. Charts of inventions, for example, are not satisfactory as the list is open-ended and is difficult to assess in terms of the relative importance of specific inventions. The significant area of information is the rate at which scientists have successively isolated the chemical elements.

This is the most important pattern of discovery with which man deals, embracing, as it does, all physical phenomena. The rate at which man found chemical elements seems to be the key controlling the development of the application of science to technology, and, following from this, the application and effect of that technology on economics and, ultimately, the effect of the new technology on society itself.

The chart on the previous page, Profile of the Industrial Revolution, begins with the year A.D. 1200, going up to A.D. 2000. We begin with a list of nine elements: carbon, lead, tin, mercury, silver, copper, sulphur, gold and iron, which were known to man at the opening of our history. We do not know when they were first isolated or knowingly used. The first known isolation of a chemical element is arsenic, in 1200. Following this, there is a 200-year gap and we come to antimony, another 200-year gap and we come to phosphorus. Then the gap narrows to 75 years and we have cobalt. From here on we average an isolation of an element every two years. It is at an extraordinary period in history that the rate begins to accelerate.

If you check the date 1730, not long before the American Revolution, you will notice that there are some separate shoulders, or plateaus, appearing on the chart. These shoulders are slowdowns when we have major wars—the American revolution, various civil wars and World War I. They show that pure science does not prosper at the time of war—which is contrary to all popular notions. Scientists are made to apply science in wartime, rather than look for fundamental information.

We can also see that in 1932, which was thought to be the depth of the depression, man made his 92nd isolation of a chemical element. This completed the element table representing the full family now mastered by man—in the sense of his ability to repeat element isolation and to rearrange elements, as fundamental ingredients of physical environment, in preferred patterns of use. From this point on we may notice something strange. Previous to completion of the table, element isolation occurred irregularly—for example, element number 19 would be the 43rd element isolated; the 45th isolation would number 30, etc. With the post-uraniums the isolations show an absolute regularity of increase—they come in by number. Man begins to control consciously the rate of development of his capability.

We must note this in reviewing the contiguous developments in environ control (as shown at the top of the chart). Just as man is able to go into cold climates by putting on fur skins or into hot by taking off clothes, he enters more hostile environments by having more control devices. The development of these devices is a fundamental measure of man's degree of advantage over his environment. The first time, to our knowledge, that he goes around the world in an invention was, as shown on the chart, in a wooden sailing ship. It comes after the second isolation. Then there is a gap of 350 years and he now goes around the world in a steel steamship. This is an entirely new magnitude of control, no longer dependent on the wind. Upon this, there swiftly follows the world journey in an aluminium airplane, then in the 'exotic metals' rocket. There is a very great contraction in time between these developments. The wooden ship takes two years to circumnavigate the earth; the steamship two months, the airplane two days and the orbiting satellite just over an hour. We have at least three accelerations of accelerating accelerations involved here.

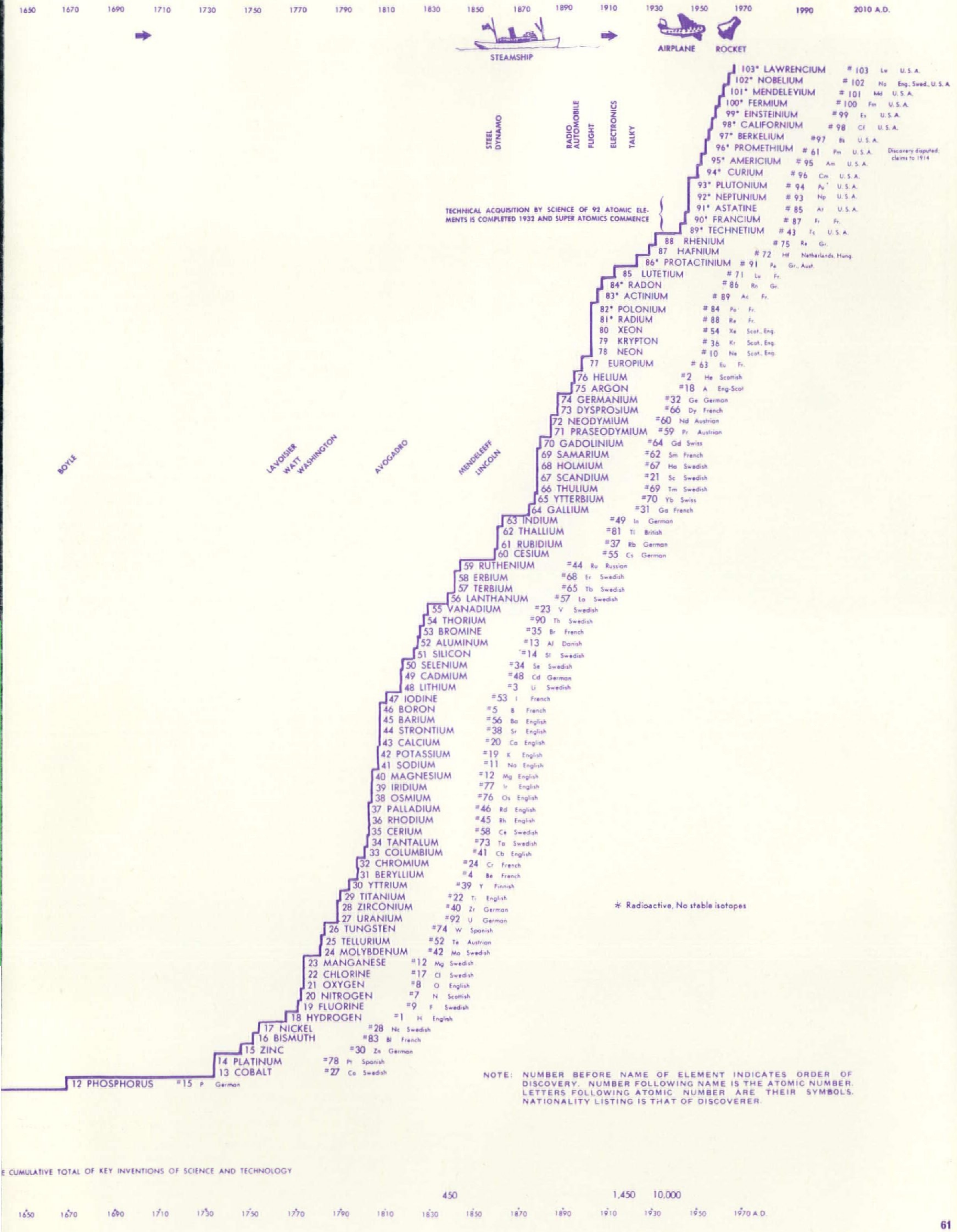
The consequence of what we have considered then, in relation to our charting, is that the next point for a significant new chapter would be around 1975, nine years from now. What that will be we can only guess at—sending ourselves around the world by radio?

The key realization is the degree of acceleration of change, and that better than 99 per cent of all important technologies affecting such change are *invisible*. Man cannot see what is going on. He cannot 'see' the chemistries, he cannot see the alloys. Most of the important rates and patterns of change cannot be apprehended by him directly in a sensorial manner. Not only does man have a very narrow range of tunability in the electromagnetic spectrum where he can actually see, but he also has a very narrow spectrum of motion apprehension. He cannot see the hands of the clock moving or the stars or any of the atoms in motion.

In the same way, man has had a limited understanding of the invisible historical factors. Few people are aware of the tremendous power wielded by a relative handful of men, of world masters, in respect to the whole world up to the time of the Great Crash in 1929. World War I was a struggle between one handful, the *outs*, and another, the *ins*. But the old invisible 'pirate' masters who ruled the seas and the men on land were not displaced until 1929 when the corresponding developments in science and technology outran their traditional capacities. The J. P. Morgans and the like had operated for centuries through manipulation of the visible, and sensoriable, apprehendable, physical factors influencing trade, economies and 'power' balances. Probably 99 per cent of humanity never knew that they existed and didn't know that they had gone. Control passed to their manager/lawyers, the people's politicians, and they are making a mess of it. One finds people around the world feeling extraordinarily well disposed to other people and with none of the emnity and suspicion which is claimed by their political leaders.

We need not be against politicians to realize that their local preoccupations

Profile of the industrial revolution revealed in the chronological rate of the acquisition of the elements—the cosmic absolutes *(see overleaf)*



2000 +

The future of the past is in the future
The future of the present is in the past
The future of the future is in the present
John McHale '65

Presentation by Robin Middleton. Chapter headings designed by James Mellor

2000 + is a special number of AD dealing with the future. The material was compiled by JOHN McHALE, (Executive Director and Research Associate of the World Resources Inventory at Southern Illinois University) who also wrote the articles on pages 65 to 95.

The issue began with the suggestion from *AD* that more attempts might be made 'to communicate the idea of technological innovation to an architecture still largely hidebound by a vision of the fine arts'. Traces of this original bias may still be found in its pictorial emphasis on the visible 'hardware' aspects of a technological revolution whose more characteristic features are now largely invisible.

It may be suggested, however, that the 'imagery' of technology may be as powerful an agency of change as the rational understanding of its scientific and technical basis. In speaking recently on the awareness of change, Ritchie Calder said, 'Eskimo children who have never seen a wheeled vehicle can identify the types of aircraft which fly overhead. The young Dyaks in the longhouses of the equatorial jungle of Borneo listen to the Beatles, and the wandering Bedouins with transistor radios, bought by selling dates to the oilmen of the Sahara, hear Nasser's radio telling how American planes are bombing Vietnam children, half the world away.'*

Change has become our byword and only constant. In just over thirty years, we shall reach AD 2000 which has long functioned as an Utopian benchmark; yet only sixty years ago, the Wright Brothers hadn't left the ground; thirty years later, the world was still excited by Lindbergh's Atlantic solo flight. Today, only nine years since the first Sputnik, news of a two-man orbital flight can almost be edged off the front page by a local by-election and the average man may casually board a 600mph jet to pay a family visit.

It is evident also that this change rate, possibly the most rapid in human history, is barely underway. Most recent and dramatic advances, such as space flight, have come from massively organized programmes of scientific research and development approximately half of whose investment has been in the last two decades. As a by-product, and further accelerator of this trend, it is estimated that, of all the scientists who have ever lived, 90 per cent are alive today. We may also note that the pace, and notion, of change itself has advanced to the point when it is no more than routinely perceived—change is normal. There is danger as well as comfort in such a phenomenon. Like severe traumatic shock, the 'culture-shock' of change may numb our perceptions of its full import and the complex interdependence of each change's forward consequence.

Within this trending, the future of architecture, for example, may no longer be distinguished as a separate strand in the overall development of environment control. The 'attitudinal' discipline called architecture, as more concerned with the symbolic shaping of man's intimate environs, may survive—but only if its practitioners become, and remain, more aware of the technologies impinging upon their function. Technology, of itself, should not dictate the forms of human environment, but rather be used by men to flexibly determine the kinds of environment of their choice.

* Ritchie Calder, 'The Speed of Change', *Bulletin of the Atomic Scientists,* Dec. 1965.

The future of the future

John McHale

We are not fundamentally concerned here with a series of predictions about the next hundred or the next thousand years, but rather with the 'futures-orientation' itself as an intellectual and social attitude. We are concerned with ways of looking forward and with some of the implications of present scientific and technological developments on our styles of living.

In general, today's modes of confronting the future are vastly different from those of the nineteenth century Utopians. In that period, men were still preoccupied with the inevitability of progress, Western style, via a science and technology which seemed capable of ever greater mastery of man over nature. This was tempered somewhat by the Malthusian feeling that the future was limited to those able to prove their material strength and mastery—a viewpoint which, in its more negative aspects, is now largely confined to the military establishments.

Today we do not view the future quite in the same way, as a great evolutionary onrush, largely independent of man's intervention and tinged with various premonitions of doom whether or not he chooses to intervene.

We realize that man does not, in the end, 'master' nature in the nineteenth century sense, but collaborates with nature—his very existence depends on an intricate balance of forces within which he is also an active agent.

H. G. Wells' *Mind at the End of its Tether* marks the conscious end point of the older intellectual stance towards the future, and one may still see it repeated in those who cannot make the breakthrough to the next period. In essence, there is a kind of intellectual polarization taking place around the mid-twentieth century which separates the intellectual establishment into two—one, those who are still preoccupied with the world as conditioned by its pre-1900 parameters, and those who are attempting to recast and reorient their world view to one which is, in many ways, quite unprecedented in human experience. The watershed of this dichotomy really lies much further back—around the Renaissance. The argument begins there about man's relation to, and conscious control of, his own forward development and reverberates down to our own period. At a particular point in time, the summation of certain discoveries and access to certain technical facilities suddenly invalidates the whole of one side of the debate. From this time forward, which one may locate as recently as World War II, one can isolate the two attitudes in the turn of a phrase, the use of a particular frame of reference.

An important point for the individual is, that once the switch in perspective is accomplished, a good deal of negative baggage drops away. The fundamental realization is that man's future is literally what he chooses to make it—and the conscious degree of control he may exercise in determining his future is quite unprecedented. There are many alternative paths to as many alternate futures. Some we have already begun to take, others await our decision. As man gains more knowledge of the forces operative in, and external to, human society, he is forced to couch his questions about the future in the form of alternative possibilities of present actions in terms of their long-range consequences. The more knowledge, the greater the number of alternative paths and the longer the range of consequences.

This realization has been borne in upon many sectors of society. Governments and industries alike, committed to long range programmes of the most varied nature find that they are increasingly forced to think not of the next ten or twenty years but of the next fifty or a hundred. To launch a manned space vehicle to the moon in 1970 requires that you start work on it about ten years before. Other decisions are of a similar nature.

But planning a series of manned rockets is relatively easy in present terms. You can forecast with reasonable accuracy the types of basic research in metal and other alloys which should be initiated this year so that their bulk production may be available in three years to phase with parallel developments in lubricants for near vacuum which you can predict will be available in four years and so on. By compiling the research trends and rates of technological development you can attain to variously workable ten, twenty or even fifty year predictions. Even such apparently straight-forward forecasting, however, is liable to swift alteration, through human serendipity.

The same might be said for much prediction regarding physical resources and their technological exploitation. But even within this area, there are still alternative paths, each with its various contingencies. All are, in varying degree, affected by factors already known or predictable in some form from today's knowledge.

When we come to social planning, the situation is very different, but the need to introduce some predictable parameters and concomitant action has become even more urgent. We have viewed the unforeseen consequences of 'not predicting' —famine and disease are preventable catastrophes. On the local scale, governments now attempt to predict situations productive of disorder and violence. Industry has become increasingly preoccupied with the markets of the '70s or '80s, the future of this industry or that. Dealing with human futures re-introduces the capacity of human beings to determine their future. This is a central point. Given his present scientific and technological knowledge, man now has an enormously enhanced capacity to choose his future—both collectively and individually.

Finding out what we want should become a major object of our attention...there is a vast difference between letting changes occur and choosing the changes we want to bring about by our technological means[1].

The outcome of the 'futures' chosen will depend on the degree to which we predict them. If we conceive a specific course of action desirable, we will tend to orient ourselves towards it. The collective aspect of choice of futures is reflected in the growing concern of our local societies, with the allocation of public funds to various programmes. We begin to agree that investments in pre-natal care, child welfare and pre-school education, etc., which may not 'pay off' for twenty or thirty years are realistic societal strategies. We attempt to legislate the future pollution of the rivers and the air, the future congestion of cities, on the same basis. The pattern of a desired future based on even the least factual or measurable prediction commits us to consensual action. Our prior 'collective' assumption is, increasingly, that the environment and form of our society are within our positive (or negative) control.

The individual's relation to his or her future has become, and is becoming, more flexible. Where a man, even in the advanced countries, would previously feel impelled to prepare himself for one occupation, profession or career, committed more or less to a particular geographic locality and determined for him largely by the circumstance to which he was born, we now have an emerging situation within which an individual may reasonably expect to change occupation, career role and geographic location many times in his lifetime. The future of the individual is based, again, on whatever expectation of the future he acquires. His paths towards this or that future, though conditioned in part by physical make up, 'talents', etc., may be viewed as more largely determined by his particular conceptual mapping. As Dennis Gabor has suggested, we are now 'inventing the future'. Man's future is most likely that which he may most imaginatively conceive of, which, in turn, will determine his action towards its accomplishment. Life may be viewed as a great number of alternative possibilities—in life style, location, occupation, etc. The so-called 'threat' of leisure is no more than a widening of 'living' alternatives.

The future of the future becomes, therefore, what we determine it to be both individually and collectively. It is directly related to how we may *conceive* any specific or vague future to be. Such mental 'blueprints' are action programmes, whether immediate or not depends on the individual and his collectivity, i.e. society. All actions have consequences and both may be effected on a larger scale, with further reaching contingencies than was ever consciously possible in human history.

Though emphasizing change, we should also note that all change proceeds within a set of regulating patterns. Life on earth has been possible only during the past billion years through the relatively stable interrelationships of the variables of climate, the chemical composition of the atmosphere, the sea, the life-sustaining qualities of the land surface, the natural reservoirs and the water cycles.

Within the relatively thin bio-film of air, earth and waterspace around the planet, all living organisms exist in a delicately balanced ecological relationship. The close tolerances of this symbiosis are presently known to us in only the haziest outline. Apart from the relatively local disturbance of earth cycles through agricultural practices, man until quite recently did not have the developed capacities to interfere seriously with the major life sustaining processes. Since the Industrial Revolution, this has changed abruptly, and from this time forward the 'eco-system' also includes man's machines, their products and an incalculable capacity to alter the natural balances.

The first great changes came with the advent of the Industrial Age, based on engines that used energy stored in coal beds, which built cities and navies, wove textiles, and sent steam trains across the widest continents.
Since then, with energy from petroleum and other sources, changes have come more swiftly. Today, radar telescopes scan the universe to record galactic explosions that occurred billions of years ago; oceanographic ships explore the undersea; electronic devices measure the earth's aura of unused energy and similar equipment traces inputs and outputs of single nerve cells; television cameras orbiting the earth send back photographs of entire sub-continents; electron microscopes photograph a virus; passenger planes fly at almost the speed of sound; and machines set type in Paris when a key is tapped in New York. These are only a few of the changes that our increasing supply of energy has made possible in the last 60 years[2].

The word, ecology, is significantly derived from the Greek *Oikos* meaning *house*, so in our references to human ecology, we are really talking about planetary housekeeping.

Writing on the human biosphere[3] G. Borgstrom, points out that the maintenance of three billion humans presently requires a plant yield sufficient to accommodate 14·5 billion other consumers. These other consumers, the animal populations, are an essential element in maintaining the humans by acting as intermediate processors for many plant products indigestible by man. Pigs, for example, consume four times more than America's 400 million people, when measured on a global scale. Despite mechanization, the world horse population still has a protein intake corresponding to that of 653 million humans—the population of China.

Yet in terms of balance, '. . . only one tenth of the caloric intake of the world household consists of animal products.' World food consumption is largely vegetarian with 90 per cent of the caloric intake and 60 per cent of protein coming from plants. This underlines the importance of each of the respiration / excretion / decomposition stages in the natural economy, with microbial activity as a key element in the recycling of materials. Amongst the non-human animal population in the food cycles, micro-organisms play a major invisible role.

The dependence of one-sixth of the world's food supply on 'artificial' nitrogen produced by the chemical industry, is another factor. To make each million tons of such nitrogen annually, we use a million tons of steel and five million tons of coal. In terms of our methods of crop use and food production, Borgstrom estimates that we will need 50 million tons of such support nitrogen annually by the year 2000. The amounts of other chemicals, e.g. sulphur and key trace elements such as phosphorus, which will require massive support technologies to augment the natural cycles, is only now becoming apparent.

But the greatest areas of developing crisis for man in the biosphere are water and air. Approximately 95 per cent of our water is in the ocean and the remaining 5 per cent of fresh 'cycling' waters are presently being used at a prodigious rate. Agriculture accounts for 50 per cent, using 400–500 pounds for each one pound of dry plant matter. This water/crop ratio varies as high as 1–1000 and 1–2000, so that agriculture in the lesser developed countries consumes as much water *per capita* as the technologically advanced—where 250 tons of water are used in producing a ton of newsprint and 25 tons for each ton of steel. When such uses are compounded with mounting waste and sewage disposal, the position is more severe. The increase of pollution in water and air has now become of national concern in many countries. An average industrial city of half a million people disposes of 50 million gallons of sewage a day and produces solid wastes at the rate of about 8 pounds a person each day. Present solid waste disposal even in advanced countries is archaic.

Pollutants are the residues of things we make use of once and throw away... As the earth becomes more crowded, there is no longer an 'away'. One person's trash basket is another person's living space...our whole economy is based on taking natural resources, converting them into things that are consumer products, selling them to consumers and then forgetting about them. But there are no consumers—only users. *The user employs the product, sometimes changes it in form, but does not consume it—he just discards it. Discard creates residues that pollute at an increasing cost to the consumer and his community*[4].

It has been noted that with present waste treatment, by 1980, effluents will be sufficient to consume all the oxygen of all the dry weather flow of 22 river basins in the USA. Within this discharge into rivers and streams goes also detergent materials, industrial wastes and pesticides from the land. Massive fish-kills of around 10 million in the Mississippi basin and the Gulf of Mexico, during 1960–64, were traced to pesticide run-off and other toxic agents from sources thousands of miles away.

With 'people kills' the toxic agencies may go unnoticed for much longer. Some 500 new chemical compounds come into industrial use yearly in one country alone, with practically no legislative attention to their long-range deleterious effects which may be nonspecific as to pass for normal deterioration. In the past hundred years the CO_2 concentration in the atmosphere has been increased by about 10 per cent—no small argument in favour of banning *with* the bomb the comparably lethal uses of coal and other fossil fuels as energy sources. Four thousand Londoners died from air pollution in one week in 1952, one thousand in 1956.

The average person daily eats about two and three-quarter pounds of food, drinks four and a half pints of water and breathes 20 pounds of air. He can postpone eating and drinking, but he cannot postpone breathing...air pollution affects almost everything in our environment... from clothing, skin and lungs to metals and paints...its damage costs are estimated in the US alone between $7 and $9 billion annually[5].

In addition to fouling the atmosphere, it has been calculated that certain elements, e.g. argon, neon, krypton, etc., indispensable to life are now being 'mined' out of the atmosphere by industrial operations at a faster rate than they are being produced by the earth's atmosphere/hydrosphere/lithosphere process.

This cursory overview is not without consequence for the future of architecture and environment planning.

The town and city planner and public health specialist of tomorrow will have to take a far more comprehensive view of human ecology than most of them yet dream of; and the costs of safeguarding human health, including the psyche, can no longer be put 'on the cuff' no matter what they may do to conventional economic progress[6].

Air pollution is not a 'local' problem—the air is not restrained within municipal or national boundaries, nor are the waters of the planet. In terms of any such planning, even the year 2000 is too short range. As a generation on the 'hinge of history' we must accept the challenge of imaginative extrapolation of human requirements beyond 100 or even 1000 years. Where it may be pleaded, for example by special interest groups, that we have enough coal, oil and gas reserves for 500 years, their continued use at the present rate is obviously precluded by their adverse effects on the eco-balance. Leave them in 'storage'—until a more evolved society may use them less prodigally and dangerously.

Some of the mandatory requirements for the merely adequate maintenance of the eco-system are already clear. We need to recycle our minerals and metals; increasingly to employ our 'income' energies of solar, wind, water and nuclear power, rather than the hazardous, and depletive, 'capital' fuels; to draw upon microbiology and its related fields to refashion our food cycle; to reorganize our chaotic industrial undertakings in new symbiotic forms so that the wastes of one may become the raw materials of another; to redesign our urban and other 'life style' metabolisms so that they function more easefully.

As we go towards 2000, it will behove us to accept the facts, that the resources of the planet can no more *belong*, by geographical accident, to any individual, corporation, country or national group than the air we breathe. National ownership of a watershed or key mineral deposit is as farcical a proposition as our supposedly national sovereignty of an 'air space'. The situation we face now is analogous to that which was fought over locally in the nineteenth century with regard to pure food legislation, public health and child welfare, etc. The same arguments will, no doubt, be raised again about the rights and privileges of the individual—to poison, swindle and infect his neighbour, or his own descendants.

Our most important discoveries, therefore, may not lie solely with technological innovation—but with social invention. We begin to recognize more clearly that our societal institutions, the ways in which we organize ourselves to live together in human fashion are not immutable, but are as much man-made 'invented' forms as television or the car. The city or nation state were comparatively recent inventions of this order which may now, in certain areas of their functioning, be dangerously obsolescent. Just as we have consciously learnt in the past few decades to organize the process of scientific and technological innovation, and its applied development over long time spans, so must we orient ourselves towards more consciously controlled and experimental social innovation. The design of new forms of human organization is already under way in many areas of public and private life and is even more evident at the international level. The UN, for example, is a second generation 'bench' prototype of the League of Nations. We now need to initiate new phases of research and development towards more viable forms of this magnitude. Our evolving planetary society must become like a great learning machine in which, 'man's intelligence (now) intervenes and directs the process which remains, nonetheless, basically an experimental process.'

Without touching upon the more familiar problems of war, hunger and human disease, even a cursory glance at our eco-system is sobering. It should be apparent to all, that we now live in such close community, and within such delicate 'life' margins, that all our actions are now cast on a planetary scale and that our gross ecological errors may reverberate for centuries.

[1] Bertrand de Jouvenel, 'Utopia for Practical Purposes', *Daedalus*, Summer, 1965.

[2] Boris Pregel, 'The Impact of the Nuclear Age', in *America Faces the Nuclear Age*. Edited by D. Landman and J. E. Fairchild, published by Sheridan House, New York, 1961.

[3] G. Borgstrom, *The Human Biosphere and its Biological and Chemical Limitations*. Global Impacts of Applied Microbiology Conference, Stockholm, 1963.

[4] *Waste Management and Control*. US National Academy of Science—National Research Council Publication 1400 (1966).

[5] Dr Karl W. Wolf, *Conference on Space, Science and Urban Life*, Seminar B. NASA 1963.

[6] Wm. Vogt, 'Man's Ecological Dilemma', *Natural History*, December 1965.

Space monkey from *A history of rockets and space.*

Outer Space

1

Space technology has provided the key image of scientific and technical progress for years. Sketching its main import and possible implications is difficult because of the extraordinary way in which it has affected, and been affected, by so many areas of scientific enquiry. Almost every branch of science, physics, chemistry, etc., through biology, medicine to psychology to para-psychology, and all forms of engineering have been pressed into its development, so that it seemingly draws upon the entire accumulation of human knowledge for the past 200 years. The reasons for this convergence are to be sought within its central purpose. To transport and maintain the human organism off the earth and outside its sustaining envelopes requires a 'duplication' of the earth itself—a protective enclosure and complex life support system which is, in effect, a rudimentary Earth in miniature. A developed space vehicle, with its protective shields and energy collectors and converters, its internal 'closed system' ecology for the cycling of air, water and wastes, its sensors and communicating devices, is a micro-miniaturized version of our planetary vehicle.

Notwithstanding, therefore, that strongest impetus to the various space programmes may be a combination of chauvinism and weaponry, their most tangible by-product is an entirely new way of regarding our planet, man himself and his relationships to it.

The question is not so much whether we can make better baking dishes out of rocket nose cone materials, or whether a highly effective device hand tailored for space at enormous cost will have mass production possibilities. The question is rather whether a society can take on with some confidence of success seemingly impossible tasks, though compatible with physical laws. In space work, society does organize itself to analyse the problem, marshal the resources, and see through to completion in timely fashion with much concurrent pushing of the state of the art. With this kind of experience, we can now take on other grand tasks which earlier man saw society needed but previously were equipped with neither the boldness nor the engineering and organizational tools to undertake. ...By the end of the next ten years, the concrete economic return should be considerable and routine. We should have fairly complete global weather reporting ...widespread use of the communications systems for point-to-point linkage of all major points of the world... world-wide navigation and traffic controls for shipping and aviation—a great stock of observation techniques of direct value to farming, forestry, water management, fisheries, mining, mapping and geodesy and geophysical studies of all kinds[1].

It may be pertinent however, to review initially some areas of possible import to 'local' environ control problems. Where not of immediate applicability, these may furnish directive paradigms towards the resolution of such problems.

[1] Charles S. Sheldon, *Space Age in the Fiscal Year* 2001' 4th Goddard Memorial Symposium, Washington D.C., March 1966.

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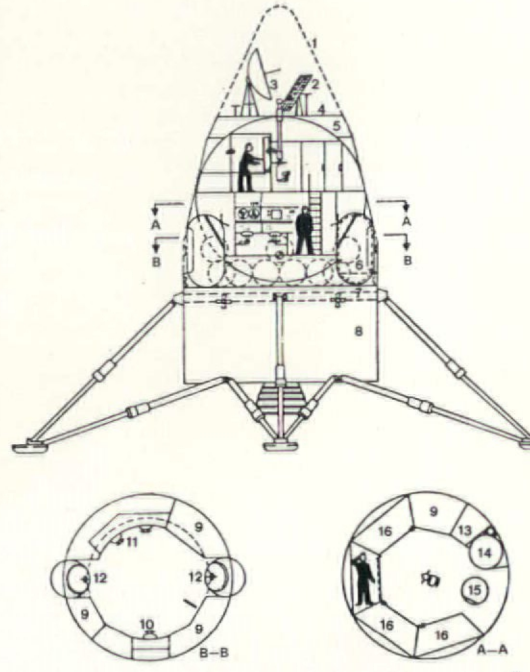


2

1
The Russian astronaut, Adrian Nicolaiev, floating weightless during a training session in an aeroplane

2
To land a pound of equipment on the moon will come to about $4000–6000; 'labour' on the moon will run to $60,000–100,000 an hour. Obviously lunar bases must be prefabricated on earth to the greatest extent possible. This lunar occupation module from Douglas Missiles and Space Systems study provides a good example of thinking in 1963 on lunar base design. To prepare the ground for a base, two men will stay on the moon for 60 days in a LEM track shelter. The subsequent permanent base will be made up of four types of 25,000lb modules identical in external envelope and landed and destaged in identical operations: occupation module, central storage module, cargo, maintenance module, and power module. The interiors of the modules would be different. The occupation module illustrated here in section and plan, is shown as it would land on the moon on a LEM-type base. Subsequently it would be jacked up to come to rest on wheels, rolled down a ramp and towed into position and linked with the other modules either on the surface of the moon or buried underground the better to withstand lunar temperature differentials

1 shroud
2 solar panel
3 antennae
4 radiators
5 polyurethane foam
6 cryogenic storage
7 separation plane
8 lunar logistics vehicle
9 storage
10 food preparation
11 data management
12 airlock
13 hygiene facilities
14 shower and laundry
15 hatch
16 sleeping decks

I. Stambler 'Lunar bases', *Space aeronautics*, Dec., 1963

3
Our conceptions of our planet and the ocean of space through which it travels have undergone radical change since the launch of the earliest American spacecraft, Explorer I, early in 1958. We are, it is now established, living in a pear-shaped planet. The large region of van Allen radiation surrounding the earth, once thought to be two belts of radiation, is recognized to be a single belt consisting of successive, overlapping layers of protons and electrons (shaded). Space exploration has also revealed a vast 'solar wind', a continuous stream of plasma emitted by the sun at speeds of several hundred miles a second

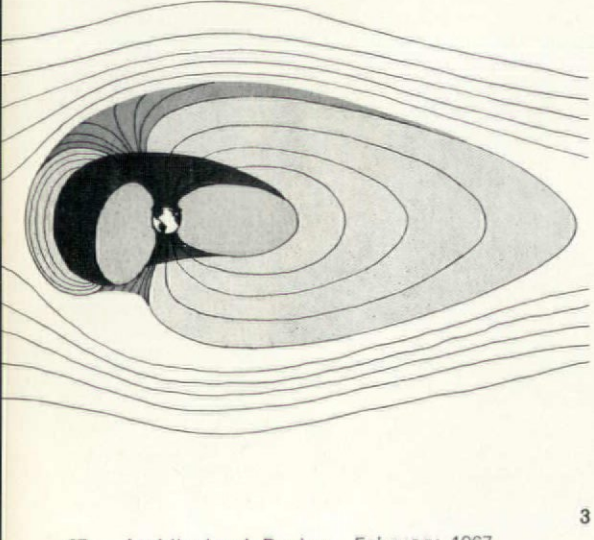
4
American astronauts experiencing weightlessness in an aeroplane flown through a parabolic arch

5
A six-man space station for launching unmanned by a Saturn 1-B vehicle and subsequently manned

6
A six-man space station launching by the Titan III

7
Manned orbiting laboratory designed in 1965
1 Gemini capsule
2 spheres for cryogenic fuels
3 living compartment
4 airlock
5 laboratory
6 camera

1 Courier, *May 1966; 2* Space Aeronautics; *3 TRW Space Technology Laboratories; 4* C. *Canby* A history of rockets in space, *1965; 5–7 Lockheed Missiles and Space Co.*



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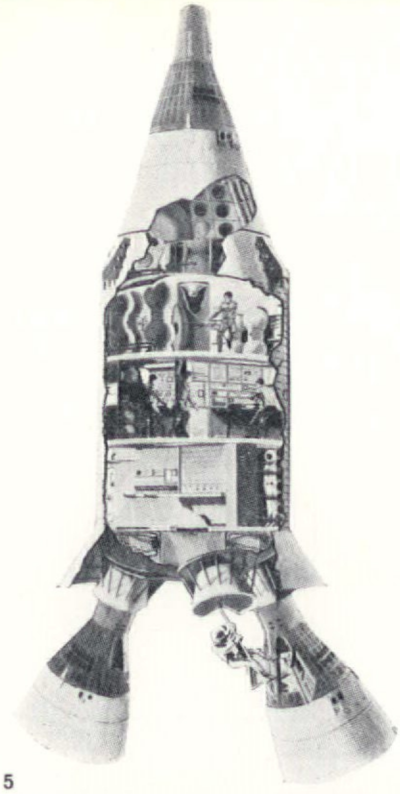

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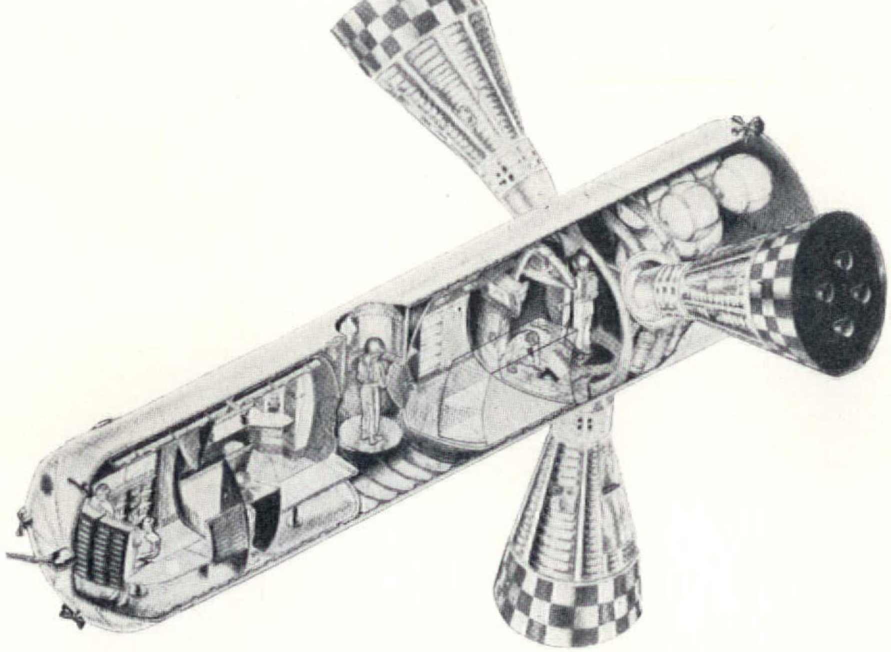

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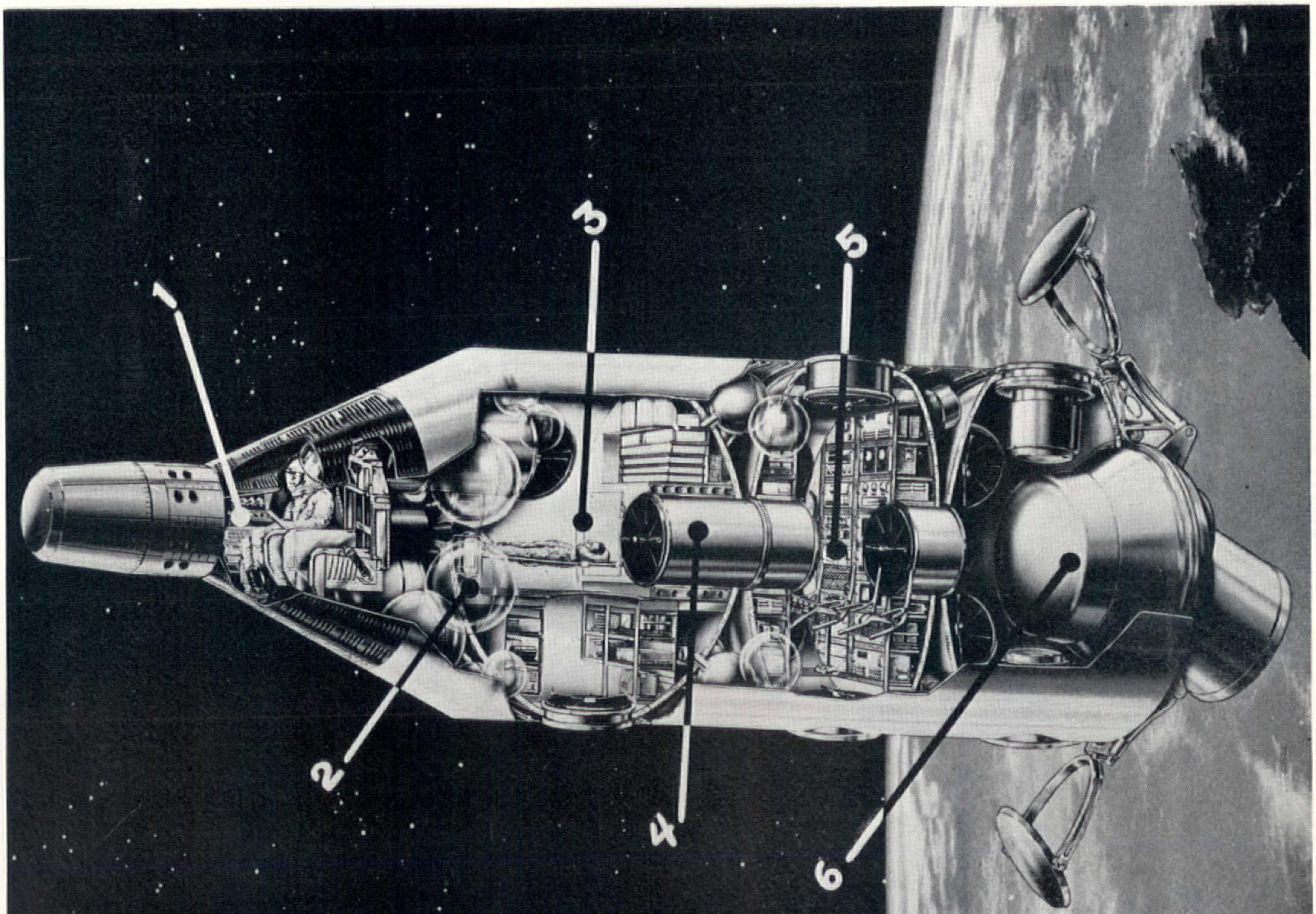

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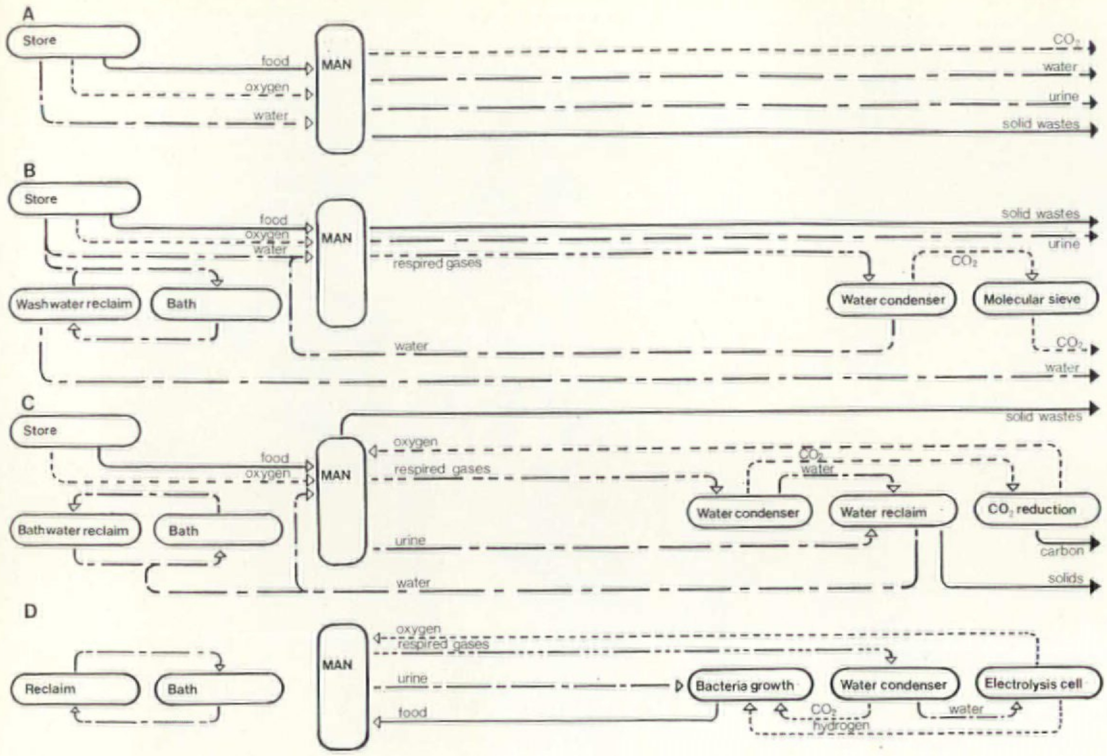

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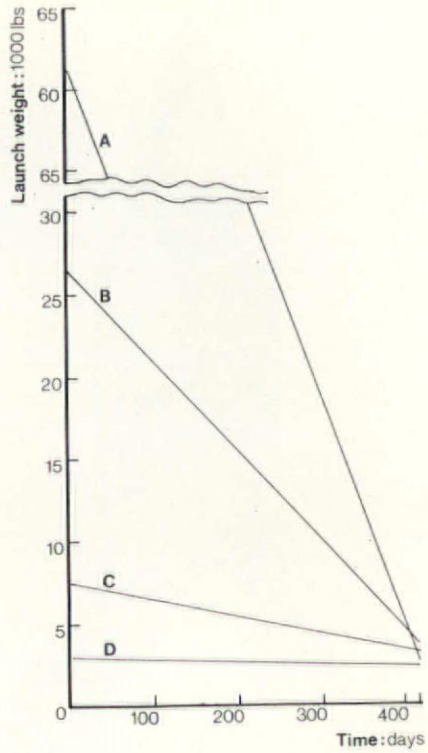


2

1, 2

Ideally the space capsule must be a microcosm of the terrestrial world: there is no air except the breathable atmospheres carried along or continuously regenerated, there is no water except that carried or regenerated, there is no food and no biological 'sponge' to soak up impurities, no waste-disposal apparatus operating through a long biological chain. Up to now prepackaged food has been used on space flights, stored water, atmospheres which are known to be safe and primitive waste disposal methods (plastic bags). But with longer space flights, because of the large cumulative weights involved, exhaled carbon dioxide will have to be reconverted to oxygen, water reclaimed from the air, wash water and urine and trace contaminants removed. Food may even have to be produced on board. Some of these needs are far off, but work goes forward to ensure that they can be met

There are innumerable ways to organize regeneration, storage and dumping in the air, water and food cycles needed to keep astronauts alive. On a 420-day return trip to Mars, a crew of six will breath about 5000lb of oxygen, exhale about 5800lb of carbon dioxide, eat about 5000lb of food (dry weight) and use about 30,000lb of water for drinking, reconstituting their dried foods and general personal hygiene. If the carbon dioxide is absorbed chemically, as in the Mercury and Gemini capsules, about 6200lb of chemicals will be needed. Clearly a recycling process is required. Diagrams 1 and 2 show some of the groupings and material balances that would be possible

A All supplies expendable, CO_2 absorbed chemically and dumped, urine dumped, solid wastes stored

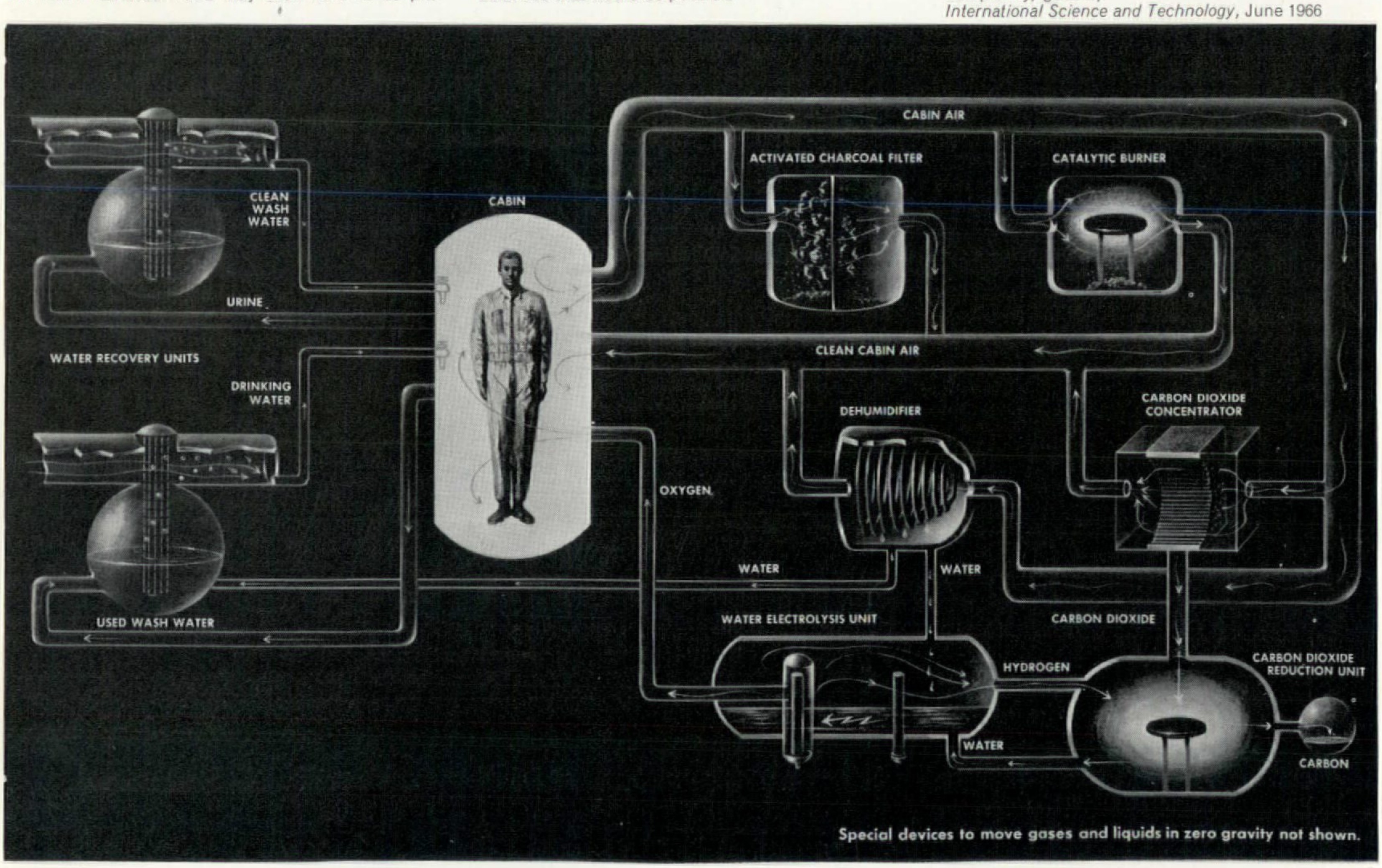
B Cabin moisture and wash water recovered, CO_2 absorbed on molecular sieve and dumped, urine dumped, solid wastes stored

C Cabin moisture, wash water and urine recovered, CO_2 reduced to O_2, carbon dumped, solid wastes stored.

D Complete closed food, water and atmosphere cycles

In evaluating these systems it is important to remember that expendable and fixed weights differ drastically, depending on how completely the spacecraft's ecology is closed. As more regenerative capacity is built in, the launch weight goes down, fixed weight (and complexity) goes up

International Science and Technology, June 1966



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The closed ecological system, for long duration space flights, is an obvious prime requirement. The weight/volume penalties on non-regenerative life support systems which would carry sufficient air, water, waste storage, etc., on a single use basis is impractical for other than the briefest mission[2].

The basic human functions furnish the parameters of the overall eco-system requirements. Man's required physiological intakes are food, water and oxygen. His 'output' materials are solids, including undigested materials, metabolic wastes (shed skin, hair, fingernail clippings, etc.) and salts; expired gases, including carbon dioxide and water vapour; liquids, respiration and perspiration moisture, urine and faecal water.

His daily metabolic turnover is in balance so that the main considerations in the physical aspect of the 'ecology' design are the 'looping back' of various exchanges to form a closed system. For example, in breathing, we exhale about 2·2lb. of CO_2 per day; on earth this is largely taken up by growing plants which convert it to oxygen and food in various parts of the photosynthesis cycle. In a closed space craft, the CO_2 can be funnelled outside, absorbed through chemical combination (as in the Gemini capsule), fed to an oxygen recovery unit or used in a 'food cycle' resembling the terrestrial man/plant exchange. The ideal system would be a completely regenerative, self-sustaining one in which water and oxygen would be recovered from metabolic wastes—air conditioning, temperature regulation, food synthesis, preparation and disposal, sanitation and hygiene requirements, etc., would be linked in one integral system. The present state of the art is exemplified in an interplanetary mission scheme for the launch period between the 1970s and mid 1980s. Emphasis is placed on the air and water recirculation systems which are integrated in certain aspects with temperature conditioning, waste management and atmospheric conditioning. The food cycle remains open, as an area of critical forward development. The full system projected is for a six-man crew on a 460-day mission, i.e. 14 months: Data is compiled in terms of man-days[3].

Omission of the food cycle from the above scheme reflects the comparative development lag in this area. Biological systems under review have almost all dropped the earlier 'algae' based models, or other photosynthetic units, because of their light energy requirements. The more recent approach is the chemo-synthetic using microbial populations which assimilate carbon dioxide and urea obtaining their energy from hydrogen rather than from 'light' conversion—hence work in the dark. As (theoretically) edible products, these organisms are protein, fats, carbohydrates and water. Various other 'bio-synthetic' processes include combinations of bacteria, algae, turnips, sweet potatoes and reportedly a small colony of duck weed which is at present in orbit. The Russians have broached the idea of a carefully programmed chicken battery re-using processed wastes, algae, etc., to achieve an endless chicken supply. Serious studies have also been put forward for using edible materials for all internal partitions, control knobs, furnishings, etc., expendable at various mission stages. 71▷

[2] H. W. Matson, 'Keeping Astronauts Alive', *International Science and Technology* June 1966.

[3] E. S. Mills, R. L. Batterton (Douglas Missile and Space Systems Division), *Interplanetary Mission Life Support System*, 1965.

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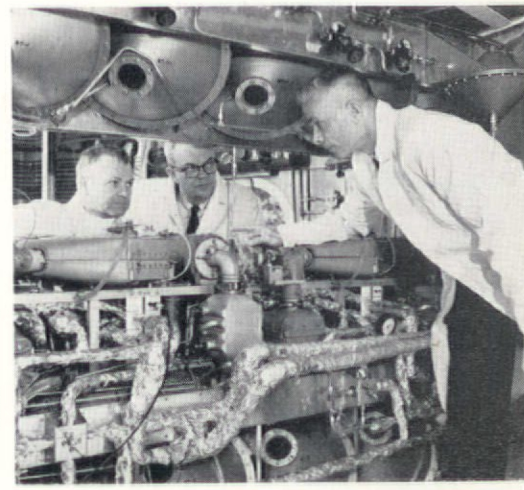

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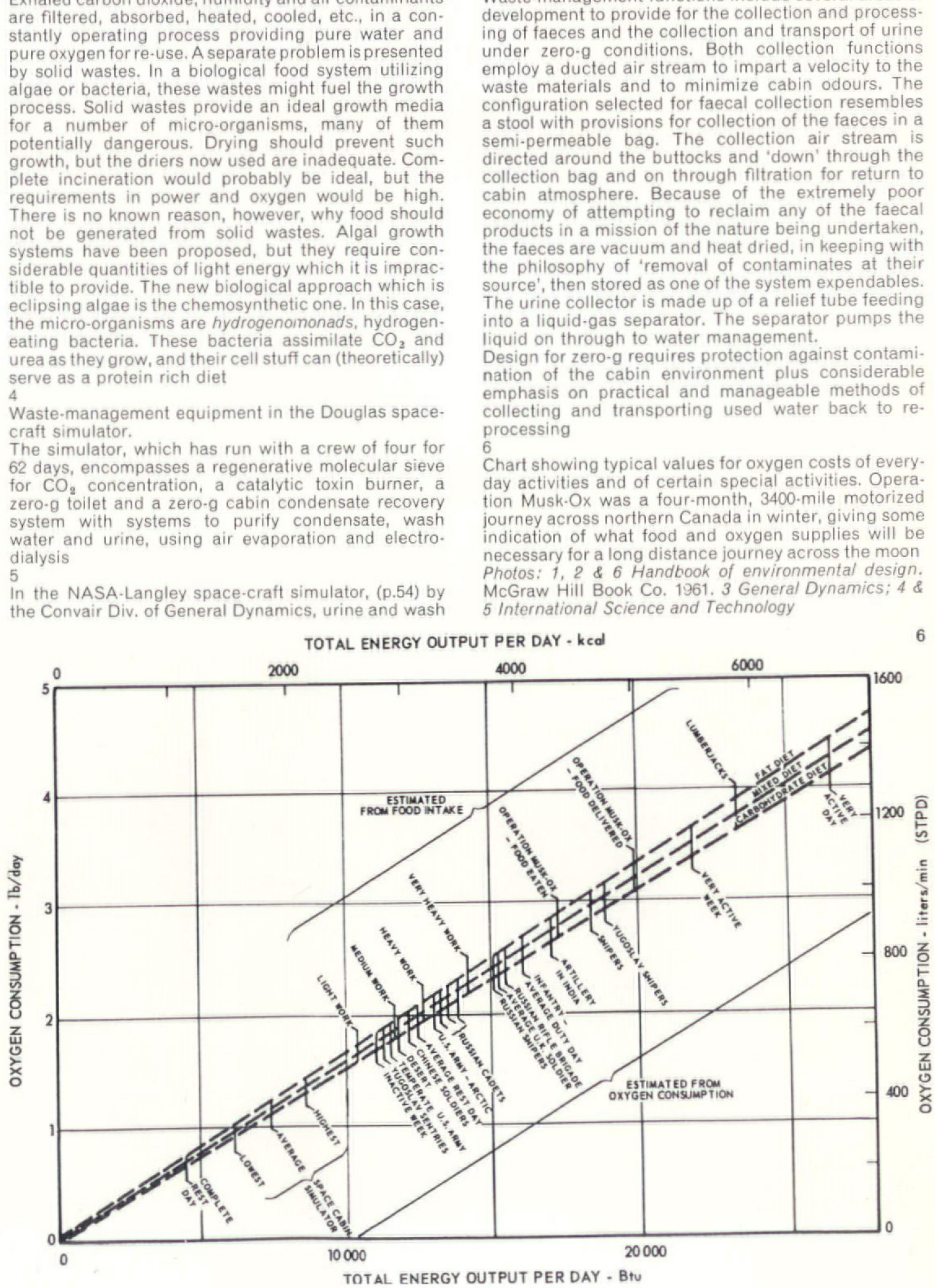
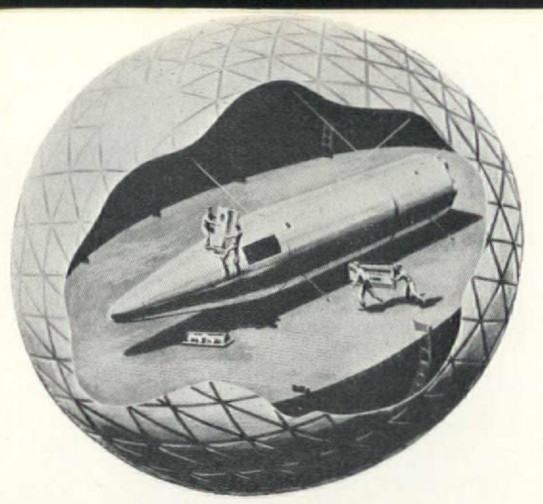
3
The General Dynamics life-support system ties water, air and waste removal into one integrated system. Exhaled carbon dioxide, humidity and air contaminants are filtered, absorbed, heated, cooled, etc., in a constantly operating process providing pure water and pure oxygen for re-use. A separate problem is presented by solid wastes. In a biological food system utilizing algae or bacteria, these wastes might fuel the growth process. Solid wastes provide an ideal growth media for a number of micro-organisms, many of them potentially dangerous. Drying should prevent such growth, but the driers now used are inadequate. Complete incineration would probably be ideal, but the requirements in power and oxygen would be high. There is no known reason, however, why food should not be generated from solid wastes. Algal growth systems have been proposed, but they require considerable quantities of light energy which it is impractible to provide. The new biological approach which is eclipsing algae is the chemosynthetic one. In this case, the micro-organisms are *hydrogenomonads*, hydrogen-eating bacteria. These bacteria assimilate CO_2 and urea as they grow, and their cell stuff can (theoretically) serve as a protein rich diet

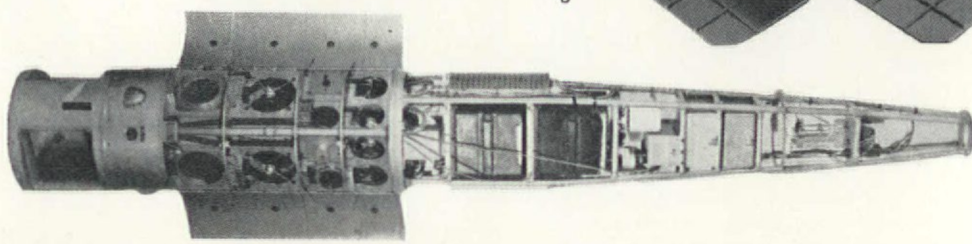
4
Waste-management equipment in the Douglas space-craft simulator.
The simulator, which has run with a crew of four for 62 days, encompasses a regenerative molecular sieve for CO_2 concentration, a catalytic toxin burner, a zero-g toilet and a zero-g cabin condensate recovery system with systems to purify condensate, wash water and urine, using air evaporation and electro-dialysis

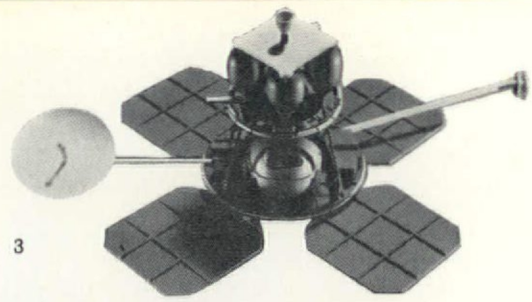
5
In the NASA-Langley space-craft simulator, (p.54) by the Convair Div. of General Dynamics, urine and wash water are air evaporated in the two flat boilers shown in the centre of the photograph. The square 'boxes' are heat exchangers, storage tanks are above and below
Waste-management functions include several areas of development to provide for the collection and processing of faeces and the collection and transport of urine under zero-g conditions. Both collection functions employ a ducted air stream to impart a velocity to the waste materials and to minimize cabin odours. The configuration selected for faecal collection resembles a stool with provisions for collection of the faeces in a semi-permeable bag. The collection air stream is directed around the buttocks and 'down' through the collection bag and on through filtration for return to cabin atmosphere. Because of the extremely poor economy of attempting to reclaim any of the faecal products in a mission of the nature being undertaken, the faeces are vacuum and heat dried, in keeping with the philosophy of 'removal of contaminates at their source', then stored as one of the system expendables. The urine collector is made up of a relief tube feeding into a liquid-gas separator. The separator pumps the liquid on through to water management.
Design for zero-g requires protection against contamination of the cabin environment plus considerable emphasis on practical and manageable methods of collecting and transporting used water back to reprocessing

6
Chart showing typical values for oxygen costs of everyday activities and of certain special activities. Operation Musk-Ox was a four-month, 3400-mile motorized journey across northern Canada in winter, giving some indication of what food and oxygen supplies will be necessary for a long distance journey across the moon
Photos: 1, 2 & 6 Handbook of environmental design. McGraw Hill Book Co. 1961. *3 General Dynamics; 4 & 5 International Science and Technology*









3

◁70

1

2

Space medicine, human factors, etc., now under the heading *Bioastronautics* offer an extraordinary range of information for the terrestrial designer.

Telemetry, for example, the sensing and transmitting of information on the state of a man or an object at great distances owes its recent rapid development to 'space' activity. This can be used obviously in any situation where monitoring at a distance is required, but at present finds its most positive developments in medicine. In ways which are now beginning to revolutionize hospital design and various chemical procedures, this family of devices would allow two-way telemetry, via, for example, micro-miniature surgically embedded sensors, feeding data to centralized computer or human/machine diagnostic and treatment centres, thus creating new forms of medical surveillance and care.

Similarly, the study of group behaviours, simulation of complex socio-psychological relations, individual and group behaviour under stress, etc., are also beginning to feedback into the social sciences. The *soft* technologies gain from space exploration may if anything be more considerable than in the *hard* areas of materials science, propulsion systems, and so on.

The structural aspect of spacecraft construction has a similar wide spectrum view as that displayed in life support systems. These structures which will perform under the most rigorous conditions, take loads, insulate, protect against radiation and meteoroids are intensively computed on a stricter performance/per pound basis than in any other type of environment control instrument. 'To come close to this ideal, the (space) structure designer must work on the level of fundamental concepts—even at the molecular level[4],' e.g., 'whisker' fibres of 0·2 micron diameter are being spun into composite matrices of flexible, metallic materials.

In terms of external configuration, form is determined by functional criteria, but in ways that bear little relation to the use of this slogan by other designers. Apart from the projectile type launch vehicle and present 'cone'-shaped manned orbiting capsules, space structures now in orbit, or under development, present an extraordinary range of design strategies. These range from rigid structures of various types exhibiting greatest variety in the unmanned 'Surveyor' and 'Nimbus' types—to developments in the variable-geometry folding, self-expandable structures which have been pioneered by Buckminster Fuller. The latter are particularly under investigation for manned lunar base needs for which large span enclosures will be required to fit into a nose cone volume for automatic opening and erection.

Similar close packing studies for the first space station include a full-scale three-storey prototype of an inflatable doughnut shaped structure of neoprene coated Dacron and foam rubber. Like a giant inner-tube, the station connects to a central hub through a 'tunnel' spoke. Prototyped at 30ft diameter, calculations allow for a 150ft diameter station within which the crew would work in a 'shirt sleeve' environment with, of course, inflatable furnishings, etc. 74▷

[4] *R. & D. Handbook, B-7*, NASA 1965.

1
Space garage in the form of a geodesic sphere

2
The instrument section of an Aerobee rocket used to detect X-ray emissions from bodies in space other than the sun. Extensive research of this sort is furthered by rockets. Physiologists are to use an Apollo space-craft to orbit a monkey for six months to a year, with electrodes implanted in its brain. A bio-satellite will test the effect of radiation on living cells under conditions of prolonged weightlessness. Already ground tests have revealed some of the positive practical results of exposure to radiation: potatoes, for instance, produce a double crop in a year

3
NASA's Lunar Orbiter, the first satellite to orbit the moon, revealing its exact shape, its gravitational characteristics and possible landing sites for future astronauts

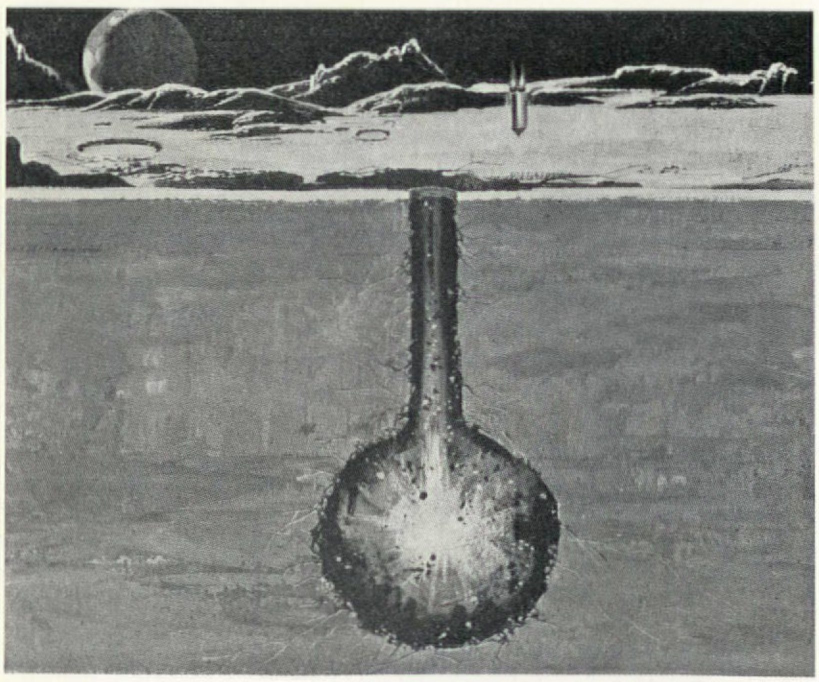
4 & 5
Proposal for excavating and preparing living quarters on the surface of the moon using a controlled nuclear blast set in a special rocket cone

6
Space laboratory constructed with empty rocket propellant tanks

7
A doughnut shaped space station for orbit round Mars

8
Interplanetary manned space vehicle, designed under the direction of Benjamin P. Martin, senior advanced systems engineer for the Lockheed Missiles and Space Company. The three-spoked configuration has at the top a modified Apollo command module with a retro rocket section attached to it. The large chamber at the bottom end of the long spoke is the mission module where work will be accomplished. To the right is the nuclear reactor that provides power for the experimental work and life support system aboard the craft. The hub where the three-spokes join is a shielded shelter against solar flares. Astronauts reach each chamber through the hollow spokes. The whole vehicle rotates around the hub to provide gravity

Photos: 1, 4, 5, 6, 7, D. M. Cole Beyond Tomorrow; *8, Lockheed Missiles and Space Company*



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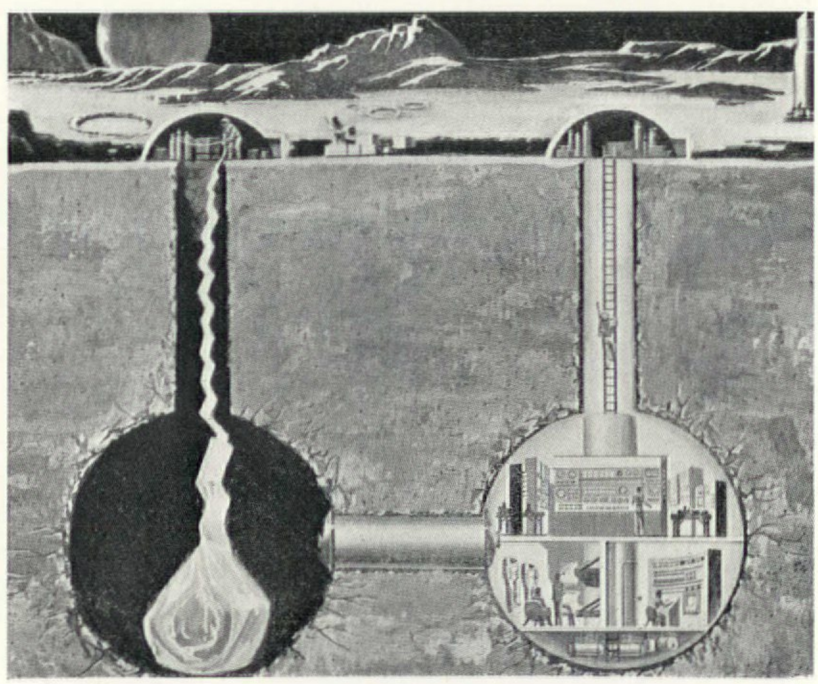

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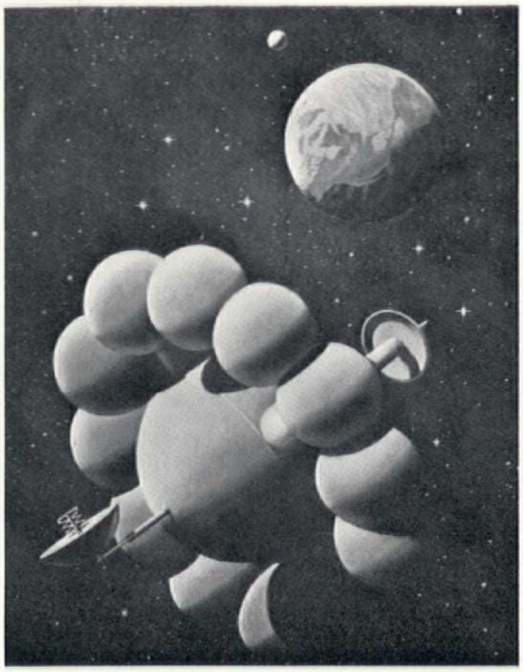
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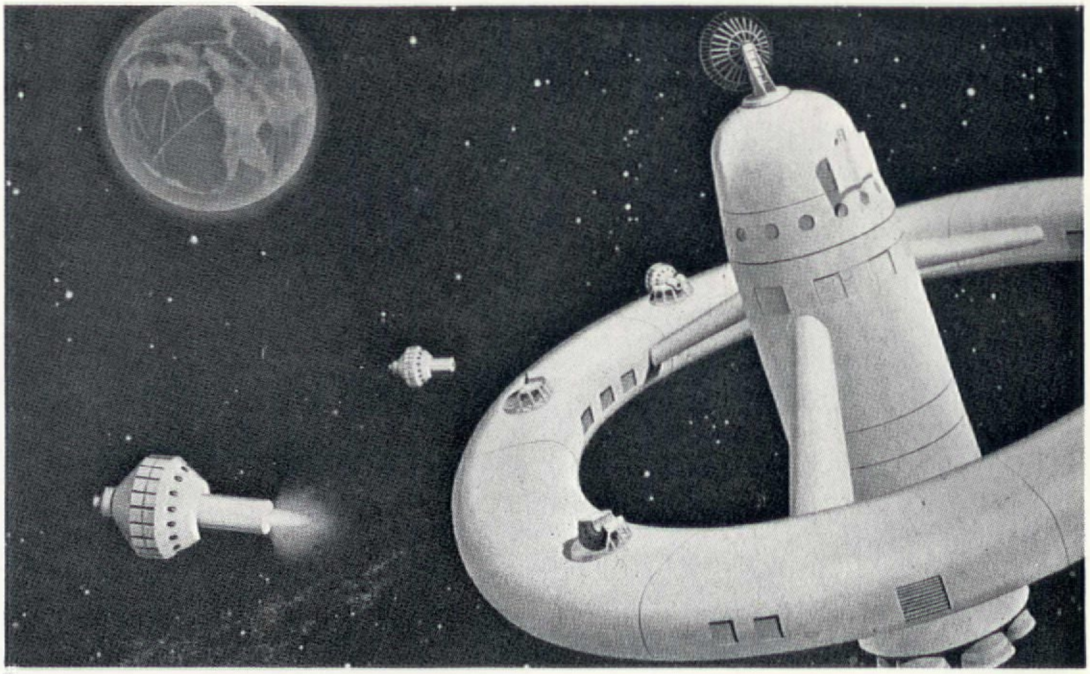
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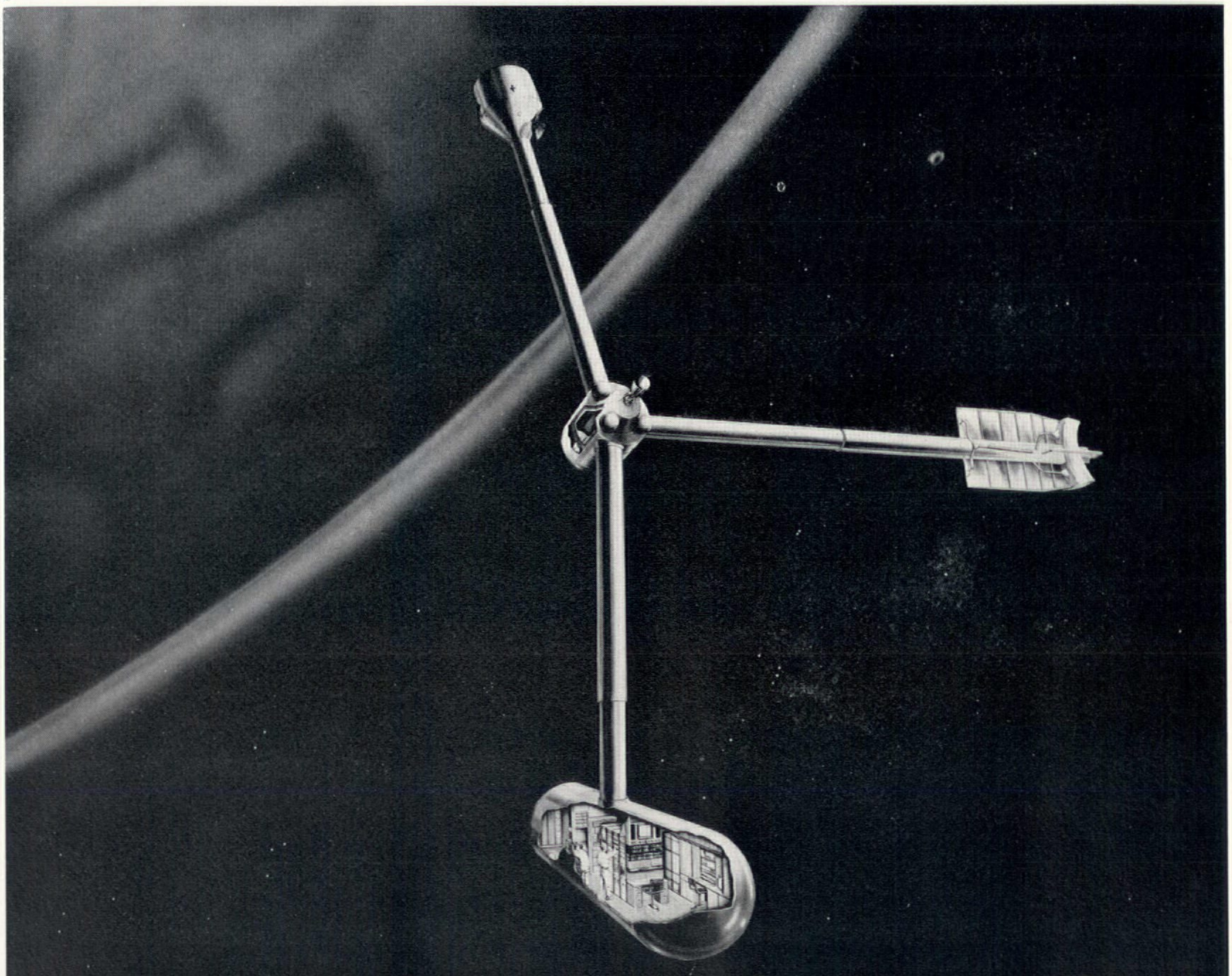
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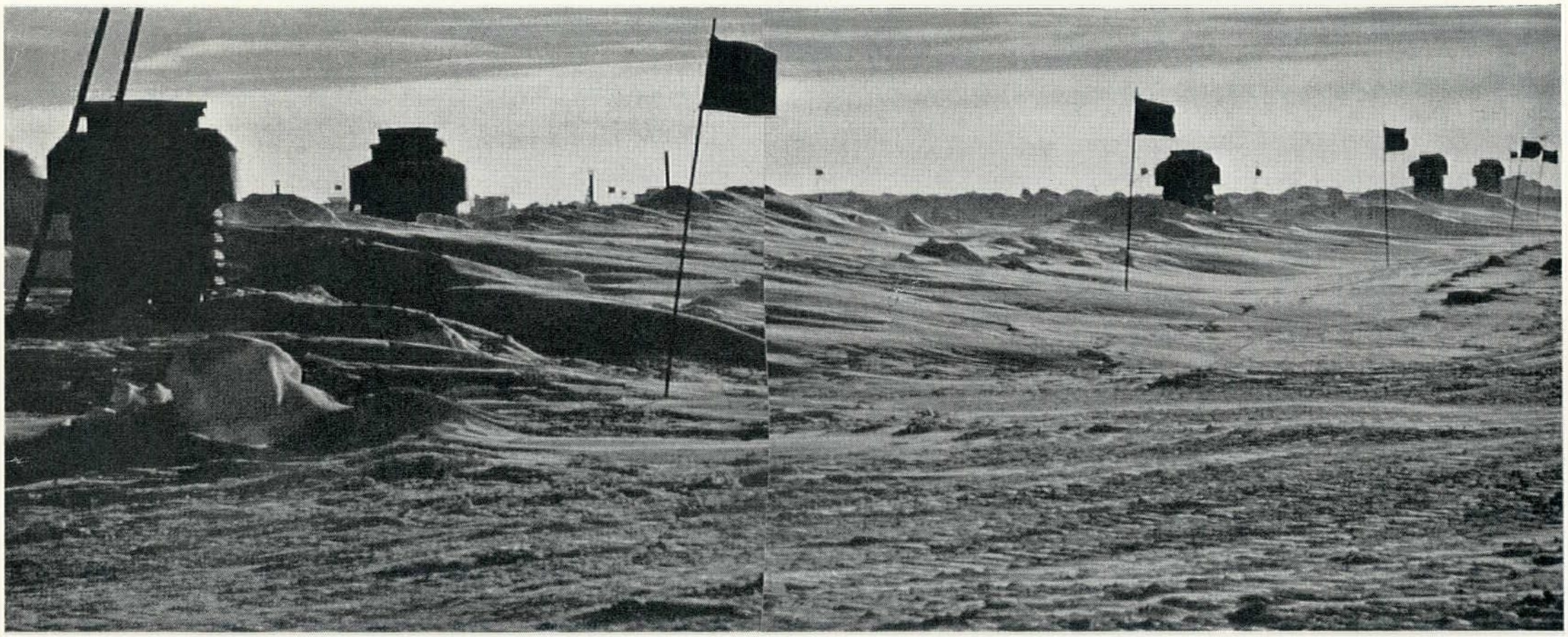

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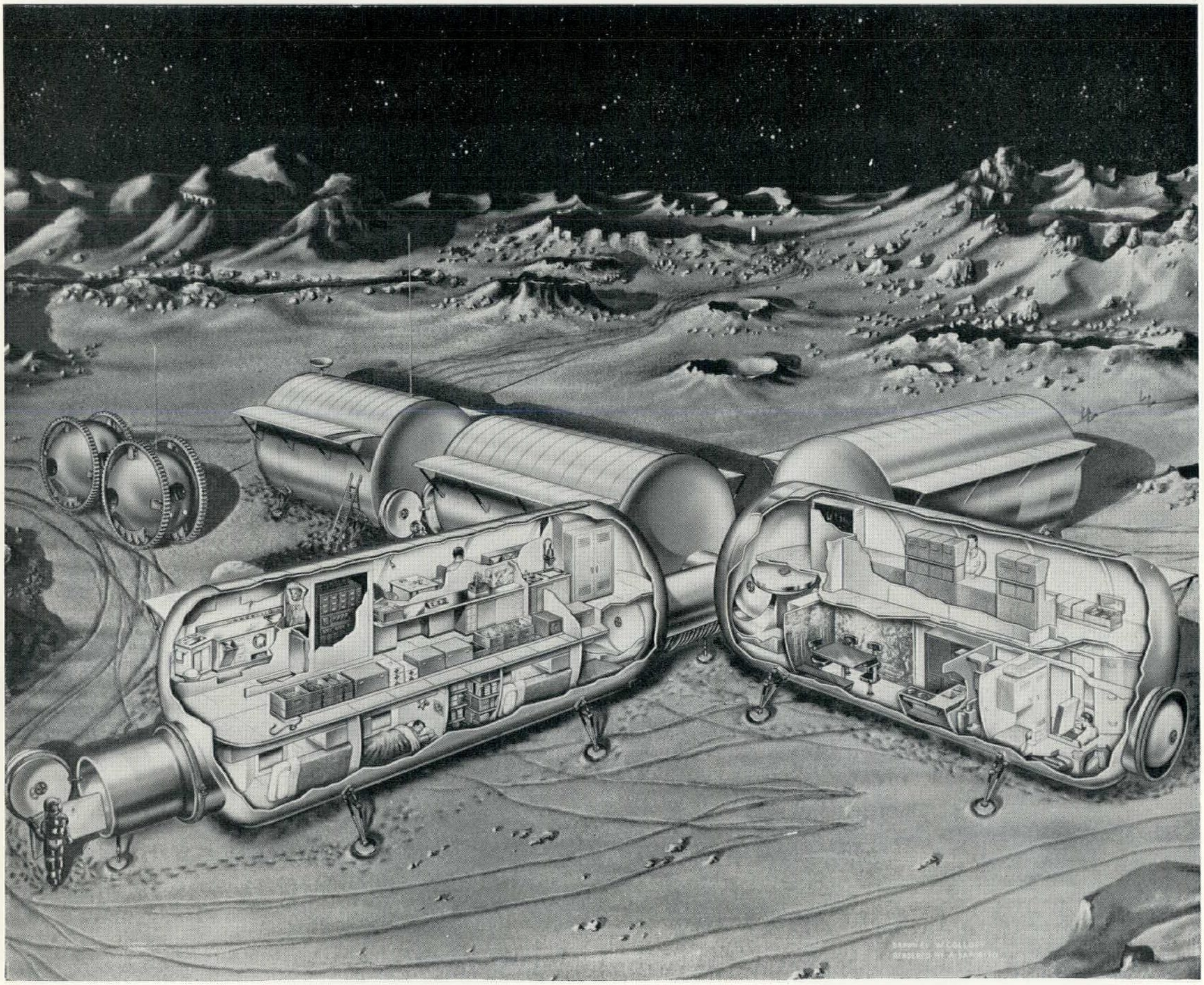


2

◁71

This macro-structure area, when compounded with lightweight/high strength advances in new alloys, metallo-plastic and other new composite materials, will soon begin to influence terrestrial structures. Micro-structuring is already an 'invisible' but enormously important 'spin off' from space research which may render obsolete many of the 'control' requirements of earth surface environment control. Presently visible mostly in the progressively smaller 'symbolic' gadgetry of the transistor radio, portable TV, etc., the development of micro-miniaturization is one of the most dramatic technical gains of the past two decades. About fifteen years ago packing densities of micro-electronic modules 75▷

1
Only flags and escape hatches mark the position of Camp century, 21 inhabited tunnels buried in Greenland's ice cap by the US Army Polar Research and Development Center to provide comfortable living and working quarters for 100 men. The tunnels were made by erecting plywood prefabs in trenches cut in the ice, protecting them with corrugated metal arches and back filling with snow. Power for heat and light is generated by a portable medium powered atomic reactor. Radioactive waste is returned to the USA

2
Design for a lunar base. Each cylinder, 20ft in diameter, is to be delivered to the moon as a completely assembled, pressurized unit with all equipment, provisions, stores and supplies installed and ready for operation. Each six-man shelter is self-sufficient except for power supply, to be obtained from a central nuclear power plant

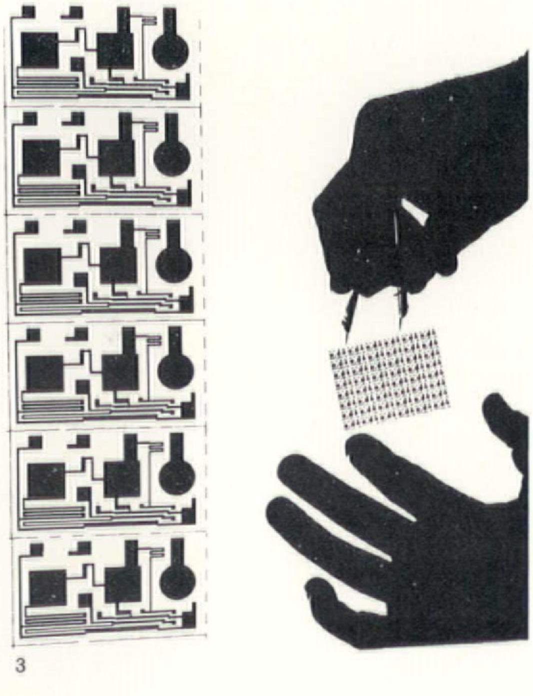
3
Micro-miniature components, printed wiring and advanced encapsulation techniques all combine to reduce complete circuits to fractions of their former size. The human brain may one day be simulated in a computer the size of a matchbox

4
Diagram of the Douglas Manned Space Cabin Simulator, built to apply the results of many analytical studies and development tests on closed lift-support systems for manned spacecraft

5
Three astronauts 'fly' a 72-hour Earth Orbital mission in the Manned Space Systems Simulator at San Diego, experiencing every condition man encounters in space except weightlessness

6
A pilot practising a rendezvous and docking with a Gemini capsule seen in the centre window of the Manned Space Systems Simulator at San Diego.

Photos and diagrams: 1, National Geographic Magazine; *2, Lockheed Missiles and Space Co.; 3, 5, 6, General Dynamics Corporation; 4, Douglas Missile and Space Systems Division*



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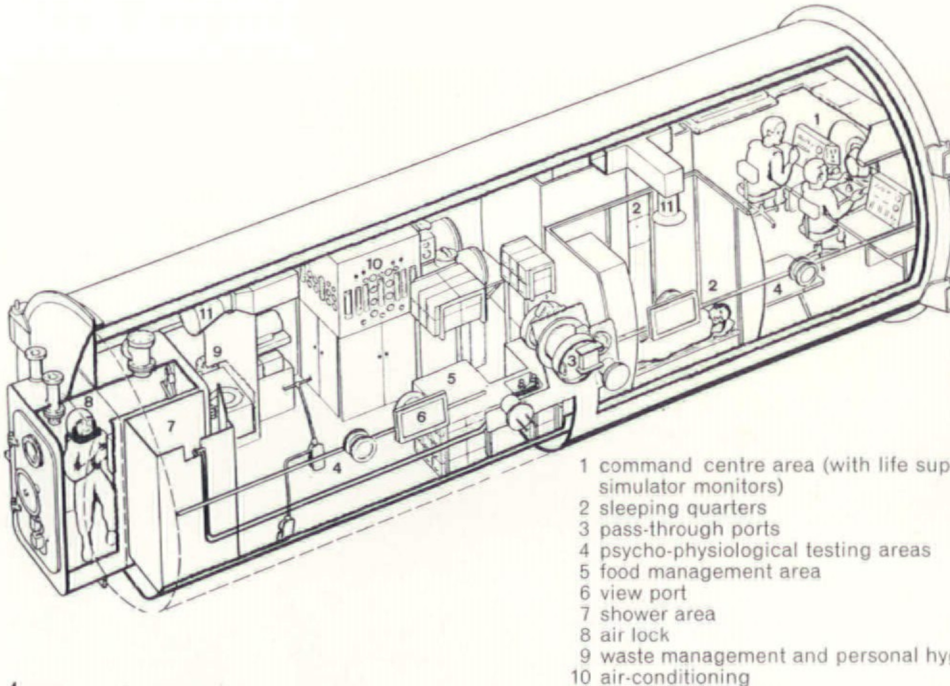
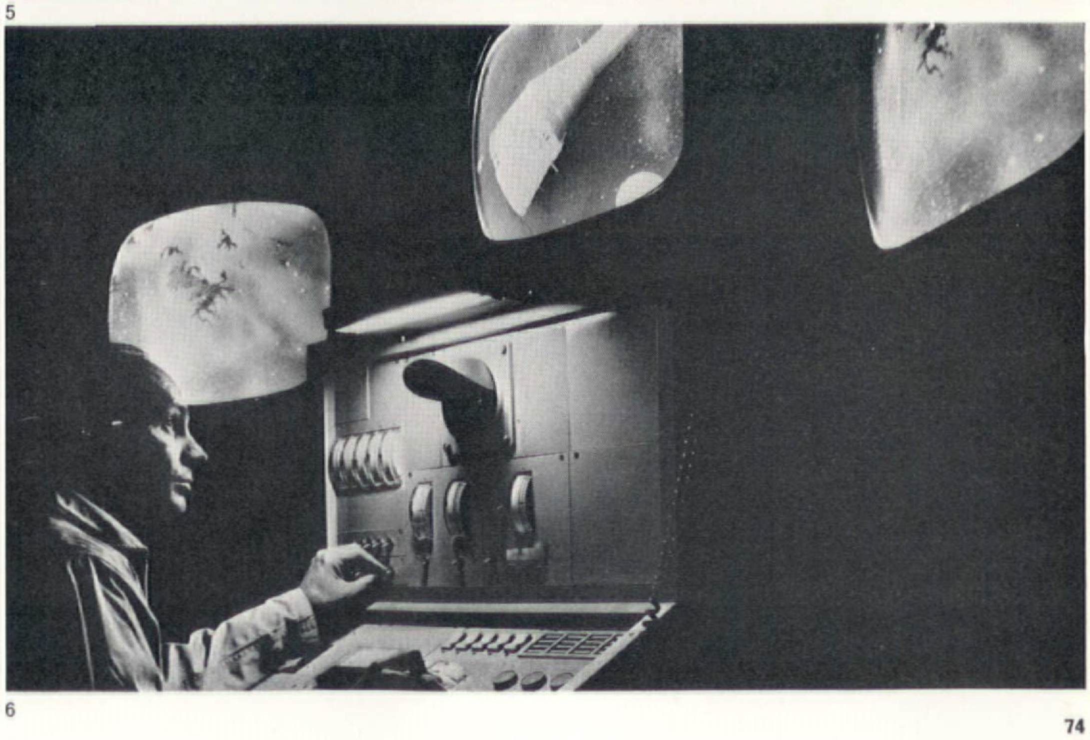


1 command centre area (with life support and flight simulator monitors)
2 sleeping quarters
3 pass-through ports
4 psycho-physiological testing areas
5 food management area
6 view port
7 shower area
8 air lock
9 waste management and personal hygiene area
10 air-conditioning
11 air distribution

4

5



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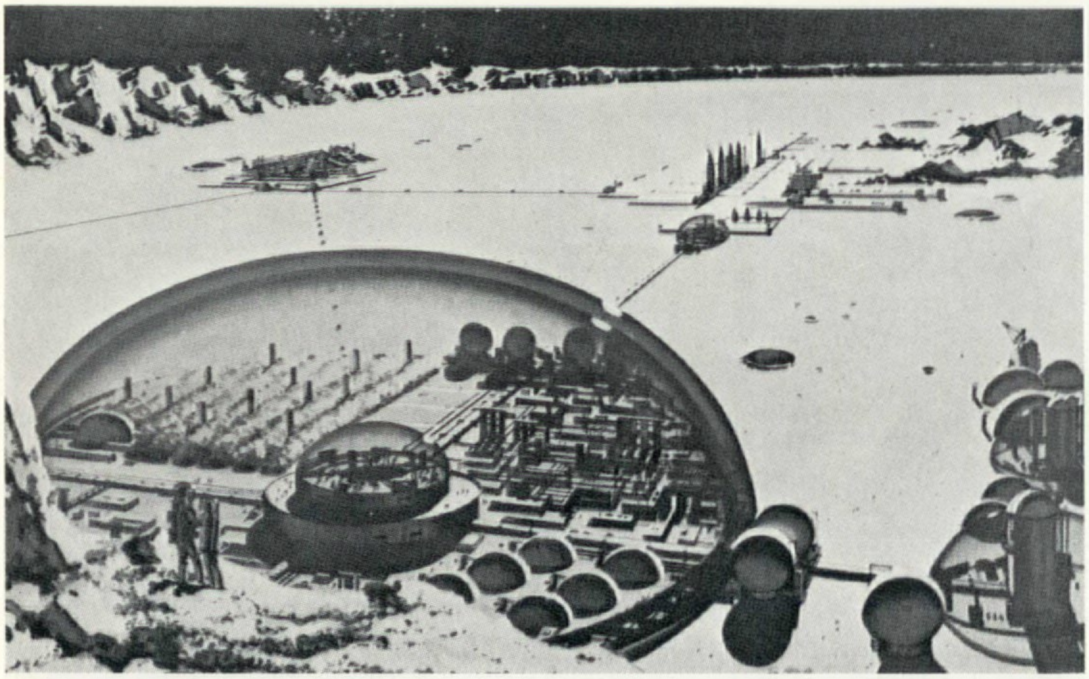

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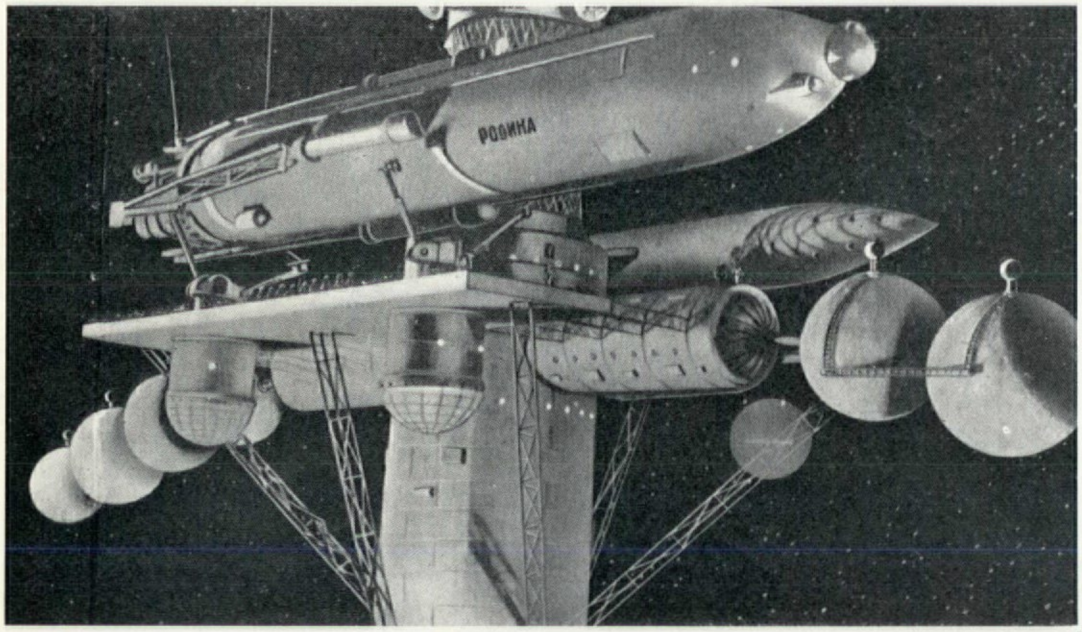

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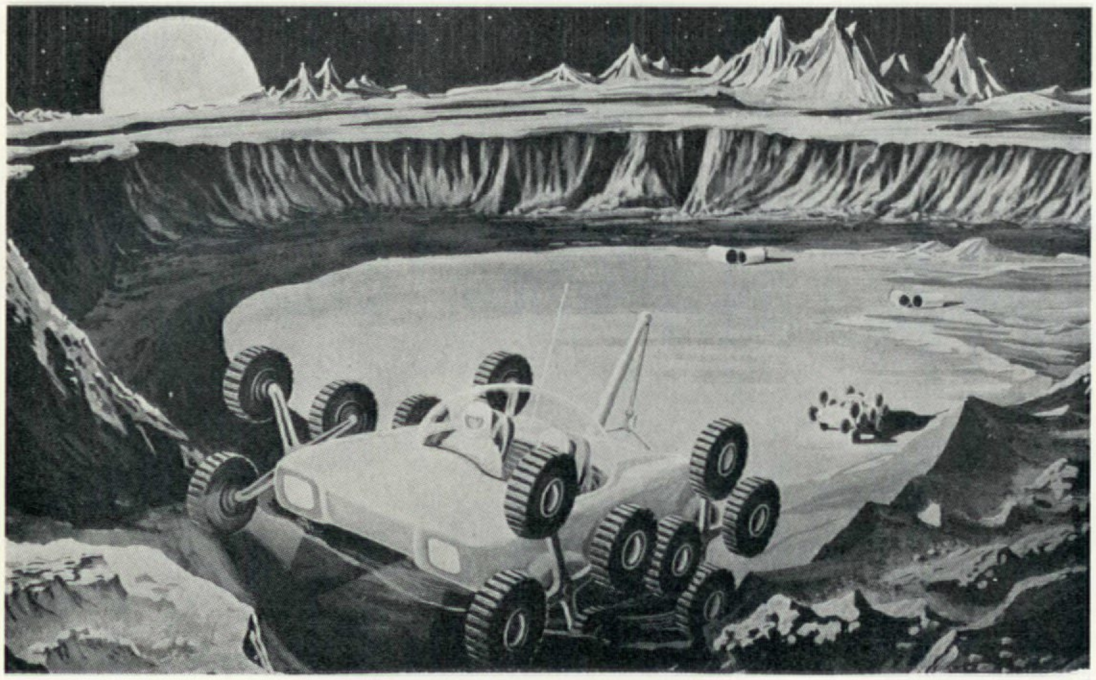
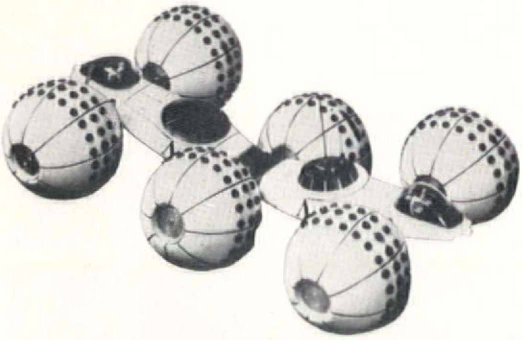


3

◁74

were around 10^6 parts per cubic ft, present off shelf components now run to 10^8 and 10^9 parts per cubic foot. At this scale, for example, more than 100 circuits comprising around 150 parts are packed in a silicon wafer an inch wide and less than 1/100th of an inch thick. If trends hold this capacity could reach 10^{15} per cubic foot within the next 30 years. The resulting electronic 'grown' components would begin to approach biological units with equivalent long life spans.
Apart from weight/volume gains, the development of such micro-miniaturization was as much driven by *reliability* requirement—an equally important conceptual parameter of space technology. In terrestrial environment control, reliability, like most other factors, is of an extremely low order. In the hostile environ of space, crucial part failure can be the literal end of the mission. Within the 'systems engineering' concept in space technology, reliability, with weight/volume/efficiency, etc., is a key concern. Apart from exhaustive testing and extremely high reliability standards, another operational aspect is the 'soft ware' design of anticipatory schedules for emergency procedures and their integration in elaborate 'back up' and self-repairing sub-units. Typically, in life support areas, units may be split in parallel 'half load' for normal conditions to assume full load in the event of either failing. Electro-mechanical modules are interchangeable allowing emergency repair piracy from one area to another. As far as possible, control/maintenance functions may be degraded successively on malfunction—from automatic to semi-automatic, to eventual manual operation of all vital units. The contrast with the design of terrestrial operations is acute, say in relation to the recent US power grid failures and the general lack of anticipatory design in our local environ control.
There are so many other technical advances currently available both in thinking and in actual hardware that any attempt even to mention them in this kind of essay would read like a catalogue. For example, new energy conversion and storage elements, communication devices, servo-mechanisms, etc. It may be more useful to a brief overview than to provide further detail.
The next stage in space, of specific import for architects will be the lunar base and manned space stations. Both the central concept of large-scale enclosure, life support and other requirements, are close to their traditional function. Current thinking on lunar base design goes in many directions, most of which will be explicit from accompanying illustrations in this section. Ancillary transport equipment designs vary from Buck Rogers type jet suits (already part operational for the recent Gemini/Agena docking programme), to balloon wheeled mobile laboratories, moon trains of various type, transport modules as mobile bases[5], flying platforms, etc. The moon race aspect brings in the Soviet work in space. So far, due to local accessibility of materials, the emphasis has been on US equipment and thinking. Though roughly parallel in technical development, there are certain interesting cultural differences in approach. The first obvious one would be that the Russians already have a woman cosmonaut[6]. The Americans have been rather silent on this aspect. A second difference may be the view of man as a component in the system. The Russians tend to emphasize even more rigorous training of human functions (extra-sensory perception, etc.) with less reliance on a tailored environment for the astronaut. This is a more rough and ready



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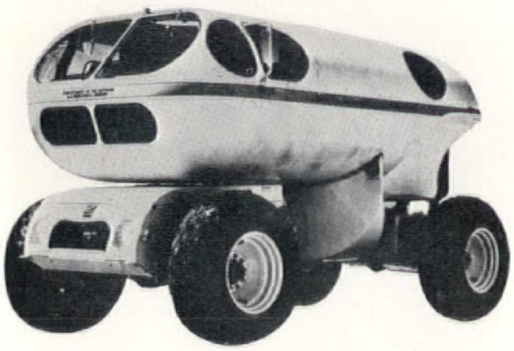

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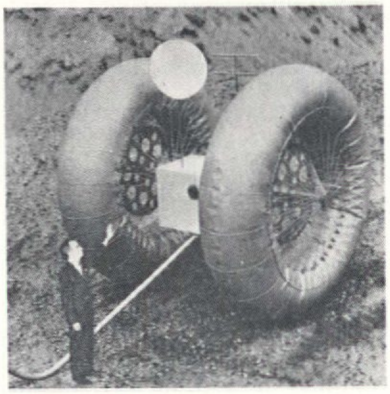

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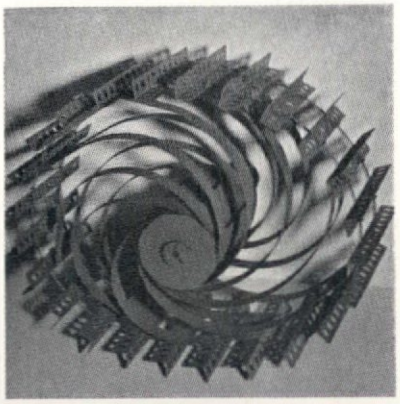

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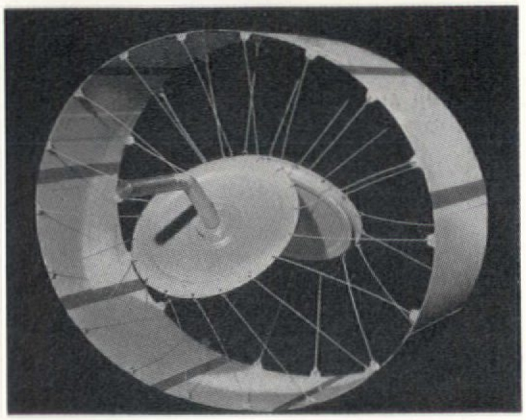


approach than the US emphasis on a 'shirt sleeve' cabin with its greater dependence on machine augmentation of human function. Other interesting divergencies may be found in the available translated material. Russian extrapolation of present technological development seems more literary and poetic in imagery. This may be a characteristic of translation. One paper, entitled 'A Trolley Bus Line in Space[7], describes a rocket rail system for interplanetary travel, using an 'ion drive' engine, which runs between solar electrical station 'guidelines' furnishing additional drive energy and guidance. Others often refer to Yefremov's novel, *Andromeda Nebula* and various science fiction works in discussion of travel to other galaxies[8]. 77▷

[5] Similar to the Wanigan mobile bases in use in the Arctic. These are long trains of snow wagons, in some cases two storeys high, accommodating a small 'village' of technicians, who travel from fixed base to base.

[6] *The female organism is more stable, compared to that of man, to the influence of a number of unfavourable conditions. This is the result of physiological traits of woman connected with her intended by nature functions of motherhood. Thus the female organism more easily endures deficiency of oxygen and unfavourable conditions of environment. But, at the same time, the nervous system of the female organism is more excitable, more strongly reacts to an unusual situation.*
Y. N. Sushkov, *Flights into Space*, Nauchno-Populyarnaya Biblioteka, Moskva, 1963. (Edited Machine translation FTD-MT-64-227 US Department of Commerce 1964.)

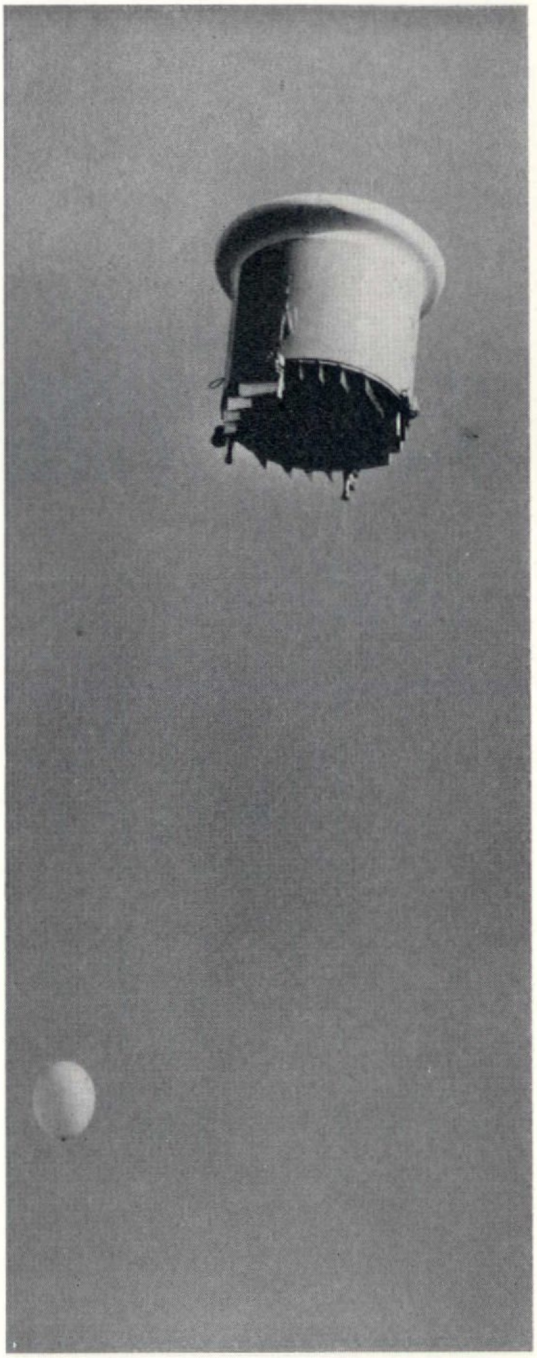
[7] V. Tobolev, *Trolley bus line in space*, Znaniye-Sila' November 2, 1964.

[8] K. P. Stanyokovich and V. A. Bronshten, *Interstellar Flights*, Kosmos, November 1, 1963.

As ideas are projected for our expanding activities in space and on the planets (such as **1**, a moon colony under a dome similar to Buckminster Fuller's Manhattan proposal, and **2**, a Russian service station for spacecraft), other inventions will also help make new patterns of our Earth-based existence. Today's roads 'might well last for generations without any further maintenance, if they had to carry only air-supported vehicles . . . there will clearly be enormous savings in road costs—amounting to billions a year—once we have abolished the wheel' (Arthur C. Clarke). In this context some of the vehicles designed for use on the moon, with their huge wheels seem an anacronism **6, 7, 8.** Lunar Jeep III **3** which has four earth-size wheels mounted about one axis at each corner has been 'out-visioned' by General Motors' articulated crawler **4.** Doing preliminary trials in the volcanic fields of southern California the 8-ton study lab **5,** is testing instruments of the type to be used in space ships bound for the moon.
The ducted fan vehicle **9,** a motorized observation balloon, carries a wide range of sensors including television and can relay information from positions inaccessible to humans; and Ground Effect Machines (hovercraf) **10, 11,** have effectively overcome most of the restrictions of surface travel. Unless some form of legislation is imposed on them GEMs are likely to cause more havoc than the automobile

When gravity can be controlled, our very homes may take to the air. Houses would no longer be rooted in a single spot; they would be far more mobile then today's trailers, free to move across land and sea, from continent to continent. And from climate to climate, for they would follow the sun with the changing seasons, or head into the mountains for the winter sports
The first men were nomads; so may be the last, on an infinitely more advanced technical level. The completely mobile home would require, quite apart from its presently unattainable propulsion system, power, communication and other services equally beyond today's technology. But not, as we shall see, beyond tomorrow's
Arthur C. Clarke *Profiles of the future*

Photos: 1 & 3, D. M. Cole, Beyond Tomorrow; *2 & 6,* UNESCO Courier, *May 1966; 4 & 5 General Motors Ltd.; 7 & 8, Grumman Aircraft Engineering Corporation; 9, General Dynamics Inc.; 10 & 11, Bell Aerosystems Co. 12-ton military Sk-9 and PACV (Patrol Air Cushion Vehicle) operated by the US Navy in South Vietnam*



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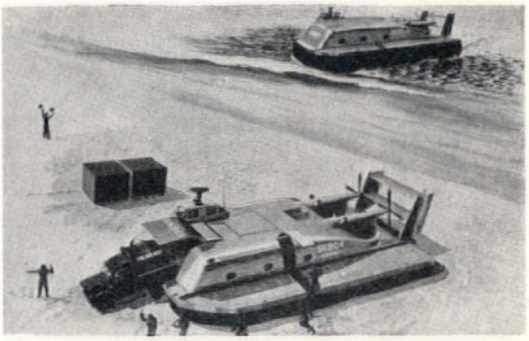

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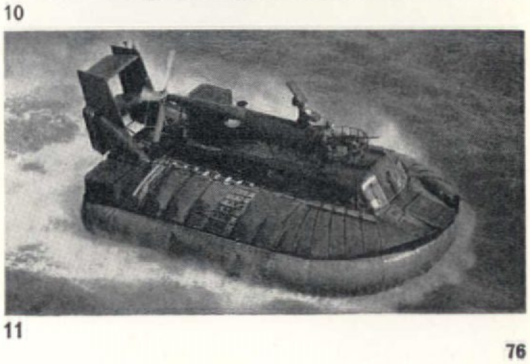

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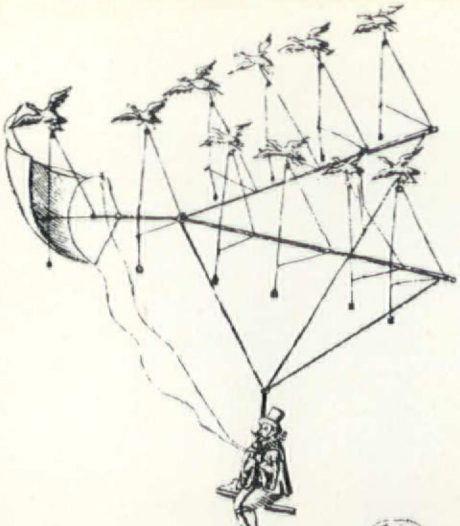

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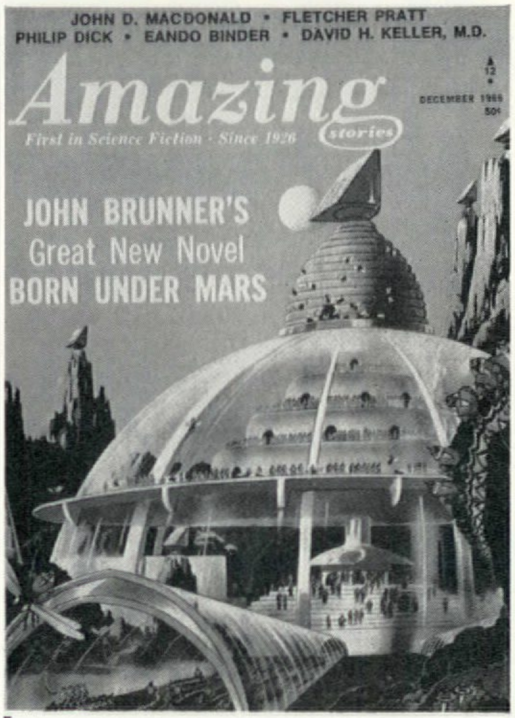

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◁76

The relation of science fiction to science fact is a fascinating one and reflects back on our earlier note about the function of the 'image' of technology on 'change conditioning'. Much of what is now ponderously termed futures extrapolation and conducted in various learned institutions was brilliantly pioneered by fiction writer/scientists, like Arthur C. Clarke in *Profiles of the future* —and countless others from Verne and Wells down through Van Vogt, Heinlein, Bester, Azinmov, etc. A recent example of such work is worth commenting on as it deals, like Clarke, in extrapolation based on close technical knowledge. D. M. Cole, author of *Beyond Tomorrow*, who died recently, was a senior space scientist at US General Electric's Space Technology Center. His lavishly illustrated volume explores far beyond the development of hardware to that of artificial intelligence modes of immortality, new life-styles. He gives a detailed exposition of the evolution of man into a macro-life society based on the terra-forming of meteoroids and other planetary bodies and developing new forms of macro-ecological relations which enable large, 10,000 people colonies to cruise space in their own self-powered, closed cycle worlds.

1
The adventurous space traveller, described by Francis Godwin in *The man in the moone* (1638), as encountered and seen by Cyrano de Bergerac in *Voyages dans les empires de la lune et du soleil* (1650)

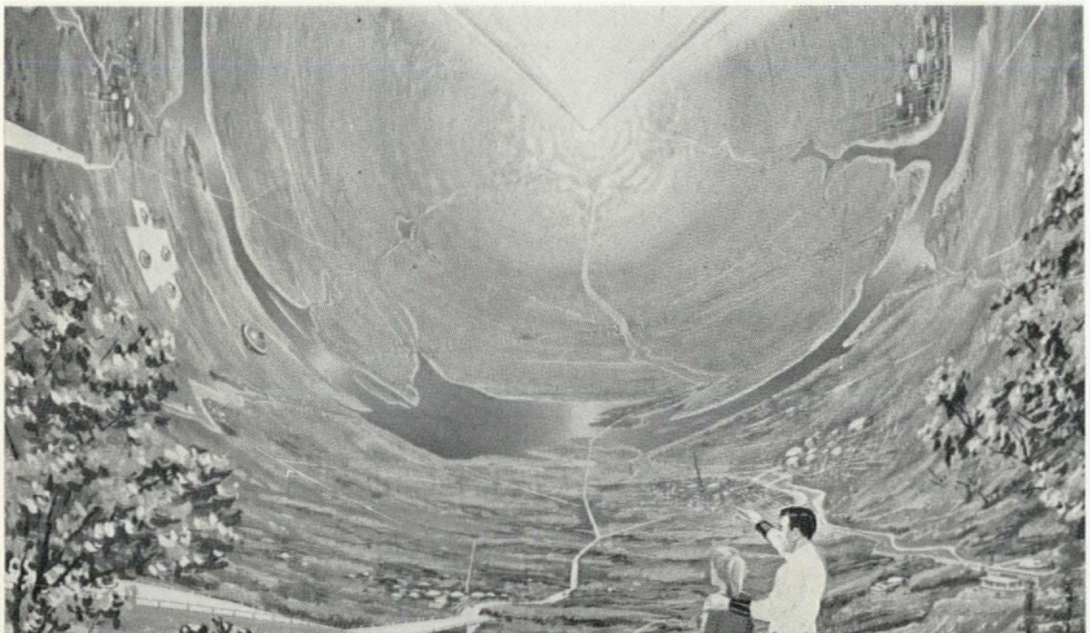
2
Astronauts in Jules Verne's *Autour de la Lune* (1865) floating, weightless in their capsule, fired into space from a 900 ft cannon embedded in the earth

3
Venusian, nineteenth-century fantasy

4
Space traveller, nineteenth-century fantasy

5
Amazing cover

6



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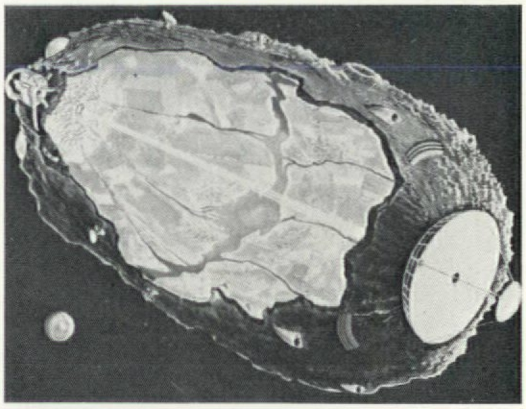
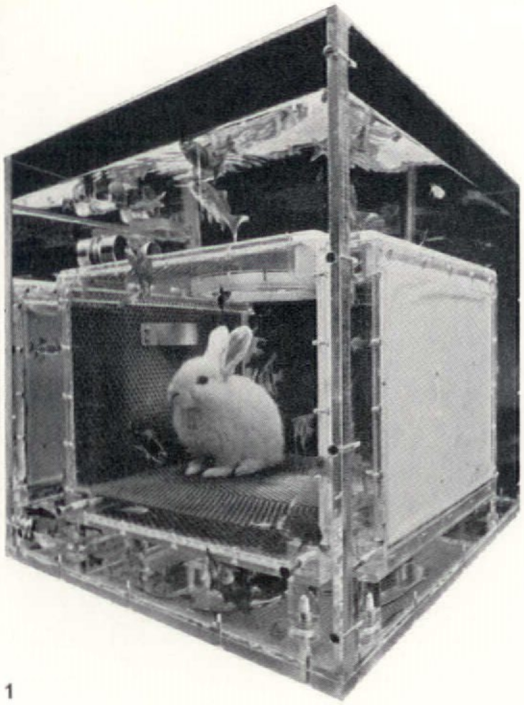


6 & 7
Vision of a 'new home among the stars', for 10,000 to one million people in a hollow asteroid, 20 miles long, 10 miles in diameter. Lighted and kept warm by sunlight reflected down its axis, all life could continue to flourish here even if the Earth itself ceased to exist. Spinning of the asteroid would produce artificial gravity. Artificial light would be produced by nuclear fuel, so that the asteroid could cruise through space far from the sun itself

D. M. Cole Beyond Tomorrow: the next fifty years in space, *Amherst Press, Wisconsin, 1965, drawings by R. G. Scarfo*

'No: the population battle must be fought and won here on Earth, and the longer we postpone the inevitable conflict the more horrifying the weapons that will be needed for victory—compulsory abortion and infanticide and anti-heterosexual legislation (with its reverse) may be some of the milder expedients.'
A. C. Clarke Profiles of the future, *London* 1962

Inner Space



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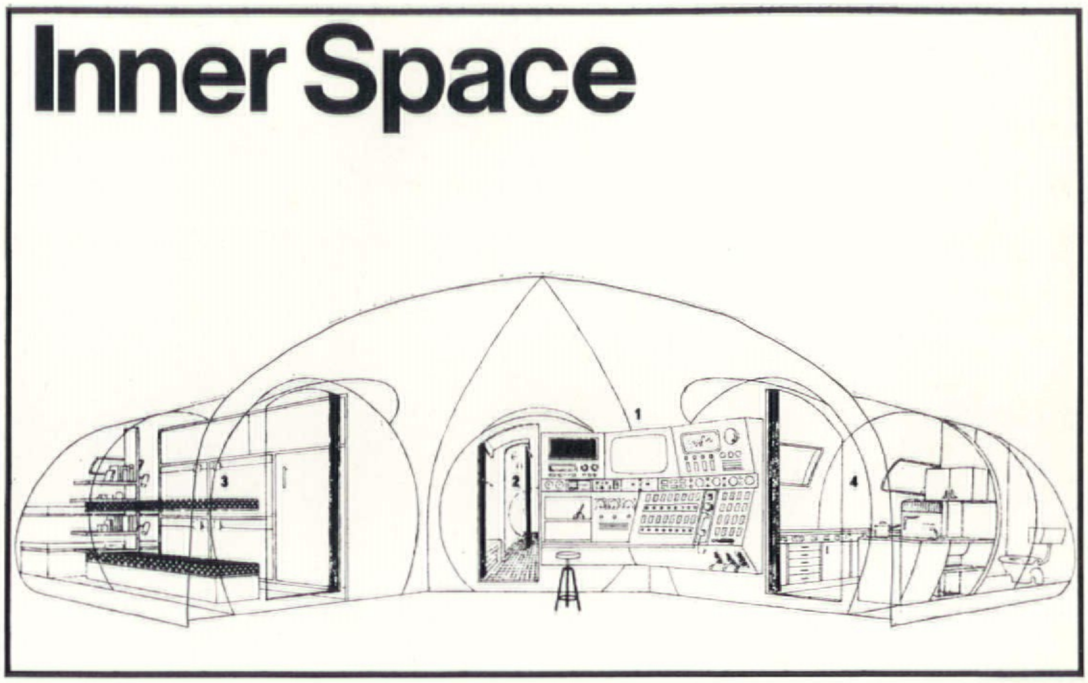


2

Whilst neither so heavily funded, nor so dramatically in evidence as outer space developments, under-ocean research may have even greater impact on our immediate manner of living.

The oceans cover more than 70 per cent of our planetary surface. In terms of space, resources and exploratory challenge, it is rather like having another world at our disposal. The comparatively shallow continental shelves *alone* afford a work/research/recreation area three times the size of the US—about half the area of the earth lowlands where most of humanity lives. More pertinent is the fact that four-fifths of the planet's animal life and the bulk of its vegetation are underwater—yet comparatively little of these are at present used as food.

The ocean is the ultimate repository of everything eroded from the continents. Over 40,000 million tons of materials are washed into the oceans every year by rivers. The winds also transport many millions of tons of materials per year[1].

Our knowledge of the oceans is rudimentary. As man's locally most 'hostile' environ for centuries, only the surface was travelled upon and its depths not investigated till recently. Barely one per cent of all sea organisms have been studied and the cyclic migrations of its larger creatures have been little charted.

As with outer space, much of the present impetus to explore the oceans is largely of tactical/military origin, e.g. the nuclear powered submarine as missile launch platform. But already the vast economic potential and obvious scientific interests have encouraged the general area of research and development. Official interest in the ocean may have just begun in time to prevent further spoilage, particularly of the coastal shelves. Old sea minefields still render parts of the latter unsafe and will do so for some time to come; indiscriminate sewage and industrial wastes have ruined other areas. Overfishing has led, not only to greatly reduced catches, but to the near extinction of certain species like the great sperm whale. A new hazard is the disposal of radio-active wastes in the sea.

The design criteria of undersea vehicles and environ control structures are, in some aspects, the reverse of those for outer space exploration. In building to withstand very great outside pressures, there is less configurational freedom in external hull design; also, hull weight varies sharply according to operating depth. Propulsion speeds are slow, drag and resistance are to be overcome, and there are special prolems of surface coating in conditions of chemical erosion, microbial growths, etc. At greater depths no external work may be carried out by human operators and remotely controlled manipulators are required. Vehicle speed, relative to energy source, gives certain limits. For example, to double a submerged vehicle's speed requires roughly eight times more propulsion power. Communications problems are, again, different from those in space flight.

The most singular differences in the two areas would be in travel speeds—and that the maximum ocean depth penetration has already been made relatively early in its exploration. The bottom of the deepest ocean trench known, the Challenger Deep, 35,800ft, was reached by the bathyscaphe Trieste in 1960.

Apart from scuba equipment used in shallow waters, or heavy diving-suit gear limited to about 200 feet, present commercial undersea vehicles are two to five men units having a top speed of about four knots with working depths up to a few thousand feet. Some of these are equipped with external remote manipulators for specimen collection. In development are larger, more manoeuvrable, longer range vehicles. Separation of the manipulatory system from the manned vehicle is also being pursued. The latter, called *telechiric* systems are essentially a family of general purpose work robots. Equipped with arms, sonar and television, these machines are an extension of their human operator who may be in, under, or on the sea.

Though many of the undersea craft illustrated are for variable depth use, the most immediately significant area for the establishment of work environment controls are the continental shelves—averaging between 600 and 800 feet depths. These comprise about 10 per cent of the total sea floor area only, but are estimated to contain half of the ocean's important biological population and many of its mineral deposits and will, therefore, be the first area to be fully exploited.

The pioneer in undersea living and working is, of course, Jacques-Yves Cousteau who set up the first manned undersea work station in 1962 off Marseilles. In Conshelf One, as it was called, two men remain submerged for a week at 33ft depth and worked outside daily for five hours at depths up to 85ft. Conshelf Two, 'the first human colony on the sea floor', as Cousteau has called it, was 36ft down in the Red Sea and housed five men for a month, including a two man work-camp at greater depth. Both Conshelf One and Two were cylindrical and domical structures tethered by umbilical communication cables, supply pipes, etc., to surface and shore stations. Conshelf Three, a spherical structure weighing 140 tons, was established at 328ft off Cap Ferrat, housing six men for thirty days. During this time, the oceanauts breathed a helium/oxygen mixture inside the base, and conducted heavy duty work for up to seven hours per day outside.

An unusual first time communication link was made when Conshelf Three's crew spoke by telephone to the crew of the US Navy's similar experimental station, Sealab II—205ft down off the coast of LaJolla, California.

Both these deep submergence projects demonstrate the practicality of opening up the whole continental shelf area in particular to research, mining, sea-farming, exploration and recreation in the near future. In effect, this new continent could become habitable within the next decade.

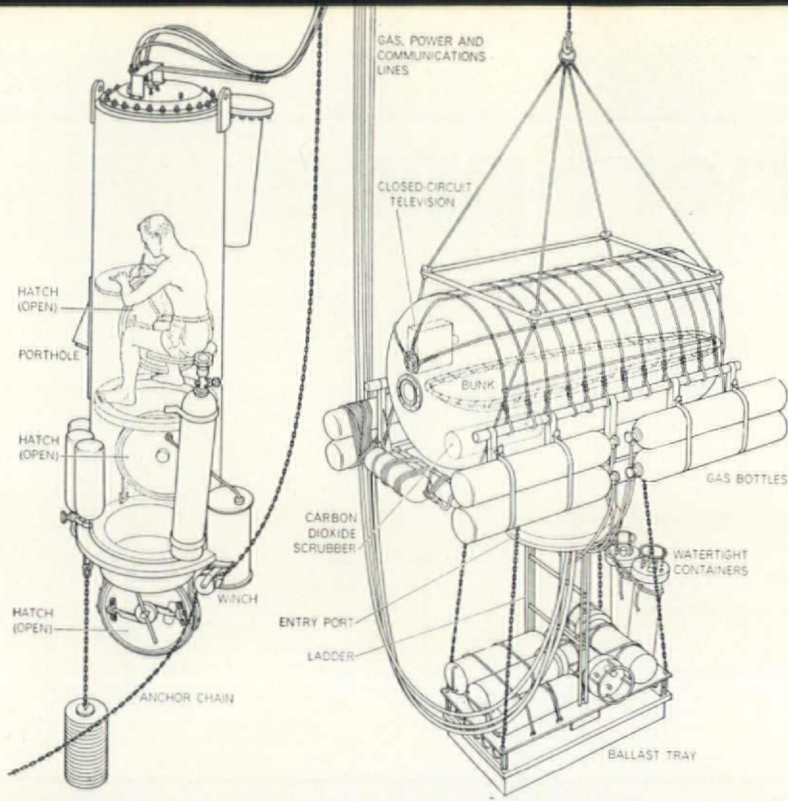
For our basic requirement of recycling vital resources, the oceans provide much more frequent ecological recyling than the land area. Fish and other organic populations have higher growth rates, vegetation has less capricious weather problems for sea harvesting. In terms of mineral resources, Mero, referring to the nodules of very high ore content accumulating on the Pacific floor, suggests that, '. . . as these nodules are being mined, the minerals industry would be faced with the very interesting situation of working a deposit that grows faster than it could be mined or consumed'.

[1]John L. Mero, 'Mineral Wealth from the Ocean Deeps', *Discovery*, July 1964.

1
Since seawater is essentially saturated with air to a depth of many thousands of feet, man may soon be able to breathe as naturally underwater as fish, using the same type of artificial 'gill' that forms the four sides of this rabbit's submerged pen. The 'gill' is an ultra-thin membrane of silicone rubber which admits air from the surrounding water and allows the carbon dioxide from breathing to escape

2
Diagram of Cousteau's Conshelf Two starfish house built for use under the Red Sea

1 Photo News Bureau, General Electric Company, USA



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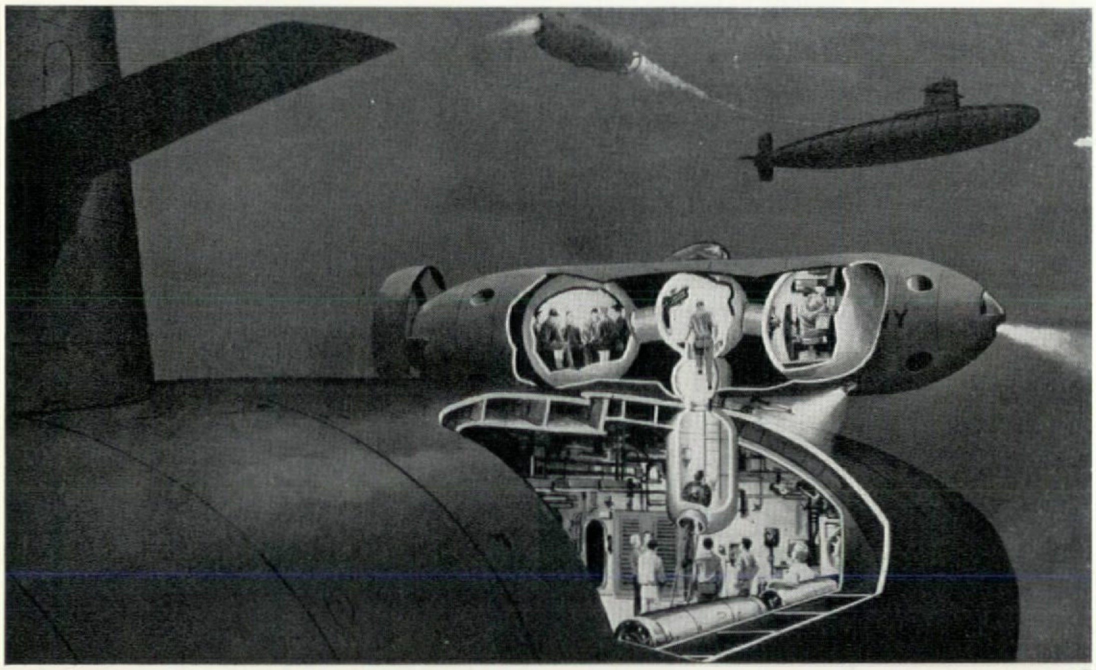
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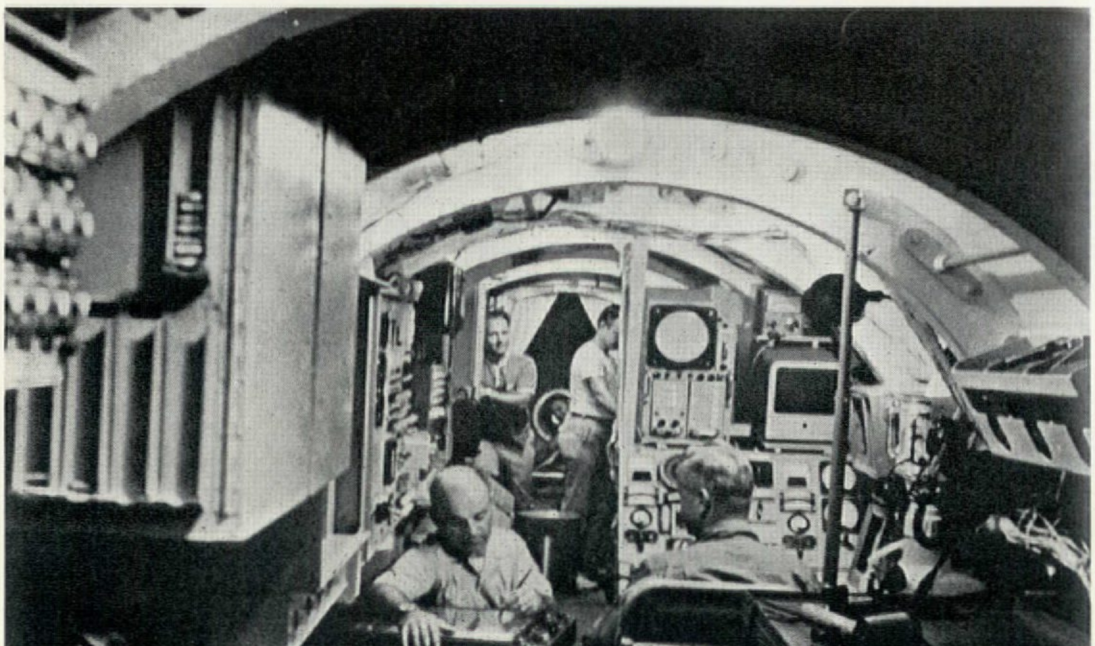

4

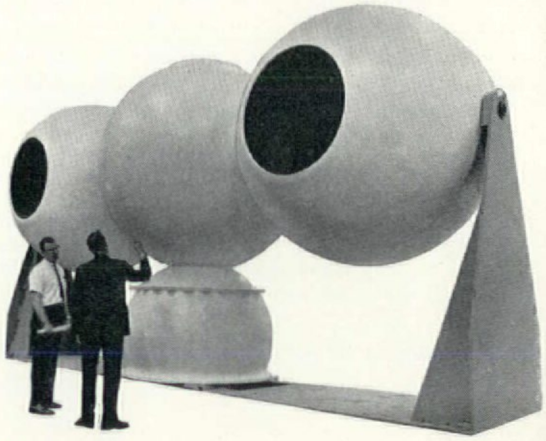
Inner space hardware

If the objective is to maintain human life under the sea with the same freedom of movement as it enjoys on land, the difficulty is not the greatly increased pressure (mice can tolerate pressures equivalent to 4000 feet below), but the control of the gas mixture they must breath. To overcome the anaesthetic effect of nitrogen at depths greater than 100 feet, helium is substituted as the oxygen dilutant. This has disadvantages; it accelerates the loss of body heat, making diving suits more complicated in construction, and it distorts speech into Donald Duck cackle. High-pressure helium has an adverse effect on equipment and machinery also. It cost the Conshelf Three project $250 a day to replace failed television tubes.

The return to the surface from deep-sea living must be slow to avoid the 'bends'. If aquanauts surface inside a decompression chamber this process can be carried out comfortably and conveniently on land or the deck of a ship. The Man in Sea project **1**, rationalized the situation by having a pressure-resistant chamber for descent and surfacing in conjunction with a submerged dwelling called SPID, made only of rubber and a steel frame, which was inflated until internal pressure equalled that of the sea. Equal pressure also enables free access in and out.

Other deep diving vehicles in which normal atmospheric conditions prevail **11, 12, 13,** must be much larger and heavier (Trieste's sphere has a steel wall five inches thick), and their capacacity to work under water is limited to the dexterity of their telechiric limbs.

Another approach to this problem is suggested by the experiment with a rabbit shown on p. 78. A man with gills made of polymer membrane could unhook his jugular vein, re-route the blood through the gill, thus by-passing the lungs, which would be filled with liquid to withstand the ocean's pressure. The membrane system has the virtue of allowing man to live and work underneath the sea on equal footing with the fish and returning to land without the danger of the dreaded bends.


3

1
Edwin A. Link's Man in Sea project, 432ft for two days. Left, aluminium decompression chamber; right, 8ft × 4ft inflatable rubber dwelling

2 & 3
US Navy rescue submarine: design proposal and prototype pressure spheres. It takes 24 men at a time from a distressed craft

4
Interior of Reynolds Aluminaut (see p. 82–84)

5
CJB-Divcon submersible chamber to be hired out complete with operating personnel for salvage, mineral prospecting etc., down to 600ft

6
US Navy Sealab II—28 men for 30 days at 205ft

7 & 8
J. Y. Cousteau's Conshelf Two project—five men living for one month at 33ft. Left, diving saucer and its 'garage'; right, 'star' house

9 & 10
Conshelf Three—6 men for 22 days at 328ft

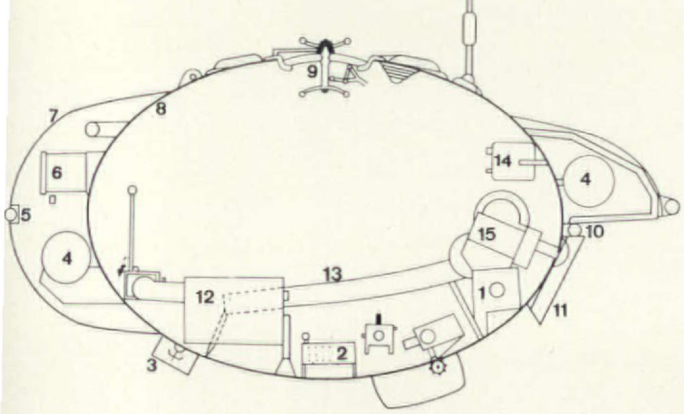
Photos: 1 & 6 Scientific American, *March 1966; 2 & 3 Lockheed Missiles and Space Co.; 4 Reynolds Submarine Services Corp.; 5 United Steel Co. Ltd.; 7 & 8* Sunday Times, *July; 1963; 9 & 10* National Geographic Magazine, *April 1966*

Undersea Research Vehicles in Operation or Under Construction (October 1965)—Interagency Committee on Oceanography

Name of Vehicle	Owner/Operator	Operating Depth (feet)	Propulsion					Dimensions (feet)			Weight		Crew	Life Support Endurance (hours)	
			Speed (knots) Cruise	Speed (knots) Max	Propulsion Endurance	No. of Prop. Units	Energy Source	Length (loa)	Beam	Height	Dry	Disp Submerged		Normal	Maxim
ALUMINAUT 17	Reynolds International, Inc./Reynolds Submarine Services Corp. (1965)	15,000*	3	3·8	32 hr at 3 kt	2-5 hp horiz (tailplane) 1-5 hp vert (amidships)	4-77 cell 32,500 amp-hr silver zinc (internal)	51	8	14·25	73·2 T	81·1 T	4-6	32	72
ALVIN I 18	Office of Naval Research, Woods Hole Oceanographic Institution (1965)	6000	2·5	4	8 hr at 2 kt	2-5 hp hydraulic motors powered by pumps driven by 2 oil-encased elec motors	3-external oil-encased lead-acid pressure comp	22	8	13	13 T	—	2	10	24
AMERICAN SUBMARINE MODEL 300 19	American Submarine Co. (1961)	300	1	6	3 hr at 3 kt	1-3 hp, 12 to 24 v	4-6 v lead-acid	13	4·2	4·75	2200 lb	—	2	8	8
AMERICAN SUBMARINE MODEL 600	American Submarine Co. (1963)	600	1	6	6 hr at 3 kt	1-3·5 hp oil-immersed	4-6 v nickel-cadmium	13	5·5	5·2	3500 lb	—	2	8	16
ARCHIMÈDE	French Navy (1961)	36,000	1	2	12 hr at 1 kt	1-20 hp 110 v (horiz), 1-5 hp (vert), 1-6 hp (direction control)	2-110 v, 860 amp-hr oil-encased alkaline battery (outside pressure hull)	69	13	26·5	61 T (less ballast & hexane)	195·9 T	3	12	32
AUGUSTE PICCARD 20	Swiss National Exposition Corp. (1964)	2500*	1-2	6	8 hr at 6 kt	1-80 hp	2-2000 amp/hr, 110 v lead-acid batteries	93·5	19·7	24	164·37 T	218·5 T	40 Passengers	8	48 (with pa
BENTHOS V	Lear Siegler, Inc. (1963)	600*	1	3	2 hr at 2 kt	2-1 hp 24 v	3-120 amp-hr, nickel-cadmium (internal)	11·3	6·1	6	4200 lb	—	2	8	16
CUBMARINE PC3A 21	Perry Submarine Builders, Inc., Ocean Systems, Inc. (1965)	300	2·5	4	8 hr at 2 kt 3 hr at 3·5 kt	1-7 hp 36 v	6-6 v 210 amp-hr lead acid	19	3·5	6	4790 lb	6580	2	12	20
CUBMARINE PC3B	Perry Submarine Builders, Inc., Ocean Systems, Inc. (1964)	600	2·5	4	2 hr at 3·5 kt 6 hr at 2 kt	1-7 hp, 60 v/120 v	50-1·5 v, 250 amp-hr silver zinc	22	3·5	6	6350 lb	7750	2	12	20
CUBMARINE PLC 4	Perry Submarine Builders, Inc., Ocean Systems, Inc. (under construction)	1500*	2	4	8 hr at 2 kt	1-7·5 hp; 2-2 hp for hovering and manoeuvring	Silver zinc batteries	24	4·5	8·7	8 T	8·8 T	2 (plus 2 divers)	5 at 1000 feet of depth	36
DEEP JEEP 22	Naval Ordnance Test Station, China Lake, Calif. (1964)	2000	2	2	4–6 hr at 2 kt	2-7·5 hp, 24 v (variable) oil-immersed	8-6900 watt-hr lead acid	10	8·5	8	8000 lb	—	2	6	48
DEEP QUEST	Lockheed Aircraft Corp., Lockheed Missiles and Space Co. (under construction)	6000*	4·5	—	24 hr at 2 kt	2-7·5 hp AC main propulsion, 2-7·5 hp AC vertical thrusters	Lead acid batteries (main) Silver zinc (emergency)	39·10	19	13·3	56 short tons	53·7 short tons	2 Operators 2 Scientist/Observers	24	48
DEEPSTAR 2000	Westinghouse Electric Corp. (under construction)	2000*	2	4	8 hr at 2 kt	Single propeller provides main thrust. Two water jets provide auxiliary thrust for controlling and manoeuvrability	Lead acid batteries	14	7	5	8000 lb dry	—	2	8	48
DEEPSTAR 4000 23	Westinghouse Electric Corp.	4000*	1	3	6 hr at 3 kt 12 hr at 1 kt	2-4·5 hp/AC free-flooded	3-lead acid 400 amp-hr in 62-2 v cells (inverter)	18	10	7	19,000 lb	—	3	12	48
DIVING SAUCER 24	OFRS-J.Y. Cousteau Westinghouse Electric Corp. (1959)	1000	1	1	4 hr at 1 kt	1-2 hp motor driving centrifugal water pump; 2 jets provide thrust	3-104 amp-hr lead-acid batteries	9·5	9·5	5·5	8500 lb	—	2	4	24
DOLPHIN AG(SS) 555	U.S. Navy (under construction)	—	—	—	—	1-diesel/electric	3 silver zinc batteries; 2 diesel/electric generators	152	19	20	700 T	925 T	22	—	—
DOWB	General Motors Defense Research Lab. (under construction)	6500*	2	5	8·1 hr at 5 kt 36 hr at 2 kt 58 hr at ½ kt	2-2 hp horiz plus 2-2 hp vert	120 outboard Delco-type cells producing total of 43·2 KWH	16	8·5	6	14,274 lb	—	2	—	40
KUROSHIO II 25	Hokkaido Univ., Japan (1960)	650	2	—	Tethered to surface power source	1-440 v AC motor	Surface power electric through cable	36·7	7·15	10·4	11·5 T	—	4-6	24	—
MORAY (TV-1A) 26	U.S. Naval Ordnance Test Station, China Lake, Calif. (1964)	6000*	6	15	3·6 hr at 6 kt	1-90 hp battery-operated torpedo motor; counter-rotating propellers	Bank of 240 silver zinc secondary cells	33	5·3	5·3	10 T	16 T	2	24	—
NR-1	U.S. Navy/Special Projects Office (under construction)	—	—	—	—	2-aft located propellers	Small nuclear reactor of pressurized water type	—	—	—	—	—	—	Periods compatibl with personal endurance and food supply.	
PISCES 27	International Hydrodynamics Co., Ltd., Vancouver, B.C.	5000*	1	6	7 hr at 6 kt 24 hr at 1 kt	2 oil-immersed DC motors 2 variable pitch propellers	60-120 v oil immersed lead-acid cells; 550 amp-hr	16	11·5	9	6·5 T	—	2	24	72
SEVERYANKA	USSR/All-Union Institute of Marine Fishery and Oceanography (VNRIO) (1958)	550	15	—	16,500 mile range at snorkel speed	Diesel/electric	Diesel-snorkel; lead-acid batteries	240	22	15	—	1180 T	60 (6-8 sci. party)	—	—
STAR I	Electric Boat Co. General Dynamics Corp. (1963)	200	·75	1	3 hr at ·75 kt	2-side mounted, ·25 hp, 18 v	2-external 18 v DC lead acid (fuel cell was used, 1964)	10·1	6	5·8	2750 lb	—	1	4	18
STAR II (ASHERAH) 28	Electric Boat Co. General Dynamics Corp./Univ. of Pennsylvania Museum (1964)	600*	1	4	8 hr at 1 kt 2 hr at 4 kt	2-side mounted, 2 hp, 24 v	External 24 v lead acid	17	7·7	7·6	8600 lb	9900 lb	2	10	24
STAR III 29	Electric Boa Co. General Dynamics Corp. (under construction)	2000*	1	4	10 hr at 1 kt 2 hr at 4 kt	7·5 hp single screw stern drive. 1-2 hp bow thruster, 1-2 hp vertical hovering motor	115 v, 30 KWH oil-immersed lead acid	24·5	6·5	9	18,300 lb	20,800 lb	2	12	24
TRIESTE II 30	U.S. Navy/COMSUBPAC (1964)	20,000* (Terni) 36,000 (Krupp)	2	—	5 hr at 2 kt	2-10 hp aft, 1-2 hp bow thruster	External 145 KWH lead	67	15	18	50 T (less ballast and avgas)	220 T	3	10	24
YOMIURI	Mitsubishi/Yomiuri Shimbun Newspaper, Tokyo, Japan (1964)	1000	4	—	6 hr at 4 kt	1-electric, AC 2-diesel	Diesel/electric. Auxiliary diesel for battery charging; alternator for AC power	48	8·2	9·2	—	35 T	6	—	—

*Has not reached design operating depth (September 1965)

Chart reproduced from *Undersea vehicles for technology*, Interagency Committee on Oceanography of the Federal Council for Science and Technology.



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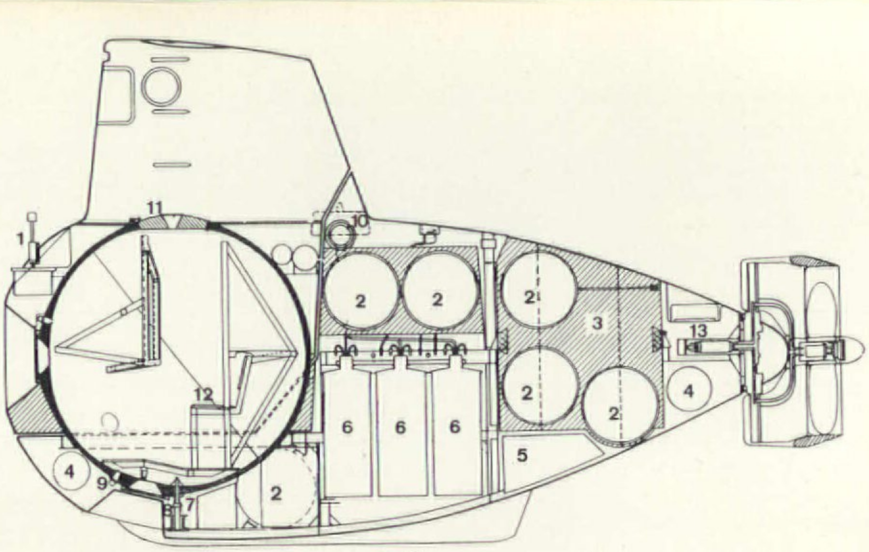


12

11
Diving saucer
1 sonar
2 telephone
3 ballast
4 mercury trim tank
5 rubber bumper
6 lead-acid batteries
7 plastic shroud
8 steel pressure hull
9 entrance hatch
10 connection for arm
11 porthole
12 internal water ballast
13 couch
14 gyroscope
15 movie camera

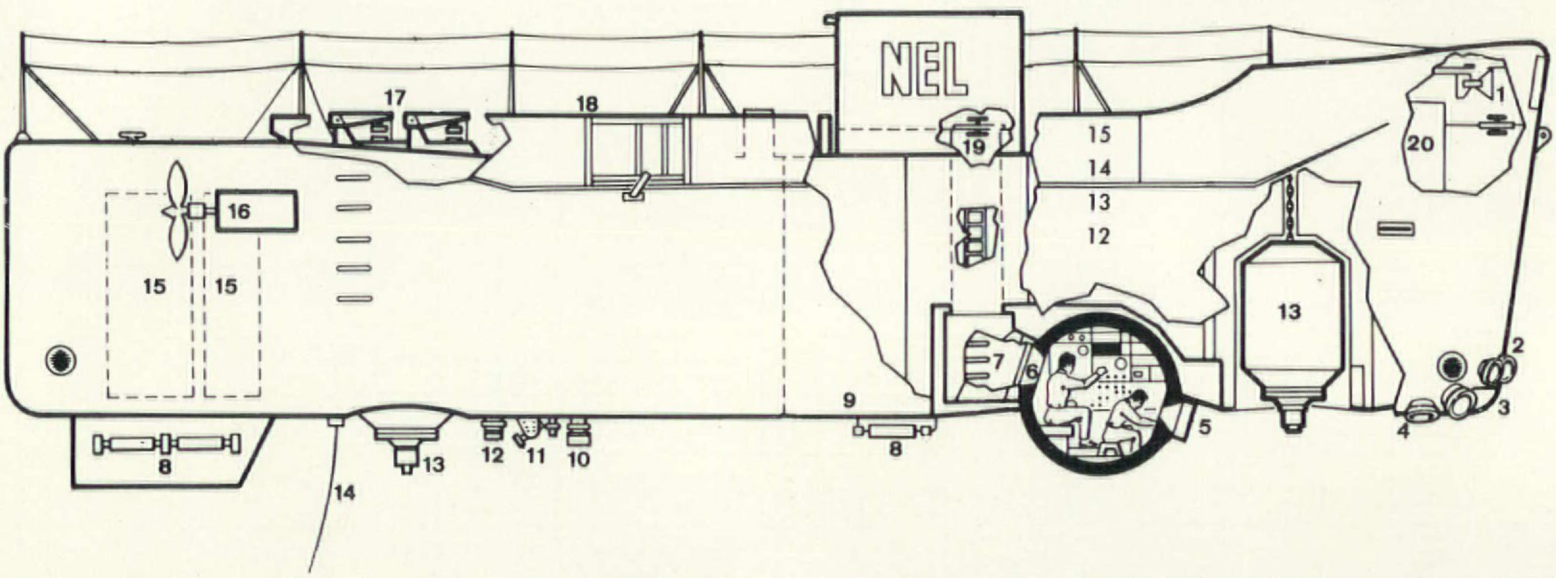
Undersea Vehicles for Technology

12
Alvin
1 scanning sonar
2 buoyancy spheres
3 buoyancy material
4 mercury trim tank
5 main propulsion and mercury trim system
6 batteries
7 sphere release
8 electrical disconnect
9 socket outlets
10 lift propeller
11 window hatch
12 seat
13 steering ram

Wood's Hole Oceanographic Institute

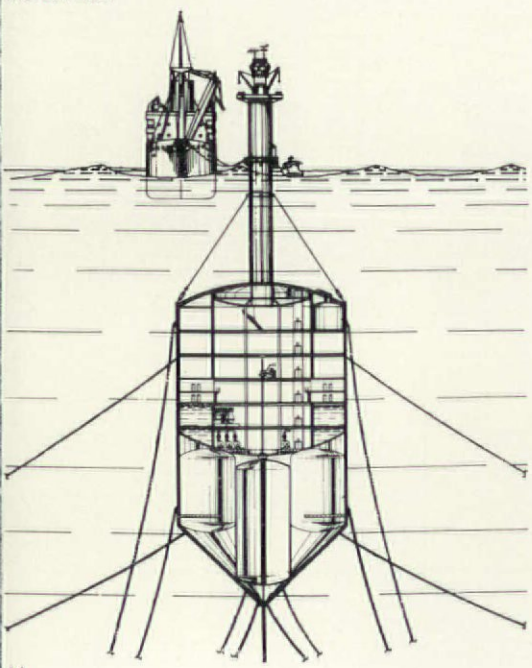
13
Trieste II
1 sonar
2 light
3 plexiglass window
4 cameras
5 viewing port
6 hatch
7 antechamber
8 anti-corrosion anodes
9 fuel tank
10 telephone
11 television camera
12 fathometer
13 shot ballast tub
14 guide rope
15 batteries
16 motor
17 shot release magnets
18 plastic fairwater
19 hatch
20 scientific well

Undersea Vehicles for Technology



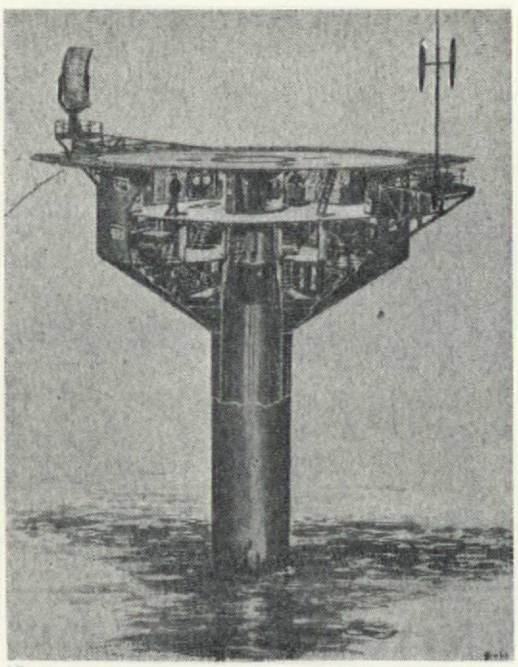
13

R. B. Fuller's design for an undersea island has special application to offshore drilling rigs, but could be used for any manned underwater operation; it would be towed into position floating horizontally on the surface.



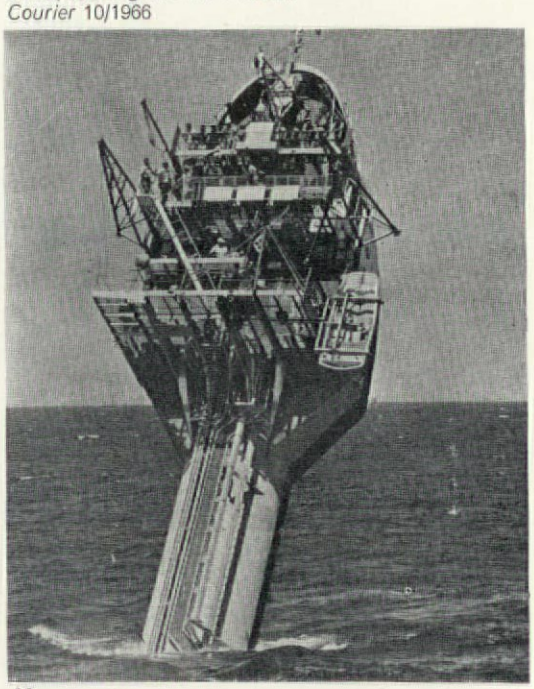
14

To cope with the increase in air traffic and its need for more accurate control, it is proposed to float four telecommunication stations at points across the Atlantic.
Submarine Cables Ltd.



15

Floating Instrument Platform (FLIP) is a 355ft long, 600-ton vessel for undersea research. Towed into position, the 300ft long probe is filled with water and sinks, leaving the aft section.
Courier 10/1966



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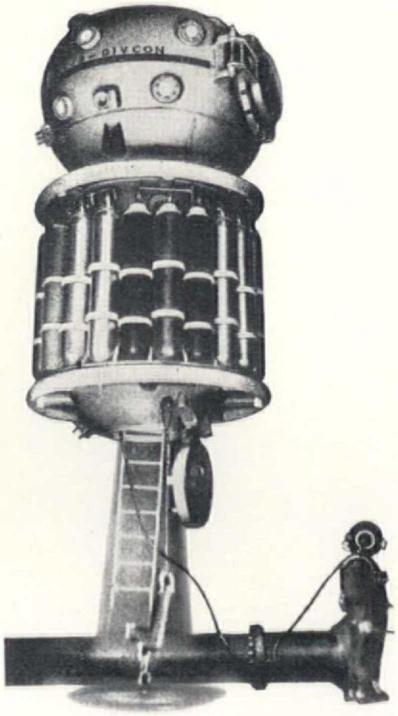

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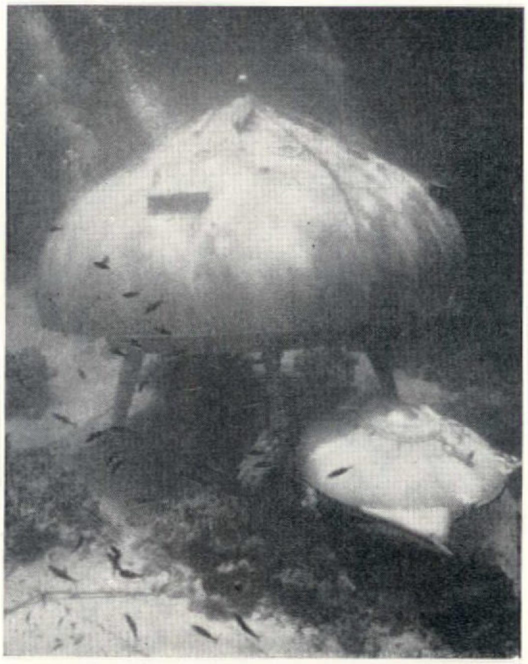

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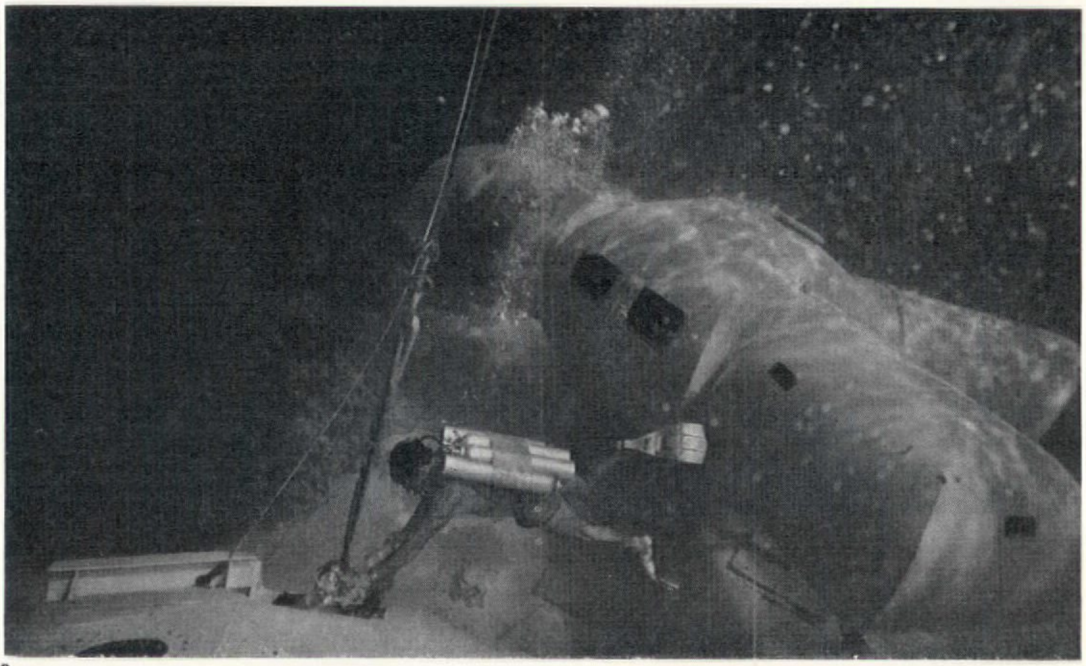

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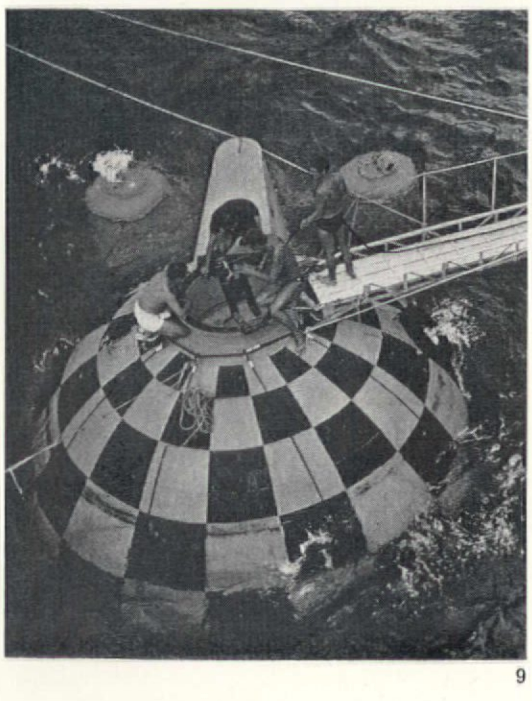


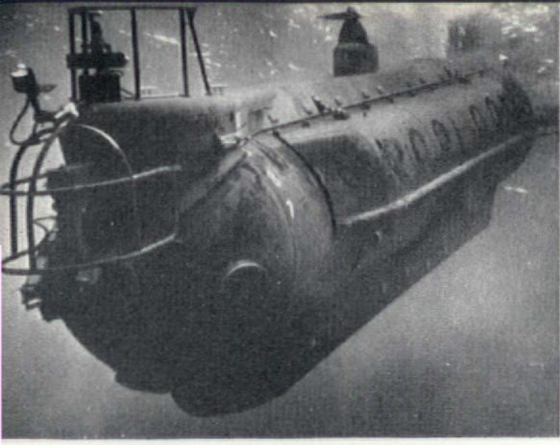
9

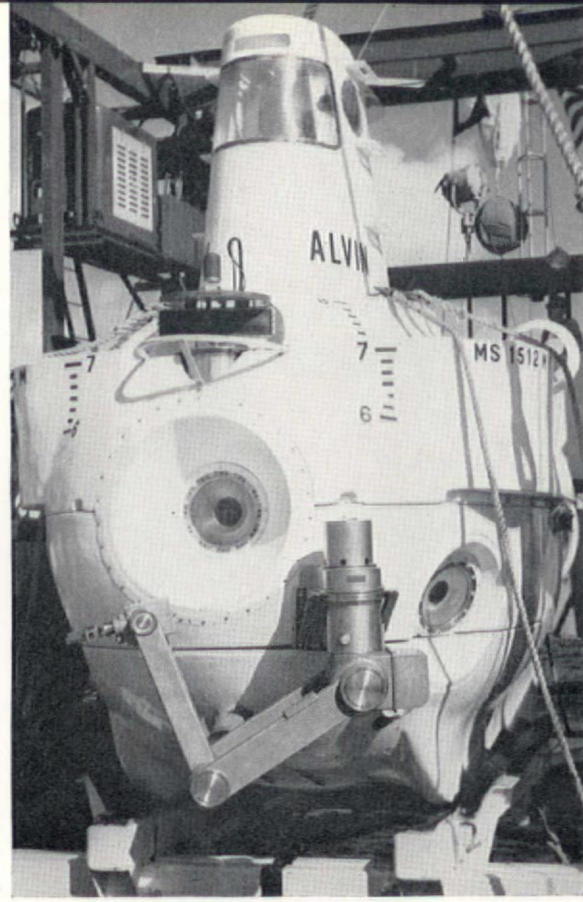
10

17	18	20
19		21
22	23	24
25	26	27
28	29	30

Payload (pounds)	Pressure Hull Type	Manoeuvring Control	Emergency Features	System Support	Remarks
6000	11-forged cylindrical sections, 40 in. long and 8 ft in diameter, 2 hemi-spherical heads of aluminium alloy 7079-T6; 6·5 in. thick. Bolted construction.	Vertical motor, rudder and control planes; variable H_2O trim tanks; puller-type propellers.	Fail-safe droppable shot ballast; 4000 lb droppable lead bar. Remote control station forward.	Towable at 7 kts; surface support from 136 ft ex-PCS PRIVATEER.	Oceanography, mineral and oil survey. 2 mechanical arms capable of taking 4-ft core samples and 1-cubic foot grab. 2 trainable TV; extendable boom; lifting ability of 4400 lb.
1200	7-ft (o.d.) sphere HY-100 steel, 1·33 in. thick.	1-trainable stern and 2 rotatable reversible propeller, mercury trim system. Variable ballast system.	Emergency sphere release; batteries and mech arm droppable; emergency expulsion of mercury.	Towable at 8 kts; surface support from 96 ft catamaran barge.	Designed to support multi-purpose scientific program. Mechanical arm, sample trays and jars. 2 additional ALVIN-type vehicles in planning stage.
450	Welded dimetcoted A-36 steel; ·375 in. thick.	Stick-type diving planes and rudder; H_2O trim tank.	High pressure system for blowing ballast and trim tanks; releasable lead keel.	Trailer and air transportable boat hoist; lifting-rings.	2 conning towers with wrap-around plexiglas windows.
750	Welded dimetcoted A-36 steel; ·5 in. thick.	Stick-type diving planes and rudder; mercury trim system; mineral oil trim tanks for vernier weight control	2-high pressure tanks for blowing ballast; releasable lead keel	Trailer and air transportable.	Single conning tower with wrap-around window; 8-in port in bottom forward.
4000	Ni-Cr-Mo forged steel sphere; 7·87 ft (o.d.), 6·9 (i.d.); 5·9 in. thick.	2 motors provide vertical movement and direction control. Trailing rope for near-bottom control.	Shot ballast automatically released on power failure.	Towable at 8 kts max by tending vessel.	Has explored Kuriles Trench (31,320 ft), Puerto Rican Trench and Tyrrhenian Sea. Uses hexane (45,173 gals) for buoyancy.
20,000	Steel cylinder, capped by steel hemispheres.	Forward and stern planes; kort tuyere; variable H_2O trim system.	Shot ballast automatically released on power failure.	Towable at 8 kts in good weather.	Tourist version used to transport 40 passengers to 900-feet in Lake Geneva during the 1964 Swiss National Exposition at Lausanne. Has scientific capability.
400	5 ft (o.d.) mild steel sphere ·625 in. thick; fibreglass fairing.	Reversible propulsion motors trainable 180° from horiz. Variable H_2O trim system.	Droppable lead ballast, high pressure air for emergency blowing of main ballast tanks.	Trailer and air transportable. Ship supported.	6 viewing ports.
750	A285 steel.	Rudder and bow planes; variable H_2O trim system.	Droppable 180 lb keel; high pressure air for emergency blowing of main ballast tanks.	Trailer and air transportable. Ship supported.	Propulsion endurance may be increased with optional silver cadmium or silver zinc batteries. Hovering motors available. Lifting capacity of 2100 lb.
950	·5 in.–A212 steel.	Rudder and bow planes; variable H_2O trim system.	Droppable 200 lb keel; high pressure air for emergency blowing of main ballast tanks.	Trailer and air transportable. Ship supported.	Lifting capacity of 2200 lb.
1500	T-1 steel.	1 vertical motor aft. Main propulsion motor on 180° swivel. 1-360° thruster motor fwd.	Droppable keel and external battery pods.	Ship, trailer, and air transportable. Ship supported 15 ton hyd. crane.	Diver support vehicle. Operators compt. fwd; diver decompression chamber aft. Diver lockout depth—1250 ft.
200	5 ft o.d. HY-50 sphere.	Rotatable motors aft.	Droppable batteries; air-filled tori, emergency marker.	Ship supported.	Neutrally buoyant vehicle. Underwater range tool and oc. research instrument. Single viewport and fixed periscope.
3400	Two intersecting marriaging steel spheres.	Integrated system—50 degrees of freedom	Jettisonable iron shot, battery, mercury, manipulator.	Motorized barge.	Designed for deep ocean exploration, mineral surveys and support of ocean engineering operations.
400-1000 lb	HY 80 steel two hemi heads welded to end—75 in. wide cylinder.	Rotatable jets; mercury trim system. Reversible main thrust motor—60 lb weight for descent; high pressure air blown tank for ascent.	Propeller battery plus 250 lb mercury supply droppable.	Air transportable; ship supported.	2 external manipulators; motion picture camera, two-way under-water telephone and surface radio communication.
100 (min)	6·5 ft o.d. 1·2 in. HY-80 sphere.	8 small, floodable bottles outside hull. Mercury trim system. Reversible, variable speed motors. 2-weights: 231-lb for descent; 187-lb for ascent	Battery (forward) and mercury supply droppable. Inflatable conning tower for emergency exit on surface.	Air transportable; ship supported.	Helicoidal operating pattern permits 60° ascent and 50° descent. Hydraulically controlled arm and specimen basket. 12,000 and 20,000-ft vehicles of similar design but stronger pressure hull planned.
100 (min)	·75 in. thick mild steel ellipsoidal. 6·5 ft (major d.), 4·9 ft (min. d.).	Rotatable jets; 2-55 lb wgts. for ascent and descent. Fine buoyancy control by internal ballast tank. Mercury trim system.	300 lb releasable mercury plus 400 lb releasable emergency wgt; inflatable conning tower for surface exit.	Air transportable. Supported by 80 ft, 100 ft, or 136 ft, boat truck.	Hydraulically controlled arm. Specimen basket. Excellent manoeuvrability.
—	HY-80 cylinder, hemispheric ends.	Water ballast, rudder and diving planes; hovering control.	—	Independent of surface support at sea.	This deep-diving submarine will be operated in support of naval oceanographic research requirements.
1021	HY-100 steel sphere ·915 in. thick; 80·16 in. i.d.	2 vertical motors; 2-horiz motors.	3338 lb reserve buoyancy. Droppable shot ballast.	Ship supported.	Optical ports at north and south poles of sphere. Outboard system below for full hemisphere visibility. TV cameras may be mounted fore or aft. Will be used for research and deep ocean engineering applications.
—	Mild steel plate.	Rudder, water ballast system.	Cable can be cut so vehicle can power to surface on batteries.	Ship supported.	Vehicle tethered to surface by 1900 ft (35 mm diam.) cable; 16 viewing ports; 5 exterior lights. Manipulator, btm. sampler. TV, phone to surface.
150-200	2·5 ft (o.d.) cast aluminium (A-356-T6) bolted spheres (1 for crew, 1 for inst.)	Tailmounted control surfaces; mercury trim system; autopilot.	Vehicle is positively buoyant; automatic mercury release; automatic buoy marker release.	Air and trailer transportable; ship supported.	Ring stiffened fibreglass hull contains syntactic foam. First vehicle to demonstrate feasibility of positively buoyant URV design. MORAY is "flown" through water. Oceano-acoustic research. No viewports; 2 TV cameras.
—	HY-80 steel.	Internal thruster tubes located foreward and aft.	—	—	First nuclear-powered deep submergence vehicle for detailed studies and mapping of ocean floor for scientific and commercial purposes, and for retrieval of objects on the seabed. Small on-board laboratory.
1500	2 spherical Algoma 44 steel sections.	Motor-drive, ballast—fore and aft inclination.	400 lb mechanical droppable ballast; donut tank around upper hull can be air-blown. Surface buoyancy tank provides adequate freeboard to allow safe entry and exit of personnel while vessel is surfaced.	Trailer and air transportable; ship supported.	Sonar systems scannable through 180° and tiltable 90°. 2 manipulators and clamping arm for holding vehicle to floor. For charter to oil industry, underseas mining, geology and geophysics.
—	—	Rudder, diving planes and water ballast.	—	Independent of surface support at sea.	Converted WHISKEY-class submarine for fisheries oceanography. Forward torpedo room converted into scientific lab. 3-observation stations with viewing ports on each side of hull and overhead. TV in bow; exterior illum; bottom sampler extendable through hull.
200	A212 grade B steel; ·375 in. thick.	Differential operation or rotatable motors with planes attached. Water ballast.	Emergency release of lead ballast.	Trailer and air transportable; ship supported.	First URV to test fuel cell propulsion.
250	A212 grade B steel; ·625 in. thick.	Variable speed rotatable propulsion motors. Water ballast. Fixed stern stabilizers.	Emergency release 360 lb skids.	Trailer and air transportable; ship supported.	6 viewports forward, downward on both sides. Highly manoeuvrable.
1000	5·5 ft HY-100, ·5 in. thick.	Hovering and bow thrust motors. Servo-powered rudder. Mercury trim system. Variable ballast tanks.	Emergency release of mercury. Mechanical arm with equipment mounting plate droppable.	Trailer and air transportable; ship supported.	Retractable mechanical arm. 5 viewports, 2 TV cameras. High payload to disp. ratio and manoeuvrability.
20,000 (with Terni sphere)	Terni-sphere: 7 ft (o.d.) 3·5 in. thick Ni-Cr-Mo forged steel. Krupp sphere: 7·2 ft (o.d.) 4·72 in. thick forged steel.	2-shot ballast silos; 47,000 gal avgas flotation. Drag rope. Gas manoeuvring tank amidships.	Snorkel for emergency at surface. Fail-safe ballast release; 2-11.6 T droppable shot silos.	Tug or ARS supported.	Vehicle presently equipped with Terni sphere; Krupp sphere interchangeable. Mechanical arms; 3 TV cameras. High payload capacity. An evolutionary improvement over T-II will be built in FY 1966 at Mare Island Naval Shipyard for naval research. Currently operated in support of DSSP Project.
—	High tensile strength steel cylinder.	Manual control of rudder and diving planes; H_2O trim; buoyancy tanks.	—	Ship supported.	Miniature submarine for fisheries oceanography and seafloor investigation. Mechanical arm. 4-floodlights, 7-optical glass windows; TV cameras. Net and pressure tank for specimen preservation.

Photos: 17, Reynolds Submarine Services Corp. and General Dynamics; 18, Woods Hole Oceanographic Institution; 19, 20, 21, 25, 26, 30, *Undersea vehicles for technology;* 22, G.M. Defense Research Laboratories and US Navy; 23, 24, Westinghouse Electrical Corporation, Underseas division; 27, International Hydrodynamics Co. Ltd.; 28, 29 General Dynamics.

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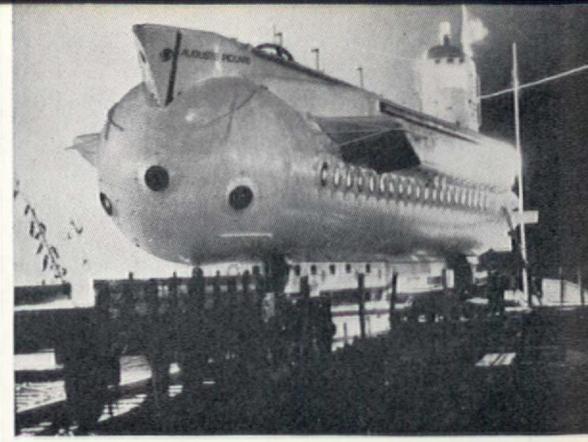

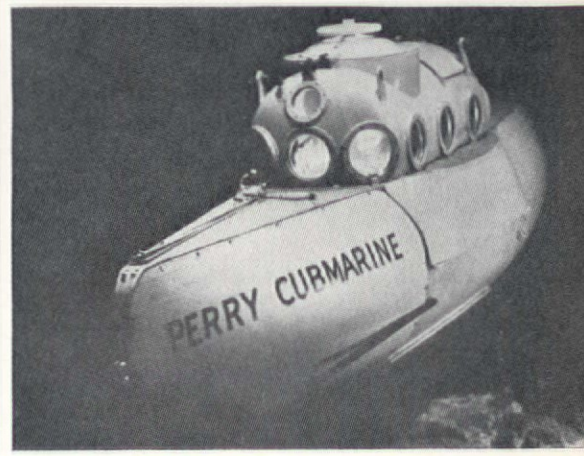
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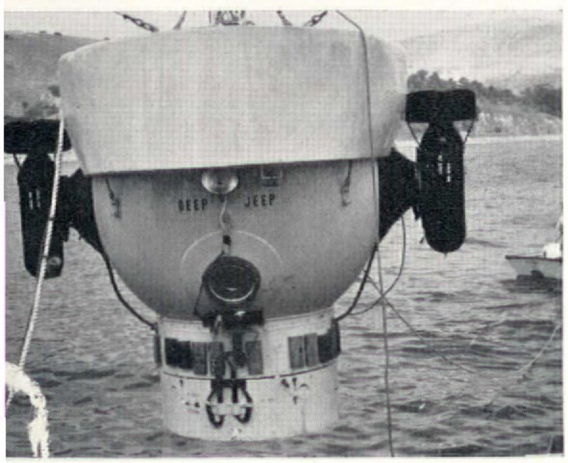
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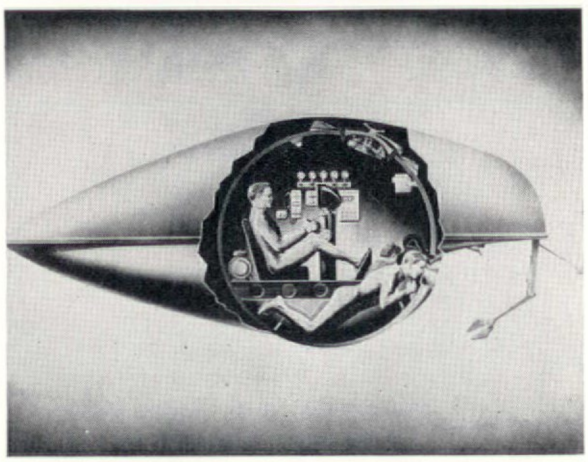

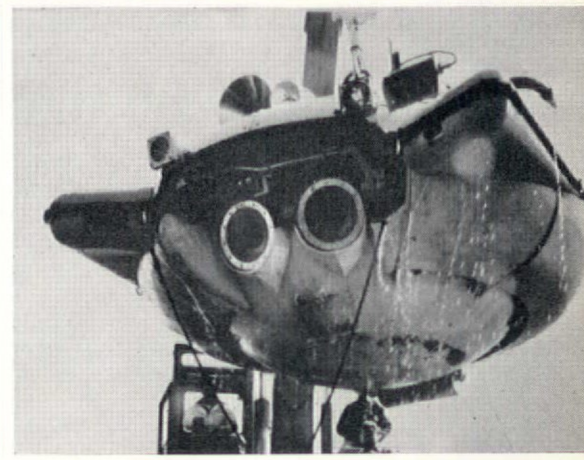

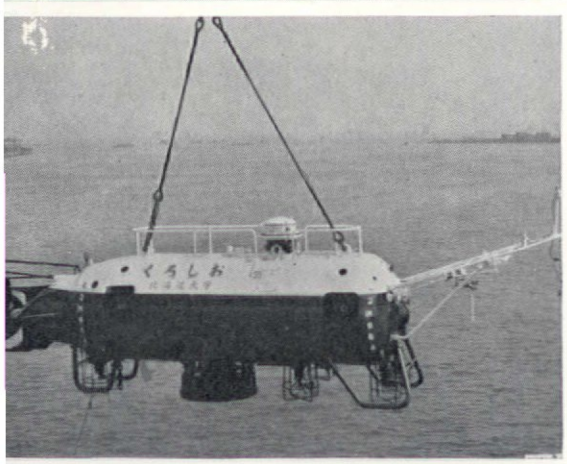
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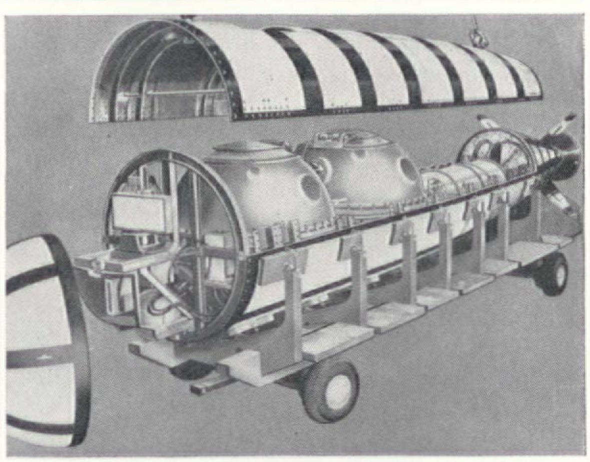

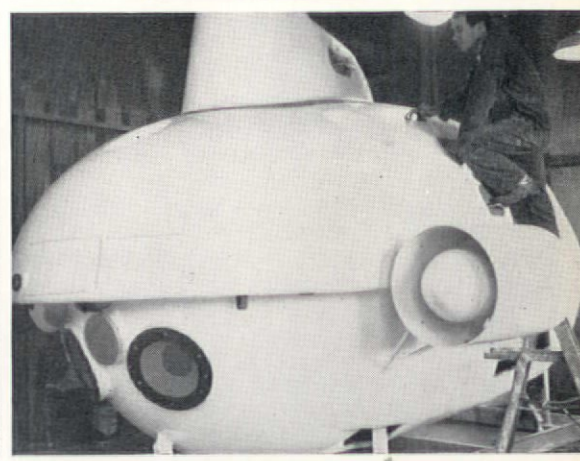

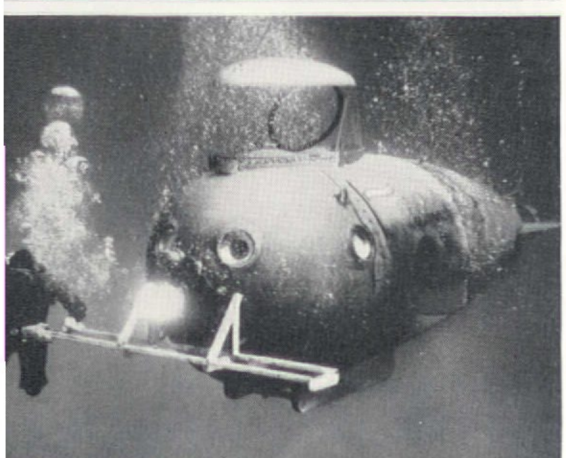

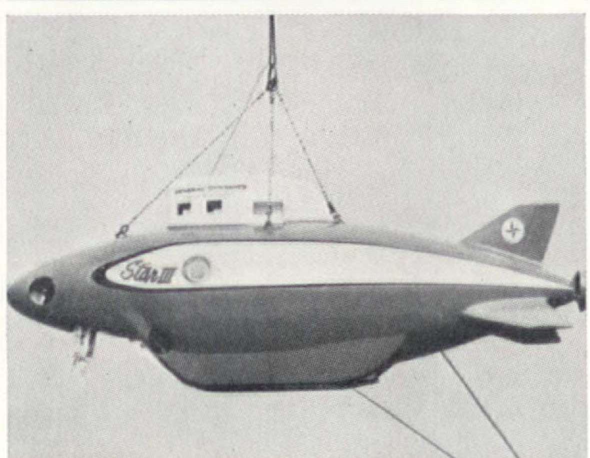
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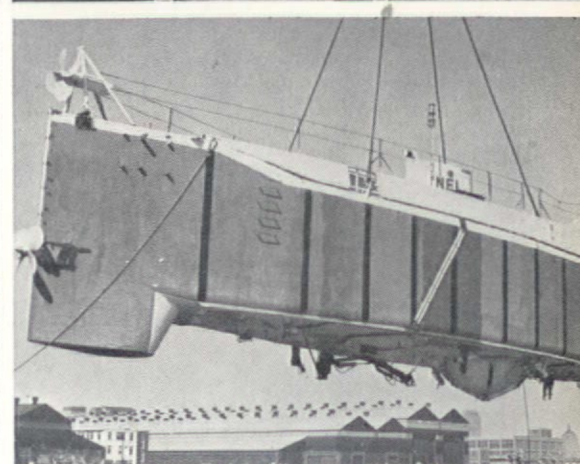

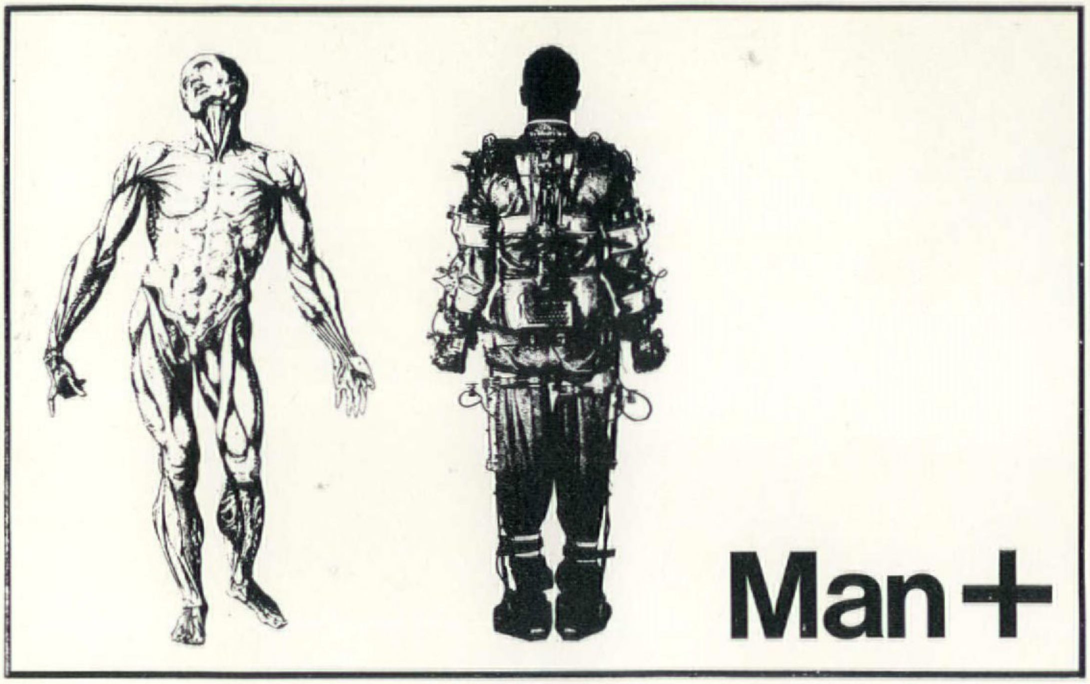

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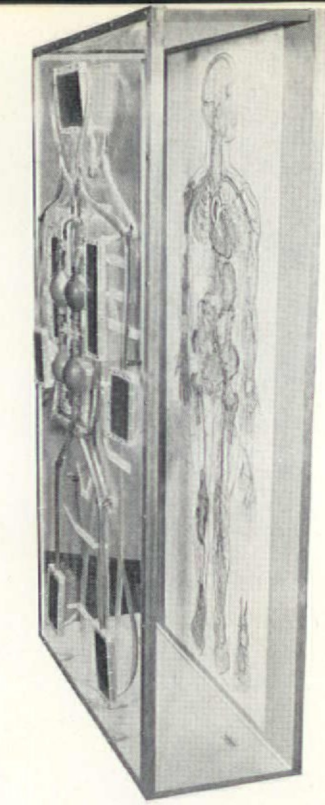


2

Implicit in all discussion of the human environment is the essential mobility of man, the ways in which he has extended himself physically. In the historical phase of this mobility, he spread out into every area of the planetary surface; now in the beginning of a second phase he has become vertically mobile, out into space and inwardly to the bottom of the oceans.

The record of technological development is one of a progressive overlay of another form of evolution on the natural genetic process. We may date this second evolutionary period, from man's first use of tools, as marking the point when he became an active agent in his own development —when his species survival was no longer dependent on natural selection. The *consciousness* of this active participation in his own development occurred quite recently—in a first groping manner around the time of the Renaissance. The consciousness of his possible *control* over his own *future* development, one would place even more recently, possibly in the decade between 1940 and 1950.

The key to this evolutionary control is the way in which man has augmented and amplified his given organic capacities through various means. The simplest was the primitive hand tool, which, physically extending the limb, amplified the hitting and leverage power of the arm and hand. Such simple tools have now become complex assemblies of tools which amplify many-fold the combined energies of large numbers of men. The automated factory is not only a series of augmented hands, but of extra brains or control systems.

In this fashion, the basic organic functions are nodes from which may be demonstrated the many stranded aspects of man's sensing, monitoring and control of his environ. From the skin as protective enclosure, we may go to clothes, houses, to cars, planes, space capsules and submarines—as mobile skins giving progressively greater protection against environmental extremes. From the eye, we extend vision, and, therefore, survival advantage, through the microscope and telescope, the photo and television camera and on to sophisticated systems which record, amplify and relate complex visual and aural patterns of great magnitude.

We might also examine, in parallel with man's exploration of horizontal and vertical (outer and inner) space, his exploration of *invisible* space—the widening band of his sensorial monitoring of the electro-magnetic spectrum. He can now *see* in the infra-red, ultra-violet and X-ray frequencies, *hear* in the radio frequencies, and, may more delicately *feel* through instruments than with his most sensitive skin area.

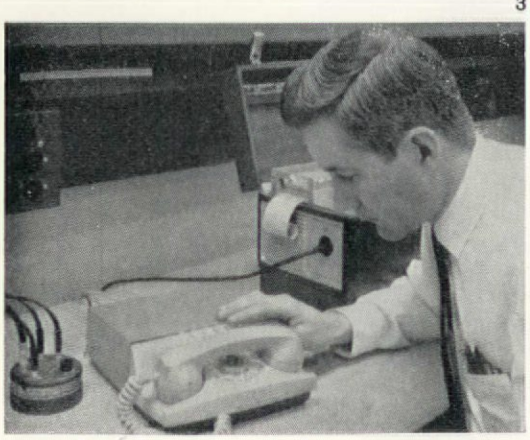
The amplification of human function is not confined to physical instruments. Ideas and concepts also shape the environment, through language, signs, symbols and images. The invention of the zero may have had as comparable an impact on planetary affairs as the atom bomb. Where ships and airplanes have extended man's physical mobility, so the arts and other communication vehicles—print, film, TV—have enormously extended man's *psychical* mobility in space and time. The larger psycho-symbolic conceptual systems—religion, philosophy, science itself—are as powerful agencies in environ shaping as the most developed physical energies[1].

Social process may also be viewed as a strand of human extension in the growth and variety of its institutions. The inventive development of cities, states, families of national groupings, as advantageous to survival, is paralleled in some measure by the more conscious invention of systems organization for large scale, long range planning, e.g. aerospace. Innovative modes of organizing complex *man to man* as well as *man to machine* relations are as crucial to the space programmes as any technical invention.

The most striking extension of all has been the general increase in human life expectancy. The control of disease, advances in surgery, etc., are specific aspects of a general advance in man's knowledge of himself.

Having gained some survival edge on the external environment pressures through even this recent period of industrialization, man has turned more attention to his own processes. Undoubtedly some of the most interesting research on human functions has come from space medicine. Fitting machines to man, and conversely, for long sojourns under severe conditions, has given rise to many questions about human physiological design.

3



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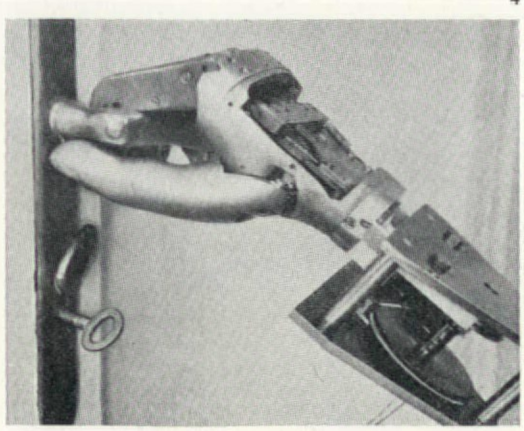

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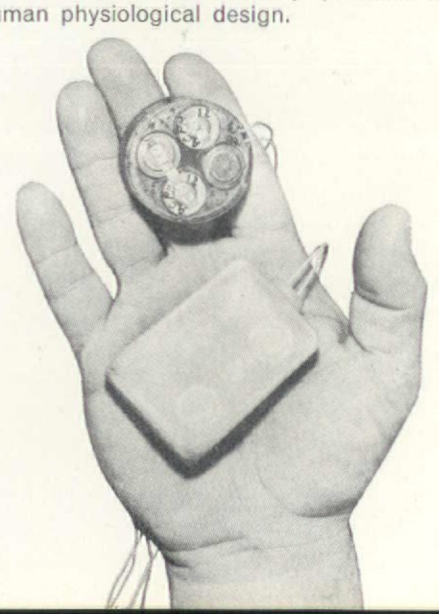


1
Seventeenth-century anatomical drawing compared to an exoskeletal harness in which motor impulses from nerves and muscles are picked up and fed to artificial muscles, greatly increasing man's mechanical performance

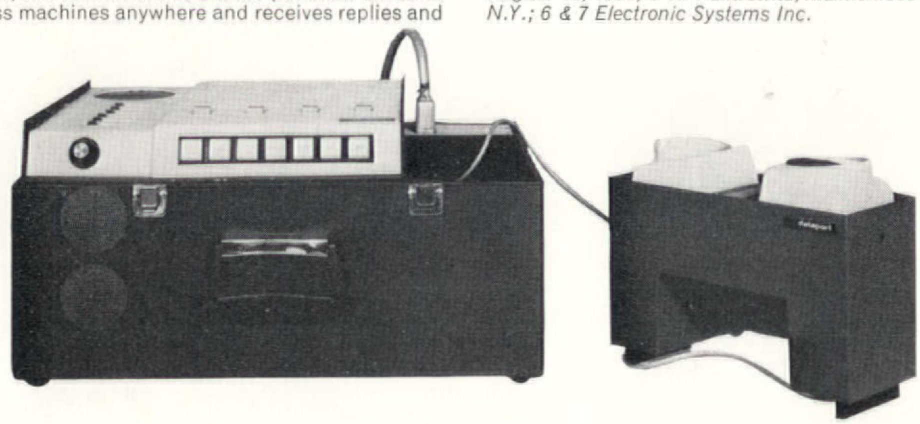
2
Blood flow simulator designed by Prof. R. Skalak

3, 6–9
Three systems that use the common telephone network, but greatly extend its capacity and usefulness. 3 transmits electro-cardiograms direct from the patient's pulse to the doctor; 6 and 7 illustrate a portable computer terminal with full type-in and print out facilities; the instrument in 8 dials punched cards to business machines anywhere and receives replies and instructions, while 9 is a Picturephone that transmits a visual image as well as sound

4
Pressure sensitive artificial hand, designed by Prof. Rajko Tomović of Belgrade, that can be used as a prosthetic device, activated by a newly learned pattern of muscle control or—more alarmingly—by remote electronic control

5
Battery-run implantable cardiac pacemakers

Photos: 1 Exoskeleton, Cornell Aeronautical Lab. Inc.; 3, 8 & 9 Bell Telephone Laboratories; 4 Design News, *August 19, 1964; 5 A. Kantrowitz, Maimonides Hospital, N.Y.; 6 & 7 Electronic Systems Inc.*



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Every other component from nuts and bolts to rocket fuel comes in a wide variety of sizes, shapes, strengths, physical and thermical properties. The human sub-system is unfortunately manufactured in only one basic model, and the engineer is stuck with it. He can ask for a hex nut or a six-way switch, but a six hundred human is not in stock.... These are intolerable limitations, and up to the present decade only two traditional approaches have been used to cope with the problem...we reluctantly accept the need for a human pilot and provide him with a minimum life support system which he carries on his back. ...The other extreme is the all-out engineering approach. Here the engineering department asks the human factors group to supply them with a schedule of numbers specifying the weird dimensions and feeble mechanical properties of human properties, the engineers then demonstrate their virtuosity by providing what we have come to call a 'shirt sleeve' environment[2].

The authors go on to propose more seriously the investigation of direct modification and augmentation of human to superhuman capacities. They point out that humans around the world have already developed such capacities in varying degrees—living at high altitudes where we normally can't breathe, maintaining normal skin temperature in sub-zero cold, thriving on otherwise dangerously ill-balanced diets. Underlining that man can be improved, they indicate that, 'trances and suspended animation, long in the same boat as the Indian rope trick, are now legitimate objects of research under the names of hypnosis and hypothermic hibernation.'

Various biomedical modifications are already routine—artificial organs and extensions of organs, electronically controlled artificial limbs, organ transplants. The artificial limb prosthetic attachment is one of the most interesting examples which, though produced in response to human defect through birth or amputation, is capable of much further application. The problems of delicacy of control and requisite power of manipulative and holding action in artificial hands reached an advanced stage of solution in 1963. Key difficulties had been power source and directive control operation which were solved by two Soviet scientists[3] who amplified bio-electrical muscle currents in the limb stump to trigger micro-miniature servo-mechanisms for the hand movements. These were versatile enough to unscrew a light bulb, lift up to nine pounds and bend each finger joint.

The use of electrical energy drawn directly from the host body itself to power various internal and external devices directly, or to use for remote control of other mechanisms, has far reaching possibilities. Apart from self powering various artificial organs, heart pacemakers, etc., this could also be used for transmitting signals for operating other controls at a distance, or acting as receiver/activators of metabolic control signals from remote medical centres.

With new valves for damaged hearts, synthetic tubes, clips, transplanted organs, assists and metabolic amplifiers of various kinds, the human body may now enter an era of synthetic regeneration. This field is now more than simply spare parts medicine. 'Surgery is essentially an engineering discipline...the integration of electronic circuits into the human body as functioning and permanent parts...is going to become very important within the next ten years[4].' The name now given to this swiftly developing field is bio-engineering. Describing his recent work on a systems model of blood flow for diagnostic procedures, Columbia University professor of engineering, Richard Skalak, pointed out that this interaction of biological, medical and engineering sciences is already under way in other areas such as water supply, waste disposal, air pollution, food preservation and public health.

We may sense again this growing eco-systems approach as beginning to operate at both the macro extremities of human environ control—within the human body itself and outwardly to encompass the entire planetary body. ▷87

[1] The differentiation into physical and non-physical instruments in this paragraph is wholly semantic in the sense that an equation or formula representing a psychic construct does act physically on the environment in directing and ordering physical materials and energies.

[2] T. Freedman, MD and G. S. Linder, *Can Man be Modified*, North American Aviation Technical Report, 1963.

[3] A. E. Kobvinsky and V. S. Gurfinkel, *Time*, December 1963.

[4] A. Kantrowitz, Dir. Cardiovascular Surgery, Maimonides Hospital, *Electronic Physiologic Aids*, New York, 1963.

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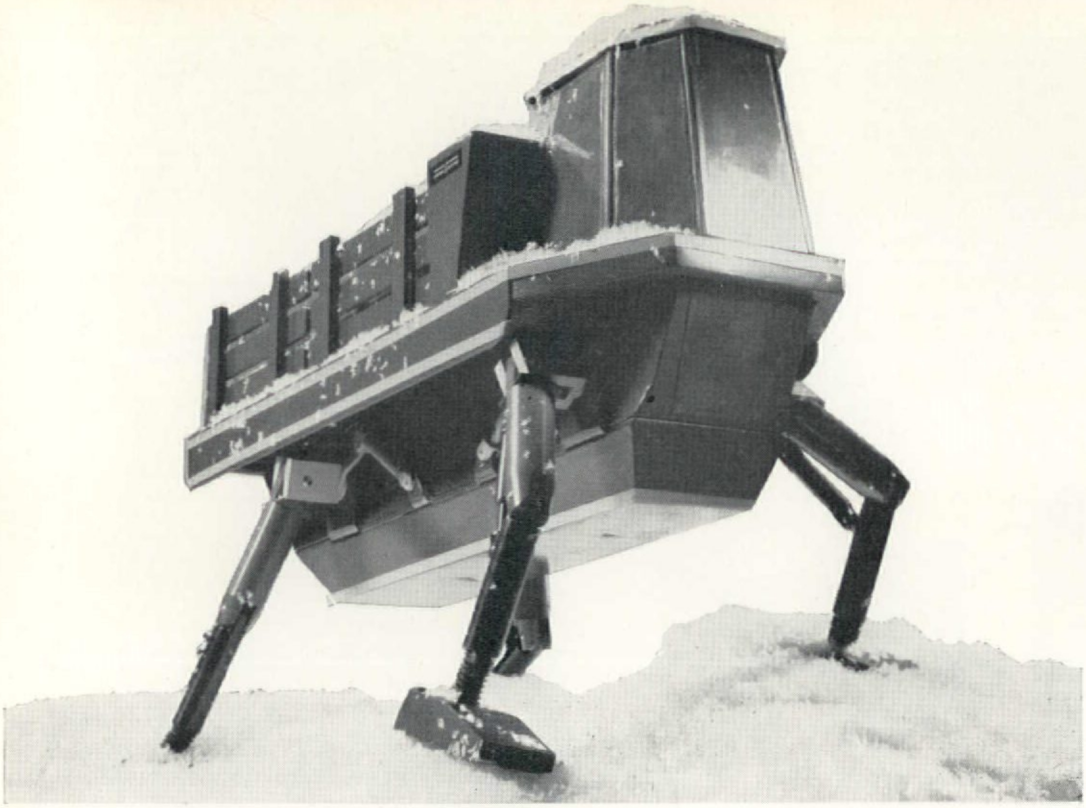

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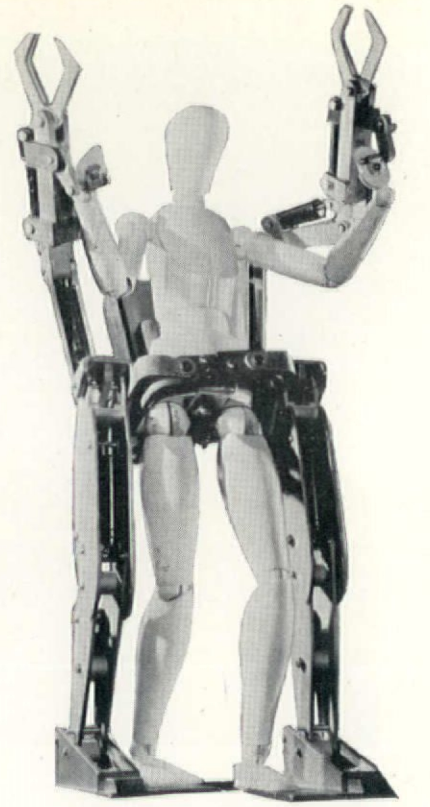


2

◁86

Electro-mechanical circuitry within man is only part of the present trend towards massive augmentation of individual human capacities through engineering. Professor Thring, Head of the Department of Mechanical Engineering, London University, lists some future branches as robot, telearchic (remote control) ocean, weather. He divides out robots (from telearchic machines) as those which do not require a human operator to carry out their tasks but rely on previous programming. Describing the use of robots and telearchic remote manipulators as due for developmental use in the next ten years in the home, industry, mining and in the ocean and aerospace areas, he underlines many of the points we have already commented upon, but particularly draws attention to the 'Moral Spectrum of Machines'.

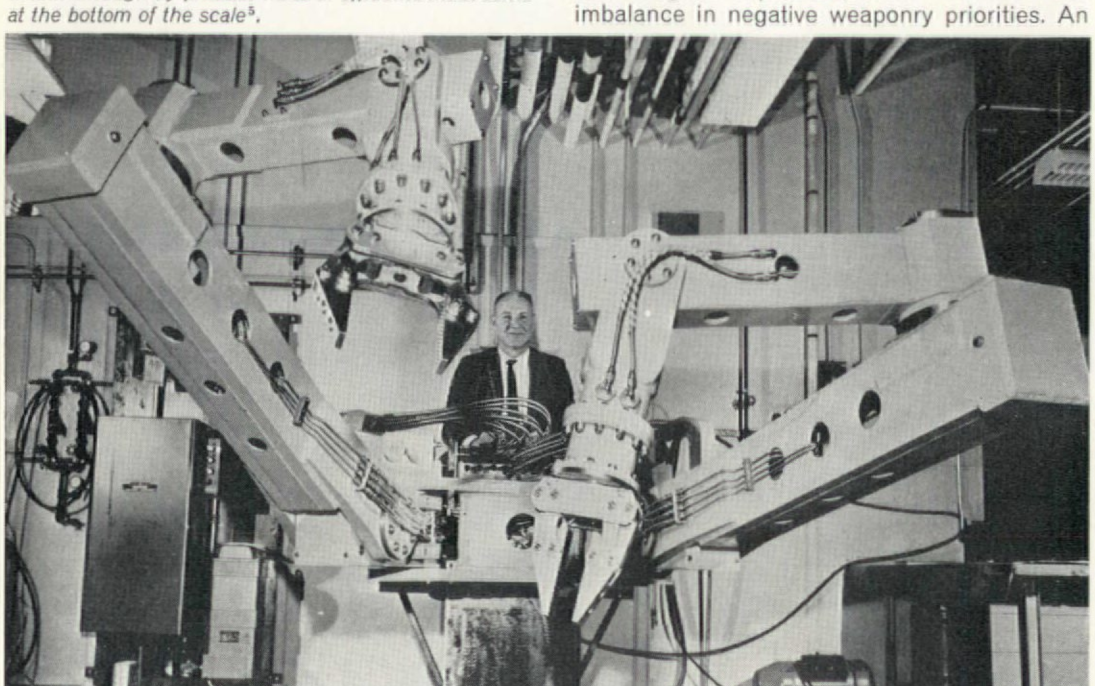
—to put the machines that the engineer can develop on a moral spectrum based on the extent to which the machines help or hinder human beings to realize their potentialities and thus to lead satisfactory lives. Machines primarily developed to kill, maim or hurt . . . harm human health through by-product noise or effluents must come at the bottom of the scale[5].

This forms part of a growing dialogue about the professional committment of science and engineering hitherto considered as 'value-free' disciplines which has also been extended recently to the social sciences[6]. Professor Thring introduces an idea which may be extremely pertinent to the future role of architectural and environment planners—that such work should be governed by some form of Hippocratic Oath as in medicine. In considering the future of any form of technological and social innovation, this is indeed a question of fundamental priority. The single or combined decisions of many individual professionals now materially effect directly, or indirectly, the welfare and often the lives of millions of people around the world. The weaponeers have no problem in calling upon the individual's sense of responsibility to his fellow X . . . ians at a moment's notice, yet, the innovation of a higher responsibility to the planetary human family is still considered rather too idealistic. The range of illustrations in this present essay, selected on the basis of most forward technological capacities, show the enormous imbalance in negative weaponry priorities. An interesting comparative series could be made of the number of matched world problems to which such technology might be applied.

A further example of military tool developments, which have positive potential, are the Hardiman and Walking Truck concepts[7]. Hardiman is the latest in a series of physical power assists, based on an external metal skeleton with electro-mechanical muscles, which give the wearer giant strength. Seemingly cumbersome now, one can easily extrapolate this development, via ultra-light high-strength alloys, to a harness no heavier than an overcoat. The next step, obviously, would be to implant the exoskeleton to create an anatomically modified super man.

In the transformation of human consciousness via LSD and other hallucinogenic agents, the groping towards memory control, the re-shaping of behavioural patterns through re-inforcement schedules, etc., we have again a parallel analogy with man's vertical extension into outer and inner space. The same extraordinary intellectual forces with which he is at present engaged in remoulding his planet are now being turned in upon himself.

1
A 'walking truck' for transporting goods over rugged terrain at a speed up to 5 m.p.h. By manipulating controls attached to his arms, legs and torso, the operator will be able to manoeuvre the machine
2
Hardiman, a set of mechanical muscles to be built by the General Electric Co., USA, for the US Army and Navy. The machine, controlled by hydromechanical servo-valves, will permit its operator to lift a 1500-pound load, while exerting only a fraction of this force
3
A pair of 9ft mechanical arms for *Aluminaut* (pp 79–84)
4
'Unimate', a combined arm and computer, which operates from a memory store of 200 operations
Photos: 1, 2 & 3 General Electric Company, USA



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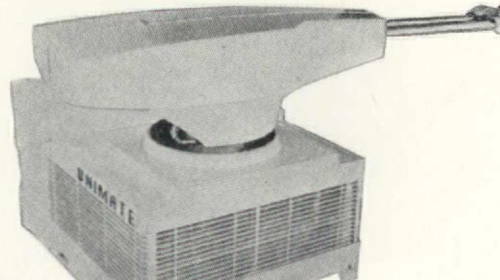


4

The results of this inward exploration may be infinitely more powerful than any physically extended voyage to Mars or to the bottom of the Challenger Deep. The territory is as unknown, and for centuries we have endeavoured to exorcize the demons and control the energies which have emanated from its depths. Our present inward probings and mappings may now illumine those aspects of human nature, the fears, belligerence and self-destructiveness, which have been a numbing constraint on all futures dialogues.

Man has always been able to induce the death of others by some agency or other. Life-inducing power has been more or less a matter of chance. His recently acquired capacities to prolong life already create population problems. These, again, may seem mild when he expands prolongation to precise genetic control of human characteristics before and after birth with the capacity to modify, by many present and emergent means, the emotional, mental and physical aspects of the human organism. Coupled with this is the possibility of creating new types of living systems based on quite different biochemical configurations.

Medicine is already preoccupied with the ethical and legal problems of the point of death ambiguity using current life prolongation and resuscitation techniques. Reconstituting men long dead, once a favourite storyline in horror films, is predicted by one zoologist as possibly routine within a century—'once the genetic code is determined . . . hundreds of thousands of duplicates (of a past genius, for example) can be created[8].' At another part of the spectrum, a group of persons have formed a Life Extension Society—freeze, wait, re-animate—to cryogenically freeze and store living persons, those for example with incurable diseases, to await future medical advances.

The concept of bio-engineering, or bio-electrochemical engineering as it might be called, is evidence of the cross-disciplinary fusing which now confronts all academically defined fields. The boundaries have suddenly vanished as new knowledge, of itself, has created new disciplinary configurations, or areas in which there are no longer any discernibly separate disciplines. The task of adjusting our educational institutions to this new order will require social inventiveness of no mean scale. Accompanying the 'mixmaster' aspect of the various sciences there is a corresponding difficulty in labelling their attendant technologies. Defining the four which he suggested might have the greatest implications for future society, one scientist recently suggested computer technology, management or 'systems' science, social engineering and bio-engineering. We may note that these sound relatively separate, but closer examination reveals a great many features in common

Cybernetics does furnish one nodal link for the four technologies above, and for many others, and, both in its conceptual theory and identifiable technological penetrations, has been one of the major change accelerators. Considered under our present heading, Man +, it may be placed as an extension of the human nervous system and intelligence. Significantly, its recent origins were during the Word War II period—firstly in developing self-correcting guidance and control feedback mechanisms for anti-aircraft guns; secondly in the operations research methods of applying logico-mathematical techniques, network theory, etc., to problems of military logistics. From the fusion of both these areas, plus ancillary developments in electronics, etc., came the computer and the systems theories based on complex multi-variable planning needs.

These elements have been the base-line of the so-called computer revolution in the past two decades. It is interesting to observe that this evolution occurs at a point which we had previously indicated as the crucial hinge of change. Also, and importantly, we may underline the change agency, in this case, as specifically developed for control and decision-making in handling large-scale problems involving many complex and variable factors. At the point then where man's affairs reach global scope he invents, with seeming spontaneity, precisely those conceptual and physical tools which may enable him to deal with the magnitude of a complex planetary society.

In general, much of our present computer usage simply regards the machine as a superfast and efficient clerical assistant. The real trend, however, is, on the one hand, towards a closer individual/computer rapport so that it becomes a generalized intelligence amplifier, and on the other, towards specific types of computer systems to assume the routine operation and maintenance of all the basic physical metabolism of human society.

The architect, planner and other professional may now work closely with the computer without the need to spell out, step by step, programmes in advance. He may talk to the machine directly during processing, view compiled output at any stage and further manipulate data in many alternative forms. The architect is now reinstated in his prime creative role. Instead of his remaining merely the coordinator of various specialists—in structure, lighting, air-conditioning—these may be encapsulated in memory units to be drawn upon as required. This man/computer symbiosis is now developed to the point where the machine also instructs its user and indicates possibilities for closer interaction. You don't have to read the manual but may consult the machine directly with the order, 'I want to do something, instruct me.' This mode of working may now be carried on at a distance with remotely linked viewing and operating consoles and, at the present developmental rates, it will obviously reach the portable, possibly 'clip on' stage before long. Micro-control components are, as we have seen, now available in many forms, and computer memories become progressively smaller in volume and larger in bulk storage capacities. There would be, of course, no need to carry such memory units, but more feasibly, to have call-up linkages to many types of such central libraries.

Various types of equipment, available now, like Sketchpad, Rand Tablet, etc., have been described in detail elsewhere, so that there is no need to elaborate on their capacities here. The computer is involved in so many areas of individual work in this way that any review of separate fields and modes would tend to cover all the sciences—and the arts.

[5] M. W. Thring, 'The Place of the Technologist in Modern Society', *Journal of RSA*, April 1966.

[6] e.g. recent US controversy over 'Project Camelot' and Michigan State University's CIA Vietnam relations, etc.

[7] US General Electric, 1966.

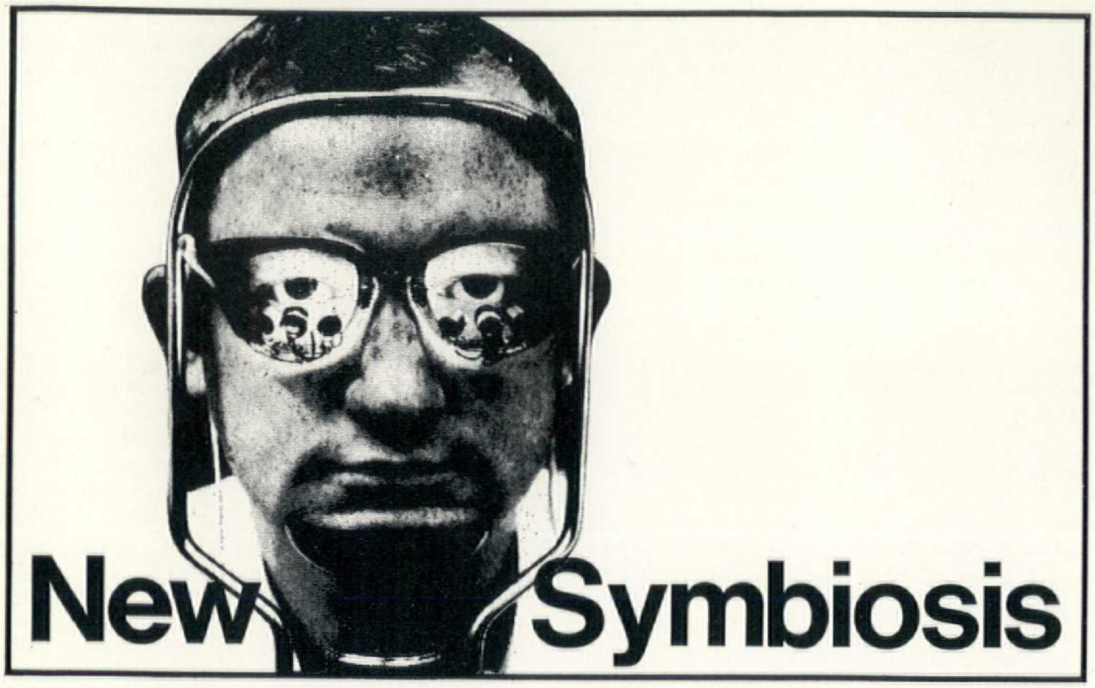
[8] Professor E. Carlson, *UCLA, AP Wire Service*, April 10, 1966.

5

6

7

5
A computer and graphic console in which a 'light pencil' is used by the designer
6
'Data phone', using punched tapes, that permits links between computers on normal telephone channels. But data can be sent and received in any of the following forms: magnetic tape, handwritten documents, graphs, maps, charts, teletypewriter, etc.
7
The Sony Video tape recorder unit which is used with a ciné camera and a monitor screen to make a sound and motion equivalent of a polaroid camera
Photos: 5 General Motors Research Laboratories; 6 Bell Telephone System; 7 Sony



New Symbiosis

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Implicit within both individual and social relations to cybernetics is the emergence of a new symbiotic growth in the eco-system of the planet. Other types of machines are merely mechanical extensions, 'there is only one organism—man—and the rest are there to help him[1]'.

But recently, as in his natural symbiotic relations with plants and animals, man's relationship to cybernetic systems has been subtly changing, towards a more closely woven interdependency resembling his other ecological ties.

This point has often been alluded to in terms of intelligent machines dominating man, but the possibility is more clearly that of the type of organic partnership which characterizes his other 'natural' relations. As Licklider suggests in one of the key papers on this topic.

(It is) estimated that it would be 1980 before developments in artificial intelligence make it possible for machines alone to do much thinking or problem solving of military significance. That would leave, say, five years to develop man/computer symbiosis and 15 years to use it. The 15 may be 10 or 500, but those years should be intellectually the most creative and exciting in the history of mankind[2].

This is being borne out in the phenomenal growth of knowledge in the past few years, both with the expanded capacities to process information via the computer and in the primary sector of knowledge discovery and communication. In this area, however, we still confuse somewhat the accumulation of *new* facts with *new* knowledge. The extension of knowledge, e.g. in science, has not been through the simple addition of new facts but marked rather by the intuitive grasp of ways in which a great mass of factual information may be simply and elegantly structured into new conceptual wholes. The process is not towards greater complexity but towards simpler and more inclusive concepts, now evident in every field.

The most pervasive aspect of the developing man/computer symbiosis, and the most immediately important in large-scale societal effects, has been the automation of production and services in the advanced economies. Man is clearly no longer required as a mechanical energy converter, as part of an assembly line or as a routine worker. Many such tasks have been taken over by automated machine—process and product wealth may be generated with less and less input of human energy, intervention and decision. This aspect of automation is only the more visible and easier to grasp. The extent to which automated systems have now assumed the operation of the invisible metabolics of advanced economies is more far-reaching. Apart from completely automated factories and continentally linked automatic inventory dispatch and control operations, the whole energy conversion and transmission system of vast areas are increasingly under automated control. Over 80 per cent of the US's electrical capacity is, for example, controlled at present by automatic dispatch systems.

The processes of control, everywhere they are encountered, that is, in living organisms, social organisms, and the psyche, lead in their development to automation. Automation creates that simplification without which further development would be impossible. Their control of the activity of the inner organs is completely automated and does not require attracting the attention. In the learning process we constantly encounter the phenomenon of automation. Even when learning to walk a system of automatic control arises in our consciousness. Habits without which the successful execution of any kind of complex activity would not be possible represent the working out of automatic responses[3].

The extension of automated control measures to the operation of national economies is being developed in many countries and is foreseeable for the planetary economy in the link-up of world airlines, energy and communication networks. This type of control design requires prior large-scale simulation. Such simulation is much the same as we do in our head when confronted with problems of decision-making under various degrees of uncertainty. We review and organize information on the problem, assign different contingencies to various possible actions and choose the optimal strategic combination of actions. These mental simulations, or models, plus the results of action based upon them, become memory/experience components in future decision-making. By organic automation, or habit, they are incorporated as patterns in our nervous systems.

The use of the computer in the simulation of processes with large numbers of interacting variables is now commonplace. Simulation of physical systems is relatively simple compared to that of social systems, of the interactions of nations; but advances are also being made in the latter area. In large-scale economic, business and politico-military simulations, actions which might take weeks or months to occur in real time may be run through in a few days.

▷91

[1] J. D. North, Boulton Paul Aircraft Ltd., United Kingdom, *The Rational Behaviour of Mechanically Extended Men*, September 1954.

[2] J. C. R. Licklider, *Man-Computer Symbiosis*, IRE Transactions on Human Factors in Electronics, March 1960.

[3] B. V. Akhlibininsky and N. I. Khrallenko, *Cybernetics and Problems of Development*, Lenizdat Publishing House, 1963; US Department of Commerce, OTS Report 64-215-17.

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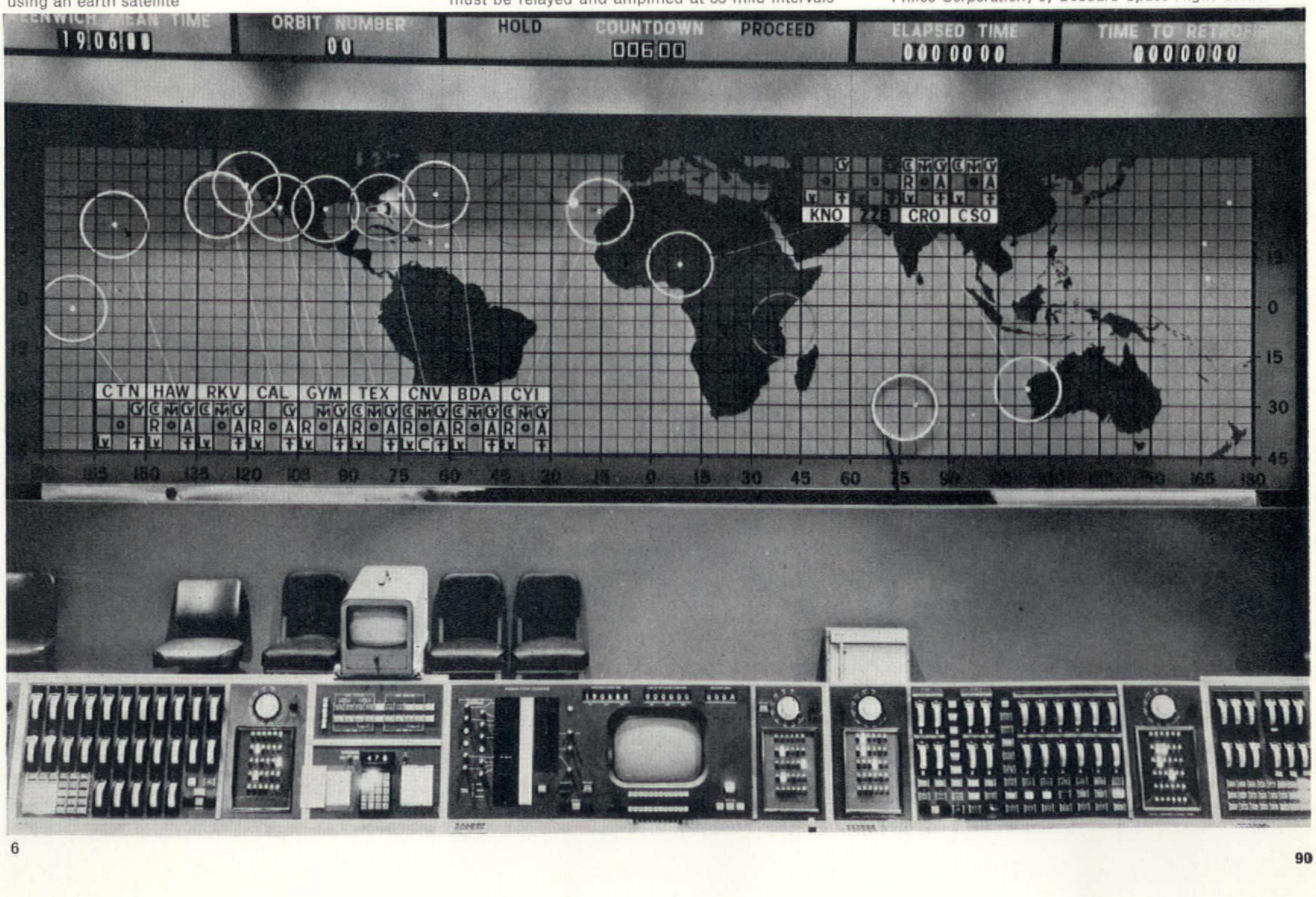
1
Photocell goggles at Massachusetts Eye and Ear Infirmary, used in the search for nystagmoid eye tremors. The patient watches a moving spot while a computer, miles away, analyses eye movement
2
Transmitting antennae used in Project Echo, the first major experiment to study long range communications using an earth satellite
3
Quad. helix command tracker at Andover, Maine, used to 'acquire' Telstar I on its first visible pass, July 10th, 1962
4
Microwave relay tower used for bulk communication services. Micro-radio waves do not 'bend' around the Earth's curvature and unless bounced off a satellite must be relayed and amplified at 35 mile intervals
5
Projection plotter used for the Gemini 5 mission
6
General view of the tracking map and control consoles located in the mission control centre, recovery room, Cape Kennedy
Photos: 1, International Science and Technology, *2–4 Bell Telephone Laboratories, 5, WDL Division, Philco Corporation; 6, Goddard Space Flight Center*



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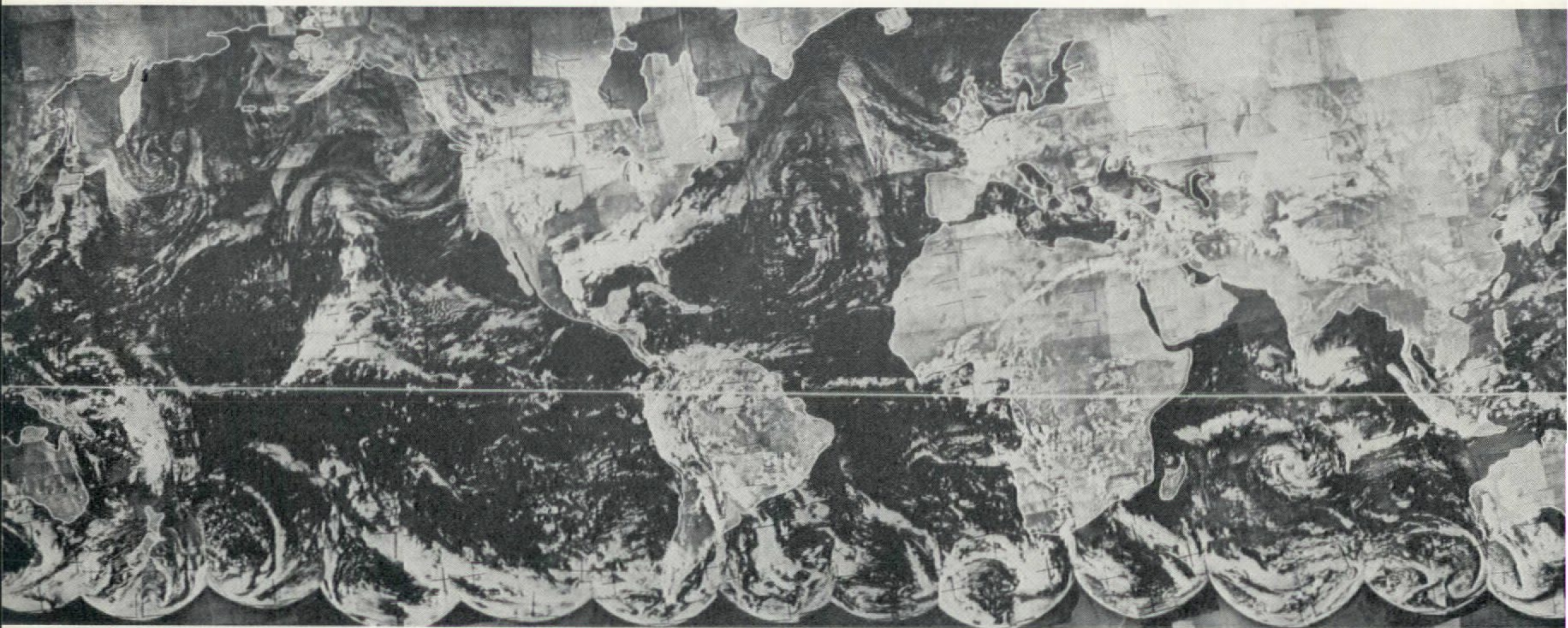
Prerequisites for such simulation, for increasing the *predictive* capacity of the organism in its environment, are adequate information and communications. It is interesting, therefore, to observe the exponential growth of information accumulation, and the parallel expansion of information and communication systems to the global level.
The most advanced development of such systems at present is, of course, in support of military prediction, planning and control procedures. When ICBMs may be launched to strike anywhere in the world in less than 30 minutes, the factors of speed in information handling of incoming data and outgoing corrections of hour by hour posture are enormous. Add to this the given figures of operational air forces of 15,000 aircraft, 1000 missiles and a quarter of a million personnel, and we have a global operation of considerable size. The facilities developed match up to the requirement. Operational data referring to the location and state of the above components, to global weather conditions, intelligence, materials inventory, transport, location is constantly being fed into such centres, and may within seconds be flashed on screens for simultaneous viewing of its complex relationships. Aircraft in flight may be contacted swiftly anywhere in the world and direct telephone contact made immediately through one handset with more than 70 subordinate centres spread halfway around the world[4].
Such worldwide systems are working examples of Marshall McLuhan's statement, 'Today, after more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both time and space as far as our planet is concerned.'
The first recorded voice was heard from a satellite only eight years ago; four years later the first live telephone, television, data and facsimile transmission was made between Europe and the USA via Telstar I and II. Since then, Syncom, Echo, and the Early Bird satellite relays have transmitted between Russia, Japan, the USA and Europe.
The less obvious uses of such satellite repeaters, observers and relay stations is their direct scientific value. One of the latest of these, Nimbus II, specifically designed to monitor weather information, was sent aloft in May 1966 for a six-month work period. Its set of Vidicon automatic picture transmission cameras will photograph not only cloud cover and weather but anything as small as a half a mile in length on the earth surface. Pictures will be relayed automatically to 150 ground stations in 27 countries.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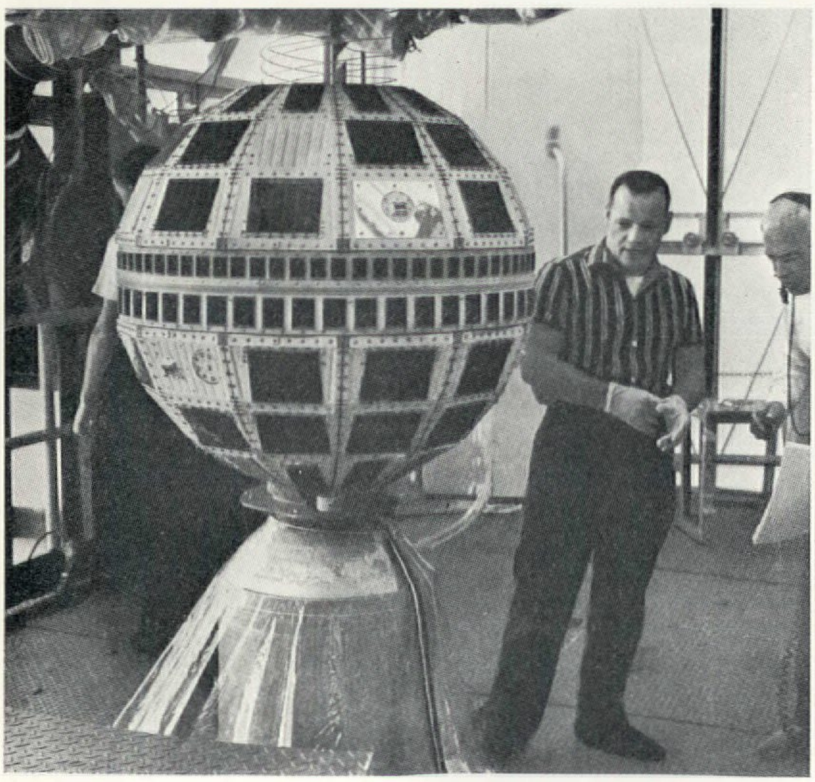
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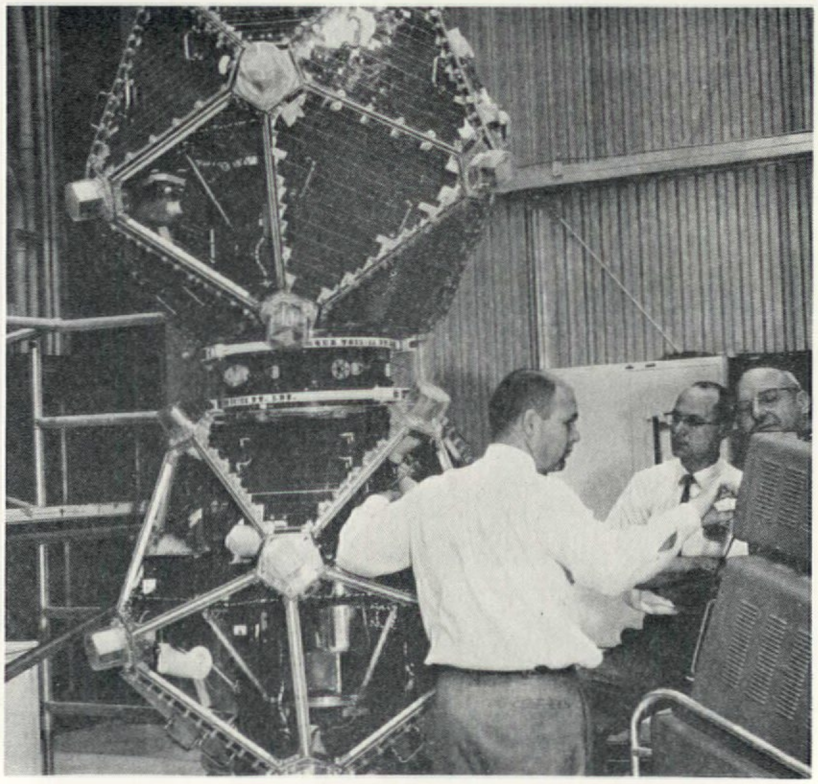
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This example may seem much less dramatic than the TV transmission of human space walks, and moon surfaces viewed recently, but information gained by such workaday satellites may be of greater direct value to the solution of various world problems. The World Weather Watch scheme, proposed in 1965 as part of the UN International Cooperation Year, seeks the combination of such satellite reported data with global weather observation at various atmospheric levels, a fast world-wide high capacity communication system and a large size computer facility containing an adequate 'numerical model of the atmosphere'.

With the World Weather Watch data, an adequate computer and global mathematical model, a vast array of experiments on weather and climate modification can be performed by numerical computation rather than in nature...full effect and potential hazard can be determined without risk to life or property. For example, a dam can be 'built' across the Bering Strait for an infinitesimal fraction of its real life cost, and we can evaluate its effect on the Kamchatka or Canada wheat growing season... we can model a megalopolis and its atmospheric cesspool, examine the extent to which it acts as an inadvertent weather modifier, then 'clean up' the atmosphere and see the difference. We can do this without taxes, political strife, vast engineering expense—in a computer[5].

4

In addition to conventional photography from satellites, multispectral sensing is also being employed with the infra-red, ultraviolet and other wavelengths such as X-rays and radar. Using infra-red, for example, it would be possible to have detailed surveys of traffic in and out of cities, of human occupancy of building through their heat patterns. Numbers of cattle on grazing range, changes in forests, fields and even animal bird migrations could be easily surveyed.

In 1966 the UN Secretary-General called upon Canada, Chile, France, the Philippines, the Soviet Union and the United States to endorse a proposed five year programme of world surveys of minerals, energy and water resources. This will be a first step towards 'an orderly systematic approach to natural resources development in the world and the developing countries in particular'. The cost of this world resources survey of non-agricultural resources is set at $10 million spread over the five-year period. The nine survey areas are:

World iron ore resources.

Important non-ferrous metals.

Selected mines in developing countries with view to increasing ore reserves and production through application of modern technology.

Offshore minerals in developing areas.

Water needs and resources in potentially water short developing countries.

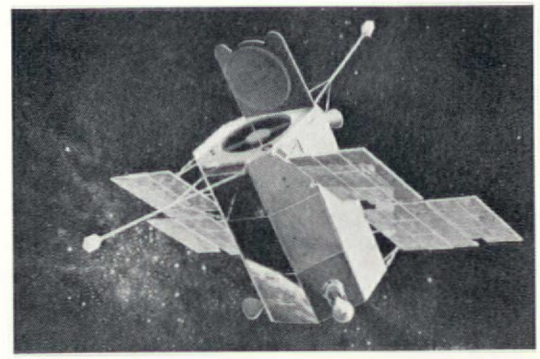
Potential for development in international rivers.

Potential geothermal energy resources in developing countries.

Oil shale resources.

Needs for small-scale power generation in developing countries[6].

In developing the theme of the new symbiotic relation of man to his most advanced machines, we have emphasized those aspects of technological means, 'that have been pressing humanity so rapidly towards a closely interconnected species, a species in full possession of the world and its abundance and with an adequate capacity for control and survival, that are reaching towards more mature and stable forms in this generation[7]'. The impact of this evolutionary process on our individual viewpoints is already quite marked. Where tribal man became disoriented when separated from his local tribe, and early city and local state man could barely conceptualize his immediate surrounding environment, we are now in a period when men think casually in terms of the entire planet.



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1
First complete view of the world's weather was assembled from 450 photographs taken from one satellite Tiros IX, within 24 hours. The new Essa satellites make it possible to examine photographs of any area within an hour of the satellite passing over

2 & 4
Telstar II being checked before being launched

3
Tandem satellites launched in 1963 after the Nuclear Test Ban Treaty. After launching they split and orbit on opposite sides of the earth

5
Grumman orbiting astronomical observatory

6
Radar telescope at Stanford, California

7 & 8
Horn antenna, within an inflated Radome, designed with the accuracy of a wrist watch. It funnels down to a pencil-thin tube that leads to a ruby maser that serves to amplify signals as weak as a trillionth of a watt

Photos: 2, 4, 7 & 8, Bell Telephone Laboratories; 3, TRW Space Technology Laboratories; 5, Grumman Aircraft Engineering Corp.; 6, Twentieth Century Engineering *Museum of Modern Art*

[4]*Information: US Strategic Air Command, (402) 294–2544/4433.*

[5]W. O. Roberts, National Center for Atmospheric Research, *Science,* Vol. 152, No. 3119, April 1966.

[6]UN Press Release, E.C. 2308, April 1966.

[7]John R. Platt, *The Step to Man,* September 1964.

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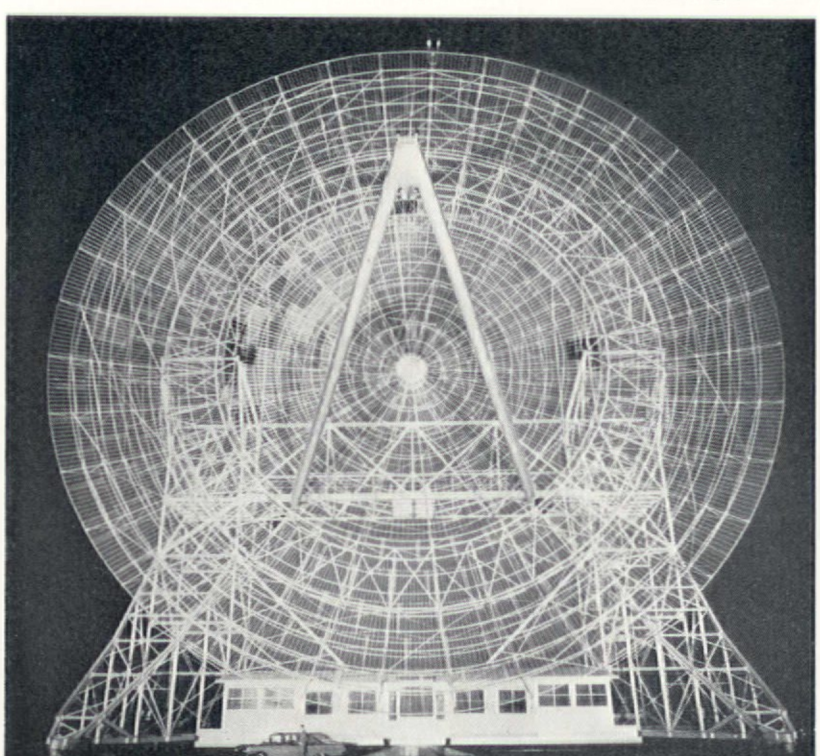

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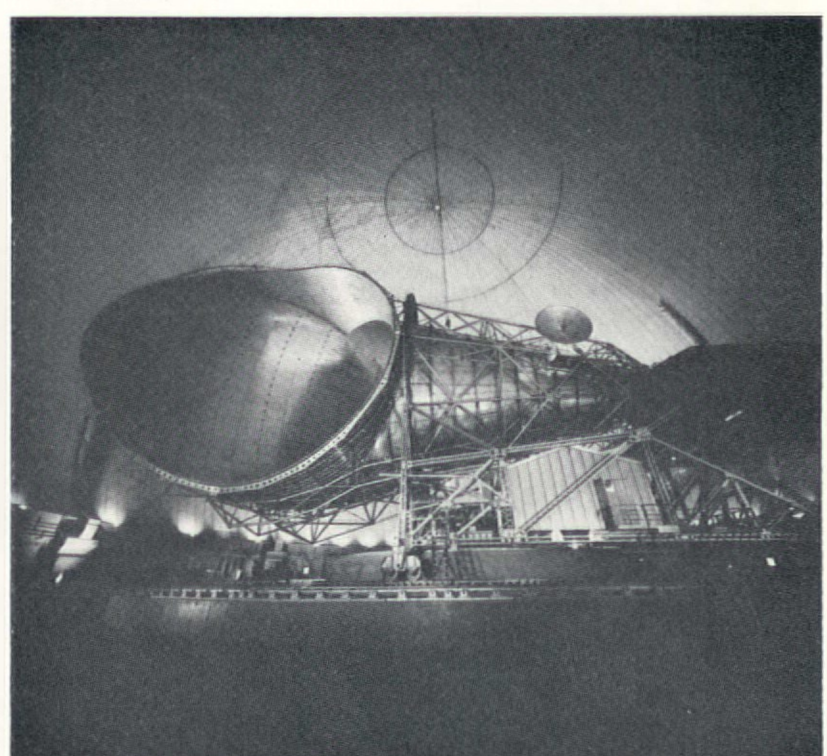

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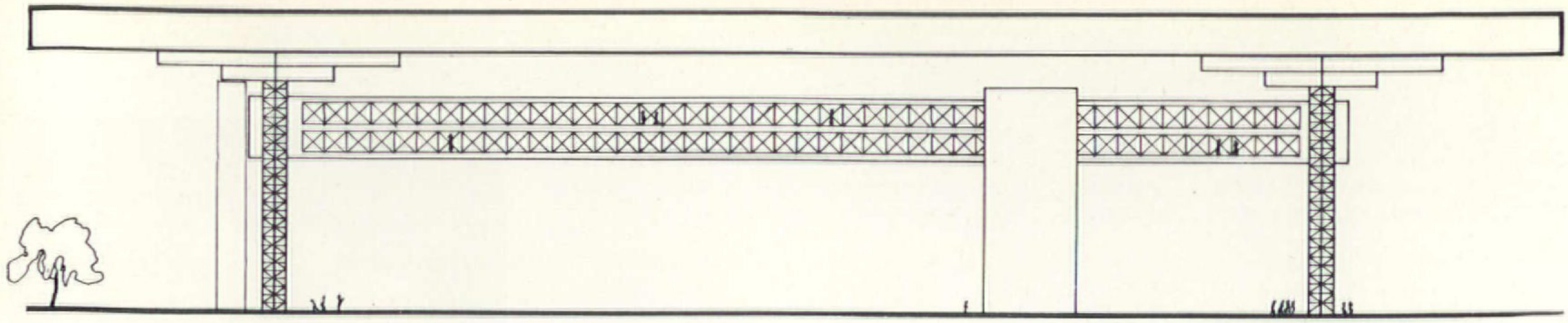


1

The World Game

An application of the new symbiosis for peaceful purposes

As part of Buckminster Fuller's World Design Science Decade 1965–75, a further development of the Geoscope concept* has been initiated at Southern Illinois University. The proposal by Fuller is concerned with the development of a large-scale, computerized, world display and 'gaming' facility as part of the University's forthcoming Centennial celebrations.

There has been a general lack in large-scale economic and social planning and adequate tools for the visualization and correlation of the myriad variables associated with major human problems. Many separate agencies in government, business and particularly the social sciences have already developed gaming and simulation procedures for their various special interest areas. The World Game will be the first attempt to set up a physical facility directed towards the solution of world problems on a scale now only available for war gaming. Though similar to the World Game, and extremely advanced technically, the large military command and control installations are limited by their purpose. In the SIU facility the whole world map complex would be treated as a dynamic display surface capable of showing a comprehensive inventory of the planet's raw and organized resources, together with the history and trending patterns of world people's movements and needs. The displays will be housed under a large space frame truss of tensegrity structure, 500ft × 400ft **1** supported on four columns linked by 20ft wide cat-walks with graphic display consoles and other auxiliary equipment for individual control, from which the relief map on the ground may be viewed **2**.

Appropriate technical means for such controlled variable displays are already available and work data would be drawn upon from local or remote information banks. The 'game interaction' of the facility would be comprised of a series of computer programmes based on the principles of game theory, general systems theory, input/output theory, etc. These would allow the setting up of:

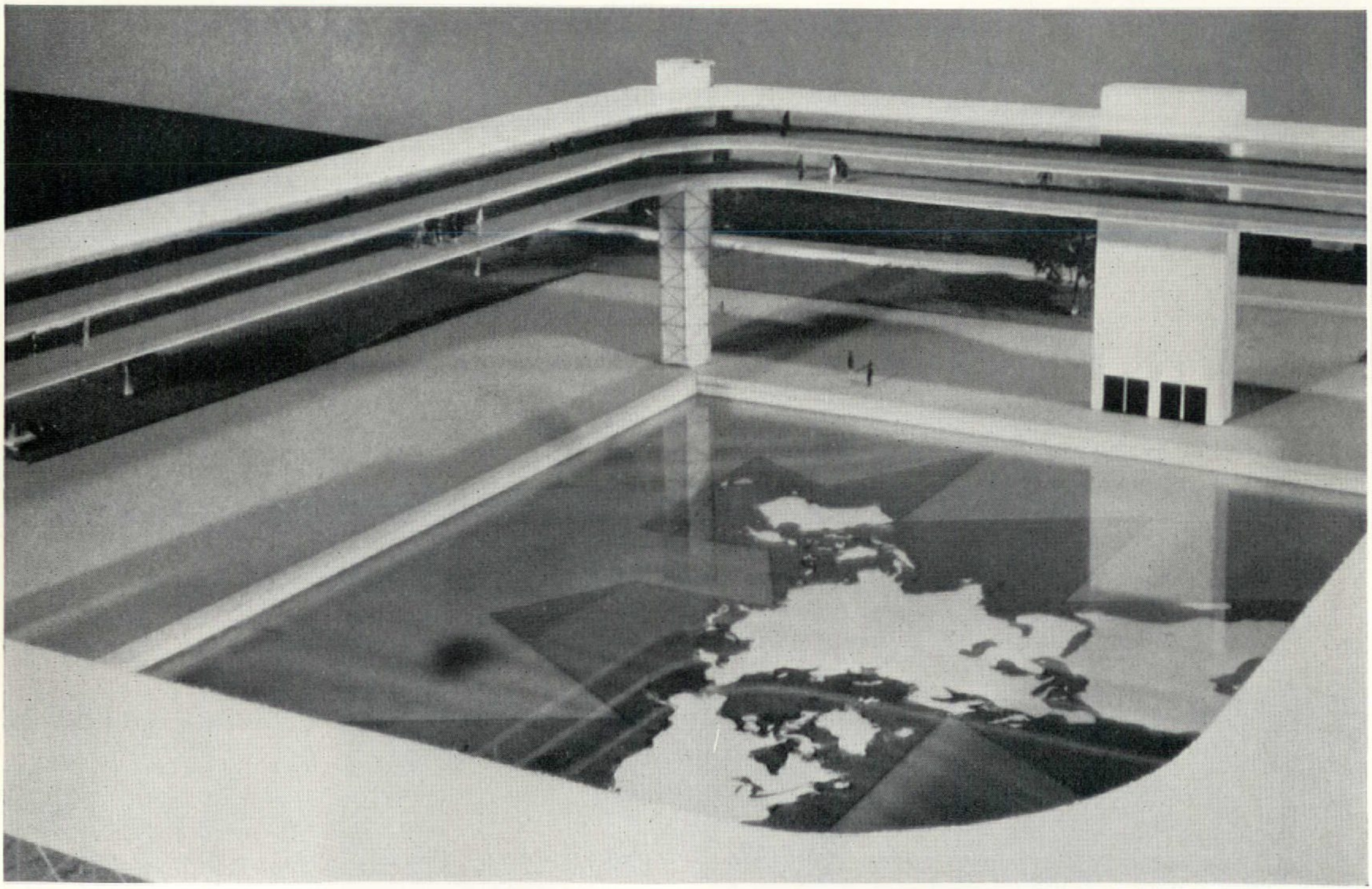
Coded displays of world problems singly, or in relation to one another, and allowing for retrospective viewing of past historical and present trending patterns with the possibility of extrapolating and comparing various trends in future time increments.

Programming various solutions to such problems in terms of immediate and future resource availability and development, etc.

Evaluating the success or failure of solutions proposed both in terms of their immediate context and in relation to other problems/solutions. All such information would be stored and, in turn, fed back into the overall programme.

Apart from such gaming aspects, the direct educational uses of such a centre will be obvious. At the scale envisaged, large numbers of students may be instructed simultaneously; advanced students and research workers may pursue individual studies; displays and programmes may be transmitted to other universities and centres.

* John McHale, 'The Geoscope', *Architectural Design*, December 1964.



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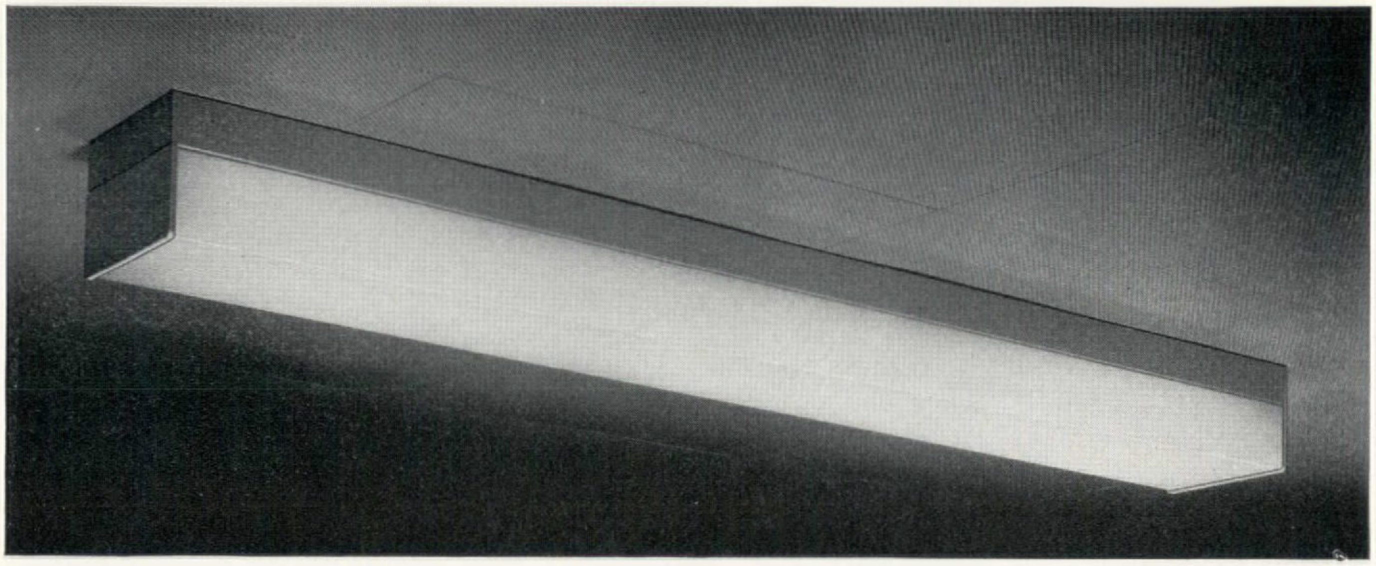

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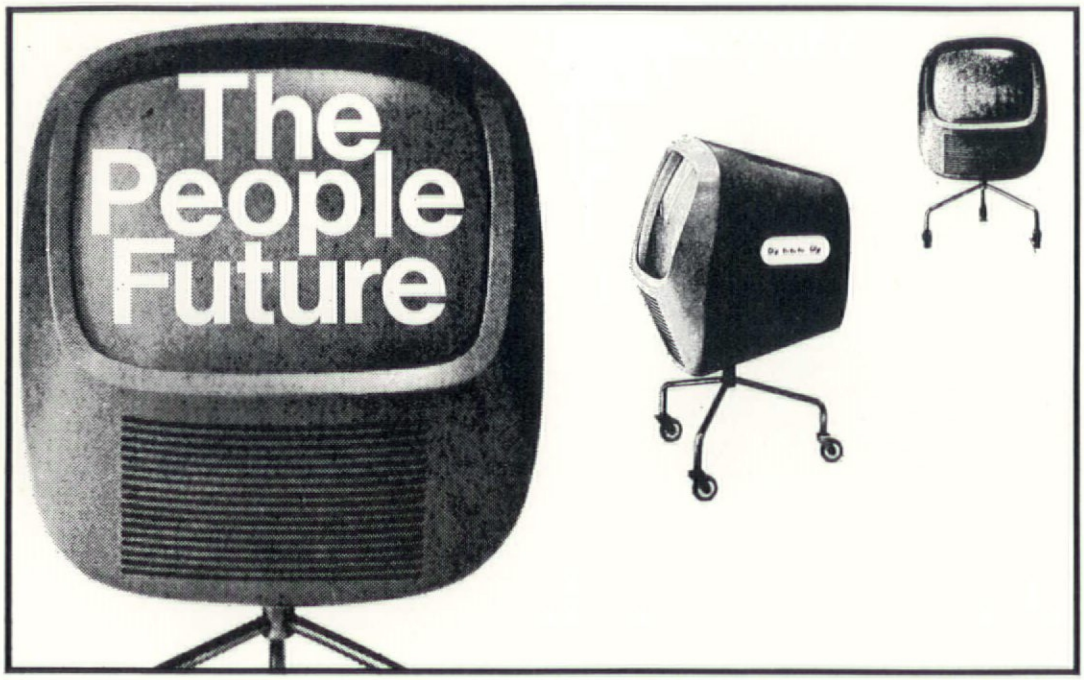

It would be usual here to run through some future extrapolations of present technologies; to review ways in which everyday life would be different in various kinds of super-mechanical and exquisitely organized environs. We could go on, at length, to discuss flexibly mobile automated 'homes of the future', with food synthesizer/dispensers, 3D television, instant laundries and recycling garbage disposals which fuel atomic power plants. Or we could deal with air-conditioned cities with personalized weather control, phone booth matter transmitters, holidays on the Moon or under ocean or time travel. Discussing the 'population problem', the bomb and other more sombre issues would allow the depiction of alternatively dark futures.

A more fruitful exercise, however, even if less stimulating, may be to try to examine our approach routes to the future in terms of individual and social attitudes. What are some of the human factors—not only the consciously measurable but also those which unconsciously influence human decisions and change orientation?

Man's future is determined, not only by what is probable and possible—but by what he determines as necessary, allowable and ultimately desirable. Our main emphasis has been on the technological means for refashioning the physical planetary environ and, to the lesser degree, on the refashioning of man himself.

Man's present ability to evaluate and determine his future goals, or solve many of his most pressing problems, lags far behind his now enormous capacity to fulfill any goals he may set or solutions he may propose. Merely to underline his possibilities of choice and control in no way illumines any of the factors which prevent him from exercising such control.

This line of enquiry usually founders in a variety of factors lumped together under the term human nature. Yet even this major constraint is lessened nowadays when we accept the innate variety and plasticity of human behaviour response. There are few instinctual human characteristics which have not been modified and shaped by learning and experience. Human nature is largely made by humans.

The most clearly identifiable organic drive is towards survival, and the strongest attitudes are those grouped around survival strategies. In seeking to define those factors which constrain positive change and seemingly negate our most inventive social strategies we would do well to re-examine some of the most cherished social attitudes, institutions and values which form the basis of human society. The key to many of our difficulties lies with the identification of those social orientations which have had great survival value in the past but which may now endanger our survival in the present—and cripple our approach to the future.

All futures are conditional on a present which is conditioned by the past. To invent the future, we must exorcize the present from obsolete past 'realities' which now operate as constraining mythologies.

All of man's past historical experience was of margin survival. His societies were based on the economics of scarcity. Bound to agriculturally determined cycles, life itself was dependent on capricious external agencies which were influenced only by propitiatory sacrifice. In such societies permanent value and meaning resided primarily in those external institutions, systems and objects which aided survival. Life expectancy was low and individual man, seemingly fleeting and impermanent, was prodigally expended in order that the group might survive. In a scant few hundred years, and more abruptly within the last century, this has all been changed. But the transition has been so swift and its effects so pervasive that the bulk of our attitudes is still moulded by thousands of years of contrary experience. The strongest myths of all, therefore, still surround the nature of wealth, value and meaning and the degree of their dependence on external agencies for validation and support.

We refuse to accept the reality of potentially 'limitless' wealth inherent in our new symbiotic relation to automated technological process.

The nature and full effects of such technological development is barely understood—even by those who have invented its components, organized its productive capacities and are responsible for its continued expansion. The stage of scientific and technical development which renders large-scale automated process possible also destroys all previous *intrinsic* value in physical resources or properties. From this point on, broadly speaking, all materials are inter-convertible. The only unique resource input is human knowledge—the organized information which programmes machine performance. The products are non-unique and expendable, as are the machines and materials acted upon by them. The only part of the whole process which is non-expendable and uniquely irreplaceable is man.

Typical of our obsolescent constraining myths are various ideological and political blocks towards effective social reorganization. Ownership of the means of production, transport and communications becomes conceptually unreal as the control, operation and further development of these outstrips the capacity of any private interest group and begins, in the case of large-scale undertakings, to go beyond that of national governments. With such fundamental change in the production of wealth, the real concern is with accountancy systems to regulate its equitable distribution. Our present systems of international regulation reflect a preoccupation with pre-industrial value standards. They still talk in terms of trade balances, deficits and currency problems and look back nostalgically to a pre-Renaissance gold standard.

Material possession is no longer a source of economic power and ownership—and no longer a necessary use relation between people and products. Use value has largely replaced owner-value. Technical means actually trend towards using and being less material.

Another outdated myth is that of the *expert*. International aid and development is very much the realm of conservative expertise. In city planning we usually recruit our experts from those responsible for the problems, and we hand over the solution of world problems to those whose record clearly disqualifies them from the task.

Human labour is no longer the yardstick of productive wealth. The virtues of hard work towards self profit, whether in the accumulation of material or spiritual goods is largely eroded. One of its last strongholds is formal education which still accords high moral value in due ratio to difficulty and labour in learning. Cultivated aesthetic taste is also associated with the acquisition of hard-won 'understanding'. Even the most recent *programmed* and *re-inforcement schedule* techniques of learning are still curiously biased on the relation of work to profit. We may see clearly that all our notions of the supposed virtues of imposed hard work and self profit are based largely on the economics of scarcity and on previous standards of marginal survival. We retain certain illusions and compulsions because we cannot design any other supports for the social edifice. In exacting 'gainful' mechanical work as required by pre-industrial society in return for sustenance and shelter, many of man's more important activities were relegated to marginal status. By still regarding them as leisure, hobbies and entertainment, we deny them status and their potential of replacing gainful work as social activities.

In discussing such problems of futures planning—like the re-investment of work time in other areas—*values* are usually cited as the restraining factor. Many of our *value* setting authorities have lost their power to indicate goals and set value standards, i.e. the Church, the family, the traditional humanities. Science is often suggested as possibly the only valid area with sufficient strength to give directive authority. The substratum of the argument is probably finer than that. This western dialogue about values, science and man has been going on in intensi-

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fied fashion since the Renaissance, when science overthrew the notion of an earth centred universe and began to erode the belief in a god centred one. On the other hand, what may have happened during the dialogue is that we have transferred our belief in God to a belief in science. It may indeed be salutary to examine the ways in which science itself has become the kind of system which purports to stand outside of, and be superior to, individual man. We may note that its most touted virtues lie in a series of abstract systems of arriving at *truth*, whose findings are evaluated in inverse ratio to the degree of fallible human judgment inherent in their method. The *value* of scientific method is the extent to which it is *objective* and independent of any specific idiosyncratic human observers.

Of course, the science of science has now begun to discover the strange ways in which science has really developed—through the unpredictable intuitions of highly idiosyncratic observers whose insights have repeatedly altered the conceptual framework of various fields. This, usually, in the face of duly scientific opposition.

It would be dangerous to accord science the function of an ideological sacred cow capable of generating new sets of human values. Considering all areas of human enquiry, science undoubtedly contributes greatly to our evolving value systems. Scientists themselves, however, have been as easily seduced by power, prestige and other inducements to cooperate in the most negative activities of man as other professionals. In the pursuit of alternate approaches to futures planning it may be useful to question the idea that science and its ancillary technologies will remain the major agencies of innovation in society—providing the mainsprings governing social change. We have relied, perhaps too much, on the notion that the individual and society could, at best, only adjust to changes forced by the pace of scientific and technological development and their attendant economic facts. Major innovative action directly affecting man and society has been increasingly accorded to hard science. The arts, humanities and soft sciences, could only express or communicate reactions to changes in the human condition—after the fact.

There are many reasons for this point of view. Given man's preoccupation up to now with basic survival, the hard sciences at least provided usable information to help control better his physical environment. The other areas provided the trimmings to adorn his living and make it more meaningful. They could also record his social processes, measure his interactions with fellow men and review critically the various institutions which evolved, more or less unconsciously, as the result of fortuitous changes in his environment. The only applied social technology was politics as the sole mechanism for low-geared social innovation and change. However, it only acted after the fact and, though we have more recently tried to set up agencies to deal with change in a less reflexive manner, they are still tied to political decision and expedients.

We have had neither the knowledge of social processes nor the appropriate individuals capable of using this in a more directly creative manner. It is possible that we now have both.

In attempting to devise ways of reaching conclusions on future social changes, Bertrand de Jouvenel, for example, suggests a Surmising Forum, '. . . a free market for surmises, allowing the thoughtful members of the public to derive their own views of what is most likely, to discern what should be done towards what seems to them the most desirable among the possibles'[1].

One type of surmising forum, the US 'Commission for the Year 2000', under chairmanship of sociologist Daniel Bell, has recently completed its first year's report. The aims of this distinguished interdisciplinary group are to 'sketch hypothetical futures' so as to enable better decisions to be made, measure social performance, anticipate developments and the kinds of political theory which might accommodate various alternative futures[2].

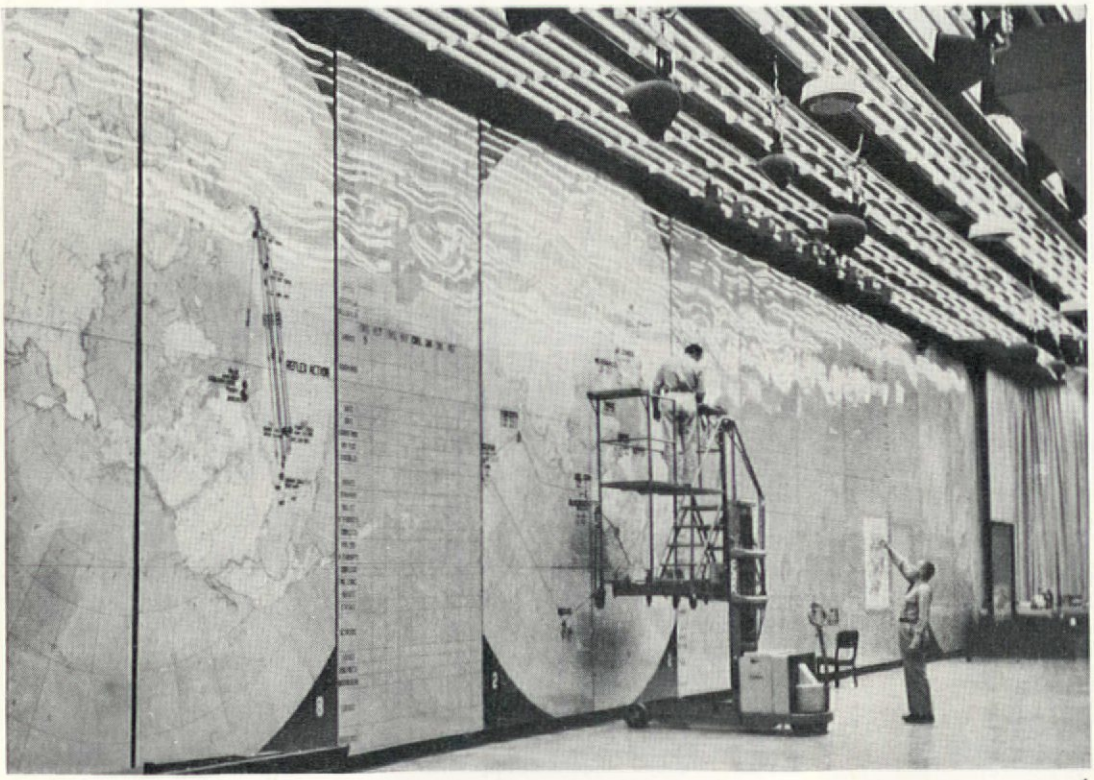
The arts are often suggested as alternative areas in defining the edge of change in society. But, as traditionally regarded, they are no longer a canonical form of communication in society. The visionary poetry of our period or its symphonic equivalent is as likely to be found on TV, or in the annual report of an aerospace company, as in the book, art gallery or concert hall. The future of art seems no longer to lie with the creation of enduring masterpieces, but with defining alternative cultural strategies. But in destroying the formal divisions between art forms, and in their casual moves from one expressive medium to another, individual artists do continue to demonstrate new attitudes towards art and life. As art and non art become more interchangeable, and the masterwork may be a reel of punched or magnetized tape, the artist defines art less through any intrinsic value of the art object than by furnishing new concepts of life style.

It is evident that if we are to redesign life styles more flexibly and provide the type of multiple choice environ of which our tools now render us capable, we shall have to look for new paradigms. When we speak of change, we remain parochial and personally indifferent to its real meaning. For the west, this is most evident in its attempts to assist underdeveloped nations. Change is encouraged, but only in directions approved by the provider of assistance. We have introduced as many socially negative ideas as useful technologies. 'The west, in attempting to export its values, more often merely communicates its complexes.'

One key criterion, perhaps, for any futures planning, any conscious design of the physical environ or social organization, is the degree to which any such design assists or constrains human activity. This overall concept is largely missing from much of our present thinking. As an evaluative attitude, it needs to be employed at every level in social accounting—from tax procedures to education—to the your-system-or-my-system theme in our present international conflicts. Man and his evolving requirements are superogative to any system conceived of by man.

[1]B. de Jouvenel, 'Technocratic Age in France', *Bulletin of the Atomic Scientists*, October 1964.

[2]American Academy of Arts and Sciences, 1966.



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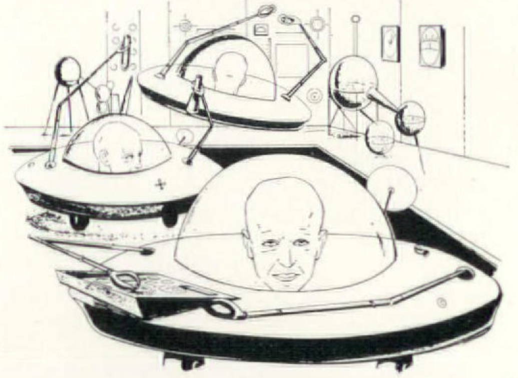

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Technology, for all its spectacular promise, also has its sombre and perverse side. The black Gothic horror of the past may easily be replaced in the twentieth century by that of the Bomb, or the sheer hollow, callous, achievement of technological advance. The fantastic ability that has been developed to ascertain and correlate information has so far been used efficiently only for military purposes. The brightly lit, unassuming interior on the left is the nerve centre of the USA Strategic Air Command's three-storey concrete building buried far below the earth **1**. From here a future war might be directed. Science is readily diverted to anti-human end **2**. 'It is already technically possible,' Dr Robert White of Ohio, has said, 'to maintain a human head and neck alive, together with the enclosed brain, after it has been removed from the rest of the body.' All pleasures and emotions would be generated through nerve impulses. *Photo: 1, US Air Force; 2, D. M. Cole,* Beyond Tomorrow

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The effects of technology on man's environment

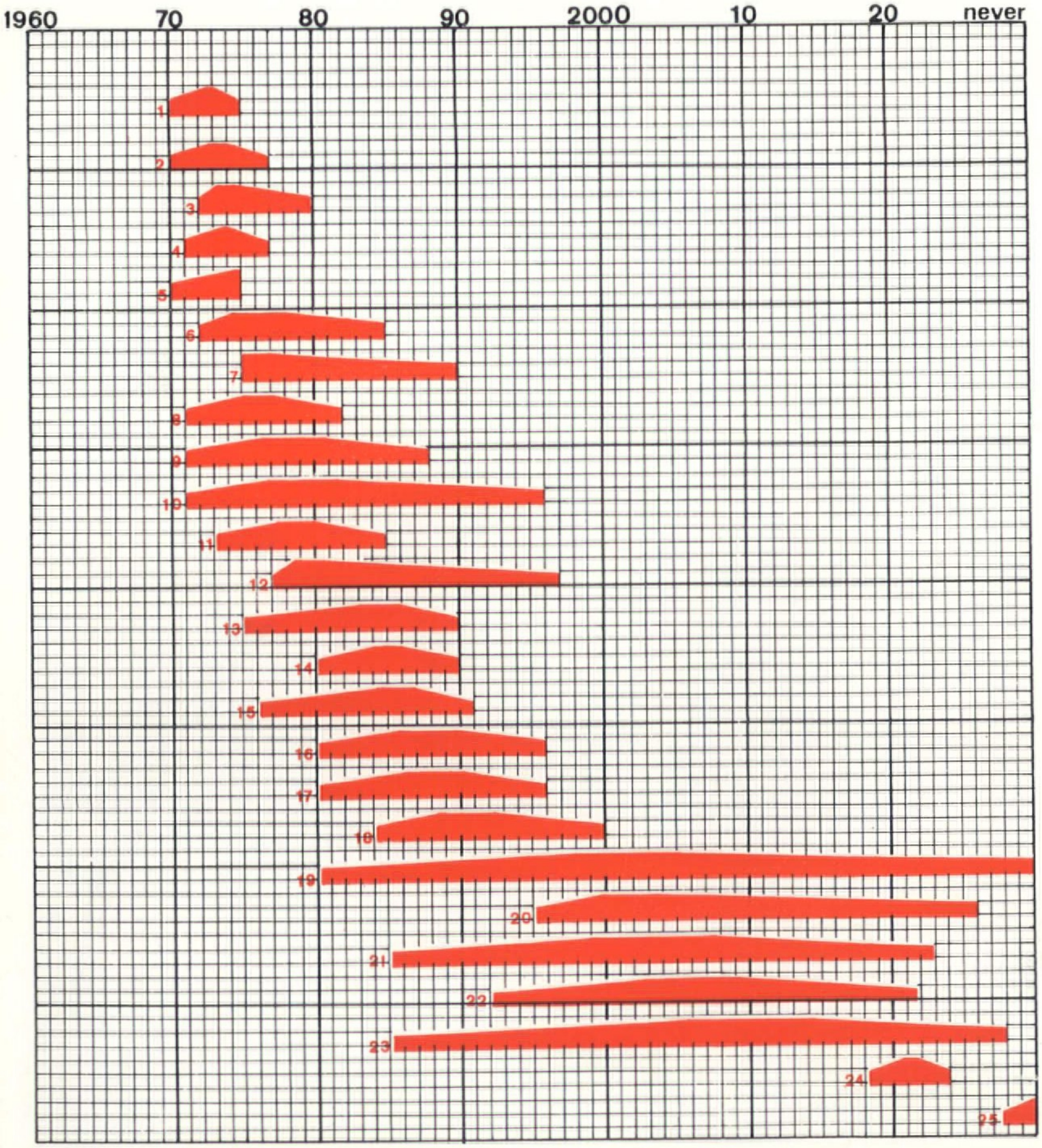
Theodore J. Gordon
(Rand Corporation, USA)

As scientific research progresses we gain greater control over our environment. Yet the power of these tools which give us this control, in the hands of an unprepared or indifferent people, faced with social pressures of unprecedented magnitude, may result not in greater control but self-extinction. It becomes imperative for us, therefore, to attempt to gain insight into the nature of the tools which can affect our environment and on the emerging society which will use them. Only through this kind of projection can we hope to avoid social calamities which may result from the sudden emergence of powerful mechanisms of control without previous preparation or understanding of the implications of their use.
Prediction-making is clearly part of our everyday life. Computers are used during political elections to predict results, based on a small (but carefully selected) sampling. In rocketry, a computer technique known as 'Monte Carlo' is used to predict the probable path of a rocket. Operations analysis and operations research are very powerful tools. The technical, military, commercial, social and political planning of our world is becoming increasingly related to prediction-making.
A study in a prediction technique was recently performed at Rand by Dr Olaf Helmer and his associates. The study was an experimental exercise in prediction, covering a period extending fifty years into the future. In addition to simple methodological results, it yielded substantive predictions from which a picture of the world and its problems fifty years hence could be formed.
The methodology of the study was known as the 'Delphi Technique'. Eighty-two knowledgeable people formed six panels:

- Scientific breakthroughs
- Population control
- Automation
- Space progress
- War prevention
- Weapons systems

The panellists never confronted each other during the study. Contact was maintained only by mail. The panellists included economists, engineers, mathematicians, and logicians, military officers, operations analysts, physical scientists, social scientists, and technical and science fiction writers. They were guaranteed anonymity, if they desired, in any publication of the study's results. The study worked this way: questionnaires were mailed to the panellists to probe their opinions about the future. In the first questionnaire, the panellists were asked what they believed might happen in the next 50 years in the areas of their specialty. The responses from the first questionnaire were collated and the results fed back to the panellists, who were then asked to assign a date to these events. The dates were then compared, and on the third questionnaire, the panellists were asked to state their reasons for any wide disagreement they held with the median opinion. The fourth questionnaire sharpened the questions further and asked for a restatement of opinions. The study group found that the projected opinions generally converged. This technique avoided common pitfalls of group meetings such as the staked reputation, 'follow the leader' and the band wagon effect.
Some elements of this picture were surprising. Here are some random samplings from the study:
Another major war, unhappily, is relatively probable (20 per cent within 25 years). However, the study produced a paucity of new suggestions as to means for preventing this war. The tools of war will make a great deal of progress, including such devices as incapacitating and lethal biological agents, perishable counter-insurgent arms, directed energy weapons weather manipulation, and hypnotic recruitment of forces from the enemy's population.
The study produced a relatively optimistic prediction about the rate of growth of the population of the world. The slowing trend was based on the belief that birth control measures would be widely accepted. Various means of increasing food production are potentially available and, if the problem of food distribution can be solved, we will not reach the Malthusian limit.
The problem of potential unemployment resulting from automation will be serious. Social upheavals may accompany automation, but suitable counter-measures may forestall these disruptions. Counter-measures may include creation of new types of employment, retraining, education for leisure, massive aid to under-developed regions, compulsory post-high school education, etc.
Actual symbiosis of man and machine may progress to the point of enabling man to extend his intelligence by direct interaction between his brain and the computer. Beyond this, there is perhaps the possibility of education by directly recording information on the brain.
Man will achieve a greater control of his

▷97



Consensus on automation
(medians and quartiles)

1. Factor of 10 increase in capital investment in computers for automated process control
2. Air traffic control—positive and predictive track on all aircraft
3. Direct link from stores to banks to check credit and to record transactions
4. Widespread use of simple teaching machines
5. Automation of office work and services, leading to 25 per cent displacement of work force
6. Education becoming a respectable leisure pastime
7. Widespread use of sophisticated teaching machines
8. Automatic libraries, looking up and reproducing copy
9. Automated looking up of legal information
10. Automatic language translator—correct grammar
11. Automated rapid transit
12. Automatic decision-making at management level for industrial and national planning
13. Electronic prosthesis (radar for the blind, servo-mechanical limbs, etc.)
14. Automated interpretation of medical symptoms
15. Construction on a production line of computers with motivation by 'education'
16. Widespread use of robot services, for refuse collection, household slaves, sewer inspectors
17. Widespread use of computers in tax collection, with access to business records
18. Availability of a machine which comprehends standard IQ tests and scores above 150
19. Evolution of a universal language from automated communication
20. Automatic voting, in the sense of legislating through automated plebiscite
21. Automated highways and adaptive automobile autopilots
22. Remote facsimile newspapers and magazines, printed in home
23. Man-machine symbiosis, electro-mechanical interaction between brain and machine
24. International agreements which guarantee certain economic minima to the world's population as a result of high production from automation
25. Centralized (possibly random) wire tapping

◁96

physiological, biological, and genetic destiny. Personality control drugs will be widely used in the relatively near future; biochemicals may be used to stimulate the growth of new organs and limbs. Progress in the psychochemicals and genetic research may lead to general immunization against bacterial and viral diseases and the feasibility (but not necessarily the acceptance) of chemical control of some hereditary defects through modification of genes; i.e. molecular engineering.

Anti-gravity is not beyond expectation, although the mechanism for such a breakthrough cannot even be articulated today. Apes and cetaceans may be bred to provide intelligent low grade labour.

Computerization may bring about a world language. Automation may increase the world's industrial productivity to the point where leisure becomes our major problem and a substitute must be devised for the Puritan ethic of work. In that day, perhaps we will have a worldwide system of distribution guarded by international agreements.

In the discussion which follows I have listed several projections. Included in each is the median date anticipated by the long-range forecasting panels. Following the median date is a discussion of the item developed by the author which provides some background information and possible correlations with other future technological advances.

Ultralight materials

The panel projected a median date of 1971. The development of new high strength materials will have a great effect on possible architectural forms and concepts. These materials can be strong plastics or composite reinforced metals; ultra strong metal whiskers have been grown in laboratories. Because of the absence of crystal fracture planes, these whiskers have extremely high strength; iridium, for example, has a strength 100 times greater than today's structural steel. It is possible that these whiskers can be alloyed or will be used to stiffen conventional materials to achieve very high strength materials.

Weather forecasts

The panel projected the advent of reliable forecasts by 1975. Almost every segment of the economy of the world will benefit from accurate predictions. For example, several years ago President Johnson estimated that predictions, accurate five days in advance, would result in annual savings of 100 million dollars in surface transportation, 75 million in retail marketing, and three billion in water resources management. Accurate weather prediction will facilitate control of air and water pollution, promote agricultural scheduling, and provide dangerous-weather warnings of increased precision and scope.

Central data storage

The panel projected the operation of a central data storage facility by 1980. Computer technology is carrying us toward large memory machines which have simple access. We have already seen that non-specialists are making use of these powerful tools. As computers are adapted to a wider variety of uses and the number of people capable of employing them increases, we can expect to see applications in fields currently planned only through intuitive judgment. For example, crop rotation might be predicted analytically, smog conditions could be anticipated and avoided through enforced restraint of automobile travel or through utilization of non-volatile fuels; urban services could be projected on anticipated population needs; and university curricula could be established on the basis of demands of the anticipated economic and business structure.

Desalination

The panel felt that economical use of desalination of sea water might occur by 1970. What can the availability of economic desalination mean to the world? Growing world population will demand new sources of food and water. As new areas are open to cultivation it will become important to discover additional sources of irrigation. Fresh water has proven to be an important tool in man's control over his environment; new sources of fresh water will strengthen and increase the span of his control.

Ocean mining

Median date projected for this development was 1989. The increasing world population will accelerate the demand for natural resources. Furthermore, the *per-capita* demand will increase since under-developed nations will rapidly expand their consumption of raw materials. Therefore, it is probable that new sources of resources will be required; mining from the ocean bottom may provide the solution. National boundaries may be extended into the oceans because of the importance of this new source of raw materials.

Ocean farming

The panel projected that by the year 2000, 20 per cent of the world's food may come from ocean farming. Ocean farming can appear in two general forms: algae cultivation and harvesting, and the cultivation of meat fish herds. As world population swells, ocean farming will become increasingly important. In order to maximize ocean food output, the technology of oceanography, ocean agronomy, and ocean ecology will be expanded. Floating or subsurface agricultural stations may be required.

Money

Median projection—1974. The advent of a credit card economy could result in the virtual elimination of money. Payment for services could be accomplished by a computer transaction, crediting the employee's account; advanced automated processes could be used to transfer these credits from the employee's account when he makes a purchase. These systems are being employed today in bank clearing houses; the extension to public transactions would involve installation of automatic data transmission systems, circuitry designed to authenticate the buyer and the seller, and perhaps television systems by which the product could be examined remotely.

Thermonuclear power

This event was projected in 1986. Experimental work is currently being conducted at Livermore and elsewhere in the USA and overseas to determine means for producing controlled thermonuclear reactions. These reactions, similar to those on the sun, consume hydrogen at very high temperature and yield helium and nuclear energy. It has been estimated that sea water deuterium expended in controlled fission power generators could meet man's increasing energy needs for billions of years. Power-producing plants employing thermonuclear power will not generate radioactive wastes. The major technical problem at present is the development of a technique for containment of the ionized plasmas which exist at billions of degrees. Fission reactors hold the promise of producing electrical energy very economically directly from heat with no moving parts. Since a major impediment to the development of desalination systems is the availability of cheap electrical power, the advent of controlled thermonuclear power might also trigger implementation of large scale sea water conversion projects. When controlled thermonuclear power stations replace conventional and atomic generation stations the production of electrical power need not contribute to atmospheric contamination.

Weather control

This item was projected at a median year of 1990. A special panel of the National Academy of Sciences has investigated the results of cloud seeding over a period of several years. Their report stated in part: '. . . we found some evidence for precipitation increases (after attempts at weather modification) of as much as 10 or even 20 per cent over areas as large as 1000 square miles over a period ranging from weeks to years.' Shortly after this report was issued, legislation was introduced in Congress to initiate comprehensive programmes of scientific and engineering research and tests to investigate the increase of the yield of water from atmospheric sources. This marked the beginning of government sponsored weather control and the programme envisioned includes rain making, snow making and hail, hurricane, tornado, lightning, and fog suppression. Many commercial operators are already in the business of cloud seeding and, judging from the AAS report, are meeting with some success. Experiments have also been conducted already in modifying the severity of hurricanes, through silver iodide crystal seeding. Artificial tornados have been produced in the laboratory and in the field. Our weather satellites in orbit are permitting more accurate weather prediction on a global scale. The Tiros and Nimbus satellite series currently provide pictures of cloud cover from orbit, transmitted to ground stations on command. Study of these data is leading to a deeper understanding of the mechanisms of global weather. The advantages of weather manipulation seem obvious; however, since the forces involved are extremely large, great environmental danger may be present.

Genetic control

The panels predicted several items related to man's emerging control over his genetic destiny. These projections included economic feasibility of commercial generation of synthetic production of food (1990), biochemical immunization against viral and bacterial diseases (1995), feasible (not necessarily acceptance) of chemical control over some hereditary defects by modification of genes through molecular engineering, biochemicals to stimulate growth of new organs and limbs (2007), and chemical control of aging processes extending the life span by 50 years (later than 2020).

Scientists are now in the process of determining the sequence of chemical alignment along the strands of DNA helices which produce specific cellular manufacturing instructions. Once these codes are determined the information will be at hand by which control over a cell's genetic instructions may be influenced. Through modification of these cellular instructions it may be possible to manufacture specific proteins *in vitro*. In all of man's history he has had to rely on animals or plants for food. Protein synthesis through DNA cellular controlled processes will give man opportunity to manufacture his food.

Genetic engineering may become important as specific codes become known and means for manipulation are perfected. It may be possible to intervene in the cellular inheritance processes and manipulate the instructions transmitted from one cell to another. Understanding of the genetic processes may lead to the ability to control the anti-body rejection and thus permit the ready transplantation of foreign organs and limbs.

What is the relationship of this biochemical revolution to man's environment? Simply this: with genetic manipulation a reality it may be simpler or more desirable to tailor man to the environment rather than environment to the man. Thus, we might create a cold-resistant strain of human beings for arctic habitation or a *g* tolerant strain for high acceleration space flight.

Fertility control

The population explosion, of course, will have a tremendous influence on man's environment of the future and his ability to control it. There is general agreement that an extrapolation of today's increasing rate of growth will place the population at over 9 billion in the next 60 years. The RAND panel felt that there would be a diminishment of the rate of increase because of acceptance of birth control measures resulting in a projected world population of seven billion at the end of 50 years. Even this doubling of population implies a doubling of food, power and resources production to maintain current *per capita* levels. This will be very difficult to accomplish. Furthermore, increasing population levels apparently inhibit the rate of economic growth of developing countries since major portions of available resources must be devoted to sustenance and cannot be diverted to other segments of the economy such as industrialization. Much has been written about the effects of overcrowding of environment. Certainly overcrowding will result in problems of waste disposal and some scientists predict that man will be doomed by his own contaminants.

Overcrowding can lead to a type of social pathology in which abnormal behavioural patterns are developed. In experiments with rats, overcrowding led to abandonment of progeny, hypersexual and homosexual behaviour, cannibalism, and other aberrations.

These conditions have been predicted for the overcrowded world of the future:*

Highways are one constant traffic jam.

The government has rigid control over the number of cars produced: a new one can be produced only when an old car is taken out of circulation.

A birth certificate is the government's permit for birth; one cannot be issued until a death is recorded.

A maximum-age bill is enacted; when this age is reached, a man may no longer be dependent on society for food or shelter.

The world's political factions are the 'juniors' and 'seniors'. The juniors believe the world belongs to the young; the seniors advocate eugenics, sterilization, and abortion. The final world war may occur between these factions.

Cannibalism breaks out.

Tax structures are modified to favour smaller families.

In the age of fertility control sexual enjoyment may be separate from reproduction. Reproduction will be the result of choice rather than chance. Marriage today is based on shared responsibility; how will our social structure change when sex brings no risk?

The world's population will not accept contraceptive practices in unison. Rather, there will be regional and geographic differences in the rate of acceptance. This imbalance may well have political consequences, if, for example, our population stabilizes while that of Africa and China continues to increase.

Direct government intervention is a possibility. Dr Homi Bhabha, President of the Indian Atomic Energy Commission, has suggested that contraceptive agents might be added to a widely used staple such as grain or salt.

The possibility of adding contraceptives to staple commodities suggests that surreptitious contamination of water supplies with contraceptive agents might be a weapon system of the future.

Man's ability to control his environment will be largely determined by the number of people whose environment must be controlled; thus acceptance of fertility control will, to a large degree, determine man's environmental future. ▷98

**T. J. Gordon* The Future
St Martin's Press, 1965.

Even to the trained eye, this "Lincoln" closet probably looks much like any other closet

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Nothing cramped about the way the "Lincoln" closet looks. Yet it projects only 25" out from the wall. That's 3" less than ordinary closets, a factor that can make all the difference in a small modern bathroom. Another feature that's right up to date—the "Lincoln" is available with either wash-down or double trap siphonic bowl. And, of course, it comes in "Ideal-Standard's" 8 fashionable colours or white. "Lincoln" by "Ideal-Standard": designed for spacious modern living—send for full specification today to:

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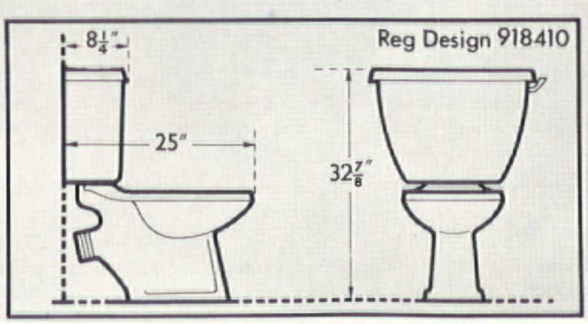

S61

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The effects of technology

Manned orbital station

The median prediction date is 1970. Aside from military utilization, an orbiting space station can provide beneficial scientific reconnaissance of the earth. For example, certain plant diseases can be detected by infra-red photography. Diseases or insects in forest trees can be scanned. Forest fires can be detected. Various sensors can be used to obtain data on the temperature of the earth's crust, on gravity and magnetic fields and the effects of weather and sun. A station in orbit can also provide aid to shipping, oceanography and coastal studies, evaporation mapping, soil characteristics identification, water and air pollution identification, weather prediction, air traffic control, navigation, search and rescue, and direct broadcasting services. Thus, by observing the earth from a point off the earth we can measure and detect the earth's environment for its potential modification, control, and exploitation.

Viewing the projections of the long range forecasting study as a group, and drawing on other contemporary social projections, there seem to be several crystallizing trends which can greatly influence man's control over his environment. These trends appear to be:

Expanding population, with its concomitant need for increasing food production, waste disposal, education, and *per capita* production.

Urbanization, which implies the vertical growth of cities and new architectural concepts which integrate services, dwelling units, places of business and places of leisure into single high rise units. Urbanization will also bring a requirement for new forms of personal and mass city transportation.

Leisure, which will come from overpopulation and increasing automation. It can bring with it decadent and degrading unused time or freedom to function.

War, with its possibility for mass destruction and ultimate environmental contamination or, if we avoid the pitfall of a nuclear exchange, its biological progeny.

Freedom, with its demand for free use of the tools of environmental control. It is all too easy to impose the fruits of scientific development on the control of man rather than his environment.

Research is leading us to a world in which man's environment will be more difficult to control but in which the tools for its control will be more powerful. Man will have to cope with contamination that comes from overcrowding; he will have to build his cities vertically and find important uses for his leisure. He will have to gain control over his wastes and his weather. If he avoids war, can he maintain individual freedom? As the scope of man's control grows, so must the awareness of the consequences of his actions.

Consensus on space progress
(medians and quartiles)

1 USSR orbital rendezvous
2 US orbital rendezvous
3 Increased use of near-Earth satellites for weather prediction and control
4 Unmanned inspection and capability for destruction of satellites
5 USSR manned lunar fly-by
6 Establishment of global satellite communication system
7 US manned lunar fly-by
8 Manned lunar landing and return
9 Rescue of astronauts stranded in orbit
10 Operational readiness of laser for space communications
11 Manned co-orbital inspection of satellites
12 Manned scientific orbital station—10 men
13 Development of re-usable booster launch vehicle
14 Solid-core nuclear reactor propulsion
15 Ionic propulsion (nuclear-generator powered)
16 Temporary lunar base (2 men, 1 month)
17 Development of re-usable manoeuvrable orbiting spacecraft
18 Manned Mars and Venus fly-by
19 Re-execution of critical experiments in deep space (Michelson-Morley, speed of light, equality of gravitational and inertial mass, etc.)
20 Permanent base established on Moon (10 men, indefinite stay)
21 Manufacturing of atmospheres suitable for human beings on Moon or planets (no implication of surrounding entire Moon or planet with an atmosphere is intended)
22 Deep space laboratories and observatories for high-vacuum, zero-g, and space research
23 Earth weather control, in the sense of having a highly reliable ability to cause precipitation from certain types of clouds
24 Manned landing on Mars and return
25 Probes (small instrumented unmanned payloads) out of the solar system
26 Manufacturing of propellants and raw material on the Moon
27 Establishment of permanent research stations on near planets
28 Commercial global ballistic transport (including boost-glide techniques)
29 Establishment of a permanent Mars base (say, 10 men for an indefinite period)
30 Manned landing on Jupiter's moons
31 Pluto fly-by
32 Inter-galactic communication
33 Long-duration coma to permit a form of time travel
34 Manned multi-generation mission to other solar systems
35 Extra-terrestrial farming
36 Regularly scheduled commercial traffic to lunar colony
37 Communication with extra-terrestrials
38 Competition for planetary raw materials
39 Non-rocket space drive—anti-gravity
40 Manned Venus landing
41 Manned manoeuvrable geocentric bombardment fleet
42 Space hydrogen ram jet
43 Military force on Moon
44 Sweeping up Earth-trapped radiation zones
45 Pulsed nuclear propulsion (as in Orion project)
46 Lunar-based laser beam for use in space vehicle propulsion
47 Heliocentric strategic fleet
48 Radiation immunization (through pills or other means)

Charts on page 96 and above, from a 'Report on a long range forecasting study' by Theodore Gordon and Olaf Helmer in appendix 1 of O. Helmer's Social technology, *Basic Books, New York 1966*

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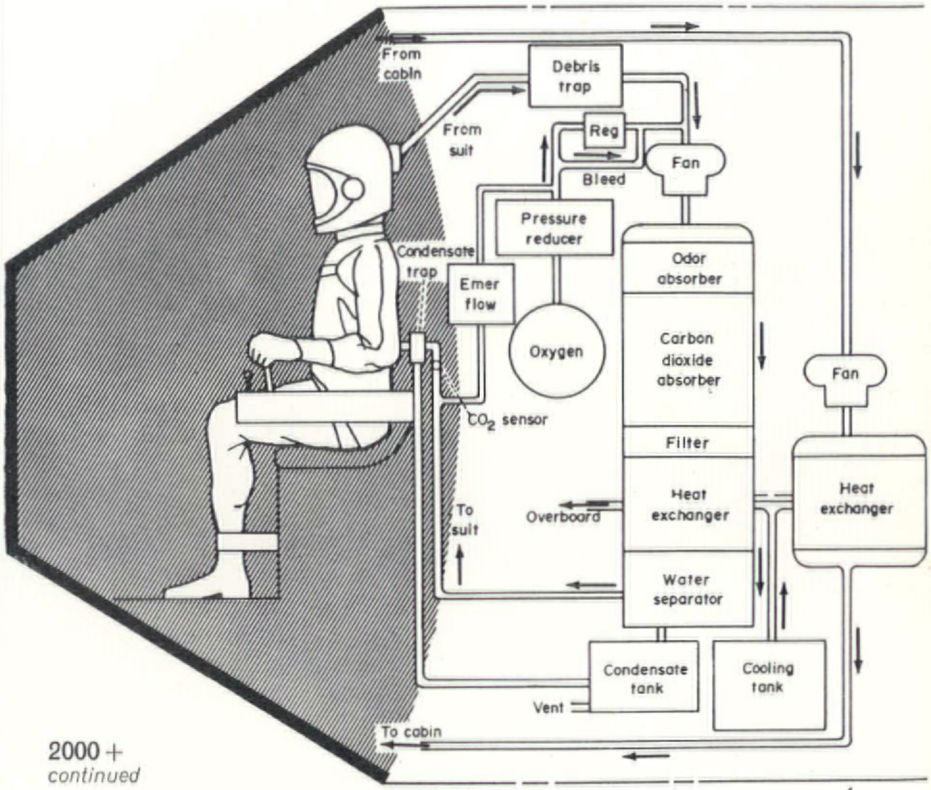

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2000 +
continued

Living

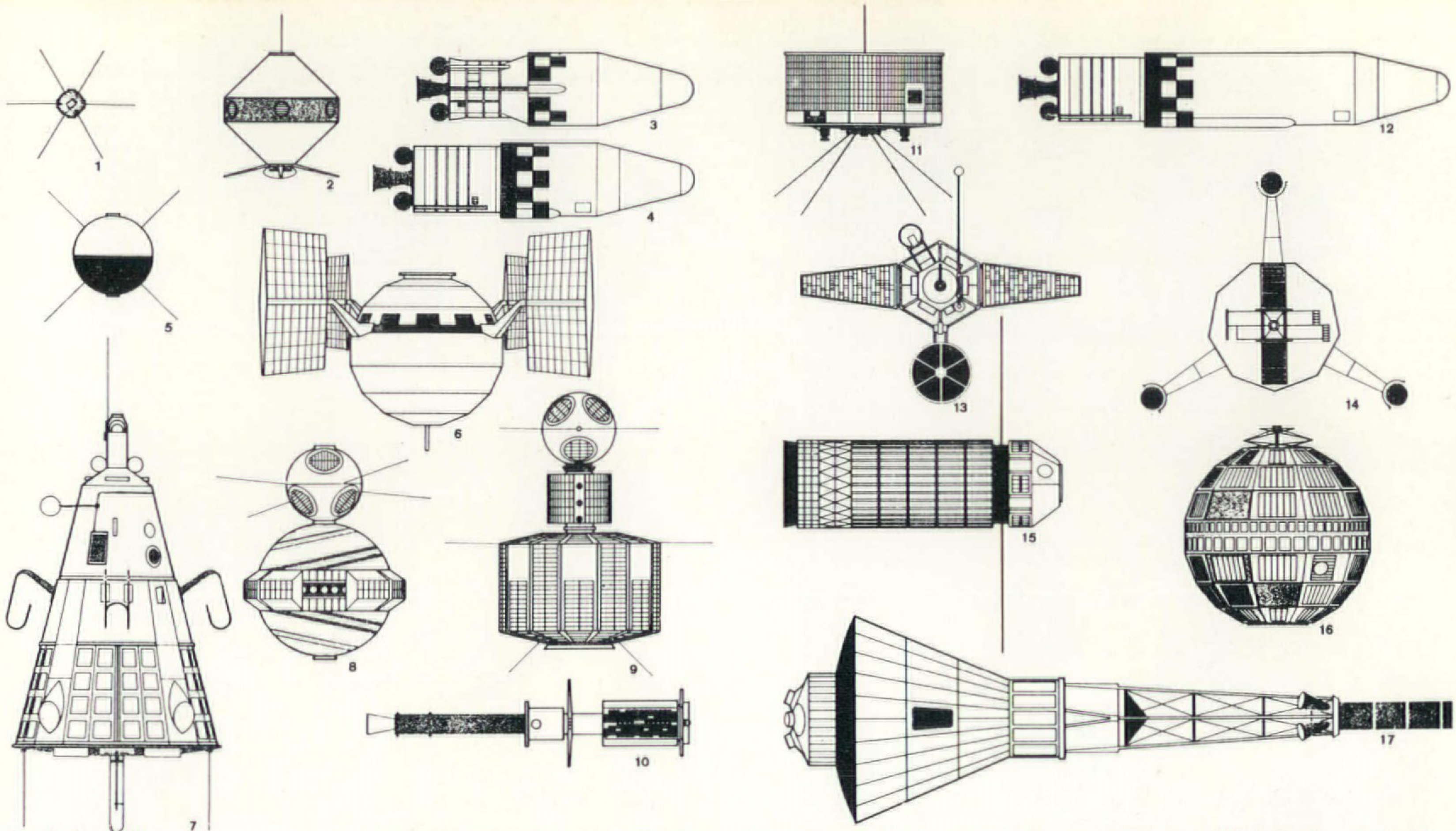
Robin Middleton

Architecture as we know it, is likely to become redundant. Space is a hostile and uninhabitable environment for man. He must carry his own environment with him if he is to survive. The designers of space capsules have thus been forced to consider far more stringently than ever before the basic standards and requirements of human survival. When the detailed knowledge on which such design is based becomes more readily available it should alter drastically our ideas of what is not only acceptable, but necessary, even here on earth. Architects have done no basic thinking or study on the subject for a long time. Research on the maintenance of an oxygen supply that is free from carbon dioxide and moisture, such as the lithium hydroxide system for the removal of carbon dioxide in diagram **1**, might impel us to combat more effectively the dangers of air pollution and contamination.

The space capsule might become our image of the ideal living environment. But even this is too limiting for our future modes of living. The space suit, which is essentially a survival kit in case of failure of the pressurizing system of the capsule, offers a vision of the future that is less confined and restricting. If we cannot, by genetic or chemical control, be transformed into a race of supermen able to withstand the elements, we may at least survive and enjoy living with no more than adequately designed clothes—no houses, no homes even. Already clothing is available in Britain that offers amenities and comforts lacking in a great many buildings. The Frankenstein Group for instance, manufacture a sound-excluding suit **2**, and a liquid conditioned suit **3** (in crimped nylon), with a heating or cooling liquid circulating through it, that enables the wearer to work in comfort at ambient temperatures of up to 70°C and down to − 10°C. Care for a romp?

Photos: 1, Nasa, educational brief; 2 & 3, Frankenstein Group Ltd.

2 3



The first satellites

1 Vanguard I, USA, March 1, 1958
2 Explorer VIII, USA, November 3, 1960
3 Discoverer XIII, USA, August 10, 1960
4 Samos II, USA, January 31, 1961
5 Vanguard II, USA, February 17, 1959
6 Pioneer V, USA, March 11, 1960
7 Sputnik III, USSR, May 15, 1958
8 Transit III-B and Lofti, USA, February 22, 1961
9 Transit IV-A, Greb, and Injun, USA,
10 Explorer XI, USA, April 27, 1961
11 Tiros III, USA, July 12, 1961
12 Midas III, USA, July 12, 1961
13 Ranger III, USA, January 26, 1962
14 Orbiting Solar Observatory, USA, March 7, 1962
15 Explorer XIII, USA, August 25, 1961
16 Telstar I, USA, July 10, 1962
17 Friendship 7, USA, February 20, 1962
Diagram from Courtlandt Canby "A history of rockets and space", Leisure Arts, London, 1964

Communications revolution

Neil P. Hurley, SJ

For millenia the communications matrix of mankind consisted of control and command systems which were exclusively human. For example, in the early military systems, spies, scouts and reconnoitering squads were employed to collect information about the enemy. Today we have ships, automobiles, airplanes, rocket-powered missiles, and space craft to select and classify data from man's environment. However, these technical devices serve as mere effector systems and so need some directing force to guide their uses. Basically all information technologies are nothing more than an extension of some human faculty of sensing and recording. The hieroglyphics of the Egyptians, the cuneiform signs of the Assyrians, and the ideograms of the Chinese were means of storing in permanent form the ideas which previously vanished with the fading echo of the human voice. The phonetic alphabet split off the affective element inherent in pictograms and allowed man to enter the rational world of science—as the Greeks proved. Print accented this power of abstraction, freeing the reader from all social contact except with the coded symbols of the author. And today post-literate man finds that he is confronting reality by means of ego-related experiences at the visceral and intellectual level.[1]

Since today's information media extend one or more of man's senses, the integration of man with the machine is nowhere more complete than in the field of communications technology. Radio extends man's hearing; the phonograph and the tape-recorder extend the range and duration of his voice; the camera and slide projector are static aids to visual memory while the motion picture, the television, and the videotape recorder are kinetic agents for sight and sound recall, and, finally, the computer heightens the capacity of man to store, retrieve, and recombine large amounts of data.

The technologies which are at hand offer several advantages in a world of expanding population and bodies of knowledge:

Economies of scale so that time, effort, and capital can be pro-rated over a larger number of persons.

Audio-visual experiences which are as intelligible to the illiterate as to the literate.

Access of information in terms of sight, sound, and data signals which can vault over deserts, oceans, mountains, forests, and skyscrapers to penetrate any corner of the globe.

A scientific language system based on the binary elements of computers rather than on the subject–predicate relation of the Indo-European system.

Personalized communication in terms of two-way pocket TV sets with a dialling apparatus, video discs and tapes which can be economically stored or shipped, home televiewing connections with libraries, hospitals, theatres, government offices, educational and church institutions.

Economies of scale

All technological enterprises require large capital investments. This is true of the broadcasting industries, the motion picture industry, and cybernetic programmes. The only justification for such outlays is in terms of the cost–revenue ratio: can an essential service be provided to enough people to recoup expenses and to allow a profit or, at least, a reasonable return on investment?

One of the most appealing arguments in the use of educational TV has been the economic one. Thus the average university TV station in the US requires about $450,000 as original investment plus between $40,000 and $50,000 a year for overhead costs and interest charges on investment.[2] Many of these universities boast of from 15,000 to 75,000 students so that these costs diminish on a per student basis as the number of students increase.

We know that the advertising agencies budget their media presentations on the basis of cost-per-millions. Thus, if an advertising client is billed $60,000 per minute for exposure of his product during a professional football game telecast, he is comforted with the fact that he is reaching 50 million viewers, mostly men. Before communications satellites were translated from the drawing board to extra-terrestrial reality, the Rand Corporation initiated a pioneer study to examine the economic trade-offs between satellites and alternate means of communication (e.g. deepwater cables and microwave relay).[3] Later, another member of the Rand Corporation explored the economic feasibility of satellite TV for mass education in developing countries and thought that it was remote.[4] Since then, new satellites have been designed. At the 1965 UNESCO meeting of experts on the use of space communications in Paris a paper was read which compared the geographical coverage and costs of ground-based television, airborne television (as realized in the Midwest Program of Airborne Television Instruction), and satellite relay TV broadcasting.[5] This study concluded that satellite TV coverage was eight times greater than an airborne system which, in turn, was almost 14 times greater than a ground station (covering 10,000 square miles). However, the author thought the costs were still expensive for satellite TV. Later a feasibility study was initiated for direct broadcasting satellite TV, based on a newly-designed satellite which could transmit directly to a home set without needing an earth station.[6] The costs for providing teacher training and pupil education for India were estimated at about $1 to $2 per person a year.[7]

In discussing economies of scale we should not overlook the qualitative advantages of instructional technologies.[8] The grand dilemma in democracies has been the maintenance of standards of excellence together with a progressive expansion of educational opportunity. It is apparent that the use of information technologies within a well-designed system not only can reduce costs but can also make available data, information, and human experiences which up till now only a comparatively few have been able to enjoy.

Lowering the literacy barrier

More than 700 million men and women over fifteen years old, two-fifths of the adult world population, cannot read or write.[9] President Johnson said in an address at the bicentennial celebration of the Smithsonian Institution, 'Unless the world can find a way to extend the light, the force of that darkness may engulf us all.[10]

Television, it has been shown, cannot only leap the literacy barrier but it can also teach literacy. Obviously, certain conditions are necessary. High saturation of set ownership is not needed for a nation to start literacy campaigns via TV. Specific audiences can be instructed on the basis of regional selectivity. If used in groups of fifty, TV instruction can permit the use of volunteer and unqualified classroom teachers.

Where literacy programmes are broadcast over the air to an entire nation, then a bonus audience is won in terms of individual illiterate viewers. This will be true in nations such as the United Arab Republic where efforts at complete TV coverage are sponsored by the government. Especially when the medium is a novelty, it has proved successful for motivating illiterates to register for class. Furthermore, the economic advantages of being literate can be stressed periodically in drama, documentaries, interviews, news specials, and even in comedy and variety shows. Similarly, recognition of literacy skills can be shown to heighten prestige and respect in the community.

Television and movies help create a supporting environment for literacy. As yet no studies have appeared on the impact of even entertainment fare for breaking down the fatalism of traditional societies, the deep-seated conviction that one is, but one never becomes. Even a James Bond, a James Dean, a Marlon Brando, a Ben Casey, or a Perry Mason offer models of behaviour which, if not always ideal, do display initiative, self-resourcefulness, and adaptation. Anything which expands the number of social roles and destroys the self-image of resignation to one's destiny is a step toward modernization.

In addition to TV, there are small, inexpensive programmed learning machines designed to instruct in literacy. In this way learners can appraise their progress by themselves since the machine will not advance to the next lesson, but rather repeat the previous one, if the correct response is not given.

Geographical penetration

In the past, schools and universities and research foundations were dependent on the presence of lecturers, books, and demonstration materials to instruct or learn. Today, radio, TV, film, and computers are collectively collapsing both time and space barriers. Increasingly, education is becoming a multi-media phenomenon with large sums of money being expended on instructional resources which will be used by large numbers.

Let us take TV to begin with. Schools and classrooms have been tied together in entire states (South Carolina and Delaware) by the use of closed-circuit TV installations. The most revolutionary application of instructional TV, however, to multiply teaching resources and enrich the curriculum is by broadcast TV. Certainly the most ambitious programme up to 1965 has been the Mid-west Program of Airborne Television Instruction (MPATI) based at Purdue University. Telecasts are transmitted from a circling DC-6 to over seven million elementary grade students in some five states of the Middle West. Worthy of mention too is the plan of the State University of New York to link up its 110,000 students and 58 component institutions by means of television. A similar plan is under way for the Big Ten universities of the Middle West.

The nations of Western Europe have a giant sound-sight bank upon which members may draw freely, thanks to an exchange organization called Eurovision. The satellite nations of Eastern Europe have a similar arrangement (Intervision) and have been exchanging programmes with the Eurovision nations. A global system of communications satellites is under way.[11] In the US the Communications Satellite Act of 1962 has created a corporation empowered to act as the manager of the space segment of a global satellite system. As of March 1966 there were 48 signatories to the interim agreements.

It was the express wish of President Kennedy, who urged the creation of Comsat, that the US system be truly global in coverage, 'including service where individual portions of the coverage are not profitable'.[12] This proviso has been incorporated into the Congressional Act which created Comsat.

While not as spectacular as manned space flight, space communications will mean that no portion of the globe will be exempt from the reach of picture, voice, and data signals. The spread of information via satellite is already making itself apparent in Latin America. For one thing, the Bank of Interamerican Development (BID) has signed a contract for $250,000 with Space Age Communications, Inc. to link up the 10 countries of South America by satellite TV.[13] While this will mean cheaper and more effective telecommunications in general, the revolutionary applications of such a plan will be the computer and the television capabilities. The Massachusetts Institute of Technology has contacted the computer centres of Latin America in an attempt to solicit the use of the MIT computer on a shared-time basis via satellite. In addition to multiple-access computation, satellites afford regional TV services. The commercial networks are already familiar with the possibilities as are the giant advertising agencies. For example, ABC Paramount Theatres Incorporated, recently merged with International Telephone & Telegraph, has a Worldvision Division[14]. This company aims to take advantage of the spread of TV sets in Latin America on the occasion of the Olympic Games in Mexico in 1968.

Certainly, all nations, peoples and institutions will be put into involuntary contact with one another through the surge of communications and the increased flow of information. This revolution in communications—and one might add, in transportation—is rapidly reducing the world to the dimensions of a global village where all inhabitants experience the same fears, hopes, joys and rumours.

The new computer language

For generations scientists have worked with verbal models, direct experiments, and hypothetic-deductive systems based on human cerebral activity. What is new in the computer phase of the communications revolution is the reduction of intricate human processes to simpler components. Turing's theorem of computation sums up the power of this reductionism: 'Anything which can be done at all can be done in fewer and simpler steps.'

This principle of economy operates mainly through simulation devices which define reality by constructs. Instead of a judgment—all crows are black—computer activity employs the *bit* and builds up a matrix of characteristics through combining and re-combining *bits*. Thus the simulation of reality is defined by plusses or minuses (*the bits*) so that information is formulated by extension and not by intention as has been the classical practice in Western academic life. To take a simple example: a computer model of human personality.[15] The model's attitude toward a group of situations is registered by digits in terms of subsystems of response, a memory system, a learning capability, and a reporting faculty. Admittedly, the robot personality as programmed has a static nature with relatively few axes of liberty. However, it acts very much like a culturally-deprived adult, that is persons in the lower strata of industrial societies and the majority of people in socially stagnant regions, who do not organize their behaviour around long-term goals but react to situations as they arise. They have little sense of their own participation in history, of their control of their destiny and thus have little preoccupation with future-focussed planning.

Computer language has constructive features despite its reductionist tendencies. Through its objectification of inputs of knowledge it eliminates a great many *unprogrammed assumptions* which traditionally have crept into the experiments and theorizing of the pre-computer age. Thus the contribution of computers and its peculiar idiom lies not in simulating the physical universe, animals, or human beings but rather in simulating theories about these subjects. The complex micro-circuitry of electronic brains is designed to represent and control the logical connections within the theories they are to approximate. These theories, in turn, are constructed to simulate the human processes they are to explain. This is a communications break-through of the first magnitude. The danger, obviously, is in attempting to reduce the non-rational to the rational, the subjective to the objective, and the spiritual to the material. But here is where other media, more specifically the imaging media of photography, motion pictures, and TV, can correct the endemic reductionism of cybernetics.

More personalized communication

In talking about radio, films, TV, satellites and computers, we are obviously talking about vast highways of communications which are only justifiable in terms of mass traffic. However, there is a micro-dimension to the communications revolution, a phase which will provide greater freedom and more face-to-face contact in long-distance communications.

One of the great promises of TV, as yet not fully realized in educational circles, is that discovery precedes verbalization.[16] The exhilaration of technological power has eclipsed unwittingly this discovery potential of the moving image in the classroom or living room. We have wed television to the airplane and now to orbiting satellites.[17] Next we shall have direct broadcast satellite TV.[18]

The day is not far off, happily, when most offices, factories, schools and homes will be equipped with two-way desk TV sets so that intercommunication will take place through a simple dialling arrangement. With the miniaturization of such sets and their reduction in cost, even poor people will be able to enjoy person-to-person contact with anyone else similarly equipped in the world, just as today the transistor radio is becoming the universal possession of the lower income group the world over. We can expect a world of lasers and masers, of manned communications satellites powered by nuclear energy, of interplanetary television from space stations on the moon and Venus—all with a person-to-person dialogue.[19]

The major complaint to date regarding the use of TV has been that it is unilateral mass education. Three recent innovations may remedy this situation considerably. It is now possible to have students and young teachers practice programming and present the fruits of their own creative urges to others. In Loyola Seminary, the philosophate of the New York Province, the prototype of a teacher-centred closed-circuit TV system enables young Jesuit students to experiment with the grammar and syntax of image language. Thus, the better programmes can be video-taped and filed for future use. This permits practice in converting conceptual thought into what is termed hot cognition.[20]

Another micro-revolutionary device is the instant play-back home recorder which sells for about $1000, a fraction of the cost of equipment used in professional studios. This device permits a person to televise an event live (as do mobile units), to record it at the same time, and play it back immediately without any processing delays.

A third innovation of boundless promise is the play-back disc or record which, upon being inserted in the back of a specially designed home TV receiver, will play back on the screen either black-and-white or colour films and TV programmes.[21]

The social and economic implications of the preceding micro-revolutionary communications devices furnish the personal feedback that instructional and educational TV have lacked up till now. The communications revolution opens up the possibility of regional and global information-flows of a variety which joins literates and pre-literates together in the same universe of discourse and understanding so that picture language and computer language extend man's *brain-eye* capacity in an effective, economic and nonetheless personal way.

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Trade notes

Alexander Pike

To obtain additional niformation about any of the items described below, circle their code numbers (S1, S2 . . . etc.) on the Readers' Service Card inserted in this magazine.

S1 Plastic soil and waste system

The Ruberoid Co. Ltd., 1 New Oxford Street, London, WC1

A PVC soil system with a jointing method which employs a 'D' section neoprene ring fitting into a groove in the pipe wall. The waste system employs ABS for greater resistance to distortion by water at near boiling point. Available in $1\frac{1}{4}$in, $1\frac{1}{2}$in or 2in bore, all in white with solvent welded joints.

S2 Plastic coating glass

Tri-x Glass Tinting Co., P.O. Box 19421, Houston 77024, Texas, USA

A plastic solution applied from an aerosole container forms a transparent tinted film on the glass, claimed 'to cut out 69 per cent of all rays causing heat and 95 per cent of those causing glare'. Claimed not to crack, chip or peal for at least three years.

S3 Plastic floor grids

Plastic Constructions Ltd., Seeleys Road, Birmingham 11

Molded polythene floor grids 20in² are available for showers, swimming baths or food processing areas. Price 25s. 0*d*. each.

S4 Plastic covered steel tubing 1

The Spiral Development Co., Granby Works, Stanley Road, Bradford 2

Helically formed from vinyl steel laminated strip and available in a range of sizes from 2in to 50in diameter, the tubing can be supplied in any length and in a large number of colours. Uses envisaged include exposed ducting in shops and offices; permanent shuttering for reinforced concrete; protective casings for electrical cables; exhibition and display work.

S5 Reinforced plastic modular ceiling grid

Brensal Plastics Ltd., Highbridge, Somerset

The Brensal 'open' ceilings system is claimed to be versatile, capable of blending with irregularities in the perimeter walls and to have several advantages over the 'closed' ceiling. The light fittings and the suspended grid conforming to a 2ft module.

S6 Plastic partitioning 2

Hellemans Plastics Ltd., Gatwick Road, Crawley, Sussex

Litewall is a plastic unit comprising two shells forming a sealed unit 200 mm² × 60mm thick. The units are available in ribbed, prismatic and clear designs, in amber, blue, turquoise, smoke and crystal. Normally manufactured in UPVC, Litewall is also available in Makrolon for applications which call for high impact strength.

S7 Plastic cistern for concealed fixing

Fordham Pressings Ltd., Melbourne Works, Dudley Road, Wolverhampton

Designed for concealed fixing in ducts or behind partitions, the Hidaway is modelled in high impact polystyrene and has an overall projection of only $5\frac{3}{4}$in. Apart from the standard lever flush mechanism a complete range of remote controls is available including finger control and foot pedal.

S8 Polystyrene ceiling panels 3

Omega Plastics Ltd., Northwick Road, Canvey Island, Essex

Manufactured from $\frac{1}{16}$in expanded polystyrene foam, Megalux ceiling panels are available in three designs. Panels 36in × 24in. Cost 5s. 0*d*. each.

S9 Tube sealant

Douglas Kane (Sealants) Ltd., Swallow Fields, Welwyn Garden City, Herts

A new technique for joining aluminium stainless steel and other hard-to-solder tubing employs a self curing material called Loctite tube seal. The elimination of screw threads enables thinner wall pipes to be used and the resin sealant provides a minimum shear strength of 2,000lb p.s.i. The temperature resistance is between −50°C and 100°C.

S10 Flooring chipboard

The Phoenix Timber Co., Rainham, Essex

Arbor Florbord, a high-pressure bonded birch chipboard is claimed to be sufficiently strong and resistant to withstand the wear encountered in light factories. The boards, with tongue and grooved edges are available in sheets 2ft or 4ft × 8ft 6in. In a range of eight thicknesses between 10 and 25mm. Prices from 1*s*. 5*d*. per sq ft.

S11 Mosaic tiles

Runnymede Rubber Co. Ltd., Staines, Middlesex

Ceramic mosaics $\frac{3}{4}$in² are embedded in white rubber forming tiles 12in² providing resilient surfacing for floors or internal or external walls. Price approximately £3 5s. 0*d*. per sq yd.

S12 Air conditioning unit

Carlisle Air Conditioning and Refrigeration Limited, 1 King Street, London, SW1

The Carlisle 36 JA006 is a self-contained air-cooled condensing unit suitable for shops, offices or restaurants contained in a sound insulated cabinet approximately 3ft 6in square × 2ft 8in high. The condensing unit works in conjuction with a fan coil unit to provide a two-piece system cooling to 60,000 Btu's per hour.

S13 Mixing valve

Meynell and Sons Ltd., Montrose Street, Wolverhampton, Staffs.

The Safemix mixing valve controls flow by means of rubber covered metering clack valve. The unit is 6in long × 4in in diameter and can be adjusted to give complete shut-off of hot water at any desired maximum temperature thus eliminating the possibility of scalding if the cold water supply fails.

S14 Aluminium eaves trim

Northern Asphalt Ltd., Cardigan Road, Leeds 6

Designed for fixing so that it is separated from the asphalt by a strip of bitumen or butyl sheeting. The trim aims to avoid damage from differential movement due to temperature changes. Supplied in 8ft lengths with internal and external angles. Prices start at about 2s. 0*d*. a foot.

S15 Cable trunking

Phillips Electrical Ltd., Lighting Division, Century House, Shaftesbury Avenue, London, WC2

The new Litebeam shallow depth trunking can be recessed into a structure or supported on hangers. In galvanized steel with white PVC cover strips. The trunking costs 31s. 0*d*. per 14ft length and cover strips, 8ft long, the cost 5s. 0*d*. or 3s. 9*d*. according to width.

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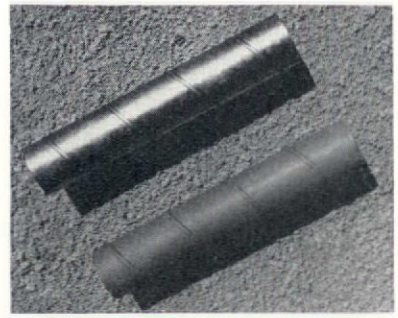

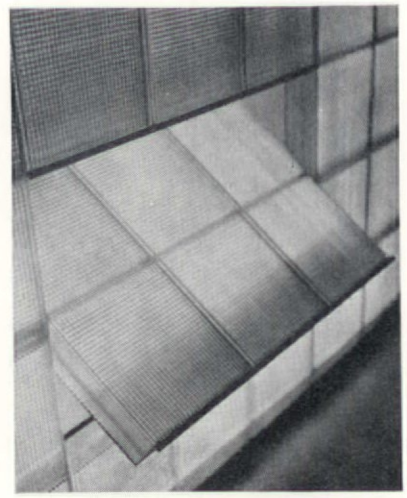

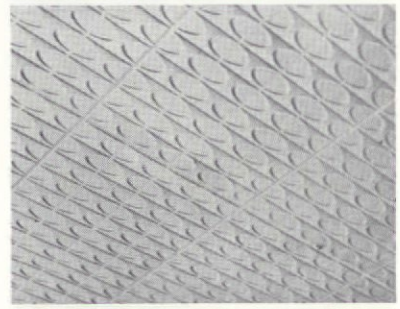

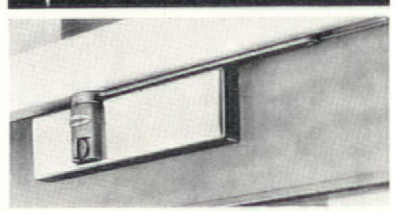

S16 Waste disposer 4

Advance Domestic Appliances Ltd., 66–68 Margaret Street, London, WC2

Designed for the housing estate market the new Westinghouse food waste disposer has a $\frac{1}{3}$ h.p. non-reversible motor and a stainless steel grinding ring. A neoprene splash guard prevents food waste from splashing back. Height, $12\frac{1}{4}$in. Weight, 16lb. Price, £32 8s.

S17 Venetian blind 5

Ventolite Venetian Blinds Ltd., Kettering Road North, Boothville, Northampton.

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S18 Door closer 6

Armstrong Patents Co. Ltd., Hydraulics Division, Eastgate, Beverley, E. Yorks.

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S19 Suction refuse system

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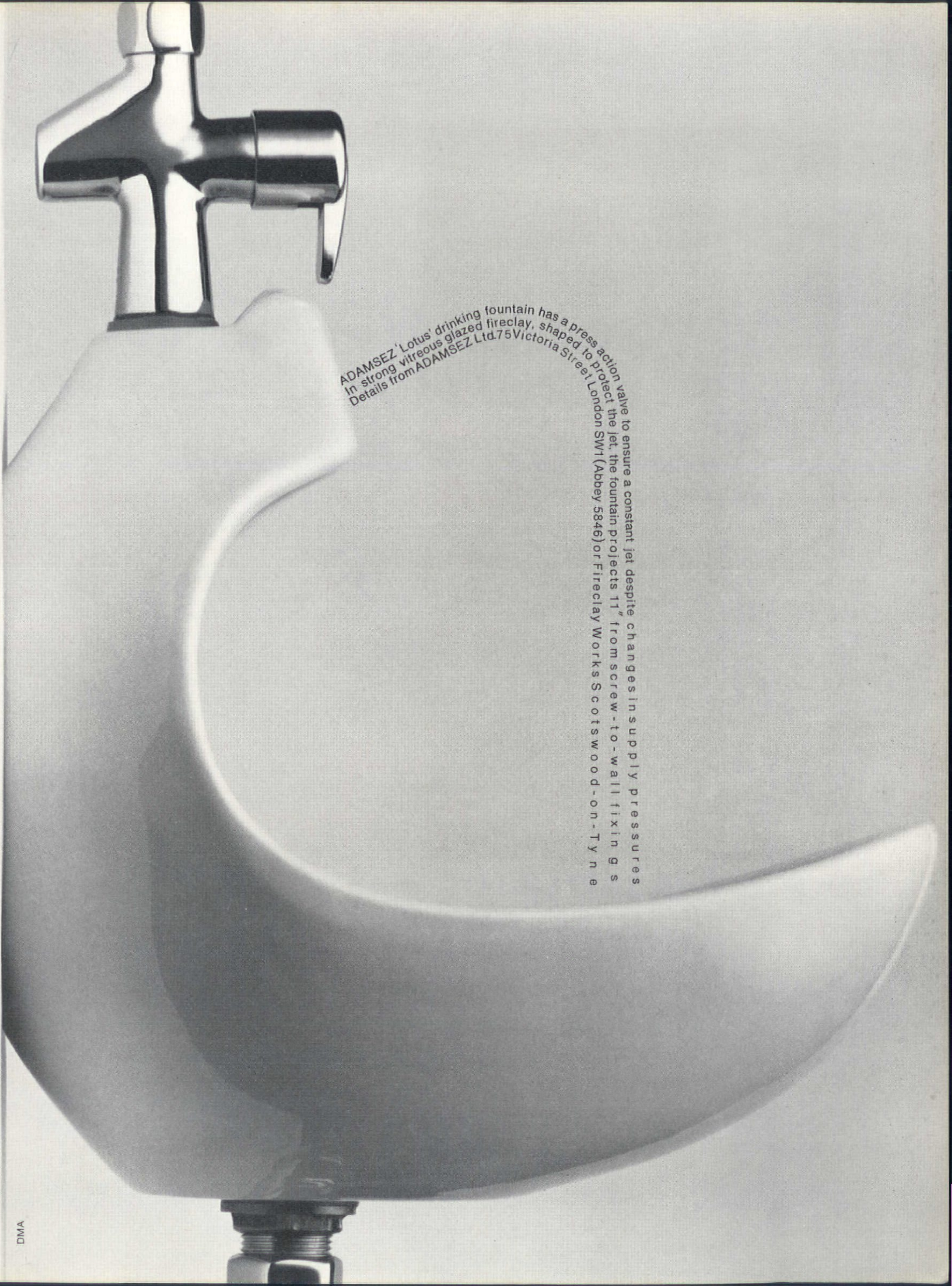
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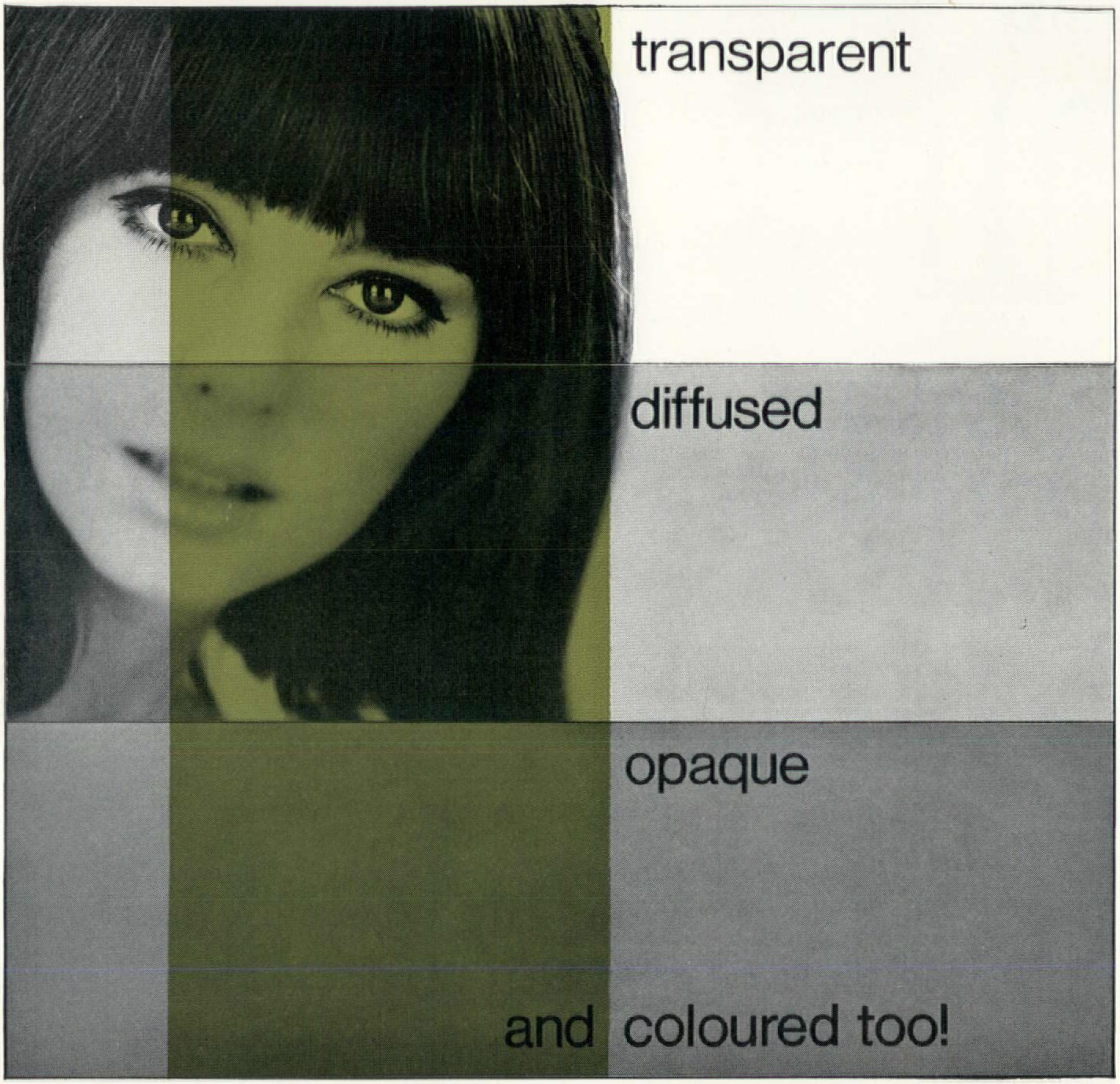

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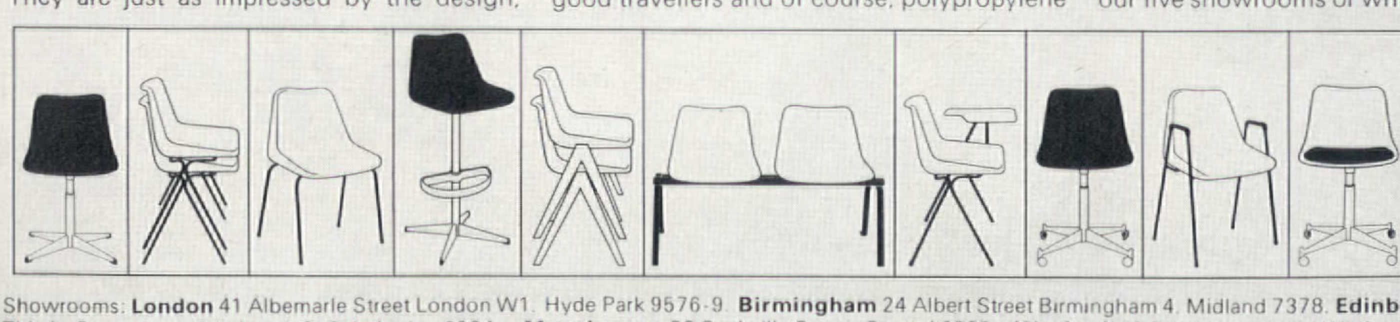

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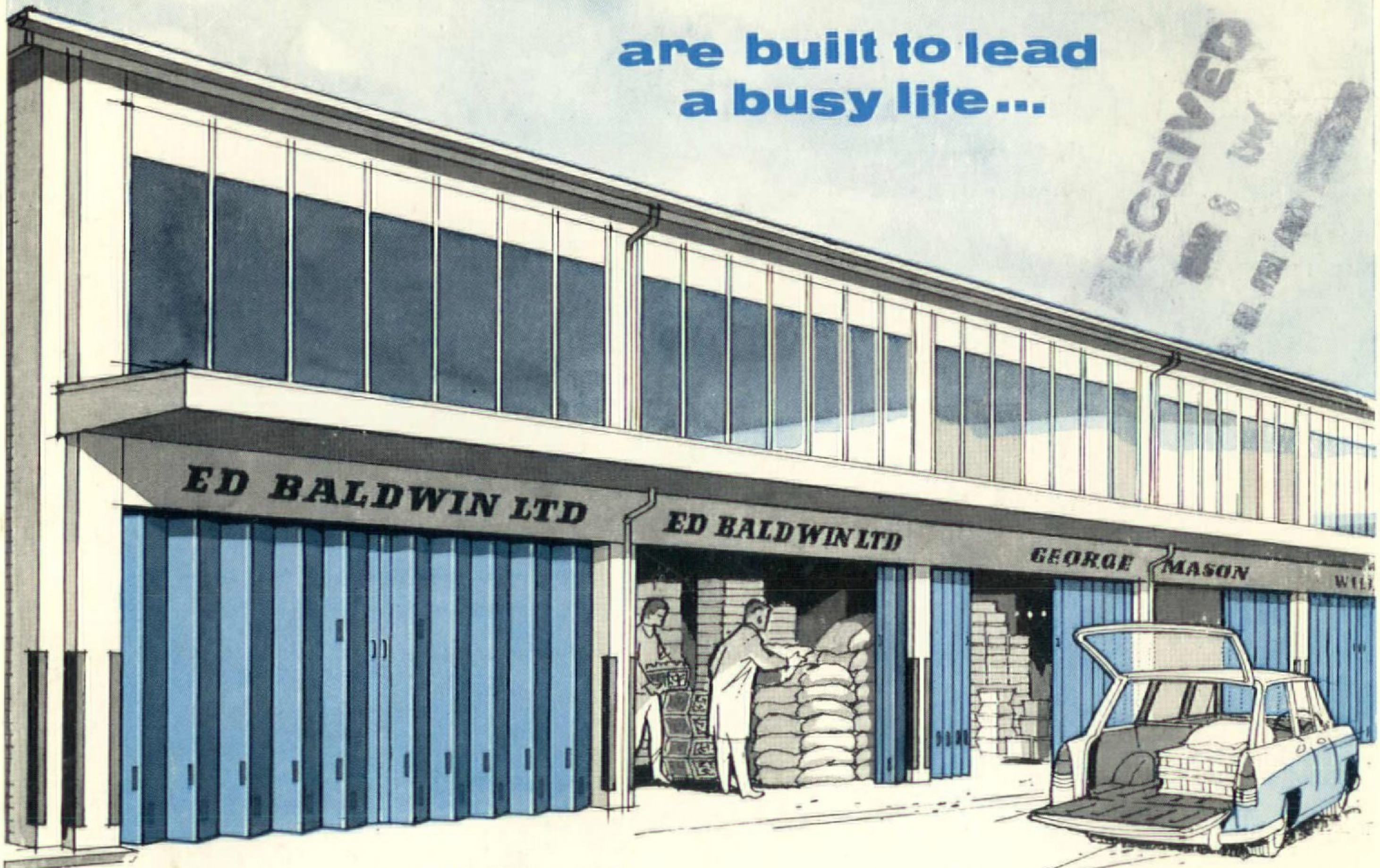

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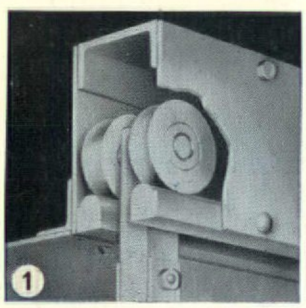
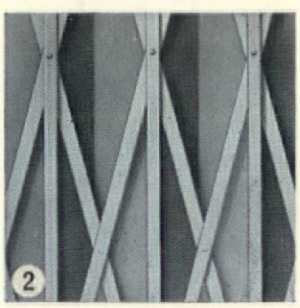
these are only four busy situations in which Bolton Shutter
Doors are continually proving their worth.
In some they will have to withstand rough, heavy usage—they're
built to! In others, they must provide instantly easy operation—they're
designed to! There are many variations—from standard sizes to
purpose-built doors incorporating special requirements. Sherardising
is the standard finish, but Stelvetite or cellulosed leaves are also available.
Bolton Shutter Doors can be power operated, and control methods
vary from simple push button to remote radio.
Whatever your closure problem, a Bolton Shutter Door is the answer.


1

Here's why...

The diagrams show just three of many reasons why Bolton is the biggest name in Shutter Doors. To get full details, write today under ref AD585.

1. Doors are hung from twin ball-bearing pulleys which run smoothly along bright steel runner rails.
2. Riveted at every intersection, the lattice arrangement ensures smooth, even movement across the whole door width.
3. Non-ferrous hinging strips connect the shutter leaves, which are wire reinforced on both vertical edges to give great strength and easy operation.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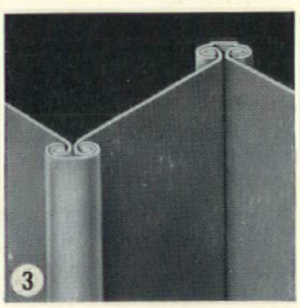
3

BOLTON *The Biggest name in Doors*

BOLTON GATE CO. LTD., BOLTON, LANCS. *Branches in London, Glasgow, Birmingham and throughout the country.*

BG.585