

1 Administrative structure of ABACUS

COMPUTERS IN DESIGN

the work of ABACUS

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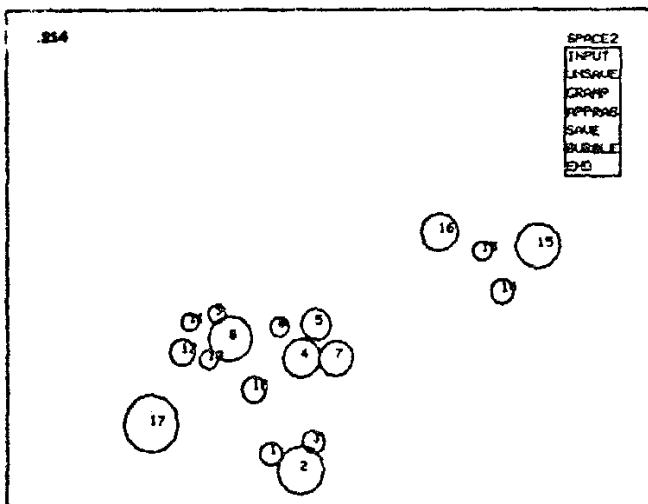
The Architecture and Building Aids Computer Unit, Strathclyde (ABACUS) - which exists within the Department of Architecture and Building Science at the University of Strathclyde - was set up three years ago to promote the effective use of computers in architecture and building design by engaging in research, teaching and consultancy.

Fifteen research workers are currently engaged on research contracts totalling about £150,000. The main themes of research include: SPACES - the development of a suite of programs for the early stages of comprehensive school design (sponsored by the Science Research Council and carried out in conjunction with a number of education authorities), PHASE - the development of an appraisal package for whole hospital design (sponsored by the SDD and carried out in conjunction with a number of regional hospital boards); and a basic study of the degree to which computers can

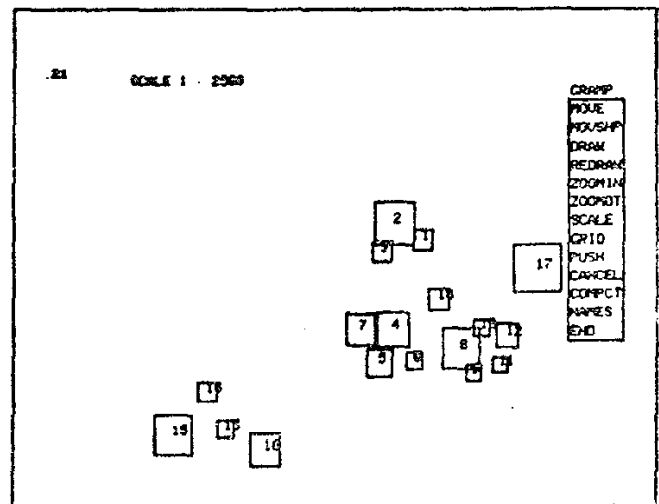
promote the participation of building users in the design activity, again sponsored by the SRC. Other topics include computer simulation of air terminal operation, appraisal of housing layouts and the generation of the causal relationships between design and performance variables. Specific research projects relate to a central core of specialists who service them by providing basic software, interface software and application package structures, 1.

On the teaching side courses are offered at undergraduate level (by means of options in years 2 to 5), at postgraduate level (within the Building Science MSc) and at mid-career level (by means of twice yearly 4-day intensive courses).

The interface with practice is developed by offering a non-profit making consultancy service to practitioners; existing software can be purchased outright or used on-line on a royalty basis; new software specific to the requirements of any practice can be commissioned.



2 Bubble diagram generated by SPACES 2; as the bubbles are moved on the screen by the designer, the overall planning index in the top left hand corner of the screen changes accordingly to indicate departure from an optimum score



3 Bubble diagram converted into squares by SPACES 2; by actuating the commands in the menu by means of the cursor, the designer can begin to manipulate these squares to provide a suitable planform

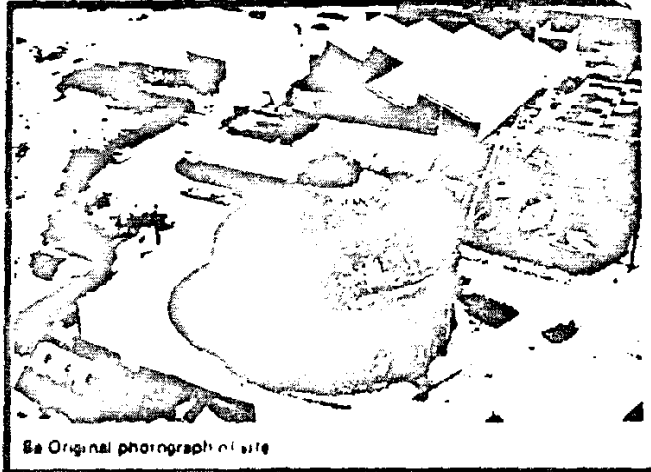
OUTPUT - SYNOPSIS	MWLC4	MWLC2	MWLC3	MWLC1	MWLC4
NUMBER OF BEDS	868	868	868	868	868
AREA - TOTAL FLOOR	42275	42275	42275	42275	42275
AREA - EXTERNAL WALL	27952	27952	27952	27952	27952
AREA - ROOF	38936	38936	38936	38936	38936
WALL/FLOOR RATIO	46	42	39	43	43
PLOT PATIO	39	39	39	39	39
SITE UTILISATION	18	14	14	14	17
PLAN COMPACTNESS	12.62	15.67	17.36	17.36	11.66
WALLS COMPACTNESS	24.98	27.37	27.36	27.36	27.92
LEFT DEPENDENCY FACTOR	518	666	509	668	669
DEPARTMENT LOCATION PER BED	3628	5740	7366	5117	5444
BOILERHOUSE LOCAL PER BED	2583	1742	2736	1720	1571
INDIC CAPITAL COST PER BED	3973	2947	3762	3777	3744
INDIC ENERGY COST PER BED	366	379	347	362	377

DO YOU WISH A PRINTOUT OF (1) ALL DETAILED OUTPUT (2) PART OF DETAILED OUTPUT (3) NO DETAILED OUTPUT

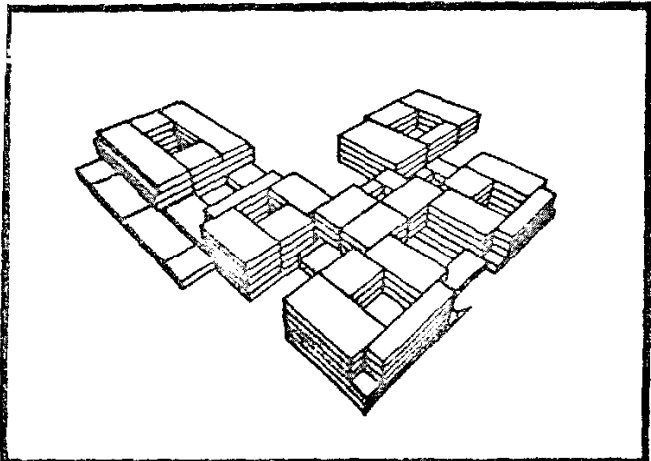
DO YOU WISH A PRINTOUT OF (1) YES UPPER AND LOWER MATRIX VALUES (2) DEPARTMENT LOCATION MATRIX (3) BOILERHOUSE LOCATION MATRIX (4) ELEMENTAL CAPITAL COST (5) ENERGY COSTS (6) HEAT GAIN/LOSS DIAGNOSTICS

TYPE IN (YES) OR (NO) FOR EACH SECTION

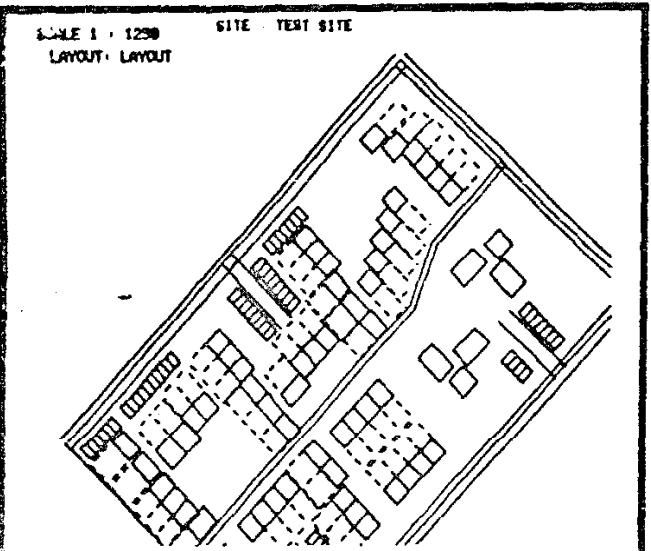
4 Synoptic output produced by PHASE. The current scheme is MWLC4; the other columns represent early schemes. Detailed output can be obtained as indicated at the foot of the Table



5a Original photograph of site



5b Perspective view of scheme MWLC4 produced by PHASE; any view can be displayed by selecting an eyepoint, a focus point and a cone of vision



6 Display of house layout, roads, footpaths, garages etc. by HELP; the cursor is used to identify any house for which appraisal measures are desired

Software for school design

The SPACES suite of programs¹ is intended to be used at the Outline Proposals stage of school design to aid the designer in the determination of an efficient schedule of teaching accommodation, the generation of a built form layout and the appraisal of this, or any other, layout.

The suite comprises

- SPACES 1 which accepts as input a detailed statement of curriculum and operational policy and outputs the relevant schedule of accommodation together with indices of space utilisation.
- SPACES 2 which accepts as input a schedule of accommodation (taken from SPACES 1 or elsewhere) and the functional relationship between elements of the schedules and outputs representations of built form layout, 2,3.
- SPACES 3 which accepts as input a geometry (taken from SPACES 2 or elsewhere) site data, constructional data etc. and outputs measures of economic, functional, spatial and environmental performance.

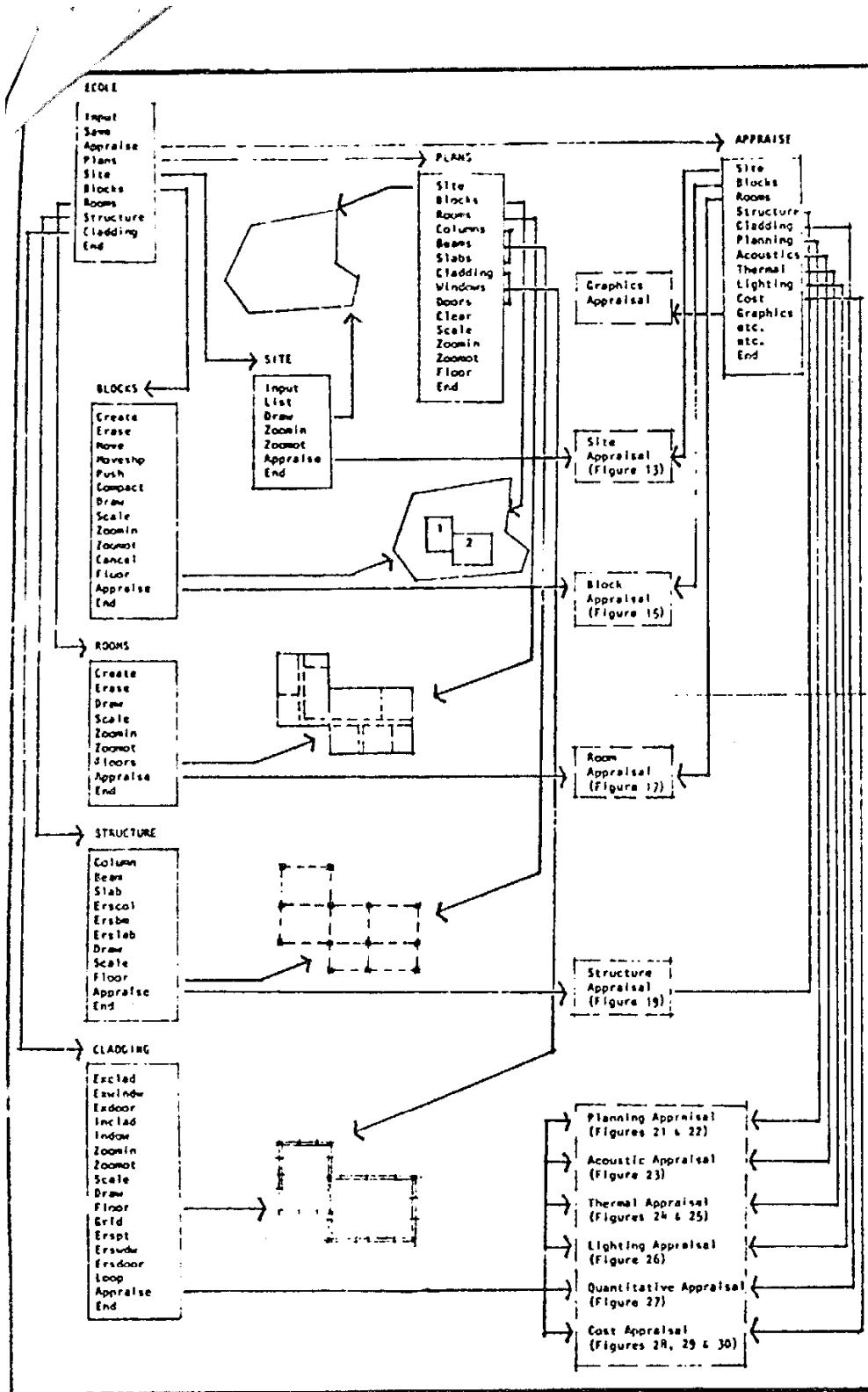
The suite is designed to be used interactively and economically by designers with no special knowledge of computers. Input and output are organised for a Tektronix 4010 but modified versions of SPACES 1 and 3 can be operated from a teletypewriter.

Software for hospital design

The PHASE package², which is relevant to the Development Control Plan Stage of hospital planning, consists of a suite of programs linked by the use of common data files. It is written for graphics on-line interactive use, allowing appraisal of design proposals with regard to the spatial, functional, environmental and economic performance characteristics of whole hospital complexes.

The package consists of

- THE BUILDING PROGRAM which provides a general appraisal of the whole range of characteristics, including planning efficiency, elemental capital energy costs, environmental conditions, etc.
- THE ACTIVITY NETWORK PROGRAM which models in detail the circulation system and its performance
- THE SERVICES NETWORK PROGRAM which models the inter-departmental services distribution system
- THE DEPARTMENT AREAS PROGRAM which allows a check of compliance with the accommodation schedule
- THE CUT AND FILL PROGRAM which allows a manipulation of relative floor levels to minimise volumes of cut and fill
- THE PERSPECTIVE PROGRAM which models the three-dimensional built form, incorporating hidden line removal, 5.



10 Logic structure for the program package ECOLE 3

Software for graphical representation

As has already been seen, 2, 3, 5, quite sophisticated graphics facilities can be incorporated in a wide range of programs, at very modest cost. The graphics software GRAMP² allows, by means of a menu of commands, total manipulation of plan layouts, 3. The program HLE³ will produce hidden line perspectives from any chosen viewpoint, 5.

HLE can be used to provide photo-montage effects. By taking a photograph of the site then specifying a view of the building from the position of the camera with a cone of vision related to the focal length of the lens, the perspective can be directly superimposed on the photograph, 8.

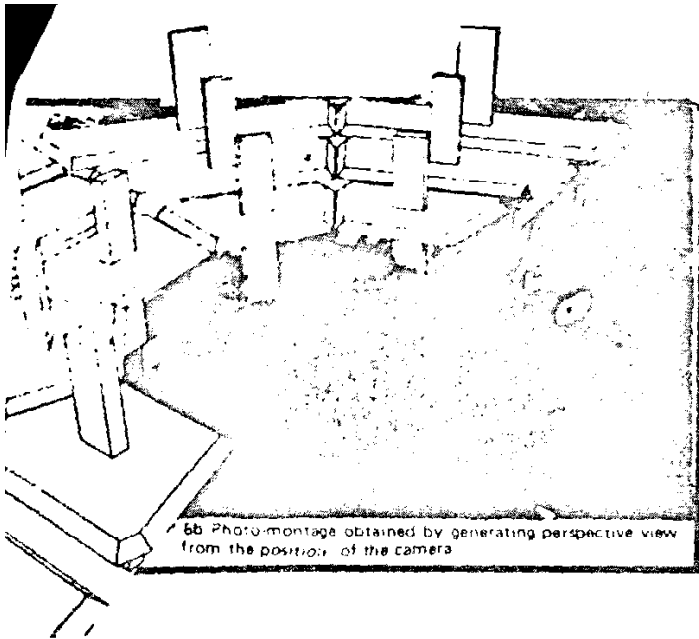
A special version of HLE will produce, from an input consisting solely of radius and frequency, perspective views of geodesic structures, 9.

Software developments

Currently under development is a major program package for the appraisal of built form at Scheme Design stage, ECOLE, 10. The design team can develop the design from the Outline Proposals stage by identifying the location of rooms and corridors, by locating columns and beams and by selecting and positioning cladding panels. As the description of the building is progressively specified, the computer outputs detailed measures relating to the economic, spatial, functional and environmental attributes of the scheme. It is intended to couple the ECOLE suite to existing production information software to allow the output of bills of quantities, schedules, working drawings, etc.

Software use in practice

A large number of ABACUS programs are now in use in practice, thus providing feedback for further development. The SPACES suite has been used by over a dozen local education authorities for the design of new and the remodelling of existing nursery, primary and comprehensive schools. The application of the PHASE package to the design of two new District General Hospitals in Scotland has been carefully monitored.



Software for specific aspects of building design

Many specific aspects of building design can be analysed effectively by computer. One major application area concerns the simulation of movement in terminus buildings, such as airports. In conjunction with the British Airports Authority, ABACUS has developed the program AIR-Q5; stage one of the program interprets the terminal activities as a closed system by means of Markov chains; stage two appraises the function of a proposed solution by simulating its behaviour when subjected to any specified throughput.

A subsystem within buildings which is amenable to simulation is the lift installation. From an input of building variables (number of storeys, floor to floor height, number of occupants) and lift variables (number of lifts, car capacity, control strategy etc.) the program LIFTS⁶ will output total and average journey times and waiting times.

Layout studies can be tackled by means of ASSIGN⁷ which uses the linear programming assignment algorithm to optimally locate functions within a given building envelope or ANSIM⁸ which, on the basis of an association matrix, will output a point plot of the

elements of accommodation in 2,3 or n-dimensional space.

Investigation of the feasibility of using alternative energy sources can be promoted by use of programs such as SOLAR⁹ which, for any location in the U.K. will predict the useful energy which can be harnessed by means of a solar collector.

Software for planning

The program LUMP¹⁰, specified by the GLC Thamesmead division, analyses land use at the urban scale, in for example, the new town development situation where inter-related decisions are required regarding population and dwelling densities, private and public housing mix, and school and open space provision. The program is given details of the fixed land uses and will then, for either the whole urban area, or for particular parts of the area, analyse interactively particular land use strategies suggested by the user.

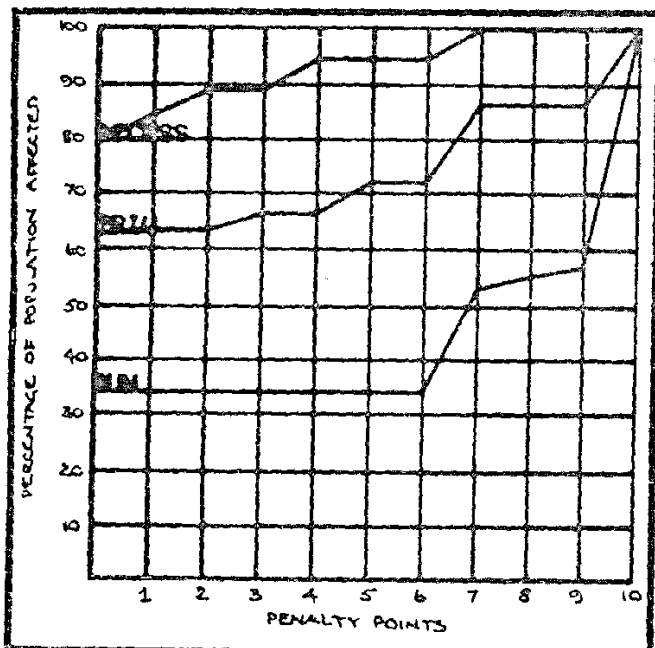
The location of central facilities such as schools, clinics, fire stations, etc. and the allocation of populations to them is handled by the program LOCAL¹¹. Constraints can be placed on the size of the central facilities and on the maximum distance allowable between a facility and a population point. Existing facilities can be modelled by the program.

Software for housing design

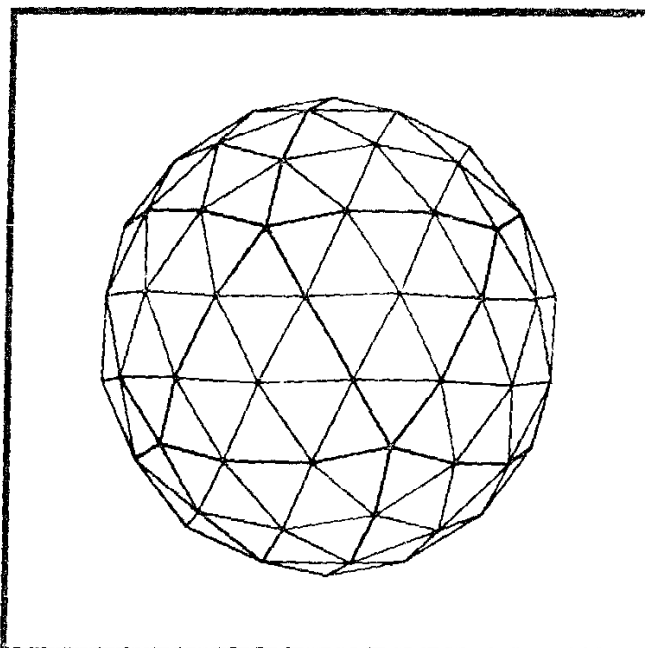
Two suites of programs have been developed for housing applications. The CASH suite³ comprises three inter-related programs COMPRESS, which generates layouts for individual dwellings, CAPABLE, which appraises these on six environmental criteria, and CALL which will store the appraised layouts in a library for subsequent recall.

The HELP suite⁴ is concerned with the appraisal of the disposition of dwellings and

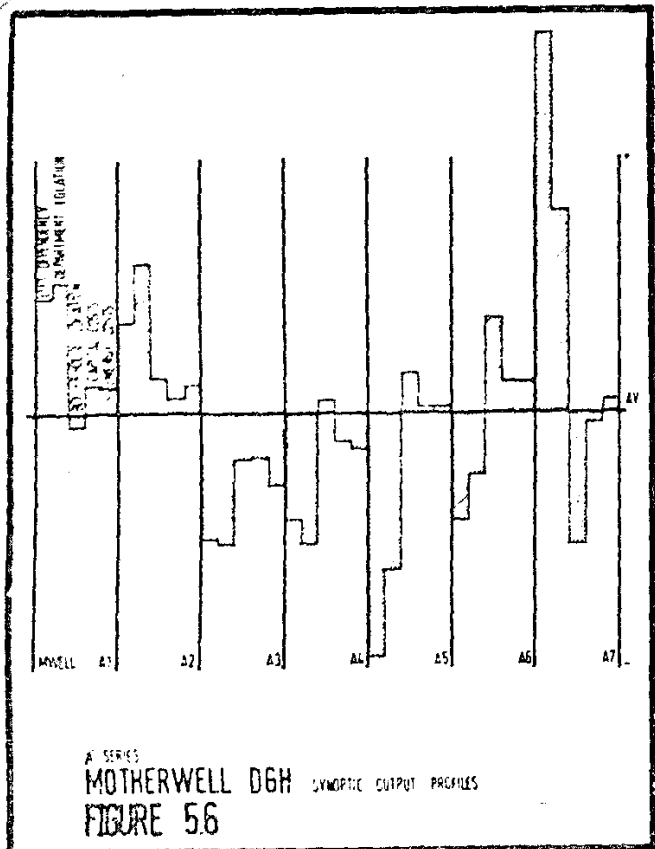
other design features (garages, parking, roads, footpaths, play areas) within a neighbourhood area. Apart from predicting cost and checking densities, house mixes etc., the suite will output measures of privacy, access, sunlight, daylight, etc. for any house within the neighbourhood unit which is identified on the graphics screen by use of the cursor. 6, alternatively, the proportion of population adversely affected by the design configuration can be summarised by the Computer, 7.



7 Summary output from HELP, graphs show the percentage of population affected adversely with regard to SUNLIGHT, PRIVACY and ACCESS



9 Perspective view of a geodesic dome, obtained from an input of radius-frequency



11 Performance profiles produced from the synoptic output of PHASE (see Figure 4). A1, A3 and A5 represent fresh starts to the design process, the profiles following these starting points illustrate progressive improvement in performance.

By plotting the performance profile based on the output for each run, 11, the improvements in design can be charted as the design team iteratively converges on the optimum solution.

The study of the interaction between formal design decisions

and performance profiles is an integral part of the research being undertaken by ABACUS and it is hoped that this work will significantly promote understanding of the fundamental nature of the design activity.

References

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- 12 'Graphics facilities for computer aided architectural design', Sussock, H., 1973. *ABACUS Occasional Paper No. 25*
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