

letters

Engineering judgement

Sir: Reading Sam Price's paper on cantilevered staircases (*arq* vol.1: no.3) was almost as delightful as hearing him present an earlier version at the Institution of Structural Engineers History Group a couple of years ago. He leaves us with the perception that there are three or four analytical models which can describe how these stairs work and various degrees of purity of application for each, but most examples are a blend and difficult to understand.

Herein lies a problem which goes back to structural engineering education. We are taught to calculate and calculations require simple mathematical models. Blending mathematical models is difficult and to be avoided. When we do there is usually an assumption based on engineering judgement.

But our engineering judgement is cultivated on mathematical analysis rather than practice. This leaves us with a very hollow feeling that is only concealed by generous applications of factors of safety. Practice, on the other hand, makes us feel robust – you build one and it works so you are very confident about building another – simple! So it was with the builders of these staircases and I am quite sure they understood what they were doing better than we do with our analysis and safety factors. They experienced the limits – we make calculated guesses at them.

The staircase by Arups at Channel 4 (Figs. 33 and 36) eloquently makes the point. Arups appear to have taken one of Sam's theories and made a staircase out of it, amenable to analysis and using calculable materials and of course, factors of safety. Previous engineers would have relied

on judgement (implying a blend of theories), craftsmanship and quite probably a live load test along the way or on completion.

So how can we make our engineers more robust in their judgement? We should let them rely less on mathematical analysis (while not neglecting the fundamentals) and exercise them more in engineering logic and proportion. Let them have ideas, test them to failure and then analyse the failure.

Nineteenth-century engineers built a great deal at a young age with more judgement than analysis. Today, we need to break out from under the weight of mathematics. Thanks, Sam, for posing the problems and putting forward believable theories and no mathematics – other than reassuring us that you had done some.

Bryn Bird
London

Bryn Bird, an engineer, is a partner in Whitby and Bird

Barcelona experience

Sir: The photograph (above) is of a staircase which we have been using for over 30 years based on the so called cantilevered staircase mentioned in Sam Price's paper (*arq* vol.1: no.3). Being unable to calculate it, we used reinforced reconstructed stone and tested it on site till collapse. It passed all the safety inspections. It is not cantilevered, being bedded 15cm in the lateral wall, but once the constructor left out the piece connecting the treads at the bottom of the staircase and it stayed up. So we assume the weight is transferred from step to step but also together with a diagonal thrust (it was a circular staircase). The maximum tread width we have built is 1.80m for a school.



MBM's staircase. See 'Barcelona experience'

For some reason or other we call it the 'gothic' staircase, perhaps because we observed its earliest use in castles, but the inspiration comes directly from the London Georgian houses, also referred to in Price's paper.

Anyway, it just goes to show that *arq* makes fascinating reading.

David Mackay
Barcelona

David Mackay is a partner in MBM Architects. See pp.28-37 of this issue

Behaviour and geometry

Sir: William Fawcett's paper, 'Architecture: functional approach or the case for user research' (*arq* vol.1: no.3), structured around five topics which introduce elements of user research, is rich in example and insight. However, I found the overall conceptual structure confusing and unsatisfactory. This I believe lies in his opposition of 'geometry' and 'behaviour' and the argument that for satisfactory architectural design we somehow need to bring these into balance in the architect's consciousness. Collectively architects

do seem to have an unenviable track record in satisfying users and the suspicion of a predilection for geometry and little else is possibly not wholly unfounded. If behaviour and geometry can be opposed, itself a questionable concept, then I believe that the problem for design and research is not simply a matter of relative quantity of these elements but of the relationship between the two.

For me, the first topic is the most problematic. It illustrates the point that random processes often display a level of order in aggregate. It is well known that if we throw two unbiased dice and add their numbers together there is a higher probability of achieving the value 7 than any of the other possible values (2 to 12). The value 7 is six times more likely than the value 2. The problem is that, if you only have one throw, even backing 7 is a very long shot. I think I know what he is driving at but his example misses the point. What is really important is where knowledge intervenes to reduce randomness and shows that there are in fact reasonably stable relationships between say the formation of populations and the way that they occupy buildings. It is typological knowledge which makes design possible even in speculative situations.

The second topic, the capacity of educational buildings, is one of very current interest at DEGW. Fawcett identifies three factors which affect utilisation: the stock of buildings (space), the curriculum (activities) and activity-space management. Following the lead provided by that brilliant research team at LUBFS in Cambridge in the 1960-70s, we refer to the first two as *supply* and *demand* and the design task is to balance these by managing either supply or demand or

both. A recent study for the University of Cambridge asked us to consider both sides of this equation in the context of an existing Arts Faculty building. When we measured space use over time we discovered some interesting patterns. Seminar rooms did achieve 80% utilisation during the periods of peak demand (in the mornings) and so, even if this old DES yardstick is arbitrary, it is not intrinsically unachievable. It will be no surprise, in a collegiate environment, that this figure was not sustained over the teaching week and, of course, measured over the academic or especially the calendar year, utilisation of these spaces is extremely low. We also found that the overall pattern of use of libraries and academic offices followed that of teaching space. Again this is not surprising in the collegiate context where the centre of activity moves from faculty to college in the afternoon. Demand in the academic environment is particularly uneven and so makes high utilisation of space extremely problematic. One of the challenges in higher education is to what extent the pattern of demand (either within or from outside) can be modified to provide a better fit (in use) to the expensive resources occupied. The office world is being revolutionised by the discovery, from user research, that new patterns of work mean that traditional formulae for the provision of office space which gave everyone a permanent workplace are no longer relevant. At the level of the individual user, our data also showed a range of patterns of use of academic offices which reflect to some degree different roles within the university. For some the office is 'home' for the whole working day (except when lecturing), the place for tutorials, preparation

study and research and, for others, not much more than an e-mail terminal. It is this type of data which has allowed us to have a creative dialogue with users. We have been able to show that the stock of space (supply) can be increased by physical design but that extending the capacity is also about innovation in use which changes the demand.

Fawcett's concept that capacity is reduced by restrictions which come from specialisation (which inevitably precludes some activity), timetabling (where people cannot be in two places at the same time) and time constraints (where activity is limited to particular times of the day or week) is elegant. However, I am not convinced that it tells us much if these elements are subsumed in a general model of use indices. The key is surely to understand the different way in which these elements can enter into the devising of intelligent design solutions. Perhaps not all design solutions are geometrical.

His final topic, the brief, finds the opposition of behaviour and geometry at its most problematic. Shortage of space prevents me from commenting in detail but it should also be noted that the concept of the brief as the 'institutionalised interface between users and designers' is outdated. Briefing is increasingly seen as a creative, iterative process conducted between the two rather than a one-off statement of intent or content.

As Fawcett argues we need more user research as well as more architects who actually believe users and not just their peer group matter. The knowledge which reduces the gap is about the relationship of social and spatial organisation. The design process that supports its closure is

one where briefing is investigative and dynamic with the user as both subject and participant.

Michael Bedford

London

Michael Bedford is a director of DEGW

Working with nature

Sir: Dennis Ho's paper on climatically responsive atrium design (*arq* vol.1: no.3) reveals a very useful piece of work, though inevitably the article compresses the information drastically. When I wrote *Atrium Buildings, development and design* (Architectural Press/Butterworths 1983 and '86), I attempted to set down a climatically responsive discipline for design but without the modelling resources now available. Most of my intuitive guidelines seem to be confirmed by the modelling, but Ho's differentiation of climatic zones is very helpful in refining understanding.

Ho concentrates on comfort in the atrium space itself rather than on the whole building where the costs and benefits have to be measured. In the UK over the past five years a generic pattern has emerged of two parallel occupied spaces on an east-west axis enclosing a Linear or Centralised atrium in Ho's terms. The north-south orientation of the occupied space optimises their comfort while, apparently, being suboptimal for atrium comfort. It is also very noticeable that taller spaces (five or six levels) work better than lower (two or three levels) in driving natural ventilation.

Ho and I are similarly interested in varying the glazing of walls between atria and occupied space to control solar gain and recognise varying daylight availability. I would add that having good, reflective walls at the top of tall atria does greatly improve light transmission to lower levels and thus the overall performance of the building.

It would be good to see Ho's work expanded in length so that it would be a real source for designers. The present compression makes it often ambiguous or unclear. Incidentally, while *Atrium Buildings* is now out of print, I still hold a stock to meet occasional needs.

Richard Saxon

London

Richard Saxon, an architect, is chairman of Building Design Partnership, 16 Gresse Street, London W1A 4WD

Hill House corrections

Sir: The purpose of this letter is to point out a few errors in my paper on the symbolic geometry of C. R. Mackintosh's Hill House (*arq* vol.1: no.3) and to enlighten readers about footnote 16.

Two figures (15 and 20) lost letters 'X' and 'CBL' respectively. I hope that the text and captions allowed readers to locate them. On p.59, 'Fig. 19c' should have read 'Fig. 19d', and vice versa. The caption to Fig. 26 should have read: 'Relations between golden-section rectangles AD and DY, and between root-five rectangles AO and BY highlight ...' The corresponding paragraph on p.60 also used the wrong letters to refer to the figure. 'LC' should be replaced by 'QD'; 'CE' by 'DF'; 'BC' by 'AD'; 'CX' by 'DY'; 'BO' by 'AO'; and 'AX' by 'BY'.

Footnote 16 refers to the analysis of the washstand illustrated in Fig. 16. The analysis was based upon a colour photograph of the washstand published in R. Billcliffe, *Charles Rennie Mackintosh: The Complete Furniture, Furniture Drawings & Interior Designs*, first published 1979 and re-issued three times since, in 1980, 1986 and 1989. The photograph differs significantly from the washstand now on show at The Hill House: the flower appears not to be filled with mirror-glass and the 'flower-ovary' appears as a dark, curved form located within the 3x5 golden-section [Fig. 16d]. Enquiries made while researching the article produced no explanation for this unique plate. Given its importance in the catalogue, in an original footnote 16, I wondered whether the washstand had been restored since the photograph was taken: perhaps the flower-mirror, which makes functional and symbolic sense, since it reflects the rose-head of the Rose-Lady, had been replaced while the curved form had been erased. The solution to the mystery came too late for the press, although there was time to amend footnote 16. It seems that the dark form in the colour-plate is the hood of a camera lens! I am grateful to Anne Ellis, Curator of The Hill House, for tracking down the photographer and establishing the truth. Although the discovery necessarily changes the explanation of the washstand at this point, the essential meaning remains the same, as indicated in the

published footnote 16.

The new explanation involves looking still more carefully at the stylised flower and seeing in it two possible interpretations. The first reading evokes the external form of the flower: a thick stalk (a square of green, ribbed leaded glass at the base of the figure) terminating in an ovary (the 3x5 golden-section of mirror-glass) at the base of the corolla (also in mirror-glass and edged with four oval segments of pink glass). The second reading evokes the internal structure of the flower: a group of three verticals on either side of the 3x5 mirror-plane, each representing a style rising from the green square, now an ovary, and terminating in an oval segment of pink glass, the stigma. The abnormal presence of two stigmata is highlighted by the discovery of the cruciform (Fig. 16c) and leads to the identification of the stylised flower with the diagram of the human female reproductive system, and of the flower-ovary at the base of the corolla (the 3x5 golden-section rectangle) with the vagina (Fig. 16d).

An off-print with amended text and captions to take account of the above errata has been produced to coincide with the Charles Rennie Mackintosh retrospective exhibition, which opened to the public 24 May at the McLellan Galleries, Glasgow. After 30 September, the exhibition travels to the Metropolitan Museum, New York (21 November 1996 to 16 February 1997), to The Art Institute of Chicago (29 March to 22 June 1997), and to the Los Angeles County Museum of Art (3 August to 12 October 1997).
Eleanor Gregh,
Glasgow

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