numerical dishonesty (Stevens 1951). It is interesting to note that psychology itself was then under attack in an age of logic as being too imprecise to deserve the title of science. Perhaps for this reason, many psychologists have been tempted to treat their data as if it were more precise than Stevens's rules would indicate. Archer's work seems a parallel attempt to force design into a scientifically respectable mould. Archer was writing at a time when science was more fashionable than it is today, and in a period during which many writers on the subject thought it desirable to present the design process as scientific.

Value judgement and criteria

It is frequently tempting to employ more apparently accurate methods of measurement in design than the situation really deserves. Not only do the higher level scales, ratio and interval, permit much more arithmetic manipulation, but they also permit absolute judgement to be made. If it can be shown that under certain circumstances 20 degrees centigrade is found to be a comfortable temperature, then that value can be used as an absolutely measurable criterion of acceptability. Life is not so easy when ordinal measurement must be used. Universities use external examiners to help protect and preserve the 'absolute' value of their degree classifications. It is, perhaps, not too difficult for an experienced examiner to put the pupils in rank order. However, it is much more difficult to maintain a constant standard over many years of developing curricula and changing examinations. It is tempting to avoid these difficult problems of judgement by instituting standardised procedures. Thus, to continue the example, a computer-marked multiple choice question examination technique might be seen as a step towards more reliable assessment. But there are invariably disadvantages with such techniques. Paradoxically, conventional examinations allow examiners to tell much more accurately, if not entirely reliably, how much their students have actually understood.

Precision in calculation

It is easy to fall into the trap of over-precision in design. Students of architecture sometimes submit thermal analyses of their buildings with the rate of heat loss through the building fabric calculated

down to the last watt. Ask them how many kilowatts are lost when a door is left open for a few minutes and they are incapable of answering. What a designer really needs is to have some feel for the meaning behind the numbers rather than precise methods of calculating them. As a designer you need to know the kinds of changes that can be made to the design which are most likely to improve it when measured against the criteria. It is thus more a matter of strategic decisions rather than careful calculations.

Perhaps it is because design problems are often so intractable and nebulous that the temptation is so great to seek out measurable criteria of satisfactory performance. The difficulty for the designer here is to place value on such criteria and thus balance them against each other and factors which cannot be quantitatively measured. Regrettably numbers seem to confer respectability and importance on what might actually be quite trivial factors. Axel Boje provides us with an excellent demonstration of this numerical measuring disease in his book on open-plan office design (Boje 1971). He calculates that it takes on average about 7 seconds to open and close an office door. Put this together with some research which shows that in an office building accommodating 100 people in 25 rooms on average each person will change rooms some 11 times in a day and thus, in an open plan office Boje argues, each person would save some 32 door movements or 224 seconds per working day. Using similar logic Boje calculates the increased working efficiency resulting from the optimal arrangements of heating, lighting and telephones. From all this Boje is then able to conclude that a properly designed open-plan office will save some 2000 minutes per month per employee over a conventional design.

The unthinking designer could easily use such apparently high quality and convincing data to design an office based on such factors as minimising 'person door movements'. But in fact such figures are quite useless unless the designer also knows just how relatively important it is to save 7 seconds of time. Would that 7 seconds saved actually be used productively? What other, perhaps more critical, social and interpersonal effects result from the lack of doors and walls? So many more questions need answering before the simple single index of 'person door movements' can become of value in a design context.

Scientists have tended to want to develop increasingly precise tools for assessing design, but there is little evidence that this actually helps designers or even improves design standards. Paradoxically, sometimes it can have the opposite effect to that intended. For example, whilst we may all think daylight is an everyday blessing