A response to William J. Mitchell's review of
Possible Palladian Villas, by George Hersey and
Richard Freedman, MIT Press, 1992

A review by William J. Mitchell, entitled 'Franchising
Architectural Styles', appeared in AA Files no. 26
(Autumn 1993). It reflects a collision between two
fundamentally opposing points of view, one held by
the reviewer, the other by the reviewed. These deter-
mine our expectations of the role of computers in
architectural design. Once computers are no longer
primarily used for drawing and image creation, but
rather as knowledge-based systems taking a more active
role in design, the nature of these expectations becomes pivotal. The view holds that eventually it will be possible for knowledge-based systems to do much of what architects now do. Related to this is the belief that it might be possible to encapsulate an architect's design methods within a concise set of rules, most notably in the form of a shape grammar. Adherents of this view justify their stance with examples from the last twenty years demonstrating that shape grammars can generate seemingly convincing Palladian plans. Frank Lloyd Wright Prairie Houses, Queen Anne style houses and blocks of flats by Giuseppe Terragni, among others. Mitchell expresses this view quite explicitly at the end of his review:

As the cost of computation continues to decline, and as the technology of knowledge-based design systems continues to develop, techniques for dealing with such systems that rapidly and inexpensively produce fairly convincing products in fashionable styles. Some architects will figure out that they can effectively use this technology to franchise their characteristic looks, much like Laura Ashley and Ralph Lauren. The work that results may not be fine, but then a Big Mac is not cordon bleu. . . . Soon or later, one of these systems will pass a sort of architectural Turing test: it will get itself published and praised in the Architectural Review.

The other approach is more measured, seeking less to replace architects with computers than to use computers to complement and extend our understanding and skills. This view is implicit in George Hersey and Richard Freedman's book. Hersey is a distinguished classical historian who has explored in his books the rich mythology of language, and of the classical language of architecture in particular, in both the symbolism of its forms (The Last Meaning of Classical Architecture) and the magic of its geometry (Pythagorean Palaces). Palladianism and Villa is written with a disarming simplicity and concision which perhaps explains why the genuine depth of its arguments have eluded several reviews - including Mitchell.

Mitchell criticizes objection to the book and the accompanying computer program is that, contrary to the authors' claim, their work is not novel, and in particular their attempts to enumerate variants of Palladian villa designs are not novel. They have attempted to develop a knowledge-based system which demands to be evaluated as a contribution to the field, yet it fails to answer the following questions: Does it adequately capture the knowledge that it sets out to capture? Does it produce what it claims to produce? Does it thus tell us something about Palladio's works that we did not already know? And does it advance the theory and practice of knowledge-based computer-aided design systems? Before considering these questions in turn, I will address some overall mischaracterizations inherent in Mitchell's criticisms.

What is unique in Hersey and Freedman's work is the application of an iterative technique to the analysis of architecture. Their approach involves postulating rules or constraints, incrementally refining the computer program and then visually testing their assumptions by comparing the computer drawings with Palladio's built works and those recorded in his Four Books of Architecture. The existence of un-Palladian features in the resulting designs is immediately apparent from visual inspection in a way that no amount of study or search for evidence in the rules and constraints would ever reveal. Such un-Palladian features led the authors to postulate additional rules and constraints. They do not claim, as Mitchell suggests, that the novelty of their work lies in using rules to characterize the work of paradigmatic architects such as Palladio or Frank Lloyd Wright in his Prairie Houses. Indeed, they acknowledge such earlier work, including that by Stiny and Mitchell (1978), which in its time was a significant contribution to the field. By following the iterative process in Hensley and Freedman's text, we are able to gain a healthy respect for the complexity of the issues and for what can and cannot be encapsulated. If they had achieved nothing more than to demonstrate that Palladio's design principles cannot be formulated as a set of deterministic rules, but must be treated in probabilistic terms, they have already made a significant contribution to rule-based studies.

Mitchell also admonishes the authors for not being aware of the extensive literature on shape grammar interpreters, programs which, given a set of shape grammar rules, can automatically and rapidly derive designs within the architectural language specified by the rules of a grammar. However, the form of shape grammar interpreters is closely related to that of the grammar rules and therefore not easily generalized. To my knowledge, a generalized rule-interpreter suitable for two-dimensional or three-dimensional architectural problems is not yet available.

I will now consider Mitchell's argument in more detail. His main criticism of Hersey and Freedman's approach to generating plans with Planner (the component of their computer program dealing with plans) is that they fail to separate the generation process into two parts, one for enumerating the non-dimensional, topological plan layouts, the other for the dimensioning and proportioning of such layouts. He accepts that their method of splitting the plan into smaller rectangles captures Palladio's ideas, but he claims that they are splitting into triads when in fact they split in a variety of multiple modes, horizontally, vertically and in combination. He is right to suggest that the method could have been expressed as a shape grammar, but wrong to claim that previous work on exhaustively dividing rectangles into smaller ones is relevant here (Stedman 1983), because in the case of Palladio we are looking at only a particular subset of divisions produced by this process and additional rules (better termed constraints) which invalidate some of them. Mitchell seems sceptical of what he sees as randomness in the generation of the splits. Yet what Hersey and Freedman are actually doing is no more than making divisions to approximately the same likelihood that Mitchell and his co-workers have done.

In advocating that the initial step in generating plans be the enumeration of the topological possibilities, we must first ask what are the advantages of doing so. Three come to mind: first, the computational method requires it (which was the case in Mitchell et al.'s earlier work on optimizing Roof plans (1976)); second, the topological configurations are a concise way of characterizing Palladian possibilities; and, third, they provide a way of classifying Palladian plans. The topological plans enumerated by Mitchell in earlier work (Mitchell and Stiny 1978) provide no way to distinguish a Palladian from an un-Palladian plan. Moreover, they contain a fairly high proportion of patently non-Palladian plans, including ones with rooms spanning the entire plan. Hence they cannot be said to characterize his villa plans. The enumerated plans also do not include configurations where some walls are shifted slightly off the underlying grid, both horizontally and vertically, so as to avoid aligning with any other walls. (Unfortunately these errors have been propagated into two of the references Mitchell cites, in which these topographic details are retained.) This problem and others discussed by Hersey and Freedman show the way to new discoveries. Most important among these is the realization that proportion is not as central to Palladian plans as it was previously thought. The belief that Palladio used only his recommended, ideal proportions 1:3, 4:3, 2:1, 5:3 and 1:1 is not true and is often not sustainable (as Hersey and Freedman discovered when trying to accommodate finial wall thicknesses between the rooms). Palladio used a continuum of proportions tending slightly towards the ideal. To sum up, enumerating dimensionless plan topologies seems to be useful only for the purpose of classification. Given that Hersey and Freedman's objective was the discovery of Palladio's design principles, not classification, we cannot fault them for a failure to enumerate such topologies. The other step, then, is to use these topologies as input to a computer program that will test the plausibility of Palladian plans. In the review, he explains how to incorporate dimensions and proportions, ostensibly to show what Hersey and Freedman should have done in the second step, had they enumerated the topological possibilities. Mitchell sees this step as involving the application of constraints, such as proportional relationships between the sides of the rooms, and solving the resulting system of simultaneous equations for the dimensions of the rooms with linear or non-linear programming techniques. (Linear programming techniques, incidentally, are used when there is a need to maximize or minimize a function of a number of variables, such as the room dimensions, which is not the case with Palladian plans.) He then goes on to mention an example of the 'Palladio problem', where proportions based on Palladio's ideal are specified for each room, resulting in a set of simultaneous equations, one for each room. If a solution exists, then the resulting proportions are feasible. Given that the overall proportion of the plan are not constrained, there will be very few solutions with overall proportions in the range that Palladio would have used (roughly between 1:3 and 1:1). Furthermore, Hersey and Freedman also show that other constraints are needed to rule un-Palladian solutions, some of which, such as the restriction on room size, apply to individual rooms, others, such as the maximum number of rooms and the fact that strings of rooms follow sequences of sizes relative to each other, apply to multiple rooms (the site sequences are built into Hersey and Freedman's splitting-rules). Mitchell's suggested solution seems to be much too
restrictive. Moreover, the problem is nullified when we realize, as Hersey and Freedman did, that Palladio's ideal proportions were not rigidly adhered to. That is to say, a continuum of proportions is acceptable as long as they fall between 1:1 and 1:1.5. Thus there is an infinite set of possibilities to enumerate, confirming that design does not follow a rigid grid system. But in C.A.D. (an error in a similar vein occurs in Mitchell's previously cited work on optimizing floor plans, where it was found that, instead of a single optimum configuration, the correct answer is actually a continuum (Gero 1978). Moreover, some parts of this continuum are likely to have been favoured by Palladio. Faced with a continuum of possibilities with varying degrees of probability, how do we present the result? Perhaps there is a way to classify and specify the nature of this uncertain continuum using stochastic methods, but Mitchell does not address the issue. By selecting randomly from this continuum to ascertain the scope of Palladio's predictions, Hersey and Freedman found a simple way out of a difficult problem, which served their need to test the viability of their hypotheses.

In the section of his review entitled 'Generating Elevations' Mitchell again addresses the theme of joining elements in a combinatorial game, this time with reference to FacadeMaker, the component of Hersey and Freedman's program which generates elevations by reflecting the demands of the plan in the elevation and vice versa. Here he implies that elevations are a trivial extension (perhaps because his earlier work omitted them). They are certainly simpler to generate than the plan. But to imply that creating elevations consists merely of combining elements from a choice of fixed alternatives overlooks several issues. For example, the layers of superimposed blocks into which Hersey and Freedman divide the elevations are not entities of fixed size, because, again, Palladio's elevations do not conform to a rigid proportional scheme (Hersey and Freedman show that the height-to-width ratio of his elevations varies considerably, with a preference for 2:1). Accordingly, the program allows the user some freedom to change roof height and base height. The elements of the elevation are also controlled by the nature of the plan. The user is not, as Mitchell indicates, free to choose the type of Order independently of other considerations. Specifically, the width of the centre zone in the elevation, which is usually determined by the width of the principal room, determines the Order of the columns because an even number of reasonably spaced columns determines the intercolumnation. The Order in turn determines the height of the columns, which in turn affects the height of that element of the elevation to which the columns are attached (the possible variation in height is considerable, especially when it is noted that Palladio sometimes used colossal Orders with columns twice the height of standard ones). The position of the columns and the choice of Order then determine the position of the windows in the elevation.

In true debating style Mitchell then introduces a red herring, in the form of a demand as to why FacadeMaker does not allow us to choose window width first and let various other design decisions follow from this; "must the arrow of causality always point in this direction?" he asks. He claims that developers of practical computer-aided design systems have discovered that design variables are often connected by networks of constraints and that Hersey and Freedman show "little awareness of this issue as investigated in the fields of Artificial Intelligence and the design of computer programs". However, presupposes full knowledge of Palladio's design methods and that it is possible to enunciate all the causes and effects in the form of rules and constraints (something Hersey and Freedman consciously eschew, thereby setting up degrees of uncertainty). The section 'Representing Architectural Knowledge' varies from another not hinging in that is proposed to judge Hersey and Freedman's program as a knowledge-based system. Mitchell asks, "How adequately does this system represent Palladio's knowledge of how to put walls together?" The question is inappropriate. It is true that the program characterizes Palladio's design tendencies with some success, it is far from a complete representation. One of the joys of the program, as I have found with students, lies in the fact that it is inadequate: it enabled us to discover how much in Palladian design depends on visual inspection - thus allowing us to discover new design rules as described by Hersey and Freedman (Sebbohn, 1993). Although, as Mitchell points out, it is good programming practice to separate, within the program, the knowledge from the part which derives results from that knowledge, this does not disqualify a program which is not written on those lines. I do not agree that Hersey and Freedman have not precisely described the rules used in their program and that the algorithmic code needs to be examined to understand how the rules work. The acid test, as with all programs concerned with graphic output, is to determine whether the results reflect the effect of the described rules. Much of the book is concerned with assessing the adequacy of the rules used on the basis of the visual output.

I cannot agree that the latest work on knowledge representation, while a lively field of research in computer-aided design, with a significant potential in the practice of architecture, would have significantly improved Hersey and Freedman's work and their insights into Palladio. Indeed, it is not clear that the current developments in the field of knowledge-based CAD have yet dealt with the issue of uncertainty that is being addressed in some of the most recent work in the field of artificial intelligence (for example, Heckerman et al. 1989). Had there existed, as Mitchell implies, a method for inducing the rules from a corpus of architecture, Hersey and Freedman could have saved themselves much effort. A paper by Mackenzi (1988), cited in one of Mitchell's references (Coyne et al. 1990), demonstrates a method of deriving the rules underlying Mitchell's 'Palladian', topological plans, leads to topologies that look even less Palladian than the originals (with multiple rooms spanning the width of the plan). Borrowing that result yet proved that it would be possible to describe a set of designs with a unique set of rules, and that it is unlikely that a set of rules can fully articulate the priorities and preferences of a designer, as Hersey and Freedman have shown in the case of Palladio, it is unlikely that there will ever be a method of rule induction which supersedes careful observation and trial and error. I am an apologist for design rules rather than the different ways one can assemble a set of parts.

Mitchell's conclusion, quoted at the beginning of this essay, predicts that one day designs generated by rule-based systems will be competing with designs created by human beings. While it is not unrealistic to expect that, for much of everyday architecture, such systems will have a significant and exciting role to play in assisting human architects, it is fully to be believed, as Mitchell seems to, that such systems will be able to resolve the diverse issues that any good design addresses. He seems oblivious to the complexity of the issues Hersey and Freedman have uncovered in Palladio's work. Where in his view is there room - to take one example from Possible Palladian Villas - for the resolution of tensions that any good design entails, such as the conflict between the monotony of uniform rooms imposed by the underlying grid and the desire for variety, which can only be achieved by flouting the grid? Any rule-based design system that only enumerates possibilities implies that all possibilities are equally plausible, Hersey and Freedman have shown that they are not. Moreover, they have shown that the range of possibilities is infinite. Enumeration places one at the beginning of the design process, which means bringing to bear on the possible alternatives the particular issues of a design situation. In any case there are far too many possibilities for any one to want to play the combinatorial game: 'Mayo or Mustard? Lettuce and tomato? Onion or not? Swiss or American? White or wholemeal?'

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References


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