

1. INTRODUCTION

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This work is conceived as a book, though it is unlikely ever to be published in hard copy because of its size and because it is continually evolving. The date appears in the header of each section, and I tend to advise those who want to cite it, to use a form something like:

Miles Lewis, '9.03 Cooling and Mechanical Ventilation', in *The Culture of Australian Building* [dynamic web publication], as at July 2015.

But there are now problems with this, as it being gradually transferred from my web site to Dropbox, and becoming (for reasons which will appear below) *Culture of Building*, rather than *Culture of Australian Building*. Thus in future a citation should be something like:

Miles Lewis, '9.03 Cooling and Mechanical Ventilation', in *The Culture of Building* [dynamic Dropbox publication], as at July 2015.

a. *technology as culture*

I here attempt an approach to the study of building technology which is novel, although not unlike some aspects of archæology. I hope that this will not make the work any the less useful for those who simply want basic factual information, or a guide to existing source materials. My scope is selective but the topics are, I believe, not only the most interesting ones, but also those most in need of cultural elucidation.

The novelty of the approach may not be immediately apparent without some explanation. This is so far as practicable a treatment of building traditions from a cultural viewpoint - their overseas sources, the reasons for local variations, the contribution of particular ethnic groups, climatic considerations, the effect of historical and economic factors. To treat technology as culture is essentially an archæological approach, such as has always been used in relation to pre-literate cultures. In that context terms are often used that refer solely to technology, like 'the Bronze Age' or to combinations of technology and style, such as 'the Bell-Beaker Culture'.

Archæologists themselves try to take a similar approach to later periods, and the discipline of historical archæology has applied archæological methodology to subjects almost of the present day. Understandably enough, however, other disciplines dominate the study of literate cultures, and in consequence of this it tends to be assumed that culture is to do with art, literature and social expression, while technology develops in an independent and linear way by means of inventions and technological developments. These developments, it is assumed, may have an influence upon culture - for example television - but they are not themselves a part of culture. My thesis is not merely that building technology influences architectural style, but that it is an important aspect of culture and worthy of study in its own right. 'Culture,' as Henry Glassie says, 'is pattern in mind, the ability to make things like sentences and houses'.¹

The technological/scientific stereotype of history is a linear one. There are inventions and achievements - firsts and bigests - successively outdoing their predecessors. There is very little of the backsliding which is possible in the artistic/literary stereotype. Knowledge of the classical principles of architecture, and the works of many classical authors, were lost in the Dark Ages. Knowledge of the roof truss and the pulley were not. While it is possible in art to have cycles of taste, or to have a Georgian revival in architecture, it is not possible in any significant sense to have a revival of Georgian technology. Minority groups preserve and refurbish steam locomotives, but there is, so far, no question of their replacing electric ones in the community at large. It is true that today some aspects of technological progress are being set aside - asbestos in buildings, fluorocarbons in pressure packs - but on the broad scale technology continues its onward march.

In building practice generally, despite what I have said about the roof truss and the pulley, the picture is not one of linear progress, or of purely mechanical reactions to practical requirements and constraints. The fact that brick veneer construction is more expensive than brick cavity construction in Western Australia, while the reverse is true in Victoria, is not the result of local conditions or building materials, but of historical and cultural factors. So is the fact that the Marseilles tile is standard over much of Australia, but virtually unknown in much of France, the country from which it derives. So also is the appearance of *fachwerk* construction in parts of South Australia and Western Victoria, and in small pockets in the Riverina of New South Wales and in Queensland. Part of what I am saying is much the same as Reyner Banham said about his writing in a kindred and overlapping field - 'this is less a book about *firsts* than about *mosts*'.² That is, it is not the invention, so much as the point at which the improvement becomes readily

¹ Henry Glassie, *Folk Housing in Middle Virginia* (Knoxville [Tennessee] 1975), p 17.

² Reyner Banham, *The Architecture of the Well-Tempered Environment* (London 1969), p 16.

available in the market, which actually affects the practice and culture of building.

This is an approach which has been evolving in my own work since 1966. It was already pretty clearly expressed in my *Victorian Primitive*, published in 1977, an updated version of which composes a small part of the present book. In my J M Freeland Memorial Lecture at the University of New South Wales, in 1988, I set out something like a manifesto for the study of building technology as culture. To reiterate what I said then:³

Building technology is generally not high technology, or universal technology. What I mean by this is that inventions like penicillin, or the jet engine, result from specialised and expensive research and represent quantum leaps in performance. They therefore spread through the industrialised world in a matter of years. Today a new development in computers, especially in software, may spread through the world almost in a matter of weeks. An important point about the archæological approach is that it does not assume a uniform spread of progress. One group of people may be living in the Stone Age, while another is already entering the Iron Age. So, on a humbler scale, the brick cavity may be common in Hampshire by 1850, but in Sydney only by 1900.

Advances in building technology are often only marginal improvements, and they involve bulky and relatively cheap materials. They spread in a slower and more specialised way, governed by social, ethnic, commercial and other linkages, so that even today there are differences in building practice between the Australian states, and between Australia as a whole and Britain, or America. These differences cannot be explained strictly in terms of costs or available materials. They have become established for cultural reasons. Even the more specialised and high technology aspects of building, such as reinforced concrete systems, tend to spread slowly through established commercial or cultural routes, because they are not so markedly cost-effective as to justify the expense of cutting through the network of patents and monopolies so as to bring them immediately onto the general market.

Of course I am not totally alone in this approach, and in some respects it is paralleled in the work of Henry Glassie, already mentioned. In Australia by the far the most exciting work in this field is the treatment of German settlements in South Australia by Gordon Young and his colleagues,⁴ which has demonstrated a continuity of culture, town planning, house forms and building technology which goes back in some respects as far as mediaeval Germany.

³ Miles Lewis, *Australian Architecture and the Technology Barrier* (J M Freeland Memorial Lecture, University of New South Wales 1987), p 11.

⁴ Reported in various publications, but best summarised in Gordon Young, 'Early German Settlements in South Australia', *Australian Journal of Historical Archaeology*, III (October 1985), pp 43-55.

But my approach is certainly not identical with Glassie's, nor with Young's, and I think a small autobiographical excursus will help to explain it.

b. the Syrian paradigm

In 1974 I made a lightning tour of Syria and western Europe in pursuit of a very simple idea. The art of stonemasonry died out in the west during the fourth century: indeed this is one of the rare cases of technological backsliding - that is of building traditions following a cultural rather than a scientific model. It was perhaps partly that the transport of stone, which was always difficult, was rendered quite impracticable by the decline of the Roman road system. It must also have been because stone buildings are slow to build and very expensive, so that they depend upon levels of political stability and of prosperity that no longer obtained in late antiquity. Whatever the reasons, properly cut and dressed stone went out of use, and the only stone buildings were built of rubble or of spoils - materials quarried from classical buildings and re-used.

The stonemason's craft was resurrected in Europe in the seventh century, and it seemed important to me to consider how this could occur. It is not a simple question. One might be able to send an architect to look at a classical building and work out how to design in the same way, but one cannot achieve much by sending a mason to look at that building, or even at the quarry from which the stone came. The mason needs certain tools as well as certain craft skills. Not only the latter, but for practical purposes the former, must be drawn from a living tradition. In the seventh century stonemasonry was still well and truly alive in only a few places, amongst which Syria was conspicuous. It happened that in the seventh century Syria was invaded by the Persians, and later by the Moslem Arabs, and that many Christians fled to Western Europe.

There is not much written about these migrations, and nothing, to my knowledge, at a grass roots level. Though I speak as an architectural historian, not a classical or medieval scholar, it seems to me that we are faced with something very like the situation in pre-literate archæology. The material remains may be the best evidence there is about the activities of the small man - the non-cleric, non-scholar, non-soldier (about the small woman they certainly say less). My objective in 1974, therefore, was to look for the connections between the ongoing tradition of stone building in Syria and the newly emerging one in Europe.

How I succeeded in this it is not necessary to discuss in detail here,⁵ but I believe I did succeed in a small way. There is one distinctive aspect of the

⁵ For the details see Miles Lewis, 'Syria and the West in the Architecture of the Dark Ages', in *Thorns and Roses* (9th Conference of the Australian and New Zealand Association for Medieval and Renaissance Studies, Macquarie University, Sydney

Syrian stonemasonry tradition - the monolithic arch - which is structurally illogical, and which would never be adopted by a mason in the normal course of events. The sudden appearance of this form in Vizigothic Spain and Saxon England not only confirms what we know of the distances masons travelled in Europe - for example, Benedict Biscop sought masons from Gaul to build his monastery at Jarrow - but it suggests that their ultimate origin was Syria. Once we get this far there are a number of other masonry details, some of them purely decorative, which reinforce the impression of this Syrian connection.

A final point must be made about this exercise. This connection, if connection it is, had eluded previous scholars both because they were too close to the coal face and because they were asking different sorts of questions. Asking the right questions will produce fascinating answers in Australia, just as much as in Syria.

c. technology per se

When archaeologists deal with a literate culture they often have trouble justifying what they are doing. When they discover a classical temple or a gold burial mask everything is fine, because these are objects of virtue in their own right, beloved of connoisseurs and, in the latter case, paid for on a grand scale by museums. But when they deal with the usual run of household detritus the situation is not so clear. How common is the historian who believes that the archaeological record has significantly expanded the historical picture? Do a few broken cups and saucers tell us anything truly significant - anything that would rate even a footnote in a serious historical account?

It is amusing to participate in a dig, where everything is scrupulously gridded and stratigraphied, and every shard and button recorded and typologised, and everything is ever so objective and value-free - to be on this dig and to experience the buzz of excitement when suddenly an intact statuette is discovered. Because archæologists are in fact only human. Not only do they love treasure hunting, but they know that treasures are what in the end will attract the publicity, the support and the money they need. When the treasures are not discovered the archæological process often seems to become an end in itself or an elaborate game - somewhere in the spectrum between pole-sitting and morris dancing.

There is another level at which archæology has a claim to produce results, apart from rewriting the historical account, evolving some model of societal or economic relationships, or producing treasures. It can contribute to the

1981), passim; Miles Lewis, 'Cross-Currents in Monastic Architecture', in J S Martin [ed], *St Benedict: a Man with an Idea* (Melbourne 1981), pp 53-8.

history of technology itself - that is, to our understanding of how classical pottery was produced, or how iron was rolled in the nineteenth century. But in the nineteenth century case, at least, the written record is likely to contribute far more than the physical one. This is not quite true of building technology. For the earliest examples of brick cavity walling and brick veneer construction referred to in this book, there is no contemporary written evidence at all. And they are interesting issues, because these techniques have been claimed to be Australian inventions.

My stance is that the history of Australian building technology is an important topic in its own right. It is a subject far more significant than, say, the history of Australian painting, which affects so small a proportion of the population. Here is where I part company with Glassie, who, despite the care and skill with which he dissects building details, still sees them essentially as a way of getting information about something else - the history of architectural design, and in his case vernacular architectural design in particular. To me, that aspect is a spin-off: the history of science, technical history, artefactual history, architectural history, art history, are all worth studying in their own right, and the history of building technology, right at the centre of this spectrum, is the most worthwhile of all.

d. the outcome

How does this technology respond to my proposed treatment of it as culture? Perhaps I can relate it to Donald Horne's analysis of Australia's modern decline. He says, of the nineteenth century, that:⁶

To play its loyal part in Empire world trade, Australia had to be innovative in its export-based farming industries and activities associated with them. But if it wanted manufactured goods it was expected to buy them from the British.

A proposition such as that can be tested only by examining the realities of trade and industry, and those realities suggest a significantly different interpretation. The Australian colonies were a part of Britain, and the majority of their population was British-born, so that neither they nor Britain saw any relationship of exploiter and exploitee. Just as in Britain, there was nothing to prevent any region from developing industry, and indeed Victoria, under the policy of Protection of native industry, did just that.

Even beyond this, however, what the building industry tells us is that the colonies were treated like British provinces in terms of trade and technology. It was not a situation like that of a western nation today selling superseded computer parts and stale antibiotics to West African nations because they do

⁶ Donald Horne, 'Welcome to the Banana Monarchy', *Age*, 3 October 1987, Saturday Extra p 4 (being extracts from Horne's *The Lucky Country Revisited*).

not meet the standards of the home market. Victoria especially was an attractive and expanding market, and it received the best. Important manufacturers opened agencies in Melbourne and often sent their sons to manage them, which was more than they did in Cardiff or Nottingham. A Victorian patent was amongst the first overseas patents taken out for any new process, and it was soon extended to the other Australian colonies. Some industries even started in Australia and then re-established themselves on British soil.

In making these assertions I appear to argue against my own basic thesis. If the newest brickmaking and stone-dressing and timber moulding machinery appears instantaneously in Australia it does not tell us much in cultural terms except for the basic facts that we were British and prosperous. But it is not in reality so simple as this, and especially it is not so simple in relation to building practice. Practices are of course more cultural than inventions. The habits developed during an apprenticeship often remain through half a century of labour; others are adopted on the basis of the example of others, or by experimental adaptation to new materials and conditions; probably fewer, in the nineteenth century, were derived from written sources such as trade manuals.

e. building culture

A further and final qualification must be made as to what this book is not. It is not a social, political or economic history of the building industry. It does not discuss the Eight Hour Day Movement (though I have done this elsewhere), the development of professional standards in building, the economic fluctuations affecting the building trades, the Acts and regulations constraining the building process - even at the national scale, such as when the Commonwealth Government intervened in the industry during World War II.⁷

Inscribed stone at 'Kolor', near Penshurst, Victoria: Miles Lewis.

Trowel used to lay the foundation stone the house 'Dominica', Ararat, Victoria.

⁷

In 1941 the Commonwealth Government assumed the authority to approve projects of a value in excess of £5,000; in 1942 it took total control of manpower and materials, so that the latter could be manufactured only under licence from the Department of War Organisation; a £500 limit was placed upon mortgage borrowing; and for some time after the war house sizes, room sizes and ceiling heights were restricted. The house size limit began to be relaxed in 1950, and in 1951 reached 15½ squares [140 m²]. In 1952 control over the distribution of building materials ceased, although shortages remained acute. Barbara van Bronswijk, 'The Design of Professional Premises for General Practitioners in Western Australia, 1945-1960' (MA, Curtin University, 1994), pp 58, 92, ref S J Butlin & C B Schedvin, *Australia in the War of 1939-45: War Economy 1942-5* (Australian War Memorial, Canberra 1977, p 173.

But there are some aspects of the micro-culture of the building industry which deserve mention, and they are especially to do with the nature of evidence. One is the use of foundation stones, which today are often confused with inscribed stones. The traditional foundation stone was unmarked and invisible, but there might also be an inscribed stone giving the date of the building, the names of the owner, architect and builder, and perhaps other details as well. The deposits traditionally placed under the foundation stone were at later dates placed under this more conspicuous inscribed stone, rather defeating the purpose of the exercise, as it was clearly marked for the guidance of any thief or marauder. Associated with the laying of either the true foundation stone or the inscribed stone, a silver trowel might be presented to the layer, inscribed with the relevant details. This can itself be a major source of information, particularly in the case of a private building, where documentary records may be elusive.

Then there are fortuitous deposits like a carpenter's bag full of tools of about 1886, found in the early 1980s under a city building where it must have been accidentally floored over.⁸ At the expense of one very unhappy carpenter, posterity has been given an perfect snapshot of state of the art carpentry tools of the 1880s. In another case a small model roof frame was found within the roof of a house of the 1920s. It would have been prepared as part of a carpenter's apprenticeship, and the apprentice must simply have forgotten where he left it.

More mysterious are deposits used for magical or ritualistic reasons, often as a precaution against witches or evil spirits. Notwithstanding my initial scepticism about such matters, Ian Evans has established that items such as shoes and dead cats were commonly incorporated in British buildings for such reasons, and there is increasing evidence of them in Australia. At 'Glengallan' homestead, Queensland, the remains of a cat were found deliberately incorporated within the structure. But Evans has not found evidence Australia of what are misleadingly known in Britain as 'mason's marks'. These have nothing at all to do with true masons marks, and are placed at points of entry, such as window reveals, doorways and mantelpieces, to deter the access of witches and their familiars.

Building completion ceremonies are not important in Australia, and the practice of topping off the completed roof frame with a tree seems to have been introduced by European migrant workers only after World War II. However a photograph of the completed dome of the Melbourne Public Library in 1911 shows it decorated with a string of flags.⁹

⁸ The building was Leicester House, 202-6 Flinders Lane, Melbourne, and the tools are now in the possession of John Thomas.

⁹ *Building*, 12 June 1911, p 53.

f. the world scene

This work began as a study of Australian building, containing only such overseas material as was necessary to explain Australian materials and practices. But it now contains much more than mere background material, and refers back in some cases to the earliest known building remains in the world. This has come about in two ways.

Firstly I have found in looking at the origins of Australian practice that there were for many topics no adequate accounts of the overseas background in existence, and I have taken up the challenge of investigating this background, and in some cases have presented my findings at overseas conferences, as has been the case with *pisé de terre*, the dragon beam, the use of stumps, *lehmwickel* and the Marseilles roof tile. Secondly, in the process of teaching a general history of world building I have gathered much interesting and little known material, and I have chosen to incorporate some of it here. In fact if I am to be honest, I have prepared this text for my own pleasure and therefore have included whatever interests me.

Having explained, if not necessarily justified, my incorporation of overseas material, I need to make it clear that my approach to it is the same, in the sense that I treat world building history, like Australian building history, in a cultural way. But there are differences as well. One of those is the nature of evidence. In Australia the physical evidence is backed up by a range of documentation, public, personal and commercial. Overseas the level of documentation declines rapidly according to how humble, how vernacular, and how early is the structure under consideration. In many cultures the form of the tomb, or of models placed in the tomb, has represented that of the house, and these tombs and artefacts are important evidence for the investigator.

Another point of difference relates to the upper parts of structures. In the short history of Australian buildings we generally have a fair idea of the nature of the upper levels and roof structure, even where they no longer exist, from documentary or other evidence. That is not the case overseas. There is a degree of uncertainty about the roof structure even of monumental buildings such as the classical Greek temple. The problem is far greater in earlier and more vernacular structures.

Archaeology delivers the ground plan often with great precision, and the nature of the ground floor structure with a degree of authority. But in most cases everything above that becomes increasingly speculative. There are cases where buildings are preserved for their full height, as at Akroteri, Santorini, but these are very much the exception. We cannot hope ever to have any certainty, for example, about the world's first skyscrapers, multi-storey structures of Carthage. The problem about this situation is that an archaeological plan conveys great authority, and this may lead us to place too much faith in hypothetical reconstructions of the structure above. Such

reconstructions are commonly prepared by architects, and they look very convincing, even though based upon little real evidence.

There are many other problems in the use of archaeological material in the study of architectural history. Building remains of stone and brick are usually recorded with great accuracy. But these are a very small minority amongst a great mass of constructions in more ephemeral materials, which are in fact more fundamental expressions of communal culture. These are far less amenable to investigation.

For example timber frames fall into two categories, the earlier and more primitive being *earthfast*, meaning that the posts go into the ground, and the building's strength derives from this. But posts in the ground decay, so that these buildings are short-lived. More durable buildings rise from a ground sill, a flat plate of timber lying on the surface of the ground, or better still raised a little above the ground on some sort of masonry base. The frame now built upon it gains no strength from the ground and must therefore be well braced, which requires sophisticated carpentry skills.

The primitive earthfast building often leaves evidence, such as charcoal in the ground where the posts have burnt. The ground sill leaves little evidence, or worse still misleading evidence, like a strip of masonry which may be misinterpreted as the base of a masonry wall. Thus we have far more knowledge of the primitive buildings than of the sophisticated ones. In fact the archaeological record tends to suggest that the ground sill was used in Roman times but then forgotten, only to be later rediscovered in northern Europe and Saxon England. The probability, however, is that it remained in continuous use through the intervening period but has left no discernible traces.

Earth construction, which was even commoner, is even more problematic. Sod building was widely practised in Europe and in moister regions elsewhere, but as sods are cut from the ground they are very difficult to differentiate from the ground. Some structures of sod still stand, like New Grange, Ireland, but those that do not stand have generally passed into oblivion.

The most primitive earth construction, pug or cob, disappears in the same way, but where was used in the drier regions of the Mediterranean and Near East it has sometimes survived, especially where it has been fortuitously barked when as building was burnt. The problem there is less one of physical evidence than of the discipline of archaeology. A large proportion of archaeologists refer to cob, or to any non-specific form of earth building, as *pisé de terre*.¹⁰ But *pisé de terre* is a totally different form of construction, relying upon sophisticated carpentry for the formwork. It was invented much later, in the first millennium BC; is far stronger and more durable, and is

¹⁰ A number of examples are cited in the discussion on Cob, below..

totally unknown in the Middle East. Where it does appear it is very significant, and its spurious appearance in archaeological literature is dangerously misleading.

Even mud brick, the most distinctive of the earthen materials, can escape the attention of those not accustomed to it. Danish archaeologists working on the island of Falaika [Faylakah] dug right through a building until they reached the stone footings. They had no idea what they had done until their driver pointed that it was mud brick, not natural soil, which they had cut through.¹¹ But the issue goes beyond the simple recognition or non-recognition of the material. The shape of a mud brick, and to a lesser extent its size, are indications of its origins and cultural connections, and I will postulate below a major division between the region of block-shaped mud bricks and the region of flat plate-shaped mud bricks. Nobody, to my knowledge, has previously considered these issues.

g. the Australian scene

Most of what we have to deal with in Australia is more or less factory-produced. To treat building technology as culture is certainly not to deny that there are inventions, patents, commercial distribution networks, agencies and licences, all of which seems quite contrary to vernacular folk tradition of the Glassie model. But it is a fact that even today Australians have very strong tradition of handyman-ship - the rate of involvement in home maintenance and repair is higher than in most western cultures. The country has a far higher rate of home ownership than most, together with strong cultural stereotypes about what a home is and how it should be used. For those who do own it, their dwelling is commonly their major capital asset, and for those who rent it is their largest budget item.

Place all this against our level of active involvement in art or music, or even sport, and the cultural significance of the dwelling is apparent. The home - and it is always called a 'home' rather than a house - is of almost iconic importance. This book is therefore concerned with the technology of the dwelling house more than with that of other buildings. The technology of the office block or of the factory is far less relevant even to those who work within the building. A minority of people fully understand these structures, or have engaged in physical work upon them. So they are not fundamental to our culture in the same way.

Farm buildings fall somewhere in between. In the nineteenth century they were commonly built by the farmer's own hands, and certainly they were part of a living cultural tradition. This we will see as soon as we compare those put up by, say, German as opposed to British settlers. Today, by contrast, many

¹¹ Geoffrey Bibby, *Looking for Dilmun* (Collins, London 1970), pp 243-4.

of these buildings are almost as remote as are factories from the realm of ordinary experience.

Before getting far into this book the reader may conclude that all this preamble has been quite spurious - that there is here no grand cultural overview, but only the usual ragbag of nostalgia and antiquarian detail. The truth is that there is a lot of factual data to be sorted before any grander picture can be drawn, and often it is so incomplete that the grander picture never does emerge. Moreover my task is very difficult, because of the arbitrary quality of the data. Much of what I discuss is concealed within standing structures, whose owners are not anxious to have them dismantled. That means that it comes to my attention more or less by chance. I discuss early brick cavity walls which seem to have appeared in Bendigo and Stawell towards 1870. If it were suddenly discovered that there was a node of this construction in Bunbury, Western Australia, and that this dated from about 1860, I would be embarrassed, but not greatly surprised.

It is a sobering thought that such an important local development will come to light only be in the unlikely event that somebody in Bunbury reads this book. Thus it will be understood that my research process is largely one of trawling. I trail an idea past someone until they react, and I thus collect some more information. Although I have not been able to trail my ideas past the citizens of Bunbury and all the equivalent towns, I have trawled a fair number of my colleagues in the areas of architectural history, conservation, historical archæology, building and engineering. I am therefore indebted to them in more than the usual sense, and I hope this shows.

There have been a number of books in this area which have tried to minimise their indebtedness to others, including me. The authors pointedly use a different source to get the same information, or use the same source as if coincidentally, and if any necessary acknowledgement is forced out of them, it appears in an obscure footnote. It will be found that I refer to my colleagues by name in the text whenever this seems appropriate, for one of my aims is to give the reader a sense of who is doing what, and what is the state of play. And my footnotes appear on the same page so that the sources are always before the reader. I have not had to purloin material from my colleagues, for they have proffered it freely, and my reliance upon their goodwill is a source of pride rather than of embarrassment.

Many topics are be touched upon only lightly, and others are entirely excluded from this survey. Such exclusions occur usually because the topic contains little which is specifically Australian, or because it is in some way marginal to the mainstream of the building industry. As to the more arbitrary of the inclusions, I hope that they have been so well embedded within the overall structure that they will not strike the reader as especially odd.