ON-LINE DOCUMENTATION OF PROVEN ARCHITECTURAL FACADE AND DETAILING IN THE TROPICS

Chew Weng Kong, Tse Swee Ling, Edward Ng[1]

Abstract

The search for quality has lately been making headlines in the local press in Singapore. Much of the call for better buildings could be achieved by better construction detailing on the part of designers. However, at present, information on proven architectural methods is rare, difficult to obtain and, if it exists, not widely shared. This paper outlines the research framework for a database of proven construction solutions for the building industry and it highlights the methods used in the collection and organisation of information. It also lays out the foundation for the assembly and evaluation of such and it postulates on the possible benefits of having this information source on-line.

Keywords

Architectural detailing, Tropics, Information technology, On-line database

1.0 PROBLEMS

The Singapore building industry spends in excess of a billion dollars a year for the renovation and the repairing of existing building stocks. A fair amount of which is wasted repairing details which were not properly designed when first constructed. Adding to the timeliness of the problem is the recent laws suits between building owners and the developers when defects appears.[2] A trend has been set for higher expectations as well as a need for better quality.

There are many reasons for the problem. Not least of which is the lack of a documentary reference of proven details which could inform better construction. At present, individual firms of architects detail buildings according to their own in-house 'know-how' and experiences. Although there is a wealth of available knowledge within the industry, much of which is confined within individual practice. The lack of cross fertilisation has resulted in designers attempt, in the dark, to re-invent the wheel each time a need is required. Or in other words, to develop an un-tested and un-proven prototype for each building erected. Researches have indicated that much of these energy could have been better channelled if information of well performed alternatives could be made available.[3] Another problem facing local designers has been the import of foreign construction materials and techniques

[1] The research team is headed by Mr Chew Weng Kong and collaborated by Mrs Tse Swee Ling and Dr Edward Ng, all of the School of Architecture, NUS. For further information contract Dr Edward Ng (akienyy@nus.sg) School of Architecture, National University of Singapore, 10 Kent Ridge Crescent, Singapore 119260, fax:(65)7793078, telephone:(65)7723567, www(Personal/part time):http://137.132.182.86/www/home, or www(School): http://www.arch.nus.sg/

[2] Straits Times, Tuesday 23 January 1995, p.22.

[3] Brewer, R, Snow, C., Technical Publications: The Design Professionals' Response, Building Research and Practice, vol 21, no 1, 1988.

into the local construction industry. Though performed well overseas, some of these techniques are not designed and not suitable for the local climate and conditions. However, there has yet to be any informed studies to provide data on their selection, execution and long term performance evaluation.

This problem of the lack of 'relevant' and quality information on 'quality is not unique to Singapore.[1]..For example, in the UK where one of the author of this paper has had some first hand experience. Despite its matured construction, professional, publication and research machinery, much of the available information is still under utilised[2]. There are two reasons for this, the information available is either too much or too little. Whereas much of the more encyclopaedic works, like the RIBA CAD, have been concentrated on cataloguing the 'average', the 'commonly in use' or the 'manufacturers' standard' construction details, not much have been done to provide quality and inspiring examples in a holistic manner. Bits and pieces could be found in various flashy magazines by internationally known architects. But little is published in a way in which one could relate one set of details to another, let alone trying to detect the reasoning and ideas behind a set of similar details[3]. And even when that little is published, it is not readily available unless one happens to know the source or even own a copy of such.

In brief, the problems are:

Lack of shared information which is relevant, useful, appropriate, contextual and available. Information available are shattered, not relate, not in-depth and not concerned with quality.

2.0 THE NEED FOR RESEARCH

A number of needs can be identified with the problems at hand. Whereas local context and conditions may alleviate one or more of the identified needs, a wider picture is presented here so that research vision may not be pigeon-holed too readily too soon.

First of all, there is the need to address the issue of the ‘availability of quality information’ which is in the right format, appropriate to the local context, relevant to the needs of the building industry, and up-to-date with the publication of a reference source of significant substance for the design professionals. This concern for an available, relevant and quality information applies to the construction industry both locally and abroad.

Secondly, there is the need to alert and make aware the issue of quality in the building industry by establishing a guideline of good architectural detailing. This is particularly important in countries where the construction industry has yet to formulate a formal, or informal, professional code on standards and expected quality of works. Singapore is one example of such a country. And perhaps this call also applies to many developing countries.

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[1] Brewer, R. and Snow, C., 'Technical Publications: The Design Professionals' Response', Building Research and Practice, vol. 21, no. 1, 1988.

[2] MacKinder, M., and Marvin, H., Decision making in Architectural Practice, Institute of Advanced Architectural Studies, York University, 1988.

[3] A notable exception to this is a book on cladding: Brookes, A. and Grech, C., The building envelope : applications of new technology cladding, Butterworth Architecture, 1990. However, even this is a bit thin on reasoning and background materials.

Thirdly, there is the need to establish a foundation to further research efforts for an on-line architectural information database and linking it to international efforts of similar concerns. With the forces of globalisation hitting the drawing board, designers can no longer afford to remain 'local' - in Singapore much of the materials are imported and a lot of buildings designed by the local architects are for overseas clients. Similarly, research efforts can no longer afford to be stand alone and be an isolated and idiosyncratic pursue. The call for a holistic approach to future research efforts, bearing in mind the above two calls for the needs of availability and quality, is a call for interchangeable knowledge beyond ones traditional boundaries. With the advent of information technology, with the need to communicate and share, and with the call for collaboration and join efforts, perhaps the availability of a knowledge protocol is as important as the information it is going to contain. And this is the area where the paper is designed to focus on.

In brief, the need is for the gathering and evaluation of a substantial body of information as well as the design of a knowledge framework which is internationally applicable and inter-changeable.

2.0 PREVIOUS PUBLISHED WORKS OF RELEVANCE

Locally in Singapore, despite the timeliness for the promotion of better buildings in Singapore, there has yet to be a co-ordinated effort in this area of research and publication. Evelyn Lip & Bill Lim, both of NUS, did some researches in the early 80s on detailing for the Tropics.[1] No analysis was offered then and the effort was not updated. A more recent addition, through not a research effort, is a construction manual produced by the CIDB[2]. This is basically a re-compilation of very basic manufacturers' details. The SIA[3] has in the past few years trying to raise awareness with the Micro Design Awards, winning entries of which have lately been edited and published[4]. Notwithstanding the efforts, there is no in-depth research offering anything beyond the physical appearance and the making of the details themselves.

Although a huge collection of books on construction detailing could be found in the library, much of which are from overseas, by overseas authors, using overseas examples and based on overseas practice. Whereas shedding much light on the more fundamental aspects of construction technology, these books fails to be useful for not providing for local conditions and practice. However, having said, the ontology of some of these could be used to construct a useful insight into the nature and thus the usefulness of information as presented. There was basically two types of books, one based on generic building components and the other based on case studies (see Annex 1). It can be noted that whilst the generic approach provides much of the information needed for a basic, or alternatively an in-depth, understanding of materials and technologies for the learners, it is the case studies which are of more usefulness to the designers.

What makes a case based approach more useful is the 'as in use' content of the knowledge. This presentation of knowledge pre-supposes a certain fundamental understanding on the part

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1 Lip, E., Lim, B., Architectural Detailing for the Tropics, NUS Press, Singapore, 1988.

2 CIDB (Construction Industry Development Board), CIDB-SIABC CADBase Distribution 4.0, 1992.

3 SIA stands for Singapore Institute of Architects.

4 Tse Swee Ling et al, Micro Design Awards, SIA Publication 1994.

of the users, thus by-passing the redundancy of information overload[1]. It also present to the users, rather implicitly, a value judgement when knowledge is applied. It tells the users what, to the designer, is correct, acceptable and appropriate. In a way, the meaning of the detail has more to tell than the physical being of the detail itself. Unfortunately, for inexperienced readers, this knowledge is not immediately apparent at all[2]. For example, none of the books examined has a section by the designer himself explaining the context of the details. This lack of 'situation', 'constrain', 'context' and 'value' is limiting the development of a 'what-if' scenario in which examples could be mutated, by the users, into new forms and incorporated into new designs.[3] The provision of a 'situation' and so on is not a simple task. And the problem with traditional publication is that it is extremely difficult to incorporate for the huge range of information required to substantiate the multivalance of enquiry modes which an example could be subjected to without committing the sin of an information overload. The traditional use of appendices, text boxes, footnotes and references helps. However, the provisions are still far from being able to cope with the range of situations at hand. This is perhaps the reason why some researchers are turning to the advanced use of information technology for a way out.

3.0 PREVIOUS WORKS ON ON-LINE DATABASE

Whilst a lot of effort has been spent on knowledge based design system, not much of which is directed towards construction technology. Dana Vanier of the Institute for Research in Construction, National Research Council of Canada, completed an outline studies on Details for a Cold Climate base on Hypertext Technology in 1988[4]. Unfortunately, the effort has had no follow up since then. A team in New Zealand, directed by Mr Mark Burry, has in the past 2 years embarked on constructing a similar database for the local[5]. The innovative aspect of the research is the ability of the team to capture substantial amount of information with very limited resources. A team in Sheffield, led originally by Dr Edward Ng and now by Ms Melanie Richardson, has in the past 3 years worked on a construction technology database for teaching.[6] The research was an attempt to assist lecturers in planning and updating their lectures with an object oriented data structure. However, since the coming of the World Wide Web, much of the technology developed has been superseded. Efforts has now been concentrated on enlarging the database and to transfer which onto the Web. A team at Aarhus University, Denmark has, for the last 6 years, completed a number of government funded project on a similar concern. Their works however have not been officially published.

The key problem with these, and many other, pioneering efforts using on-line technology is the lack of a 'critical mass' in that researchers are still, behind close doors, trying to re-invent the wheel. As Professor Burry rightly pointed out,

> An inherent problem with creating a multimedia application is generating the mass of information needed in order for it to be comprehensively useful. This is especially true when the subject is building construction for which any informative resource

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[1] Schon, D., Reflective Pratitioner, Ashgate Publishing Company, 1995.

[2] Lawson, B.R., Design in Mind, Butterworth Architecture, 1994.

[3] Mitchell, W., The Logic of Architecture, MIT Press, 1990.

[4] Vanier, D. J., Hypertext: A computer Tool to assist building design, The Electronic Design Studio, William J. Mitchell (ed.), The MIT Press, Mass., 1990.

[5] Burry, M., Prentice, R., Wood, P., Walking before running: a prelude to multimedia construction information, Conference proceedings, ECADDE Conference, 1995.

[6] Ng, E., The Electronic Hartlib Project, Conference Proceedings, ECAADE Conference, Glasgow, UK, 1993.

> must cover the whole range of the material within its scope from the outset rather than merely be a sampler. Construction studies involve a large and diverse range of generic' or 'model solutions' which, in an ideal learning situation, are placed in context with historical and contemporary examples to aid a sense of critical evaluation.

And the solution seems to lie in the development of a protocol which

> generates material with a usefulness beyond its immediate pedagogical goals and prior to its ultimate incorporation into a multimedia application.

4.0 THE CRITICAL ISSUES

There are two issues involved. First of all, theoretical works on the so-called second generation Case Base Reasoning Design Support System seems to suggest that the failure of earlier efforts could be accounted for by the inability of the early systems to 'accommodate the cognitive complexity of design thinking', and that future efforts should concentrate on 'the formulation and structuring of all knowledge required for dealing with a particular design task and the provision for memory organisation and indexing for retrieval in the task.'[1] The need therefore is not so much for a design aided system but a design support system in which 'breadth' rather than 'depth' is required[2]. This need is particular of importance in the field of construction technology where 'coverage' is a prerequisite of any construction technology information system.

The second problem involved is the organisation of the information to cater for this 'breadth'. Researches have indicated that the need for information is contingent upon a number of variables and that, due to the 'knowledge rich' nature of architectural design, the matrix of variables could not be universally determined[3]. That is to say, any attempt to build a close indexing system, regardless of how comprehensively it is constructed, is bound to impose restriction to the way information is accessed. However, on the other hand the object oriented technique, borrowed from software engineering, where data can be freely tagged will run into the problem of management and house-keeping once critical mass is approached.

There is no easy and neat solution. Instead, a partially structured database is sometimes proposed. There are, broadly speaking, two classes of structure favoured by researchers. The Hyper-link structure[4] and the Hierarchical structure. The two structures are not without limitations. Notwithstanding the criticisms of 'getting lost in hyperspace' identified by many researchers, Hyper-link structures is inherently 'value-less' in that it does not grade or qualify the relative positioning of a data as related to the overall picture. This is due mainly to the fact that there is no 'overall picture' in a 'jumping from links to links' mode of navigation, and partly to its open morphological structure. Various remedial suggestions have been proposed, for example the use of a 'core plus secondary' navigation structure, but none has yet to

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[1] Oxman, R., Case-Based Design: Cognitive Models for Case Libraries, Knowledge based Computer Aided Architectural Design, edited by Gianfranco Carrara & Yehuda E. Kalay, Elsevier Science B.V., 1994, pp. 45-68.

[2] Oxman, R., 'The Library of Babel: The Representation of Technological Knowledge in Electronic Libraries', Conference Proceedings, ECAADE Conference 92, Barcelona, Spain, 1992.

[3] Rittel, H.W.J., Webber, M.M., Dilemmas in a general theory of planning, Policy Science, 4, 1973.

[4] Yankelovich, N., Meyrowitz, N., van Dam, A., 'Reading and Writing the Electronic Book', IEEE Computer, vol.18, no.10, October 1985, pp.15-30., 1985.

provide a satisfactory solution. On the other hand, the Hierarchical structure, basically an extension of the traditional library classification system, attempts to formalise knowledge based on an open and yet pre-defined classification system. The assumption here is that knowledge can be 'graded' and that information needed can either be found within a class, or immediately and vertically adjoining the class. The key problem of a Hierarchical approach where data is classified into super-class, classes and sub-classes is that the respective classes and sub-classes may not necessary have to relate to each other. That is to say, it is almost impossible to relate say a level 5 sub-class of one branch of knowledge with a level 5 sub-class of another. This impose severe limitation in lateral reasoning.

Bearing in mind the limitation of both the Hyper-link structure and the Hierarchical structure, an open matrix structure combining the merit of the two can be proposed. A matrix information system has the advantage that it is partially structured and, depending on the number of axis chosen, is capable of associating information in nth ways. There are however two key limitations in using a matrix information system. Firstly, the representation of more than 3 key axis can be too abstract for many to comprehend. Secondly, the naming of the axis can be difficult. Fortunately, in the field of construction technology where information classification is relatively simple, the problem may not be an insurmountable one. As will be demonstrated later, the use of TIME, PEOPLE and CONTEXT as the three key axis will provided for a framework that is comprehensive and yet flexible.

5.0 THE INFORMATION MATRIX-STRUCTURE

At NUS, a research project has been launched to add meat to the open matrix structure. The proposed database seeks to address this issue of the 'availability of quality information' in the right format, of relevance and with proper references to the design professionals, through three key facilitating sub-programmes:

Firstly, to develop a knowledge framework upon which information could be systematically engineered, matching generic data with design and construction requirements. An outline **Taxonomic chart** has been constructed to guide the classification of studied examples into a relational database to ensure that captured data is systematic, comprehensive and relevant (see Annex 2). The development of such a system is informed by researches in knowledge engineering and design method studies pioneered by Lawson and by Powell. The chart does not rely on traditional typolological classification methods, instead it uses a more generic approach whereby the 'means of construction' rather than the construction itself is emphasised. However, that said, within each pigeon hole, the traditional method will still be used. A two tier information collection method would then be used to collect the sample**A Scanning function** will be put in place to capture raw data for subsequent quality auditing. The function could include causal personal contacts and recommendations by the SIA and other government and professional bodies. Scanning posts could be established through collaboration with architect offices, contractors and building material manufacturers**A Net function** will also be initiated to capture significant but less well-known samples. This function could include a systematic questionnaire based on market research and tele-interviewing. A stratified approach based on the Taxonomic chart will be adopted in the data collection.

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[1]. Lawson, B R, How Designers Think, Butterworth, London, 1988.

Secondly, based on the knowledge framework, to construct a database, on-line and otherwise, of substantial substance for the benefit of the construction industry. The data identification process will be followed by **a Recording function** when the sample will be visited, photographed, measured and recorded. To achieve this, the Architect for each respective detail will be interviewed, the performance of the detailing and the materials used will be studied and commented, the manufacturers of the components will be referenced for additional product information, the users' views will be noted and compiled. Further information on standards, codes and development since the detail was constructed will be added and additional sources of information, local and overseas, will be appended. The information collected will be formatted to conform to existing and 'on the horizon' international standards.[1] Having obtained the generic information, the research team will attempt to analyse the samples. Initially, **The Analysing function** will consist of 4 X-dimensional, 5 Y-dimensional and 3 Z dimensional attributes (Annex 2). The 4 X-dimensional attributes are the Initiator, the Gatekeeper, the Maker and the User. The 5 Y-dimensional attributes are, after Betts, Product, Project, Enterprise, Institution and National.[2] The 3 Z-dimensional attributes are As Design, As Built and As Is. Together they form a three dimensional matrix upon which the rationale and the contextual formation of each individual sample could be identified and its subsequent performance could be commented and understood. The development of the matrix is informed by researches on Knowledge Engineering[3] and could be refined to cater for more complex information requirements later on.

The final stage of work involves the dissemination of the findings and the formatting of information into a useful knowledge base for the designer. Each set of data will be made into a self-contained 'mega-case'[4] in accordance to the Taxonomic Chart with its content structured through the XYZ matrix and monitored through close collaboration and feedback from the professionals. Each mega-case will contain several cross referenced mini-cases. The number of mini-cases depends on the complexity of the mega-case. The information will be made available through the Internet, probably using the World Wide Web as the delivery media. This work will be informed by studies, by others, in its ontology.[5]

7.0 CALL FOR COLLABORATION

As explained earlier on, the proposed taxonomic chart and all related functions is not meant to be the definitive method for the problem at hand. The main purpose of this paper, apart from laying the theoretical ground work for the research at hand, is the call for wider participation and collaboration. Without which the research would fall into the trap of being another isolated attempt to 'single-handedly re-write the entire Encyclopaedia Britannia'! - the resources required to achieve that would be far beyond the command of a single institution. And even if that is achievable through determination and shear stubbornness, the

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1. Wik, J, Common Standards for data exchange, Construction Computing, Spring 1989, pp 13-15.
2. Betts, M, Mathur, K, Ofori, G, Information Technology and the Construction Industry of Singapore: A framework for a communications Network, NUS Press, 1989.
3. Marchionini, G., Bshneiderman, B., Finding Facts vs. Browsing Knowledge in Hypertext Systems, IEE Journal Computer, 1988.
4. Schmitt, G, Cheng, C.C., Classes of design - classes of methods - classes of tools, Design Studies, Butterworth-Heinemann, The Netherlands, March 1991, pp 246-52.
5. Vanier, D.J, Internet opportunity for distributed construction information, The International Journal of Construction Information Technology, vol 2, no 3, Autumn 94, pp 45-65.

acceptability of which and its applicability beyond once own boundary is still of an unknown question to be answered[1].

There is already an MOU between the authors' team at Singapore and Professor Burry's team in Australia to further the research effort. Three other institution in the UK, Brazil and Spain respectively are in the process of joining the effort. However, this is still far from enough. What we are trying to propose is a two tiered collaboration structure where institutions could gauge their level of commitment according to their own available resources. At present we are proposing two levels of participation. Level 1 participation will concern with the participant contribution information in an agreeable format in return for the use of the entire database. Level 2 participation requires collaborative work on the development, refinement, testing and evaluation of the data structure as well as contributing information. This is no doubt time consuming and not for the light-hearted. Bearing in mind the afore-mentioned approach is still in its early stage of inception and is at best the authors' own 'best solution', it is important that institutions wishing to join as Level 2 participant should attempt to do so as soon as possible. Please contact the authors for further information.

8.0 CONCLUSION

This paper outlines the two key problems in producing an on-line database for construction studies, namely the need for a body of information and the need for a structure. Having briefly analysed the options available, an open matrix structure is proposed and the various functions designed to achieve the information collection, classification and analysis are outlined. A call for collaboration is issued and a wider picture of a research paradigm is outlined.

The work that needed to be done is still in its early stages of implementation. Although much of the knowledge framework has been studied and a slightly more comprehensive one is proposed, much of the hypothetical assumptions have not been proven yet. Ironically, this is a catch 22 situation. The assumptions could not be proven until a substantial body of knowledge is assembled, but the assembly of this information cannot be achieved without devising a suitable knowledge framework. May be it is not for nothing that Ludwig Wittgenstein is reported to have said:

> You think philosophy is difficult enough, but I tell you it is nothing to the difficulty of being a good architect.

The authors believe that a 'spiral' IT technique whereby issues are dealt with concurrently and interactively will be the answer. In this respect, this paper is not presented as the definitive result of a programme but as an exploratory inquiry into the possibility of such an open-system in the studies of construction technology.

9.0 POSTSCRIPT - A GENERIC RESEARCH STRUCTURE

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[1] Ng, E., The Electronic Hartlib Project, ECAADE Conference Proceedings, Edinburgh, 1994.

[2] Gray, P., King, W.R., McLean, E.R., Watson, H.J., MoIS - Management of Information Systems, The Dryden Press, New York, 1994.

Research is never a standalone endeavour. The afore-mentioned research program is part of a wider and perhaps more ambitious attempt to develop a more integrated Design Support System, or using Lawson's words, for the designers to have a 'parrot on the shoulder'[1]. Information is value-less unless used[2]. An interactive schema outlining the didactic nature of the expert and the user has been proposed and part of its studies has been reported (figure 1[3]). The concern of this paper sit squarely between the Author and the Designer, without which nothing much could be achieved.

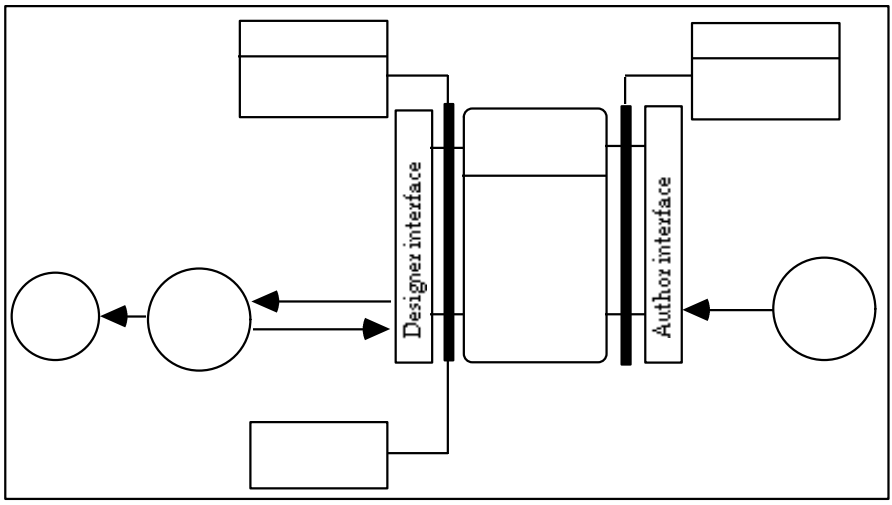

figure 1 A theoretical schema by Professor Lawson & Dr Ng at Sheffield University

[1] Lawson, B.R., Parrot on the Shoulder, Intelligence and Visualisation in Architecture, edited by JJ Conner, Elsevier Science Publishers, 1993.

[2] Daniels, N.C,, Information Technology, Economic Intellience Unit, 1995.

[3] Lawson, B.R., Ng, E., A semi-intelligent design support system, unpublished research report, Sheffield University, 1993.

ANNEX 1

Generic contents of selected books on construction

	Component based	Case based	country	General			Detail			
				photo	Txt	Dwg	photo	Txt	Dwg	Ref
The Building Envelop		Yes	Int	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Connections		Yes	Int	Yes	Yes	Yes	P	Yes	Yes	Yes
The way we build now		Yes	UK	Yes	Yes	Yes	No	Yes	Yes	No
Architecture in Steel		Yes	Aus	P	P	P	No	Yes	Yes	No
Building Technology	Yes		UK	No	No	No	No	Yes	Yes	Yes
Barry Series	Yes		UK	No	No	No	No	Yes	Yes	No
McKay Series	Yes		UK	No	No	No	No	Yes	Yes	No
Mitchell Series	Yes		UK	No	No	No	No	Yes	Yes	Yes
The Professional HandBk	Yes		USA	No	No	No	Yes	Yes	Yes	Yes
Building Construction	Yes		USA	No	No	No	No	Yes	P	No
Construction	Yes		USA	No	No	No	No	Yes	Yes	No
Architectural Detailing	Yes		USA	No	No	No	No	Yes	Yes	No
Wall Systems		Yes	USA	Yes	Yes	No	No	Yes	Yes	No
	Yes		Sing	No	No	No	No	No	Yes	No

P = Partial

Books:

Brookes, A.J., Grech, C., The Building Envelope - applications of new technology cladding, Butterworth Architecture, 1990.
Brookes, A.J., Grech, C., Connections - Studies in Building Assembly, Butterworth Architecture new technology series, Butterworth-Heinemann Ltd., 1992.
Orton, A., The Way We Build Now, Van Nostrand Reinhold, London, 1988.
Ogg, A., Architecture in Steel - the Australian context, the Royal Austrelian Institute of Architects, 1987.
Seeley, I.H., Building Technology, 3rd edition, Macmillan Building & Surveying Series, London, 1986.
Barry, R., The Construction of Buildings, vol. 1-6, 2nd edition, BSP Professional Books, 1988.
McKay, J.K., MaKay, W.B., Building Construction, Longman, London, 1975.
Mitchell's Building Series, Pt 1 - Structure & Fabric, Pt 2 - Introduction to building, Longman Scientific & Technical, London, 1994.
Edward, A., The Professional Handbook of Building Construction, John Wiley & Sons, New York, 1985.
Ching, F.D.K., Building Construction Illustrated, Van Nostrand Reinhold, New York, 1975.
Olin, H.B., Construction - Principles, materials & Methods, Van Nostrand Reinhold, New York, 1990.
Allen, E., Architectural Detailing - function, constructibility, aesthetics, John Wiley & Son, Inc., New York, 1993.
Sands, H., Wall Systems - analysis by detail, McGraw-Hill Book Company, New York, 1986
Lim, B., Lip, E., Architectural Detailing for the Tropics, NUS Press, 1988.

ANNEX 2

The Taxonomic chart and the Analysing function