Abstract

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 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. An obstacle, then, against creating resources dealing with detailed design is the risk that if it is not completed in its entirety there is no useful outcome. This paper outlines the 7 steps of a process which generates material with a usefulness beyond its immediate pedagogical goals and prior to its ultimate incorporation into a multimedia application. The paper also describes the problems and solutions involved in treating this material as data in a generic format so that its future usefulness is not compromised by current needs. It also outlines the programmes written to streamline an otherwise unwieldy process and deal with the inevitable non-conforming output from the participants.

Background
To a greater or lesser extent, every country has a range of specific building conventions. Countries may have a lot in common but their differences necessitate some form of national building practice description which can be catalogued either as standards or as approved solutions. The smaller the nation, the more isolated it is from others and the greater the range of climate, seismic and exposure zones, the more difficult it is to produce any generic building description. A country like New Zealand has at least the same range of building complexities as elsewhere and its relatively small population (3.5 million) means the market is less able to afford the comprehensive documentation of the full range of building options for educational purposes. The inevitable outcome is a restriction in the range of building options which has as much to do with provider ignorance (through lack of documentation) as it has to do with the effects of economic limitations within a small country. An additional obstacle against healthy up-to-date descriptions of generic building details is the rapid changes that the building industry undergoes not just through the development of new materials and techniques but also radical changes in building philosophy.

Our aim has been to organise a readily editable multimedia resource which has the flexibility of being able to compare national generic and specific building options with their overseas equivalents. After two years of studio work students have produced 400 pages of drawings using AutoCAD covering most generic construction systems as well as a range of details from 50 respected local buildings. These accompany word processed explanatory texts and references (figures 1 and 2).
PRECAST CONCRETE PANEL JOINTS

The joints have two lines of defense for weatherproofing. The typical joint consists of a rain barrier near the exterior face and an air seal close to the interior face of the panel. The rain barrier is designed to shed most of the water from the joint, and the air barrier or air seal is the discontinuous line between the inside and outside air pressures. Between the two stages is an equalization or expansion chamber which must be vented and drained to the outside. A P.V.C. strip may be added to provide further protection. The simplest form of a horizontal two stage joint is the well known dry joint, in the two stage joint, the exterior seal or rain barrier prevents entry of most amounts of water. If wind or rain penetrates the barrier, it will drain off in the air chamber as the kinetic energy is dissipated by splashing and the air will go up to the atmosphere. The air chamber which is vented via the jointing to the outside envelope helps a pressure equilibrating space. Pressure equalization is achieved by using ship-shaped horizontal metal strips, by breaching the air space or by leaving an open horizontal joint at the ends, which necessitates flashing details. With pressure equalization, water should not penetrate the wall system far enough to cause any problems.

The slight exterior seal is the primary means of preventing warm, moist air movement and controlling the effectiveness of the air chamber and exterior rain-barrier. It is essential that the air seal be maintained as below the air seal should result in complete breakdown of the joint sealing mechanism. These the barrier on seal should be excluded line.

Water either from precipitation or condensation should be drained from the joint by flashing metal strips. It is advisable to use those flashing details at corners or sides to avoid vertical movement of air in the expansion chamber caused by wind and outside air turbulence. Flashings should be installed at regular spaced intervals along the height of vertical joint. A P.V.C. strip is used in general on all joints from water penetration and aid drainage of the vertical air chamber.

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The sides of the building being screened from the road by trees, the presence of Aquatic Centre provided a problem of scale in scale with existing conditions and precedents in Kilbourn, Wellington. Built in 1956 and located next to the Kilbourn Bowling Club, it is one of the largest sports venues in Wellington. Designed here was the builder, be it the full range of competitive and recreational swimming activities. The spaces are set up to 1,000 spectators. The normal height of building is governed by the height over the swimming pool and height lines from the spectator seating. By reducing the height from the visual aspect as a series of cascading troughs, the impact on the neighbouring propinquity was kept to a minimum.

A sense of revolution between within and around the building was seen as the key. The roof of swimming pool area was well designed and the building seems to gently wash with variety of gardens. The progression through the building was well continued but not overpowering.

The opened up window between the swimming pool and and main pool area offers a sense of spaces heightened by the exposure of volume and structure, all contributing to the fun and enjoyment appropriate to the complex.

The main pool area in '75. The pool is a beautiful design, three separate by inside-bulldog design, three separate boxes, and a waterpark for recreation and relaxation.

The main deck area with the swimming pool complete, the height to measure well handled. The overall form of the space has been given due consideration in design. By creating the sense of the building, the architects chose Wood and panels for swimming and upper walls, together with exposed glulam beams and internal glass of the roof, there is point in emphasis of the pattern in the overall design.

Since, the centre offers help for a varied, lively atmosphere. The Aquatic Centre has become a popular well known locality in Wellington.

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CONSTRUCTION COMMUNITY

The working environment has been developed to enable students with cursory CAD skills to become productive extremely quickly within protocols designed to avoid reprocessing and ensure consistency of output. Even if the fruition of the multimedia version remains some time away, through collating the material electronically and organising it according to a data model designed for this purpose, we have guaranteed a useful product both for now and the future. Each year profits directly from the work of the previous with the opportunity for ongoing refinement. Individual creative endeavours have been harnessed to distinguish between notions of ‘making’ and ‘made’ informing of how ideas can be turned to artefacts.

The sophisticated methods which have been devised to accommodate the students’ maverick tendencies have had an unexpected value: an exceptionally robust suite of programmes for collecting and collating the material. These data-input forms can be distributed to other schools of architecture both nationally and internationally allowing the collection, dissemination and cross-referencing of a greater variety of material of mutual benefit. Scanned original drawings, photographs, renderings and animations are being added to complement interpretive drawings. Until the student work is suitably voluminous and of an appropriate consistency to fulfil the needs of a complete multimedia ‘virtual handbook’, it is being published as a series of textbooks, each 400 pages in length. By these means, and with very little expenditure, we have achieved the automatic compilation of authoritative textbooks as a valuable interim measure while maintaining the integrity of the source data for incorporation into a future multimedia application.

Obtaining Primary Material

The thematic amplitude demanded by a broad-based description of construction technology means that the resource depends on a large number of files without any hierarchical ordering. Drawings and text are being added to the collection annually and existing drawings are being reworked both by students and editors over a period of time. The system we have devised is a consequence of the problem of data collation and management. The opportunities that the system has provided - knowledge sharing - is an outcome of solving this problem.

Two concepts have been established: a central database which contains the information about the status and filed location of all the material and a central controlling programme which orders the material. By archiving the resources in read-only format and only adding to it through the central controlling programme we can ensure that the large number of diverse and non-hierarchically ordered files can be located and processed easily.

There are three components to the students’ assignment: a measured drawing of a detail from a local historic building, a ‘generic’ detail and a study of an ‘iconic’ local building. The project is based on the premise that a CAD programme can be used to generate all the drawn information associated with this particular construction technology course. Once the students have submitted their work, a programme batch-plots the set of CAD drawings as graphics files suitable for inclusion in a word-processed document. An interface
programme is used to control the input of written material which is stored as a ‘data’ file in a generic format. A macro applied to this data file within a word-processor incorporates the titles, text, acknowledgments and graphic material as a consistently formatted and editable electronic document. These various programmes are essential to ensure the productivity and flexibility which makes the project worthwhile.

In the first exercise the students, working in groups of four, are asked to locate a local historic building from a single photograph of a component (a window, for example), gain access to the building, measure the component shown in the photograph and produce a CAD drawing which combines the plan, section, elevation and axonometric views (figure 3). The objective is an understanding of traditional construction techniques as well as being a fast-track introduction into CAD competency.
With the second exercise the students are required to interpret building details from a variety of published sources. Each student is supplied with a carefully prepared A4 prototype drawing of a generic detail obtained from USA, UK and other European publications (our main reference sources are all *ex patria*). The student produces a number of A4 sheets of details (using AutoCAD) with accompanying text (using a Netscape data-input programme) modelled on the provided prototype. So far 300 usable examples have been produced (figure 1).

The final exercise involves the students individually selecting a building worthy of study within New Zealand, contacting the original architects (if still alive) or their successors in order to obtain detailed plans and working drawings, and preparing from the plans a
range of detailed studies which express the built character of their subject. Typically, this means a range of scanned plans, sections and elevations accompanied by five or six detailed A4 studies drawn in AutoCAD. The CAD drawings have each building material drawn in a layer pertaining to that material in a colour that matches the Australasian (and British) standard for building representation. This ensures that each student understands at a fundamental level what each part of the building is composed and ensures that they determine what is in section and what is in elevation. This lends the drawing to a streamlined printing process where sections through each material are registered by an appropriate pen thickness.

**Relating Databasing to Production**

The most debilitating problem to be overcome when working with the large number of sheets produced has been associating each piece of work with the original prototype and author, and its provisional placement within the framework of a textbook. Associating particular text with several drawings is also a problem and a method which determines whether a drawing has been added to or subtracted from the set without manually sorting through copious pages is resolved through maintaining the central database. The following sequence is the step-by-step process by which student work proceeds from assessment of their scholarship to publication. Almost every step in this sequence has been automated (figure 4).

1. All the files that will be required by the students (ascii text and AutoCAD templates) are prepared before the start of term (fig 2). At this stage, all the known information relevant to their assignments - original references, drawing title, number of templates to be issued (eg 3 for generic detail sheet, 6 for building, 1 for measured drawing) - are included in the central database (Paradox).

2. The central controlling programme (UNIX TCL) automatically issues uniquely named copies of the prototype drawing to each student. Alternatively a second data file can be created containing a list of student names from which partially completed drawings (from previous years, for example) and students are matched either randomly or by design. When issuing templates, the programme makes modifications to include known information such as the student’s name (as we know they cannot be trusted to fill this in correctly!).

![Diagram of text and drawing production stages]
3. After their research, students draw and write in the provided templates. The graphics based files are copies of a prototype AutoCAD drawing which has preset drawing size, fonts and sizes, dimension styles as well as predefined layers and attributes.
(figure 5). A customised menu and various clean-up and checking utilities (AutoLISP) been provided to aid students in completing their drawings according to a protocol.
A Netscape dialogue box driven programme is used for editing the text templates to ensure the students fill in the necessary
items correctly (figure 6). This is necessary to prevent maverick formatting and checks for correct use of upper-case/lowercase as well as non-negotiable font selection. Since each template is issued with all the known information included, these items, though displayed, cannot be edited in this environment. The only information the student needs to add is their text and references to books and companies. The references are linked directly into indices from which the students choose their references. This prevents incorrect spelling or unorthodox wording. The index lists are stored centrally so that if the appropriate reference is not present, the student can register it within the central data file, making it available generally thereafter.

4. Files are automatically gathered into the course coordinator’s directories using the central controlling programme using just three parameters: time, search criteria and appropriate location for the collected material within the central database. Disk references to the text and drawing files are stored within the central database. The files can be printed immediately after collection allowing the students to collate their own work physically in class as a fail-safe for subsequent assessment.
The central controlling programme can be used to make a data file from the central database which is read by the batch plotting routine (AutoLISP). The batch plotting routine adds information to the hardcopy allowing it to be identified. This includes the drawing’s unique reference number, student’s name, drawing title, ‘xrefs’, disk reference and current date. This is to avoid any subsequent confusion and does not appear in the final textbook preparation.

5. Text and drawings are assessed and reworked as necessary (often substantially). Quality control, the process of editing, cannot be automated. This is the essential step which guarantees the overall authority and quality of the finished document.

6. Drawings are plotted (using the batch plotting routine described above) as graphics files suitable for inclusion in a word processed document.

7. Text and graphics files are brought together into spreads ready for printing. This currently uses a WordPerfect macro which reads a data file created by the central controlling programme from the central database to organise which templates to format and in what order. The macro collates the spreads into chapters which are then collated with title pages added and the document ‘generated’ to produce the contents, general index and index of manufacturers.

Further Development

We have become aware of the limitations of standard word-processing programmes as desk top publishers and are investigating more sophisticated proprietary software or, given our current strategy, develop a specific text-formatting programme. If the central database is to serve more efficiently as the central locale of information, its data must be complete and correct. For this to be the case, the central controlling programme must include functions to perform all file handling tasks associated with course work so that having performed the handling task, it can update the central database with the location of the files.

This method of organising data is highly efficient and large numbers of pages of details with their associated text can be handled relatively easily. This makes it suitable for integration with material from sources other than our own school of architecture. Collaboration with other universities would involve issuing the template text file and the dimensions of the graphics image so that completed templates and associated graphics files can be integrated seamlessly into the system. In return, the collaborating universities would get the benefit of our experience, a library of New Zealand details which may be of interest to countries less familiar with light-timber frame construction, for instance, and if suitable, programmes for controlling and processing the information. Details received back from other sources could automatically be made into a central database ready for processing as hardcopy and the same material can be incorporated into multimedia publications combining text, photographs, video, drawings, rendering and
animation giving a total picture of building construction. Sections would be prefaced with essays by lecturers from collaborating universities each tailored to their own market and without regard, necessarily, to compilations made elsewhere. Such ‘grand plans’ do not require the other parties to use AutoCAD, WordPerfect or even Dos, only that the information is transferred between participating parties as ASCII text and encapsulated postscript graphics in PC format. These are industry standard file formats familiar, obviously, to all.

Conclusion

Our principal objective has been to establish a method to ensure that student research work is worth more than course assessment. Starting as a means to produce updatable handbooks, the project has moved to wider publication as textbooks. The concept used to achieve this has been to define a generic data format that can be automatically processed into a variety of outputs. An unfortunate consequence in an otherwise liberal education is the need to control student output in the way described. But through introducing such measures we have ensured a consistency of product which goes further than the immediate creative needs of each student. Our experience has been that the students’ real interest in their collective endeavours has offset particular concerns of the ‘office formula’ in which they have been obliged to be in comply. There is, in fact, plenty of room for manoeuvre within the scope of their individual ‘iconic’ building. Currently, and until we have collected sufficient quality material, this effort will be dedicated to producing authoritative textbooks. The proposed outcome of our own work in two years time, at a pace that we can afford and with an absolute comprehensiveness in mind, is an interactive CD multimedia environment which brings all the threads together. Extending our remit as such to a level of international collaboration would result in a multi-media publication showing how buildings are detailed in different locations on the globe but which deal, after all, with similar sets of conditions. This would be an unparalleled teaching resource in the collaborating universities where each department could produce a multimedia application pertinent to its own needs but incorporating material in compatible formats from elsewhere. Viable in its own right as matters stand here in New Zealand, it is a rewarding thought that a cautious and non-specific beginning to the project may bring and provide dividends beyond our own immediate needs.