

A Critical Survey of Software Packages for Use by Interior Designers

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Declarations

The content of this dissertation is the result of my own independent work and investigation except where otherwise stated. All sources are acknowledged by explicit references to the bibliography.

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I declare that this work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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Abstract

The interior design industry is a very egocentric profession, with individuals all trying to be at the cutting edge of design. In the past, all of the conceptual sketches, drawings and design and built drawings were manually created and a source of pride for the profession. The drawing was as valuable as the design scheme itself, being the intellectual property and copyright of the designer. Here in this survey, we want to examine the extent to which CAD/CAM software packages have successfully replaced the human hand in the generation of design concepts, schemes and the production of drawings to reflect the ideas. We want to examine if the intangible qualities found in manual drawings are retained by the use of digitized technology now. The results of the qualitative survey presents an idea of the level of acceptance by the profession, of exploiting digital technology to expedite and enhance the workflow of the interior design industry.

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Chapter 1 Introduction

1.1 Research Objectives and Problem Statement

Drawings speak thousand volumes. They are the tools of communication for all sectors of the interior construction industry. The clarity of a drawing can make all difference in the overall aesthetics, expediency, budget and final end result of the construction project. Hither to the advent of information technology into this industry, all drawings were manually and laboriously drawn by hand. With the proliferation of information technology, computerized drawings have been made possible by the rapid development of CAD/CAM software packages. To what extent have these CAD/CAM packages been successful in replacing the manual tediousness of the various stages of feasibility study, conceptual design, design development, construction and the project management function of the interior design industry?

1.2 Limitations of the Scope of Study.

This critical survey of CAD/CAM packages available for use by interior designers will take into consideration packages whose primary purposes are as follows:

- 1.2.1 used in interior design rather than architectural/manufacturing/engineering or other professional disciplines.
In the market place, there are packages catered especially to the industry specific that supplied by vendors that are not turnkey contractors who require that the customer buys the hardware workstation together with the software package. Most or all of them are fully integrated, with one common database where the aerospace, automobile and industrial manufacturing can access to and work in parallel, through all stages of feasibility and conceptual design, modelling, mocking up, re-modelling, modification, re-modelling and commercial manufacturing, lessening the chances for errors. We shall be excluding these turnkey packages supplied by vendors where hardware is involved together with the purchase of the software.
- 1.2.2 can be loaded onto desktop personal computers without the need for additional peripherals or third party developers.
We are examining in this study, simple out of the box software that can be easily installed and up and running, without the need for extra paraphernalia, both at home and in the office.
- 1.2.3 either as a separate entity with each supporting a specific stage of the interior design industry or a fully totally integrated software package that supports all stages of the interior design.
- 1.2.4 Here, our aim is not to simply to provide a comparison chart of the various brands of CAD/CAM software in terms of their features, price, functionalities and what they can or cannot do, as most CAD/CAM software currently being sold in the market do possess most of the basic rudimentary features that any typical interior design outfit needs. But first, we would want to try to establish and ascertain the features and needs that interior designers consider as most important after interviewing them, and then re-look at all the legalised and licensed CAD/CAM packages available in Singapore to evaluate them. Our evaluation of the packages would be based on the stated requirements of these respondents. The packages would then be evaluated on the basis of the availability of the required features to see the extent to which they meet the needs of the respondents and whether there are any clear gaps to what is available or if there are any clear 'best buys' amongst those considered and if prices are perceived to be 'reasonable' by respondents.

1.3 Background History of CAD/CAM Software Development for Desktops

The first interactive computer graphics software that was the precursor of today's CAD/CAM/CAE (Computer-Aided Design/Computer-Aided Manufacturing/ Computer-Aided

Engineering) was based on¹ Ivan Sutherland's 1963 Ph.D. thesis 'Sketchpad: A Man-Machine Graphical Communications System'. The program ran 'online', unlike most computer jobs in the early sixties where 'batches' of jobs were submitted by users to the computer operators who would only work on the computers when the jobs could be scheduled to keep the machines fully occupied. The turnaround time for each job took an hour or more and sometimes overnight. Ivan Sutherland ran his interactive computer graphics program on a 320 kilobytes TX-2 computer at MIT's Lincoln Laboratory, funded and commissioned by the Air Force. He used a light pen, the display and bank of switches as the first interface to create engineering drawings on the cathode ray tube (CRT).

Ivan Sutherland's Sketchpad could create drawings that could be manipulated, duplicated and stored with a scale representation of 2000:1. His pioneering work expounded upon the concepts of graphical computing which included memory structures to store objects, rubber-banding of lines, the abilities to zoom in and out on the display screen, to make lines, corners and joints. Ivan Sutherland's work set the precedent for the first GUI (Graphical User Interface) which followed later.

In later years, Ivan Sutherland worked on a variety of projects on timesharing and artificial intelligence and it was during this period in the sixties, that he met Dave Evans at the University of California at Berkeley. Evans also worked on timesharing concepts and his work played a pivotal role in the early development of modern computers. His expertise on incremental computing laid the cornerstone of what was to be the basis for practical computer graphics. As computer graphic pioneers like Sutherland and Evans continued with the relentless task of making new ground in computer graphical engineering, it was left largely to others in the computer software industry to refine and work upon the concepts developed by these two large 'giants'. Thus sprang the intense interest in graphical computing by commercial software vendors who recognized the laissez-faire potential of this new technology particularly for the aerospace, automobile and industrial manufacturing.

²Other pioneers who jumped on the bandwagon advocated the implementation of simulation on computers. They used personal computers to model throughput in a machine shop for example rather than write operating systems and compilers on them so that others can use them to write programmes. Thus began the practice of manufacturing concerns of trying to undertake the virtual presentation of physical reality in computer systems, using geometric operations that would allow for three dimensional modelling and simulation. More vendors evolved software tools to allow commercial businesses to model the real world on their personal computers before venturing into full-scale industrial manufacturing of moulds and parts. This was particularly prevalent as aforementioned in the automobile, aerospace and fast moving consumer goods industries.

The battle for dominance of the CAD software market with the rapid rise to success by 'high-end' vendors began. These vendors sold full-function and turnkey solutions aimed at more 'sophisticated' users. These packages not only dealt with the drafting/drawing work, but also had fanciful features that catered to solids modelling and parametric design for engineering design.

This vanguard of movement towards design automation was lead by many large companies listed in *Appendix A*. Their packages contained technology that could solve problems in the design segment of the manufacturing process. The software had the ability to represent and manipulate 'difficult' geometry. ³The turnkey systems offered a fully parametric wireframe and surface modelling capability attempting to support sophisticated mechanical applications like 3- and 5-axis N/C whereas desktop CAD could only provide lines, arcs, circles and the occasional splines and conic sections. The essential difference between early desktop CAD and turnkey CAD was the disparity between the technological features they could provide users. Large industries had a

¹ [46]

² [48]

³ [1]

lot to gain and lose if they did not automate the design and manufacturing processes. These large companies particularly the aerospace and automotive industries were responsible for some of the most significant advances in the art and practice of CAD/CAM/CAE.

They also produced a generation of engineers and designers to the use of computer-assisted techniques which later laid the foundation for the eventual success of the desktop CAD.

But eventually the technological divide between turnkey CAD and desktop CAD in the critical areas of modelling representation lessened as desktop vendors made significant progress and inroads in software development, thus began the ascent of the desktop vendors as they began to climb the technology curve.

Questions posed now to turnkey vendors now: why didn't they jump on the bandwagon and benefit from the gradual revolution of desktop CAD when the trend was so plain before their eyes? To answer this question, one has to examine the background of turnkey CAD in order to understand these companies' reluctance to acknowledge the trend towards desktop CAD. The answer has more to do with the self-image and perceived destiny that these high-end vendors view themselves rather than with sensible business decisions.

⁴Traditionally, desktop CAD was ignored by turnkey vendors in the early days of its development as they honestly discounted any value which desktop CAD systems could offer to users as compared to their high-end systems. They also believed that the concept of "CAD-on-a-PC" conflicted directly with their perception of their own essential purpose in life, which was to bring order, power and complete integration to the design and manufacturing process. Drawings were only by-products of the process and not an end-product by itself, that the systems provided users with a tool to design with rather than just do production drafting and that users could create complete digital representations of their models. In addition, the integrated applications packaged together with the software allowed users to access the models directly taking whatever application-specific data it needed, thus there would only be one copy of the data which is the same for everyone. It gave flexibility to FEM (final engineering model) users to access the original model, subjecting it to analysis, re-design and successive refinement. Stylists can also obtain photo realistic visual output directly off the models and tool paths can be created automatically that would drive machine tools. Draughtsman can produce drawings by working directly with the models. Users could directly obtain data from one application to another without having to re-input it, therefore in the minds of these CAD/CAM veterans, that any user with a sensible decision making skills would choose the turnkey system over the desktop CAD/CAM except only if they could not afford the former, hence would be forced to settle for a the poorer cousin of the latter offered by desktop vendors.

By ignoring the desktop vendors as they did not seem to pose a threat to their high-end market, it provided the feeding ground for upstart companies like Autodesk to flourish and grow their business and eventually when their software improved by leaps and bounds with competitive low prices as compared to the turnkey vendors due to their economies of scale, soon these desktop vendors penetrated the turnkey market grabbing customers and never returning them. In *Appendix A*, a list of currently viable CAD/CAM desktop vendors whose software are in use in the market place is attached for reference.

1.4 Thesis Organization

The dissertation consists of five chapters. Chapter 1 is an overall overview introductory chapter to this study. Chapter 2 discusses the methodologies used in the conduct and production of this survey and the difficulties encountered. Chapter 3 will review the workflow and processes that are atypical of the daily occurrences that happen within an interior design firm with variations in the local business context of Singapore. The workflow processes will provide the framework for Chapter 4 where this framework would be used to as a guideline, against which we would want users to evaluate the strengths and weaknesses, features, focal points, advantages and

⁴ [48]

disadvantages of the typical CAD/CAM software used in one work phase of the interior design industry based on focus group interviews with interior designers. The framework will also highlight the key areas in which the survey would focus upon as it would not be possible given the restricted time frame of this dissertation to examine each and every aspect of the work process and how CAD/CAM software has been successful in replacing manual labour. Chapter 4 will summarize the outcome of focus interviews conducted with design, technical users and managers of CAD/CAM software in local interior design firms in Singapore would be presented and analysed against the context of the framework of work flow processes discussed in Chapter 3. A concluding chapter 5 will conclude with a summary of the findings of the survey and the recommendations if any for additional features or functions that may or may not be lacking in the present CAD/CAM software packages currently available in the Singapore market place and any value added qualities that having or omitting these features, might have on future releases of CAD/CAD software packages for the interior design industry.

Chapter 2 Methodology of Research for Survey

⁵Data is the source of all successful research. It provides information to identify and discover the key issues on hand, specifying the problems to be solved and directing the solutions or strategies to resolve these problems. In any survey project, secondary and primary data form the basis of informed decisions and conclusions made at the end of conducting the survey. There are primarily two types of data required in any research survey namely, secondary and primary data. Data can be classified as external data that is collected outside the firm and internal data that is drawn from company data sources.

2.1 Secondary data comprises of external and internal data.

- 2.1.1 Secondary external data has to be considered here. This type of data would help in providing the information and knowledge with regards to the environmental trends, demand patterns, competition and distributor network for CAD/CAM desktop software. This information would also provide insights about current economic, social and political developments and their impact on the general business and industry conditions. External data can also provide insights concerning competitive factors like market share, characteristics of leading competitive products and services, the business strategies and policies of leading competitors, the number of current and potential customers and corporate/ individual customer profile (customer characteristics, place of work/ abode, their motivations and interests, where and how frequent they purchase, value of purchase, method of purchase that is cash, credit card or credit line) all have a hand in influencing purchase/ use patterns.
- 2.1.2 Secondary internal data can be derived from the software vendors' accounting records relating to sales and cost data. This type of data provides information about the profitability and growth trends for specific products, product lines, geographic regional growth trends, channels of distribution and the effectiveness of different marketing tools like advertising, merchandising, sales promotions, personal selling and price cuts (discounts). Note must be taken that such data is subjected to variations in the different national accounting, fiscal and taxation systems of different countries.

2.2 Primary Data.

- 2.2.1 Primary data is particularly vital to our understanding of industrial products like CAD/CAM software. Primary data collection generally in most research survey projects could be sourced from sales representatives whose close contact with customers can provide vital clues as to existing and potential customer needs and preferences. Surveys of sales persons' opinions may also be taken in order to provide input for new product development decisions, product modifications and changes in promotional or delivery policies. The use of such procedures helps to reduce costs associated with surveys of clients and potential customers. But the set back is that caveats need to be issued especially in the use of sales representatives' opinions since bias will become a factor in factoring the overall rating of the product that is represented by the sales representative.
- 2.2.2 Primary data can also be collected from existing and potential customers but this method is more tedious and requires resources like time, effort and finance invested in it. Here, the data would be more reflective of the users' opinions and requirements albeit not necessarily more accurate. Bias judgement still comes into play by way of the researcher, depending on his level of ethnocentricity in the conduct, collection and interpretation of data.

⁵ [6].

2.3 Methodology in Secondary Data Collection.

As aforementioned, secondary data can be collated both from external and internal resources. The external data for this research survey project was gleaned primarily from material posted on the websites of a multitude of vendors of desktop CAD/CAM packages. Prior to that, the author had managed to peruse a fair number of books that pointed the way to the URLs of the relevant websites of these vendors. A list of vendors of desktop CAD/CAM software is enclosed in *Appendix A*. It must be qualified that the CAD/CAM software evaluated here must be used for desktops on the Windows Operating System. They must also be readily available in Singapore, through the manufacturers' international partners or resellers' programmes. We have excluded those for the Macintosh and Linux Operating Systems, as they are not popularly found on desktops except for certain specialty professions, trades or hobbies.

Secondary external data is limited as almost all the CAD/CAM software marketed or sold in Singapore sold through independent resellers or appointed distributors and not directly through the company's own subsidiary with the exception of one that is Autodesk. Whatever published reports either available on the Internet or libraries are pertaining to their mother companies at the headquarters, domiciled at the place of origin. Most of the secondary external data available pertain to the American, Canadian or European markets where the respective software originated and therefore not relevant at all to the Singapore context. None of the CAD/CAM software surveyed originated from anywhere in Asia.

2.4 Methodology in Primary Data Collection.

After browsing the Internet from the initial list of vendors of CAD/CAM software drawn up in *Appendix A*, those that have representation in Singapore were identified. These firms listed in *Appendix B* have legitimate partners or resellers to conduct distribution, training or support agreements in Singapore, with the mother or parent company that produces the software. Telephone calls were subsequently made to their respective Singapore offices to ascertain if they were currently actively selling or had existing customers using their CAD/CAM packages in the interior design industry. Other information gleaned from the telephone interviews lasted approximately about ten minutes to twenty minutes included the following items on the agenda:

- the price of their commercial package licences (excluding non academic or student versions)
- the nature of the business of their predominant customers (architectural, interior or others)
- the length of time they had been in operation in Singapore (since company inception or appointment of distributorship by parent company)
- training services were included in the packages' retail price or excluded
- technical services were included in the packages' retail price or excluded
- if their packages were part of a turnkey system (including hardware) or off the shelf
- if it had security features like software serial number or software lock (dongle)
- the respondents' contact details.

The outcome of these telephone interviews yielded the results tabulated in *Appendix B*.

2.5 Results and Analysis of Primary Data Collection.

It would seem that there are several brand name players in the Singapore market place but these resellers have refused or were unable to disclose their Singapore sales figures, volumes or customer details which is understandable, thereby making it difficult for one to ascertain the extent and level of their success in their penetration with their respective generic CAD/CAM software into the interior design industry. Most financial reports available on their respective websites relate only to the company's turnover on a global basis, the USA, Europe and North Asia being the predominant contributors to their sales revenue. Secondary internal data is

unavailable at press time due to the reluctance of the vendors to divulge confidential company material. Most of the estimates provided were ballpark figures provided at the top of the head by the sales associates based on their experience. Some of the re-sellers' software packages catered to industries other than interior design, which basically narrowed the search down to only a few brand names currently available in Singapore. The software packages currently available in Singapore for use in both the architectural and interior design industry (which overlap) include the following brand names

1. Vectorworks-2D
2. Autocad 2000-2D
3. Autocad LT-2D
4. Intellicad-2D
5. Fastcad-2D
6. Microstation-2D & 3D (by Bentley, USA)
7. Revit-2D
8. Drawbase-2D
9. Archicad-2D
10. 3D Studio Viz-3D/Animation (bought over by Autodesk renamed Autodesk Studio Viz)
11. Micro GDS-3D & 2D (by UK)
12. Sketchup-3D
13. Vue D'Esprit- 3D Animation for landscaping

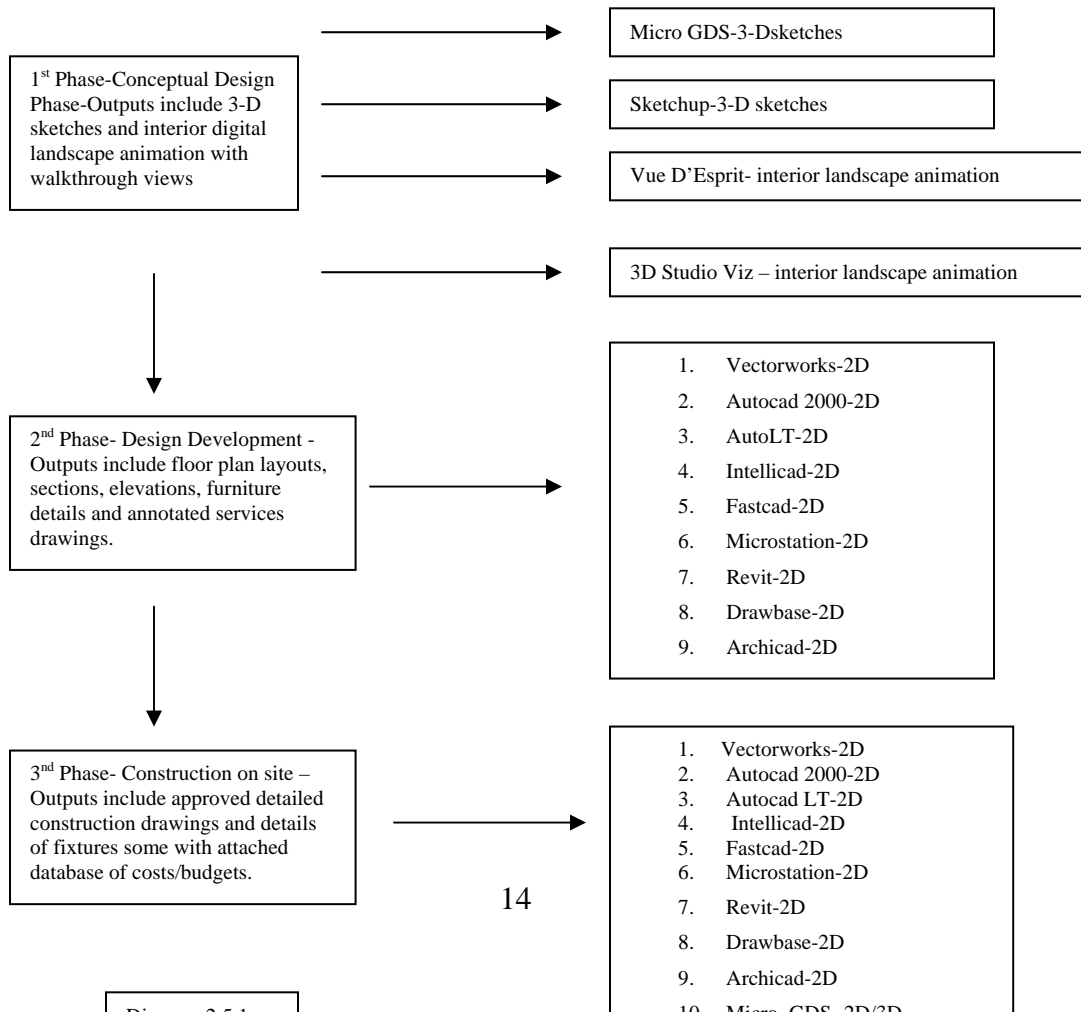
From the above, it is noted that not all of them provide the necessary tools to cater to the complete work process of interior design. Most of them provide drawing tools that are geared towards producing drawings like layout plans that take off from a 2-dimensional plane and then the plans or layouts are extruded by exporting it to another piece of software that produces the 3 dimensional qualities of the drawing. Some of the above software do have 3-D features incorporated in them but they still require plotting of the object or spaces in question, with the complete set of data and axis input to form the three dimensional digital images. Software that allow complete intuitive freedom to project three dimensional blocks, unrestricted by dimensions and axis controls and allow for play with a simple 'click of the mouse' orientation are far and few in between.

All the above packages play an important role at different phases and times of the interior design workflow process. In order to ascertain the value and usefulness of the features found in each of the above packages, one would firstly have to come to grasp with an understanding of the interior design workflow process which is documented through a series of data flow diagrams in Chapter three. The understanding is crucial to our maintaining a fair assessment of the above software packages as some claim to cover the entire process while others only cover a particular phase of the interior design process. How well have their packages served their claims remains to be seen in chapter four when we measure up the features found in the various packages against the respective phases of the interior design process that they lay claim to cover. Here we must set our benchmark, as we would not be able to evaluate software packages that cover the entire interior design process given the time constraint. Hence, this dissertation would only evaluate software packages available to cover the conceptual design phase of the interior design process. By narrowing the focus of this study and limiting ourselves only to examining one phase of the entire interior design process, we discovered that a number of the above listed packages might be deemed unsuitable. We discovered that to be the case from initial investigations made through verbal conversations conducted with users. From the initial investigations, we found out the following:

2.5.1 that there is a certain constantly repetitive pattern as to the type of software packages regardless of the brand name, selected currently for use by practitioners in the interior design industry during the respective phases of the interior design work cycle (details of which we have documented and detailed in Chapter 3).

During the course of our survey, we learnt that there are three major phases in a typical interior design project regardless of the size or nature of the project be it commercial, retail, residential or hospitality. These phases are locked tightly in a methodical and hierarchical cycle. A hitch in one phase of the work would cause a domino effect and delay other areas in turn. For example, if the concrete screed on the floor is not dry, the tile layer cannot lay the tiles, which in turn affects the delivery and complete installation of other dry fixtures like furniture. This example refers only to a phase where the interior job has already been executed on site. What about prior to actual construction on site? We discovered that the processes are very much inter-dependent and tightly locked together, very much like the waterfall cycle in software design process. Here, we realised that in the 1st and 2nd phases (all prior to construction on site), all users surveyed used roughly the same or similar software packages that perform the required functions for that phase. Secondly, that there is no software package available currently in Singapore that performs and fulfils the required functions for the 1st and 2nd major phases of interior design prior to construction on site. Each software package has its own strengths and weaknesses.

As illustrated in the diagram 2.5.1 below and based on the available popular software packages currently in use in Singapore, it shows certain software packages are used predominantly by users for that phase of the interior design cycle prior to construction on site. The dedication of certain software packages to certain phases of the cycle provided a hint to us that currently there is no software package that has all the features which would meet all the needs of the three phases of the interior design cycle, it is a lot of mix and match to concoct the best brew that would suit the user.



2.5.2. In addition,⁶ there is the added presence of an organised body registered as a private limited company called ‘SIACAD Private Limited Singapore’. It was founded by a group of dedicated professional architects as a resource centre to research and develop software or add-ons for existing CAD/CAM packages currently in use by the architectural and interior industry. It also wants to source for more price economical and value for money alternatives to the packages provided by Autodesk, who has a virtual monopolistic foothold by default through the years, on the CAD/CAM software market catering to architecture and interiors. As the major league player that appears to be on every one’s lips, it is not surprising to find grouses aplenty in the interior and architectural design industry in Singapore as every time Autodesk releases a new upgraded version release for the market, users have to spend money and time to buy and learn the new versions. Although Autodesk claims that upgrades are meant to improve workflow, but judging from the responses that the author had whilst doing some initial informal surveys with users, that it is otherwise. Most users feel that the amount of money and time spent on the new upgraded versions have little or no effect on improved efficiency as there are no new noteworthy features worth the time and energy expended on the upgrades which are ever so frequent.

2.6 Conclusion

We will find out more in Chapter 4, through our in-depth focus group interviews with users, the type of software packages they have adopted for use in their conceptual design development and if those actually serve the purpose they so set out to do. This chapter provides us with some initial ideas as to the software packages available in Singapore through our brief but rather useful telephone interviews with CAD/CAM companies operating in Singapore, their sales associates and a random selection of end-users. From the short telephone conversations, we were able to glean some useful information to allow us to draw some conclusions that would provide us the platform to take the next leap to our in-depth focus group interviews with end users in Chapter 4.

⁶ [3].

Chapter 3 Interior Design Information Processes

An interior design project is a complex undertaking which involves multi-faceted tasks performed by numerous participants, each of whom would have something to contribute towards the successful completion of the project. The participants would handle the design, technical and managerial tasks to ensure that the project meets delivery schedules, budget and quality. Within the design and construction process, an enormous amount of information would be generated. The information would manifest itself in the form of paper and electronic documents or verbal information transmissions during daily work interactions, of which the latter is the most difficult to keep track of and likely to cause misunderstandings. This chapter serves to document the structure and information transfer processes that occur during a typical interior design project. The major types of information, the transfer formats and their generation mechanisms have been investigated and documented systematically using hierarchical data flow diagrams. With a clear understanding of the processes involved in the various stages of a typical interior design project, we would be able to critically evaluate the currently available software packages in the Singapore market, against what these packages were initially intended to provide and fulfill.

3.1. Limitations of Scope of the Information Model.

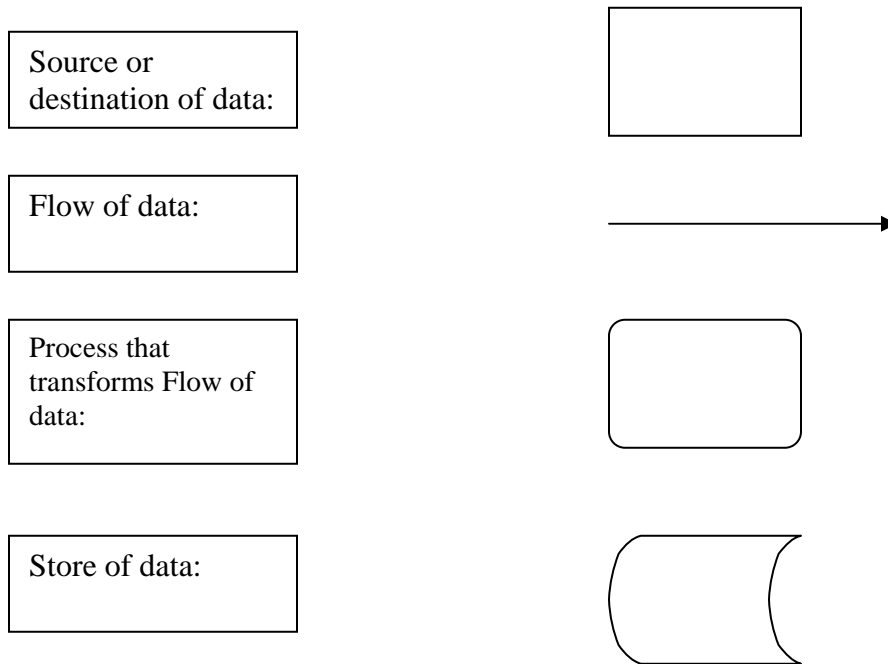
In order to develop this information model, certain guidelines were drawn up to limit the scope of coverage of the model. This interior design information model would have the following characteristics:

- it would encompass the processes of typical interior design of commercial offices, retail, hospitality, industrial and residential outfits
- the processes would be representative of interior design practices in the Singapore context only
- the processes would only involve the interior designer as being the professional consultant of the project and would not be compromised in the actual building and construction works
- the processes would demand that the interior designer or the firm he/she represents be a separate entity from the client, developer, contractor and other professional disciplines.

3.2. Knowledge Acquisition and Method of Presentation.

In order to develop the outline, structure and visual presentation of this model, research was conducted by interviewing interior design firms that strictly conformed to the above limitations as stated in 3.1. Hence only firms that acted in the capacity as professional consultants were considered in the drawing up of this information model. Technical standards, design and construction documents relating to the interior design process were collected and incorporated in this model. National and international building regulations, safety codes and quality assurance standards that guided the interior design process were included.⁷The data flow diagram (DFD) notation was chosen as a method to represent the information model in diagrammatic format. There is some variation in the notation commonly used. We have used the following as illustrated in *Diagram 3.2*

⁷ [50]



Information and documents transfer amongst the various participants in the interior design process are the key elements to mapping and understanding the workflow process that a typical interior design project follows. Armed with an understanding of the interior design workflow model, we can compare the critique prepared, of some of the features and usefulness of the various software design packages available in the Singapore market place against the functions that it needs to fulfill in the interior design workflow process. In this interior design workflow model, an analysis of the two levels of interior design data interchange has been carried out-at the information and the document level.

3.3. Information Flow Analysis in the Interior Design Process.

In the analysis of the interior design information workflow, we have focused on the information and the logical flow of data rather than the actual means of physical delivery of the information or data. To simplify matters, we have ignored the complications involved in tracking the means and methods whereby the information transfer was transmitted.

The analysis of the information flow in a typical interior design set up was based on typical data, information and documents collected from a few local interior design firms, who have been actively involved in local projects of diverse nature ranging from hotel hospitality, retail, commercial, industrial, institutional and high-rise and low rise residential design. Typically in any new interior design project, there are a number of key personnel involved in it. A list of the major project participants, their role definition and job scope is briefly summarized in *Appendix C*. In all interior design projects particularly those of a sizeable nature around 5000 to 10000 square feet in Singapore, most if not all of the above participants are involved during the entire design and construction phases. The contractual relationships of the major participants are briefly outlined in *Appendix C*. Each project participant influences the whole process through his data and information input rather than just utilizing the output from the process. The other entity that is not included in the above table would be that of the public health and government agencies that exist to safeguard public interest and to ensure that safety standards are adhered to.

3.3.1. Level 0 Data Flow Equivalent.⁸

⁸ Interior Design process excluding construction process is detailed here step by step.

1. Identify parameters of project: location, area, cost & theme in line with company vision, mission statement & objectives by client's top management.
- ↓
2. Client does self-audit & assessment to produce preliminary design brief by interviewing & consulting internal staff & executives.
- ↓
3. Client selects interior designer⁹ through recommendations, interviews or design competition by open tender.
- ↓
4. Selected interior designer analyses preliminary design brief addressing site & environmental concerns & any other issues, draws up design programme.
- ↓
5. Interior designer consult other consultants to produce conceptual schematic sketches, 3-D models & perspective views.
- ↓
6. Design development process takes place where approval & consent is sought from client & relevant government authorities.
- ↓
7. Construction design & working drawings with specifications forwarded to QS for cost estimates & issuance of tender documentation for tender.
- ↓
8. Preambles & tender documents issued to MC for pricing & cost estimates by open tender or selective closed tender on by invitation basis only.
- ↓
9. Tender Evaluation & Tender Award leading to start of Pre-Construction Procedures.
- ↓
10. Start up of Actual Construction on site, excluding details of the Construction process.

As seen in 3.3.1 Level 0 Data Flow Equivalent diagram, our focus will be on the workflow process that occurs during stages 4, 5 and 6 where most of the initial conceptual sketch ideas take root to crystallise into three-dimensional spaces. Finally it translates into two-dimensional drawings where floor plans, elevations, sections and as-built drawings of design details and furniture and fixtures are determined. We have omitted the construction process details before stage 4 and after stage 6 as it does not form the focus of this paper.

In a nutshell, the various stages can be briefly summarised below:-

In stage 4, the preliminary design brief has already been worked out by top executive management representing the client (client representative) before it is handed to the Interior Designer. If the Interior Designer had been appointed through a series of qualifying competitions, then this stage would be omitted as the interior designer would have clarified all the work processes in Stage 4 during the competition. To avoid confusion, we assume here that the interior designer has been appointed through recommendation or on his professional reputation through his portfolio successes. The design brief is handed to the appointed interior designer who works on it, clarifying and updating essentials through a series of subsequent meetings with the client representative. During this series of meetings, concerns ranging from internal environment, lighting, ambience, theme, staff count, storage needs, geomancy and superstition beliefs,

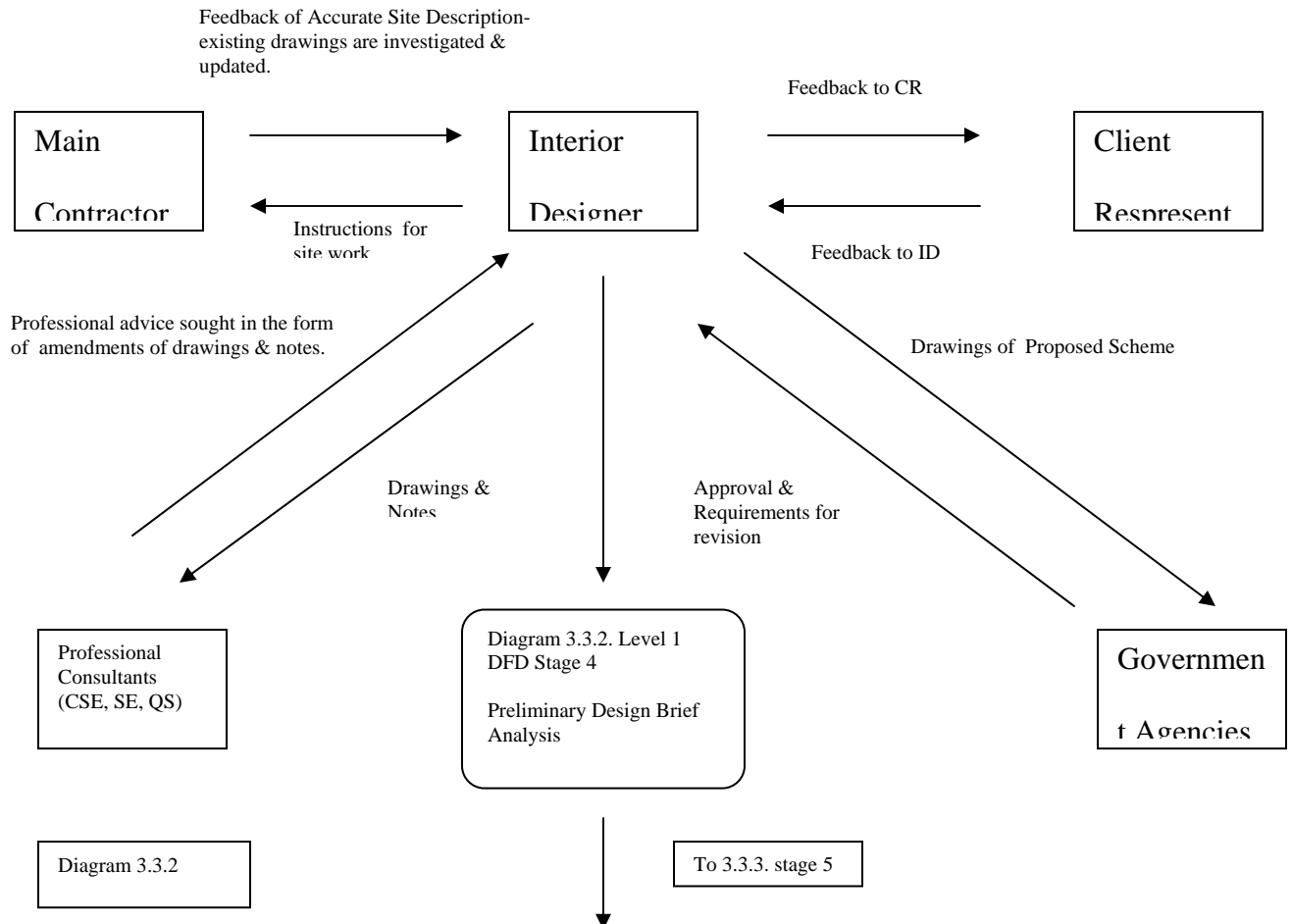
⁹ Sometimes the interior designer may be the architect himself, it depends on the client if he wants to appoint the Architect as the interior designer, to save on time and hassle of briefing another party, especially if the Building is a newly built structure. To avoid confusion, we assume that the Interior designer and architect are two separate entities.

governmental regulations and a host of other issues would be ironed out between interior designer in consultation with other service professionals and the client representative. A programme of works or design work schedule is planned by interior design in consultation with all parties with a realistic time frame for the realization and completion of the project.' Bubble' diagrams would be worked out in conjunction with client representative to conceptualize workflow for spaces to be used.

In stage 5, conceptual ideas would evolve from 'bubble' diagrams and eventually visual sketches of interior spaces envisaged by the interior designer based on the design brief's requirements would emerge from the drawing board. The sketches would be hard lined into perspective drawings by draughtsman working for the interior designer and eventually modelers would be producing a three dimensional model as a visual aid kit to enable the client to visualize the interior spaces better. In recent years, the use of three dimensional models has reduced in popularity largely due to the increasing use of three dimensional visualization software that allows for the ease of change when interior spaces to be modeled on the computer screen with full visual digital 'walk through' of the proposed interior spaces with complimentary animation, sound and lighting effects.

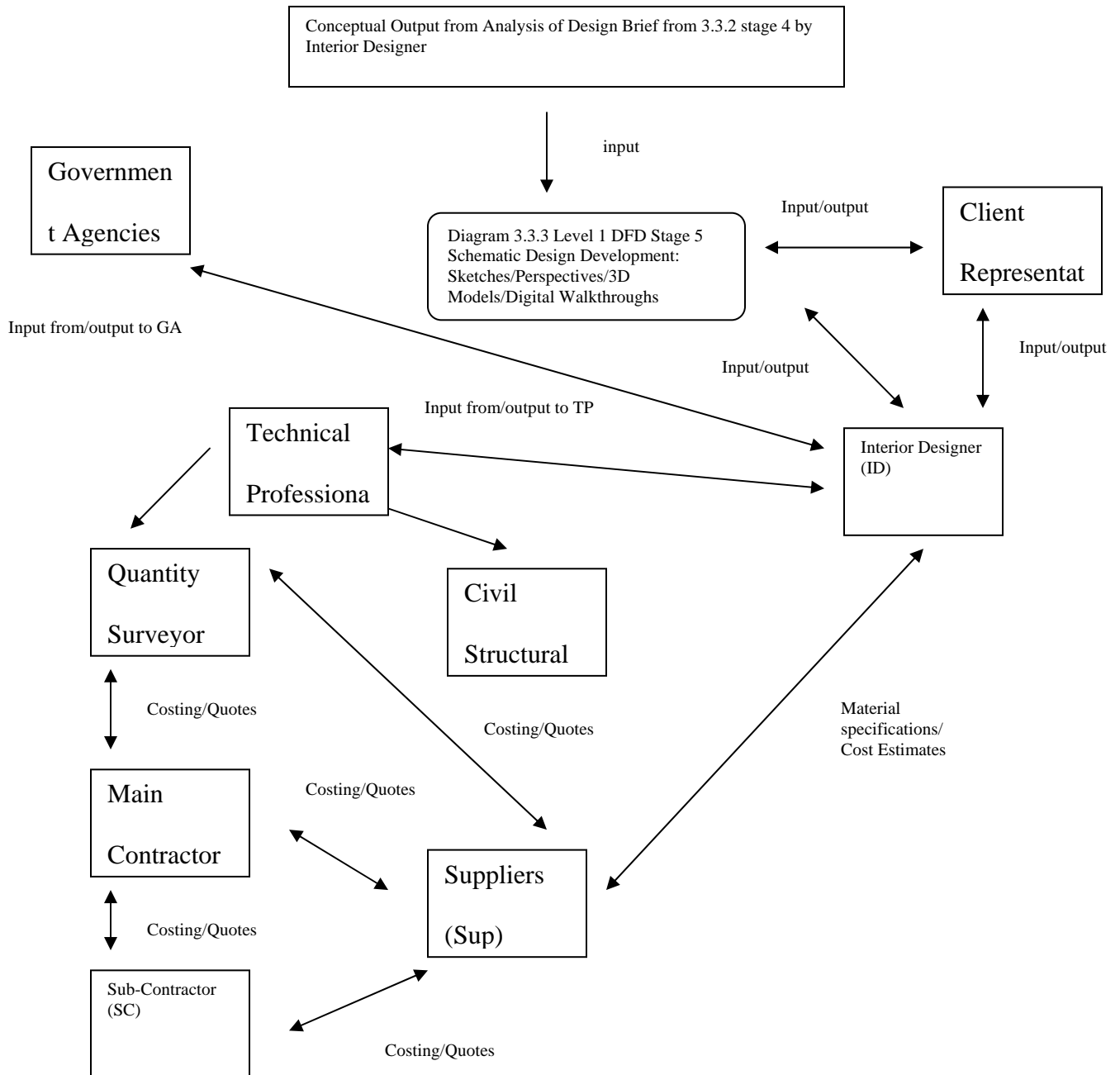
In stage 6, once the conceptual interiors are approved by the client and then details are developed further in conjunction with other professional consultants like engineers and quantity surveyors, contractors and the relevant governmental agencies. The process of design development is a repetitive process of going back and forth to the various parties until all of the client's criteria is met.

3.3.2. Level 1 Data Flow Diagram for Stage 4



In stage 4 here during the ‘preliminary design brief analysis’ process, the interior designer starts his conceptual design from the requirements stipulated in the design brief handed down by the client. Before the interior designer starts work on his conceptual sketch designs, he holds a series of site meetings with the appointed main contractor to assess the conditions of the job site. The interior designer also works with the main contractor on meeting a realistic work schedule based on the site restrictions. Some sites would still have some restrictions like the client’s staff working whilst the renovation work is ongoing. The main contractor will also refer to the interior design the actual site dimensions as existing floor plans may not be totally accurate due to the expansion or shrinkage of drawings during print time. This will ensure that in the later stages of the project beyond stage 6, the 2-dimensional floor plans are accurately annotated. Throughout the conceptualization of ideas, the interior designer would consult the other professionals employed by the client; the civil and structural engineer, the services engineer and the quantity surveyor. In addition, government agencies would also have to be consulted if the interior design involves any major changes or alteration to the building structure that would directly impact upon the safety of its inhabitants for example partition changes for rooms that would affect the fire sprinklers etc located on the false ceilings of the existing building shell.

3.3.3. Level 1 Data Flow Diagram for Stage 5.



Here in Stage 5, the conceptual ‘bubble diagrams’, workflow diagrams, work schedule and site issues approved in principle by the client in stage 4, copies are relayed to the technical professionals to advise in civil structural and services areas like lighting, sprinkler systems and sewage. With their professional expertise incorporated at the early and initial stages of the conceptual design development, need for changes would be minimised and pre-empted earlier. Here the theoretical concept of the design is translated into three dimensional imagery through the

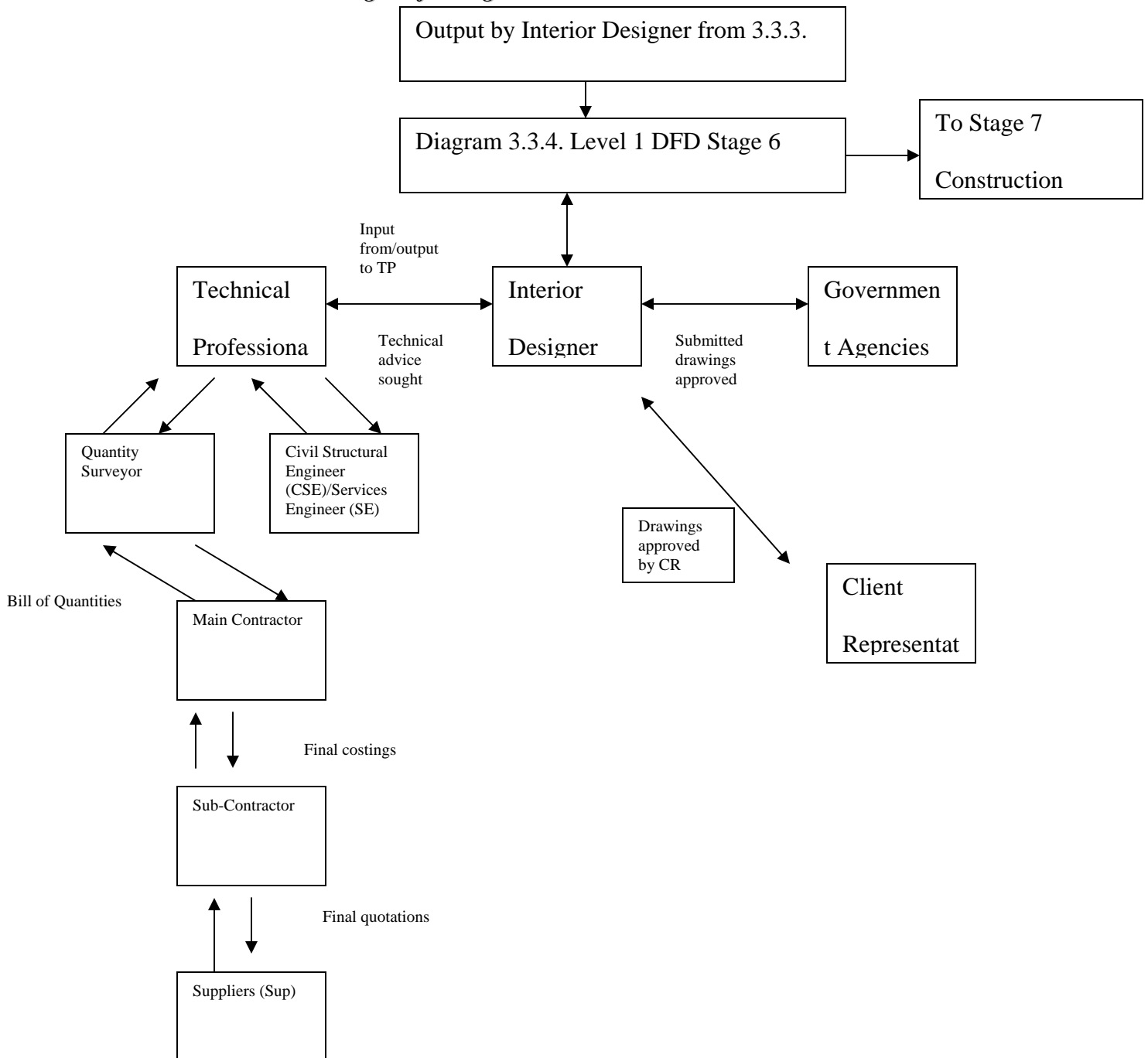
use of free hand sketches and perspective views of the interiors; slick digitised versions accompanied by 3-dimensional models or digital walkthroughs on the screen. Thereafter, the conceptual design is approved in principle by the client and then sent to the next stage 6, where the 3-dimensional aspects of the interior spaces are worked out to useable interior spaces. Design details like floor plan layouts, lighting sections, elevations and colours would be produced at stage 6.

In addition, a ball park figure of the costs involved in building the interiors would be provided by Quantity Surveyor. Materials to be used to achieve the overall objectives of the interiors would be selected by interior designer, will accompany a ball park figure of the costs. Here, the interior designer would meet up with the suppliers directly to increase his knowledge of the availability of materials at his disposal for selection. The interior designer would scan imagery of the texture and colour of the surface materials into the digital walkthroughs produced to achieve a more realistic view of the final interiors, accompanied by sample boards of the actual materials proposed for a realistic feel of the material textures and more accurate reflection of its surface colours.

In stage 6, the conceptual sketch schematics are ferried to and forth between the client and the interior designer for feedback and approval. Simultaneously, a similar process takes place between the interior designer and the other professional consultants like the engineers and the quantity. They would work hand in glove with the interior designer, who would try to pin down the vision of the client and at the same time toe the line in terms of meeting government regulations.

Here, the schematics that are transmitted down from stage 5 have theoretically met the approval of the client and relevant government agencies. In stage 6, the schematics would have to be transformed to hardlined, dimensioned and annotated drawings, bearing in mind the site conditions and actual built to fit conditions. Layout plans, elevations, sectional elevations and interior sections are worked out and produced to accompany the 3-D schematics. Sketch layouts produced by the interior designer may not fit the actual site at times when drafted by out the draughtsman on the interior designer's team, hence some re-working has to be made to the layouts. When changes occur, the chain of events repeats itself with the interior designer referring back to the client about the changes and in consultation with other consultants and government agencies. This cycle goes on until the final stages when the entire interior meets with the client and government agencies' approval. The project is given the green light by the government agencies to be executed on site and the drawings are endorsed formally by the client. Simultaneously the quantity surveyor has prepared final budgetary costings for the client, who by now would have a fair idea of his final bill. The drawings together with the specifications are handed down to the next stage- Stage 7, which will not be mentioned in detail here.

3.3.4 Level 1 Data Flow Diagram for Stage 6



3.4. Level 2 Data Flow Diagram Stage 4

Here the interior design sub-processes can be broken down into several smaller process components as shown in diagram 3.4. It illustrates the documentation flow of the sub-processes. The filing system, be it on paper or paperless electronic files, outlines the types of documentation generated during Stage 4. The documentation that result from the management and communication processes during the design brief analysis Stage 4 will generate the following types of files.

3.4.1 Design File (Interior Designer)

This file belongs to the interior designer where documents relating to the design brief requirements are filed. Amendments requested by the Client representative or necessitated by existing site conditions would be noted and updated in this file.

3.4.2 Site File (Interior Designer)

Prior to the appointment of a main contractor for the interior works, the project co-ordinator from the design team would take over the preliminary work on site, hence the site file would include minutes of meeting taken on site tours during the brief design stage. It would also include information on existing site check reports like site measurements reported back to the Interior Designer for designing, tentative work schedule based on existing site conditions and contractual documentation of any existing items belonging to the Client Representative prior to takeover of the site by Interior Designer.

3.4.3 Minutes of Meeting File (Client Representative)

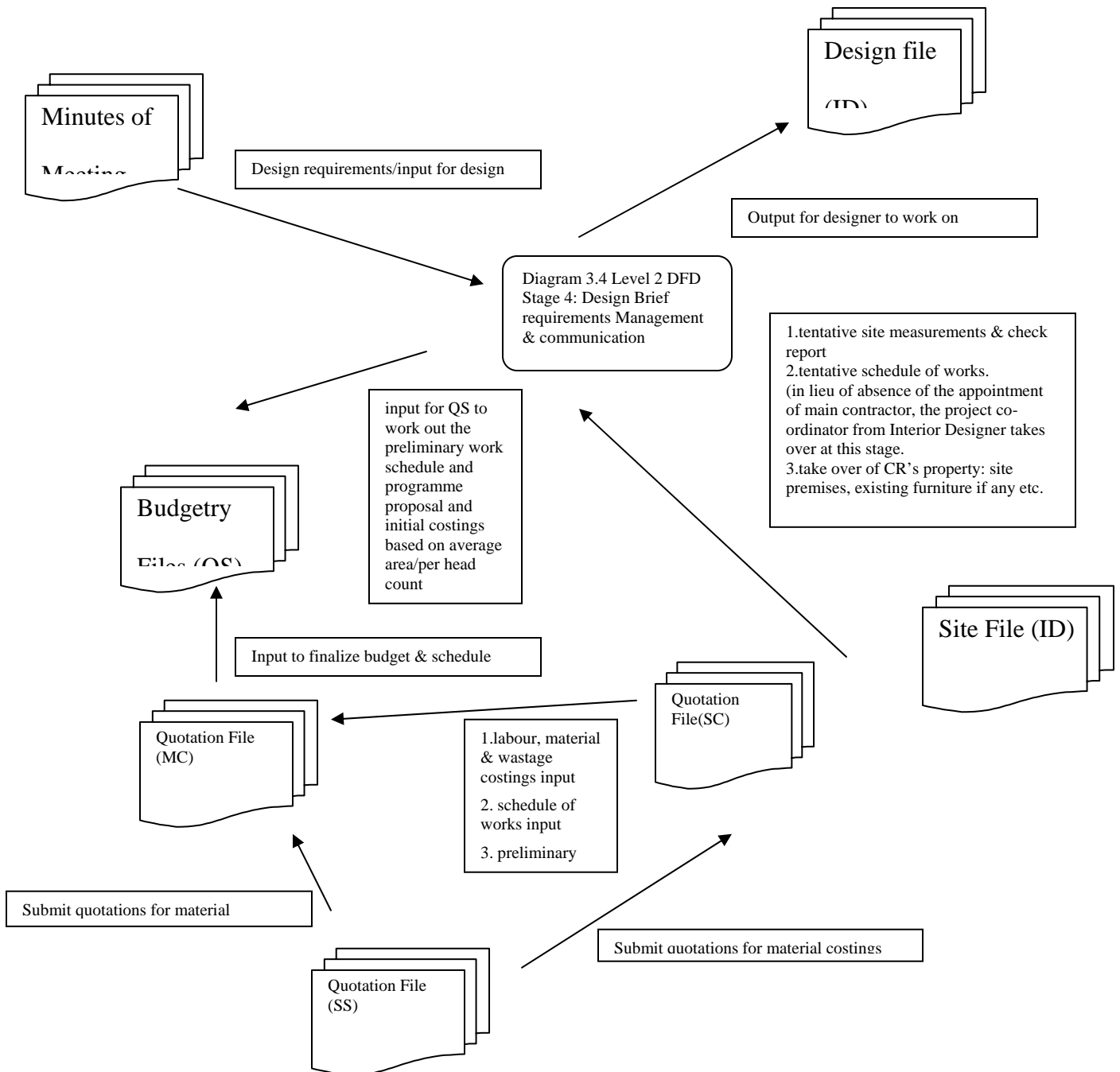
Copies of meetings held between Interior Designer are routed to the Client representative for record.

3.4.4 Budgetary Files (Quantity Surveyor)

This file would contain initial budgetary figures based on the bills of quantities worked out by the quantity surveyor. The Quantity Surveyor provides the bill of quantities to be worked out to the main contractor who in turn gets his sub-contractor and materials supplier to work out the actual costs. Each entity in turns puts a markup on the costs of raw materials or finished goods (adds in labour costs for installation and service charges), ensuring reasonable margins. The ultimate costs are provided to the Main Contractor who in turn adds his own expenses known as ‘profit attendance’ for acting as the middleman, to the Quantity Surveyor. The Quantity Surveyor would also do random checks directly with materials suppliers and Sub-contractors to ensure that markups by the main contractor are reasonable. In some cases, like system furniture and seating contracts, they do not fall under the main contractor’s jurisdiction but contract directly with the client representative. If the interior design project is a small scale one, generally the quantity surveyor’s role would be filled by a project co-ordinator from the interior designer’s team who has experience in doing materials take-off.

3.4.5. Quotation File (Main contractor, Sub-contractor and suppliers)

The Main Contractor /Sub-Contractor files contain ongoing quotations provided by suppliers to Main Contractors and Sub-contractors, whilst the supplier files contain outgoing quotes on record. The quotes will be revised as an ongoing concern as the design drawings are continually being firmed up at each stage.



3.5. Level 2 Data Flow Diagram for Stage 5.

In Stage 5, the set of files differs slightly from that found in Stage 4. Files in Stage 5 are listed as follows:

3.5.1. Design File (Interior Designer)

This file remains with the interior designer where documents relating to solutions for the design brief requirements are filed. The solutions in this stage would include sketch drawings of the interior design. Electronic filing would be involved in most cases as the 3-D visuals, sketch layouts, plans, sections and elevations, façade surface treatments and modelling would be created and simulated on CAD software. The filing system according to the ISO 9000 standards would require that projects be properly documented at every stage of the process. An example of a

electronic filing system for drawings is enclosed in *Appendix G*. Here a typical interior design project before it is confirmed, is given a code number series that is unique and not repeated for the year. In this example it is '202', followed by abbreviations of the drawing title, for example 'LP' representing 'layout plan' and ending with a drawing number in chronological order. The number of revisions that the drawing had undergone are indicated by the 'triangle symbol'. Amendments requested by the Client representative or necessitated by existing site conditions would be noted and updated in this file.¹⁰ Interior designers in Singapore are not required to adhere to the Singapore Institute of Architects code of practice for CAD drafting standards under the Code of Practice CP 80 (1999), CP 83 Part 1/2/3/4/5 (2000), CP 93 (2002) and CP 97 (2002), although it is highly recommended that they do so. Currently, the Society of Singapore Interior Designers and Singapore Institute of Interior Designers are registered as private charities. They are not legislated under the Professional Architects Act.

3.5.2. Site File (Main Contractor)

A main contractor for the interior works would be appointed at this stage based on preliminary budgetary costings and sketch layouts produced at Stage 4. The project co-ordinator from the design team would hand over the site responsibilities to the Main Contractor, hence the site file would include minutes of meeting taken on site inspections. It would also include information on existing site check reports like site measurements reported back to the ID for designing, tentative work schedule based on existing site conditions and contractual documentation of any existing items belonging to the Client Representative prior to takeover of the site by Interior Designer.

3.5.3. Minutes of Meeting File (Client Representative)

Copies of meetings held between Interior designer are routed to the Client Representative for record.

3.5.4. Budgetary Files (Quantity Surveyor)

This file would contain initial budgetary figures based on the bills of quantities worked out by the quantity surveyor who then provides the numbers to be crunched to the main contractor who in turn gets his sub-contractor and materials supplier to work out the actual costs. Each entity in turn puts a markup on the costs, ensuring reasonable margins. The ultimate costs would be provided by the main contractor to the quantity surveyor. The quantity surveyor would also do random checks directly with materials suppliers and sub-contractors to ensure that markups by the main contractor are reasonable. In the case of movable furniture and seating contracts, they do not fall under the main contractor's scope of work but are contracted directly with the Client Representative. If the interior design project is a small scale one, generally the quantity surveyor's role would be filled by a project co-ordinator from the interior designer's team who has experience in doing materials take-off.

3.5.5. Quotation File (Main contractor, Sub-contractor and suppliers)

The quotation files of the Main Contractor and Sub-contractor contain ongoing quotations provided by suppliers to main contractors and sub-contractors respectively, whilst the supplier files contain outgoing quotes on record. The quotes will be revised by the Main Contractor, Sub-Contractor and Suppliers as they furnish them to their respective files. This will be an ongoing concern as the design drawings are continually being firmed up between the Interior designer and the Client.

3.5.6. Consultants File (Technical Professionals)

Generally if the job requires the setting up of dry wall partitions, then the existing fire safety devices would be affected on the site. A partition may be built where a fire sprinkler or smoke detector has been installed on the building grid by the original owners or developers of the building. The shifting in position of fire safety devices and other related issues that have an affect on the safety of the building's occupants require that technical professionals be employed for

¹⁰ [3]

3.6 Level 2 Data Flow Diagram for Stage 6.

In Stage 6, this set of files differ slightly from those in stage 5.

3.6.1 Design File (Interior Designer)

This file still remains with the interior designer where the final documents relating to solutions to the design brief requirements are filed. The solutions in this stage would include final drawings of the interior design. Electronic filing would be involved in most cases as the hard-line layouts, plans, sections and elevations generally known as 'as measured' drawings are completed using CAD software. Once the design meets the client's requirements with the proper technical input from technical professionals in adhering to the government agency's regulations, the drawings are channelled back to the government agency for approval. This file will continue to serve the purpose of documenting this process.

3.6.2 Site File (Main Contractor)

Costings provided by the Main Contractor would be more accurately estimate, based on firm designs drawings from the Interior Designer. The Project co-ordinator from the Interior Designer's end, would continue to co-ordinate the site responsibilities with the Main Contractor. Thus the site file would continue to be an up to date record of minutes of meeting taken during site meetings. It would also include information on weekly site inspection reports and site clearing in preparation for actual construction, work in progress reports, firm work schedule based on existing site conditions and documentation of equipment and labour movements. Materials from suppliers would be delivered progressively on site as work commences.

3.6.3 Minutes of Meeting File (Client Representative)

Copies of minutes of meetings held between interior designer are routed to the Client representative for record.

3.6.4 Budgetary Files (Quantity Surveyor)

This file would contain more accurate budgetary figures based on the bills of quantities worked out by the quantity surveyor who repeats the process by providing the bill of quantities to be costed to the main contractor. The Main Contractor gets his sub-contractor and materials supplier to work out the actual costs. All parties put a markup on the costs, ensuring reasonable margins. The ultimate costs would be consolidated by the main contractor and submitted to the quantity surveyor. The quantity surveyor would also repeat the process of stage 5 with checks made

directly with materials suppliers and sub-contractors to ensure that markups by the main contractor are reasonable. The rest of the process is similar to that of stage 5.

3.6.5 Quotation File (Main contractor, Sub-contractor and suppliers)

The quotation files of the Main Contractor and Sub-contractor contain ongoing quotations provided by suppliers to Main Contractors and Sub-contractors respectively. The Supplier files contain outgoing quotes on record. The quotes will be revised continuously by the Main Contractor, Sub-Contractor and Supplier as they furnish them to their respectively to the various files, as the design drawings are continually revised by the interior designer and the client. The files are maintained in a similar manner to that of stage 5.

3.6.6 Consultants File (Technical Professionals)

Technical professionals like Civil Structural Engineer and Services Engineer will continue to maintain a file record of their comments, correspondence with the Interior Designer, Client Representative and Government Agencies with regards to the design and their subsequent final signatory endorsements on the design drawings to the Government Agencies.

3.6.7 Government Agencies (Entity)

The government agency continues with in the same role and capacity as a watchdog to ensure that designs meet public safety building standards. The government agencies involved include the Ministry of the Environment, Fire Safety and Shelter Bureau, Power Gas, Public Utilities Board, Drainage Department and Sewage and Water Department. Not all the government ministries or agencies are involved, it depends on the needs of the design.

3.7 Summary of the main types of design information in Interior Design Processes for Stages 4, 5, and 6

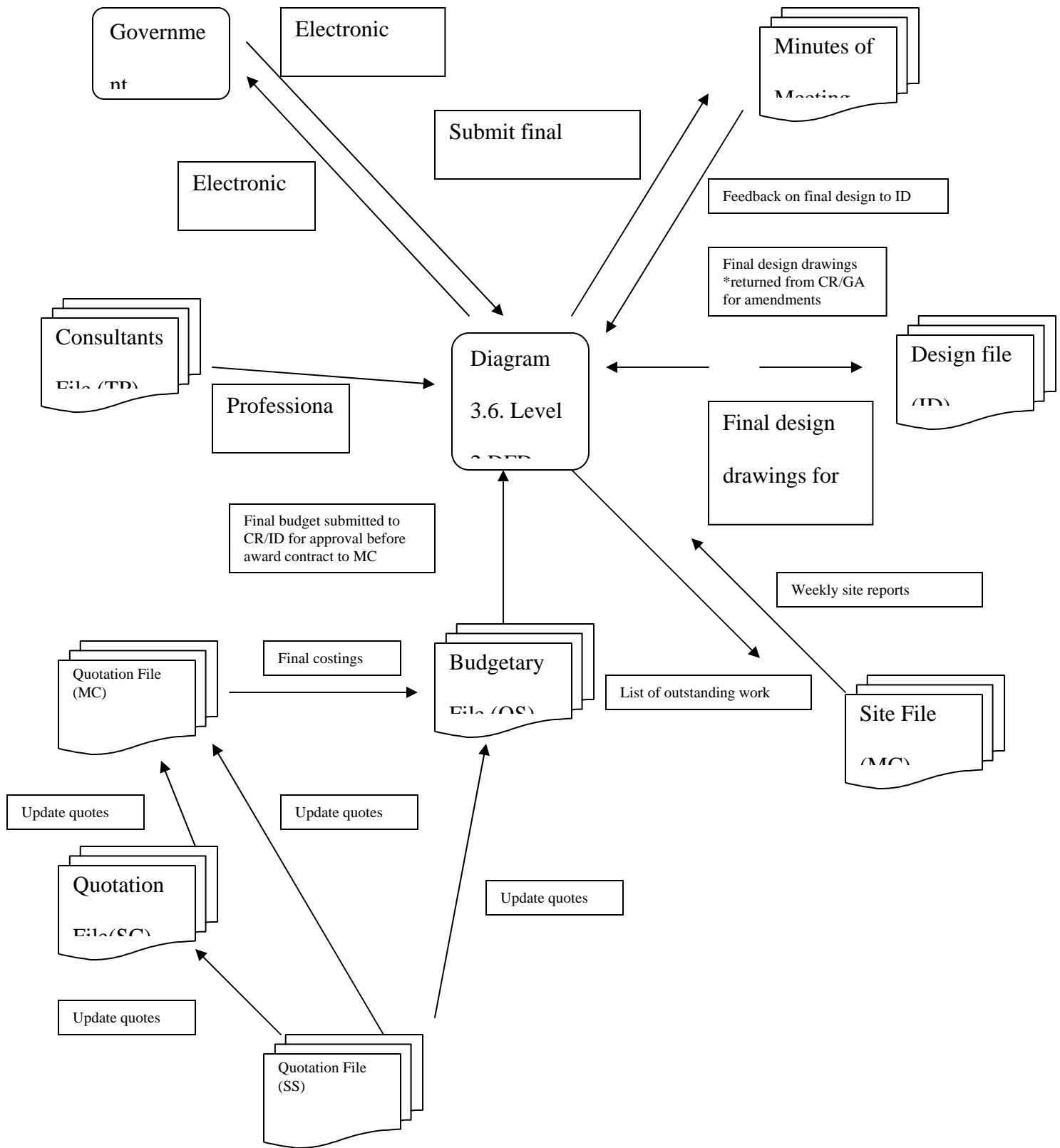
An overall view of the information transfer conditions is illustrated in diagram 3.7.1. Most of the information transfer during the design stage is bilateral between the participants. As seen in the diagram, most of the communication that takes place is either formal or informal. As noted, all participants will communicate with each and every other participant.

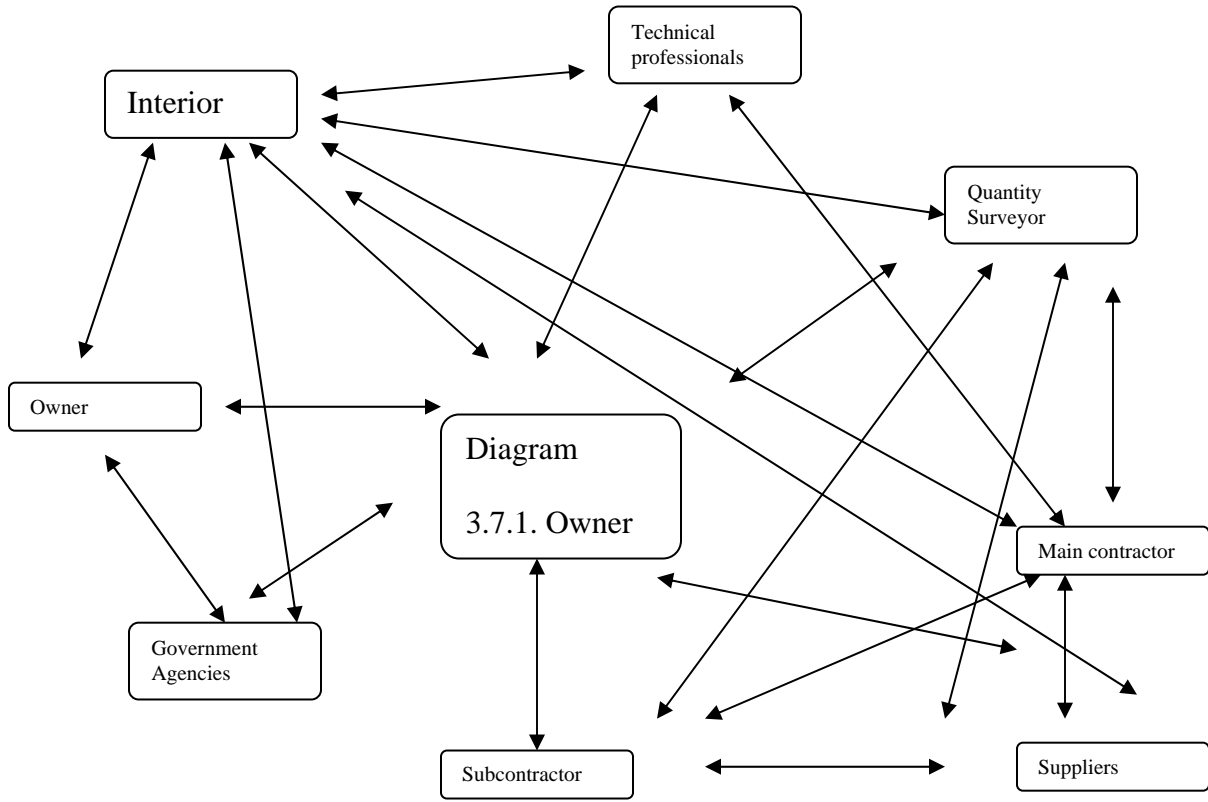
Informal interactions include telephone, walkie-talkie, face-to-face conversations that covers both urgent and trivial matters. Facsimile and email is gradually being treated as a special type of informal interaction method. At most times during the design processes, a significant amount of information exchange is informal and is not followed up by formal documentation. The co-ordination of main contractors, sub contractors and site co-ordinators (ID) is also performed mainly through telephone calls and personal conversations without involving paper or electronic information. The processes that occur on-site happen too quick for formal documentation to catch up. Formal information interactions that do occur will be through paper or electronic transfer of text or graphic documents during the design process of stage 4, 5 and 6. Fax, postal or courier services are used for certain items like materials selection where actual samples are used as they cannot be replaced by scanned colours or textures.

When formal information interaction does take place, the information is recorded by participants involved and archived with the received documents in their respective document storage files. We refer to¹² **Appendix F** Table 3.7.2. which lists the main types of information exchanged between the various participants. The format that it appears is different, either in text or drawings (graphics). Generally a piece of information is usually needed by more than one participant, in addition to its direct receiver.

¹² [5]

In the next chapter, we can elicit the view of the selected interviewees in our focus group interviews with an understanding of the work processes that occur during the interior design cycle and to be able to constantly make reference to it.





Chapter 4 Results of the Survey

4.1.Introduction

The survey was carried out by conducting a series of personal one on one interviews with individuals that are involved in the interior design business. In fact, this technique of exploratory research is categorised as a ¹³‘non survey data collection’ technique. It provides some contradiction to the title of this thesis as being a survey. The pool of individuals were selected on the basis of their various roles in the varied stages of the interior design process in addition to some other factors as well, which will be discussed in this chapter. How the research plan was conceived would be discussed in this chapter with a summary of the results of the survey.

4.2.Plan for Research

The choice of an appropriate data collection technique had to be determined. The selection of the most suitable technique was determined by the type and quality of information that would be expected as the outcome at this end of carrying out this survey. It was determined at the onset that a comprehensive in depth understanding of the underlying motivations and attitudes concerning the change in the work habits of individuals in the interior design industry vis-à-vis the extensiveness and intensiveness of the proliferation of the use of graphical software as aids in their work, be studied. Therefore the nature of the data that is collected for consideration and analysis would not be quantitative but qualitative. Given the nature of the problem being investigated, it is felt that qualitative data would be more appropriate. As we are only interested in underlying motivations and attitudes towards a product that is not in the category of a fast moving consumer goods (FMCG) but rather an industrial product for a niche market in Singapore only. Mass quantitative data would be meaningless here. A small sample of carefully selected respondents was used. The qualitative data collection technique used is unstructured in character, thereby allowing one to focus on probing how respondents think, feel and react in response to specific situations or stimuli. It is also an appropriate technique as there is a need to establish the equivalence and comparability of the concepts, attitudes and behaviours examined amongst different cultures in Singapore, which suggests a need for exploratory research to identify and define relevant phenomena to be examined, especially when we lack the background knowledge or familiarity of the culture of the respondent being investigated. Here, the main interest is to gain an understanding of the Singapore market rather than quantifying relevant data.

4.3.Criteria for Selection of Sampling Pool

To meet the constraints of small sample respectively,

In the evaluation of the choice of the respondents bore in mind the following factors

4.3.1. cost constraints

With an non-existent financial budget, this factor weighed heavily and placed limitations on the extent and breadth of the sample size. Hence, the sample size was limited only to at most twenty respondents.

4.3.2. time constraints

Given the relatively short time frame as a part-time student with work commitments, this was a very real factor, placing constraints on being disciplined in meeting submission datelines. Hence, the sample size was limited only to at most twenty respondents who had prior dealings with the writer here and were willing to be put on tape and named in this dissertation.

¹³ [6].

4.3.3. *The Emic versus the Etic Dilemma*

This survey is contained within the boundaries of Singapore and it is not a across borders research. But we need to take into consideration data equivalence. The reason being that Singapore is a multi-racial country with a non-homogenous population and the small sample size comprised of a few non-Singaporeans of various ethnic and cultural origins working in the interior design industry.

The issue of comparability has often cropped up in research work where varied cultures within each country would have its own idiosyncratic features and with its own unique pattern of sociocultural behaviour patterns and values. Therefore constructs used would have to be specific to a certain country or culture. Comparable constructs and concepts cannot be identified. Once equivalent (standardized) measures are used, there might be loss in accuracy and precision in any given culture or country. Even if common constructs can be identified, some idiosyncratic or country-specific measures may be required.

¹⁴Two schools of thought have traditionally dominated the social science research scene, namely the 'emic' and the 'etic'. The 'emic' school holds the idea that attitudinal and behavioural phenomena are unique to a culture and best understood in their own terms. Emphasis would be placed on studying the particularities of each country, identifying and understanding its unique facets. This implies that our survey would have to take into consideration cross-national differences and similarities in qualitative or judgemental terms, since each measure is 'culture-specific'. But for the sake of simplicity given the constraints in time and budget, to resolve this dilemma, we have adopted an approach known as the 'etic' school of thought.

The 'etic' school is primarily concerned with identifying and assessing universal attitudinal and behavioural concepts and developing pan-cultural or 'culture-free' measures. This approach may simplify and facilitate comparisons for the purpose of this academic exercise, but in reality, it would give rise to methodological problems such as it can lead to the adoption of a 'pseudo-etic' approach where constructs and measures adopted in one country are applied without, or with minimal adaptation to other countries. The 'emic' and 'etic' approaches are on the polar extremes, with one emphasising cultural uniqueness and the other pan-culturalism in behavioural patterns and the underlying processes and that we are more interested in trying to identify similarities than differences, as it offers better opportunities for any transfer of products, services and for the integration of strategies for future developments of graphical software.

We will adopt the 'etic' approach here. Admittedly differences will still arise with adopting an 'etic' philosophy stance in our research orientation where our prime emphasis is on identifying and developing constructs and measures in our questionnaire that are as comparable as possible across countries and cultures, but they will be dealt with.

We agree that it is more desirable to adopt a two prong approach where procedures allow for the examination of both the reliability of existing available constructs and measures and the identification of 'emic' or culture-specific constructs and measures. The experience gained from identifying relevant constructs and measures in their national contexts can then thus be utilized in developing more measures more specifically adapted to other national contexts, but due to the time and budget

¹⁴ [6].

constraints here, we have tried as far as possible to lean towards an 'etic' pan cultural approach.

4.3.4. *sample representativity.*

The sample comprised of personnel from interior firms in Singapore involved in the various aspects of the life cycle of an interior design project. The sample taken of the respondents, was conscious of the fact that there were different nationalities involved. We categorized it into the different nationalities to see if there were 'real' differences or 'perceived' differences at the end of the research survey, although the questions posed were 'decentered' or 'neutralised' that is eliminating any cultural bias arising from development in the country of origin, and adaptation to the specific national or cultural context of interest.

Anyhow, the sample is too small to detect or conclude indefinitely any 'real' differences amongst the different nationalities.

4.3.5. *What is data equivalence?*

As aforementioned above, any research that involves different nationalities should include both the emic and etic elements but here in this research survey, we deliberately 'overlooked' the cross-cultural element here and tried to identify any 'emic' or culture-specific constructs and measures that may creep into our concepts used in the survey, nevertheless this may 'creep' into the survey. So wherever available, country-specific concepts and measures are identified and thus compared and where similar put together and combined. Concepts that are unique to a single country will be modified and wherever possible, pan-cultural concepts that do not have any specific cultural bias are used. Allowance would be made for existence of certain concepts that are idiosyncratic to an individual nationality. Similarly, as far as possible, a set of pan-cultural measures of concepts are identified, though in some instances, modifications to suit the context of the research may be necessary.

Pan-cultural measures here also requires consideration of the stimuli presented to respondents. It is not so critical here as the interviewer being the researcher knows the respondents on a personal basis, therefore the stimuli would only be the manner in which the researcher conducts the interview. Understanding that external stimuli affects the quality of the responses is essential as the truthfulness of the responses would depend on the comfort level the researcher establishes with the respondents. Here it is not so critical, as all the respondents are familiar and comfortable with the researcher who is known to them on a personal basis for a length of time.

4.4. *Criteria for Questionnaire Design and Question Formulation.*

The first step in the questionnaire design is to determine what information should be obtained, which in turn would determine the type of questions to be asked and how they be formulated. Since this survey requires that we obtain information with regards to opinions and attitudes of users in the interior design industry as to how they feel that software has successfully or otherwise proliferated and replaced the use of manual labour in drawing for the interior design industry, information may be required in relation to three types of variables which are namely

4.4.1. *their demographic, background or respondent identifying characteristics*

respondents' year of birth, professional educational qualifications are asked for in order to determine their ease of use, comfort zone levels with the use of graphical

software in the professional career as the proliferation of graphical software to the interior design industry has become only more rampant in the 1990's, hence the generation of interior designers trained academically before the 1990's are generally not exposed nor comfortable in the exploration and use of software in the interior design process.

4.4.2. *their behavioural or product/brand usage data*

questions are created that probe and lead to, if any given indication of their work habits and current product preferences

4.4.3 *attitudinal, psychographic and lifestyle variables.*

questions are created that probe if any, deeper underlying attitudes that point towards a fixed pattern of psychographic and lifestyle variables that may influence future purchases.

4.5. *Nature of the Structure of Questions Posed.*

It is important the questions are phrased in such a manner that it has equivalent meaning and evoke responses that are comparable across cultures.

4.5.1. *Open end versus Closed Questions.*

Open ended questions as far as possible to allow for open end replies. The questions are attached in *Appendix D*. Questions asked include the background knowledge of the respondents' past and current academic and professional encounters with graphical software in their interior design pursuits, and their views and opinions with regards to the ability and capability of existing CAD/CAM software packages being able to replace the selected stages of the interior design project cycle and replace the human aspects successfully or otherwise.

Hence the questions are constructed in a totally open ended manner. It is advantageous as they do not impose structure or response categories and avoids the imposition of cultural bias by the researcher. Furthermore, they do not require familiarity with the respondent's possible responses. Open ended questions allow respondents freedom to provide their preferred responses and the questions can be posed directly or indirectly so that the purpose of the question can be disguised from the respondents.

On the other hand, open ended questions tend to entail a very tedious process of establishing coding schemes and equivalent measures of the responses as this researcher found out in the course of work and tabulating them once the data has been collected.

In addition, differences in levels of literacy may affect the appropriateness of using open ended questions as opposed to closed ones. They require that respondents are able to respond on his own terms and have a moderate level of sophistication and comprehension of the topic on hand, otherwise the responses will not be meaningful.

We have decided to use open ended questions as this is appropriate for this type of exploratory research where the primary objective is to identify relevant dimensions, concepts or terminology associated with the problem studied. They can be used to elicit content domains relating to software, attitudes towards software or advertising stimuli or the associations evoked by such stimuli. For example, respondents would be asked to list their feelings towards the ease of use and first impressions of GUI (Graphical User Interface). Subjects would be asked to indicate adjectives, words or phrases that best describe or characterize the stimuli such as their first impressions of the software and the ease of use.

4.5.2. *Direct versus Indirect Questions*

Another consideration is whether direct or indirect questions are utilized. Direct questions are devoid of ambiguity with regards to content and meaning, but respondents may be reluctant to answer some direct questions as they deem it as encroaching on their privacy. A question in point

is the one which asks about their year of birth. The main objective of this question in the questionnaire was to elicit ideas as to the extent of the proliferation of the use of graphical software during their time of their academic pursuits and professional careers. The question also served to shed light on the comfort levels of the respondents with the use of graphical software in interior design. As all respondents were on first name terms with this researcher, the answers were forthcoming.

The results seem to indicate that respondents born in the between the early years between 1950s to late 1960s tend to avoid the use of software in their work as they were not exposed to it much during their academic pursuits or internship training. Back then, there was hardly any 'ease of use' graphical software packages or the computer hardware developments to support it. Hence, this group of respondents tend to spend more time using manual methods for interior design. But even with these valid reasons, there appears to be more respondents from that age group who seem to be rather reluctant presently, to embrace graphical drafting technology, preferring to simply acquire the theoretical knowledge and superficial skills in the manipulation of the features and functions in the software packages. They appear to the researcher, preferring to leaving it where possible and available to the technical support staff.

4.6. Results of the Survey

4.6.1. Profile of Respondents in Sample

The respondents were initially selected and divided according to their nationalities to see if there were any 'real' or 'perceived' differences in their responses. Strangely enough, despite their varied and different backgrounds in academic pursuits and professional expertise in the different stages of the interior design process, their similarities and differences can be attributed more to their varying levels of academic training and emphasis, job scope and specialisation and inclination rather than due to their different nationalities, cultures or ethnic origins. As we analyse the outcomes of the raw data collected from the transcripts recorded during the one-on-one interviews, we will present the results by highlighting the similarities or differences uncovered from their responses to the questions in the survey questionnaire in the order as attached in *Appendix D*.

4.7 Responses and Outcomes to Survey Questions.

4.7.1. Responses to Questions 1 to 4 from Section A Personal Background.

From the questions posed with regards to the definition of their job scope, the respondents can be categorized into the following five main categories. For ease of convenience, the groups would be termed as 'Category 1' to 'Category 5'.

- 1) Category 1: Sole Proprietors of 'OMO' (affectionately known locally as 'One Man Operation')
- 2) Category 2: Sole Proprietors of small to medium sized interior design companies with staff numbers between 2 to 25
- 3) Category 3: Cad Technical Manager (unfortunately due to time constraints, we were only able to obtain an interview with only one respondent)
- 4) Category 4: working (non-owners) Interior Design Directors and Design Architects of small to medium sized firms with staff numbers between 2 to 25
- 5) Category 5: working Interior Designers (non-owners) of a large interior design firm with staff strength of 100.

Clearly being able to define the respondents into the various categories is important to this survey as it enables one to see the common traits or differences that align or distinguish the nuances to be found in these five categories of respondents. These nuances would provide insights into, as to

what extent graphical software could have or had replaced manual labour in their practice of interior design.

The commonalities of the five categories given their respective job scopes, as we found out, is that some type of graphical software is used by the respondents in all the five categories, be it an off the shelf package or an up market customised package. But not all the respondents were 'hands-on' users of graphical software. It was found that Category # 1 and 2 respondents were more 'hands-on' users of graphical software in the various stages of the interior design process. Category # 3, 4 and 5 respondents tend to be more 'managerial' in their attitude and application of graphical software. Their response was that they would typically spend more time managing their clients, interior design and project related matters, internal staff and external parties like government bodies, other service professionals, contractors and suppliers than to actually 'use' graphical software. They tend to specialise either in design or project management all the time or for specifically mentioned projects and delegate the 'use' of graphical software of their sketch work to be hardlined and drawn up, to their subordinates or other junior staff. The reason being also that the scale of the interior design projects belonging to Category # 3, 4 and 5 tend to be on a larger scale than that of Category # 1 and 2.

4.7.2. Responses to Questions 5 and 6 from Section A Personal Background.

The responses wrought from these two questions confirmed our hunch that categorizing them into age groups for ease of reference was the right step as it threw up some interesting points. It became apparent also that respondents born in the early¹⁵ and late¹⁶ 1950's and early¹⁷ 1960's were not as at ease as their younger counterparts with the advent of information technology in interior design.

By now in the 21st century, all the respondents would have been equally exposed and adapt to the idea of using graphical software during their course of work but the comfort level varies.

According to the transcripts of the interviews with respondents from these three age groups. In general, it can be generalized that amongst the three age groups, the respondents in the age group born before the 1960's was admittedly not as familiar nor as comfortable as the respondents who were born in the late¹⁸ 1960's and after, with the influx of digital technology into the interior design profession.

These respondents born prior to the late 1960's did not have the opportunity available to them, to include in their academic curriculum, a formally taught module on the use and application of graphical software in interior design. By default and not by choice, as the formal study in the use of graphical software was not so prevalent and readily available then. There were not many off-the-shelf packages but more turnkey systems as discussed in Chapter 1. Therefore students had to actually queue up and wait for days for their turn at the super computers to generate their drawings. The technology was not object oriented and drawings had to be constructed with setting out. The time taken to generate drawings was very long, generally more than a day. Due to the exorbitant cost of acquiring the hardware to run the software, the ratio of computers to number of students was unbalanced. Since it took long time to generate drawings, ost preferred to work by hand for their school interior design projects which was faster.

These respondents could not recall the names nor brands of the graphical software used during their academic tenure but most have been exposed or actively using predominantly Autocad

¹⁵ Early 1950's references to respondents born between 1951 to 1955

¹⁶ Late 1950's references to respondents born between 1956 to 1960

¹⁷ Early 1960's references to respondents born between 1961 to 1965

¹⁸ Late 1960's references to respondents born between 1966 to 1970

Release 13 since its launch in late¹⁹ 1980's onwards. Most would have 10 to 15 years of exposure to graphical software since then.

4.7.3. Responses to Questions 7,8 and 9 from Section A Personal Background.

Question 7 investigates the profile of the type of clientele that the respondents service which has a bearing on the frequency of use of graphical software in the various stages of interior design process. From *Appendix E*, the list of respondents can also again be sub-categorized into designers who service the following five sectors:

- commercial office and banking sector which includes corporate offices and retail banking
- hospitality sector which includes resorts, hotels, hostels and recreational facilities with instay
- retail sector which includes shopping centres and malls and stand alone boutique shops
- institutional sector which includes civic buildings like library, court house, hospitals, schools, and buildings for community use
- residential sector which includes private sector stand alone bungalows, mansions, walk up apartments, small scale or large scale condominiums and public sector residential mass housing.

Most interior designers would specialise in one sector but the medium to large firms may take on jobs in other sectors should there be excess capacity or if the project proves to be profitable. With this question, we deduced from the answers that the frequency of use of graphical software is very much in synch with the sector in which the interior design firm operates in. The reasons being that the highrise buildings with repetitive floors on large scale would require the most use of draughting software due to the need to update drawings and make amendments to the drawings during the progress of the project on site. Hence through the interviews, we find that most of the graphical software used for 2-D drawings occur in the following sectors:

- commercial office especially high rise office blocks
- hospitality sector especially hotels
- residential sector especially private sector large scale condominiums and public sector residential mass housing.

In these three sectors, the majority of the floors are repetitive with the core services being centralised like the sewage, human transportation like elevator cores and stairwells are totally repetitive with little difference amongst the floors, with the exception of the basement, ground and penthouse floors.

According to the respondents' feedback, the greatest frequency of use of 2-D draughting graphical software occurs in these three sectors. The above situation only applies to the Singapore context. In countries with ample land like the United States of America and Canada, respondents who were educated and worked abroad, mentioned that in the private sector for large scale stand-alone residential housing, affectionately known as 'cookie cutter' houses in the United States of America, applications and usage of graphical software pervades almost every stage of the interior design process as potential buyers would be looking to purchase houses 'cut' and 'design' from the same mould throughout an estate with minor modifications by the potential buyers, in terms of non-structural interior decorations.

Paradoxically, we were informed that there were also owners who would purchase land and customised their own designs both in the United States of America, Canada and Singapore. For this elite group of clients, respondents that dealt with such exclusive residential interiors would not generally use CAD software in most of the stages of the interior design process. The reason

¹⁹ Late 1980's references to the years 1986 to 1990

being the individual residential projects do not warrant the economies of scale to plot the details using CAD software, omitting mention that it is time consuming and tedious. Most of the respondents involved in projects of this nature find it easier and faster to design, draft and update changes manually by hand.

In response to question 8, most respondents confirmed that despite servicing different sectors of clientele in their respective outfits, they would only utilise and adhere to one particular brand of CAD software, with hardly any change of vendor at all. The reason being that it is difficult to employ readily skilled draughtsman, not only in terms of operating the CAD software package but also in reducing the learning curve for adjusting to the standard operating procedures of the company. Respondents even expressed 'fear' of upgrading their present CAD packages to newer versions due to downtime for training, thereby taking away 'precious' time from work.

Despite the different sectors the respondents may service in any one firm, the same CAD packages would be used throughout the same stages of a residential or a commercial office interior design project. The reason being that medium to large firms tend to keep the draughting pool as a centralised unit to service their clients from the various sectors like commercial office and residential for example, without having to employ two disparate groups of CAD operators for the two sectors that they service. There is no need for sector specific specialisation for draughting.

In response to question 9, different types of CAD packages are definitely used for the different stages of the interior design process. Respondents have expressed that no one current package is comprehensive enough to cater to all the demands of the multi facets of design. The CAD packages that are used for the various stages of an interior design project are highlighted in Chapter 1. There are a number of packages with the capability of interchangeable and interoperable files being utilised by all respondents in their respective firms for their projects. Most have confirmed that the commonly used CAD packages for the three major phases of the interior design process are as follows:

- i) 1st Phase where the conceptual Design Phase-Outputs include 3-D sketches and interior digital landscape animation with walkthrough views. Here most respondents confirm the use of 3D Studio Viz as the software package that most interior designers would use to produce, develop and generate 3-D walk through and animation with sound, light and colour effects for presentation to their clients. Currently, 3D Studio Viz has been acquired by Autodesk and is renamed 3D AutoViz. For the initial budgetary costing, most respondents resort to using Microsoft Excel or Microsoft Project. A lot of the work at this phase is sub-contracted to outside vendors for drawing up as most interior design companies do not have the draughting personnel that is well equipped with the skills nor 'eye' for design detail that the output requires, to make the difference between a professional and an amateur. Also to maintain skilled staff is costly. Unless the company has a constant flow of large-scale jobs that require such skills, most of the time, it is preferable to sub-contract it out. When companies do maintain such staff, these technicians normally multi-task as well.

It must be mentioned that animation software is only used extensively in large-scale development projects by the large firms. The respondents mentioned that animated presentations are only produced when the scale of the project warrants it as the man-hours involved in producing interior stills and animated walk-throughs for interior architecture is highly prohibitive. The costs have to be weighed against the monetary returns upon securing the project.

Other than financial considerations, respondents mention that other considerations to be considered would include if the job is a high profile

project worth securing for publicity and image reasons, jobs on private 'by invitation only' tendering basis (unsecured projects but invited to bid for job on a selective basis by potential client) or open tendering (unsecured projects but invited to bid for job on openly competitive basis, the decision to participate or not depends on the reputation of client and scale of job).

- ii) 2nd Phase where the Design Development occurs -Outputs include floor plan layouts, sections, elevations, furniture details and annotated services drawings. Here majority of the respondents use the standard CAD software package Autocad by Autodesk for 2-D draughting except three respondents # 4,5,9 and 10. Respondents # 4 and 5 use Microstation predominantly in the firm they work with presently, although they had prior experience with MicroGDS in their previous job. Respondents # 9 and 10 use Drawbase predominantly although they had knowledge of Autocad but due to their familiarity with Drawbase, they did not convert. All four respondents # 4,5,9 and 10 are able to import and export most of the time, successfully their files to and fro Autocad for compatibility with other co-professionals in the industry.

We glean from the survey that Autocad by default, is the 'defacto' standard software that is dominating the Singapore market as the desktop CAD software for the building industry. According to the respondents, it is the industry standard to use Autocad as it seems that its dominance in the market was due in part, paradoxically to piracy of software that had flooded the market in the early years of Autodesk's development. Autodesk at that time did not clamp down hard on piracy, which turned out to be a blessing in disguise. Pundits claimed that it was a brilliant marketing ploy by Autodesk deliberate or not, as piracy unwittingly helped in the 'marketing' of its product Now most users would be reluctant to upgrade to a original copy of another brand of CAD software should they be able to afford it, once they are used to Autocad's interface.

- ii) 3rd Phase- where the construction on site happens – Outputs include approved detailed construction drawings and details of fixtures with database of costs/budgets. All the respondents use Autocad except respondents 4,5, 9 and 10 for the reasons aforementioned. Microsoft Excel and Microsoft Projects is used for budgetry purposes although Autodesk, Microstation, MicroGDS and Drawbase have their own project management packages. But according to the respondents, these project management packages have to be totally customized to their respective organizations' method of quantitative take-offs, thereby rendering them rather restrictive. Customization would also be time consuming and costly. Therefore, all respondents expressed that they prefer the use of spreadsheets from Microsoft Excel or Microsoft Project package.

As it can be seen, from Phases 1, 2 and 3, a combination of packages are used. Not one single software package covers the entire spectrum of work for interior design. All respondents feel that there is not a single software available at this point in time to meet the comprehensive needs of all the work processes in the interior design. Each software package has its own strengths and weaknesses.

4.8 Responses to Questions for Section B Stage 4 Preliminary Design Brief Analysis.

Here respondents are posed a series of open ended questions as to how they conduct their work at the various stages of the interior design, what software packages are used in order to facilitate their work, if any or not. From their answers, we will probe further as to how they feel about their

work methods, manual or otherwise; the software tools that they use to help them and the reasons for their choice and if manual labour was used at this stage of interior design, then we would be interested in the reasons behind it as well.

At Stage 4, we examined the respondents' relationship with two major entities which we have identified and spoke at length about in Chapter 1; the main contractor and the Client/Tenant. Here, we hold the same assumption as stated in Chapter 1 that the preliminary design brief has already been thought through as to its requirements laid out the Client before it is handed to the Interior Designer. (If the Interior Designer is appointed through a series of qualifying competitions, then this stage would be omitted as much of it would have been done and submitted by the Interior Designer during the competition. To avoid confusion, we assume here that the Interior Designer has been appointed through recommendation or word of mouth and professional reputation through his portfolio successes.) It is handed to the appointed Interior Designer who works on it, clarifying and updating essential pointers through a subsequent series of meetings with the Client. We also assume that the Interior Design and the Main Contractor are not one and the same entities with financial liaisons and therefore is not a turnkey contractor. The Interior Designer acts in the capacity of a professional consultant only.

Based on this assumption, we learnt from the respondents about the types of documents (data types) that is generated and the type and brand of software that is used to for communication between the two parties. If software was used, we also learnt of the extent of the proliferation of CAD software used for communication between the Interior Designer and the Main Contractor. Before doing that, we have to define the three categories of Main Contractors that Interior Designer would use. Survey respondents categorize them as follows:

- 'regular' Main Contractor²⁰
- Main Contractor appointed by open tender²¹
- Main Contractor appointed by pre-qualified tender on a selective and 'by invitation only' basis.²²

4.8.1 Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and 'Regular' Main Contractor.

Respondents who have had most of their projects built by Main Contractors that belong to this category are respondents # 2, 3, 6, 9, 10, 11 and 12. We have been told that after the award of the

²⁰ 'regular' Main Contractor (MC) is defined as the person or the company that the Interior Designer works with on a personal and regular basis, generally a lot of the graphical or written communication is informal, budgetary estimates are provided but many on site changes which will affect the costs known as 'variations' are accommodated with little bureaucracy. A lot of unspoken goodwill occurs in the relationship between the Interior Designer and the Main Contractor. The projects are pre-dominantly private sector small scale to large-scale projects with varying high to low cost budgets and little bureaucracy and red tape to decision making. Regular main contractors range from your regular 'Joe' One Man Operations to medium and large sized firms.

²¹ This sort of open tender is used only to source for a Main Contractor for small and medium scale (private sector) projects with modest to high cost budgets. This is normally for small to medium sized projects of less than 10000 square feet built-up area . The Interior Designer would select a few to quote for the project with no specific criteria for the selection or the Contractor would pro-actively market his services to the Interior Designer in order to be allowed to tender.

²² This is sort of 'by invitation only' tender has a pre-qualification status whereby the potential nominee is measured against his financial standing before he qualifies for short-listing on the pre-selection list. This is the norm for most important, prestigious and high profile public sector (large to medium scale) projects and private sector (large to medium scale) projects. The Contractors must be able to handle high budgets/high volume or low budgets/high volume work..

project, drawings are printed out manually and on hard copies (drawings printed on paper) for communication with their regular Main Contractor.

According to respondents # 2, 3, 6, 9, 11 and 12, in the initial meetings with the Client/Tenant²³, normally the existing site drawings provided by the Client/Tenant to the interior designer are generally 'hard' copies on paper. Very rarely is the Client/Tenant in possession of an 'as-built' 'soft' copy of the structural shell of the building unless the Developer/Owner²⁴ of the building or the Architect of the building had provided it to them. The Developer/Owner, even if he had a 'soft' copy from the building Architect, would have misplaced it! If buildings had been erected within a ten year time frame from the time of erection, then the building architect would have soft copies.

Otherwise, after the ten year stipulation, most building Architects are not obliged under the law to archive the drawings, although privately, most Architects do so. Then, anyone who wanted a soft copy of the structural shell of a more than ten year old building would have to put in a request to the Government archives for one.

It is rare that the Architect of the building ends up playing dual role as the Interior Designer for the many Clients/Tenants of a particular building. The financial returns may be too minute for the architect to justify his time and his company's resources on the interior project, so generally speaking, most of the interior work is taken up by either the Interior Designer of the Client/Tenant's choice or by Main Contractors who employ Interior Designers to work under their auspices. We have categorically stated that we would assume in Chapter 1 that the Interior Designer and the Architect are two separate entities and that the Interior Designer and the Main Contractor are two separate entities. But this does not preclude the possibility of the building Architect being employed as the Interior Designer for a job within the building premises leased by one of the Clients/Tenants. Some of the respondents in this survey, respondents # 1,2,3,5,7 and 13 are trained Architects who also perform the interior design function within the companies that they own or work for.

How often is CAD software used between the Interior Designer and the appointed Main Contractor to communicate is dependent on either one of the following 3 scenarios

1) where the Interior Designer and the Architect are two separate entities and the building is less than ten years old, in a such a case

the Interior Designer may be able to obtain a 'soft' copy of the structural shell drawing from the Architect particularly if the building is new and standing for less than ten years. As most buildings would be still under building defects rectification law where the Main Contractor would still have to be responsible for any building defects within the ten year period after the handover, hence the Architect would still have to store and update the soft copy of the drawings. The Client/Tenant would also be able to request a soft or hard copy from the Developer/Owner for the appointed Interior Designer.

Respondents mention that these soft copies with 'dwg' extension files (the Autocad file extensions) would include most recent site measurements taken by the appointed Main Contractor. The measurements would update and override the existing dimensions on file.

2) where the Interior Designer and the Architect are two separate entities and the building is older than ten years.

²³ Client/Tenant here may refer to the Leasees who may occupy some floors of the premises and pay rents to the building's Developer/Owner

¹⁰ Developer/Owner of the building refers to the actual landlord of the premises who may occupy some floors themselves and lease out the rest to external Clients/Tenants for rent.

Here, the soft copy is not available for buildings older than ten years, according to the respondents, what happens is that a hard copy would be provided to the Interior Designer directly from the Client/Tenant, who in turn would have obtained it from the Developer/Owner. The Developer/Owner would have probably some hard copies of the building shell on file. After ten years, the architect under Singapore Law is not obliged to store the drawings for availability on hand for immediate retrieval. Anyone who is keen on the retrieval of the said drawings would be able to obtain a copy from the Government archives which would mean time and trouble incurred.

If a soft copy is obtainable by any means, the same procedure would follow as in scenario 1. But if a soft copy is not available, then the Interior Designer would either have to convert the paper drawing from a raster image into a vector image file with the help of a scanner and scanning software.

There are problems associated with this method of working as respondents pointed out. The scanned images are scanty, grainy and proportionately inaccurate. Contraction and shrinkage occur when drawings are printed out on paper. There are associated problems with converting paper drawings to CAD system. The problems are inherent in every step of the automatic conversion. The original paper drawings are inaccurate to begin with due to manual drafting practices where fudging goes on. Although lines may look straight but are actually running at a slight angle to match up, corners may look square but are off by a degree, circles appear to have an accurate radius but are either under or over sized and fillets may not join at the corner (most manual drafters overshoot or create 'crosses' at all corners to resolve this issue in the past) and dimensions may not measure up to their stated distance. As the scanner reads the paper drawings as an array of meaningless dots, it can only read rudimentary patterns along the dots, a substantial amount of information would be lost along the translation. The 'cleaning up' work takes time and very tedious, albeit less time than starting on a new drawing of the shell as site measurements have to be taken by the Main Contractor with the Draughtsman in tow.

Respondents mentioned that over the years of practising interior design professionally, they have accumulated a database of electronic drawings of most of the major commercial buildings in Singapore.

Respondents who practise residential interiors excluding mass private or public housing development, generally would have to start from scratch as the house owner may not have an electronic copy of the existing or new structure, unless the Architect and the Interior Designer are one and the same entity. These respondents generally prefer to draw up their existing house structural drawings by hand as it is a lot faster. They also mention that residential Clients/Tenants generally prefer hand drawn drawings particularly those in Europe and the United States of America as it is more intimate and personal. Respondents have made mention that graphical software makers like Autodesk are aware of the need for personal touch, and have increased the variety of line types, a number of them emulating human hand drawn lines.

3) where the Interior Designer and the building Architect are one and the same entity and the building is either less than or older than ten years.

This problem is less complex if the building is less than ten years old, then the Interior Designer cum building Architect would have the soft copy of the building shell and is able to provide one to their regular Main Contractor. Most building Architects do archive all their drawings digitally even though it is not required under the law after the ten years has lapsed. Even if it exceeded ten years, most Architects would still retain an archived copy.

The procedure of inputting site measurements would be similar to the first scenario. The Main Contractor takes the site measurements and reports the updates to the Interior Designer who updates the electronic copy.

The extent where graphical software usage serves as a replacement for manual labor in the production of drawings and documentation to facilitate work flow with ‘regular’ main contractors is infrequent. The nature of private sector interior design projects is such that emphasis is placed on getting the work done before sorting out the documentation, hence the cart is put before the horse at most times. Speed is of the essence as time loss equates to financial loss. The ‘regular’ Main Contractor being a regularly used contractor by the Interior Designer would have in existence a strong prior working relationship based on trust, hence a lot of the ‘red tape’ and documentation is omitted during the work processes. The Interior Designer would be more lax in the frequency of use of graphical software to produce and update drawings until much later. A lot of communication is verbal with the use of sketch drawings and amendments on printed drawings. Updating the electronic files takes place later after the work has been completed on site.

4.8.2. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and Main Contractor (open tender).

Respondents that work with this category of contractors characterize them as being more proactive in sourcing for work by marketing themselves to Interior Designers in order to be invited to quote for potential projects. This group of contractors are more information technology savvy than the ‘regular’ contractor. This group of contractors are gradually replacing the old timers.

Respondents who have worked with this category have affirmed that in meetings, measurement of existing site structures, site meetings, work schedules and budgetary estimates are updated regularly mostly digitally using Autocad and Microsoft Excel. They employ their own project Clerk of Works on site who is able to manipulate graphical software to update and make amendments to electronic files and return them electronically to the Interior Designer for review, update or record.

4.8.3. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and Main Contractor (pre-qualified tender).

Respondents term this category of contractors as the ‘big boys’. They are the serious internationally affiliated consortiums with financial muscle. They have the human resources to provide graphical software support for preliminary site and structural measurements, drawings and work schedule analysis.

4.8.4. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and Client/Tenant²⁵.

Respondents categorized Clients/Tenants into 2 categories

- the seemingly ‘know-all’ Client/Tenant
- the well informed Client/Tenant.

At this stage of design pedestrian traffic studies, geomancy (feng shui) requirements, site studies of vehicular flows, budgetary studies, imagery studies (particularly for retail designs if it needs to follow a particular style instituted by corporate headquarters), lighting studies and fitting and fixture studies would have to be made. Initial studies are normally made on all projects, the intensity only varies with the scale and size of the project.

For small projects, the abovementioned studies are made through observations and experience. Spreadsheets are used to tabulate the budgetary estimates for the bills of materials and take-off quantities. At this stage, most of the work is prepared manually like material boards, hand drawn sketch ‘bubble’ designs to illustrate workflow, human and urban landscape interaction studies.

²⁵ Client/Tenant may refer to the Owner or leasee of the premises or his representative under his employ.

In medium to large scale projects, respondent # 1 who works for an American design firm and respondents # 3 and 4 who work for a Singapore based consortium used a primitive software to analyze human traffic and vehicular traffic flows. This software called “Pedroute” is implemented on the main frame. But in order to generate the projected analysis, the respondents mention that the data input would be taken from past data of human and vehicular traffic patterns at important retail or institutional buildings. The data was wrought from stationing persons at existing facilities to perform manual counts of daily traffic over a period of a year. Budgetary estimates and bill of materials take off were prepared on spreadsheet software.

We drew conclusions based on respondents’ feedback that at this stage, most of the interaction with the Client/Tenant is done manually. Actual material boards and design sketch drawings are used to communicate ideas to the Client/Tenant and spreadsheet software is used to present project costs, budgets and material estimates.

4.8.5. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and other Service Professionals.

With other professionals, all respondents concur similarly that most communication is conducted through electronic mail, facsimile and over the telephone locally and for the developed countries. For projects that are based in undeveloped countries where the telecommunications infrastructure is less sophisticated, then paper prints are couriered over. Communication is conducted via facsimile, telexes and telephone calls to follow.

According all the respondents, in the last ten years, all the Professional Consultants are geared up to use information technology locally. Most of the graphical communication is electronic using predominantly Autodesk’s products namely Autocad LT 2D (Autocad Light) and Autocad (Full Version). Most supporting Professionals like Civil and Structural Engineers, Electrical and Mechanical Engineers tend to use only the Autocad LT 2D as they require only to participate in the updating and drafting process in 2-D plans, elevations and sections. Therefore possessing the full version is redundant.

4.8.6. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and Government Agencies

“A landmark memorandum of understanding (MOU) that was signed between the Construction Industry Development Board (CIDB), the National Computer Board (NCB), the Singapore Productivity and Standards Board (PSB) and the Singapore Chapter of the International Alliance of Interoperability (IAI) to jointly sponsored the development of common standards.”²⁶

Its main aim was to facilitate a faster and wider exchange of electronic information via drawings- the main stay and tools of communication in the construction industry. This MOU was signed on the 29th September 1998 co-signed by the Presidents of all the major eight construction Professional bodies in Singapore as signatories. Since then, all government agencies have never looked back. The MOU adopted common standards like layering convention, use of symbols and classification of data among Developers, Architects, Engineering consulting firms and Quantity Surveyors.

With this development, all respondents mention that their communication with Government agencies like the building authorities and the Fire Safety Bureau is limited as most interior work does not involve extensive structural renovations, unless it affects the safety of the occupants. Most of the interior renovation work is surface treatment. If there is a need for building approval for drawings, then normally a licensed Architect’s signature would be required for endorsement. It is the Client/Tenant who would liaise with the Architect for submissions should it be required

²⁶ Extract taken from www.corenet.gov.sg

in conjunction with the Interior Designer, unless the Architect and the Interior Designer are the same entity.

Submissions have to be electronically done over the Internet using files in 'dwg' format. As it is, most consulting firms are using software from Autodesk, the integration is seamless.

4.9 Responses to Questions for Section C Stage 5 Schematic Design Development.

The analysis of the respondents' responses are categorized as follows

4.9.1. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and the Client/Tenant.

At this stage of work, most of the preliminary studies would have been completed. Conceptual sketches would be ready. All respondents involved in design work have indicated their preferences to 'doodle' their quick sketches by hand with markers and charcoal/sketch pencils. Most have expressed that in all their years of academic and professional practice, they have not been able to find a CAD software that can match the expediency (by way of the CRT screen generation and refreshment rates of images) and personalization of hand drawn sketches that the human mind and hand can manipulate.

Also, when doing initial sketch proposals, overlays of tracing paper are used. For large-scale projects, the tracing paper is between A3 and A0 size which is easier to handle by hand. A lot of 'doodling', preliminary sketches and layouts are made, layers upon layers. Currently, computer hardware and software cannot simulate this function.

Firstly, hardware computer display screens are limited in size. The generation and processing speed (with reference to desktops, not mainframes) is not as fast one would expect. The computer screen limits the number of frames that one can display at any one time to compare and contrast the endless concept sketches an Interior Designer can churn out for comparison and consideration.

Secondly, CAD software's 'do' and 'undo' function is limited to the number of steps it allows one to trace and retrace the sketch designs.

The final analysis is that, all the respondents unanimously agree that at this stage of design, free hand drawn sketches to illustrate concepts and ideas are more agreeable to the nature of the task at hand than to deploy a draughtsman or themselves to plot the sketches digitally at the onset of the initial schematic design process. Multiple changes and amendments to the design ideas occur the most at this stage of design. This is particularly poignant for residential stand-alone projects.

All respondents brought up the point that they would only recommend the use of digital software with animated and sound effects to present their design concepts when they are closer to the final stages of the schematic design meetings with the Client/Tenant where changes are less frequent. Then digital visual sketches to demonstrate the quality of the ambience of the indoor and outdoor spaces, illumination levels, walkthroughs of all transitional spaces, interior landscaping painted with true to 'life realistic interior material finishes, colours and textures are drawn up for Client/Tenant's viewing pleasure and approval. Animated presentations are costly. Respondents mention that they are only provided in the following circumstances:

- the high value of the project justifies the cost of putting up an animated presentation
- there are economies of scale to be reaped from putting up the animated presentation, for example large scale commercial projects with repeated floors with alike layouts, thereby making the transition from 2-D to 3-D and vice-versa, seamless and versatile.
- there is available internal manpower and skill
- if there is lacking internal manpower/skill, then the costs of outsourcing the work is justified through project value or the Client/Tenant is willing to foot the bill

For small scale to medium scale projects that do not meet the above criteria, respondents would produce digital perspectives and stills, without animated walkthroughs and sound effects to reduce cost.

The most commonly used graphical software at this Stage 5 are generally Autodesk's 3D Studio Viz in conjunction with Adobe's Photoshop and Autodesk's Autocad (Full Version).

Massing for large-scale projects can be digitally enhanced by the use of software like Micro GDS-3-D sketches. Although hand-built scale models are still required to provide a feel of the massing blocks in relation to the site especially for large scale projects like mass housing, institutional and commercial office buildings. Graphical software cannot totally replace human made models. The layman is unable to visualize due to their lack of training. Generally massing models are built for architectural projects and not particularly relevant to interior design. Respondents that were both Professional Architects and Interior Designers brought up the point that hand-made models would enable one to feel the actual human scale of the spaces designed.

4.9.2. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and the Government Agencies and Authorities.

Respondents' meetings with relevant Government Agencies and Authorities are limited at this stage. Except for submissions of initial proposed interior floor plans, elevations and sections with structural changes and changes that may affect fire safety regulations like movement of existing sprinkler systems. Otherwise, contact with Government Agencies is minimal through the services of an employed Architect under the direct payroll of the Client/Tenant. If the Interior Designer is the Architect, then the contact is direct.

The CAD software that all respondents use in relation to their production of drawings for government submissions is Autodesk's Autocad. But respondents # 4,5 and 7 use MicroStation with 'dwg' file extensions in conjunction with Autocad for their projects with the Light Rail Transportation Authority of Singapore.

4.9.3. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and Other Service Professionals.

With other service professionals, Autodesk's Autocad 2-D or Autocad LT is the graphical software that all the respondents use to produce drawings for communication with their civil structural, electrical and mechanical counterparts. As only 2-D floor plans, sections and elevations are exchanged, there is very little need for sophisticated CAD software.

Respondents highlight that most professionals even the SOHO (small offices home offices) or the 'one man operation' professional uses some graphical software. There are exceptions to the case, according to respondent # 10, in India where Autodesk is not a dominant player there.

4.9.4. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and Contractor/Suppliers

At this stage, respondents would be issuing paper prints to contractors who need to supply drawings to their Clerk of Works to verify site dimensions.

Most contractors in the 21st century unlike in the early and late 1980's and early 1990's, have established site offices where it is fully equipped electronically with computers wired up to the Internet. Information technology has created a plethora of possibilities for remote access to files on the servers.

Paper prints of drawings of initial site dimensions and markings for the erection of dry wall partitions or material partitions can be printed out on site instantaneously, transmitted from the

respondents' office for immediate response. Respondents who worked on small to medium scale projects mention that their contractors would be provided paper prints during site meetings, via courier services or the contractor would do a personal 'pick-up' at the respondents' offices whilst being present for their meetings. Respondents would also provide up to date paper prints to the Main Contractor and all the related sub-trades, service professionals and Client/Tenant during their regular site meetings.

Most small to medium sized contractors still rely on sub-contractors to do their work for them as it would be too costly to maintain a permanent crew of plumbers, electricians and related tradesman. Most contractors do not maintain a database of information of digital drawings. They rely on the Interior Designer as the main source of information as they are not disciplined housekeepers.

Respondents would generally provide paper prints of drawings to material suppliers to aid their understanding of the quantity and layout of materials to be supplied in their bills of quantities. Generally suppliers' quotations would be revised repeatedly over the entire course of the design process. Spreadsheets and 'letter' style documents, with a attached photocopied copy of the original paper print provided by the interior designer, the areas specified in the quotation documents being highlighted or color coded would be submitted. Some suppliers who supply generic materials used on interior surfaces even make reference to the dimension lines x-y axis grid in their quotations and drawing reference numbers as official reference codes in quotations to avoid confusion as there could be repeated floors with the same layout.

4.10. Responses to Questions for Section D Stage 6 Final Design Development

In Stage 6, respondents affirm that this is the stage where most of the 2-D graphical software is used. Respondents interviewed used Autodesk's Autocad, Drawbase and MicroStation.

Respondents # 1,3,4,5,6,7,8,11,12 and 13 use Autocad 2-D to draft their plans, elevations and sections and axonometrics for 'as-built' construction drawings with details. Respondents # 9 and 10 are Drawbase 2-D users whereas respondents # 4,5 and 7 use a mixture of Autocad and MicroStation. Respondent # 8, a Cad Manager is a proficient user of both Autocad and Drawbase.

The analysis of the respondents' responses are categorized as follows

4.10.1. Frequency and Extent of the Proliferation and Use of Graphical Software by Interior Designer Internally for Communication within the Company.

All respondents attest to the fact that the most intensive use of 2-D graphical software of any brand occurs at this stage of the interior design process. All plans, sections and elevations are digitally plotted out either by themselves if they are a 'one man operation' or by their draughting personnel. Once the initial drawings are produced, they are sent back to the Interior Designer for checking electronically by the draughting personnel.

In the early days, the file transfer process between individuals had problems. Respondents who were 'one man operation' outfits did not have this file transfer protocol problem that the small or medium sized firms (with or without server networks) had. The drawing file transfer protocol had the following problems:

(i) accidental overriding of drawing files particularly with Autocad as file extensions were limited in the earlier versions of Autocad. A draughtsman can only work on one project at anyone time or only one floor of a project at anyone time, otherwise there would be files overriding each other. Co-ordination amongst multiple draughtsmen was a problem.

(ii) inability to have multiple users working on the same file concurrently for fear of overriding of files. It was not possible for different areas of the floor plan to be worked on by multiple users especially for high rise commercial building office interiors where there are different wings on the same floor and all the floors are repeated throughout the entire high rise floor. The ability to

have different users dedicated to the different wings of the same floor have to be organized carefully in the manner of file storing and naming the file extensions. For example, if one floor of a commercial office project had different wings like the 'North', 'South', 'East' and 'West' and different users were working on all the four areas concurrently, the last person to save his file would override all the others. Although during work, a small window menu would 'pop' up on all four users' screens as a warning.

Most Respondents work around that problem by manually organizing their digital drawing file system by doing the following:

1. disintegrate the original file, for example the original drawing has been named as 'MainDrawing.dwg' into four separate files 'DrawingNorth1.dwg', 'DrawingSouth1.dwg', 'DrawingEast1.dwg' and 'DrawingWest1.dwg'.
2. After disintegrating it amongst the four users, each user continually updates his drawings as follows; 'DrawingNorth11.dwg', 'DrawingNorth12.dwg', 'DrawingNorth13.dwg' and so forth. The same applies to the users of the other three files.
3. Finally, if the last drawing for each user ends in the following file extensions 'DrawingNorth14.dwg', 'DrawingSouth12.dwg', 'DrawingEast12.dwg' and 'DrawingWest12.dwg', what follows is that a main coordinator is appointed to perform the 'patch' for the final drawing by 'cutting', 'pasting' and merging the above four final drawings into the main original drawing which is the file with the extension 'MainDrawing.dwg' but re-saving it with another new file name called 'MainDrawingRevision1.dwg'. The original main file 'MainDrawing.dwg' is retained for reference and untouched.

This is generally the manual system that most small to medium size companies adopt even with a server to ensure that their files are coherent and not duplicated. Respondents that work with large outfits generally have a dedicated personnel on one project. Respondents # 4 and 5 work with MicroStation which is sophisticated enough to manage projects where many users need simultaneous access to the data. Each layer of a drawing is held as a separate file. A project database tracks the location of these files, and manages the file 'locks' to ensure that everything works smoothly even if more than one user tries to log on and edit the file at the same time. It also allows them to organize the files into folders and directories automatically with the settings in place. There is no need for a deliberate effort to consolidate them into a final drawing like the manual method which the small and medium sized firms use, with off the shelf graphical software.

4.10.2.Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and Client/Tenant.

The use of graphical software for production of plans, sections, elevations and construction details for communication with the Client/Tenant is made using paper prints. Digital copies are not transmitted to the Client/Tenant as they do not generally require electronic copies for updates. Most documentation that the Interior Designers hand to the Client/Tenant for filing or endorsement are generally paper prints.

Respondents noted that for large scale projects where independent Project Managers are employed by the client/tenant, then electronic documents are sent to them for updating. Upon handover of the job site, a digital file of all 'as-built' drawings and documents are provided to the Client/Tenant via the Project Manager for record.

4.10.3. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and Main Contractor.

Respondents attest to the fact that most Main Contractors, other than the ones involved in multi-million dollar architectural projects, are technology averse. Others do not have the financial resources or long-term foresight to upgrade their offices. Most site offices are set up on an ad-hoc basis. After completion of the project, the site office would be cleared. Most contractors would not bother to invest in any sort of digital highway setup to facilitate remote on site communication with the Interior Designer.

It is only the younger generation of contractors born in the late 1980's that would be more comfortable with technology. Most of them would carry a cellular phone with built-in PDA (Personal Digital Assistant) or laptop on site to facilitate drawing transmission on site. These files are generally 'read-only' files for hand held PDAs. Drawing files sent to laptops can be amended. Respondents mention that most contractors or their Clerk of Works would install Autocad LT on their laptops for minor amendments to plans, elevations and sectional details. All drawings at this stage are 2-D, there is no need for 3-D graphical software here.

With the small 'old timer' contractors, communication is through the use of the traditional paper medium.

4.10.4. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and Other Service Professionals.

All drawings are produced digitally and communicated electronically with professionals like Quantity Surveyors, Civil and Structural engineers, Mechanical engineers and Electrical engineers. Most drawings are in the 'dwg' format and Autodesk is the dominant player locally. There are compatibility problems with the exception of respondents # 9 and 10 who made mention that the earlier versions of Drawbase had problems reading Autocad files. There was information loss during the transfer. Paradoxically, Drawbase files were read by Autocad seamlessly with no information loss during file exchange. Mention was made that the current Drawbase software is an improved version with less problems.

Quantity Surveyors, on the other hand, do not use any sort of software to automate the upstream quantification activities to enable an automated down stream procurement of construction products and materials, partly due to the following reasons:

- 1) the very nature of interior design is such that every interior designer wants to outdo another with avant-garde designs, layouts, colours and use of materials. Their creativity lends to the difficulty in the standardization and formalization of the quantification of materials. Any 'weird' or outlandish construction details require that the quantity surveyor work out the actual costs manually. This is particularly true for retail design of specialty shops, boutiques, hospitality, residential and civic buildings excluding commercial office and mass housing which are repetitive. The egoistic nature of interior design makes it difficult to impose strict standards and guidelines across the board.
- 2) Each design detail in the various types of projects mentioned above except commercial office and mass housing differs from one to the other. There are no economies of scale at all. As such, the Quantity Surveyor finds it more efficient to perform manual 'take-offs' by scaling and measuring the drawing details from plans, elevations and sections to calculate the amount of materials manually. After that is completed, worksheets are filled up manually and the completed worksheets or bills of quantities are tabulated and typed up using normal spreadsheet software like Microsoft Excel.

4.10.5. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and Government Agencies.

At this stage of work, all submissions are required to adhere strictly to the cad layering naming conventions stipulated in CORENET²⁷. These sets of legislated standards aims to standardize the naming format of CAD layer and to recommend a set of layers for different disciplines in preparing their CAD drawings. Currently, all respondents confirm that for interior work, they do not adhere to these sets of standards drawn up for the architectural body as interior works involve less structural and wet works. Most work is purely decorative and non-structural in interior design, therefore, strict adherence to the layering convention only tends to complicate and increase the file size of drawings. Also interior designs do not have that amount of complexity that is required to design and construct a building from scratch. Currently, most of the respondents who are practicing architects tend to modify the cad layering conventions established by CORENET to suit their needs simplifying and reducing the number of layers and file size.

4.10.6. Frequency and Extent of the Proliferation and Use of Graphical Software between Interior Designer and Suppliers.

In Stage 6, all respondents affirm that only paper prints are provided to suppliers for calculating their bills of quantities. As aforementioned, the upstream automation of quantification cannot take place due to the very individualistic and creative nature of design, therefore uniformity and economies of scale in the ordering of materials cannot occur. Wear and tear and changes occur more frequently in interiors and after the project's completion, users change and move mobile items around without consultation with the Interior Designer. As such, most Interior Designers do not feel the need for strict housekeeping and updating constantly, a digital file of drawings with the suppliers code numbers and symbols or objects of their products supplied and installed on site.

The other reason being that Singapore is a very small market and the amount of sizeable and profitable interior design jobs are limited, as such interior designers tend not to want to provide digital files to suppliers for fear of leakage of confidential information particularly at the very early stages of the project when numerous Interior Designers are competing and vying for the same job.

Even after the job has been awarded, respondents affirm that at most times, paper prints are provided so that the supplier is not able to reuse the same plan drawing and provide a quotation accompanied by digital plan drawings from Interior Designer X that provided the digital file, of which the supplier had used the 'shell' drawing and replaced the properly laid out generic objects with the supplier's own library of product object to another Interior Designer 'Y'. For selfish reasons, this is to prevent the supplier from re-using the 'building shell' for another interior designer Y, who perhaps does not have the means to provide a digital drawing but the supplier is able to replace X's laid out generic objects by erasing it, and then putting Y's laid out generic objects onto the 'building shell' plan, thus providing a 'free' drawing at X's time and expense to 'Y'.

4.11. Responses to Questions for Section E Stage 7 Hardware and Software Wish List.

The one-on-one survey with each respondent ended with an open ended question ubiquitously, probing what they feel is needed, wanting or lacking in the current provision for hardware and software to support the needs of the interior design profession.

The responses from respondents are as follows:

4.11.1. Respondents' Desire for Hardware Development

²⁷ www.corenet.gov.sg

Respondents have indicated the desire to have

- (1) ²⁸larger CRT (Cathode Ray Tube) screens for work as the currently available ones at 21 inches are still far too small for use. The preference is for larger albeit slim line models for the desktop like the 21 inches flat panel monitor. Generally costs increases as the square of the diagonal length of screens. With higher pixels or dots per square inch, the power consumption is also higher. All respondents particularly those involved in purely design work and not drafting express the desire for dual screen system where users can work on files using two separate screens. But current graphical software in existence does not support the available hardware. This function is purportedly used in electronic manufacturing where existing software supports this function. The high price commanded by manufacturing design software is justified by its voluminous manufacturing base.
- (2) more economically priced LCD screens and plasma television screens as the resolution is truer to life and more accurate. The new technology for LCD screens allows for a lineup from 37" to 13" and offers crystal-clear images, lower power consumption, extended backlight life expectancy but at a price most cannot justify as compared to CRT screens.
- (3) more economically priced scanners. Currently top of the line scanners are US\$25,000 a piece and the cheapest is just under US\$10,000. These are large-scale scanners to scan commercial size A1 to AO paper drawings. There are cheaper ones that can go under US\$500 but they are useful only for scanning A4 size text documents.
- (4) printers and plotters which are more flexible as the ones available when plotting curvilinear line work produces printed line work that is not 'smooth' and 'stiff' looking.
- (5) cheaper printers for specialized use like printing drawings larger than A4 size. Printers that print A1, A2 and A3 size drawings are more expensive as compared to their counterparts that print A4 size drawings.
- (6) more economically price printer/plotter ink. Complaints about the current price of replacement cartridges are high and expensive. Majority of the respondents noted that with the use of refiller devices, costs be may be reduced but the quality of prints suffer. Refiller devices cause air bubbles in the existing cartridges and it affects the final prints as spurts of ink may appear in some areas of the prints.
- (7) better quality ink pigment has been requested by all respondents. Most ink media do not ensure life long plots as most tend to fade after a few years.
- (8) use of touch screen or stylus for design rather than the keyboard to simulate the human motion. All respondents involved in design work except respondent # 8 who is a Cad Manager, expressed their preference for a instrument or device likened to a sketch pencil. The hold would be more natural on the hand for sketching conceptual designs. They also preferred minimal use of the keyboard for any sort of data entry for conceptual design work, if not at all. ²⁹Currently the keyboard and the mouse is a cheaper option than the stylus and digitizer board as it is used by the masses to input data. Designers prefer the stylus method as they tend to 'doodle' whilst thinking and prefer 'human-like' instruments that allow for the 'sketching' motion.
- (9) faster processing chips for quicker turn around time when rendering animations. All respondents profess the need and urge for even faster processors to handle the generation of animated renderings for the initial stages when presentations of the conceptual spaces are done.

²⁸ [35].

²⁹ [42].

Most respondents have expressed that they are not connoisseurs of hardware. They feel that what they own currently is sufficient for their use professionally. They also feel in general that hardware developments have not paralleled the speed of software developments, therefore any added features found in graphical software is rendered useless unless hardware costs are lowered as current prices for peripherals and accessories are high.

4.11.2. Respondents' Desire for Software Development

Most respondents have indicated a preference towards the use of the manual methods of conceptual design using tracing paper and the sketch pencil.

- (1) ³⁰They want software that can facilitate pure design work by imitating the manual motions of the human hand in design. But currently, almost all the graphical 3D conceptual design program that is not meant for 2-D drafting use but one that is intuitive and more accessible. There is the expressed desire for a program with an interface that allows users to simply draw up the edges of the design model in 3D, just like they would be using pencil and paper and then allowing intelligent inferencing capabilities to automatically determine the nature of the lines and 'fills' shapes to create 3D geometry. This approach to 3D is more natural for the respondents used to traditional media as it allows a freer, looser and more exploration, as is the nature of conceptual design and drawing.
- (2) They want automatic scanning software
- (3) They want software that allows for multi-user mode without accidental overwriting of drawing files.
- (4) They want the possibility of a totally integrated software package that would accommodate the forward and backward integration of all aspects of the interior design process without having to use plug-on software as patches for the weaker or lacking areas in any particular package. This need is expressed very much by respondents # 9,10,11 and 12, all either 'one man operation' or small outfits, where employing an extra mouth means overheads. Currently, no graphical software is able to meet the needs of all the work processes in all the stages of interior design. Even Autodesk is not integrating all its various packages. It prefers to acquire other independent software companies to add on to its present stable of products, rather than re-invent the wheel. The need is for a software that allows changes in any one stage of the interior design process to be reflected and automatically updated in all the other aspects of work. For example, a change in the 3-D modeling perspective view of the exterior windows is reflected automatically in the sections and elevations by the software having the intelligence programmed inside to update the other aspects of detail drawings. This is not possible as the probabilities of millions of combinations of colours, material specifications and constructional details would make it impossible for any software company to include that in its coding, particularly for interior design where every Interior Designer wants to be different and unpredictable.
- (5) the prohibitive cost of acquiring such a totally integrated package if available, should be affordable. Currently, all respondents including respondent # 8, a professional Cad Manager, have commented on the continuously upward spiral in the costs of their yearly subscription for the maintenance and service contracts that they have with their respective software vendors. Ever so frequent, the previous edition of the graphical software that they use is updated with supposedly new patches. In essence they are similar to the previous edition patches. Most of these features and functions soon become 'white elephants'.

³⁰ [36].

Chapter 5 Conclusions, Recommendations and Critical Evaluation

5.1 Introduction

Based on the results from the survey done with the thirteen respondents, we have obtained a fair idea of whether the current CAD/CAM packages can meet the needs of the market and the gaps amongst the various packages can be evaluated against the light of this revelation.

From *Appendix B*, a list of the various brands of CAD/CAM packages used by Interior Designers, we can see that not one single package can cater for all the requirements and needs of every stage in the interior design process. Each package must be evaluated on its merits and demerits. Its' merits is reflected in its dominant and frequency of use by Interior Designers in that particular stage of the interior design process. It is not the aim of this survey to evaluate the all the features of every package but to compare the software wish list drawn up in Chapter 4 by the respondents against the salient packages existing, new or in development that might meet their stated requirements.

We were able to obtain ³¹test copies of some the CAD/CAM graphical software mentioned in *Appendix B*. In some cases, access to demonstrations by the vendors of the graphical software package was given. Other information with regards to the features and functions of the other brands, were obtained online from their respective websites. Information with regards to Beta versions are obtained from on-line resources from the software manufacturer's website. Hence this evaluation has to be taken at this face value.

5.2. Extent to which Existing Packages Meet Needs of Market and the Gap (if any) amongst Existing Packages

Clearly not all packages meet the needs of Interior Designers at every stage of their work, clearly some packages work best for only one particular stage of the process while others perform better at general multi-task functions.

As seen from *Diagram 2.5.1.in Chapter 2*, the existing packages in the market can be categorized into the three major groups to reflect their current status of utilization. Respondents say that not all of these existing packages meet their needs at every stage. Most of them are specialty packages in many ways with strengths and weaknesses in niche areas.

Based on the copious feedback from respondents, their views concur with that of our *Diagram 2.5.1* of how the various CAD/CAD software packages in use can be categorized into 'use' patterns that can be broadly defined by the 3 phases of interior design.

- (1) In the 1st phase, where 3-D conceptual designs and sketches are put up by the 'thinkers' and creative personnel, all respondents excluding respondent # 8, the Cad Manager, use the manual method of pencil and paper. No mention has been made of the use of CAD software. It is only when the sketches are put to the draughtsman for visualization, then is CAD graphical software used.

So far there is no package available yet that can emulate this human function. The closest package would be ³²Sketchup. There are problems associated with the use of Sketchup. Beyond the 'sketch' and 'doodle' function, Sketchup performs marginally in other areas. It allows the export of sketches done in 3-D to basic 2-D outline plan, elevation and section drawing with little else to offer.

³¹ [52, 53]

³² [32]

After exporting, the user has to import the 'dwg' file into either Autocad or other CAD packages for producing working drawings or to ³³3D Studio Viz for presentation visuals. As such, Architects who are experimenting with the use of Sketchup, discovered that they still would have to buy or retain their existing use of 3D Studio Viz for visual presentation to Clients and Autocad or other packages for construction drawings and details.

³⁴Vue D' Esprit is an exterior landscaping animation software used to enhance the interior visuals produced by 3D Studio Viz.

The only CAD package that comes closest to performing all of the above functions with some tweaking required is ³⁵Micro GDS, but the learning curve for new users is long as it is not a very intuitive software, in addition to its prohibitive costs.

In the long run, users still prefer to maintain the time tested traditional pencil and paper methods for sketch design and concepts and leaving the details of the work in the 1st Phase to be drawn up and presented to clients using visual animation and presentation CAD packages like Vue D'Esprit and 3D Studio Viz and in the 2nd and 3rd Phases, 2-D drafting packages like Autocad.

Clearly gaps do exist and are apparent amongst the listed packages in terms of features and functions but not prices for the 1st phase. For example, respondents find that despite the high costs of 3D Studio Viz, it produces better quality output for presentation to the client. Compared to cheaper software like Sketchup, which performs a different function. It is a quick sketch and design software with limited features for razzmatazz presentation. 3D Studio Viz produces more sophisticated presentation visuals. Prices here cannot be used as an indicator of quality of the CAD packages in the 1st Phase list as not one single CAD package can perform the total sum of the all functions required. There is no comparison to be drawn here amongst all the packages as they are all clearly different in what they can offer to the user. The clear gaps that exist amongst them are in the areas of functionality, features and use. They cannot be compared as like-for-like in terms of price points.

- (2) In the 2nd phase, drawings are hard lined. Autodesk's Autocad is the overwhelming brand of choice here. The users here are the draughtsmen, who take instructions from the respondents in the 1st phase. In 'one man operations' or small outfits, they tend to be one and the same persons. To reduce interfacing and incompatibility problems between the software used in the 1st phase and 2nd phase that may arise, if they were different, respondents would insist that personnel in the downstream follow and use alike or the same products as in the upstream.

Here, Autodesk's products seem to be de rigueur and de facto industry standard.

Other alternatives are available with 'dwg' file extensions, but respondents agree that most local users tend to stay with Autocad for 2-D drafting as it has been time tested and supported regionally. There are many competitors in this 2nd phase where drafting only software floods the market. As the functions required of 2-D drafting products are very straightforward, new entrants to this 2nd phase of the interior design process find low entry barriers to the creation of such packages to be sold commercially.

In **Appendix B**, are some of the more popularly used packages mentioned by respondents used for drafting purposes. There are clear gaps even amongst these packages. For example, if the work for which the software is required to update and perform amendments to drawings only, then Autocad LT would clearly be sufficient

³³ [30]

³⁴ [33]

³⁵ [20]

for that purpose. Paying for the full Autocad package or even Autocad 2D package would be an ‘overkill’ as not all the features and functions would be maximized to justify its costs. From *Appendix B*, for the package most akin in proximity to the features and functions found in Autocad, ³⁶Intellicad and ³⁷Fastcad are the ones. They are also attractive in price but paradoxically, it does not command the market leader position in Singapore. The place of honour still belongs to Autodesk’s Autocad, albeit its high price as compared to the rest of the packages in the same league.

- (3) In the 3rd phase, where detailed construction drawings and bills of quantities of materials are used, Autodesk’s Autocad is lacking in auto-generation of the bills of quantities.

From respondents’ feedback, it seems all the software packages available in the market are rather lacking in the ability to churn out bills of quantities related to drawings. The reason being that there is an absence of an international body governing building requirements and statues. Most governing bodies are regional rather than international. Different countries have their own accounting systems for quantity take offs depending on what they have inherited from their predecessors. For example, Singapore being an ex-British colony uses the metric system for building construction but modifies the building standards and statutory requirements due to environmental differences. It does not adopt the United Kingdom system totally. According to the vendors of CAD software packages that the writer has spoken to, it is difficult to create a true database that is attached to the drawing file that automatically generates a bill of quantities when a drawing is drawn up. The multitude of possibilities due to the differing standards from country to country makes it difficult for software creators to incorporate all the possibilities without creating large files with millions of lines of codes.

Although there are some databases created for the more sophisticated packages like Micro GDS but they are more generic than ethnocentric. As Singapore is very low volume market, no software manufacturer in its right frame of mind would create a specialty database for it. This is unlike the electronics or automobile industry where high volumes and world markets prevail.

SIACAD Private Limited, a Singapore incorporated body affiliated with the Singapore Institute of Architects have researched and created a database of building product specifications, as an ‘add-on’ resource for Architects. At the time of submission of this dissertation, the development is still on going. The database is used by Architects to draw up bills of material to accompany their construction drawings as the building products specification database concerns mainly exteriors, structural and wet works of new buildings.

For simple drawing amendments and updating on job sites, ³⁸Autocad LT seems to be the package of choice due to its good pricing and ease of use as Autodesk has streamlined it to make it user friendly.

5.3. Availability of Clear ‘Best Buys’ Among Packages Considered.

There are no new virgin markets in Singapore. It is a niche market, where most respondents use Autocad by Autodesk, for all intents and purposes. The product meets general needs albeit rather unsophisticated. For more specialized tasks, it cannot meet the mark. The Singapore market is dominated by small number of brands. Due to its low volume market, a mass market is not available, therefore, profit margins are eroded constantly. New comers are reluctant to venture

³⁶ [24]

³⁷ [23]

³⁸ [28]

into the Singapore market let alone tackle the South East Asian market which is not homogeneous and would require huge resources. As such, new software manufacturers are reluctant to take on Autodesk directly or indirectly, who has been around for umpteen years. Software creators rely mostly on distributors, resellers or representatives who may not do as good a job, as they wear different hats and represent other products simultaneously.

Clearly, there are still some considerable 'best buys' amongst the packages evaluated. Based on respondents' feedback, for the 1st phase, sketching and 'dodding' conceptual sketches, Sketchup is considered a good buy and value for money.

For visualization purposes, Autodesk's 3D Studio Viz is time tested and reliable. Most respondents prefer a product that is well-supported by its parent company, despite its hefty price tag.

For the 2nd phase, most respondents consider Autocad LT for simple drafting of 2-D plans, sections, elevations and construction details, drawing amendments and updating, as a good buy, without having to pay for the full package of Autocad. Autocad LT is deemed sufficient here. Unless there are multi-level users and the projects are large public sector items, then the more sophisticated packages like Micro GDS would be more appropriate.

For the 3rd phase, Autocad LT is considered a 'good buy' as most respondents emphasized that till to date, all budgetary costings are created on spreadsheet software like Microsoft's Excel, hence they do not see the necessity of a CAD software package tied in with a database. Most of the electronic drawings produced and needed to be updated here are in 2D mode, so unless a multi-user level platform is required, Autocad LT seems to serve its purpose here.

5.4 Perception of Prices of Packages by Customers.

All respondents interviewed for this survey are well informed and educated customers. They do not equate high prices with useful features and functions, nor do they expect 'bells and whistles' from packages costing under US\$300 as the old saying goes; 'pay peanuts, get monkeys'. For a software package priced at a certain price point, all respondents are reasonable customers, they know full well what to expect.

For the small one man operation and the 'quick fix' and 'fly by night' Interior Designers cum contractor companies, the writer made a quick telephone survey to some of these operators to elicit their informal opinions.

Most of them use pirated copies of Autodesk's AutoCad software packages which are easily available. They 'kick start' the process by obtaining pirated copies and upgrading to the original version only when the business is out of the 'red'. To circumvent the anti-piracy laws, those that can afford it, will buy only one copy of the original software. This group of businessmen operating under the guise of Interior Designers perceive the prices of software packages to be 'ridiculous' for something that is intangible. Thankfully, our respondents on the formal interview circuit do not share similar views.

Respondents who are sole proprietors and owners of small outfits feel in general that 2-D off the shelf CAD packages priced below US\$1000/- are affordable and sufficient for the size of their present operations.

All the respondents on our survey using Autodesk's software have grouses about the yearly subscription rates that they have to pay to their resellers in order to obtain regular patches and updates that Autodesk insists, are useful. Most respondents complain that the updates would provide features and functions that are not useful nor groundbreaking. For an idea of the subscription rates amongst the various brands, reference can be made to ***Appendix B.***

5.5 Recommendations in critical areas of requirements

5.5.1 Automatic Scanning Software

The rule of thumb is, that higher the resolution of the paper drawing, the slower the scanning speed, the better the scan and vice-versa for low resolution drawings. High resolution drawings require large file sizes which take up more storage space, take longer to load into software and

longer to process. The files can be compressed but compression increases the time it takes to load and save raster files.

All scanners would include software that adjusts the image for minor imperfections like skewing where the drawing was not fed through at precise right angle, adaptive thresholding where it automatically creates the highest contrast between light and dark areas and cleaning up detritus or imperfections in the paper drawings. Although the included software may have the capability to correct the above mentioned problems, still, there exists some more problems where additional software purchases are necessary to clean up, print, archive and retrieve the scanned drawings. Scanning software performs the automatic and manual functions.

Automatic means that the software will try to do its best to do the work itself and manual means that the CAD operator has to perform the task manually. Respondents have asked for a fully automatic graphical software to do the job which currently is unavailable. Most methods involve a combination of automatic and manual. Most of the raster editing software available comes in three styles namely stand-alone³⁹, batch mode⁴⁰ and CAD environment. The software that operates in the CAD environment allows one to mix raster images and vector drawings. But currently, most CAD packages can only load and display raster images but do not provide any raster editing tools for correcting scanned images, hence there is need for such a software. Even if the scanner can process drawings of unlimited length, the problem with such a feature is that there is the other problem which exists, a limitation to computer memory to store the large files which leads to the next problem.

⁴¹Most raster formats are stored in GIF (graphic interchange format). GIF has small files without losing details or adding artifacts around text and lines. JPEG can compress large files but the compression has side effects in that it creates artifacts which are unwanted additions to the image. Artifacts are not noticeable in digital photographs but are visible in line drawings, hence one never uses JPEG file format to store drawings. Other alternatives to these two include TIFF, PNG and RLE.

CAD's most perplexing problem of feature recognition has yet to be solved, such that it is possible for software to automatically convert a scanned manual drawn image into an accurate vector CAD file. What happens during scanning is that the raster scanner contains a row of light sensors to read light (paper's background) or dark (a drawn line) and most scanners sense up to 256 relative levels of light and dark (levels of gray). Hence the resultant data is a mixture of values, dark and light. It is then up to the computer software called 'raster to vector converters' to make sense of the dots. The software, according to respondents, that exists today can even determine lines and arcs, recognize text and even reconcile dimensions but it is done through a combination of automatic and manual methods. The existing software cannot recreate the layers, attributes, colours, database links and line types.

An alternative solution rather than hoping for a new software to appear, respondents have resorted to the use of external service CAD bureaus to input drawings into electronic format for them. CAD bureaux perform tasks like

- scanning drawings with a scanner
- digitizing the drawings by hand if the software reads only rudimentary patterns amongst the dots
- do extensive post-conversion editing on the vectorized drawing within the CAD system

In a nutshell, all data that you find on paper drawings cannot be totally digitized to electronic copies- nor they ever will be through raster to vector conversion process. We can safely conclude

³⁹ This software reads a raster file for editing, which is saved after editing.

⁴⁰ This software allows one to set up the cleanup parameters, then it reads raster files in a subdirectory or folder, processes all at one go and saves the final result.

⁴¹ [45]

till today, there is not a single software package that meets the automatic raster to vector conversion process that interior designers desire, and nothing so far known comes close.

5.5.2 Multi-User Mode

This is a highly desired function mentioned by most respondents on the survey, especially on large scale projects with many users, multi-user capabilities allow many team members to work on the same drawing at the same time without conflict. It permits working from different sites. This simultaneous multiple user access via independent locks per layer permits greater flexibility for interior design as respondents have indicated at times, when project datelines are looming too close for comfort, freelance help can be sought and this is where the multiple user mode is critical to prevent accidental overriding or erasure of files.

Many a times, freelancers who are employed by interior design outfits to help out with tight schedules, are not familiar with the filing extensions and systems of their employers. Most respondents who work with freelancers have encountered problems, where more than one freelancer working on the same project will at one time or other override the other party's file by accident. With the normal out of the box CAD/CAM graphical software, this multi-user mode feature is not included. It is found only at the upper echelon of the CAD/CAD market in brands like Micro GDS, Microstation and Archicad. The price differential between these mentioned brands as compared to the others without the multi-user mode is rather wide as it can be seen from **Appendix B**.

What remains to be seen is that if this multi-mode feature is a 'must have' in any interior design outfit. 9 out of the 13 respondents interviewed, are currently using Autodesk's Autocad software. The opportunity costs of sacrificing their current licenses, lost man hours for re-training of staff should a new software be acquired for this multi-user mode feature, the long learning curve and increased costs of new licenses, it might not be worth the trouble. The present manual electronic filing systems which most respondents have confirmed are tweaked in such a way that users would be made aware that someone else is viewing the same file with a 'pop up' screen which provides the warning to users. Here only one person can save the layer of drawing at any one time. As the saying goes, 'don't fix what isn't broken'. Most respondents prefer to stick to this manual electronic filing system than pay more, unless the multi-user mode feature comes bundled together with the cheaper below US\$1000/- softwares.

5.5.3 Intuitive 3-D Conceptual Design Software

Most respondents have highlighted that the present CAD/CAM software tools are merely drafting instruments for 2-D and 3-D drafting. All respondents except the respondent # 8 who is a CAD Manager, preferred intuitive software that resembled very much the way Interior Designers would sketch and draw conceptual sketches. This phase of design has always proved to be elusive to software providers. What has been lacking in the digital realm has always been support for conceptual design, an activity that is typically carried out in a fast paced, personal 'conversational' setting between a Designer and his Client to create a series of sketches, through the medium of soft pencil on paper.

⁴²Freehand-like sketching has been made possible with pixel based 'paint' software like Photoshop and Macintosh CAD software like PowerCADD but the conventional software for the DOS or Microsoft Windows Operating System still has a long way to go in catching up with these developments. Autocad, Archicad, Microstation and MicroGDS have not incorporated this sort of technology for freehand sketching digitally.

The transitional stage from freehand-sketching to CAD technology has not been worked upon and developed. Until recently, Autodesk, in their efforts to bridge that transition to create a digital environment that is more user friendly and accessible to Interior Designers and those that prefer the pencil sketching methods, Autodesk has introduced Architectural Studio to address this problem.

⁴² [45]

In paper-based design studios of yore, most respondents would draft their sketch layouts over manually drafted existing floor plans, photos or over another freehand sketch as an underlay. Normal CAD software does not allow this to take place. Architectural Studio professes to take care of this earliest schematic and conceptual design phase, which all of the respondents in this survey desire, that until now, have not been entirely computerized.

What it does is that it allows for the creation of initial 3-D conceptual designs, rather than the detailed rich mathematically enhanced exact models that are created in full-featured CAD programs used to construction blueprints. CAD programmes presently do a wonderful job of automating the creation of blueprints but is not suited for the concept stage which is still done mainly with pencil and paper.

The beta test copy available from online resources lay claims to possessing the benefit of being simple to learn because Designers can use graphical on screen tools like pencils, knives, erasers, pens, markers, brushes and tracing paper that mimic the actual tools designers use manually at the drawing boards. One can draw a line which increases or decreases in dimension and that is reflected immediately.

The set of 3D tools provided can be squished, combined, carved or dragged into place on a 2D background. It is also possible to extrude 3D shapes from 2D drawings and 2D drawings can be used to mark up the surfaces of 3D objects. Snapshots of 2D or 3D work produced in this software can be digitally pinned up in the workspace as thumbnails for future reference and handy access or they can exported to other software for refinement as rendered images or production drawings. Drafting work and models from other design software from Autodesk can be brought into Architectural Studio for editing or as backgrounds for additional sketches and studies. Photographs, scanned images, site plans and other materials can also be brought into the workspace for reference or as backgrounds, like the way interior designers normally work in non computerized design studios. Architectural Studio supports the use of digital tablets, flat panel monitors with digitizer pens and stylus pens that emulate a traditional sketch pad.

The only setback is the cost of the hardware and the size of the screen needed for drawings larger than A3 size. The costs for Architectural Studio accordingly to Autodesk, at this point in time is about US\$1000 per user, with additional US\$600 annual fee for real time collaboration services. Architectural Studio is totally compatible with the other Autodesk products, at press time release when we spoke the Autodesk representative in Singapore. The product is not available in Singapore currently, as Autodesk Singapore does not see a viable market for it. The reason for this is that labour costs are lower in Asia on the whole as compared to the west, therefore, it does not make sense that architectural and interior design outfits in Singapore and the rest of Asia would automate the conceptual design stage of the interior design process. Resistance would prevail, as owners of design outfits would work out the dollars and cents of buying a licence for software that professes to help in the conceptual stage of design but still cannot totally automate it by translating it to reliable blueprints for construction as manual touch ups are still required using other add-on packages.

As compared to Architectural Studio, the only other package that comes close to providing the 'quick time' sketch features requested by respondents would be Sketchup from Informatix Software International, which is a 3D modeling software that has a '3D Painting' programme called Piranesi incorporated in it. The '3D painting' technology allows one to quickly fill in the the missing details using photorealistic and hand drawn effects. The company targeted Sketchup with Piranesi, according to its Director of Product Design Yasser Malaika 'the simplest, most elegant solution for creating 3D content. Its attractive price tag of US\$538 as indicated in *Appendix B* has made it the most attractive buy for many 'one man' operation and small interior design outfits.

SIACAD Pte Ltd, the software arm of the Singapore Institute of Architects is currently promoting this software to Architects and Interior Designers in the hope of providing a cheaper alternative to Autodesk's products and displacing the stronghold that Autodesk has on the market.

The only set back for Sketchup despite its attractive price tag is its lack of certain features like controlled lighting (it has only daylight lighting for all countries in the world) and limited translation from 3-D modeling to 2-D blueprint features. Without the controlled lighting feature, its use is very limited to only outdoor and simple interiors. Retail, hospitality, resort or entertainment interiors that require the play of lighting would not be suited to the use of Sketchup. In addition, for large scale projects, the direct translation of 3-D models to 2-D plans and elevations are very limited, only the basic outline would be produced. A lot of details like dimension lines, material thickness and other construction details would still have to be drawn up using conventional 2-D drafting software as plug-ons.

5.5.4 Forward and Backward Integration Software

As mentioned, all respondents have stated a preference for a totally integrated software package that is economically priced below US\$1000/-. One that would cater to changes made at any stage of the interior process, the changes be reflected and updated throughout the files. There does not exist any economically priced CAD programme that caters to all the stages of the interior design process, not to even mention, a package that can allow changes in one stage of design to automatically update its other files in the other stages of the design process.

So far, only the high end packages like Microstation, MicroGDS and ⁴³Archicad currently available in the Singapore market are able to automatically update changes from the upstream and downstream end of the design process but excluding the conceptual design stage. But it can be seen from *Appendix B*, that initial single user licence costs and subscription rates for these three packages are rather high as compared to the other pared down version of CAD programmes which takes care of only the downstream 2-D construction blueprint stages of the interior design process.

5.5.5 Compatible File Formats and Common Standardized Classes

All respondents have lamented about the state of total infidelity between CAD programmes as the Autodesk DWG format becomes the de facto standard CAD file format for the architectural and interior design industry. In the past, the DWG file was not totally documented by Autodesk and only the DXF, the IAI's IFC, Spatial's ACIS SAT and other documented formats are available openly that can represent drawings created by AutoCAD but not with one hundred percent fidelity.

What has been done in the past years, was the massive effort in reverse-engineering by third party developers in creating toolkits for DWG files with APIs. These toolkits eliminated the need for intermediary formats like IGES and DXF. But still the openDWG alliance formed by Visio, would provide free access to the APIs to any member of the alliance for use, provided that they report anything they figure out about the still unknown code sections of the DWG file format. So far to date, most parts of the DWG format has been figured out except some areas, so one hundred percent fidelity is out of the question. Respondents who are ⁴⁴Drawbase users report that there are still eccentricities when DWG files are imported from AutoCAD to Drawbase, the files in Drawbase would still have some information loss. This data loss does not apply in the reverse situation when Drawbase files are read within AutoCAD.

Respondents have complained of some CAD software using proprietary file formats and customer lock-in as defensive weapons, thus causing even further data translation problems due to their complexity and proprietary technologies.

⁴⁵The use of objects has compounded the problem further with the use of Objects in CAD software like walls, doors and windows, in an attempt to create an intelligent real world where one is no longer limited to drawing lines, circles and arcs. These objects are defined with a number of variables and processes. For example, when you invoke the 'wall' command in an

⁴³ [25]

⁴⁴ [26]

⁴⁵ [8]

object modeler, the class definition of wall is called up. The type of wall is entered – brick or gypsum, height, length and thickness. Once the CAD object is created in the database and another object ‘window’ is introduced, the built-in behaviour (process) of both the objects, the wall and the window interact in a meaningful way. Each real world object is controlled by a small sub-programme called the parent application. The parent application holds the behavioural intelligence to each instance of that object, a single pane window behaves and interacts differently with the wall, from a double pane window.

The use of objects means that drawings not only represent objects, but it has the ability to model and analyze with intelligent feedback. The graphical interface relies on vectors as its primary representation and the benefits are enormous as these objects are pre-programmed to interoperate with each other providing greater productivity. For example, when one inserts a window into a wall, one just clicks and points, with all finishing details handled by the respective parent applications, to your specification. If one wants to remove the window, one simply grabs and moves it and the wall repairs its automatically.

The problem with the use of objects is that the pre-programming of the objects may differ amongst the various CAD programmes. The task of defining the classes of everything that goes into a building is near Herculean. Sometimes, objects when transferred from one CAD programme to another, may not behave the way that you intended it to. Exchanging object information between different CAD systems for example Drawbase, Revit and Autocad, object problems which include geometry, behavioural intelligence, annotated product information and relationships occur in the exchange process, not only the x, y and z vector information, line styles, layers and colours, which currently still exist.

Take the case of Revit, which was bought over by Autodesk at the beginning of year 2003. When this researcher was shown a demonstration of the Revit software at the Autodesk re-seller’s offices, it was discovered that AutoCAD’s files when imported into Revit for use, created problems. The DWG files would be imported, exploded and amended in Revit, but when re-exported out back to AutoCAD, all the line styles and layers would be lost. But when Revit’s RVT files are imported into AutoCAD, there is no information loss, as Revit works only on a single layer for all its objects.

At this point, the Autodesk reseller told this researcher, that Autodesk is in the midst of trying to integrate the ability of file exchange between Revit and AutoCAD. This is to complete their stable of products to be able to compete with high end integrated packages like Microstation or MicroGDS, with its multi-user platform and ability to update changes from upstream all the way downstream for the various stages of the interior design process. In addition, Revit possess the quick sketch and draw abilities of conceptual design CAD software like Architectural Studio and Sketchup and has the ability to take care of downstream mundane activities like producing construction 2-D blueprints. The patch for file exchange between Revit and Autodesk’s products is currently under development.

As different standards prevail globally, even as this survey is being written, CAD vendors are trying to develop more object based models for their packages. The chances of data being passed from one company to another and being exchanged gets more remote as each company strives to be different from the other. The only hope that the CAD industry has for cross-platform, object-based solutions that will allow data exchange between companies lies in the international bodies like IAI (International Alliance for Interoperability) who are trying to develop a set of common standards like IFC (industry foundation classes) which is still slow in completion.

5.6 Critical Evaluation of Survey

This survey paints a largely true and representative picture of the state and extent of automation in the interior design industry. The sample is not large enough to make definite conclusions. It is not a statistically accurate reflection in terms of trying to determine the market shares that the various brands of CAD software have in Singapore, but it hopes to present a poignant picture

about the true state of affairs of the level and frequency of digital and electronic automation in the various stages of the work processes of interior design.

The number of respondents were drawn from a pool of varying experienced individuals with rather different academic and professional resumes, providing a wider breadth of views rather than narrowing it down to Interior Designers who specialized in a particular interior design sector, for example retail only.

New CAD software creation and development is in a state of flux as the Singapore and the Asian markets are not homogeneous or voluminous enough to warrant to entice software developers to make changes to suit the local context.

If this researcher were starting over again, on hindsight, she would have approached the work differently by increasing the sample size, analyzing and examining the results according to the various design sectors, for example retail as opposed to commercial design, as these two sectors have slightly different needs in their CAD software requirements. This approach could only take place if she had had more resources, like the luxury of time and finance. The results would definitely be significantly better and more precise.

Another approach that this researcher would have like to have taken would be to investigate and examine the differences in needs amongst 'one man' operations, small, medium and large-scale interior design outfits. The differences in attitudes and profiles of an Interior Designer who is the entrepreneur/ employer/ boss of the company and vis-a-vis one who is simply an employee. Their differences in status quo would definitely have an impact on their wants and needs from their CAD packages. It may seem on first impression that the 'one-man' operation and small outfits would not consider investing in a totally integrated package even if one was available as they may not have projects with the economies of scale to justify the returns of such a purchase. But on the flip side, they may even throw caution to the wind and invest if they calculated the costs of man-hours savings and that the benefits outweigh the initial set up costs. An understanding of the buying motives due to their status quos would fuel further interest into another area of research which time does not permit here.

Other areas of interest for future research would include areas like remote access to CAD files on site, the ⁴⁶provision of CAD services on the world wide web and the Internet and the latest 'bluetooth' technology that would enable data files to be streamed over the air waves to 3-G (third generation) cell phones.

⁴⁶ [54]

Bibliography

- [1]. Danaher, Simon. (2001). *Digital 3D Design*. Watson-Guption Publications, New York
- [2]. Singapore Institute of Architects. (2002/2003). *Singapore Institute of Architects Yearbook 2002/2003*. Singapore Institute of Architects, Singapore & Angsana Press, Singapore.
- [3]. Singapore Institute of Architects. (2004). www.sia.org.sg
- [4]. Ministry of National Development, Singapore & Building and Construction Authority, Singapore. (2004). *Construction & Real Estate NETWORK*, www.corenet.gov.sg
- [5]. Li, Sun. (2000). *An Information Model for Construction Site Intranets-A Thesis*. Department of Civil Engineering, National University of Singapore, Singapore.
- [6]. Douglas P. Susan & Craig C. Samuel. (1983). *International Marketing Research*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632.
- [7]. Easterby-Smith, Mark; Thorpe, Richard & Lowe, Andy. *Management Research: An Introduction*. (1991). Sage Publications, London, Newbury Park, New Delhi.
- [8]. Grabowski, Ralph. (2002). *Cad Manager's Guidebook*. Onword Press, Thomson Learning, New York.
- [9].Autodesk. (1993,1995). User's Guide Autocad LT Release 2 for Window. April 12, 1995, Autodesk, USA
- [10].Beall, E. Michael & Fulmer, M. Howard. (1997). AutoCad 14 Fundamentals. New Riders Publishing, Indianapolis, USA.
- [11].Autodesk. (1993). AutoCad LT for Windows User's Guide. Autodesk. November 22, 1993, Autodesk, USA.
- [12]. Autodesk. (1994). AutoCad Release 13 Customization Guide. September 13, 1994,Autodesk, USA
- [13].Autodesk. (1993-1994). AutoCad Release 13 Documentation Guide. September 21, 1994, Autodesk, USA.
- [14].Autodesk. (1992-1994). AutoCad Release 13 Installation Guide for Windows. November 2, 1994, Autodesk, USA.
- [15].Gesner, Rusty & Autodesk. (1993). AutoCad LT for Windows Tutorial for Architectural & Mechanical Design. November 5, 1993. New Riders Publishing, USA.
- [16].Autodesk. (1993-1994). AutoCad Release 13 Command Reference. September 17, 1994, Autodesk, USA.

- [17]. Autodesk. (1993-1994). *AutoCad Release 13 Learning AutoCad for Dos and Unix*. September 16, 1994, Autodesk, USA.
- [18]. Autodesk. (1993-1994). *AutoCad Release 13 User's Guide*. September 15, 1994, Autodesk, USA.
- [19]. Singapore Institute of Architects.(1996). Conditions of Appointment and Architect's Services and Mode of Payment. 3rd Edition, September 2002, Singapore Institute of Architects.
- [20]. Informatix Software International. MicroGDS. <http://www.informatix.co.uk>
- [21]. Bentley Systems Incorporated. MicroStation. <http://www.bentley.com>
- [22]. VectorWorks. VectorWorks. <http://www.nemetschek.net/sales/international.html>
- [23]. Evolution Computing. FastCad. <http://www.fastcad.com/n-intl.shtml>
- [24]. IntelliCad Technology Consortium. IntelliCad. <http://www.intellicad.org/members/memberlist.asp>
- [25]. Graphisoft U.S. Inc. ArchiCad. <http://www.graphisoft.com>
- [26]. Graphisoft U.S. Inc. DrawBase. <http://www.drawbase.com>
- [27]. Autodesk. AutoCad 2004. <http://www.autodesk.com>
- [28]. Autodesk. AutoCad LT 2004. <http://www.autodesk.com>
- [29]. Autodesk. Revit 5. <http://www.autodesk.com>
- [30]. Autodesk. Autodesk Viz 4. <http://www.autodesk.com>
- [31]. Autodesk. Autodesk Architectural Desktop 3.3. <http://www.autodesk.com>
- [32]. SketchUp. SketchUp. <http://www.sketchup.com>
- [33]. E-on Software, Inc. Vue D' Esprit 4. <http://www.e-onsoftware.com>
- [34]. Ringen, Jonathan. (June 2002). Visions of Light. <http://www.metropolismag.com>
- [35]. Hernandez, Jr., Tomas. (2003). Looking at Display Devices. <http://www.architecturalrecord.com>
- [36]. Novitski, B.J.. (8 May 2002). Autodesk Goes Conceptual. <http://www.ArchitectureWeek.com>
- [37]. Evans, Pete. (8 May 2002). Exploring a Virtual Future. <http://www.ArchitectureWeek.com>

- [38]. Laiserin, Jerry. (2003). Digital Product Reviews: Autodesk puts “ design” into CAD. <http://www.ArchitecturalRecord.com>
- [39]. Konicki, Steve. (Feb 12 2002). Design Collaboration Gets Real-Time Boost. <http://www.InformationWeek.com>
- [40]. Becker, David. (Feb 12 2002). CAD Loosens Up; Architects Get Sketchy. <http://www.CNETNews.com>
- [41]. Leon, Mark. (Feb 8, 2002). CAD Goes Mouseless. <http://www.InfoWorld.com>
- [42]. Laiserin, Jerry. (November 2002). The Pen is Mightier than the Mouse. <http://www.PennWell.com>
- [43]. Day, Martyn. (16 Nov 2002). Architectural Studio-Preview. <http://www.cadserver.com>
- [44]. Ferris, Sara. (July 2001). Where’s the Revolution? (Industry Trend or Event). <http://www.cadalyst.com>
- [45]. Campbell, Marc. (2002). The Complete Idiot’s Guide to Computer Illustration. Pearson Education, Inc, USA.
- [46]. Sun Microsystems. (1994-1996). Sketchpad: The First Interactive Computer Graphics Ph.D. Thesis, 1963 Massachusetts Institute of Technology. Sun Microsystems, Inc., CA, USA. <http://www.sun.com>
- [47]. Leong, Pik Yin. (July 21 2003). Home Renovations: It’s a Jungle in There. The Straits Times, Singapore. <http://www.sph.com.sg>
- [48]. Walker, John. (4th Edition, 1994). The Autodesk File. Autodesk, USA. <http://www.autodesk.com>
- [49]. Weaver L. Philip, Lambrou Nicholas & Walkley Matthew. (1998). Practical SSADM Version 4+ A Complete Tutorial Guide 2nd Edition. Financial Times Management, Pitman Publishing, London, United Kingdom.
- [50]. Avison D.E. & Fitzgerald G.. (1997). Information Systems Development: Methodologies, Techniques and Tools. McGraw-Hill Book Company Europe.
- [51]. Bott Frank, Coleman Allison, Eaton Jack & Rowland Diane. (1998) Professional Issues in Software Engineering. University College London.
- [52]. Autodesk. Revit Release 4.5 Getting Started with Revit Test Drive CD. Autodesk, USA.
- [53]. Autodesk. Autodesk Architectural Desktop Hands-on Test Drive CD. Autodesk, USA.
- [54]. The Computer Times, USA. <http://www.computertimes.com>

Appendix A Cad Vendors for WINDOWS

The following list of CAD vendors is, of necessity, incomplete and may be out of date by the time this dissertation is completed due to mergers, closures and changes. The CAD software products listed here use the Windows operating platform.

<u>Software Name</u>	<u>Software Company</u>	<u>Website URL</u>
1. Alibre	Alibre	www.alibre.com
2. AllPlan	Nemetschek	www.nemetschek.com/en/products/allplan
3. ArchiCAD	Graphisoft	www.graphisoft.com
4. ArchiTECH.PC	SoftCAD International	www.softcad.com

5. ArchT	Eagle Point Software	<u>www.eaglepoint.com</u>
6. ARRIS	Sigma Design International	<u>www.arriscad.com</u>
7. Autocad	Autodesk	<u>www.autodesk.com/autocad</u>
8. Autosketch	Autodesk	<u>www.autodesk.com/products/asketch</u>
9. Bricsnet Architecturals	Bricsnet	<u>www.bricsnet.com/about/services/architecturals</u>
10. Cadkey	Cadkey	<u>www.cadkey.com</u>
11. Cadsoft Build	CADSOFT	<u>www.cadsoft.com</u>
12. CADStd	Apperson and Daughters	<u>www.cadstd.com</u>

13. Cadvance	FIT	www.cadvance.com
14. CATIA	Dassault Systèmes	www.catia.com
15. Chief Architect	Advanced Relational Technology	www.chiefarchitect.com
16. DataCAD	DataCAD LLC	www.datacad.com
17. DesignCAD	Upperspace	www.designcad.com
18. DESI-III	H.Marien	users.Pandora.be/desi-iii/index.html
19. FastCAD	Evolution Computing	www.fastcad.com

20. FelixCAD (CAD)	Graebert Systems	<u>www.fcad.com</u>
21. Generic CADD	CaddVillage (discontinued by Autodesk)	<u>www.genericcadd.com</u>
22. I-DEAS	SDRC	<u>www.sdrc.com/ideas</u>
23. IDRAW 2000	Design Futures	<u>www.designfutures.com</u>
24. IntelliCAD 2000	IntellicadCAD Technical Consortium	<u>www.cadopia.com</u> / <u>www.intellicad.org</u>
25. IronCAD	IronCAD LLC	<u>www.ironcad.com</u>
26. JustCad	JustCAD	<u>www.justcad.com</u>
27. ME10	CoCreate Software	<u>www.cocreate.com</u>

28. MEDUSA	PTC	www.ptc.com/products/medusa/drafting.htm
29. MicroGDS	Informatix	www.informatix.co.uk
30. Microstation	Bentley Systems	www.bentley.com/products/index.htm
31. MultiCad	MultiQuant	www.multi-cad-c.com
32. PC Draft	Microspot	www.microspot.com/software/pcdraft.html
33. Pro/ENGINEER	Parametric Technology Corp	www.ptc.com/products/flex_eng.htm
34. Project Architect	AEC DesignWare	www.aecdesignware.com

35. QuickCAD	Autodesk	<u>www.autodesk.com/quickcad</u>
36. Revit	Revit Technology Corp	<u>www.revit.com</u>
37. SmartSketch (Imagineer technical)	Intergraph	<u>www.intergraph.com/smartsketch</u>
38. Solid Edge	Unigraphics Solutions	<u>www.solid-edge.com</u>
39. SolidMaster	CADMAX	<u>www.cadmax.com</u>
40. SolidWorks	SolidWorks Corp	<u>www.solidworks.com</u>

41. Swiss Precision Engineer	Precision AG	<u>www.swissprecision.com</u>
42. T-FLEX Parametric	Martin Sales International	<u>www.tflex.com/products.html</u>
43. thinkdesign	think3	<u>www.think3.com/products/products_td.htm</u>
44. Tlinea	Inicio	<u>www.iespana.es/tlinea/indexi.htm</u>
45. TurboCAD	IMSI	<u>www.turbocad.com</u>
46. Unigraphics	UGS	<u>www.turbocad.com</u>
47. Uni-Tool	Advanced EMC Solutions	<u>www.aemcs.com/patrucco_main.html</u>
48. Vdraft(Virtual Drafter)	Softsource	<u>www.vdraft.com</u>

49. VeCAD	Comandor	<u>www.comandor.khv.ru/vecad.htm</u>
50. VectorWorks	Nemetschek North America	<u>www.nemetschek.net</u>
51. Vellum Draft	Ashlar	<u>www.ashlar.com/Products/Draft_99</u>
52. Visual CADD	IMSI	<u>www.imsisoft.com/products/visualcadd</u>
53. VX Vision	VX Corp (formerly Varimetrix)	<u>www.varimetrix.com</u>

Appendix B CAD/CAM Software Costs

Software Name	Telephone	Fax	Contact Person
1 Vectorworks	63556232	63556253	Joseph Kwok
2 Autocad 2004 (2D + 3D)	64618100	67355188	Chow-Jin Ho
3 Autocad LT 2400			Chow-Jin Ho
4 Intellicad	62253823	63993454	Ben Thum/Zait B Ismail
5 Fastcad (Defunct as at January 2003)	63993454	63993454	/Ben Thum/Zait B Ismail
6 Microstation	62256158	62252975	Kelvin Ng
7 Revit 5	64618100	67355188	Chow-Jin Ho
8 Drawbase	68963500	65631565	Dennis Wong
9 Archicad	68963500	65631565	Dennis Wong
10 3D Studio Viz Release 3 (now Autodesk Viz 4)	64618100	67355188	Chow-Jin Ho
11 Microstation GDS	68722522	68725655	Gary Ng
12 Sketchup	63993454	63993454	Ben Thum/ Zait B Ismail
13 Vue D'Esprit	63993454	63993454	Ben Thum/Zait B Ismail
14 Autodesk Architectural Desktop 3.3 (2D + 3D)			Chow-Jin Ho

Software Name	Name of Vendor	Address
1 Vectorworks	Solutions 3	53, Kim Keat Road #04-01 Mun Hean Building, Singapore 328823
2 Autocad 2004 (2D + 3D)	Autodesk	391B Orchard Road #12-06 Ngee Ann City Tower B Singapore 238874
3 Autocad LT 2400	Autodesk	391B Orchard Road #12-06 Ngee Ann City Tower B Singapore 238874
4 Intellicad	SIACAD Pte Ltd	32 Wallich Street #02-60 Wallich Street Singapore 078880
5 Fastcad (Defunct as at January 2003)	SIACAD Pte Ltd	32 Wallich Street #02-60 Wallich Street Singapore 078880
6 Microstation	Bentley Systems Incorporated	10 Anson Road #30-15 International Plaza Singapore 079903
7 Revit 5	Autodesk	391B Orchard Road #12-06 Ngee Ann City Tower B Singapore 238874
8 Drawbase	Collaboration Technologies	1 International Business Park #01-15B The Synergy Singapore 609917
9 Archicad	Services (Asia Pacific) Pte Ltd	1 International Business Park #01-15B The Synergy Singapore 609917
10 3D Studio Viz Release 3 (now Autodesk Viz 4)	Autodesk	391B Orchard Road #12-06 Ngee Ann City Tower B Singapore 238874
11 Microstation GDS	Planet Asia Co Pte Ltd	Block 20 #09-15 Ayer Rajah Crescent Technopreneur Centre Singapore 139964
12 Sketchup	SIACAD Pte Ltd	32 Wallich Street #02-60 Wallich Street Singapore 078880
13 Vue D'Esprit	SIACAD Pte Ltd	32 Wallich Street #02-60 Wallich Street Singapore 078880
14 Autodesk Architectural Desktop 3.3 (2D + 3D)	Autodesk	391B Orchard Road #12-06 Ngee Ann City Tower B Singapore 238874

Footnotes:

- 1.Price per package based on Commercial non academic prices
- 2.Prices based on currency exchange rate of US\$1 = S\$1.7
3. Prices quoted are as current and updated subject to changes at time of publishing
4. Training costs is on a per head basis regardless of duration of course
- 5.Training fees quoted per head basis are based on the entry level or module

Software Name	Price@ package(US\$)	Cost of Training(US\$)	Cost of Technical Support(US\$)
1 Vectorworks	1029		117 included in package price 176
2 Autocad 2004 (2D + 3D)	3908		382 included in package price renewal yearly subscriptions
		for same course 550 for same course 550	
3 Autocad LT 2400	1323	of package)	included in package price 200(4 days 2D+3D course for fir renewal yearly subscriptions
4 Intellicad	117	200(4 days 2D+3D course for fir	included in package price
5 Fastcad (Defunct as at January 2003)	588	200(5 days course for first time	included in package price
6 Microstation	4705	264(2D Basic)/176(2D Advance	included in package price
7 Revit 5	3635	485(basic 2D & 3D)/352(advanc	included in package price
8 Drawbase	1705	Cost of Training US\$	included in package price
9 Archicad	5294	course 680	included in package price
10 3D Studio Viz Release 3 (now Autodesk Viz 4)		included in package instructions	included in package price renewal yearly subscriptions
		purchase, subsequent normal charges	
		purchase, subsequent normal charges	
11 Microstation GDS	2852	self explanatory package2 days	included in package price
12 Sketchup	538	self explanatory package	included in package price
13 Vue D'Esprit	223	self explanatory package	included in package price
14 Autodesk Architectural Desktop 3.3 (2D + 3D)	3294	self explanatory package with sel	included in package price subsequent normal charges for renewal yearly subscriptions training

Appendix C Interior Design Project Participants

No	Name	Abbr.	Definition of Job Scope
1	Client	Client	The person, firm or organisation requiring work to be done
2	Client Representative	C/R	The person, firm or organisation employed to take overall responsibility of management of the project
3	Interior Designer	ID	The person, firm or organisation employed to take overall responsibility of the design of the interior spaces. The interior designer designs the spatial qualities of the layout, appearance etcetera.
4	Architect	Arch	The person, firm or organisation employed to take overall responsibility of the design of the exterior building and sometimes the interior in conjunction with the interior designer by providing professional expertise.
5	Civil & Structural Engineer	CSE	The person, firm or organisation employed to be responsible for design and supervision of the static or structural elements of the project.
6	Services Engineer	SE	The person, firm or organisation employed to be responsible for design and supervision of the dynamic or systems elements including mechanical, electrical services, telecommunications & drainage etcetera.
7	Quantity Surveyor	QS	The person, firm or organisation employed to advise on and monitor the cost control of the project and prepare the documentation against which contractors are selected.
8	Main Contractor	MC	The person, firm or organisation employed to carry out construction work and to coordinate and control sub-contractors and suppliers.
9	Sub-Contractor	SC	The person, firm or organisation employed by the main contractor to carry out specialist construction or installation work. He may be selected by the main contractor, nominated by the interior designer or Architect or emerge as the winner of a tendering process
10	Supplier	Sup	The person, firm or organisation employed the main contractor or sub-contractor to provide construction materials and equipment during the construction of the interiors or exteriors of the project.

No	Name	Abbr.	Role In Organisation
1	Client	Client	The employer of design and construction organisations
2	Client Representative	C/R	Project Manager (PM) who takes care of the management of the project.
3	Interior Designer	ID	To provide suitably proportioned and arranged interior spaces and lead the interior project for client.
4	Architect	Arch	To provide a building incorporating suitably proportioned and arranged exterior and interior spaces (in conjunction with the interior designer).
5	Civil & Structural Engineer	CSE	Acts under supervision of Architect to provide structures that will stand up to self and imposed load.
6	Services Engineer	SE	Acts under supervision of Architect to provide environmental conditions conducive to building function
7	Quantity Surveyor	QS	Acts under supervision of interior designer to ensure the interiors are provided within pre-determined cost criteria. Acts under supervision of Architect with regards to exterior & external building works.
8	Main Contractor	MC	Acts under supervision of interior designer or Architect to provide completed interiors or exterior building respectively which meets the design and cost criteria.
9	Sub-Contractor	SC	To provide the main contractor with specialist services & assisting with the completion of the interior or exterior works.
10	Supplier	Sup	Suppliers may be nominated by the interior designer or Architect or selected by the Main Contractor or Sub-Contractor

Appendix D Questionnaire

A. Personal Background.

Interviewee's name?

Interviewee's Company, address and telephone number?

Interviewee's profession?

Detail your job scope within the parameters of the company's organization chart.

Interviewee's year of birth? (related to the issues of the type of software available at the time of his academic and professional life)

Number of years using graphic software in academic pursuit and professional career.

Profile of clientele: Commercial, Hospitality, Retail, Residential?

Different software for different clientele or same?

Different software for different stages of work? Or totally same package? Or integrated customized package? Or off the shelf package?

Stage Four Preliminary Design Brief Analysis

Provide Short critique on the features & functions of the software used for following work functions for input/output of data

<u>Nature of Task</u>	<u>Data Type</u>	<u>Software Used</u>	<u>Appropriateness of Software Features for Task at Hand</u>
-----------------------	------------------	----------------------	--

- meeting with main contractor
- . Existing site dimensions
- . Existing site structures
- . work schedule

Stage Four Preliminary Design Brief Analysis

Provide Short critique on the features & functions of the software used for following work functions for input/output of data

Nature of Task *Data Type* *Software Used* *Appropriateness of Software Features for Task at Hand*

- meeting with client
- . brief requirements detailing
- . spatial qualities 3D
- . workflow/sequential human motion
- . aesthetic preferences
- . budgetary constraints
- . material specifications
- . lighting specifications
- . fitting specifications
- . fixtures specifications

- meeting with other Service Professionals
- . civil & structural
- . mechanical
- . electrical

- meeting with Government Agencies
- . data input required

Stage Five Schematic Design Development

Provide Short critique on the features & functions of the software used for following work functions for input/output of data

Nature of Task *Data Type* *Software Used* *Appropriateness of Software Features for Task at Hand*

- meeting with client
 - . Visual sketches of interior spaces to demonstrate quality
 - . ambience & illumination levels for indoor
 - . light quality of outdoor spaces
 - . 3-Dimensional walkthroughs
 - . animation effects
 - . sound effects
 - . 'true to life' realism of interior material textures

- meeting with government agencies
 - . submission of plans, sections & elevations for government permission & approval

- meeting with Technical Professionals
 - . civil & structural input
 - . electrical input
 - . mechanical input
 - . sewage input
 - . budgetary input

Stage Five Schematic Design Development

Provide Short critique on the features & functions of the software used for following work functions for input/output of data

Nature of Task

Data Type

Software Used

Appropriateness of Software

Features for Task at Hand

- meeting with Suppliers
 - . material selection
 - . budgetary ball park figures

D. Stage Six Final Design Development

Provide Short critique on the features & functions of the software used for following work functions for input/output of data

<u>Nature of Task</u>	<u>Data Type</u>	<u>Software Used</u>	<u>Appropriateness of Software Features for Task at Hand</u>
- meeting with client - Various Types of Plans -floor plans -organization layout plans -furniture layout plans - Various Types of Elevations <ul style="list-style-type: none">. exterior elevations. interior elevations . Types of Sections <ul style="list-style-type: none">. exterior sections. interior sections			

D. Stage Six Final Design Development

Provide Short critique on the features & functions of the software used for following work functions for input/output of data

<u><i>Nature of Task</i></u>	<u><i>Data Type</i></u>	<u><i>Software Used</i></u>	<u><i>Appropriateness of Software Features for Task at Hand</i></u>
<ul style="list-style-type: none"> - Axonometrics? - Perspectives? - meeting with government agencies 			
	<ul style="list-style-type: none"> . submission of plans, sections & elevations for government permission & approval 		
<ul style="list-style-type: none"> - meeting with Technical Professionals 	<ul style="list-style-type: none"> . civil & structural input . electrical input . mechanical input . sewage input . budgetary input 		
<ul style="list-style-type: none"> - meeting with Suppliers 	<ul style="list-style-type: none"> . material selection . budgetary ball park figures 		

Other Areas of Concern.

1. What else would you like to see in the development of hardware to support your professional needs?
2. What sort of features would you like to see in the development of 2-D and 3-D software for Interior Design?

Appendix E Respondents

Appendix E

No	Last, First Name	Sex	Nationality	Position	Year of Birth	Category
1	Ong, Agerico	M	Philippines	Director	1958	CO/HS/IN
2	McCleod, David	M	Scotland	Sole Proprietor	1966	CO/RE
3	Tsou, Stephen	M	America	Director	1953	CO
4	Chong, Soo Lee	M	Singapore	Architectural Assistant	1961	IN
5	Huang, Eu Chai	M	Singapore	Architect	1962	IN
6	Tay, Joo Ann	M	Singapore	Design Director	1950	CO/HS/RT/IN/RS
7	Wong, Mun Summ	M	Singapore	Sole Proprietor	1962	CO/HS/IN
8	Yeo, Kane	M	Singapore	Cad Technical Manager	1968	CO
9	Tay, Frank	M	Singapore	Sole Proprietor	1950	CO
10	Shah, Rajesh	M	Singapore	Sole Proprietor	1964	CO/RT/RS
11	Leyau, Diana	F	Singapore	Principal Designer	1970	CO/RT
12	Poon, Shirley	M	Canada	Interior Design Director	1968	CO/RT/RS
13	Lok, Kathy	F	Singapore	Resident Design Architect	1970	CO/HS/IN/RS
* Category						
	Commercial Office/Banking	CO				
	Hospitality	HS				
	Retail	RT				
	Institution	IN				
	Residential	RS				

No	Last, First Name	Company	Address	Zip Code	No of Pple
1	Ong, Agerico	Arthimage Design Incorporated	34 E Wilson Street West Greenhills Philippines	NA	20
2	McCleod, David	MA Architects	111 North Bridge Road Road #27-01/02 Peninsular Plaza	179098	2
3	Tsou, Stephen	M. Moser Associates (S) Pte Ltd	19 Carpenter Street #04-01	59908	25
4	Chong, Soo Lee	Land Transport Authority	No.1 Hampshire Road	219428	100
5	Huang, Eu Chai	Land Transport Authority	No.1 Hampshire Road	219428	100
6	Tay, Joo Ann	DBA Design Phase Pte Ltd	11 Stamford Road #03-05 Capitol Building	178884	20
7	Wong, Mun Summ	WOHA Designs	175 Telok Ayer Road	68623	25
8	Yeo, Kane	M. Moser Associates (S) Pte Ltd	19 Carpenter Street #04-01	59908	20
9	Tay, Frank	F.D. Chapman Design	75 Bukit Timah Road #05-11 Boon Siew Building	229833	4
10	Shah, Rajesh	Raj Shah Associates	392A East Coast Road	428992	1
11	Leyau, Diana	Boss Design International Pte Ltd	134 Joo Seng Road, Level 4, Nobel Design House	368359	5
12	Poon, Shirley	LPT Architects Pte Ltd	250 Tanjong Pagar Road #09-01 Saint Andrews Centre	88541	1
13	Lok, Kathy	ADDP Architects	61A Tanjong Pagar Road	88482	25

* Category

Commercial Office/Banking

Hospitality

Retail

Institution

Residential

No	Last, First Name	Company	Tel	Fax	Email
1	Ong, Agerico	Arthimage Design Incorporated	632-7257272	632-7267272	adesign@info.com.ph
2	McCleod, David	MA Architects	65-65593725	65-62354121	davybill@pacific.net.sg
3	Tsou, Stephen	M. Moser Associates (S) Pte Ltd	65-64384188	65-64384188	stephent@mmoser.com
4	Chong, Soo Lee	Land Transport Authority	65-63961270	65-63961126	aikiken@singnet.com.sg
5	Huang, Eu Chai	Land Transport Authority	65-63961270	65-63961126	hnq001@singnet.com.sg
6	Tay, Joo Ann	DBA Design Phase Pte Ltd	65-63393677	65-63347280	windsurftay@pacific.net.sg
7	Wong, Mun Summ	WOHA Designs	65-64234555	65-64234666	admin@wohadesigns.com
8	Yeo, Kane	M. Moser Associates (S) Pte Ltd	65-64384088	65-64384188	kaney@mmoser.com
9	Tay, Frank	F.D. Chapman Design	65-63394611	65-63399422	fdchapmn@singnet.com.sg
10	Shah, Rajesh	Raj Shah Associates	65-63450940	65-63450961	rajshah@singnet.com.sg
11	Leyau, Diana	Boss Design International Pte Ltd	65-63835133	65-8581300	sdchang@singnet.com.sg
12	Poon, Shirley	LPT Architects Pte Ltd	65-67344733	65-67346233	spdaa@singnet.com.sg
13	Lok, Kathy	ADDP Architects	65-62201088	65-62240280	kathylok@yahoo.com
* Category					
Commercial Office/Banking					
Hospitality					
Retail					
Institution					
Residential					

Appendix F Main Types of Project Information used in the Interior Design Process.

Types of Information	Likely Generators	Likely Users	Likely Sources	Likely Formats
1. Rule & Regulation	Government Agencies	All	Law book, clause regulation text book	
2. Licence & Certificate	Government Agencies	main & sub contractors, client, suppliers	certificate, letter	text
3. Approval & Permission	Client, Interior Designers & Engineers	owner, main & sub contractors, suppliers	letter or form (usually attached with method description & drawings)	text & graphic
4. Design Approval	Government Agencies	Interior Designer Technical professionals	letter or form	text
5. Design Information	Interior Designer, Technical professionals	owner representative, main & sub contractor suppliers, quantity surveyor	meeting minutes, drawings & description	text, graphic
6. Cost & contract administration information	Interior Designer (after sorting out site information with owner representative)	Quantity Surveyor	letter, meeting minutes, drawing & description	text, graphic
7. Specification	Architect, technical professionals owner representative	Owner, Interior designer, main & sub contractor, suppliers, quantity surveyor	product specification book clause extension	text, graphic
8. Plan and Schedule	Owner representative, main contractor	Owner representative, main & sub contractor, suppliers, quantity surveyor interior designer	meeting minutes, reports, charts, tables	text, graphic
9. Menu and method description	approved main contractor	owner representative, main & sub contractor, suppliers, quantity surveyor interior designer	meeting minutes, menu ,drawing & description	text, graphic
10. Site management and supervision record	Owner representative, main & sub contractors, suppliers	all but mainly site project management personnel	forms, log books	text
11. Instruction	owner, owner representative, main contractor	owner representative, main & sub contractor ,suppliers	letter, meeting minutes, forms, messages	text, verbal
12. Site Information	owner representative, main & sub contractors	owner, interior designer, technical professionals, Quantity Surveyor, suppliers.	letter, meeting minutes, transmittal memo, variation orders, drawings	text, graphic
13. Contract	owner, interior designer, main & sub contractor, suppliers	owner, interior designer, technical professionals, main & sub contractors, suppliers, quantity surveyor, owner representative	contract book & contract clause extension	text
14. Invoice and Order Variation	main contractor, suppliers, interior designer, technical professional	main contractors, suppliers, owner representative, main & sub contractors, suppliers	invoice, receipt, form letter meeting minutes, drawings & description	text, graphic
15. Claim	main & sub contractors	owner, quantity surveyor	meeting minutes, forms, letter, drawings.	text, graphic
16. Bills of Quantities and valuations	quantity surveyor	main contractors, owner, owner representative	form, table, report	text

Types of Information	Likely Generators	Likely Users	Likely Sources	Likely Formats
17. Correspondence	all	all	letter, transmittal memo,	text
18. Quotations	Suppliers, sub contractors	main & sub contractors, quantity surveyor, interior designer, owner, owner representative.	quotation letters	text, graphic

Appendix G Sample Documents

DRAWING LIST									
DWG. NO.	REVISION	DATE	DWG. TITLE	REMARKS	DWG. NO.	REVISION	DATE	DWG. TITLE	REMARKS
202LP101	3	16/04/02	FURNITURE LAYOUT PLAN		202ELF-1	1	21/03/02	WALL ELEVATION F @ RECEPTION AREA	
202CR102	1	16/04/02	CROSS-REFERENCE PLAN		202ELF-2	1	21/03/02	WALL ELEVATION F @ RECEPTION AREA	
202PP103	1	16/04/02	PARTITION LAYOUT PLAN		202ELG	1	04/03/02	WALL ELEVATION G @ RECEPTION AREA 2	
202CP104	1	09/05/02	REFLECTED CEILING LAYOUT PLAN (2ND PHASE)		202ELJ	1	16/04/02	TYPICAL ROOM ELEVATION	
202CP104.1	2	09/05/02	REFLECTED CEILING LAYOUT PLAN (1ST PHASE)		202DT01	1	04/03/02	SECTIONAL DETAIL	
202CP104A	1	16/04/02	SMOKE DETECTOR PLAN		202DT02	1	21/03/02	SECTIONAL DETAIL	
202EP105	1	16/04/02	ELECTRICAL LAYOUT PLAN		202DT03	1	21/03/02	SECTIONAL DETAIL	
202FP106	1	16/04/02	FLOOR FINISHES LAYOUT PLAN		202D01	1	16/04/02	TYPICAL DOOR DETAIL	
202WP107	2	16/04/02	WALL FINISHES LAYOUT PLAN		202D02	1	08/02/02	CONFERENCE DOOR DETAIL	
202EL/A	1	21/03/02	WALL ELEVATION A @ RECEPTION AREA		202F01	1	21/03/02	RECEPTION COUNTER @ RECEPTION AREA 1	
202EL/B	1	08/02/02	WALL ELEVATION B @ RECEPTION AREA		202F02	1	19/03/02	TOP HUNG & LOW CABINET @ PANTRY AREA	
202EL/C	1	21/03/02	WALL ELEVATION C @ RECEPTION AREA		202F03	1	10/04/02	TOP HUNG & LOW CABINET @ COMMS. AREA	
202EL/D	1	21/02/02	WALL ELEVATION D @ RECEPTION AREA		202F04	1	08/02/02	SOFA @ RECEPTION AREA 1	
202EL/E-1	1	21/03/02	WALL ELEVATION E-1 @ RECEPTION AREA		202F05	1	21/02/02	BOARDROOM TABLE @ CONFERENCE RM.	
202EL/E-2	1	10/04/02	WALL ELEVATION E-2 @ RECEPTION AREA		202F05A	1	21/02/02	BOARDROOM TABLE @ CONFERENCE RM.	

AS-BUILT

Drawn & Valid By: **Project:**
Drawn/Frame By: **Scale:** **Drawn/Frame By:** **Scale:**
Drawn/Frame By: **Scale:**
Drawn/Frame By: **Scale:**

Project Title:
Project No.:
Project Name:
Project Address:
Project Contact:

BOSS Design
INTERNATIONAL PTE LTD
 1200 Orchard Road
 #05-01
 Singapore 238853
 Tel: 65-63490000
 Fax: 65-63490001

Notes:
 ALL DESIGN ARE COPYRIGHT
 OF BOSS DESIGN INTERNATIONAL.
 THEIR PERMISSION IS REQUIRED
 FOR REPRODUCTION.
 DO NOT SCALE DIMENSIONS.
 DIMENSIONS MUST BE CHECKED
 AT THE SITE BY THE CONTRACTORS.

<u>S/NO.</u>	<u>PROJECT :</u> SCHERING AG, GERMANY (00/912/03)	
1	Sales Enquiry Form / Submission Form / Signed Quotation	<input type="checkbox"/>
2	Insurance	<input type="checkbox"/>
3	Budgetary	<input type="checkbox"/>
4	Variation Master List	<input type="checkbox"/>
5	Work Schedule	<input type="checkbox"/>
6	Take Over of Customer's Property	<input type="checkbox"/>
7	As-built Drawings / Material schedule	<input type="checkbox"/>
8	Transmittal Form	<input type="checkbox"/>
9	Purchase Order	<input type="checkbox"/>
10	Correspondences to & from Client	<input type="checkbox"/>
11	Correspondences to & from Supplier / Subcon	<input type="checkbox"/>
12	Correspondences to & from Bldg. Management	<input type="checkbox"/>
13	Subcontractor List	<input type="checkbox"/>
14	Work Progress Report	<input type="checkbox"/>
15	Site Visit Report	<input type="checkbox"/>
16	Inspection Checklist	<input type="checkbox"/>
17	Final Inspection (w/ Subcon)	<input type="checkbox"/>
18	Handover Form	<input type="checkbox"/>
19	Aftersales Report	<input type="checkbox"/>
20	Miscellaneous	<input type="checkbox"/>
21	Others : (please specify) _____	<input type="checkbox"/>
22	Objective Status	<input type="checkbox"/>
23		<input type="checkbox"/>
24		<input type="checkbox"/>

MAIN FILE



SALES INQUIRY

No. : 000305

Date: 26/11/02

Customer's Particulars	Inquiry Source : <input type="checkbox"/> Magazine <input type="checkbox"/> Newspaper <input type="checkbox"/> Trade Shows <input checked="" type="checkbox"/> Repeat Customer <input type="checkbox"/> Recommended By _____ <small>Phone Others</small>
	Customer Name / Company Name : <u>Schemaf</u>
	Address : <u>19 LAYANG WAY # D6-26</u>
	Site Address : <u>19 LAYANG WAY # 04-25/27.</u>
Contact Person : <u>WALAF</u> Tel: <u>65468733</u> Fax: <u>65468371</u> H/P: _____	
Type Of Project : <input checked="" type="checkbox"/> Corporate Office <input type="checkbox"/> Retail Outlets <input type="checkbox"/> Bldg Interiors <input type="checkbox"/> Display Showrooms <input type="checkbox"/> Others : _____	
Expected Commencement Date : <u>1/1/03</u> Expected Completion Date : _____	
Budget : <input type="text"/> Size Of Premises : <u>2500sqft</u>	
Recorded By : <u>PATRICK</u> Signature: _____ Date: <u>26/11/02</u>	
Project Dept.	To : Project Director <u>26.11.02</u>
	Scope Of Work : <input checked="" type="checkbox"/> Turnkey Project (Design & Build) <input type="checkbox"/> Design & Manage <input type="checkbox"/> Others : _____ <small>(Customer's Requirements To Be Recorded In Forms : QP- 4.4 - F2 to F5 , Refer to attached)</small>
	Resources Availability : <input checked="" type="radio"/> Yes / No Project Executable : <input checked="" type="radio"/> Yes / No
DX Appointed : <u>Patrick</u>	
Reviewed By : Project Director Signature: _____ Date: <u>26/11/02</u>	
Design Dept.	To : Design Director
	Design Layout Plan <input checked="" type="checkbox"/> To Be Prepared By (Designer) <u>Celso</u> Proposed Completion Date <u>1st week 8/12/2002</u>
	Design Perspective Drawings <input checked="" type="checkbox"/> <u>Nath</u> of <u>Dec 2002</u>
	Design Detail Drawings <input type="checkbox"/>
	Preparation Of Finishes Specifications <input checked="" type="checkbox"/> <u>Stefani</u>
Preparation For Quotation <input type="checkbox"/>	
Reviewed By : Design Director Signature: _____ Date: <u>26/11/02</u>	
Purchase Dept.	Project Awarded : <input checked="" type="radio"/> Yes / No Quotation No : <u>01/0472/PT.</u>
	If Yes, Pls attach signed quotation from customer & 1st Payment Of 40% of Contract Sum To Purchasing Exec. for Job No. CONFIRM JOB No. : <u>01/902/03.</u>
	Submission required <input checked="" type="radio"/> Yes / No * Specify submission: FSB / BCA / URA
Reviewed By : Purchasing Executive Signature: _____ Date: <u>10/2/03</u>	
Mgt. Evaluation	If Not Awarded, (Rejected Evaluation)
	Comments : _____
	Reasons : _____
	Reviewed By : Chester Goh Signature: _____ Date: _____

* : Delete Where Appropriate

BRIEFING REQUIREMENT FOR NEW OFFICE PREMISES	SHEET 1 OF 1
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Company :	:	_____
New Office Location :	:	_____ _____
Contact Person :	:	_____
	Tel :	_____
	Fax :	_____

IN-PROCESS WORKS / MATERIALS INSPECTION CHECKLIST



Client _____
 Project title _____
 Job no _____

* Please Tick Applicable In-Process Work Inspection Checklist

Page 1 of 4

To Tick	In-Process Works Inspection Checklist	Compliance / Acceptable ?	Date Rechecked	Status
<input type="checkbox"/>	FLOOR PROTECTION Common Corridor Protected Existing Flooring In Renovation Area Protected Checked By : _____ Date :	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> No	_____ _____	_____ _____
<input type="checkbox"/>	FLOOR MARKING Floor Markings Are Carried Out According To Drawings Checked By : _____ Date :	<input type="checkbox"/> Yes <input type="checkbox"/> No	_____	_____
<input type="checkbox"/>	PAINTING TO PLASTERED WALL / GYPSUM WALL SURFACES Plastered Wall Surface - Smooth & Even Evenness Of Paint Work Checked By : _____ Date :	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> No	_____ _____	_____ _____
<input type="checkbox"/>	CEILING INSTALLATION Ceiling Level Height In Relation To Adjacent / Other Trade Plastering Smooth Checked By : _____ Date :	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> No	_____ _____	_____ _____
<input type="checkbox"/>	DOOR FRAMES INSTALLATION Straight & Vertical Alignment Checked By : _____ Date :	<input type="checkbox"/> Yes <input type="checkbox"/> No	_____	_____
<input type="checkbox"/>	DOOR INSTALLATION Right Alignment and Door Swing As Per Drawings Door Vertically Installed, No Sag / Warps Locksets Are Fitted Properly, No Dent, No Stains, & Ease Of Opening and Closing of Doors Checked By : _____ Date :	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> No	_____ _____ _____	_____ _____ _____
<input type="checkbox"/>	Glass Panel Installation Adequacy Of Silicone Applied & Finished Smooth No Scratches / Chips & Cracks On Glass Panel Checked By : _____ Date :	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> No	_____ _____	_____ _____

Prepared By : _____

Approved By : _____

QP - 4.10 - F1 / R0 / 1.7.2000