3D Virtual Reality Tour in Real Estate

A thesis submitted to the Graduate School in partial

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ABSTRAK

Tujuan utama penyelidikan ini dijalankan adalah untuk mendedahkan para pengguna dan syarikat perumahan dengan keistimewaan e-dagang sebagai strategi pemasaran yang efektif. E-degang memainkan peranan yang penting dalam Internet. Di samping itu, penyelidikan ini juga bertujuan untuk mempromosi model rumah maya yang kemudiannya akan meningkatkan keuntungan syarikat perumahan. E-dagang merupakan saluran elektronik yang paling popular dalam Internet. Aplikasi ini akan memberi kebaikan kepada pihak syarikat perumahan dan juga pembeli. Aplikasi ini dibangunkan dengan menggunakan metodologi *Web Page Development (WPD)*. Penyelidikan ini menghuraikan beberapa pencapaian dan juga kekurangan yang dihadapi ketika pembangunan aplikasi. Sehubungan itu, beberapa cadangan ditemui demi mengatasi kekurangan ini dalam penyelidikan aplikasi e-dagang di masa depan.

ABSTRACT

The main purpose of this research is to deliberate Virtual Reality (VR) application in E-commerce which is suitable towards real estate home builders who are increasingly driven. The Internet is widely expected to become a channel for electronic commerce and it also has an enormous potential for transforming online shopping into a real world equivalent. VR interfaces to e-commerce sites on the Internet promises to make the e-shopping experience more natural, attractive, and fun for buyers. It allows the buyers to interact with the e-commerce service through a 3D representation which supports natural actions such as walking, looking around, and picking up products from the listing. The next purpose of this research is to endorse VR home model as the best way to reduce marketing cost and increase profit. This e-commerce application would become the most powerful sales tools to come along in decades. This application has been developed using *Web Page Development (WPD)* methodology. Last but not least, this research discusses how the web site fulfills homebuyers' requirements and limitations that were discovered during the development of these applications. Therefore, some recommendations are proposed to defeat the limitations for the future research in this e-commerce application.

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CHAPTER ONE

INTRODUCTION

1.0 Introduction

"Virtual Reality (VR) is a system which enables users to move and react in a computer-simulated environment" (Jones *et al.*, 1997). In addition virtual reality can also be defined as an artificial environment created with computer hardware and software and presented to the user in such a way that it appears and feels like a real environment (Roehl, D.J., 1996). Virtual Reality can be made by creating 3D real time interaction environments to get as close as possible to the real world. Virtual Reality is being used commonly on the Internet especially on e-Commerce web site in order to naturalize e-shopping experience and also make it more interesting for the customers. E-Commerce is a type of business model, or segments of a larger business model, that enables a firm or individual to conduct business over an electronic network, typically the internet (John, B.G., 2001). Electronic commerce operates in all four of the major market segments: business to business, business to consumer, consumer to consumer and consumer to business. One of the challenges of e-commerce is the design of web sites which effectively present products and are easy and pleasant to use by the buyers.

Virtual reality is bringing a whole new dimension to the market for real estate (Larijani, C., 1994). Buyers can view various properties online in an interactive, immersive manner. Most of what currently is called "virtual home tours" today is just a series of

videos panning across the home exterior or across rooms. A true virtual real estate tour is an interactive, three-dimensional experience in which the userdetermines the perspective and the movement of the tour. Virtual tour is now a strong economic driver. Virtual tour allows real world be represented so factual to show off the structure of building and the design of the houses. Virtual tours in general are growing as a popular way to market real property via the internet. Traditional open houses are labor intensive for the realtor, require the owners to leave the home during the event, are affected by local weather conditions, and are difficult for potential buyers from out-of-town. Virtual tours enable potential buyers to see a home from the comfort of their home.

As technology advanced, the virtual tour consisted of panoramic, 360-degree views, a method used for real estate Web sites. Buyers may tour around and have detailed information on the building regarding size, interior design, and facilities near by, facing area and others. Eventually, buyers are able to save time on going to see the model of house, which might be too small and many detailed are disregard. A part from that, buyers are able to avoid the crowds on viewing the models (Rheingold, H., 1991). Internet has become an effective marketing tool for real estate professionals, giving a competitive edge to those taking advantage of its many benefits including those of its virtual reality aspects. Potential homebuyers are turning more and more to the Internet over the traditional advertising. Not only buyers looking for listings, but also seeking for real estate agents and developers.

1.1 E-Commerce

"Electronic Commerce (E-Commerce) is about the sale and purchase of goods or services by electronic means, particularly over the Internet" (Roger, 2001). E-Commerce is a modern business methodology that addresses the needs of organizations, merchants, and consumers to cut costs while improving the quality of goods and services along with increasing speed of service delivery. More commonly, E-Commerce is associated with the buying and selling of information, products, and services via computer networks today and in the future via any one of the myriad of networks that make up the Information Superhighway (I-way).

When talking about E-Commerce, most people think that this means shopping online. However, this activity actually represents only a small part of E-Commerce. The term of E-Commerce also refers to a wide range of electronically mediated commerce, which includes online marketing, brokering, auctions, barcode verification, fax and e-mail. In addition, E-Commerce includes business-to business transactions among big corporations over Electronic Data Interchange (EDI) network. However, in this report, the term of E-Commerce refers to Internet commerce, and particularly to Web Commerce, online shopping and electronic business transactions over web sites. Today, it is obvious that the Web has become a significant marketplace for the buying and selling of products and services. E-Commerce and online retail have rapidly grown and increased in popularity.

Due to a growing online population as well as to an increase in buyers' spending amount and a higher percentage of online shoppers, this trend will not stop in the near future.

1.2 Benefits of E-commerce

1.2.1 Introduce another Channel to Market

Business web site can take orders 24 hours a day, every day of the year, and is readily accessible to customers all over the world. A successful business web site can produce a highly profitable revenue stream.

1.2.2 Lower the Cost of Order Processing

The direct cost-of-sale for an order taken from a web site should be lower than through traditional means (retail, paper based), as there is no human interaction during the on-line electronic purchase order process. Also, electronic selling should virtually eliminate processing errors, as well as being faster and more convenient for the visitor.

1.2.3 No Physical Space Limitations

More products can be offered with an eCatalogue, which can physically stock on shelves.

1.2.4 Buy and Sell Faster

Requirements, brochures, quotations, purchase orders, delivery schedules, etc., can be emailed within seconds to the suppliers and customers all over the world.

The whole process of buying and selling can be made much more efficient and responsive using emails.

1.2.5 Boost Sales with Exports

Using web site and email as a low cost way of extending the geographical reach of business marketing activities, and to develop a global export market for products and services.

1.2.6 Exchange and Share Data across the World

Text messages, documents, graphics, photographs, music, video, CAD/CAM files, and much more can be converted into data and sent as email attachments or presented on a web site. There are no postage, printing and packaging costs with eCommerce communications. So, this new communications' method is used to work quicker, and in new ways, with customers and suppliers outside of your locality or country.

1.2.7 Update Employees Instantly With New Policies or Procedures

E-Mail works well when communicating with colleagues who are off-site, out of the country, or tele-working.

1.2.8 Hold Web Meetings (Data Conferencing)

A great way to have a virtual meeting is to upload a document (spreadsheets, project plans, etc) on to a web site and enable it to be viewed and edited in real-time through the Internet. Holding virtual meetings can save significantly on travel expenses and time.

1.2.9 Use the Internet to Improve Business Administration

With a mobile phone connected to a portable computer, employees working off-site can access and up-date internal information, such as customer records, price lists, time sheets, schedules, and job reports. Providing remote Internet access for staff makes it possible for the latest information to be at hand, for administrative tasks such as invoicing, employee whereabouts, and expense claims.

1.2.10 Introduce Collaborative Working

With fast, reliable, and cheap eCommerce communications, it is possible for colleagues, customers, suppliers and partners, to use collaborative working practices to manage, share, and enhance project work, regardless of location.

1.3 Virtual Tour

Virtual tour empowers viewer to explore sample house in detail. Just with a little mouse gesture, the viewer can move into every part and examine every aspect of the sample house. The viewer can scroll up and down, move left and right, zoom in and zoom out in the virtual tour and at the same time can have an idea from the floor plan as to which direction of the sample house they're exploring. And with a single click on the hotspots in the virtual tour, the viewer can shuffle from the bed-room to the kitchen and from the hall to the garden, indeed, any corner of the sample house viewers wishes to see. Virtual Tours allow users to see the "whole picture" enabling them to make a qualified decision on viewing and buying property.

1.3.1 The important of Virtual Tour

It is a well-known fact among those in the industry that buyers are increasingly using the Internet to preview homes. Any website that features listings will agree that listings with virtual tours are viewed more frequently by online consumers than those with few or no photos. Customers interested in listing their home typically look for the Real Estate professional who does the most to generate leads.

1.3.2 Survey on Virtual Tour

- 72 percent of buyers searched houses for sale in the Internet.
- 46 percent walked through a house after first visiting the home online.
- 78 percent viewed photos of the houses listed on the Internet.
- 46 percent said virtual tours are useful.
- Only 15 percent of online buyers failed to use virtual tours in their previewing process.

1.4 Benefits of Virtual Tour

1.4.1 Buyers

- Real Estate Virtual Tours increase the chance of matching a property to the buyers' requirements.
- Real Estate Virtual Tours save home buyers time and expense when searching for a property.
- Easiest way to evaluate a property prior to a visit or without visiting it at all.

- Real Estate Virtual Tours are becoming the prime property listing resource for home buyers.

1.4.2 Property Builders and Developers

- Fast technique to sell properties.
- Attract prospective buyers from around the world.
- Show house is open 24 hours a day, 7 days a week, regardless of time from anywhere with email or Internet access.
- Put on view the quality of the materials and craftsmanship by preparing virtual tours for each stage of construction
- Display virtual tours, which support and expand upon the information displayed on floor plans.
- Differentiate from the competition by showing the willingness to go that "extra mile" to gain their trust.
- Provide an accurate representation of the property and decrease the time and expense of showing properties in the physical world.

1.5 Problem Statement

Since the early 1990s real estate agents have looked at the Internet as a marketing tool. At first the Web sites were no more than static catalogs of their listings, the more tech-savvy agents and developers soon discovered the benefits of virtual reality to their real estate sales. The first attempts were crude by today's standards, no more than panoramic static photos of the homes for sale. Motion was added to the photos with scripts written just for

that purpose. Some real estate sites added music and titles, and some even offer audio voice over to give a more feeling to their attempt at virtual reality. Therefore, 3D Virtual Reality Tour in Real Estate can make customers imagine actually being in the home guided by the agent on a tour rather than physically visiting to the house. Based on National Association of Realtors Profile of Home Buyers and Sellers (2003), it shows that most homebuyers prefer a virtual reality tour of the homes. By offering virtual reality tours of the listed properties definitely developers can provide more listings to the buyers, saving time by pre-qualifying buyers, more showings to interested parties, provide an edge over the competition, and being at the forefront of the technology.

Virtual tour is an informational website concerning the evolution of virtual reality and its growing application to real estate marketing.

Although the application of virtual tour was already implemented in the market but the vast majority of virtual home tours is not yet multi-dimensional or genuinely 3D virtual reality. Existing e-commerce applications on the web provide the users a relatively simple, browser-based interface to access available products and also do not provide natural images where consumers have to imagine what the real version of a computer generated home really looks like.

Buyers are not provided with the same shopping experience as in an actual real estate. This experience, however, can be achieved by the creation of a 3D virtual reality tour this

is proposed to be carried in this project. It also creates three-dimensional real property tours for the consumer market and also instead of showing the property to one buyer; the agent can reach thousands of people through the virtual reality tour offered by the Internet. Virtual real estate tour is that almost anyone can afford. 3D helps buyers to handle an object by turning it around to see all sides of it. Depictions are very natural and the buyer does not have to imagine what the real version of a computer generated home really looks like.

Existing virtual home tours does not provide consumers to view the property by turning it around to see each and every side of it. For example, detailed information on the building regarding size, interior design, and facilities near by, facing area and others.

1.6 Objectives

The Internet is one of the most important medium influencing how real estate is bought and sold. Not only can potential purchasers search for an ideal property, but can also experience new levels of convenience and time savings through the use of real estate virtual reality tours.

The main objectives of this project are to enable buyers to view homes via virtual tours before physically viewing the property and make qualified decision on buying the property.

The specific objectives include fulfilling customer's requirements who will fully expect the better home builder to have embraced this new technology. Meanwhile, home buyers can also save their time and expense when searching for a property. Home builders can provide listing resource for buyers, and also provide the buyers with an open show houses 24 hours a day.

1.7 Significance of the research

This 3D virtual reality tours project is going to be a new innovative site that sells and displays virtual real estate on a dynamic. It takes a unique idea to get media attention and widespread recognition. With the creativity of 3D virtual reality, real estate will surpass all other similar sites, and become the next internet advertising phenomenon. Even though the basic components of virtual reality have existed since the early 1980s, but it was not assembled. Today the use of virtual reality is growing. It is one of the few technologies that are bounded only by the imagination. VR is shared and objectively present like the physical world, a work of art, and as unlimited and harmless as a dream. When VR becomes widely available, around the turn of the century, it will not be seen as a medium used within physical reality, but rather as an additional reality. 3D virtual reality tours are important in the real estate industries. Virtual reality tours provide an introduction to the relevant technologies and discuss future applications. The best property will go fast.

1.8 Research Scope

The 3D virtual reality tour is a useful method to sell real property through the World Wide Web and achieve the real estate target market. Physical open houses are time consuming for the real estate agent, displace the family living in the home, are affected by local weather conditions, and are costly for out of town buyers. Virtual reality tours enable prospective buyers to see a home with the convenience of internet access, with little incremental effort for the realtor or inconvenience for the seller. Another advantage of virtual tours is safety. Real estate agents do not have to be concerned about trying to monitor several people who may wander through different areas during a tangible open house. Alternatively, it is important to pay attention to how much depth of security systems and valuables appears on virtual tours. 3D virtual reality tour will display homes inside and out, letting potential buyers view a house from room to room, rotating 360 degrees, taking a tour, as it were, without the realtor leaving the office, or the buyer leaving their internet computer. This project will play an important role to make VR the best form of presentation short of an actual visit.

CHAPTER TWO

LITERATURE REVIEW

2.0 Virtual Reality for E-Commerce

Joravsky, (2005) defined that Virtual Reality (VR) is a form of human-computer interaction in which a real or imaginary environment is simulated and users interact with and manipulate that world. Users travel within the simulated world by moving toward where they want to be, and interact with things in that world by grasping and manipulating simulated objects. In the most successful virtual environments, users feel that they are truly present in the simulated world and that their experience in the virtual world matches what they would experience in the environment being simulated.

According to Michael, (2003) virtual reality is a rapidly evolving platform displaying information in a realistic simulation. Due to its ability to realistically simulate real life it has been adopted into e-commerce applications. In addition, virtual reality is a human-computer interaction paradigm, in which users are no longer mere external observers of images on a computer screen, but the active participants in a three-dimensional (3D) virtual world (Patrick, M.D., 2006).

Mark, (2000) found that the virtual reality for e-commerce is much more economical than such difficult programming. It uses special photographic techniques to truly show 'real'

depictions, those that a consumer is used to seeing as opposed to 'fake' computer generated models.

Virtual Reality is being used commonly on the Internet especially on e-Commerce web site in order to naturalize e-shopping experience and also make it more interesting for the customers. Virtual Reality can be made by creating 3D real time interaction environments to get as close as possible to the real world (Klinger, E., 2003).

Keith, (2001) noted that real estate is a promising setting for studying electronic commerce because it is an information-intensive and information driven industry; transaction-based, with high value and asset-specificity; marketing term diary (agents and brokers connect buyers and sellers rather than buying or selling themselves); and experiencing on-going information technology related changes.

Virtual reality for e-commerce takes two basic forms - *places* and *objects* such as people or products (Kessler, R. C., (1998). Places can be depicted in virtual reality on the internet for many reasons, mostly dealing with the real estate market. For example, virtual house walk-through and examination of rental properties or model homes for as yet inbuilt neighborhoods. The consumer can see what a site looks like, tour a home or other facility or go places that are otherwise inaccessible. Perhaps the greatest potential for display on the internet using virtual reality involves showing objects. One of the things that the web can do that a catalog can't is allow the consumer to handle an object

which can be turn it around to see all sides of it or even to see the product in 3-D? Instead of a static picture of an object, the consumer is able to see it from all sides (Brey, P., 2003).

2.1 Virtual Reality Tour

A virtual real estate tour is not just a cool gimmick real estate agents use to show off the technological prowess (Williams, H.E., 2004). It helps home buyers to get an immediate and efficient way to view and eliminate the homes. According to the 2003 National Association of Realtors Profile of Home Buyers and Sellers, seventy-eight percent of customers who shop for homes on the Internet say the most important feature when searching online is quality photos, followed closely by detailed property descriptions and a virtual real estate tour. Customers who demand a virtual real estate tour are more likely to be smarter and wealthier consumers compared to those who do not take a virtual real estate tour. On a typical day, more then two million people are using the Internet to go on a virtual real estate tour, according to the Pew Internet & American Life Project. Virtual real estate tour, however, are among some of the most common tours taken. The survey said it's a particularly common tool in the high-end market, where the best are professionally produced in living color, often with voice over as if the real estate agent is along for the virtual real estate tour. The best part is easy to navigate, allowing buyers to smoothly tour the listing room by room, as if walking through the home and looking up and down, left and right.

Through modeling the sight navigation into global model and local model, the user can virtually tour the scenes (Levy, J., 1995). Virtual tour can create a wide view angle image and allow the user to virtually tour from here to there with a small view window. This system greatly reduces the storage space because the whole walkthrough needs only several panorama images and hot images.

2.2 Panoramic View

Chorafas, & Steinmann, 1992 found that the capturing of panoramic 360◦ images has become a popular photographic technique. While a panoramic image gives an impressive view of the environment, many people have difficulties to understand the spatial scene arrangement from this flat image. Applications of this are, for example, real-estate or hotel advertising, featuring virtual tours through the apartment. A semi-automatic reconstruction process used in which the user marks the room corners in the panoramic images. These can be translated into viewing-angle measurements, from which an algorithms can compute the exact sizes of the walls, based on a pre-defined geometric model.

Visualization can provide a more comprehensive presentation of the scene to the user than a flattened panoramic image where the room geometry is not visualized (North, M., 2001). Another application could be the reconstruction of scenes in surveillance systems, in which the objects are extracted from the video and inserted into the 3-D model at their corresponding real-world position. It should be noted that both reconstruction algorithms

can also be used directly with panoramic video instead of single images, providing video textures on the walls of the 3-D model. Even for the video application, the geometry model only has to be computed once, if the positions of the cameras are fixed.

2.3 3D Environment

Adam, (2000) found that virtual environments allow users to explore an ancient historical site, visit a new home with a real estate agent, or fly through the twisting corridors of a space station in pursuit of alien prey. The visual experience of immersion in a 3D environment was stimulated by rendering images of a computer model as seen from an observer viewpoint moving under interactive control by the user. If the rendered images are visually compelling, and refreshed quickly enough, the user feels a sense of presence in a virtual world, enabling applications in education, computer-aided design, electronic commerce, and entertainment. A system for real-time walkthroughs of non-photorealistic virtual environments tackles the four main challenges of such a system interactivity, visual detail, controlled stroke size, and frame-to-frame coherence through image based rendering of non-photorealistic imagery.

Gross, (1999) noted that existing technology and standards allow the creation of three dimensional, virtual-reality browsing experiences. Such an interface may be more attractive and natural. In particular, with the increase in electronic commerce, the creation of virtual reality shopping seems of potential value. However, there are substantial

challenges in the use of existing virtual reality tools to create a real estate tour. The main challenges are the substantial size of the representation of the space, difficulties of navigation using typical UI devices, and support for interconnecting separately designed spaces.

Real estate tour is an integrated solution for creation, online operation and navigation in three dimensional. It enables continuous navigation between separately designed and incremental loading of spaces and objects as needed. Furthermore, real estate tour offers simplified navigation with less decision making via an automated walk modes (Satava, M.V., 2000).

2.4 Internet-based virtual reality

Orsi, (2001) noted that the Internet has become an effective marketing tool for real estate professionals. Potential homebuyers are turning more and more to the Internet over the more traditional advertising. Great majority of homebuyers prefer using Internet because of the time-saving factor. Buyers seeking information on the Internet spent three weeks less time looking at houses and their counterparts using traditional methods. In the early days of Internet marketing, real estate mimicked traditional advertising which a written description of the home along with one or more photos. As technology advanced, the virtual tour consisted of panoramic, 360-degree views, a method used by the majority of real estate web sites.

The growth of commerce on the Internet has attracted special interest. Since the Internet is a public network, and increasingly ubiquitous, it neatly addresses the problem of connectivity between potential trading partners (Neches, et al., n.d.), extending even to the general consumer.

CHAPTER THREE

METHODOLOGY

Leading technology, skilled professionals, and flawless execution are essential components for creating effective web-based solutions. Equally important are the thorough planning and careful oversight that bring web development projects together.

To do a business on the internet, one of the most important aspects of businesses success is web site. If the web site doesn't look professional, no matter what product is being offered, the chance of success will be minimal. The appearance of a website plays an important role of success. Product or service will literally be judged by the appearance of website. Poor web design is one of the leading causes of small business failure.

Web pages can be created in a number of different ways, such as:

- Plain text using HTML language
- Using Internet Assistant in Microsoft Word
- Using a web page editor, such as FrontPage, Macromedia Dream weaver, Page Mill

3.0 Five requirements of an effective web site

These five basic requirements in web site design methodology will dramatically increase the probability of having an effective web site.

a) Alignment

Alignment is the process of insuring that all processes in the business including web site are aligned with business goals. Without alignment, it's impossible to have an effective web site. Even if it works great, it's not going to be much help to the business.

b) Clear Purpose

Each section of the web site must have a purpose that is clearly understood by the site visitor. Purpose is the foundation of each site section. Purpose defines the look and feel (graphic design) and the content of the section. Having a clear purpose helps to create this content and it helps the site visitor understand what the site is about. Web site must clearly define its purpose. Shouldn't let customers try to figure it out for themselves. They will probably get it wrong.

c) Create Action

Every web designer will agree that navigation is one of the most important aspects of good web design. However, most designers view navigation as only the links and buttons that allow people to find information they are looking for. The true importance of navigation is insuring that the site visitor knows what is expected and what action are required. This is not the traditional "direct marketing" call to action. Rather, it is insuring that the "purpose" of the site section is clear and that the correct action is clearly defined. The vast majority of

site visitors appreciate knowing what is expected. They enjoy having a path to follow. Even those who consider themselves free thinkers and prefer finding their own way appreciate it when the information they are trying to locate is clearly defined.

d) Relationship focused content

A relationship is required for any transaction to occur. In the physical world this relationship is taken for granted. Someone walks into a business, talks to a sales person, experiences the environment and makes a purchase. In the virtual world there is no person to help create a relationship. In fact, the virtual world is the home of non-relationship, where a user can wander anonymously around the site, purposefully avoiding the creation of any relationship. This makes it absolutely necessary to focus the content on creating and enhancing a relationship that is a connection between the site and the user.

e) Measurement

Without measurement cannot methodically improve a web site. Effective measurement tells that a web site is helping meet the business goals.

To build a successful web site specific methodologies are required. In developing 3D Virtual Reality Tour, Web Page Development (WPD) methodology which was developed

by December J. (1996) was selected in order to produce such a best web pages. Figure 3.0 shows December's WPD methodology.

December's methodology is based on the idea that web development can benefit from knowledge and skills in many areas and attention to six processes and six web elements. Key to this methodology is a view of the web as a medium with unique characteristics and qualities.

Developing information for the web requires a focus on meeting user needs. To accomplish this, December's methodology involves six elements and these six continuously ongoing processes:

a) Planning
b) Analysis
c) Design
d) Implementation
e) Promotion
f) Innovation.

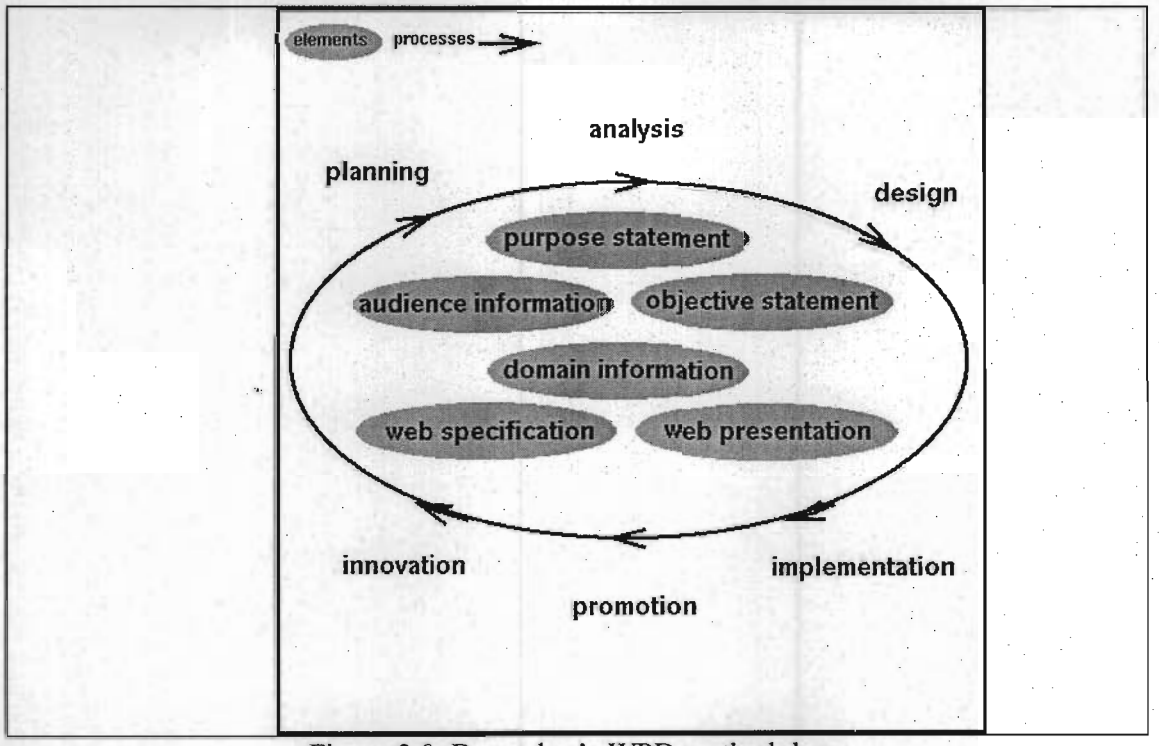

Figure 3.0: December's WPD methodology

3.1 Planning

Planning is the first stage in developing a web page. Planning is a process of choosing among competing opportunities for communication so that overall goals for the web can be set. These goals include defining and gathering information about the audience, purpose statement, objective list, web specification and web presentation as illustrated in Figure 3.1. Planning also is done for domain information through a process of defining and specifying the supporting information that must be collected, how it will be collected, and how the information will be updated.

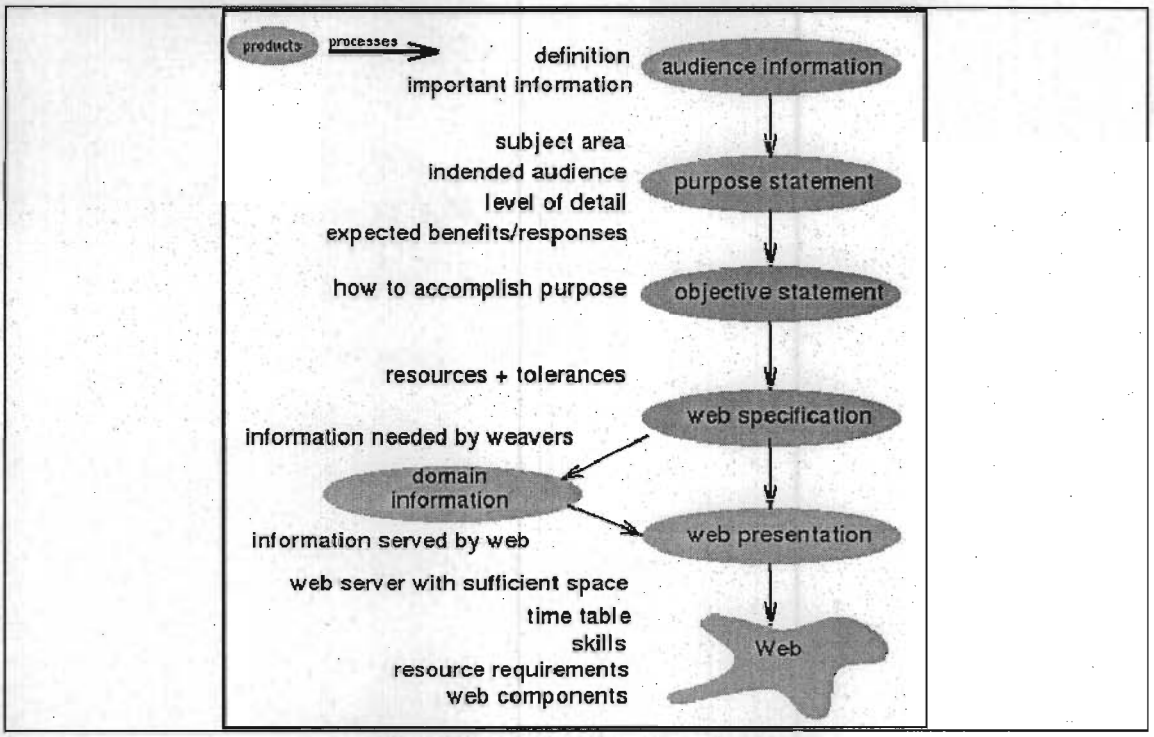

Figure 3.1: The Planning phase

3.1.1 Audience Information

Audience information is a store of knowledge about the target audience for the web as well as the actual audience who uses the information. In developing audience information, it is a need to answer the question "who will use this web?" One method to generate this information is more about the audience's background, interests, proclivities, and all detail helpful to shaping the information to suit the users' needs. All this information might not be complete at any time during the web-development process unless a store of information develops over time. The audience information might be very useful and accurate at one time and it then might pass out of currency as different users start accessing the web.

Audience's targets have been identified in this phase. The content of this web site must fulfill homebuyer's needs that have not enough of time to make right decision at right time regarding which house to purchase. When homebuyers access the home models via virtual home tours, they can save their time and travel expenses in looking around for new houses.

For those homebuyers with extremely stretched commitment, this web site really makes sense for them in a way where they can start hunting for new houses on the web. So basically, audience information giving some ideas on how to design a site and what are the contents to include in this web site.

3.1.2 Purpose Statement

The purpose statement is an expression of the reason for and scope of the web's existence. It is a must to have a written purpose statement available at all times during web development. A succinct statement of this purpose, however general, serves as a guidepost for the web-development processes.

This web serves more specific purposes for the homebuyers such as offering online house booking system with relevant information and offering exclusive services where homebuyers can walkthrough the new

house with 3D motions in any angles turn the property around, zoom in and out before making their final decision.

3.1.3 Objectives list

The objectives list flows from the purpose statement and defines the specific goals the web should accomplish. An objective statement based on the purpose used in the preceding paragraph, the objective statement changes as the purpose of the web changes, but also as the information about the audience changes. Some possible objectives include business objectives, information objectives, functional objectives, user interface objectives, development objectives, operational objectives and quality objectives.

This web site was developed based on business objective. It consist of advertising new home, draw potential buyers, improving customer service and increasing company profit.

Business objective can be accomplished via this web site by persuading homebuyers that 3D virtual reality tour can accurately expose the house that buyers wanted to buy. Meanwhile homebuilder companies can survey whether the house design meets buyers requirements through 3D virtual reality. This will later on help homebuilders to cut cost and increase their profit.

3.1.4 Domain information

Once objectives are set, the next stage is to gather domain information which supports the objectives. Domain information is a collection of knowledge and information about the subject domain the web covers, both in terms of information provided to users of the web and information that the web developers need.

For example, this website which offers new house for sale consists of information like price, specification, property listings, and floor plan. While not all the information would necessarily be made available to the users of the web, this domain knowledge may be helpful for the web developers to have so that they understand how this knowledge is structured and the vocabulary and concepts associated with it. Often, domain knowledge makes a good complement to the information the web already offers.

3.1.5 Web specification

Web specification is a detailed description of the constraints and elements that will go into the web's design and implementation. In this web site, the specification statement specifies what pieces of domain information will be presented as well as any technical or policy limitations on that presentation. For example, one part of a specification might state that the

graphics at the site must be under a certain size or must be a certain format.

3.1.6 Web presentation

According to the web site, the web presentation is by which the information is delivered to the user. The presentation is the result of design and implementation processes that build on the web specification. In these processes, creative choices are made among design and presentation techniques to achieve the web specification; considerations for efficiency, aesthetics, and known web-usage patterns also are made.

This list of the elements involved in the web-development methodology shows that there are many interactions and relationships among them. In fact, all the elements depend on the best information being available about the other elements in order to be successful. Similarly, the elements interact with the processes of the methodology.

The web presentation which web's information is delivered to the user essentially the sum total of all the HTML files plus associated multimedia files or other software (CGI, Java, or other) to support the web. The presentation is the result of design and implementation processes that work within the web's specification.

3.2 Analysis

Analysis phase includes the process of gathering and comparing information about the web and its operation and use in order to improve the web's overall quality and to identify problem areas. Web analysis intended to check web elements (audience information, purpose and objective statements, domain information, web specification, and web presentation) and performance (information about how users have used or are expected to use the web). This analysis process covers the technical validation of a web's HTML implementation as well as analysis of the web's planned or existing content and design. This process also touches on usability and style issues. Because of the dynamic information environment in which a web operates, these ongoing efforts to evaluate web quality and usability become the key to increasing the effectiveness of an organization's web communication.

This information analysis process also involves gathering information about other competitor webs that may be accomplishing a similar purpose or reaching a similar audience. When performed with the other people involved in web development processes, web information analysis serves as a check of the web's overall quality and effectiveness.

Figure 3.2 shows an overview of information useful in analysis. In the figure, the web's elements are in rectangles, and supporting or derived information is in ovals. Key checkpoints for analysis are shown in small circles, labeled A through F. At each checkpoint, information about the elements or information derived from the web

elements will be compared in order to see whether the web is working or will work effectively.

The key to the analysis process is that it is meant to check the overall integrity of the web. Results from the analysis process are used in other processes to improve the web's performance. If analysis of the web's domain information shows that it is often out of date, for example, the planning process needs to be changed to decrease the time between updating the domain information. The analysis process on the web's elements helps all processes of web weaving work correctly and efficiently.

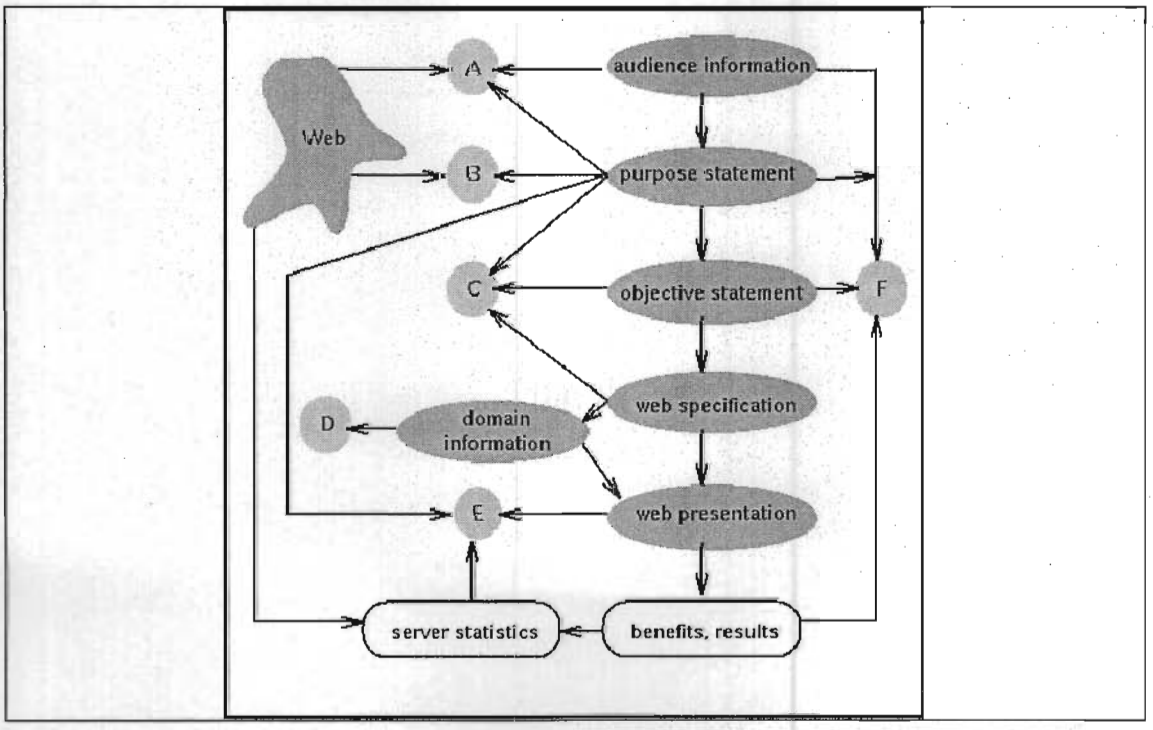

Figure 3.2: Information useful in analysis

3.2.1 Entity Relationship Diagram

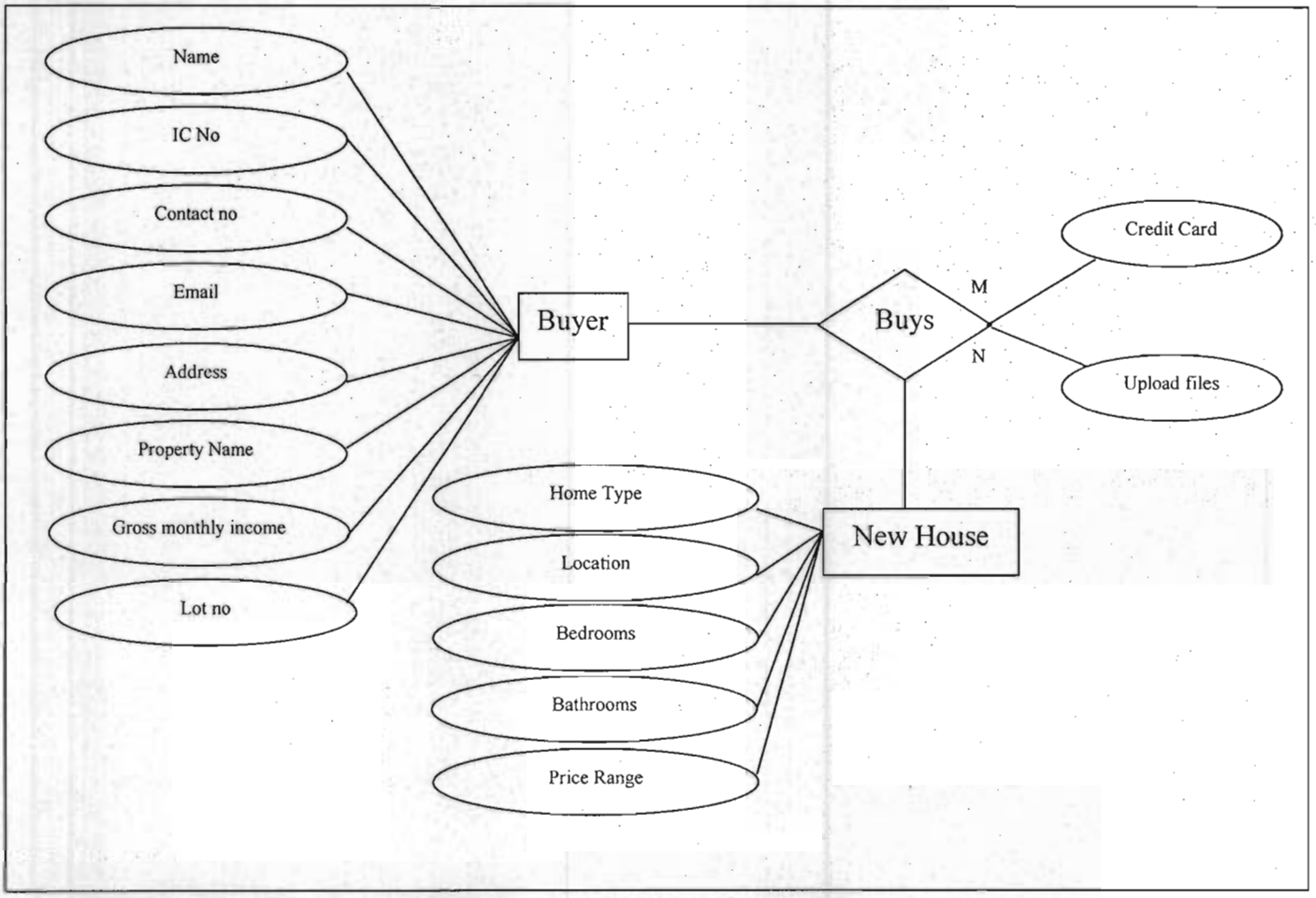

Figure 3.2.1: ER diagram representation of the home buyer and new house entities, and the sale relationship between them

Figure 3.2.1 represents the entity Relationship Diagram (ERD) for Dream Home. There are two entities that are buyers and new house.

Buyer can access the new house information such as home type, location, number of bedrooms and bathrooms preferred and price range which is stored in the new house data store. After accessing all the information buyers may choose a new home to buy. Then

buyer can take a virtual walkthrough tour of the house that is kept in the Virtual data store.

Once buyers decide to buy a house, personal details such as name, IC number, contact number, email, address, monthly gross income, property name and lot number need to be uploaded. Required house will be matched with income obtained by the buyers. If it is affordable buyers can proceed to book the house by making credit card payment (deposit) and finally upload the relevant documents for loan purpose. Otherwise, there will be a message saying that the buyer's income does not match with the price range and option will be given to choose some other houses.

3.3 Design

Design is this process of creating a map of the relationships among pages of the web and the look and feel of individual pages. The design stage includes taking into consideration about how web components will accomplish the web's objectives. A web's design is essentially its look and feel. A good design should take into account all the web elements-audience information, purpose and objective statements, domain information, and web specifications and combine them to produce a plan for implementing the web.

In developing this web site a repertoire of techniques for packaging, linking, and cueing information using one or more design methodologies was made. Throughout this process, they should be sensitive to users' experiences of the web's information space, texture, and

cues. Very practical issues are involved in design, such as considerations for inline images and graphics, how much to put on a single page, and which text or images should be made a link as opposed to which should not. The design process, however, is just one process in the interlocking web development processes.

The web design process (as shown in figure 3.3) takes information from all elements of web development and combines them to produce a look and feel design that then is used by the implementation process to create a working web. By separating the design from the implementation process, information about the web's structure and operation can be cast in a hypertext, language independent form. Whereas the design process is influenced by knowledge of what is possible in the target design language, its product can be implemented in any language that can capture the features used in the design. In this way, this design process can be used with successors or alternatives to the widely used HyperText Markup Language (HTML).

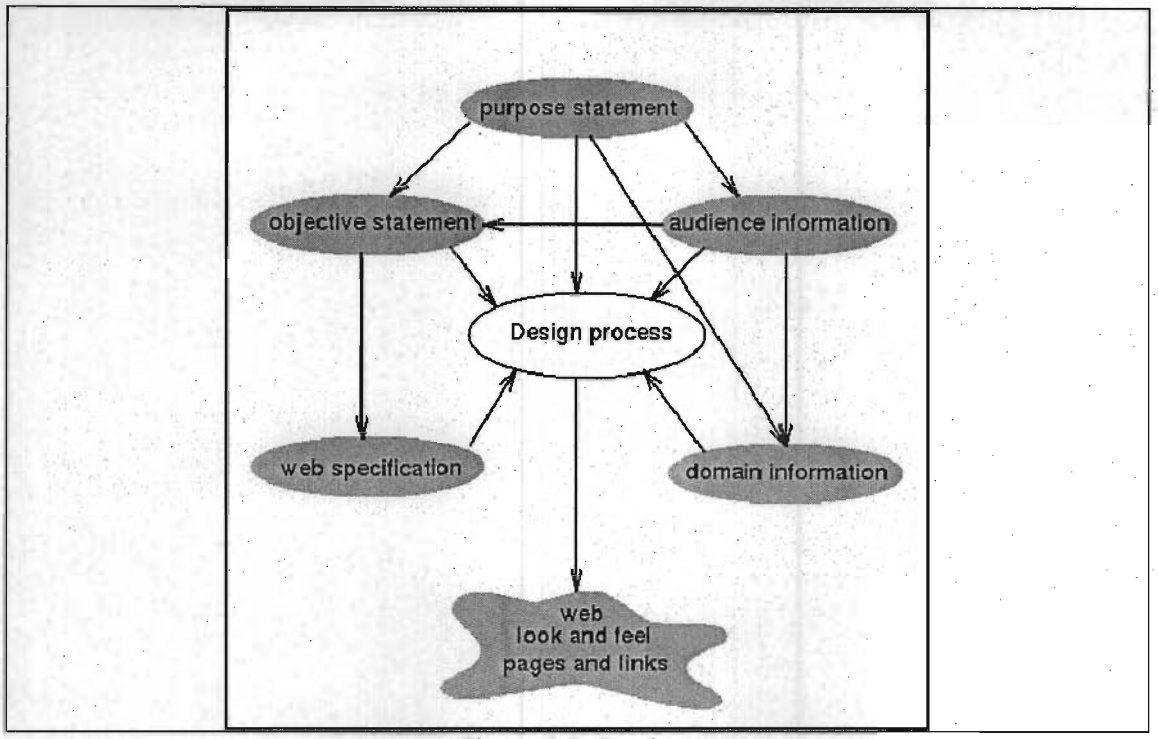

Figure 3.3: Design process

3.3.1 Web design methodologies

In developing this web site, three types of approaches were chosen. All the types are explained below.

3.3.1.1 Top Down

In the top-down methodology, web site is started with a front or top page (often called the home page) for a web and then branch off from there. Prototype holder pages that contain only minimal information but hold a place for later development in the web might be created. The benefit of the top-down approach is pages can be developed according to one central theme or idea. This provides a good opportunity to affect the look and feel of the

whole web very powerfully because all pages are designed according to the top page look and feel. A good way to do this is to design a set of templates for types of pages in a web and use these during the implementation process.

3.3.1.2 Bottom Up

Web designers know how specific pages will look and work, working from these specific pages to the top page might be the way to proceed. This is particularly true if they already have existing pages as a result of the development of some other web or service.

If web designers have no pages from which to start, they can begin by designing leaves or pages that accomplish specific objectives and then link them through intermediate pages to the top page. The benefit of this design is that the designers aren't constrained by the style of a top page in the leaf pages. Instead, they design the leaf pages in exactly the right style based on their functions. Later, they adjust the pages to create a common look and feel for the whole web.

3.3.1.3 Incremental/In-Time

Similar to the top-down and bottom-up approaches, the incremental/in-time approach develops pages "just in time" when they are needed. An initial home page might be needed as well as specific leaf pages that implement particular objectives. These are created and linked with the understanding that later, intermediate pages might be added. This works well if web developers want to very quickly have a working web that grows incrementally rather than deploying all at once.

3.3.2 Creating User Interface

Microsoft FrontPage 2003 is an auto generated web development tool used to develop this web site. Web site created without programming and also without installing web server on the computer.

Microsoft FrontPage 2003 offers both design (layout) and development (programming) support. Supports all major server-side scripting languages (ColdFusion, ASP, PHP, JSP), Javascript, XML, and ASP.NET (VB.NET and C#). Integrates well with Adobe Flash and Adobe Fireworks (both formerly Macromedia).

3.3.3 Creating 3D Virtual Reality Tour

3D virtual reality tour was developed by using LightWave 3D 9, Pixmaker Pro and JavaScript.

LightWave 3D offers modeling and scene set-up, and animation and rendering, which is handled by two separate but discreet applications: Modeler and Layout. The camera system also offers a completely new set of camera types. The Advanced Camera can be set up in a bewildering variety of ways, and it's safe to say that no other 3D program offers the same flexibility. There are more features such as Time Sweep and Ray Start. Practically any physical camera lens can be simulated, or a range of seemingly impossible effects. The surface of a mesh object can be rendered to create a true spherical camera using a sphere object that load into Layout. There are scores of other useful new features hidden away in LightWave 9, including a new node-based surfacing system, OpenGL 2.0 implementation in Layout and general workflow enhancements such as the automatic content directory feature, which enables to load scenes from other locations without having to set the content directory first. LightWave continues to be an impressive 3D animation and rendering package. It also helps to maintain its position as a favorite among artists and studios alike.

JavaScript was added into this web site. JavaScript is a simple language used to develop dynamic (interactive) behavior in elements of the Web page. These scripts can easily be embedded into HTML document or actually create a HTML document. JavaScript is also a dynamic scripting language supporting prototype based object construction. The basic syntax is intentionally similar to both Java and C++ to reduce the number of new concepts required to learn the language.

Pixmaker pro was selected to create panoramic views in this web site. Pixmaker extends an immersive user experience that simulates three-dimensional objects and places. In pixmaker, user interactivity is enhanced because user can control panoramas by clicking and dragging various hot spots with the mouse. Pixmaker panorama lets user stand in a virtual place and look around. It provides a full 360 degree panorama and the ability to tilt up and down a full 180 degrees. The actual horizontal and vertical range, however, is determined by the panorama itself. To look left, right, up and down, user simply drags with the mouse across the panorama. Pixmaker allow user to "handle" an object, so user can see it from every angle. User can even rotate it, tilt it, and turn it over.

Virtual reality information is typically stored as a panorama, made by stitching many images together so they surround the user's viewpoint or surround an object that the user wants to examine.

3.4 Implementation

The goal of the Implementation phase is to create a polished and fully functional web site that will be deployed and used by people in the target audience. All of the code, graphics, and HTML are thoroughly tested, both individually and together as a whole, to ensure that the web site works as intended and will download quickly. All of the content is also checked for accuracy.

Instead of developing the entire web site at once and waiting until the very end to deploy, select parts of the web site are created and deployed incrementally. The most important functions and subsides are developed first and made available for use to early adopters. The feedback from these people is used to drive the immediate design and development of the rest of the web site. Staged development must be handled carefully, though, because if the web site is rolled out too early and shows a lack of content and polish, people may avoid the site later on.

A web implementer creates hypertext markup language (HTML), Common Gateway Interface (CGI) programs, and/or Java scripts and/or applets. The implementation process resembles software development because it involves using a specific syntax for encoding

web structures or a programming language in a formal language in computer files. Although there are automated tools to help with the construction of HTML documents, a thorough grounding in HTML enriches the web implementer's expertise. Figure 3.4 demonstrate implementation phase in WPD methodology.

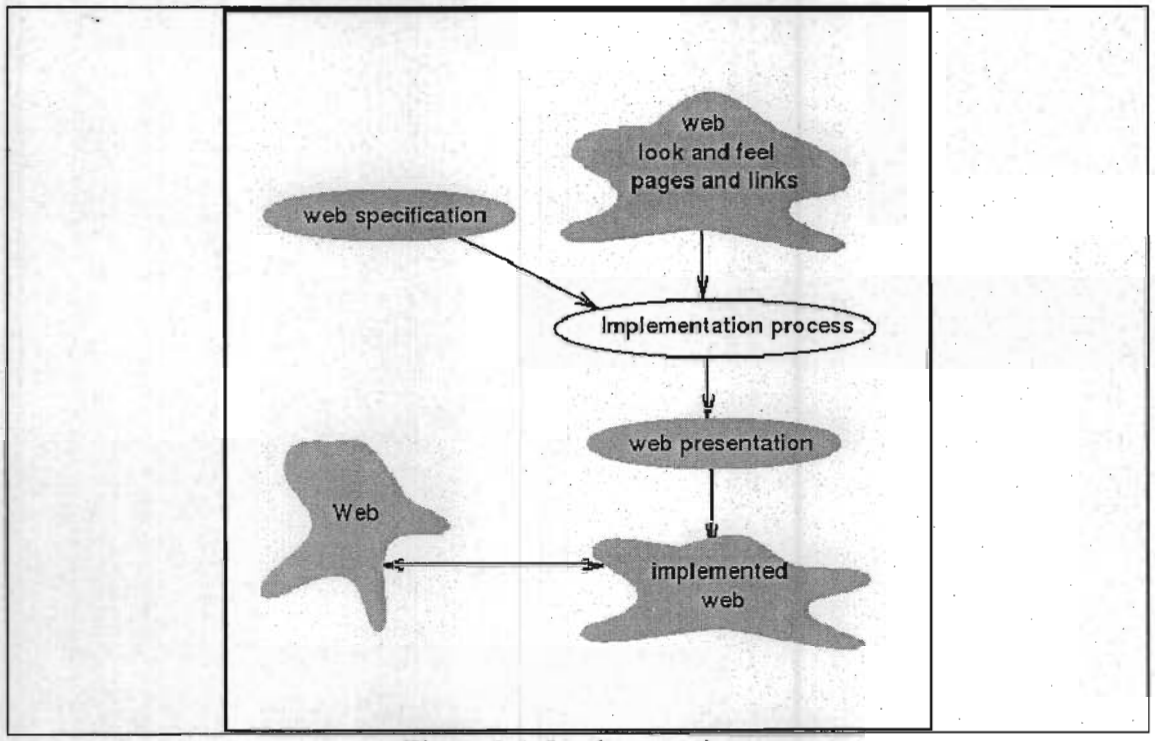

Figure 3.4: Implementation process

3.5 Promotion

Promotion is the process of handling all the public relations issues of a web. These include making the existence of a web known to online communities through publicity as well as forming business or other information relationships with other webs. Promotion may involve using specific marketing strategies or creating business models.

3.5.1 Web business Model

Web is growing as a place where businesses reach audiences. Ways of reaching and supporting customers on the web are emerging and evolving. An initial presence on the web serves as an organization's base from which to expand and evolve other services.

The act of web promotion is to increase the web's radiance, or the links that go into a web, giving potential buyers a way of locating a web. Quality also is a consideration; reaching the target audience, not necessarily everyone on the web, is the primary goal.

Through service, publishing, sponsorship, or advertising, a web can meet the needs of potential buyers. The buyers on the web take part in information, communication, and interaction on the Web. As part of this activity, they have a cone of attention, or a region of web space of which they are routinely aware. Doing business on the web, then, involves taking part in activities and integrating a web with existing and evolving communities of interest. Figure 3.5.1 illustrates web business model.

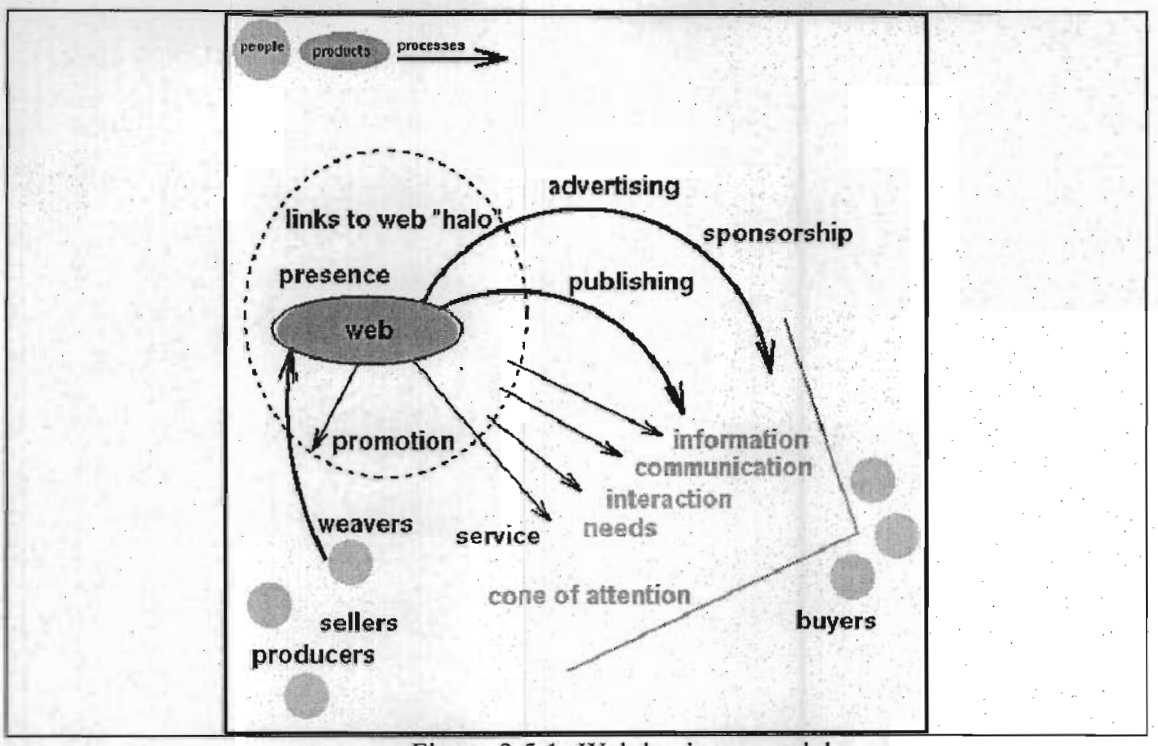

Figure 3.5.1: Web business model

3.6 Innovation

The innovation process works closely with the other processes of web development. In fact, innovation is a complement to each of the web development processes. It draws information from them about the current web and identifies new needs for the web to serve users. No one person on a web development team is designated as the single web innovator. Instead, all the team members participate in innovation. Innovation involves using a variety of techniques and strategies that evolve as web developers gain experience.

Innovation is a creative, dynamic process that can't be fully encapsulated in a series of how-to steps. Instead, innovation is a repertoire of skills in creatively monitoring and

understanding user needs and developing web structures to meet those needs. Because the World Wide Web is dynamic, highly enmeshed, competitive, and often a continuously available, global service, developing a web never stops. The information space in which a web operates constantly changes, and, possibly, the domain information of a web changes. The amount that a web changes depends on users' needs, the nature of the domain information, and other factors such as the growth of competitive webs. The key to approaching this need for continuous development is to keep all web development processes operating. After plans are made for a web, those plans should be reevaluated and adjusted to new conditions. All the methodologies such as planning, analysis, design, implementation, and promotion of a web need to integrate with each other in order to accomplish many tasks, and continuously strive to improve the web for the good of the user.

CHAPTER FOUR

RESULT

4.1 The flow of Dream Home Web site

For this research, a web site called Dream Home was developed. Dream Home plays a role as a homebuilder. It publishes listings of new houses and also upcoming projects. Home buyers can browse through the web site via 3D impressions. Buyers could also view the whole unit through a 360 degree panoramic view. Once the houses meet buyers' requirements, then they can straight away book the house through online. At the same time, Dream Home will help to calculate whether the house selected by the buyer matches their gross income or not. Incase if the house chosen is not affordable, then it will give another option where buyers can afford to pay the monthly payment.

Dream Home web site was developed in order to allow home buyers to view and choose new house, eliminating time consuming trips to the show house session. This web site also provides valuable and up to date data compare to the traditional house selling process.

4.2 E-commerce business model

Dream Home in this research implements Business to consumer (B2C) e-commerce business model, which is illustrated below in Figure 4.1 below. B2C e-commerce refers

to the emerging commerce model where businesses /companies and consumers interact electronically or digitally in some way. In a typical B2C flow of information between Dream Home and home buyers typically is through the medium of Internet. B2C e-commerce reduces transactions costs (particularly search costs) by increasing home buyers access to information and allowing buyers to find the most competitive price for a product or service.

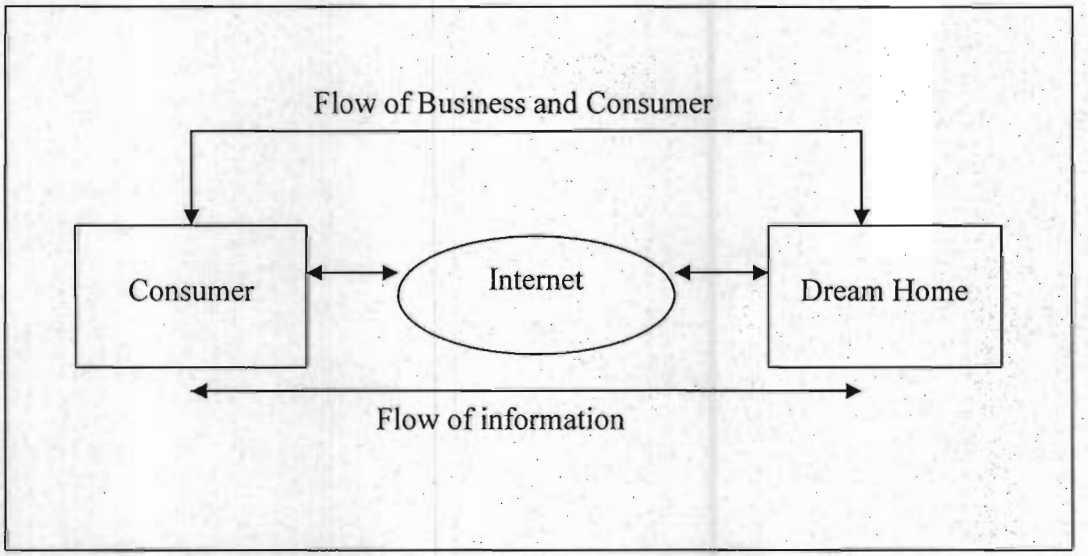

Figure 4.1: Business to consumer (B2C) e-commerce business model

4.3 Snapshots of Dream Home

4.3.1 The main page

The main page includes some search criteria which need to be chosen by the home buyers. For example, buyers need to select

⇨ House type (single storey terrace, semi-detached or double storey)

⇨ Location

⇨ Number of bedrooms preferred

⇨ Number of bathrooms preferred

⇨ Price range

Figure 4.3.1 below illustrates the main page of Dream Home web site.

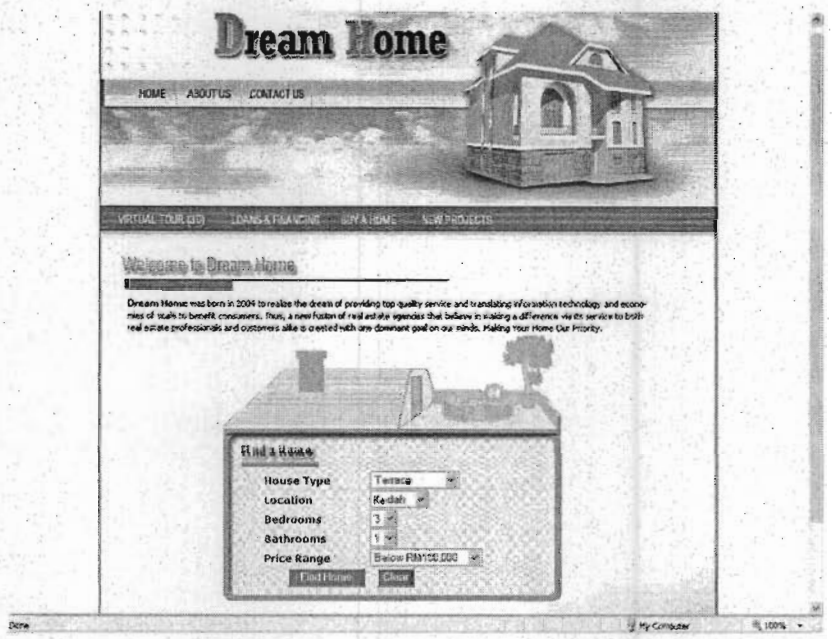

Figure 4.3.1: Index page of Dream Home

4.3.2 House listing page

Once buyers key in all the criteria in the main page, the next page will display the results that matches the requirements. Buyers can find all the listing available for that particular search. Figure 4.3.2 shows the search results based on buyers selection.

Figure 4.3.2: House listings

4.3.3 Floor plan

Home buyers need to click on the 3D Virtual Tour button in order to have a close up view of the selected house. A floor plan will appear and buyers can have a look on the living area, bedroom 1, bedroom 2 and kitchen one by one. If buyers wish to have a quick walkthrough of the whole unit then they can click on the flythrough button.

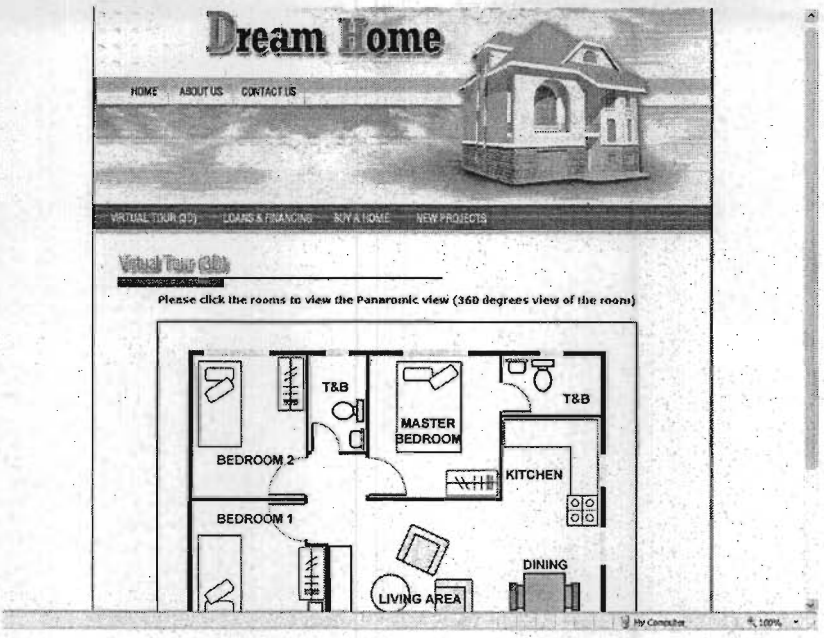

Figure 4.3.3: Floor plan

4.3.4 Virtual 3D walkthrough

Dream Home uses virtual reality technology on its web site to display three-dimensional (3D) new house to home buyers. Virtual home model enables buyers to walkthrough three-dimensional replications of homes. Home buyers can feel the 3D walkthrough by clicking living area, bedroom 1, bedroom 2, kitchen and so on the floor plan. Instead of viewing the 3D panoramic view separately buyers could also click on the flythrough button which will take the buyers go around the whole unit in and out. Appendix A includes figures 4.3.4a, 4.3.4b, 4.3.4c, 4.3.4d and 4.3.4e showing the 3D panoramic view.

4.3.5 Online booking

Home buyers need to submit some important particulars such as name, IC number, contact number, email, address, monthly gross income, property name

and lot number via online. Buyers can also book the preferred house via online by paying the deposit using a credit card. Once booking done, buyers need to upload some relevant documents in order of loan arrangements. Later buyers will be contacted by the respective staff for further process. Appendix B consists of figures 4.3.5a, 4.3.5b, 4.3.5c which illustrates the process of online house booking in dream Home web site.

4.3.6 Loan and Financiers

There are also information based on the list of financiers (banks) available and the types of loans provided by each bank. Home buyers can always have a look at this information in order to apply for housing loan and get their targeted dream home. Figure 4.3.6 shows the financier's details.

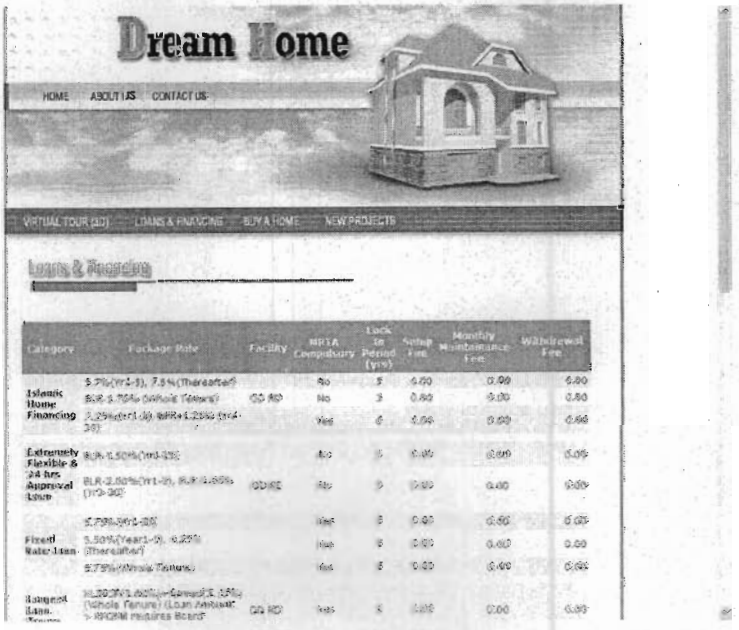

Figure 4.3.6: Loans and financing

4.4 Web design

In e-commerce, the first impression will give the best impression to the customers. It is essential for a web site to make it easy navigation for customers in order to find what they exactly want to buy.

4.4.1 Flowchart of the Dream Home website

A flowchart was derived in term of getting clear picture of the requirements of the project. Figure 4.4.1 illustrates the flowchart for Dream Home.

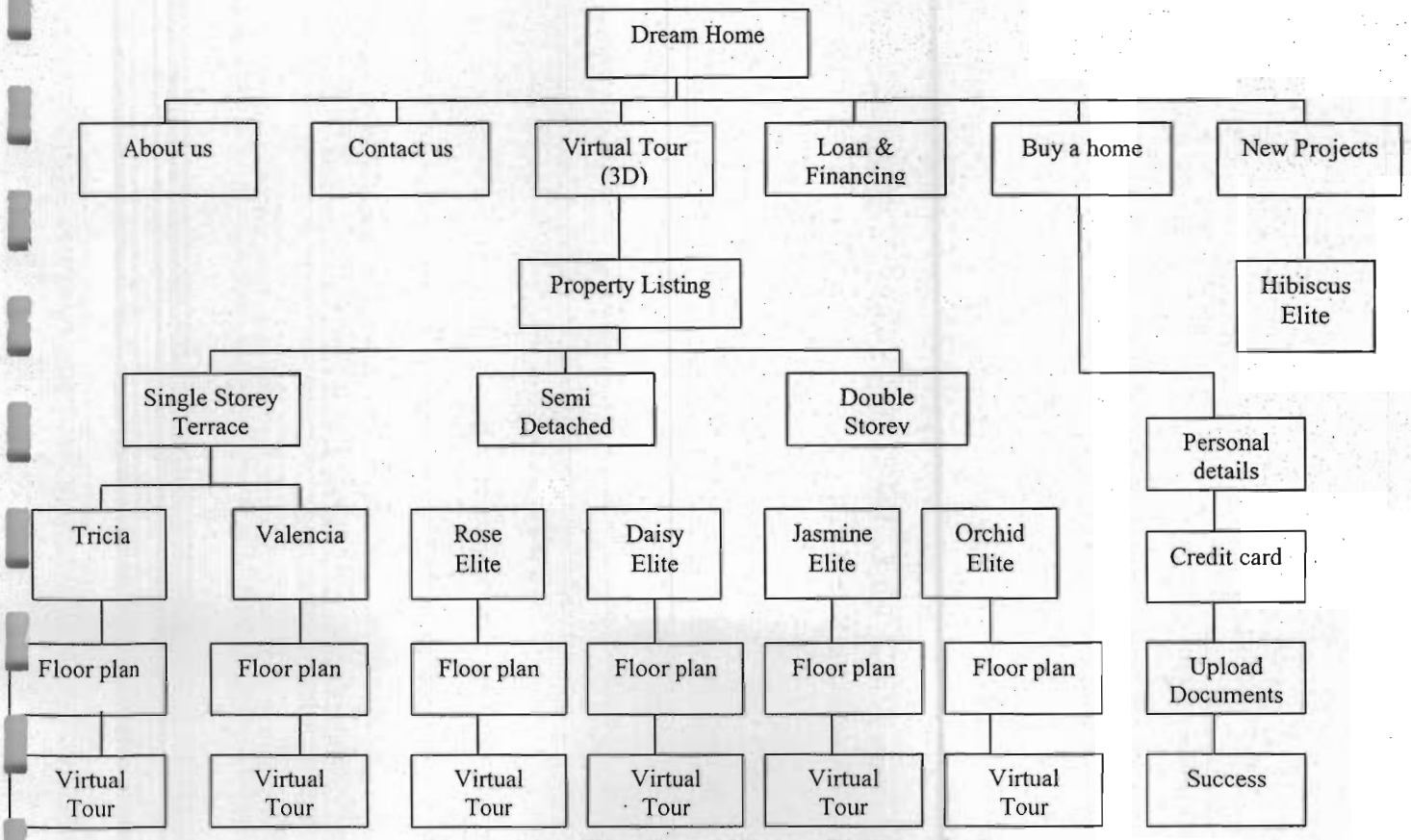

Figure 4.4.1: Flowchart of Dream Home web site

Dream Home links buyers to such pages as listed below:

⇨ About us

⇨ Contact us

⇨ Virtual Tour (3D)

⇨ Loans & Financing

⇨ Buy a home

⇨ New Projects

4.5 Generating 3D image and panoramic view

Appendix C showing the process of generating 3D image and also panoramic view.

CHAPTER FIVE

CONCLUSION

E-commerce involves carrying out business over the Internet with the assistance of computers, which are linked to each other forming a network. To be specific e-commerce would be buying and selling of goods and services and transfer of funds through digital communications. E-commerce helps reduce the delivery time, labor cost and the cost incurred in the following areas:

- Document preparation
- Error detection and correction
- Reconciliation
- Mail preparation
- Telephone calling
- Data entry
- Overtime
- Supervision expenses

Shopping on the Internet is the flexibility to place an order at a time suiting the buyers. The Internet is an exciting tool that not only puts vast information at buyer's fingertips but expands their shopping options like never before. Now, with only a few clicks of a mouse, buyers can go online to buy just about anything they need no matter from foodstuff, airline tickets till booking a new house.

Home buyers are becoming much more Web savvy. 60% of home buyers are using the Internet to get home buying information.

Virtual home tours in general, are taking off as a popular way to sell real estate through the World Wide Web. Virtual home tours have become one of the most important tools for selling a house. 92% of home buyers consider the addition of property photos to an online listing to be very important. Traditional open houses are labor intensive for the realtor, displace the family living in the home, are affected by local weather conditions, and are costly for out-of-town buyers. Virtual home tours enable prospective buyers to see a home with the convenience of internet access. Virtual home tours are a great way for buyers to see multiple homes at a distance. Currently, it provides information on current and potential applications of virtual reality technology. Currently, most virtual home tours online are just videos than pan across the exterior or rooms of a house. Instead of that this project allows virtual reality home tours to explore the home three-dimensionally and interactively.

The main strength of virtual reality tour is that it generates something new and different where home buyers can really see without considering where they are. With the concept of interactivity, virtual reality tour allow buyers to navigate and explore 3D images. Buyers can turn all the way around an environment, taking their time to stop, go back and even zoom in. The tours provide an accurate and realistic experience in order to ensure buyers get closer to that environment as possible as they can without being there physically.

5.1 Fulfillment of the web site

The Internet is becoming a major factor in searching the majority of properties listed for sale. Rather than merely viewing a small exterior photo and a plain text description, Dream Home web site allow home buyers to see full color 360° views of properties. Dream Home is a 24 hours open house available online without agents. The development of the Dream Home web site in this research is expected to fulfill home buyers' requirements. For example, home buyers are very busy with their career and don't have sufficient time to go around and search for houses. Buyers need not have to search for agents or brokers and waste their money and time. What they have to do is just browse the web site and make online booking if the property listing matches their preferences.

Besides that, by using virtual reality technology in e-commerce applications, this research increases the degree of interactivity by selling houses through online. Virtual walkthrough feature which is offered in this web site replaced traditional home selling method.

Dream Home web site enables out-of-town buyers to make qualified decisions efficiently and conveniently because now they have the ability to visually walk through the property without having to be there.

Internet homebuyers become more educated and invest significant time investigating the housing market and financing options. By the time home buyers contact a home builder,

they have a good understanding of what they want, where they want to live and what they can afford, they tend to look at fewer homes and buy faster. In other word, home buyers would choose the neighborhood they want to evaluate, narrowed their choice of homes, come up with a list of homes they want to see, and understood what they can afford.

Dream Home web site could reach more buyers with the virtual tours than with any other comparable product or service on the Internet. It also offers home buyers the chance to take a virtual tour from anywhere with Internet access no matter from their home, office or from any remote location.

5.2 Limitations of the Research

A number of limitations and constraints had been pointed out throughout the research.

(i) No sound effect

Dream Home web site does not include any soft audio as the background music to make the home buyers feel more accompanied.

(ii) Walkthrough is too fast

It has been noticed that all the walkthroughs for single storey terrace, semi-d and double storey houses which are available in the Dream Home web site are extremely fast. The speed of walkthrough should be reduced in order to make the user feel more convenient when they walk into the respective houses.

5.3 Future Plans

Since Internet has been chosen as the promotion tools, there are few things need to be considered in order to make the web site more attractive and worth viewing. Additional elements such as sounds can be added on to the web site. Dream Home web site must be the best web site among the competitors in future.

Instead of these, another element also can be added to the web site that is the user's feedback column. So that, improvements will take place based on the feedbacks or comments given by the users.

The process of creating something different from the others requires greater knowledge and specialty. This is where an individual proficiency plays an important role. The combination of several expert will eventually create something different which not many people able to do. Flash animation can be embedding into the web site in term of emphasizing the tremendous features that the software holds.

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URL: http://www.placetour.com/examples.html

URL: http://www.viniinfinity.com/3DVirtualReality.asp

URL: http://www.placetour.com/softwaredemo

URL: http://www.ashi.org/customers/VHI/VHI.htm

URL: http://www.virtualworldrealestate.com/faq.htm

URL: http://www.easypano.com/virtual-tour-gallery.html?gclid=COeTrtXk65ACFQEeewodUGLFOQ

URL: http://virtual-reality.archiform3d.com/index.php

APPENDIX A

Figure 4.3.4a: 3D panoramic walkthrough –Living area

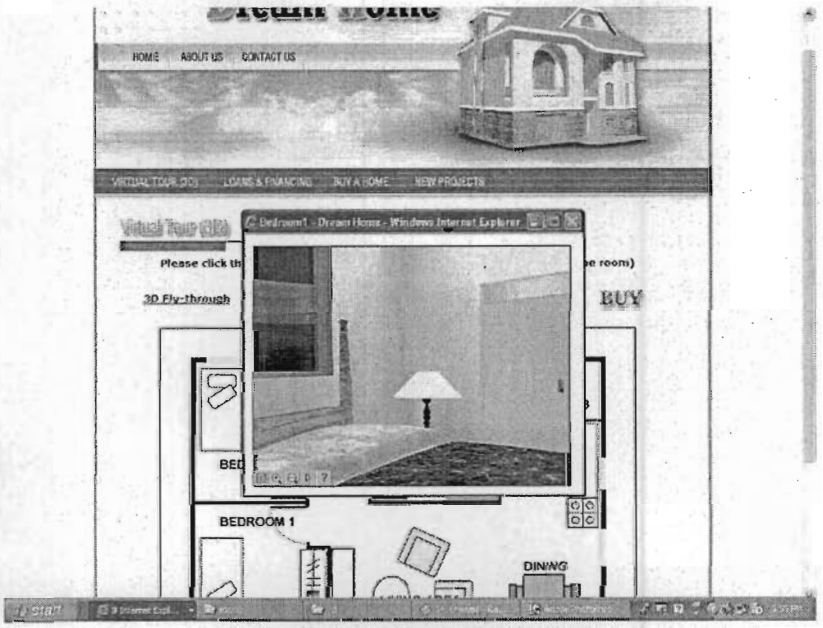

Figure 4.3.4b: 3D panoramic walkthrough –Bedroom1

Figure 4.3.4c: 3D panoramic walkthrough –Bedroom 2

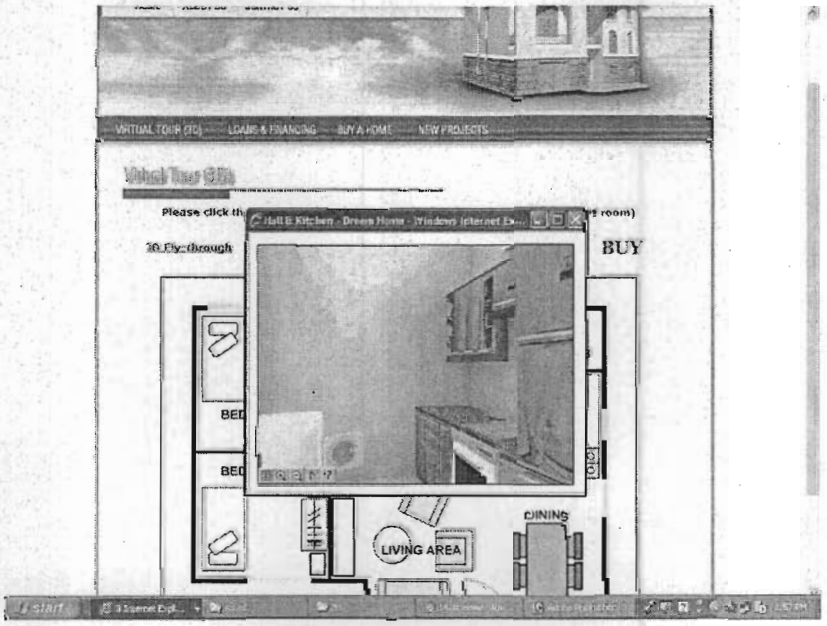

Figure 4.3.4d: 3D panoramic walkthrough –Kitche*n*

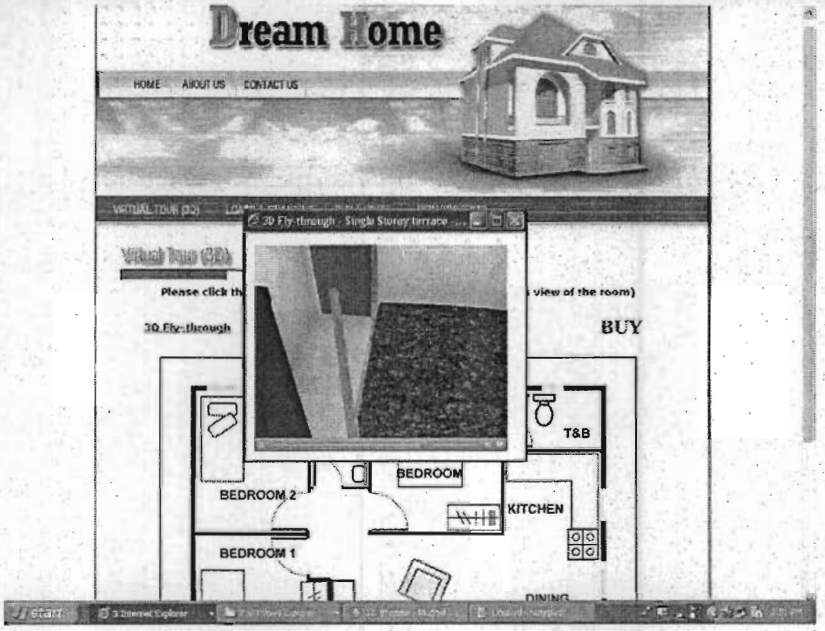

Figure 4.3.4e:Flythrough of the whole unit

APPENDIX B

Figure 4.3.5a: Personal details

Figure 4.3.5b: Credit card information

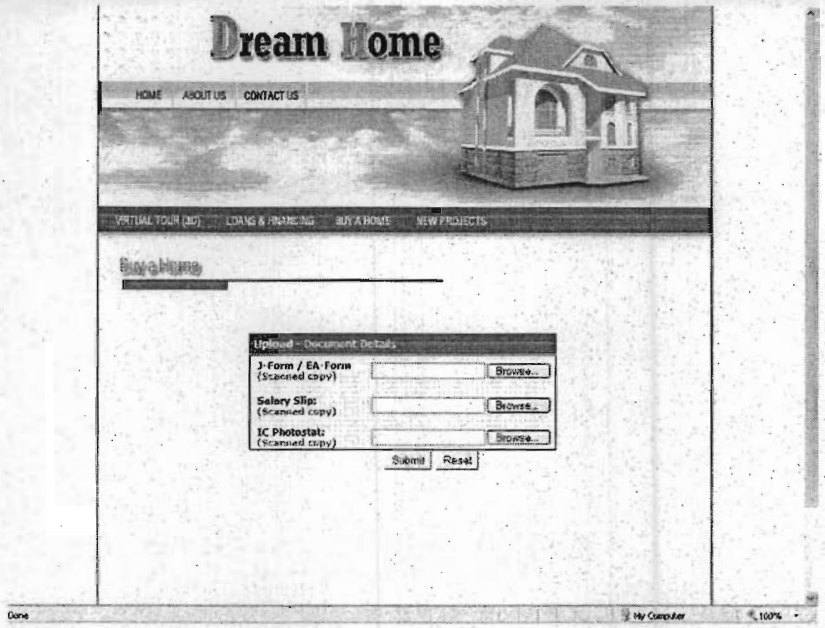

Figure 4.3.5c : Uploading some important documents for loan application purpose

APPENDIX C

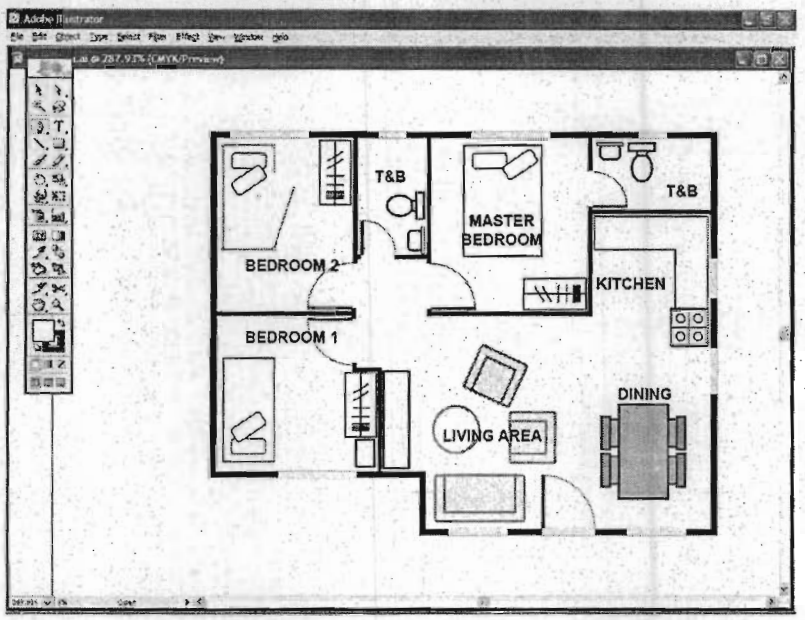

Figure 4.6a : - The plan is drawn using Adobe illustrator

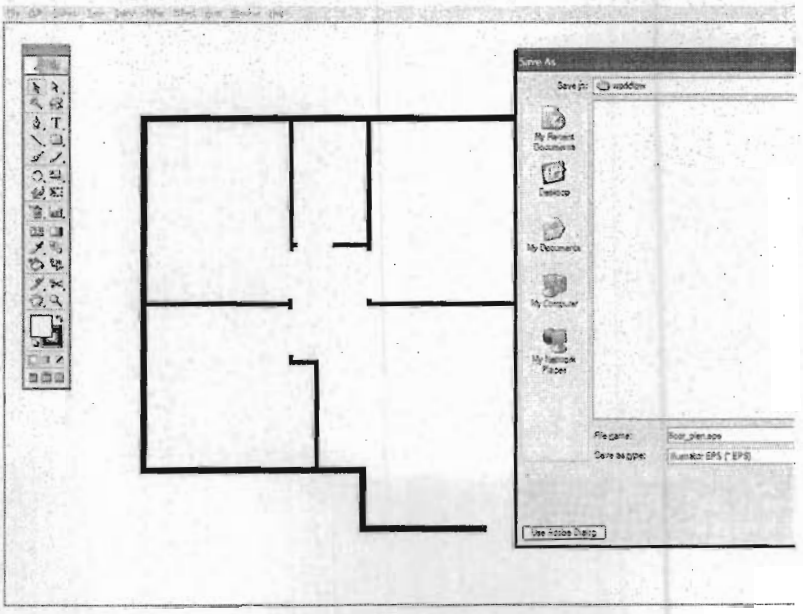

Figure 4.6b: - The wall part is export to *.eps format

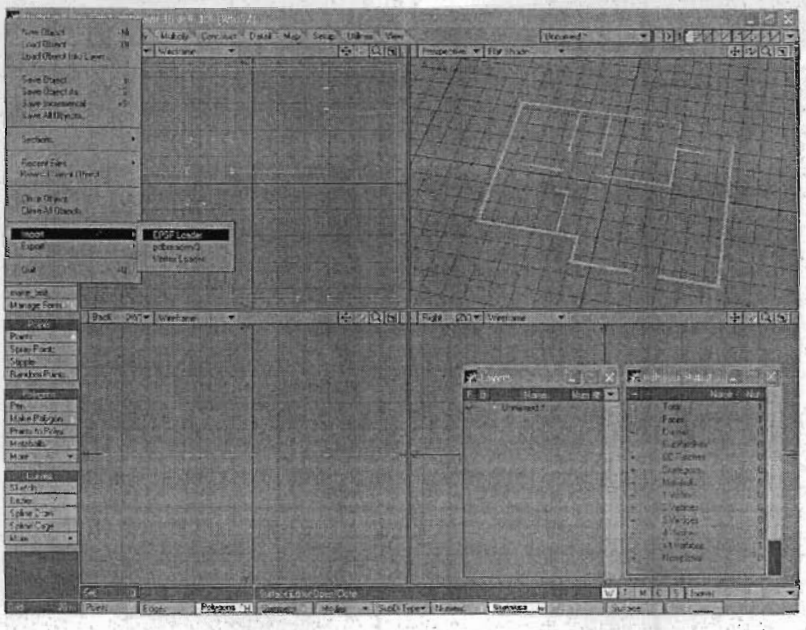

Figure 4.6c: - The plan imported intoLlightwave 3D modeler

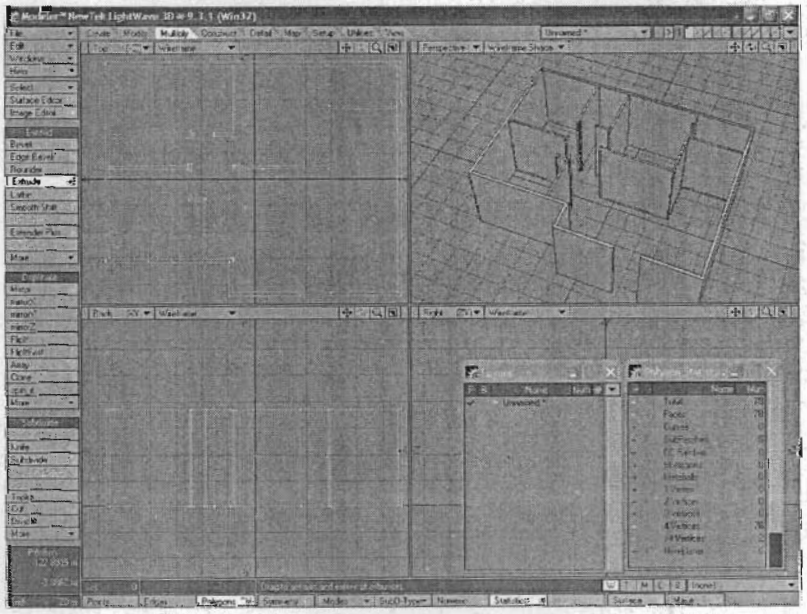

Figure 4.6d : - The wall plan is extruded to get the 3D wall of the house

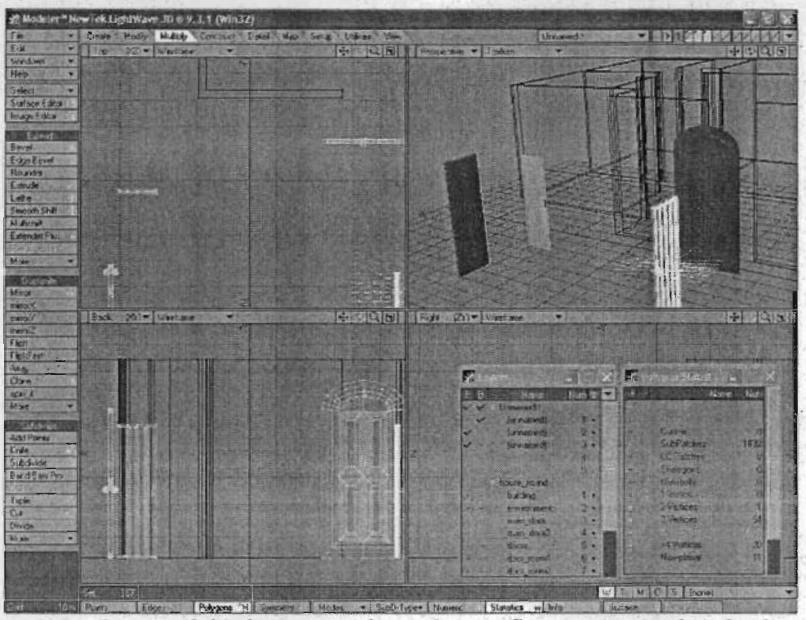

Figure 4.6e: Parts of the house such as doors, floor, etc need to be inserted

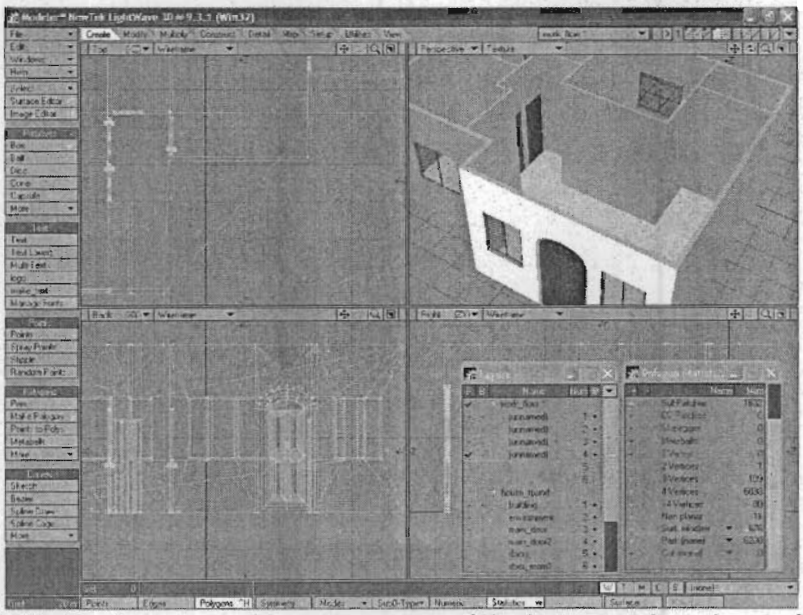

Figure 4.6f : Further steps of inserting parts of the house such as doors, floor, etc

Figure 4.6g : Inserting parts of the house such as furniture, photo frame, etc

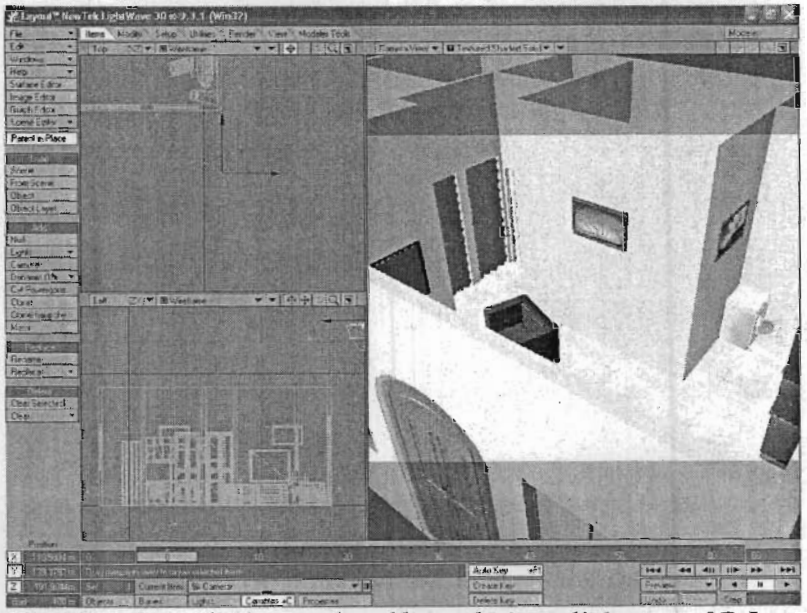

Figure 4.6h: The 3D model is saved and brought in to lightwave 3D Layout to do animation. The camera is set to position

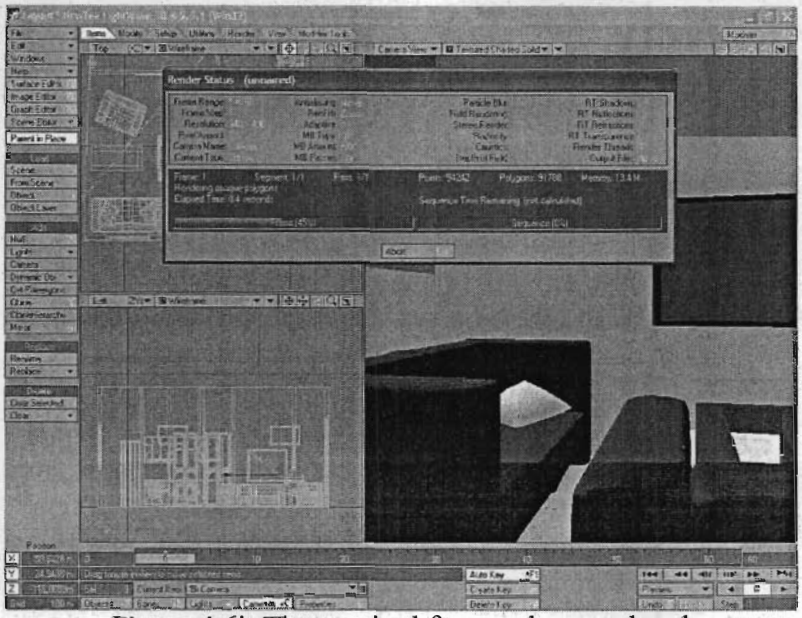

Figure 4.6i: The required frames then rendered

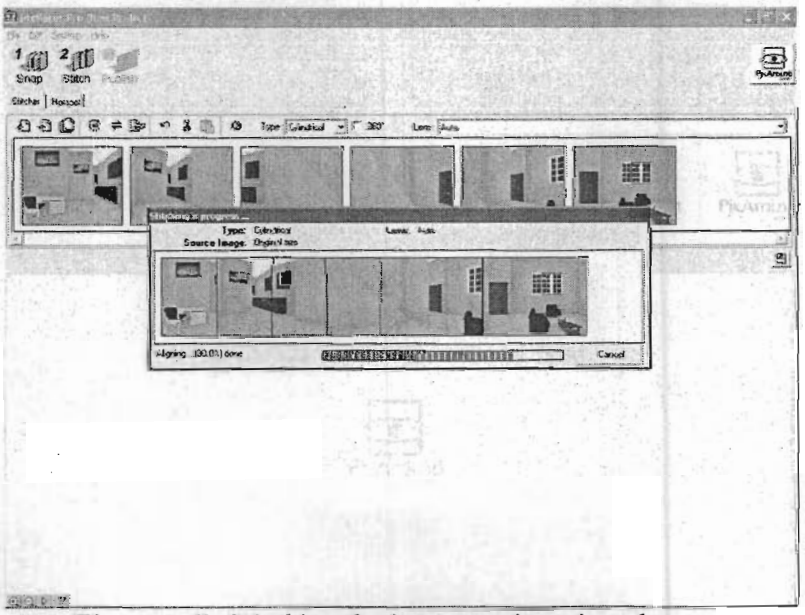

Figure 4.6j: Stitching the images using pixmaker pro

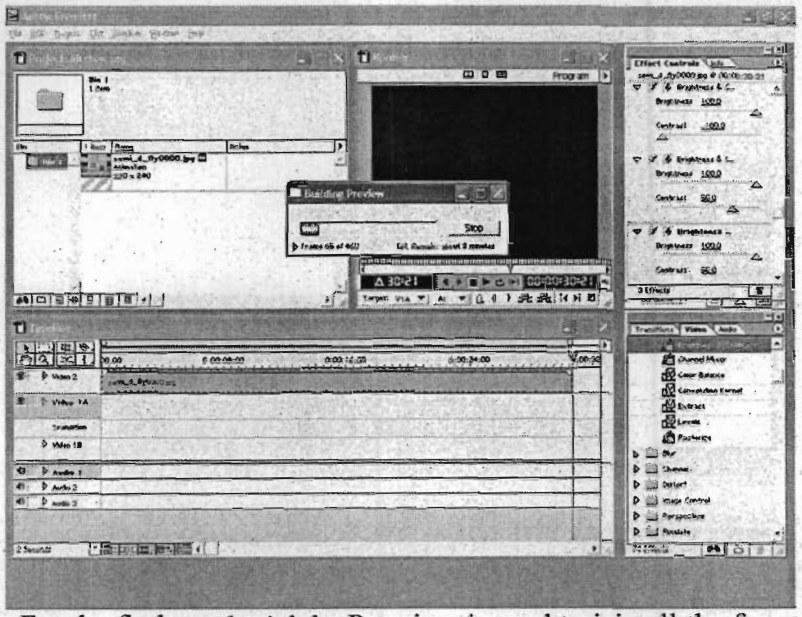

Figure 4.6k: For the flythrough, Adobe Premiere is used to join all the frames into mov. file

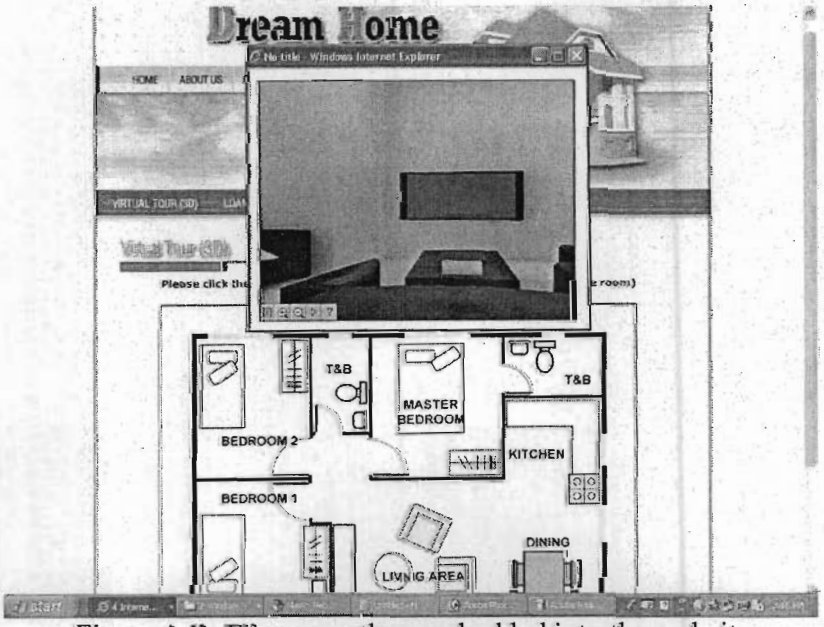

Figure 4.6l: Files were then embedded into the website