INTERACTIVE MODELS FOR DORJIPARAH CONSERVATION

by

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ABSTRACT

The aim of this thesis is to utilize digital media to create an extensible framework to document a historic site for conservation. The framework is then analyzed to determine if it serves as a viable alternative for architectural documentation. The framework is illustrated by means of a case study. The case study is a street in Dorjiparah, a historic neighborhood in North Calcutta, India.
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CHAPTER 1. OVERVIEW

1.1 Structure of this report
The introduction chapter of this report elucidates the importance of documentation in architectural conservation. By tracing the evolution of architectural documentation, the introductory chapter builds a case for an extensible framework for digital documentation. This chapter also contains a brief history of Dorjiparah, which provides a context for this report.

The next chapter describes the framework that I have created for digital documentation. The details of the constituent components of this framework are discussed here. Due to the highly interactive nature of this framework, it is best appreciated by viewing my web site. However, this document highlights the salient features of my web site, so that the reader is able to obtain an understanding of my thesis work.

The concluding chapter highlights the considerations that must be taken into account when using digital technology for architectural documentation. A vision for the future of this thesis is provided here.
CHAPTER 2. INTRODUCTION

2.1 Importance of Documentation
Specifications for the preservation of cultural property vary from country to country depending on the nature of a country’s historic past and the changes caused by development and modernization. Nevertheless, documentation is perceived as an important step towards active integrated conservation.

2.2 Evolution of Architectural Documentation
Traditional methods of documenting historic sites involves volumes of inventories showing social, economic, and built form surveys, a set of base maps, and detailed drawings. Traditional publications are highly structured and linear. In other words, they follow an orderly progression from the front cover to the back cover. Manual methods of documenting and cross-indexing large amounts of information are cumbersome, and require lots of space, time and energy. Furthermore, maintaining this information and keeping it current is a formidable task by itself.

Over the past decade, computers have played an increasingly important role as a primary tool for the documentation of historic structures. Digital technology has become the medium of choice for storing, transmitting, and manipulating information, gradually replacing print, photographs, movies, sound recordings, and conventional data archives. Digital technology provides tools that aid efficient creation, storage, retrieval and maintenance of large volumes of information.
2.3 Digital Media in Architectural Documentation

A significant reason to implement documentation using digital media is to utilize the extensive cross-referencing and searching capabilities offered by digital technologies. This is in sharp contrast to traditional documentation, which is highly structured and linear. Other significant reasons to implement digital documentation are to broaden the audiences by removing geographic boundaries, and to allow for varied and customized presentation. All of the above can be done while maintaining the original order and protecting fragile originals from use.

2.4 Framework for Architectural Conservation Documentation

Based on the preceding discussion, one can clearly build a case for architectural documentation using digital media. By creating a framework using digital technologies, one can capitalize both on the flexibility provided by electronic access and on the effectiveness of established practices in the field of architectural conservation. This is precisely the goal of this thesis. A framework can be defined as a structure that contains a set of components combined with broad guidelines for implementing solutions for a given problem domain.

I had previously documented a historic site for conservation, using traditional methods, for my thesis towards my Master’s Degree in Architecture. In this thesis, I have combined the knowledge gained during my previous research with my knowledge of digital media to formulate general recommendations for digital documentation for conservation. These formulations have resulted in the creation of a general-purpose framework for digital documentation.

In order to illustrate the power of this framework, I shall be using a case study. The case study is a street in Dorjiparah, a historic neighborhood in North Calcutta, India.

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1 My Master’s Thesis is titled "Dorjiparah - Towards Conserving a Local Residential Neighborhood in the North of Calcutta".
2.5 Context
Dorjiparah is a historic neighborhood of Calcutta. Calcutta was one of the earliest settlements of the British, and its origin is closely linked to the founding of the British East India Company. Around the year 1698, the East India Company was given ownership of three villages in Eastern India comprising Sutanuti, Dihi Kolkotta, and Govindpur. These three villages are the precursors of modern day Calcutta. Sutanuti was a major center of handloom weavers who produced exquisite chintz. It was in Sutanuti, that a market called Shobha Bazaar was established and eventually the tailor sect started living around the bazaar, which came to be later called as Dorjiparah (‘Dorji’ meaning tailor and ‘Parah’ meaning town).

Figure 1. Modern day Calcutta map showing Dorjiparah

Refer to HISTORY section of my web site for a detailed history of Calcutta and Dorjiparah.
I chose Dorjiparah as a case study for documentation because it has special architectural, historical and cultural interest, the character and appearance of which need to be preserved and enhanced. The historic character of the neighborhood consists of a remarkably consistent building tradition. Its picturesque streets, narrow lanes and by-lanes define the urban morphology of the neighborhood\(^3\). The formal appearance of the built-form as defined by scale, size, construction, materials, colors and decoration still exists, even though they are in a state of deterioration. However, the condition of the neighborhood is such that it can still be restored to its original past by careful conservation attempts.

Figure 2. Photographs showing historic character of Dorjiparah

\(^3\) For a complete description of the urban morphology, spatial organizations, and conservation issues, refer to the CONSERVATION section of my web site.
In order to illustrate the framework using a case study, I have chosen 13 buildings situated in 3 historic streets in Dorjiparah.

![Site plan of case study area](image)

**Figure 3. Site plan of case study area**

I conducted site-visits to gather historic information, obtain base maps, and create measure drawings the buildings. Subsequently, I utilized digital media to create plans, elevations, sections, details, 3D models, and virtual walkthroughs. I have also taken photographs, and video-clips. I created a database containing architectural inventory of the case study site. I used my interactive framework to present these architectural details. The next chapter describes the framework in detail.
CHAPTER 3. DETAILS OF THE FRAMEWORK

The framework is made up of two categories of elements viz., Architectural Elements and Web Infrastructure Elements.

The architectural elements represent the abstraction of the best practices in architectural conservation documentation. Based on my experience as a conservation architect and my experience in documenting historic sites, I have identified three key architectural elements that must be part of digital documentation for conservation.

- History Element
- Virtual Exhibit Element
- Conservation Element

In addition to these elements there needs to be an infrastructure to present this digital documentation. I recommend the use of web technology to create an infrastructure to store the architectural elements. The web infrastructure element consists of web pages and server-side scripts that dynamically drive the content from a database.
3.1 History Element

It is important to understand the history of the conservation site before making any conservation attempt. This thesis recognizes the need for a framework element that provides historical details of the conservation site. The history element of this framework addresses that need, by providing broad guidelines for presenting history information.

I gathered historic information during my site visits, by collecting information from various government organizations like Calcutta Municipal Corporation, NATMO⁴, local architectural offices, and also by taking photographs and video-clips. In addition I had obtained copies of historic maps and pictures from the local authorities.

The history information can be stored and presented in a variety of ways. This framework recommends the use of digital technology to produce a digital representation of the history by scanning the photographs and pictures, digitizing the video-clips, and converting the history text into a machine-readable document. The digital information thus created can be displayed in a variety of ways. For example, one can just store the images on a CD-ROM as digital documents, or they can be stored in an imaging database. This framework recommends that history be presented in the form of web pages. Furthermore, the Web Infrastructure⁵ element of this framework simplifies the task of presenting the history web pages.

⁴ National Atlas and Thematic Mapping Organization, Calcutta, India.
⁵ Refer to section 3.4 of this document for a discussion of the Web Infrastructure element
The following example illustrates the look and feel of the history element of this framework.

![Screenshot of a web page showing history information.](image)

**Figure 4. Sample web page showing history information**

This history element can be extended to include history information for other historic sites as well.\(^6\)

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\(^6\) Refer to chapter 4.7 for a vision for this history element.
3.2 Virtual Exhibit Element

Documenting a site for conservation involves drawing base maps, creating architectural drawings, and organizing the detailed inventory. In traditional documentation, these architectural drawings and inventory information are presented on paper. One browses through many pages in order to search for information. There is a clear need to store this information in an easily accessible format. The virtual exhibit component fills that need.

I used CAD technology to produce architectural drawings such as plans, elevations and models for all the buildings that comprise the historic site. I used database technology to store the site inventory information such as number of floors, number of courtyards, and building age. This thesis recommends that architectural details be presented in the form of a virtual exhibit. The virtual exhibit comprises a study area and a query interface.

The study area contains an image of the historic area along with an intuitive user interface to aid in viewing the architectural drawings. The query interface is a finding aid to search the inventory database. The results from the query interface are linked to the study area.

Thus the virtual exhibit enables a conservation architect to explore the historic site and study its architectural details interactively. In addition to using the virtual exhibit to contain the digital drawings and database, I have also utilized the virtual exhibit to contain video-clips of the historic site, thereby exploiting further, the power of multimedia for digital documentation.
3.2.1 Interactive Query Facility

The interactive query facility provides an intuitive way to search the inventory database. The following illustration provides a snapshot of my database.

![Figure 5. Snap shot of inventory database.](image)

Refer to Appendix A for a detailed description of the database. This database does not contain all of the inventory information for the historic site, but it contains enough information to illustrate the framework.
The following illustration describes a usage scenario for the interactive query facility. Through this interface, one can query buildings that match specific criteria. The buildings that match the search criteria are highlighted. The illustration shows a sample search operation where the inventory database is queried for buildings that are greater than 150 years old and have more than 2 floors.

![Figure 6. Usage scenario for interactive query facility](image-url)
3.2.2 Study Area

The study area allows an architect to interactively view the architectural details of the historic site. I created plans, elevations, sections, details and 3D models using AutoCAD, and created virtual walkthrough and renderings using 3D Studio MAX. I have also taken photographs and video-clips of the area under case study. I converted the photographs and renderings to a GIF file format using PhotoShop. I converted the architectural drawings such as plans, elevations, section, and details into a PDF file format. The following table summarizes the architectural details that I created for the case study.

<table>
<thead>
<tr>
<th>Building Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drawings</strong></td>
</tr>
<tr>
<td>Plans</td>
</tr>
<tr>
<td>Elevations</td>
</tr>
<tr>
<td>Sections</td>
</tr>
<tr>
<td>Details</td>
</tr>
<tr>
<td>Renderings</td>
</tr>
<tr>
<td>Photographs</td>
</tr>
<tr>
<td>Video Clip</td>
</tr>
</tbody>
</table>

**Figure 7. Table of available architectural details**

The above information is stored in a table that will be used by the navigation scripts in the virtual exhibit. By using an intuitive user interface, an architect can easily navigate through the study area and view the details. To view the architectural details of a particular building, one moves the mouse over a desired building in the study area. The building on which the mouse is over is highlighted. Clicking the mouse on a building displays a pop-up menu containing a list of architectural information available for that building. The pop-up menu is dynamically created based on the information in the navigation table. The menu thus only shows the available information for the chosen building.
The following illustration highlights the salient features of the study area. The interactive nature of the Study Area is best appreciated by viewing the web site. However, I have included architectural details of one building in Appendix E so that the reader can view the architectural details without having to browse the web site.

Figure 8. Illustration highlighting features of virtual exhibit
3.3 Conservation Element

After documenting the history of the area and creating architectural details, the final step is to identify common conservation problems that pertain to that area, and offer solutions to those problems. This framework recommends that general information about conservation be presented first, followed by specific issues of the neighborhood.

The conservation element of my framework consists of a series of web pages that provide general conservation information, in a fashion similar to the history element. I have also utilized this element as a placeholder for virtual walkthroughs of the neighborhood. The virtual walkthroughs are in the form of 3D animations and video clips.

The conservation element also includes an interactive conservation problem resolution facility. This consists of a database of common conservation problems and their solutions, and a finding aid to retrieve this information. The illustration below shows a sample query:

![Interactive Database for Conservation Problem Resolution](image)

Figure 9. Example problem resolution session

In the example, a user has chosen 'Flooding in the courtyard' as the problem. The web page then displays solutions to this problem.

---

8 Refer to Appendix D for a brief background on conservation in Dorjiparaha. Refer to my web site for a more detailed description of conservation issues in Dorjiparaha.

9 This database contains conservation problems and solutions for Dorjiparaha. However, this database can easily be adapted to store problem/solution information for other historic sites as well. Refer to the conclusion chapter of this document for a discussion on evolving this database into an expert system for conservation problem determination.
The solution contains inputs from perspectives such as Design Solution, Professional Solution, Management Solution and Planning Solutions.

Figure 10. Solutions provided by the problem resolution database

This illustration shows the results of a sample problem resolution session. One should note that the solutions offered by the problem resolution database serves only as an example. These solutions only indicate how the framework can be used to create a problem resolution database.

*In order to create an accurate database of conservation solutions a thorough analysis of the conservation problems must be made, and accurate solutions must be stored in the database.*
3.4 Web Infrastructure
Web technology is recommended as an underlying infrastructure to implement the framework. This is primarily due to its popularity, standards and global reach.

All of the interactive models created for the history, virtual exhibit, and conservation elements are presented using this web infrastructure. The web infrastructure includes web pages using server-side scripts, and a database to drive the web content and navigation. The web pages consist of a header area, a main content area and a footer area to provide a common look and feel to the entire web site.

The header area consists of the menu bar and the scripts to control navigation based on the menu selections\(^{10}\). The content area displays the three key architectural elements of this framework. For example, when the history menu item is chosen, the content area displays the web pages that pertain to the history of the conservation site. The footer area consists of global navigation aids. The number of pages for an element and the name and order of the web page are stored in a database. The web scripts query the database whenever a navigation button is pressed. Based on the value returned by the database, the web infrastructure can determine whether there are more pages to navigate or whether the user has reached the end of the section. It is easy to add more web pages to a topic. One has to enter the name and sequence of the history web pages into the navigation database for the corresponding topic. The web infrastructure will then automatically drive the dynamic content based on the database. The following example shows a sample navigation table for Conservation.

<table>
<thead>
<tr>
<th>Web Page Sequence Number</th>
<th>Web Page Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conservation.asp</td>
</tr>
<tr>
<td>2</td>
<td>Conservation2.asp</td>
</tr>
<tr>
<td>3</td>
<td>Conservation3.asp</td>
</tr>
</tbody>
</table>

**Figure 11. Sample navigation table for conservation topic**

\(^{10}\) Though the header area contains menu items that pertain to this project, one can easily add new menu items and modify the scripts that control navigation for other scenarios as well.
The following diagram shows the interaction between the navigation database and the scripts that control the navigation. The diagram shows the interaction when a user chooses 'history' item from the menu.

Based on the menu item selected, the navigation scripts consult a table to determine the topic to be displayed in the CONTENT AREA. The selected menu item is highlighted to indicate current topic.

Depending on the current web page displayed in the CONTENT AREA, the navigation scripts consult a table to figure out the next sequential page for navigation. If the end of chapter is reached a message box is displayed.

Figure 12. Web infrastructure – Sample navigation scenario
CHAPTER 4. CONCLUSION

I arrived at the following conclusions based on the experience I gained during the creation of this framework.

4.1 Technology Obsolescence Considerations

Digital documentation is certainly a viable solution. However, solutions using digital media are not without risk because they rely on complex hardware and software to be able to store and retrieve data. Rapidly evolving computer technologies speed the obsolescence of hardware and software at a pace faster than our ability to migrate or archive critical data. Further, the ease of replication and manipulation of digital files raises many questions about rights and provenance. Archival stability and migration are significant problems, which are only beginning to be addressed, since architectural records will be an essential tool for architectural practice in the twenty-first century. Until such time the solution to address this problem is to employ digital media to produce hard copy documentation as well.

4.2 CAD Technology Considerations

Photogrammetry is the preferred way to produce CAD files. Computer-Aided Drafting, or CAD\textsuperscript{11}, has mechanized the task of drafting. Designed for making drawings for new construction, CAD assumes great precision, with all measurements exact, all alignments perfect, all floors level, and all walls plumb. Lines are points and vectors of known length, which works best for rigidly orthographic forms. Historic structures, which seldom exhibit these characteristics, are thus difficult to document in CAD. Measuring around the perimeter of an historic structure and expecting the floor plan to close with 1/64" accuracy does not occur. Tolerances in the construction industry simply are not that precise.

\textsuperscript{11} Refer to Appendix C for a brief overview of advantages of using computer-aided design, modeling, rendering, image editing, and animation tools.
CAD/Photogrammetry merges the science of measuring using a sequence of convergent photographs with computer-aided drafting, the results reported as CAD files. It made Photogrammetry available to non-photogrammetrists by using the computational power of a desktop computer to overcome the lack of geometric rigidity required by traditional stereophotogrammetry. While most of the software works similarly and with great precision, gathering and entering the data requires care to avoid impairing the accuracy of the results. One must have a firm grasp of geometry, understand optics and photographic techniques and technologies, and possess a working knowledge of computer-aided drafting.

In order to use photogrammetry it is desirable to take pictures using a large format camera and then convert them into drawings. Otherwise complex historic structures would take a long time to draft using CAD technology. When using photogrammetry however, it must be remembered that one cannot base measurements on a photograph because of the distortion factor. One should keep in mind that orthographic measurement and field records are the most complete and accurate.

For this thesis, I have produced all my drawings using just CAD software, since I neither have access to photogrammetry software like PhotoCAD, nor a large format camera (4" x 5") to take pictures.

4.3 Scanning Technology Considerations
The major advantage in offering scanned drawings is that a many-fold increase in usage can be achieved without risk to the original document. Scanning historical drawings and converting them into CAD drawings seems, at first glance, as simple as operating a copier machine. Like a copier, the first product of a scanner is a raster image, a series of dots located in a grid to replicate the original image. A scanner, however, can be too faithful to the original; watermarks, stray marks, blemishes, creases, and other defects in the original become part of the computer image. If the original document has changed shape, the scanned image will be of the distorted original. While working on this project I
produced some unsatisfactory scanning, because the originals were blemished. I later had
to input the drawings into a CAD tool and manually draft the drawings.

Another consideration is the reliability of the original drawing, its original purpose,
drafting conventions, and accuracy will be characteristics in the derivative scanned
image. Independent verification of the accuracy and suitability of the scanned image to
the task at hand is an essential step before scanned historic drawings can be used as the
basis for contemporary work.

There are file size/download time constraints as well when the drawings are scanned in
various resolutions. One ideal solution would be scan the same images in varied
resolutions and provide users with a variety of resolutions to choose from. In that case
however, the cost of storage has to be evaluated as well.

4.4 Search Capability Considerations
It is desirable to have a searchable text database when developing digital documentation.
One consideration is the complexity of the descriptive information fields. Studies show
that people use less than 50% of these fields. So it may be worthwhile implementing a
controlled vocabulary hierarchical index and keywords that would provide a more
powerful search capability. I have not implemented a search engine yet. It has been left as
an exercise for the future.

4.5 Data Entry/Version Management Considerations
Any conservation inventory database needs to be periodically updated with the latest field
records. It is desirable to have a data entry system to help the entry of periodic updates.
This has been left as a future exercise as well. Like any digital documentation, a strict
version control mechanism must be in place in order to recover to any previous
checkpoint.
4.6 Data Interchange Considerations

There is an increase in proprietary linkages between software application packages. Project data moves through a number of different software packages, each of which deals with a different aspect of the project. It is desirable to import and export building data between these various projects. XML and its variants are promising as data interchange standards. I have not converted the data into such format yet, but it will not be a huge task to convert to an established standard.

Collaborative computing will become popular in a few years. In this mode of computing, various people directly use and modify CAD drawings. In such cases, the drawings must be hosted on a file server in order to enable fast access, and control concurrent access.

4.7 Vision

We are in the infancy of a technology of enormous potential. This framework is only a starting point for creating a broader framework for conservation documentation in general. In this section, I shall list a few ways in which this thesis can be extended.

This framework allows remote users to access architectural documentation. However, there may be a need in the future to also allow uploading of information to the database. It is left as an exercise for a future thesis.

Templates can be created for each of the framework components. Templates enable faster adaptation of this framework for documenting any historic site. These templates can be in the form of skeleton web pages, and database schema for inventory tables.

The History component can be integrated with other library information systems to create a rich warehouse of historic information.

The Study Area can be integrated with a geographic information system. A user can then choose to click on the desired area and further details could be provided. The user interface then becomes more intuitive and always provides a bearing on the desired area.
The Conservation Problem Resolution database can be evolved into an expert system for conservation problem determination. I shall describe a possible implementation. Firstly, an architectural vocabulary of the conservation site is created and stored in the expert system as a set of rules. The expert system uses this vocabulary as a basis for evaluating data that enters the inventory database and identifying potential conservation problems. For example, inventory information about a new building is entered into the expert system's database. Let us assume that the building has 'segmental arched windows' and the ratio of built to open space is 3:1. The expert system evaluates its stored rules to determine whether the newly entered values fit the architectural vocabulary of the neighborhood. If the data does not fit the vocabulary, the expert system indicates that there is a potential problem and offer solution to fix the problem.

The purpose of this thesis was to create an extensible framework for conservation documentation using digital media and to analyze the framework to determine its viability. I have concluded that such a framework is certainly a viable solution for architectural documentation. I can envision such frameworks being used by regional and national architectural organizations, thereby creating a hierarchy of inter-linked architectural repositories. Digital frameworks must keep in pace with emerging technologies. I have chosen web technology as a foundation for this framework and it is expected that web technology will continue to establish and provide standards for global information access.
APPENDIX A

Discussion – Use of database technology used in the creation of this framework

Preparation of a detailed inventory of a conservation site is a very important task in conservation. This involves classifying the data into appropriate categories and recording them thoroughly, both graphically and descriptively.

In India, access to a detailed inventory is difficult to obtain. I conducted various methods of research like, literature review, social economic and built form survey, and map survey in order to accumulate adequate information.

Database technology offers powerful solutions in classifying and organizing the inventory information. I used the database technology\textsuperscript{12} for two purposes:

- To store inventory information (Inventory Tables)
- To store web content information (Web Content Tables)

The tables pertaining to inventory information are:

- **BuildingTable**. It contains inventory information for 13 buildings chosen for conservation. It contains fields like Building Number (Key Field), Age, Number of Courtyards, Condition, Conservation Significance, and Land Use. I have normalized this table\textsuperscript{13}.
- **ConditionTable**. It contains the condition of the buildings.
- **ConservationLevelTable**. It contains the architectural significance of the building.
- **LanduseTable**. This table contains the land use patterns.

\textsuperscript{12} I have stored both inventory and web information in the same database named HouseDatabase. One may choose to implement them in separate databases as well. The database does not contain all the inventory information I have gathered, but contains enough information for a reader to understand this thesis work.

\textsuperscript{13} Normalization is a process that reduces redundant data in a table. The tables ConservationTable, LanduseTable, and ConditionTable were created as a result of normalization.
APPENDIX B

Discussion - Use of web technology in the creation of this framework

Web technology has well defined standards and offers a global portal for presenting research information. Therefore, I published my thesis project as a web site. I created a web content database and some reusable web scripts that would enable easy adaptation of this framework for other documentation needs.

I used Microsoft’s Active Server Page technology in order to maintain browser independence\(^\text{14}\). I have made extensive use of Frame, Layers and client-side JavaScript to create Dynamic-HTML effects such as hover text, mouse-rollover and popup menus. I created a CSS stylesheet, which contains all the styles, used in this web-site. This creates a uniform look and feel for the entire web site.

All the dynamic web content is served out of a database. The database contains a table for each chapter of this web site. The database contains a list of pages in each section and other related information to display the web page\(^\text{15}\). There exists one master prototype (template) of the web page for each section, and the server side scripts use this prototype to create individual web pages on demand. This eases the task of maintaining the web pages.

The title animation was created using Macromedia Flash, a powerful vector graphics creation tool. Using this I created animation effects like motion tweening and shape tweening\(^\text{16}\) as well.

\(^{14}\) I used some features of DHTML Layers that may require the use of Microsoft Internet Explorer. With some programming effort it can be made browser-independent.

\(^{15}\) The names of the web content tables are IntroductionTable, BackgroundTable, InteractiveAnimationTable, InteractivePhotoTable, InteractiveRenderingTable, InteractiveTypologyTable, DiscussionTable, ConservationTable and BibliographyTable.

\(^{16}\) Appropriate Flash Plug-Ins must be installed in order to be able to view this.
APPENDIX C

Discussion – Use of computer based tools used in the creation of this framework

Manual drawings are difficult to change, and maintain. They are not easily accessible over a broad geographic area. Computer aided drawing tools offer significant advantages over these manual methods. The following results summarize my experiences in using these tools during this thesis:

Computer Aided Design Tools

Some advantages in using these tools\(^\text{17}\) are:

- One can work with real dimensions without first requiring setting a scale or drawing size.
- Different categories of information or alternatives can be superimposed as layers and selectively edited or viewed.
- One can attach an external file into the drawing. This helps to incorporate existing drawings in other drawings but not accidentally modify them.
- Simple ways are available for creating difficult geometric elements commonly used in historic drawings.
- One can set up associative dimensions. These are dimensions that refer to particular objects and which change automatically when the size of the object is changed. Use Boolean operations on pairs or groups of objects. For example, one can perform subtraction or addition of objects.
- Provide facilities for group work across a network.
- Create a reusable library of commonly used objects in the problem domain.

\(^{17}\) I used AutoCAD to create the plans, drawings and models and 3D Studio Max to render and animate, and Adobe Photoshop was used to touch-up the images.
**Modeling Tools**

- One can create models without the use of traditional materials like wood, plastic and paint.
- One can manipulate and edit the objects in a model by moving, rotating, scaling, duplicating and editing them.
- One can explore a three-dimensional model by defining a line to serve as a path through that model, or by defining a point to serve as reference point from which the image can be seen.
- Data can be exchanged between various modeling and rendering applications by using common interchange formats.
- The model can be viewed from a variety of viewpoints and in different projections. Varying the position and intensity of natural and artificial lighting can control the lighting on the model.

**Rendering Tools**

- Objects originally constructed as surfaces can be converted into solids.
- One can specify information about an object's color, surface texture and pattern, to define translucent or transparent materials, its color and refractive qualities.
- Lighting sources and lighting effects can be controlled more precisely than is possible with simple modelers.
- One can set up precise viewpoints using numerically defined co-ordinates or by placing cameras.
- Pictures of the model can be produced using a variety of rendering techniques. One can choose from the simplest 'wire-frame', in which objects are represented only by their edges, to the most realistic 'ray-tracing', in which all attributes of objects and their shadows and reflections can be portrayed.
- One can portray the effect of inter-reflection of light between objects.
**Image Editing Tools**

- The raw image produced by any rendering program may need further processing and editing. An image-editing program such as Adobe Photoshop is indispensable for sizing and cropping, adjusting brightness and contrast, touching up errors etc.

**Animation Tools**

- An animation program can be used to generate a moving picture of the view, which would be gained by moving past or through a model of a proposed or existing building. Animation is made up of individually rendered frames, which are then presented, sequentially on the screen.

- One can start with the start and end views of a model, and have the program interpolate the series of views or frames between them. The series of frames can then be displayed in sequence to give the effect of an animated film.

- One can animate the movement of particular object such as doors.

- One can simulate changing lighting conditions. For example, the path of the sun or the change in position or intensity of artificial light sources.
APPENDIX D

Background of conservation in Dorjiparah

The neighborhood in the 1740's had mud roads with fewer numbers of houses, which belonged to rich landlords. Most of these houses had multiple courtyards, a garden, a pond, a temple, and a lot of land surrounding the house. These houses had more than three courtyards, which were used for worship, social gatherings, and cultural gatherings. During this period, a 'joint-family' system was prevalent, where family members lived as one unit in the same large house. Their landed estates were rented out for bazaars and slums, which yielded them a constant income.

Figure 13. Base map of Dorjiparah: Left – 1690 A.D  Right – present day
Source: Calcutta Municipal Corporation

With succeeding generations, the 'joint-family' system started disintegrating into nuclear family as a result of growth in family size and changes in the economic status. This led to
the division of properties. As a result of division of properties, new access ways had to be created. This led to increased number of roads with increased property divisions. Open space was reduced due to infiltration of built form and change in the localized system of ownership. Community and cultural gathering places reduced in sizes. Figure 8 shows the reduction in open spaces.

The administrative and economic status of Calcutta had attracted migrants from its hinterlands as well as other provinces, giving a city a cosmopolitan character. During this period, the slum areas in the neighborhoods of North Calcutta increased. Many mansions in Dorjiparah that has open spaces were rented out to these immigrants. This largely reduced the open spaces in the neighborhood. Community and cultural gathering spaces became limited except for the courtyards inside the houses and sudden widened spaces on the streets and lanes.

**Conservation Problems of Dorjiparah**

The distinctive character of Dorjiparah is now under the threat of change, primarily due to commercialization and explosive population growth, both placing a heavy stress on the infrastructure. The rapid commercialization of Central Avenue and Jatin Mohan Avenue, which act as major edges for the neighborhood, has caused changes in the land use patterns from residential to commercial along the fringes. The mushrooming of small-scale industries in the North part of Calcutta is bringing about prosperity and change. This is manifesting itself in new forms of buildings and urban patterns that have no reference to the historic character of the area. Also, an unprecedented growth in real estate due to low land values is causing excessive development in some parts of the area.
APPENDIX E

This section contains architectural drawings and photographs for some of the buildings. It is provided here only to provide the reader of this document with a sample of the drawings that may be seen in the virtual exhibit section of my web site.

Figure 14. Section of Bhor house
Figure 15. Front elevation and detail of Bhor house
Figure 16. Plans of Bhor house
Figure 17. Plans of Bhor house
Figure 18. Photograph of Nilamani Mitra house

Figure 19. Rendering of a house on Beadon Street
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These are some of the web sites that I used as a reference during my thesis work. There is no guarantee that these sites will be available at a future date.