3. EXPERIMENTAL PROCEDURE

The creation of 3D design library is systematically done in three phases. They are as follows

3.1 Phase I – Preference Study
3.2 Phase II – Creation of 3D Design Library
3.3 Phase III – Evaluation of 3D Design Library

3.1 Phase 1 – Preference Study

The main aim of the study is to find out the preference for the basic garment styles worn by women. The materials and the methods used for the preference study are as follows:

3.1.1 Nature of Research
3.1.2 Selection of Area
3.1.3 Selection of Sample
3.1.4 Selection of Sampling Techniques
3.1.5 Selection of Basic Garment Styles
3.1.6 Selection of Data Collection Method
3.1.7 Processing and Analysis of Data
3.1.8 Results of the Survey

3.1.1 Nature of Research

This is a descriptive research. Rubin and Babbie (2001) state that descriptive studies seek to portray accurately the characteristics of the population and it attempts to make generalizations about the attributes of that population by studying a small part of population. The preferences of the consumer for basic garment styles are studied using qualitative research. According to Brannon (2006), qualitative research is used to ask questions like ‘why’ and ‘what’, which probes the customer’s relationship to a style. Frings (1999) defines style as a particular characteristic or look in the apparel and
remarks ‘fashion changes but styles remain’. In this descriptive research, the investigator has concentrated the basic style only. In the fashion business the role of the ultimate consumer is very important one in the final analysis denotes Dickerson (2003).

3.1.2 Selection of Area

India is divided into six major zones – North India, South India, East India, West India, North East India and Central India. Southern India covers states like Tamil Nadu, Kerala, Goa, Karnataka, Andhra Pradesh and Union territory of Lakshadweep (maps of india.com, 2011). Considering the convenience and time factor, Tamil Nadu, Kerala, Karnataka and Andhra Pradesh were selected for the study.

3.1.3 Selection of Sample

Consumer has the power to accept or reject fashion opines Easey (2009). College going students set the trend for the fashion. They also adopt and follow styles quicker than any other group of people. Tallon (2008) is of the view that this new generation of students and recent graduates are born with a mobile in one hand and a mouse in the other, which is evidenced on the professional fashion scene. Research by Jain and Pant (2010) predict that about three fourth of the female students gained knowledge about textiles as compared to the 63.5% male students. To quote Ireland (1996), students of fashion design are introduced to a broad spectrum of the industry, combining creativity with an opportunity to study fashion design, pattern cutting and garment production. With reference to the above facts, college girls studying the fashion related courses were the choice of the investigator for this preference study.

3.1.4 Selection of Sampling Techniques

The process of sampling involves using a portion of a population to make conclusions about the whole population describe Zikmund and Babin (2010). Deliberate sampling, also known as purposive or non-probability sampling method is employed in this study. Deliberate sampling method involves purposive or deliberate selection of
particular units for constituting a sample which represents the universe explains Kothari (2008). Ten colleges which responded to the researcher’s request were selected. Care was taken to check if the selected colleges offered fashion designing courses.

### 3.1.5 Selection of Basic Garment Styles

The basic garment styles commonly seen in India were listed and categorised into formal, informal/casual and party wear for women. Table 1 presents the list of basic garments used for the preference study with categories.

<table>
<thead>
<tr>
<th>Table I - List of Basic Garments Used for Preference Study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formal Wear</strong></td>
</tr>
<tr>
<td>Salwar Kameez</td>
</tr>
<tr>
<td>Saree and Blouse</td>
</tr>
<tr>
<td>Midi and Tops</td>
</tr>
<tr>
<td>Pants and Tops</td>
</tr>
<tr>
<td>Frocks</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

### 3.1.6 Selection of Data Collection Method

Surveys are widely used for gathering data. Collecting data through questionnaires is popular, particularly in case of big enquiries opines McBurney (1994). The success of questionnaire method depends more on the quality of the questionnaire itself view Ray and Mondal (1999). The researcher must construct his questionnaire cleverly as to elicit reliable and authentic information reviews Thanulingam (2000). Kotler and Armstrong (2009) were of the opinion that the questions should be simple,
direct, unbiased and should be arranged in a logical order. Considering these facts the investigator has prepared a set of close-ended questionnaire for the respondents to tick their preferences.

The data collection phase of the research process typically begins with pilot testing. Pilot study aids in identifying the weaknesses in design and instrumentation describe Cooper and Schindler (1999). A pilot study was conducted for testing the validity of the questionnaire. It was conducted in the Bishop Appasamy College of Arts and Science, Coimbatore among the post graduate students of Costume Design and Fashion. The questionnaire consisted of list of garments and the occasions for which is meant. The respondent ranked the garments according to her preference. Based on the results of the pilot study, the questionnaire was modified and used for the actual study (Appendix 1).

In the questionnaire method, questionnaires can also be mailed to the respondents with a request to return after completing the same views Kothari (2008). One set of 25 questionnaires each were sent to the selected college Principals / Head of the Departments with a self-addressed envelope with a request letter. In the letter permission was sought for students to fill questionnaire and return the same after completion. A regular follow up was done through the phone calls till the filled in questionnaire reached the researcher.

3.1.7 Processing and Analysis of Data

Technically speaking, processing implies editing, coding, classification and tabulation of collected data so that they are amenable to analysis. According to Kothari (2008), computers are ideally suited for data analysis concerning large research projects. They can aid huge storage of data, their faster retrieval when required and processing of data with various techniques. The ranking given by students were entered in Ms Excel program and imported to SPSS (v.7.5) for analysis. The sums of the ranks provided for
each garment were calculated and the preference was studied. The lower the rank, higher was the preference. Preference scores were compared using Wilcoxon Signed Rank test. P values were computed and a ‘p’ value less than 0.05 was considered statistically significant.

3.1.8 The Results of the Survey

The students ranked one for the highest preference and gave the highest number for the least preference in the listed garment type. Hence a lower number (rank total) denoted higher preference. The ranks given by the students for different garments were presented under the following heads.

3.1.8.1 Women’s garments – formal wear
3.1.8.2 Women’s garments – informal/casual wear
3.1.8.3 Women’s garments – party wear

3.1.8.1 Women’s Garments – Formal Wear

The formal wear of women’s garments was ranked as given in Table II.

<table>
<thead>
<tr>
<th>Name of the style</th>
<th>Rank</th>
<th>Overall Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salwar Kameez</td>
<td>1028</td>
<td>I</td>
</tr>
<tr>
<td>Saree and Blouse</td>
<td>1163</td>
<td>II</td>
</tr>
<tr>
<td>Midi and Tops</td>
<td>1321</td>
<td>III</td>
</tr>
<tr>
<td>Pant and Tops</td>
<td>1430</td>
<td></td>
</tr>
<tr>
<td>Frockes</td>
<td>1628</td>
<td></td>
</tr>
</tbody>
</table>

For the formal occasions like workplaces, Salwar Kameez gets the highest preference followed by Saree with Blouse and Midi with Tops. Pant and Tops has won the fourth place followed by the Princess Line dress in the fifth place.
3.1.8.2 Women’s Garments – Informal / Casual Wear

The results obtained regarding the informal/casual wear preference is tabulated in Table III.

Table III - Student ranking of Women’s Informal/Casual wear

<table>
<thead>
<tr>
<th>Name of the style</th>
<th>Rank</th>
<th>Overall Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salwar Kameez</td>
<td>1680</td>
<td>I</td>
</tr>
<tr>
<td>Midi and Tops</td>
<td>1762</td>
<td>II</td>
</tr>
<tr>
<td>Pant and Tops</td>
<td>2190</td>
<td>III</td>
</tr>
<tr>
<td>Saree and Blouse</td>
<td>2424</td>
<td></td>
</tr>
<tr>
<td>Jeans and Tops</td>
<td>2481</td>
<td></td>
</tr>
<tr>
<td>Frocks</td>
<td>2907</td>
<td></td>
</tr>
<tr>
<td>Long Skirt and Tops</td>
<td>3028</td>
<td></td>
</tr>
<tr>
<td>Half Saree</td>
<td>3395</td>
<td></td>
</tr>
<tr>
<td>Pinafore</td>
<td>3716</td>
<td></td>
</tr>
</tbody>
</table>

Salwar Kameez was ranked first by the college students. Midi with Tops was ranked second while the Pants with Tops was ranked third followed by Saree and Blouse, Jeans and Tops, Frocks, Long Skirt and Tops, Half Saree and Pinafore.

3.1.8.3 Women’s Garments – Party Wear

Long Skirt and Top, a traditional style has won the first rank for women’s party wear. Even though the garment, Saree and Blouse was ranked second, it is almost equivalent to Full Skirt as the differences in rating are very marginal. It may be observed that Midi with Tops, Princess Line dress and Maxi/Full gown was less preferred by the respondents. Half Saree, a traditional garment of South India was least preferred.
The preference for party wear as ranked by the respondents is given in Table IV.

Table IV - Student Ranking of Women’s Party Wear

<table>
<thead>
<tr>
<th>Name of the style</th>
<th>Rank</th>
<th>Overall Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Skirt and Tops</td>
<td>1391</td>
<td>I</td>
</tr>
<tr>
<td>Saree and Blouse</td>
<td>1392</td>
<td>II</td>
</tr>
<tr>
<td>Salwar Kameez</td>
<td>1476</td>
<td>III</td>
</tr>
<tr>
<td>Midi and Tops</td>
<td>1670</td>
<td></td>
</tr>
<tr>
<td>Maxi // Full Gown</td>
<td>1807</td>
<td></td>
</tr>
<tr>
<td>Half Saree</td>
<td>2198</td>
<td></td>
</tr>
</tbody>
</table>

The following Table V gives the consolidated results of garments that are ranked first, second and third.

Table V – Ranking for Preference of Women’s Garments

<table>
<thead>
<tr>
<th>Categories of garments</th>
<th>I Rank</th>
<th>II Rank</th>
<th>III Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal wear</td>
<td>Salwar Kameez</td>
<td>Saree and Blouse</td>
<td>Midi and Tops</td>
</tr>
<tr>
<td>Casual / Informal wear</td>
<td>Salwar Kameez</td>
<td>Midi and Top</td>
<td>Pant and Tops</td>
</tr>
<tr>
<td>Party wear</td>
<td>Long Skirt and Tops</td>
<td>Saree and Blouse</td>
<td>Salwar Kameez</td>
</tr>
</tbody>
</table>

It is evident from the above table that the order of preference from the highest to the lowest can be listed as Salwar Kameez, Saree and Blouse, Midi and Tops, Long Skirt and Tops and Pant and Tops.

3.2 Phase II – Creation of 3D Design Library
Design is a hybrid and creative process, driven by a need which leads to an invention of some sort, be it practical or artistic, functional or simply attractive, devised to enhance life in some way state Rath et-al (2008). According to Jarnow et-al (1987), designs are individual interpretations or versions of the same style compared with the number of styles in any product and the possible variety of designs are limitless. Gioello and Berke (2004) define style as an essential characteristic of a garment with regard to the silhouette, design features, proportion, colour and fabric.

Design library is the collection of designs. The garment designs are traditionally represented in the form of 2D sketches or photographs. An attempt has been taken to create the design library in the 3 dimensional form (3D form) using 3D Studio Max. Watanabe (2009) is of the opinion that fashion design drawings will be more convincing if the model and garments are portrayed with a certain 3-dimensional effect. In other words the design library is now replicated into a digital library of 3-dimensional garment designs.

Digital libraries basically store materials in electronic format and manipulate large collections of those materials effectively. The full-fledged digital library is one in which all the information is available in the digital form explain Babu et-al (2000). A digital library is a library in which collections are stored in digital formats (Wikipedia.com 2010). Creation of 3D design library is discussed under the following heads.

3.2.1 Selection of Garments
3.2.2 Selection of Software
3.2.3 Creating Garment Silhouettes for Selected Garments
    3.2.3.1 Evolving 3D Human Figure of a Woman
    3.2.3.2 Preparation of Basic 3D Garment Silhouettes
3.2.4 Creating Variations in the Basic Garment Silhouettes
3.2.5 Application of Colour and Texture to the Model and the Garment
3.2.6 Animating and Rendering the Image and Creating an Output
3.2.1 Selection of Garments

The design library is planned for creating 500 garment designs for the most preferred women’s garments. It is evident from the preference study, that the most preferred four garments were Salwar Kameez, Saree and Blouse, Midi and Tops and Long Skirts and Tops. Hence the above mentioned garments were taken for the designing 3D design library.

3.2.2 Selection of Software

Autodesk 3ds Max is general purpose computer modelling and animation software. It can be used to create professional quality 3D models, photo-realistic still images and film quality animation. Over the years, 3ds Max has become industry standard, 3D modelling and animation software capable of producing photo-realistic rendered scenes and animation (Kogent Solutions, 2007). Autodesk 3ds Max is a very powerful software with integrated 3D modelling animation, rendering and composting tools that enable visual graphics artists and computer graphic designers an effective and faster solution to bring 3D graphics into production (Fast Track, 2011).

The design library is created in the 3D form using 3D Studio Max software. 3D Studio Max is the most effective and widely used 3D animation program. The output of the 3D designs created in the 3D Studio Max can be viewed as a video file in any media player. Hence the researcher selected 3D Studio Max for designing the 3D images.

3.2.3 Creating Garment Silhouettes for Selected Garments

Silhouette is the overall outline or contour of a costume, also referred to as ‘shape’ or ‘form’ define Jarnow et-al (1987). The preparatory step in creating a garment is sketching of a human model and a silhouette. It is discussed under the following heads
3.2.3.1 Evolving 3D Human Figure of a Woman

3.2.3.2 Preparation of Basic 3D Garment Silhouettes

3.2.3.1 Evolving 3D Human Figure of a Woman

In the context of garment design, the underlying form is a model of the human body or mannequin and the mathematical specification of the body must be of a bi-parametric form. Typically such body surfaces can originate from two sources, either another CAD system or a 3D digitizing system states Fairhurst (2008). The design sketch can be produced with the aid of a figure template, which enables the designer to produce ideas quickly, relating to proportions, layers and details of the figure quotes Ireland (2008).

The creation of 3D design of a human figure is time consuming and highly complicated. This is partly because of the mathematical calculations and the complicated shapes and features of a human figure. Moreover a number of researches has been carried out in 3D design of human figure and are readily available in the net. This study focuses on creating garment design library and therefore a woman model similar to an Indian woman is downloaded. This was in the ‘daz’ file format. The figure is opened in the Daz Studio 3D software. Flowing straight hair is added to the human figure and the figure is exported and saved in the ‘obj’ file format. The ‘obj’ file is imported into the 3D Studio Max and saved as ‘max’ files. A human model for working garment designs is thus evolved. The selected woman model is presented as in Figure 1.

**Figure 1 – Front, Back and Side View of Woman Model**
3.2.3.2 Preparation of Basic 3D Garment Silhouettes

Garment designs are usually created as a silhouette initially. The preparations of basic 3D garment silhouettes for the selected garments are explained in detail under the following heads.

3.2.3.2.1 Salwar Kameez
3.2.3.2.2 Saree and Blouse
3.2.3.2.3 Midi and Tops
3.2.3.2.4 Long Skirt and Tops

The designing in the 3Ds Max starts with setting up of view ports. Four different views can be set in the screen of which one is usually a perspective view. The other views are top, right and left views. This enables the designer to view the figure at different angles and ensure that the placements are perfect. For a closer view the viewport on which the designer is working can be maximized as and when required.

3.2.3.2.1 Salwar Kameez

Along with Saree, Salwar Kameez is the identity of Indian women. Salwar Kameez is made up of three pieces. The Kameez is a long and loose flowing tunic like long shirt that is worn from top using a wide opening at the neckline. The Salwar is the loose Pyjamas that accompany the Kameez. The Duppatta can be worn in different styles as a loose wrap around the neck, or slipping down the shoulder or even covering the
The steps involved in creating the garment silhouette of a Salwar Kameez are explained below.

- In the process of designing the upper part Kameez was designed first followed by the Salwar and the accessories.
- The woman model and the hair were frozen while designing the garment. This will ensure that the model will not be altered throughout the designing process.
- Objects can be created by using polygons, primitives and mesh objects. Polygons are the surfaces that are formed by joining three or more points in a 3D space (Kogent Solutions, 2008). A polygon was created and placed over the body on the right side of the woman’s figure at the centre front line.
- The polygon was converted into an editable polygon.
- The editable polygon was modified by selecting one edge at a time and extending it in the desired angle and length.
- The vertex of the polygon was selected and modified to suit the shape of the body.
- Care is taken to see that the polygon is draped evenly over the chest.
- When the front half was completed, the same procedure was followed at the back.
- The sleeve for the right hand was also prepared in a similar fashion.
- The front, back and sleeve is selected and mirrored after cloning the same.
- The same sequence was followed for the Salwar also.
- The Kameez was hidden while working on the Salwar.
- After the completion of Salwar, the Kameez was “unhidden” and the model was “unfrozen”.
- Duppatta also was created by modifying a polygon.
- The Salwar, Kameez and Duppatta were modified into ‘mesh smooth’ where the polygon and the edges were smoothened. Smoothing creates this illusion of roundness by assigning smoothing groups at the face, element or object level explain Elliot et-al (1994).
The Salwar, Kameez and Duppatta were subjected to “UVW mapping”. This makes the texture mapping more effective.

A pair of bangles and a slip-on shoe was created.

The garment design was given a file name and saved in a folder.

The Figure 2 brings out the stages of creating a Salwar, Kameez, Duppatta, bangles and slip-on shoes.

**Figure 2 – Step by Step Procedure for Creation of Salwar Kameez**
3.2.3.2 Saree and Blouse

Saree and Blouse is a traditional garment of India. According to Druid (2007), the sari, worn by women throughout the Indian sub-continent is probably the most elaborate garment consisting of just one piece of stitched cloth. Askari and Arthur (1999) are of the view that each area in India has its own distinctive method of draping a Saree and it may vary in length from three to eight metres. It is draped over a woman in different fashions in different parts of India. The most common type is the one worn by Tamilnadu women and the Gujarathi women. Even though the Saree and Blouse do not fall under the tailored garment, this is selected for designing because the Saree is a traditional garment and is treasure to our Indian heritage. It is the need of the hour for the younger generation and yet to come generation to view this diminishing costume. The steps involved in creating the garment silhouette of a Saree and Blouse are explained below.

- Blouse was first created and then the Saree was draped over the model
- The woman model and the hair were frozen while designing the garment. This will ensure that the model will not be altered throughout the designing process
- A polygon was created and placed in the centre front line over the model
- The polygon was extended and draped over the front and back bodice till the waistline
- The front and back bodice was cloned and mirrored
Then the Blouse was selected and frozen, which ensures that the Blouse remains unedited.

A skirt was draped over the body by creating and extending the polygon.

A layer of Saree was draped around the waist four pleats were created in the centre front from the waist line.

Three pleats were formed and spread over the chest and was converged to the shoulder line.

Three pleats hang from the shoulder at the back.

After the completion of Saree and Blouse, the model was “unfrozen”.

The Saree and the Blouse were then modified into ‘mesh smooth’ where the polygon and the edges were smoothened. This was done after the completion of every part.

The Saree and the Blouse subjected to “UVW mapping”. This makes the texture mapping more effective.

A pair of bangles and a slip-on shoe was created.

The garment design was given a file name and saved in a folder.

The Figure 3 shows the stages of creating a Saree and Blouse.

Figure 3 – Step by Step Procedure of Creation of Saree and Blouse
3.2.3.2.3 Midi and Tops

Midi and Tops is a two piece garment, where Midi is a skirt worn at the waist and the Tops is a bodice block. In India this garment is worn by the children and adolescents.

The steps followed in creation of the basic style is as follows:-

✓ The woman model and the hair were frozen
✓ A polygon was created and draped over the body
✓ One half of the front and back bodice block was created and developed by extending the polygon
✓ Sleeve was also created using the polygon
The bodice front, back and sleeve were cloned and mirrored
The Tops thus created was hidden while creating the Midi
Knee length skirt was also created using the polygon
One half of the skirt was created and mirrored after cloning
After the completion of skirt, the Tops was unhidden and the model was unfrozen
The Midi and Tops were then modified into ‘mesh smooth’ where the polygon and the edges were smoothened
The Midi and Tops were modified for “UVW mapping”. This makes the texture mapping more effective
Pair of bangles and a slip-on shoe was created
The garment design was given a file name and saved in a folder

The Figure 4 shows the stages involved in creating a Midi and Tops.

Figure 4 – Step by Step Procedure for Creation of Midi and Tops
3.2.3.2.4 Long Skirt and Tops
A Long Skirt is also termed as full skirts as the length of the skirt extends to the foot of the wearer. Silk skirts, lachas and serraras are full skirts worn during the festive seasons. A top to suit the skirt is worn along with the skirt. The method of construction of Long Skirt and Tops is similar to Midi and Tops except that the length of the skirt is longer and the steps is as follows :-

- The woman model and the hair were frozen
- A polygon is created and placed in the centre of the figure
- One half of the front and back bodice block was created
- Sleeve was also created using the polygon
- The bodice front, back and sleeve were cloned and mirrored
- The Tops thus created was hidden while creating the skirt
- Full length skirt was also created using the polygon
- One half of the skirt was created and mirrored after cloning
- After the completion of skirt, the Tops was unhidden and the model was unfrozen
- The Long Skirt and Tops were then modified into ‘mesh smooth’ where the polygon and the edges are smoothened
- The Long Skirt and Tops were subjected to “UVW mapping”. This makes the texture mapping more effective
- A pair of bangles and a slip-on shoe was created
- The garment design was given a file name and saved in a folder

The Figure 5 shows the stages involved in creating a Long Skirt and Tops. It is similar to the Midi and Tops. Hence only the additional steps are shown in Figure 5.
3.2.4 Creating Variations in the Basic Garment Silhouettes

Variations are created from the basic garment styles of Salwar Kameez; Saree and Blouse; Midi and Tops and Long Skirt and Tops by altering the sleeves, necklines, yokes in the bodice block and skirts. To quote Satyan (2011), the style looks different by way of design changes to the pattern parts, by use of value added processes like embroidery and printing. In addition to the variation in the structural design of the garment, textural differences were also created. The variations created are discussed under the following heads:-

3.2.4.1 Salwar Kameez
3.2.4.2 Saree and Blouse
3.2.4.3 Midi and Tops
3.2.4.4 Long Skirt and Tops

3.2.4.1 Salwar Kameez

A variety of Salwar Kameez’s created include - normal Kameez, short kurta, flare type, frock type – single layered skirt, frock type – double layered skirt, frock type – three layered skirt. Loose Salwar and tight salwars were the variations of Salwar. Neckline variations are – close, open, halter necklines and shoulder straps. Plain sleeve and sleeveless types were made in the armhole. Panels were created at the centre and
sides. Shoulder yoke and neckline yoke were also added as variations in Kameez. Other variations include asymmetric designs, border at the hemline, half/ half designs.

3.2.4.2 Saree and Blouse

Saree and Blouse is an Indian traditional garment. The Saree is a rectangular piece of fabric of 5 ½ m draped around the body in different fashions. Most commonly used two draping styles such as South Indian (Tamil nadu style) and North Indian style (Gujarathi style) were created. In the Tamilnadu type, pleated style and single pleated style Saree were created with border and without border. Plain Sarees, embroidery Sarees, printed Sarees, net Sarees and transparent Sarees were created. In the plain sleeve and sleeveless Blouse the following neckline variations namely, close neck, open neck and halter neck are done.

3.2.4.3 Midi and Tops

The variations in the Midi include tubular skirt, tubular skirt with frills, gathered skirt (normal and fully gathered), double layered skirt and three layered skirt. The neckline variations in the Tops include close, open and halter neck, shoulder straps and shoulderless. The plain sleeve and sleeveless Tops have princess line yoke, shoulder yoke and neckline yokes. Panels were introduced in the centre and sides. Other variations include asymmetric designs, paneled skirt and tops.

3.2.4.4 Long Skirt and Tops

The variations in the Full Skirt and Tops are similar to the Midi and Tops. In addition to the above mentioned changes, silk skirts and skirts laid over with a transparent fabric were created. Variations are created from the basic garment styles by altering the sleeves, necklines, yokes in the bodice block. The skirt variations include gathers and flares. The number of variations are created in basic garments are as follows,
3.2.5 Application of Colour and Texture to the Model and the Garment

Colour is the fundamental consideration in the design process and is often the first element that was noticed state McKevley and Munslow (2010). Shading is the process of calculating the colour of a pixel or a shading sample from user specific surface properties. Shading model and texturing is the method of varying the surface properties from point to point in order to give the appearance of surface detail that is not actually present in the geometry of the surface explain Ebert et-al (2005). According to Vaughan (2005), once a 3D object is created, textures and colours are applied to it to make it seem more realistic – rough and coarse or shiny and smooth. Colour was applied to the woman model with the material editor, where the colour shades are selected from the colour palettes. The ambience, diffusion and secular level in the material is controlled so as to create a texture of human skin.

When a material is wrapped around the surface of an object, it can be stretched or shrunk so as to follow the shape of the object. This approach is referred to as texture mapping describes Avadhani (2006). Texture application is a method of projecting pictorial information (materials) onto surfaces. Materials make the model and the garment look real and interesting. The texture is applied with the material maps available in the material library. In addition to the existing material maps, the researcher collected fabric swatches in the web and stored them as ‘jpeg’ files in the material library. The researcher also photographed around 6800 fabric swatches and added them to the material library as ‘jpeg’ files. The selected texture was mapped over the garments in the planar, cylindrical, spherical, shrink wrap, box and face forms. Mapping is a method of projecting pictorial information (materials) onto surfaces. It is like wrapping a present.
with wrapping paper, except that the pattern is projected mathematically, with modifiers, rather than being taped to the surface. The garment portions to be textured were selected and filled using the material editor. For example, the yoke in a Salwar or border in a Saree was selected for adding textures.

The fabric library created for texturising the garment sums upto 680 and the same is evidenced in the Appendix 2. A variety of fabrics were collected ranging which include plain fabrics, printed fabrics, embroidered fabrics, netted fabrics and fabrics with special weave patterns and finishes. Some of the fabric swatches were collected from the internet. A majority of the fabrics were photographed and saved in the image library. Some of the fabric swatches collected by the researcher for the material library is presented in the Figure 6 and the entire collection is presented in Appendix 2.

**Figure 6 – Sample of Fabric Swatches**

Plain fabrics

![Fabric Swatch 1](image1.png)
![Fabric Swatch 2](image2.png)
![Fabric Swatch 3](image3.png)

Printed fabrics

![Fabric Swatch 4](image4.png)
![Fabric Swatch 5](image5.png)
![Fabric Swatch 6](image6.png)
Stage set was designed to be viewed from a distance and at a given resolution, whether it’s that of a TV camera, a movie camera or the human eye writes Ebert-et-al (2005). The model and the image are positioned on a stage by merging the design file. A 3D camera was focused on the model. Spot light and two additional helper lights were positioned to give proper lighting to the scene.
3.2.6 Animating, Rendering the Image and Creating an Output

Computer animation is achieved by displaying a series of individual frames at a speed fast enough to create the illusion of motion writes Peterson (1997). The animation step involves defining objects motion and how the lightning and views change defines Shuman (2002). Fashion rendering is adding yet another dimension to fashion illustration, created by a typical and specific style of shading and texturing the illustrations which in turn makes them more informative opine Singhal and Bharati (2010). Rendering produces the final output file and needs specifying the file type, frame size and frame rate states Parekh (2008). Rendering is a technique that facilitates users to get a preview of how objects can appear in the final 3D product after the users have modelled them, animated them and applied the desired shading, texturizing and lightning on them (Kogent Solutions, 2008).

A circular path was set for the camera to move. The render setting was set for 1000 frames. Brightness and contrast level were adjusted to give more clarity to the scene. Time taken for rendering of an image was 45 to 75 minutes. For rendering 2000 images time taken was 100,000 minutes (approximately 1700 hours). The output of the rendered scene was saved in the ‘avi’ format. The ‘avi’ files occupy a larger disc space (1.79GB=18.77,449 KB). Hence the ‘avi’ files were converted into ‘mpeg’ files (4.8 MB = 4,900 KB). The files can be played in any media player. For viewing a garment design, the file required has to be selected, which automatically runs in the windows / default player. The model revolves at 180 degree which helps the viewer to view the garment fully in the front, back and the sides.

3.2.7 Creating 3D Design Library

A digital library is a library in which collections are stored in digital formats. Aldrich (1999) states that using libraries of 3D garments along with related texture and drape, provides an accurately represented garment without it being constructed physically. The primary step in the creation of a library is cataloging or grouping the
collection of book in the order of author and year. In our case the designs were places in folders and files. 3D Design Library, thus created was presented in 4 separate Digital Versatile Discs (DVD). Design library 1, 2, 3 and 4 was recorded in four DVDs, one on each DVD. The samples of the garment styles are presented in the results and discussion chapter. The details of the DVD’s are as follows,

3D Design Library 1 – Salwar Kameez
3D Design Library 2 – Saree and Blouse
3D Design Library 3 – Midi and Tops
3D Design Library 4 – Long Skirt and Tops

3.2.8 Creating Website for the Design Library

Internet surfing is very common; hence a website is created to evaluate the design library, with the help of ‘Samantha technologies’. A domain is purchased and the website is named as ‘3ddesignlibrary.com’. The homepage of the website displays the abstract of the thesis. The project has design library 1, 2, 3 and 4. The entire design library has styles grouped and arranged in folders and files. When a particular style is selected the garment design on the model runs for thirty seconds for a full 360 degree rotation. This helps the viewer to view the garment in the front, back and sides. The ‘about us’ page gives the profile of the researcher and the guide. The contact address is also provided on the webpage. Once a video is played by a viewer, he / she can rate the video and write the comments in the box given below. Also there is a counter at the bottom of the webpage, which gives us the details as to how many have visited the website. Figure 7, 7a, 7b and 7c presents the glimpse of the website created for the study, which includes the home page, ‘about us’ page, ‘project’ page and the ‘view of the garment design’ page.
Figure 7 – Website Created for the Study – Home Page

Figure 7a – Website Created for the Study – ‘About Us’ Page

Figure 7b – Website Created for the Study – ‘Projects’ Page

Figure 7c – Website Created for the Study – ‘View of the Garment Design’ Page
3.3. Phase III – Evaluation of 3D Design Library

The design library was evaluated by the different group of people. Two different questionnaires were prepared for the evaluation purpose. The first questionnaire was used by the textile and garment manufacturers, textile and garment showrooms, tailors, consumers (college students, working women, housewives), computer professionals and computer illiterates and aids in evaluating the garment collection, feature variations, textural variations, colour combinations used, suitability of the garment and the design, operating the 3D design library, presentation of garments in the 3D form, view of the garments in all the angles and replacement of the catalogs with 3D designs. The questionnaire used by them is presented in the Appendix 3.

Fashion designers, faculty members and students of fashions design field were given a different set of questionnaire which is presented in the Appendix 4. One additional question was added in this questionnaire. The question was added to find out the efficiency of using the design library as a tool for teaching. This group of people are involved in the process of teaching and learning designs and hence were asked to evaluate the efficiency of design library as a teaching aid.

3.3.1 Evaluation by the Fashion Designers

Fashion designers create garment styles that become fashion. Fashion designers are also termed as fashion leaders. A group of 50 fashion designers were presented with a design library for evaluation. The designers evaluated the design library for its quality, variety, effectiveness, uniqueness.

3.3.2 Evaluation by the Faculty Members of Fashion Design Courses

Teachers and lecturers handling classes for fashion design related courses will have to explain the features of garment styles in detail. The 3D design library can serve as an educational material to teach the garment styles. To test the
effectiveness of this study material, 100 faculty members of fashion designing courses were asked to evaluate the 3D design library for its usefulness.

3.3.3 Evaluation by the Fashion Design Students

Students of fashion learn the features of garment styles in detail. Hence, 100 post graduate students studying fashion designing courses of the Avinashilingam Institute for Home Science and Higher Education, Coimbatore and Bishop Appasamy College of Arts and Science, Coimbatore were briefed about the design libraries. After viewing the designs the students evaluate the 3D design library in the given questionnaire.

3.3.4 Evaluation by the Textile / Garment Manufacturers

Fabrics and accessories are the raw materials of the garments and together they make up a collection and as such play an important role in its production writes Martin (2009). To convince the buyers, display of samples is an important step for the textile and readymade garment manufacturers, mainly the exporters. Weavers of textile weaving units in the Thekkalur and Nehemem village near Coimbatore represented the group of textile manufacturers. The 3D library was presented to fifty weavers for evaluation. Also a group of fifty garment manufacturers in Coimbatore and Bangalore were requested to evaluate the 3D design library.

3.3.5 Evaluation of the Textile / Garment Retail Showrooms

The retail showrooms present their stock in the form of catalogues to its customers for the purchase of designer wears. The presentation of collections in the 3D form is more cost effective and attractive. Owners and managers of the hundred textile and garment showrooms in and around the Coimbatore were approached. For those who responded 3D Design library was presented and evaluation was done in the questionnaire.
3.3.6 Evaluation by the Tailors

Custom made garments are stitched by the tailors. Customers and the tailors also refer to the design magazines for selection of design. After viewing the design libraries the tailors evaluated them in the questionnaire given to them. One hundred tailors performed the evaluation.

3.3.7 Evaluation by the Consumers – College Students, Working Women and Housewives

Customers today can choose from an almost unlimited range of styles, materials and colours, states Entwerfen (2010). Marketing certainly hinges on understanding “the lady” and creating a customer out of her through this understanding opine Ramaswamy and Namakumari (2010). The consumers were selected from the following categories – students, working women and housewives (100 each). The consumers were presented with the questionnaire for evaluating the 3D design library.

The views of the students are collected from the college students of Bishop Appasamy college of Arts and Science, Coimbatore from various departments like commerce, business management and visual communication. The design library presents a collection of selected women’s garments and hence only female students evaluated the collection. Another category of evaluators include working women and housewives who are key decision makers in the purchase of garments for themselves and for their children.

3.3.8 Evaluation by the Computer Professionals

The researcher has selected 3D Studio Max software is used for creating the 3D design library. The faculty members of the computer science department of Bishop Appasamy College, Coimbatore, computer professionals of IBM, Cerner
health care solutions and Magus Customer Dialog Private Limited were selected for evaluation. IBM and Cerner Health Solutions are software companies of Bangalore and Magus Customer Dialog Private Limited is a call centre in Chennai. In order to check the correct use and application of software, computer professionals were requested to evaluate the design library.

### 3.3.9 Evaluation by the Computer Illiterates

Computer illiterates refer to the group of people who do not have a basic awareness on the usage of a computer. The investigator has opted to evaluate women of self help groups of Pethapampatti and Illuppanagaram in Madathukulam taluk of Tiruppur district. This is a rural village near Coimbatore. The 3D design library produced should be user friendly, hence was tested for its user friendly nature with the computer illiterates. The investigator demonstrated the use of computer and method of operating the 3D design library. After a weeks’ time the investigator visited them to ask their opinions. The opinions of the computer illiterates were recorded in the questionnaire.

### 3.4 Evaluation through Internet

Internet has become a very important source of reference in the fashion industry, view Centner and Vereker (2008). The 3D design library was hosted in the internet for viewing in the ‘3ddesign library.com’. The viewers were requested to rate and post their comments. The website will also give the details of the number of viewers who have visited for the website.

### Data Analysis

A Likert scale is a psychometric scale commonly involved in research that employs questionnaires. It is the most widely used approach to scaling responses in survey research (wikipedia 2012). The reliability of the questionnaire in capturing
subjective data with 5 point Likert Scale was tested using Cronbach’s alpha. Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. A "high" value of alpha is often used as evidence that the question measure an underlying construct (in this study – features of the 3D design library). The Cronbach’s alpha was 0.73, by empirical means suggesting good internal consistency.

Responses were tabulated irrespective of the category of the respondent. Further cross tabulation was performed to analyze response by respondent category. The tabulation and the analysis are presented in the chapter ‘Results and Discussion’.