A Method of Selection the Textile Materials for Virtual Reconstruction

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Abstract. A reconstruction of historical costume can be applied to the movies, theatres, and online museums. Additionally, in the contemporary fashion and industry, the historical European costume has been one of the most essential inspiration for new design. This article developed a method of selection the analogues of textile materials which have been used in European men’s suits from 1850s to the 1920s based on published books and real historical male coat. This investigation will be useful to reconstruct historical men costume in virtual reality with high-precision.

1. Introduction

Heritage comes in many ways – in tangible forms such as sites, buildings, landscapes, or as intangibles, like memories, emotions, values and customs [1]. During runways of latest fashion weeks in Paris, Milan, New York and London, the relevant elements and features of historical costumes have been appeared in many notable brands’ design [2]. Especially the turn of 20th century, men’s everyday suits were similar to contemporary styles, emphasized quality tailoring, practicality and well-dressed [3]. Therefore, the better understanding of historical costumes can provide an inspiration for contemporary fashion designers. To date, however, full appreciation of historical costume still affected by lots of restrictions, such as costume heritage has a relatively short life, since costumes normally consist of old organic fibres which are vulnerable to the environment and quickly degrade, compared to other relics [4]. For this purpose, many science researchers are working on reconstructing historical costumes by 3D technology which not only on the realistic simulation of fabric mechanical properties but also virtual garment on the synthetic avatar and some other aspects.

In order to accurately reconstruct historical costume and improve construction efficiency, the primary factor is to find textile materials that are consistent with historical prototype. In 3D CAD system, not only the surface appearance of the fabric, but also its physical and chemical properties such as buckling ratio, buckling stiffness, density etc. are optional. An overview of academic historic textile and costume collections which presents the guidelines for the management of such collections has been published in the monograph of Welters LM [5]. Kang et al. demonstrated the way about how to create the design and the fabric image in Photoshop CS5, and express surface detail and adjusted the capabilities of different fabrics in DC Suite [6]. Cybulski M. done the exploration about the properties that archaeological textiles had in the past and developed the way of virtual reconstructions of textile [7, 8]. The research team, led by N. Maginen-Thalmann developed a method of 3D modeling and
simulating for different styles of historical costume according to the characteristics of textile materials
[9].

However, it is still unable to find the prototypes of historical textile materials of European men’s
suit during 1850s to 1920s from current scientific research results and the fabric market. And it is also
inaccuracy to test textiles from the real historical men’s suit directly, because it degraded by many
factors. In order to selection the perfect substitute for historical textile materials, this research is going
through the following process. Firstly, the structure and layer of each garment of men’s suit should be
analyzed to determine which textile material need to be study. Secondly, the information of textile
material based on books and historical coat prototype will be established and searching for the
contemporary substitute. Thirdly, selection the similar textile materials in CLO 3D to prepare for
virtual reconstruction. This approach will be helpful not only for traditional museums and material
cultural heritage inheritors, but also for the 3D clothing technology and new digital media.

2. Textile Materials for Men’S Suit
From 1850s to 1920s, men’s suit usually consists from shirt, drawers, trousers, waistcoat and coat.
Theses five garments shown in figure 1 (a) [10, 11]. Figure 1 (b) shows the location of each garment
which were formed the men’s suit during this period [3].

![Figure 1. Men’s suit: (a) prototype (1895-1915) [12], (b) cutaway view.](image)

As we can see from figure 1 (b), men’s suit was made from many kinds of fabrics at the turn of 20th
century, such as cotton, silk, wool, etc., that can let each garment have different functions. According
to our research on the layers of men’s suit, there are totally nine kinds of textile fabrics which we need
to study as shown in table 1.

| No. | Garment       | Area   | No. | Garment     | Area                                      |
|-----|---------------|--------|-----|-------------|-------------------------------------------|
| 1 & 2 | Shirt, drawers | Top fabric | 6   | Top fabric, lining on forepart |
| 3 | Trouser       | Top fabric | 7   | Pad on forepart       |
| 4 | Waistcoat     | Front   | 8   | Lining on Side, skirt and tail |
| 5 | Back, lining  | 9   | Lining on sleeve |

Table 1. Different historical textile materials of the men’s suit.
3. Methods
For each textile material of men’s suit, the information we can find was limited, so we need to adopt different approaches for different fabrics. Here are two methods for us to speculate the contemporary fabrics which are similar with historical fabrics:

- Finding properties from historical books such as fiber content, type and weight (density).
- Simple testing and measuring of real historical men’s coat such as fiber, thickness, weave and fabric count.

4. Results and Discussion

4.1. Results from the 1st method
According to Grace (1923) [13], Dyer (1923) [14], Waugh (1964) [11], Cole and Deihl (2015) [10], the fibers and the type of common fabrics can be find. It should be noted that the thickness of the wool will be changed depending on a season. Weight of fabric per yard has been published on Emanuel (1920) [15], but according to the International System of Units, we need to convert the weight of fabric from oz. per yard to g. per m². Based on these three basic properties, we could found the similar contemporary textile material from fabric market. Table 2 shows the results of parts of historical fabrics and the similar modern fabrics. The No. of each fabric are same with table 1.

Table 2. Information about historical textile materials for the men’s suit and its contemporary substitutes – Part 1.

| No. | Historical | Weight (density, g/m²) | Contemporary |
|-----|------------|------------------------|--------------|
| 1 & 2 Cotton | Madras, percale, oxford, white cambric | 176.48 | Cotton, percale, 175 |
| 3 Wool | Usually lighter in weight than for the coat, high quality wool, jersey-weaves, merinos, doeskins, cassimere, kerseymere, ratiné. | 337.85 | Wool, worsted, 150 ~ 337.84 |
| 4 Wool | Plain, checks, tweed or cotton pique. | 119.8 | Wool, worsted plaid, 122.58 ~ 200 |
| 5 Silk | Silk satin or brocade, and cotton in different weaves and finishes | 82.09 | Silk, brocade, 83.33 |
| 6 Wool | Superfine wool, worsteds, cassimere, tweeds, vicunas. | 506.79 | Wool, worsted melton, 300 ~ 506.67 |
| 7 Linen | Canvas, cotton and linen mixtures. | --- | --- |
| 8 Cotton | --- | --- | --- |
| 9 Cotton | --- | --- | --- |

4.2. Results from 2nd method
Three fabrics No. 7- No. 9 couldn’t be ascertaining by using 1st method so we used 2nd method to find fiber, thickness, weave and fabric count.
Real historical men’s coat which was made in 1900s from Garment Design Department (Ivanovo State Polytechnic University) collection as shown in figure 2 (a) has been chosen for measuring. Figure 2 (b) presents the cloth thickness gauge for measuring the fabric thickness. This product has an error of ± 0.01mm. Figure 2 (c) presents the 60-fold fabric analysing glass for observing the weave and fabric count. Cotton and wool fabrics are expressed in terms of metric density, that is, the number of warp or weft yarns within a width of 10 cm. The two-digit latitude and longitude density of the fabric is indicated by the symbol "X". For example, 236×220 means that the fabric has a warp density of 236 threads/10 cm and a latitudinal density of 220 threads /10 cm [16].

![Object and tools for measuring.](image)

Figure 2. Object and tools for measuring.

Table 3 presents the results of No.7~9 historical fabrics. Based on these properties, we could found the scope of the similar contemporary fabric.

| No. | Fiber | Thickness (mm) | Weave | Fabric count | Details |
|-----|-------|----------------|-------|--------------|---------|
| 7   | Linen | 0.34           | Plain | 130×110      | 55% linen, 45% cotton, plain, 0.35mm, 162.5 g/m² |
| 8   | Cotton| 0.34           | Twill | 320×290      | Cotton, twill, 0.35mm, 189.19 g/m² |
| 9   | Cotton| 0.21           | Plain | 320×260      | Cotton, plain, 0.21mm, 100 g/m² |

4.3. Selection of textile material in CLO 3D for virtual reconstruction

We compared the historical textile materials information with contemporary fabrics in virtual try-on software, especially the type, composition, weight and thickness. Finally, identify the properties of digital contemporary fabrics which are similar to historical fabric prototypes. The selected digital textile materials are shown in table 4 which from library of CLO 3D.
Table 4. Properties of digital textile materials in CLO 3D.

| No. | Type       | Classification   | Weight (density, g/m²) | Thickness (mm) | Stretch-weft stiffness (g/s²) | Stretch-warp stiffness (g/s²) | Bending-weft stiffness (g/mm²/s²/grad) | Bending-warp stiffness (g/mm²/s²/grad) |
|-----|------------|------------------|------------------------|----------------|------------------------------|-----------------------------|----------------------------------------|----------------------------------------|
| 1&2 | Cotton     | Oxford           | 165                    | 0.37           | 217,880                      | 440,584                     | 1445                                   | 1289                                   |
| 3   | Wool       | Super 120s Wool  | 157.5                  | 0.27           | 165,263                      | 182,216                     | 976                                    | 976                                    |
| 4   | Wool       | Super 120s Wool  | 157.5                  | 0.27           | 165,263                      | 182,216                     | 976                                    | 976                                    |
| 5   | Silk       | Charmeuse        | 81.1                   | 0.19           | 9672                         | 48.714                      | 156                                    | 375                                    |
| 6   | Wool       | Coatweight Twill | 345                    | 0.84           | 368,706                      | 489,034                     | 1300                                   | 1300                                   |
| 7   | Linen      | Linen            | 173.39                 | 0.36           | 215,456                      | 799,917                     | 850                                    | 1500                                   |
| 8   | Cotton     | Gabardine        | 189                    | 0.35           | 1,700,000                    | 1,700,000                   | 2200                                   | 4500                                   |
| 9   | Cotton     | 50s Cotton Poplin| 105.03                 | 0.21           | 280,769                      | 356,091                     | 938                                    | 1289                                   |

5. Conclusion
The method of selection textile materials of historical men’s suit based on written materials and real historical male coat prototypes have been developed and the information of both real and digital textile materials have been established. Based on these results, we are reconstructing real costume now. At the same time, combined with the digital twin with historical male body and method of historical clothing shaping during making and finishing, the more accurate simulations will be produced.

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