June 2023

Comparative Study and Expansion of Metadata Standards for Historic Fashion Collections

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Abstract

This research seeks to contribute to efforts to standardize metadata across the costume and fashion domain by adding new metadata elements and controlled vocabularies to Costume Core. Expanding the metadata schema could increase the searchability and discoverability of fashion collections. To expand Costume Core, we used vocabulary from pre-trained Natural Language Processing (NLP) models to identify potential new descriptors from a conceptual latent space provided by a technique known as word embeddings. We also pulled from controlled vocabularies shared by fashion collection personnel from across the United States via online surveys.

Author Bios & Acknowledgements

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Fashion (historic costume or dress) artifacts related to the process and product of dressing the body (including clothing, textiles, and accessories)[1] are forms of primary data that provide "evidence" of what was worn in the past.[2] The artifacts are thus forms of material culture that indicate the social norms, values, mores, and ways of life humans adopted during a specific time and place. More specifically, fashion artifacts provide information about social structures around age, gender, social class, and race/ethnicity. While the general practice of describing clothing uses simple metadata standards such as the Dublin Core, the majority of collections primarily concentrate on detailing the artifacts within their holdings. Examples include the database described by Sklar et al.[3] which primarily features traditional Syrian clothing, or the case report by Zeng[4] detailing a project focused on the historic fashion collection at Kent State University Museum. In their study, Cai et al.[5] ranked metadata elements from the Dublin Core, the VRA Core, and the proposed elements from Qipao-related literature to produce a schema dedicated to the Chinese costume "Qipao." Europeana Fashion,[6] which operates as a metadata aggregator like the DPLA (Digital Public Library of America),[7] uses a simple and broad categorization system such as the Dublin Core to aggregate metadata from different institutions. However, this approach and many interoperability initiatives come at a cost for fashion researchers who may encounter challenges conducting effective searches due to the lack of specificity in the categorization system.[8]

Due to its focus on fashion artifacts, Costume Core,[9] a metadata application profile featuring metadata elements and controlled descriptive terminology (vocabulary), is a more suitable standard for describing fashion artifacts. In addition, it offers controlled vocabularies for aspects such as age/stage of life, gender, social class, and country of origin,[10] making it particularly relevant for this purpose. However, Costume Core is still limited in its ability to provide precise descriptions, hindering accessibility and discoverability of dress and textile/fashion collection holdings. For instance, online users may experience failed searches due to discrepancies between keywords and published titles or descriptions. To address this challenge, we aim to expand the Costume Core by adding new metadata elements and controlled vocabularies to make fashion collections more searchable and discoverable.

Through this project, we contributed to interoperability initiatives across the costume and fashion domain by addressing the lack of standardized metadata within the costume/fashion/dress

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[1] Joanne B. Eicher and Sandra L. Evanston, *The Visible Self: Global Perspectives on Dress, Culture and Society* (New York City: Fairchild Books, 2014): 3.

[2] Jules D. Prown, "Mind in Matter: An Introduction to Material Culture Theory and Method," *Winterthur Portfolio* 17, no. 1 (1982): 2, https://doi.org/10.1086/496065.

[3] Monica Sklar, Katherine Hill McIntyre, and Sharon Autry, "Preserving cultural craft heritage: Digitizing a traditional Syrian clothing collection," *Craft Research* (2021): 317-333, https://doi.org/10.1386/crre_00055_1.

[4] Marcia Lei Zeng, "Metadata Elements for Object Description and Representation: A Case Report from a Digitized Historical Fashion Collection Project," *Journal of the American Society for Information Science* 50, no. 13 (1999): 1193-1208, https://doi.org/10.1002/(sici)1097-4571(1999)50:13<1193::aid-asi5>3.0.co;2-c.

[5] Xinxi Chen and G. G. Chowdhury, "The outreach of digital libraries: A globalized resource network," *International Conference on Asian Digital Libraries* (November 2012), https://doi.org/10.1007/978-3-642-34752-8.

[6] Henk Vansteppen, "Europeana Fashion," *Europeana Pro* (2020), https://pro.europeana.eu/project/europeana-fashion.

[7] Vansteppen, "Digital Public Library of America and Europeana," *Europeana Pro* (2011), https://pro.europeana.eu/post/digital-public-library-of-america-and-europeana.

[8] Getaneh Alemu, Brett Stevens, and Penny Ross, "Towards a conceptual framework for user-driven semantic metadata interoperability in digital libraries: A social constructivist approach," *New Library World* 113 (2012): 38-54, https://doi.org/10.1108/03074801211199031.

[9] Costume Core Vocabularies, "Features," https://airtable.com/shrsDOAeaRxjg70Lh/tblSPjhYxPqxPRhL0/viwjAnLSa2s7eAj39.

[10] Arden Kirkland, "Costume Core: Metadata for Historic Clothing," *Visual Resources Association Bulletin* 45, no. 2 (2019), https://online.vraweb.org/index.php/vrab/article/view/36.

field.[11] Online fashion archives often lack adequate descriptions, according to Pecorari,[12] which can lead to inaccuracies that, along with the lack of standardized metadata, may result in negative outcomes such as failed searches for users of online historic dress databases and, ultimately, limiting the reach and accessibility of fashion collections' online holdings.[13] Metadata standardization may be achieved, however, through the wide adoption and use of Costume Core among fashion collections.[14] Our vision is to transform the historic costume and fashion field by creating a revised metadata schema that can be widely adopted within the field due to its ability to describe fashion artifacts precisely.

This research was conducted following metadata digitization for a North American university fashion collection,[15] the Oris Glisson Historic Costume and Textile Collection at Virginia Tech.[16] The collection holds primarily Western garments and accessories worn by local donors, university alumni, faculty, and students. However, the collection also contains some items acquired during international travel, including traditional and folk costumes from Northern Europe and Asia.

We acknowledge that our study is limited to identifying descriptors for primarily Western fashion artifacts. It should be noted that to ensure accuracy when cataloging/digitizing metadata for non-Western artifacts, however, we adopt the names and descriptors of the garment as they are presented in world costume textbooks, including *The Worldwide History of Dress*[17] and scholarly articles, such as those featured in dress and culture textbooks – including *The Meanings of Dress*[18] – and record them in a free text[19] description field within the Costume Core template. Cai et al.[20] mentioned similar challenges related to lacking metadata elements in describing non-Western costume collections. Work is underway to develop "how international garment names and craft details relate to expanded and more inclusive terminology" and fit within fashion and costume archive standards, which speaks to the limitations of metadata schemas in describing non-Western fashion artifacts.[21]

Method and Procedure

Previous efforts to expand the Costume Core schema consisted of digitizing and re-cataloging holdings of a university fashion collection[22] in Costume Core. While cataloging, 63 terms were added to the controlled vocabulary to more precisely describe the collection's diverse artifacts, which included accessories such as hats, shoes, jewelry, handbags, and sunglasses. In addition, new terms to describe the colors and materials (e.g., "silver, metal," and "stone/gems") were added. The added controlled terms were borrowed from authoritative sources such as the *Fairchild Dictionary of*

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[11] Arden Kirkland, et al., "Sharing Historic Costume Collections Online," *Dress* 41, no. 2 (2015): 114, https://doi.org/10.1080/03612112.2015.1130394.

[12] Marco Pecorari, "Fashion archives, museums and collections in the age of the digital," *Critical Studies in Fashion and Beauty* 10, no. 1 (2019): 20, https://doi.org/10.1386/csfb.10.1.3_7

[13] Kirkland, et al., "Sharing Historic Costume Collections," 113-117.

[14] Kirkland, "Costume Core," 14; and Kirkland, et al., "Sharing Historic Costume Collections," 114.

[15] Denise Nicole Green and Kelly L. Reddy-Best, "Curatorial reflections in North American university fashion collections: Challenging the canon," *Critical Studies in Fashion and Beauty* 13, no. 1 (2022): 8, https://doi.org/10.1386/csfb_00035_2.

[16] Virginia Polytechnic Institute and State University College of Liberal Arts and Human Sciences, "The Oris Glisson Historic Costume and Textile Collection" (2023), https://liberalarts.vt.edu/departments-and-schools/apparel-housing-and-resource-management/experience/collections/the-oris-glisson-historic-costume-and-textile-collection.html.

[17] Patricia Rieff Anawalt, *Worldwide History of Dress* (New York: Thames & Hudson, 2007).

[18] Kimberly A. Miller-Spillman and Andrew Reilly, *The Meanings of Dress* (New York: Fairchild Books, 2019).

[19] Kirkland, et al., "Sharing Historic Costume Collections," 116.

[20] Chen and Chowdhury, "The outreach of digital libraries."

[21] Sklar, et al., "Preserving cultural craft heritage," 328.

[22] Green and Reddy-Best, "Curatorial," 8.

Fashion,[23] *Survey of Historic Costume*,[24] and "Vocabulary of Basic Terms for the Cataloguing of Costume."[25] This vast collection provided an extensive dataset that allowed us to identify more terms, much like the Vassar College collection used to develop the original Costume Core template.[26]

To further expand the Costume Core schema, we used vocabulary from pre-trained Natural Language Processing (NLP) models to identify potential new descriptors from a conceptual latent space provided by a technique known as word embeddings. This provided a novel, automatic approach for identifying controlled vocabulary for costume/dress/fashion descriptions. The use of NLP builds upon the previous work of Muralikrishnan et al., in which the researchers trained an NLP model to map free-form text descriptions of costume items to Costume Core terms.[27] Our second approach was to pull vocabulary from metadata schemas shared by other fashion collection personnel across the United States via online surveys.

Natural Language Processing

We used a language model pre-trained on the Google News dataset to pinpoint terms similar to those in Costume Core, indicating valuable contributions to the metadata. To establish model reliability and ensure descriptor quality, we provided the model-generated output for review by three trained undergraduate students knowledgeable in the fashion domain, with a dress domain expert and manager of a university fashion collection performing final confirmations. However, we expected that simply sending descriptors in the form of textual data would prove tedious and time-consuming. With this in mind, we developed MOCHA, a Model Output Confirmative Helper Application, to facilitate the review process.

A screenshot of the application is shown in Fig. 1. To begin using the application, the user uploaded a file containing approximately 6,500 potential descriptors generated by the model to the application. The descriptors then populated the screen in column two, where the user selected the descriptors they felt were accurate. When selected, the descriptors automatically appeared in column three, labeled "New Descriptors."

Once moved to column three and selected as descriptors, the descriptors could be edited. This feature was added after an initial walk-through with the fashion domain expert, who noted that many descriptors contained terminology relating to multiple Costume Core fields. Editing allowed for terms relating to material, color, and work type (style or type of garment or accessory) to be separated. However, this may have been a limitation of the application, as only one part of the descriptor could be selected and retained. For example, "taffeta dress" contains terms relating to material and work type. The descriptor could be edited to capture only "taffeta" or "dress" – thus, only taffeta or dress could be designated as a new descriptor. Once edited, the user categorized the descriptor type by selecting one of the following categories (which reflected the names of

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[23] Charlotte M. Calasibetti and Phyllis G. Tortora, *The Fairchild Dictionary of Fashion*, 3rd ed. (New York: Fairchild Publications, 2003).

[24] Phyllis G. Tortora and Sara B. Marcketti, *Survey of Historic Costume* (New York: Fairchild Books, 2015).

[25] International Committee for the Museums and Collections of Costume (ICOM) (1982), https://terminology.collectionstrust.org.uk/ICOM-costume/.

[26] Kirkland, "Costume Core," 1.

[27] Madhuvanti Muralikrishnan, et al., "Using Language Processing to Predict Costume Core Vocabulary of Historical Artifacts," *IEEE International Conference on Machine Learning and Applications (ICMLA)* (2022), https://doi.org/10.48550/arXiv.2212.07931.
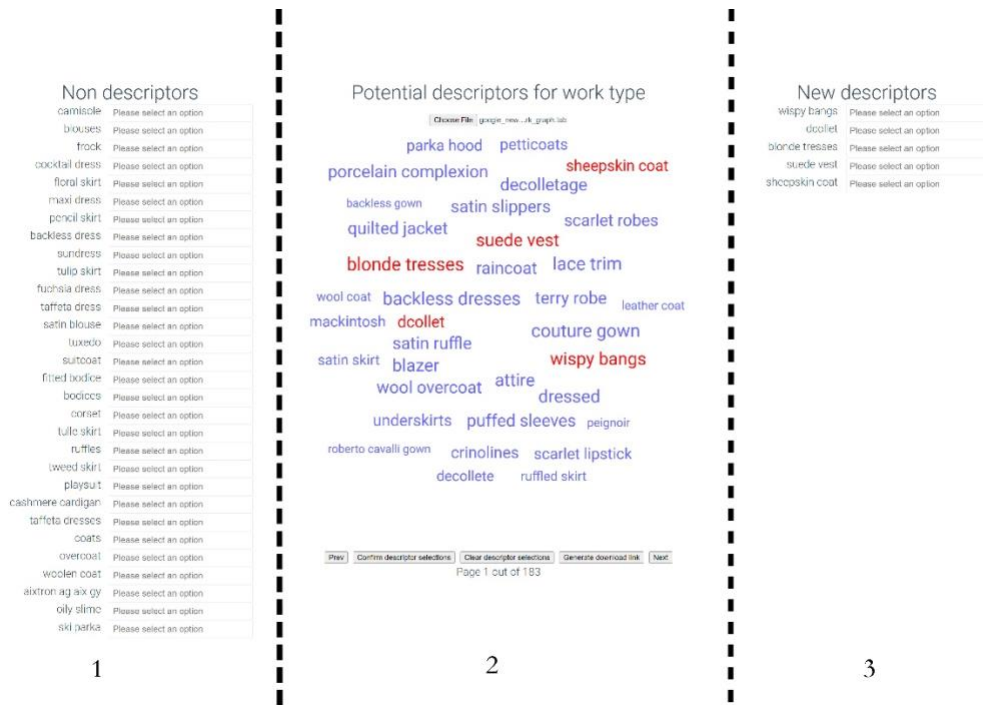
Figure 1: MOCHA: Column 1 stores descriptors not selected by our reviewers; Column 2 stores descriptors currently being processed; Column 3 stores descriptors confirmed by our reviewers.

Costume Core fields) that appeared in a drop-down menu: work type, closure, skirt type, material, color group, costume components, dress type, and color. Once all the descriptors on the screen were selected, edited, and categorized, users clicked "Next." Then they repeated the process until the full list of the descriptors within the uploaded document was reviewed. To finalize the list of new descriptors, users selected "Confirm descriptor selections," which placed all descriptors that the user did not select in column one – "Non-descriptors" – where terms were available for later selection in case a mistake was made and needed to be corrected. Finally, to create a record of new descriptors, the user selected "Generate download link."

To prevent non-descriptive terms from being added to the schema and to promote domain-specific terms appropriate to the subject matter, our review process used a human-in-the-loop approach to confirm generated descriptor choices. This process involved having the three undergraduate students majoring in fashion merchandising and design (i.e. students knowledgeable within the domain) generate new descriptors from three pre-trained models using MOCHA and share the documents containing the new descriptors with a fashion domain expert for review. Having a fashion domain expert serving as a filter for useful descriptors could increase the overall efficacy of the schema. The expert used a strict term selection process, weighing term selections based on thorough comparisons of scholarly articles and encyclopedic documents and extensive knowledge of terminology relating to the fashion industry's manufacturing process (e.g., fibers, yarns, fabric structures, finishes, and garment construction). For example, the expert was careful to separate terms used to describe fibers (e.g., cashmere) and fabric structures (e.g., satin) from terms used to describe garment styles (work type: e.g., cardigan, blouse) to alleviate concerns surrounding the quality of the descriptors chosen for our updated metadata schema. The fashion domain expert's list of confirmed descriptors was shared with MOCHA's developer for further analysis.

Results

We performed data analysis on the finalized descriptors to provide an accurate interpretation of the model's performance. Based on preliminary results, using machine learning models for metadata expansion is justifiable due to the accuracy of generated descriptors and its time-saving potential.

Our domain experts processed the top 25 similar tokens for each term in the Costume Core vocabulary set. We also created files of the top 20, 15, 10, and 5 most similar words as generated by the models. Below are the plotted graphs of the percentages of words having a particular cosine similarity score graphed against the cosine similarity score for both original model-generated and confirmed tokens. As expected, Figure 2 shows that the top 5 most similar words generated by the models have higher cosine similarity values on average than the top 25 most similar words.
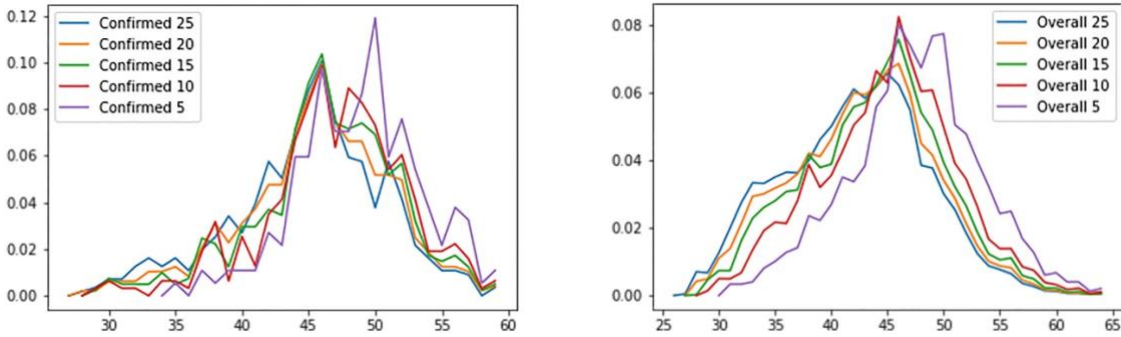
Figure 2: Model Confirmed versus Overall Similarities Comparison

However, the measure of the model's efficacy in predicting descriptors is displayed in the gap between the cosine similarity scores of the confirmed descriptors and the overall generated descriptors. If the model's predictions are accurate, we would expect words with higher cosine similarity scores to have a larger chance of being confirmed by our domain experts.

As seen in Figure 3, there is a clear distinction between the original, model-generated descriptors and the descriptors that our reviewers actually confirmed. This indicates that words the model thought more likely to be beneficial were selected more often than words that the model perceived as less valuable.

To further demonstrate this difference, we examined the relative averages of confirmed and overall descriptors. Consistently, the confirmed descriptors had a higher cosine similarity score on average than the overall model-generated descriptors, though this average difference decreases as the number of terms being looked at is reduced.

Figure 3: Model Confirmed Overall 25

Model Output CS Scores	Top 25	Top 20	Top 15	Top 10	Top 5
Confirmed CS Score	0.6063	0.6145	0.6244	0.6329	0.6575
Overall CS Score	0.5688	0.5777	0.5901	0.6071	0.6370

Table 1: Percentage of generated descriptors that were confirmed at each level.

Survey

Kirkland et al. highlighted that many collections developed customized vocabularies and authority lists for fashion and costume makers based o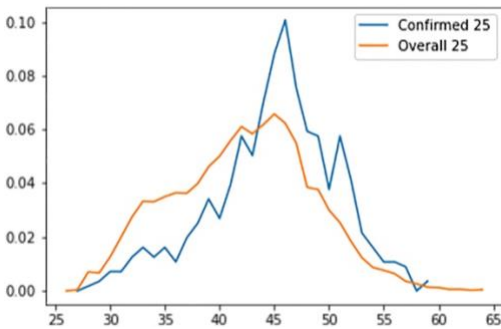n their local collections. Sharing these resources with the broader costume/dress/fashion history community could help identify a wider variety of terms and synonyms for communal assessment and use.[28] Alemu et al. found that current metadata approaches are predominantly authoritative and digital libraries often adopt an objectivist approach that emphasizes metadata simplicity. They argued that achieving semantic metadata interoperability in digital libraries will continue to be challenging unless information objects are supplemented with metadata generated through a collaborative, user-driven approach.[29] In light of these findings, we employed crowdsourcing – a technique for gathering information "from extensive groups of people through the internet"[30] – to collect terms from fashion collection staff who are subject specialists. We directly contacted them via email through a Costume Society of America newsletter issue and the Visual Resources Association and Digital Library Federation listservs. This approach aimed to harness the collective expertise of these professionals and promote semantic metadata interoperability in digital libraries by fostering a more collaborative, user-driven metadata generation process.

The criteria for participation in the survey were that the respondents self-identified as directors and/or staff members of fashion collections, aged 18 years or older, living in the United States. The respondents also were required to have experience cataloging artifacts. Members and affiliates of the Costume Society of America were targeted because the organization potentially holds the largest number of dress/costume historians and practitioners in the field of historic costume/dress/fashion curation, conservation, preservation, and collection management.

Instrument

Upon approval from the Virginia Tech Institutional Review Board, data were collected using a survey created with QuestionPro. Participants were asked to select the name(s) of the metadata schema(s) and controlled vocabularies they use in their collections (e.g., VRA Core, Costume Core, Dublin Core, ICOM Vocabulary of Basic Terms for Cataloguing Costume, Getty Art and Architecture Thesaurus), metadata fields/elements used to document artifacts (e.g., data, description, color, provenance), and resources used to determine accurate terminology/vocabulary (e.g., Fashion2Fiber image database, HistoricDress project, *Fairchild's Dictionary of Fashion*, *Fairchild's Dictionary of Textiles*). The survey's final section requested that participants upload documents illustrating the types of metadata schemas they use and samples of controlled vocabularies. If documents were unavailable, the survey showed participants an image of a sample garment and asked to respondents to input examples of metadata directly in the survey response text box. The

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[28] Kirkland, et al., "Sharing Historic Costume Collections," 118-119.
[29] Alemu, Stevens, and Ross, "Towards a conceptual framework," 38-54.
[30] Chiara Bonacchi, et al., "Crowd-sourced Archeological Research: The MicroPasts Project," *Archeology International* 17, no. 1 (2014): 61, https://doi.org/10.5334/ai.1705.

survey data were analyzed using descriptive statistics and qualitative coding, in which words or phrases were coded into categories using content analysis.[31]

Sample

A total of 31 individuals initially responded to the survey and 12 completed the survey, achieving a 40% completion rate. The survey took an average of six minutes to complete. The research team expected the number of respondents to be between 12 and 35 since there are a limited number of active fashion collections[32] across the United States, and the academic field of historic costume/dress is relatively small, limiting the pool of potential participants.

Participants included directors, curators, collection curators/managers, archivists, graduate assistants/interns, and metadata and digital projects coordinators working in collections across the United States, most of which (66.67%) were collections in a university or higher education setting. Participants' experience describing and cataloging fashion artifacts ranged from three months to 30 years, with an average of 11.2 years. Their experience was primarily obtained through formal coursework and degrees in fields relating to fashion history and library and information science studies as well as on-the-job training, including graduate assistantships, internships, and current places of employment.

Results

Responses regarding the types of metadata schemas and resources employed in cataloging were analyzed using descriptive statistics. Of note is that no specific metadata category for fashion artifacts was selected by all 12 participants, indicating high variability in collection cataloging systems. For example, as shown in Table 2, the garment type/title description, period, and label (care/brand) categories were the most frequently selected ($n =8$), while metadata relating to culture, life stage, and relation (related items) was rarely selected ($n = 3$). Metadata related to socioeconomic status was not selected ($n = 0$). In addition to the options provided, other metadata collected included: the name of the artist/designer, information about the wearer, object number, maker, object description, credit line, location in the collection (such as closet, shelf, or box number), components, number of pieces, lining, structure, cut, torso, edges, hem, and Getty genre. Some of the "other" metadata provided by participants corresponded to the choices offered, including object name, date of the object, maker (usually captured by label), and country (i.e. provenance, region).

Element	Count	Percent	Element	Count	Percent
Garment Type/Title Description	8	5.80%	Closure Type	4	2.90%
Period	8	5.80%	Closure Placement	4	2.90%
Donor	7	5.07%	Treatment	2	1.45%
Gender	7	5.07%	Technique/Decorative Elements	5	3.62%
Function	4	2.90%	Label (Care/Brand)	8	5.80%

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[31] "Content Analysis," Columbia University Mailman School of Public Health (30 March, 2023), https://www.publichealth.columbia.edu/research/population-health-methods/content-analysis.

[32] Sara B. Marcketti and Jennifer F. Gordon, "'I Should Probably Know More:' Reasons for and Roadblocks to the Use of Historic University Collections in Teaching," *Journal of Conservation and Museum Studies* 17, no. 1 (2019): 8, https://doi.org/doi.org/10.5334/jcms.169.

Element	Count	Percent	Element	Count	Percent
Medium/Material/Fiber Content/Fabric	7	5.07%	Provenance	6	4.35%
Color	7	5.07%	Region	4	2.90%
Pattern	5	3.62%	Culture	3	2.17%
Neckline Style	5	3.62%	Life Stage	3	2.17%
Collar Type	5	3.62%	Socioeconomic class	0	0.00%
Sleeve Style	5	3.62%	Condition	5	3.62%
Waistline	5	3.62%	Relation (Related Items)	3	2.17%
Silhouette	5	3.62%	Measurements/Size	5	3.62%
Length	5	3.62%	Other	3	2.17%

Table 2: Metadata collected on fashion artifacts.

Regarding metadata schemas, participants indicated that they primarily used Dublin Core (*n*=5), while one indicated they used Costume Core. The remaining participants selected "other" (*n*=4). One participant wrote that they used Nomenclature 5.0. In contrast, the remaining participants indicated that they used a schema customized to their collection (e.g., "internal language," "some custom," and "created by the archive I work in").

The resources used to determine accurate terminology/vocabulary when cataloging artifacts included costume/dress history textbooks (*n*=6), *Fairchild's Dictionary of Fashion* (*n*=3), *Fairchild's Dictionary of Textiles* (*n*=3), Getty Art and Architecture Thesaurus (*n*=3), ICOM "Vocabulary of Basic Terms for Cataloguing Costume" (*n*=1), and "other" (which included Picken's *Language of Fashion*, c. 1939 and *A Dictionary of Costume and Fashion* – both sewing, needlework, and embroidery dictionaries/encyclopedias). When asked how they decide which terms to use for items whose meanings may have changed over time, participants selected the following options: "Use the best term I know/think is best based on reference materials, such as *Fairchild's Dictionary of Fashion*, *Survey of Historic Costume*, etc." (*n*=5), "Use the best term I know/think is best based on my own lived experience" (*n*=4), "Choose from the terms provided in the metadata schema I use" (*n*=4), and "Other" (*n*=5). Open-ended responses to "other" included, "Write redundant information to clarify definition," "Use the period term or take it to its broad objective use," and "We will do library research at a local University Library system."

Participants were asked to describe the sample garment shown in Fig. 4 using the same metadata/terminology they use in their collections. The terminologies reported by participants are listed in Table 3. The researchers classified these terms according to the Costume Core field with which the sample terms may be associated. Therefore, the classifications are also shown in Table 3. Table 4 shows terms repeated within the five participant descriptions of the garment, and Table 5 shows terms provided by participants along with the number of participants who mentioned the terms. Again, the terms are presented as the researchers categorized them according to Costume Core fields on Table 5.

Figure 4: A recreation of a gown housed in the [Louisiana State University Textile & Costume Museum](#) was used as a sample artifact and prompt for participants to provide sample metadata/terminology.
Photograph taken by one of the authors and reproduced with permission.

Costume Core Elements	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5
Work Type	-	-	dress	gown	dress, gown
Gender	-	-	-	-	female
Color	-	-	white	-	white/cream
Medium	lace	-	muslin, lace	cotton, linen, lace	-
Technique	scalloped	-	scalloped hem	-	-
Neckline	high, shallow	-	boat neck	-	-
Sleeve Type	set-in	-	dropped shoulder	-	-
Sleeve Length	long	long	-	-	-
Waistline	-	-	-	-	-
Dress Type	empire waistline	-	empire waist	-	-
Skirt Type		A-line	-	-	-
Skirt Length	full-length	ankle-length	-	-	-
Costume Components	-	-	puffs, lace inset, lace trim	-	-
Style Period	-	-	19th century	Regency era	-
Date	-	-	1820s	-	-
Lifestages	-	-	-	-	adult
Classification	-	-	-	reproduction	-

Table 3: The terminology used by participants (1-5) to describe the sample garment and classified by the researchers according to Costume Core fields.

Costume Core Elements	Terms provided by participants	count (*n=*)
Work Type	dress	2
Work Type	gown	2

Color	white	2
Medium	lace	5
Technique	scalloped	2
Waistline	empire	2
Sleeve Length	long sleeves	2

Table 4: Repeated terms.

Color	n =	Medium	n =	Technique	n =
Baby	1	Acetate* satin	1	applique*	1
Black*	3	Brocade*	1	beading*	2
Blue*	2	Cotton*	2	cording**	1
Blue-green	1	Cotton broadcloth	1	devore*	1
Light blue	1	Cotton plain weave	1	drawnwork	2
Bright	1	Cotton velveteen	1	embroidery*	3
Brown*	1	Digitally printed synthetic	1	handmade*	1
Dark brown	1	Embossed*	1	homemade	1
Checked**	1	Embroidered*	1	inset	1
Copper	1	Fine	1	openwork	1
Dark	1	Fragile	1	pintuck pleats	1
Faded	1	Gabardine	1	pleated**	1
Green*	1	Jersey*	1	n/a	1
Light	1	Knit*	1	rhinestones**	1
Metallic gold	1	Lace*	2	rouleaux trim	1
Multi*	1	Laser cut	1	rouching	1
Muted	1	Leather*	2	ruffled**	1
Neon	1	Linen	2	satin stitch	1
Ombre	1	Rayon* velvet*	1	scalloped	1
Orange*	1	Rough	1	sequin*	1
Orange-red	1	Satin	1	smocking*	2
Pale	1	Silk*	1	soutache	1
Pink*	2	Silk* chiffon*	1	stitching	1
Plaid**	1	Silk* satin*	1	tatting	1
Purple*	1	Silk* taffeta*	1	trapunto	1
Red*	3	Tape lace	1	vyndayk	1
Red-Purple	1	Valenciennes lace	1	-	-
Royal	1	Velour*	1	-	-
Silver*	1	Velvet	1	-	-
Sheer	2	Wool	1	-	-
Striped**	1	Wool* boucle	1	-	-
Vivid	1	Wool* crepe*	1	-	-
White/Cream	1	-	-	-	-

Color	n =	Medium	n =	Technique	n =
Yellow*	1	-	-	-	-
Yellow-Green	1	-	-	-	-

Table 5: Sample metadata terminology shared by participants and classified by the researchers according to Costume Core fields.

*Color terms or synonyms currently included in the Costume Core metadata schema.
**Terms or synonyms currently included in the Costume Core metadata schema that are assigned to fields other than color.

Discussion
Natural Language Processing

Overall, the results of the NLP analysis show that there was a difference between generated descriptors predicted to be accurate and descriptors that were deemed accurate and confirmed by the domain expert. While the difference between the distributions of generated versus confirmed terms lacked statistical significance, our model was trained on over 100 billion tokens from a wide variety of sources, allowing us to select from a wider array of descriptors than we could have identified on our own. In addition, our revision process allowed us to achieve our aim of expanding the Costume Core controlled vocabulary, identifying a total of 780 potential descriptors. Of these descriptors, 528 were absent from Costume Core and 252 terms were either originally part of Costume Core or previously added while cataloging items from the university fashion collection.

The difference between model-predicted and confirmed descriptors may be explained by the domain expert's systematic method of separating descriptors that described fiber or fabric structure (medium) or color and style (work type, dress, skirt, and pants type). The domain expert analyzed all terms according to those used to describe textile products in each stage of the textile manufacturing process. Referring to the textile manufacturing process[33] likely differed from the process other creators of metadata schemas have used to select descriptors. For example, the Costume Core developer consolidated elements from several fashion collections across multiple institutions while also borrowing elements from established standards, including DC and Visual Resources Association (VRA) Core, based on guidelines from Cataloging Cultural Objects (CCO) and Categories for the Description of Works of Art (CDWA).[34] The domain expert's process may be unique because the discrimination of fibers, fabric structures, dyes/coloration, and finishes requires extensive domain knowledge that catalogers outside the domain and novices within the domain may not have. Indeed, one appeal of Costume Core is its ease of use among novice catalogers.[35] Costume Core can be revised to include elements, allowing catalogers to naturally draw from even a basic knowledge of the textile manufacturing process to describe artifacts accurately.

The predicted and confirmed descriptors may have differed due to unintentionally excluding terms through editing the descriptors. For example, one proposed descriptor was "denim capris," which contained one descriptor for medium (denim) and one descriptor for pants type (capris). There was no option to keep both descriptors and sort them into the "New Descriptor" column. Thus, the two-part descriptors could have been edited to either "denim" or "capris," eliminating one of the terms as a potential descriptor.

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[33] Billie J. Collier and Phyllis G. Tortora, *Understanding Textiles* (Upper Saddle River, NJ: Prentis Hall, 2001): 9-13.
[34] Kirkland, "Costume Core," 5.
[35] Kirkland, et al., "Sharing Historic Costume Collections," 8.

Survey

Among the ten responses received regarding using metadata standards for describing fashion artifacts, four indicated that they used Dublin Core, while one used Costume Core. The remaining five responses used other metadata standards. These survey results indicate a lack of standardization in the field, with no clear consensus on which metadata schema to use. Furthermore, the low adoption rate of Costume Core suggests that it is not widely used by the costume/dress/fashion community. This lack of standardization may contribute to difficulties in creating consistent controlled vocabularies for fashion artifacts. This poses challenges for the field as there should be consistency in metadata to make fashion collection holdings more accessible and discoverable.

The inconsistency in metadata may stem not only from the use of various schemas but also from the use of reference materials that inform how fashion artifacts are described and which terms are selected. For example, Kirkland et al. mentioned that *Fairchild's Dictionary of Fashion* contains standard terminology used in the fashion industry but is not consistent with apparel construction and sewing books or other sources containing fashion vocabulary; thus, which terms are selected depends heavily on the resources cataloguers use.[36] Therefore, because participants indicated that they use a variety of sources, the terminology used to describe fashion styles also varies.

For example, the terminology used to define the style of dress worn in the Northern Renaissance varies between Hill's[37] and Tortora and Marcketti's[38] costume/dress history textbooks. Hill explained that the English term "kirtle" referred to an open-front gown with a busk bodice gown worn by women in the Northern Renaissance.[39] In contrast, Tortora and Marcketti referred to a similar style as a combination of a petticoat and overdress.[40] Hill's use of the term "kirtle" contrasts with its more general use to describe garments in the Middle Ages worn by both men and women, otherwise known by the French term "cotehardie."[41]

When asked about respondents' decision-making processes for selecting appropriate terms for items with meanings that have changed over time, the majority of respondents (n=5) indicated that they selected terms based on reference materials, while an equal number (n=4) indicated that they selected terms based on both the metadata schema used and their lived experience. The latter method may introduce the potential for bias but can still produce accurate terminology for describing artifacts, depending on the cataloger's level of expertise and familiarity with their metadata schema. However, everyone's lived experience is different, and the terms selected may be influenced by their cultural backgrounds. For example, catalogers from the United States may prefer "pants" over "trousers," a term more commonly used in the United Kingdom.

Since participants did not provide sample metadata records and catalog cards from their collections, we relied on the metadata that the participants used (Table 3) to describe the sample garment (Fig. 4) to compare and contrast the controlled vocabularies they use in their collections. The descriptors that appeared most frequently are lace (n=5) and an equal number (n=2) for dress, gown, white, scalloped, empire, and long sleeve. Given the small sample size, there is minimal overlap in the terminology used, and it is difficult to determine how they typically describe or catalog artifacts in their collections (Table 3). However, there is an apparent inconsistency in the descriptors used (Tables 3 and 4).

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[36] Kirkland, et al, "Sharing Historic Costume Collections," 115.

[37] Daniel D. Hill, *History of World Costume and Fashion* (Upper Saddle River, New Jersey: Prentice Hall, 2011): 379.

[38] Tortora and Marcketti, *Survey of Historic Costume*, 153.

[39] Hill, *History of World Costume and Fashion,* 379.

[40] Tortora and Marcketti, *Survey of Historic Costume*, 153.

[41] Hill, *History of World Costume*, 379; and Wikipedia, "Kirtle" (last modified 15 February, 2023), https://en.wikipedia.org/wiki/Kirtle.

To analyze responses with sample metadata, we manually mapped the terms provided by participants to the Costume Core elements, which served to visualize the difference in descriptors provided and those currently included in the Costume Core metadata schema (Table 3, 4, 5). Although controlled terms in Costume Core are collected from the Europeana Fashion thesaurus[42] and others mentioned above, based on the sample metadata provided by participants, there appears to be a wide variety of characteristics of fashion artifacts that are not captured by the schema.

Regarding color, three participants used basic color terms to describe hue, while two participants used a combination of hues/colors. As one respondent explained, "I restrict colors to objective color wheel color or metal colors, not fashion or subjective name colors." Other respondents did not provide color names or hues (base colors or names of the primary, secondary, or tertiary hues used to create the color and found on the 12-hue color wheel). However, the participants gave descriptors of color values (the darkness or lightness of a color) such as vivid, faded, dark, and light or color intensity (the brightness, purity, or saturation; e.g., muted, bright, sheer).[43] One participant provided terms that are pattern descriptors (e.g., striped, plaid, checked) rather than color descriptors.

Regarding fabric and materials or medium, a variety of terms were listed, including those that indicated fiber content (e.g., linen, cotton, silk, wool), fabric structure (e.g., brocade, knit, lace, velvet, satin), as well as a combination of fibers and fabric structures (e.g., cotton broadcloth, cotton velveteen, silk chiffon). In addition, one participant listed descriptors of the material's texture (rough), thickness (fine), and condition (fragile). The wide range of terms reflects that there are innumerable ways in which mediums may be described and how materials are created. For example, a satin material may be made with cotton or silk fibers. Does it therefore make sense to list every possible combination of fiber and fabric structure within one field of the metadata schema? While there are multiple columns for medium (for example, medium, medium.2, medium.3) in the Google/Excel sheet of the Costume Core template that we used, each field should record one distinct aspect of the textile. Thus, the schema may be expanded to include a field strictly for fiber (cotton, silk, wool) and another for fabric structure (plain weave, crepe, velour). Other fields may be added to record the material's texture and thickness. At the same time, condition descriptors may be relegated to the free-text field for "condition description."

Regarding textile techniques, the sample metadata included seven terms (or synonyms) in Costume Core (Table 5). In addition, two terms or their synonyms were included in other fields of Costume Core (for example, "rhinestones" are defined as a material in Costume Core, as is "cord"). Thus, there are differences in how textile techniques are categorized across metadata schemas.

Expanding Costume Core

We combined the results from the analysis of the survey data with that of the comparison of established controlled vocabularies and NLP processing to identify new descriptors that will be used to create a revised metadata schema and set of controlled vocabularies. By crowdsourcing controlled vocabularies, we discovered 48 new terms (Table 5) that may be used to expand the metadata schema, including "dropped shoulder," "scalloped," "puffs," "lace insertion," "vivid," "sheer" "ombre," "neon," "boucle," "soutache," "tatting," and "drawnwork." In addition, as previously

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[42] Marie Riegels Melchior, "Digital Fashion Heritage: Understanding europeanafashion.eu and the Google Cultural Institute's We Wear Culture," *Critical Studies in Fashion and Beauty* 10 (2019), https://doi.org/10.1386/csfb.10.1.49_1; and personal communication with Costume Core developer (30 January, 2023).

[43] Ann Marie Fiore, *Understanding Aesthetics for the Merchandising and Design Professional* (New York: Fairchild Books, 2010): 135-139.

mentioned, NLP techniques helped us to discover 528 new descriptors that can be used to expand the Costume Core controlled vocabulary.

Our next step is to compare new controlled terms identified from the survey and the potential descriptors identified through NLP with other established controlled vocabularies, including the International Council of Museums (ICOM) Vocabulary of Basic Terms for Cataloguing Costume and the Getty Art and Architecture Thesaurus. Based on this comparison, we added new terms to the controlled vocabularies in Costume Core. A list of descriptors added to the schema is shown in Appendix A.

This study highlighted differences in how metadata are categorized and revealed that metadata schemas designed to catalog fashion artifacts, including Costume Core, do not allow for the description of each artifact at its most basic level. Thus, this study provided insight into adding metadata elements in the form of fields or columns, in addition to controlled vocabularies. For example, the element "medium" currently encompasses the fiber content (the materials from which an artifact is made) and fabric structure (how the artifact is made). To more accurately describe the artifact's medium, "fiber" could be added as a metadata element, separating the artifact's fiber content from the artifact's fabric structure. More refined metadata elements could be added for color representation. Color can be categorized according to basic hues or using terms on a standard color wheel. Consequently, distinct fields may be incorporated to capture hue, value, and intensity. Furthermore, new descriptors on the list may best fit under newly created metadata elements. For example, since there is a field for "dress type," "skirt type," and "pant type," a metadata element "hat type" could be created where the new descriptors "cloche hat" (Appendix A, 83) and "cowgirl hat" (Appendix A, 95) could be categorized. Adding such metadata elements could potentially enrich the schema and promote greater standardization.

Conclusions

Natural language processing (NLP) and survey methodologies assisted in discovering a large number of potential controlled terms in a small amount of time that we might not have otherwise discovered through other means. In addition, examining controlled terms provided by participants helped inform how Costume Core might be revised to classify artifacts better (for example, classifying fiber content separately from fabric structure). The combination of crowdsourcing and NLP successfully guided the expansion of Costume Core by introducing metadata elements and controlled vocabularies, providing more options to describe fashion artifacts accurately. These processes also allowed us to contribute to the "micro thesauri" for the field of costume and fashion. To further enrich the metadata schema, future researchers can compare and contrast the schema with existing international costume records through metadata aggregator services such as Europeana and DPLA. The implications of our expansion of Costume Core may include encouraging wide acceptance of the metadata schema, promoting metadata consistency, and increasing metadata interoperability, thereby improving resource discoverability and searchability.

NLP and survey methods are particularly suitable for any domains in which the nature of language is more flexible and ambiguous and not reliant on scientific names. For example, in the realm of entomology, rigid taxonomy-based classifications in the animal kingdom – which adhere to binomial nomenclature – are used, and scientific names denote relationships between subspecies and genera through a well-defined hierarchical order. In contrast, the study of natural heritage with its humanistic focus revolves around the ambiguous and adaptable nature of language. For example, throughout history, the various terms used to describe the names of fabrics, colors, and styles of garments have taken on different meanings over time, making it difficult for the contemporary reader to understand extant or historical written material and interpret the attributes of the garment. Thus, Natural Language Processing is useful in identifying terms for domains in which vocabularies

are constantly in flux and that reflect the various social and cultural contexts from which they were introduced.

As part of our future work, we aim to design and evaluate a user-friendly visual interface incorporating the expanded Costume Core metadata schema in an online/digital platform. The interface will enhance the precision of fashion artifact descriptions. The proposed tool will feature images of artifacts from the university fashion collection, accompanied by descriptions incorporating original and new Costume Core controlled terms.

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Appendix A: New Descriptors Identified from NLP Analysis

N	Term	N	Term	N	Term	N	Term	N	Term	N	Term
1	bracelet	101	baptismal	201	poplin	301	lined	401	peep toe shoes	501	collarless
2	cloak	102	brooch	202	silk tulle	302	cropped	402	scalloped edging	502	loincloth
3	scarf	103	housecoat	203	velveteen	303	brief	403	mermaid silhouette	503	turban
4	necklace	104	sweetheart neckline	204	robin's egg blue	304	shapes	404	tunic top	504	baptismal gown
5	jewels	105	high waisted skirt	205	buttery yellow	305	lacquering	405	pearl inlay	505	bandeau
6	bra	106	fishtail skirt	206	charcoal gray	306	bindery	406	pendant	506	bikini
7	sash	107	tiered ruffles	207	teal blue	307	woodcarv-ing	407	foam	507	crown
8	armor	108	smock dress	208	cobalt blue	308	ikat	408	polycarbon-ate	508	kevlar
9	hood	109	suspender belt	209	canary yellow	309	cutting	409	filament yarn	509	oven mitt
10	earrings	110	tutu skirt	210	peri-winkle blue	310	creases	410	polyester yarn	510	shinpads
11	rings	111	argyle	211	mauve	311	lounge-wear	411	batik	511	midi skirt
12	watches	112	hounds-tooth	212	taupe	312	partywear	412	crystal beads	512	scrunchie
13	crystals	113	shorty shorts	213	jewel toned	313	formalwear	413	yarn	513	house-dress
14	sweatshirt	114	stone-washed denim	214	rainbow hues	314	pashminas	414	mulberry	514	brides-maid gown

15	quartz	115	leggings	215	bright colors	315	rainwear	415	polyuret-hane	515	costume
16	cardigan	116	peasant skirts	216	neon colored	316	playwear	416	resin	516	scarves
17	fuschia	117	flared trousers	217	cerulean blue	317	casualwear	417	leotards	517	garden-ing
18	sundress	118	cropped pants	218	topaz	318	pantyhose	418	tank tops	518	harems pants
19	frock	119	parachute pants	219	seafoam green	319	thong panties	419	biker shorts	519	tulip
20	pajama bottoms	120	stirrup pants	220	crimson	320	bras	420	cellulose	520	backless
21	corset	121	peasant blouses	221	lime green	321	tightie whities	421	manmade fiber	521	shin guards
22	camisole	122	fringe trim	222	kelly green	322	pinstriped	422	tiara	522	knee pad
23	backless dress	123	leg warmers	223	tulip skirt	323	beret	423	corsage	523	poncho
24	tuxedo	124	trackpants	224	playsuit	324	headwear	424	boutonniere	524	draped
25	parka	125	denim cutoffs	225	helmet	325	fusible web	425	heathered	525	pashmina
26	tweed	126	waistcoat	226	heels	326	watercolor	426	embroidery floss	526	faux suede
27	cocktail dress	127	leopard-skin	227	stockings	327	stitchery	427	stockinette	527	percale
28	suitcoat	128	suspen-ders	228	charms	328	cutwork	428	couture	528	laces
29	overcoat	129	skinny jeans	229	accessor-ies	329	threadwork	429	jeggings	-	-
30	cravat	130	boxer shorts	230	orna-ments	330	topstitch-ing	430	pewter	-	-
31	puffed sleeves	131	gyspy skirts	231	rosary	331	felting	431	lilac	-	-

32	underskirts	132	bootcut jeans	232	harness	332	afghans	432	dark colors	-	-
33	lace trim	133	blue jeans	233	fastened	333	cross stitching	433	tracksuit bottoms	-	-
34	raincoat	134	chambray	234	pin	334	tearing	434	collared shirt	-	-
35	blazer	135	socks	235	emerald green	335	engraving	435	multihued	-	-
36	suede	136	tartan	236	platinum	336	foil stamping	436	neon	-	-
37	terrycloth	137	gaucho pants	237	copper	337	diecutting	437	iridescent	-	-
38	bomber jacket	138	drawstring	238	violet	338	lamination	438	pale colors	-	-
39	wind-breaker	139	coveralls	239	woven	339	saddle stitching	439	cyan	-	-
40	t-shirt	140	lycra	240	knots	340	overlaying	440	pearlescent	-	-
41	sportcoat	141	drainpipe trousers	241	canvas	341	embellish-ments	441	glow fluorescent	-	-
42	tracksuit	142	ballerina flats	242	tin	342	watercolor painting	442	rawhide	-	-
43	shinguards	143	chino	243	clip	343	pastel	443	cowhide	-	-
44	khaki	144	collared shirts	244	textiles	344	piecing together	444	wicker	-	-
45	sleeveless dress	145	embroid-ered lace	245	nickel	345	stringing	445	deerskin	-	-
46	hoodie	146	rouching	246	enamel	346	reassem-bling	446	upholstery	-	-
47	undershirt	147	cotton voile	247	silicon	347	decon-structing	447	tanning	-	-
48	wallet	148	shirring	248	ceramic	348	stitching	448	micron	-	-
49	polo shirt	149	lambs-wool	249	ebony	349	magenta	449	quilted fabric	-	-

50	satchel	150	silk brocade	250	aqua	350	armholes	450	alpaca fiber	-	-
51	mini skirt	151	alpaca fur	251	peach	351	spaghetti strap	451	fusing	-	-
52	hem	152	hooded poncho	252	hazel	352	straight silhouette	452	moisture wicking fabric	-	-
53	detachable hood	153	alpaca yarn	253	slit	353	looping	453	cheesecloth	-	-
54	zip fastening	154	cashmere wool	254	indigo	354	asym-metrical silhouette	454	wiring	-	-
55	hatband	155	silk crepe	255	chestnut	355	muted colors	455	gradient	-	-
56	pullover sweater	156	shearling	256	mahog-any	356	geometric pattern	456	briers	-	-
57	bustier	157	charmeuse	257	auburn	357	babydoll	457	mustard	-	-
58	sweatsuit	158	floral appliques	258	boots	358	monokini	458	clips	-	-
59	sandals	159	mermaid gown	259	briefs	359	fishnet tights	459	mermaid	-	-
60	pendants	160	pashmina	260	sneakers	360	scalloped	460	swirl	-	-
61	gemstones	161	micro-suede	261	bonnet	361	ultrahigh	461	pile	-	-
62	wrap-around sunglasses	162	multi-colored stripes	262	neutrals	362	belted waist	462	tubular	-	-
63	oversize sunglasses	163	waffle weave	263	botanical	363	nipped waist	463	briefcase	-	-
64	eyewear	164	toile	264	tropical	364	elasticated waist	464	cargo pants	-	-
65	purse	165	hemp linen	265	triangular	365	puffer jacket	465	backpack	-	-
66	wristlet	166	burlap	266	octagonal	366	bearskin	466	fluorescent	-	-

67	goggles	167	bronze	267	camou-flage	367	knapsack	467	mask	-	-
68	aviator sunglasses	168	beaded embellish-ments	268	rectangles	368	pouch	468	umbrella	-	-
69	hobo bag	169	chantilly lace	269	palazzo pants	369	fanny pack	469	toile	-	-
70	grosgrain	170	pheasant feathers	270	pajamas	370	armband	470	shoelace	-	-
71	mittens	171	peacock feathers	271	hand drawing	371	fasten	471	velour	-	-
72	latex	172	faux leather	272	lettering / letter-work	372	chin straps	472	waterproof	-	-
73	zebra print	173	calfskin	273	marble	373	velcro strap	473	floral embellish-ments	-	-
74	gladiator sandals	174	broad-cloth	274	tile	374	velcro closure	474	flat brimmed	-	-
75	tights	175	eyelet lace	275	top	375	goldtone	475	herringbone	-	-
76	bowtie	176	wire mesh	276	flare	376	drawstring waist	476	fur trims	-	-
77	headdress	177	cotton terry	277	flap	377	bandeau tops	477	sash	-	-
78	cufflinks	178	chinchilla fur	278	fringe	378	knotting	478	pastel	-	-
79	yarmulke	179	jade	279	casual	379	waterproof material	479	shirred	-	-
80	necker-chief	180	rubies	280	triangle	380	loafers	480	boucle	-	-
81	cinched waist	181	sapphires	281	paisley	381	sweater vest	481	tartan	-	-
82	bandeau dress	182	silicone	282	pajamas	382	seersucker	482	peasant skirt	-	-

83	cloche hat	183	viscose	283	corset	383	tuxedo pants	483	track pants	-	-
84	hotpants	184	bamboo	284	camisole	384	oxford shirt	484	bobby socks	-	-
85	faux fur	185	knitted fabric	285	hem	385	studs	485	argyle socks	-	-
86	paisley print	186	lyocell	286	bustier	386	fringe	486	stone washed	-	-
87	harem trousers	187	chunky bangles	287	maxi skirt	387	tennis skirt	487	cami	-	-
88	capelet	188	dangle earrings	288	cocktail	388	sari	488	flannelette	-	-
89	high waisted	189	synthetic yarns	289	suspender	389	starched	489	breeks	-	-
90	cocktail frock	190	acrylic yarn	290	playsuits	390	frilled	490	britches	-	-
91	leopard print	191	swarovski crystals	291	bootcut	391	button-down	491	gypsy skirt	-	-
92	inverted u	192	tussar silk	292	leopard	392	trench coat	492	jogging pants	-	-
93	poodle skirt	193	bungee cord	293	pinstripe	393	fireproof material	493	fluorescent	-	-
94	lederhosen	194	crepe paper	294	ruched	394	rain poncho	494	flounced skirt	-	-
95	cowgirl hat	195	synthetic rubbers	295	unitard	395	duster coat	495	smock	-	-
96	concentric squares	196	corsages	296	chaps	396	horned helmet	496	jumpsuit	-	-
97	ivory	197	boutonn-ieres	297	babydoll	397	belt loops	497	khaki pants	-	-
98	newsboy cap	198	whittling	298	stockings	398	hooded cloak	498	shalwar kameez	-	-
99	leotard	199	earthtones	299	pointy	399	pith helmet	499	tank top	-	-

100	dressing gown	200	worsted wool	300	tailcoat	400	racerback	500	jean skirt	-	-