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Although most members of the military services are well-served by regulation garment sizes, a small percentage of men and women require custom-made clothing. Measurements of individuals requiring these garments are currently recorded on written forms, and sent to the Special Measurement Office of the Defense Supply Center-Philadelphia (DSC-P) where they are processed. Problems inherent in the use of written forms can result in failure to deliver uniforms in a timely fashion and the need for costly returns and replacements. This report describes a portion of the research invested in the development of an electronic order form (EOF) that would greatly expedite the design, manufacture, and delivery of special measurement clothing. The activity described here concerns itself chiefly with the development of editing algorithms designed to produce complete and accurate information on the electronic form. Other work briefly outlined here includes checking the accuracy of measurement instructions and development of a scaled-down version of the order form (EOF Lite) for use on individual personal computers.

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PREFACE

This document is the final technical report of one of a series of inter-related projects under the title, "Data Collection/Verification: Improved Forms DD358 & DD1111". The organization of those inter-related projects is documented in the body of the report.

As with any collaborative effort, the final report here is the result of the help of many people, both up front and behind the scenes. The author would like to thank Dr. Nancy J. Staples, Clemson Apparel Research, for her efforts in guiding the complex of organizations towards a common goal. Statistician James Hardman, Miami University, produced the many regression equations needed for the error checking part of this task. James Annis, Anthropology Research Project, Inc., developed the dimension minimums and maximums with his usual thoroughness. Dr. Richard Jarvis, also of Clemson Apparel Research, helped focus the effort by his persistent questioning of statistical methods. Belva M. Hodge, Anthropology Research Project, painstakingly formatted the regression equations, not only for delivery to Dr. Jarvis, but also for this report. Ms. Hodge also prepared the final draft of this report. Finally, Ilse O. Tebbetts (ARP) edited the final draft for clarity, completeness, and consistency.

EXECUTIVE SUMMARY

Although most members of the military services are well-served by regulation garment sizes, a small percentage of men and women require custom-made clothing. Measurements of individuals requiring these garments -- those who wear extreme sizes and those who are unusually proportioned -- are currently recorded on written forms, and sent to the Special Measurement Office of the Defense Supply Center-Philadelphia (DSC-P) where they are processed.

A number of problems inherent in the current special measurement system originate in the paper forms. These include: misinterpretation of directions which results in incorrect measurements; failure to fill out the form completely; and the forms themselves which do not solicit the complete set of measurements that many contemporary patternmakers need when creating made-to-order clothing.

Advances in technology in the last 15 years have made it possible to address all these problems by using an electronic data form. Anthropology Research Project, Inc. (ARP) worked with other organizations in the development of such a form. The bulk of this report concerns ARP activities leading to the development of error-checking algorithms incorporated in the electronic form.

Anthropometric data have characteristics that lend themselves to editing. The two most important are: (1) finite range, and (2) relatively high correlations between certain dimensions. Computerized editing programs long used by ARP in collecting anthropometric data make use of these principles. The first of two companion programs alerts users to extreme values for a given dimension; the second alerts users to a value outside the range of values predicted by closely correlated dimensions. These programs were adapted for the electronic order form (EOF) by using the DSC-P order history in the editing software for each of the relevant garments.

Other work described in this report includes checking the accuracy of measurement instructions to be incorporated in the electronic order form, ARP participation in a video that illustrates correct measurement, and development of a scaled-down version of the order form (EOF Lite) for use on individual personal computers.

The EOF represents a significant improvement in the military customer's ability to place an order for special measurement uniforms with accurate and complete information. It significantly improves the ability of DSC-P's special measurement office and military contractors to create patterns for these customers with some assurance that they are using complete and accurate measurement data.

DATA COLLECTION/VERIFICATION:
Improved Forms DD358 & DD1111

INTRODUCTION

Background

Keeping U.S. military personnel looking smart in their uniforms is a considerable challenge in view of the wide variety of body sizes and shapes found in the military services. To meet this challenge, designers of dress clothing and item managers at the Defense Supply Center-Philadelphia (DSC-P) stock many sizes of each uniform item. It is not cost effective, however, to stock sizes for extremes of body size and shape. Further, some individuals are proportioned so unusually that a standard garment (of whatever size) would never fit. These individuals – those who wear extreme sizes and those who are unusually proportioned – are currently accommodated by DSC-P's Special Measurement Program. In this program garments are created especially for the ordering individual. The individual is measured and the measurements are recorded on a Special Measurement Form (SF DD358 for men; SF DD1111 for women). The form is then sent to the Special Measurement Office at DSC-P, where, usually, patterns are made. (Some variation exists in the actual process depending on the pattern-making ability of the ultimate garment contractor.) When the system is working well, the ordering individual has a well-fitting garment created especially for his or her needs within a few weeks.

The DSC-P special measurement program does not, however, always work well. A number of potential problems, inherent in the system, often prevent either the production of a well-fitting uniform, or its timely delivery. Anthropology Research Project, Inc. (ARP) participated with several other organizations in a research effort aimed at finding a solution to these problems. This report describes the portion of the research undertaken by ARP. A subsequent report from Clemson Apparel Research will document the entire project.

This effort is one activity of the Apparel Research Network (ARN). The ARN is funded by the Defense Logistics Agency to address a wide range of improvements in the manufacture, acquisition, and distribution of military apparel.

Need for an Electronic Order Form

There are three fundamental problems with the current system involving the paper forms DD358 and DD1111. First, users can easily misinterpret the directions on the form so that body dimensions are measured incorrectly. For example, Figure 1 shows the illustration for Arm Length and Shoulder Length from Form DD1111. Note that the illustration is not at all clear about where the measurement should begin (near "A") and, for Shoulder Length, it is not at all clear where on the rounded surface of a

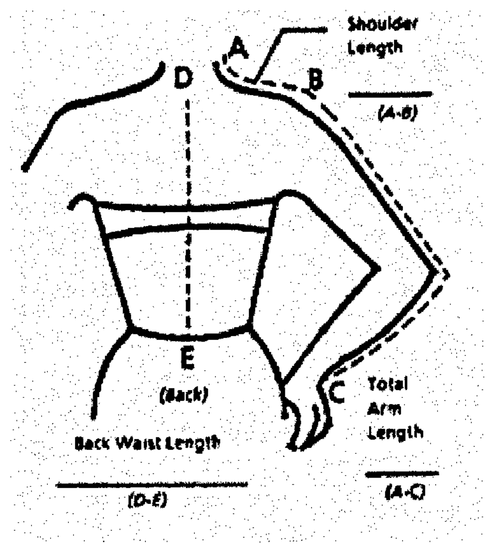

FIGURE 1

Arm Length and Shoulder Length from Form DD1111

woman's shoulder, the dimension should end. There are similar problems with other measurements on the form, and similar problems with the men's form DD358. The result of these problems is that the organization receiving the form, either DSC-P's Special Measurement Office or a pattern-capable contractor, is faced with inaccurate information on the form. Clearly inaccurate information leads to incorrect patterns, and an ill-fitting garment.

Second, information is frequently left off the forms that are currently submitted. Paired with a missing address or other incompletely filled out information, failure to list a phone number can dramatically impede a garment getting to its intended recipient in a timely way. More often the person placing the order omits one or more measurements when completing the form. This may be the result of a judgment that the given measurement is not needed for the garment being ordered, or it may be simply an oversight. In either case, inadequate information forces the pattern maker to make guesses about what the measurement should be. Such guessing delays the completion of the pattern, causing a delivery delay, and when the guesses are incorrect, the garment does not fit well.

Third, the forms themselves do not solicit the complete set of measurements that many contemporary pattern makers need when creating made-to-order clothing. For example, the men's form does not take into account the body-builder physique. When making garments for individuals of this body configuration, a measurement of the flexed biceps (upper arm) muscle is needed. Without some of these more specialized measurements, the pattern maker is again forced to make guesses about the shape and proportion of the ordering individual. In the absence of complete information, the resulting patterns produce garments that are more "normal" in proportion than may be needed by the recipient.

Advances in computing technology in the last 15 years have made it possible to address all the problems noted above by using an electronic version of these data forms. Inaccurate data can be addressed by the greatly enlarged capacity of an electronic form which would provide the user with the much more detailed textual and illustrative instructions for how to take measurements. Missing data can be addressed by software tools that alert the user when more information is needed. The problem of insufficiently requested data can be addressed by simply updating the measurement list for populations in the 1990s, and by algorithms which prompt the user to measure additional dimensions for body-builders when that physique is in question.

Project Structure

Description of Final Product. In order to understand how this project was structured, and subsequently to understand ARP's role in it, it is first necessary to outline features of the final software product. The electronic order form is a world-wide-web (WWW) based software product that facilitates the ordering of special measurement military uniforms. From the user's perspective, the software works in the following way:

1. After accessing the appropriate WWW address, the form asks for several bits of administrative information. These will be familiar to military customers, as they are currently at the top of forms DD358 and DD1111. The list contains such items as customer name, branch of service, organization, SSN, rank/grade, and so on.

2. After the customer information is given, the specific garments to be ordered are identified. The specific garment, e.g., Navy Men's White Choker, will determine which measurements are subsequently requested.

3. After selecting garments, the user is led to a page that shows how to prepare the body for measurement. This page includes such information as locating landmarks on the body, how the individual should be attired, and so on. In the current version, the explanations are limited to text with accompanying line drawings. During 1998, video clips will be added to illustrate how to locate landmarks.

4. After the body is prepared, the user is led to the first measurement. The list of measurements is determined by the aggregate of all garments being ordered. When the list of measurements is assembled, it is presented to the user in a reasonable measuring order, i.e., from the top of the body down towards the floor.

5. With each measurement, a line drawing is shown, illustrating how to take the measurement. In addition, a complete text description is on the screen,

describing the measuring method. During 1998, video clips will be added demonstrating the measurement process for each dimension.

6. As each measurement is entered, it is checked against a known population minimum and maximum for reasonableness. The user is able to override the warning, but he/she will know if an entered value is larger than the largest value ever seen, or smaller than the smallest value ever seen. This check will greatly reduce entry errors.

7. After certain measurements are entered, they are checked against cutoff values for determining body-builder status. For example in a men's coat, if the difference between chest circumference and waist circumference is greater than 8 inches, the additional body-builder measurements will be triggered.

8. After all the measurements are entered, all the measurement values are checked one against the other, for reasonableness. This is an excellent way to identify potential typographical or other sources of error. The user is warned that an entered value is not within an expected range based on the customer's other measurements. As with the minimum and maximum checks, however, the user may override the warning and proceed.

9. The final screen presents a summary of all the entered information and gives the user an opportunity to make final corrections, and to add comments.

10. When the user hits the "send" button, the order is transmitted electronically to a web server at DSC-P, and the order can be processed.

There is considerable sophistication in the way data are handled and transmitted from the ordering location to the servers at DSC-P. Those transactions have no bearing on the work done at ARP, and will be reported in detail in the subsequent Clemson Apparel Research Report.

Organizational Structure. The lead organization on the electronic order form (DDFG-T1P2) was Clemson Apparel Research (CAR), with Dr. Nancy Staples as Principal Investigator. CAR was responsible for overall project management, as well as software and video. ARP was responsible for the numeric algorithms used to check entered data for accuracy, as well as advising on dimension descriptions and line drawings. In addition, ARP Principal Investigator Dr. Bruce Bradtmiller served as the measurer in the video clips. University of Wisconsin-Stout was responsible for the initial drafts of the measurement descriptions and the line drawings. Finally, EDI Integration Corporation was responsible for the portions of software that handled data transfer between the electronic order form, DSC-P, and CAD-capable manufacturers.

Project Activities

CAR identified 17 separate activities needed to complete the EOF. These are identified below, with the appropriate participating ARN partners indicated in parentheses.

Activity 1.	Review and analyze existing manuals and/or videotapes for special measurement purposes. (UW-S, CAR)
Activity 2.	Write verbal description of body measurements in clear lay terms. (UW-S, ARP, CAR)
Activity 3.	Develop line drawings of body measurement locations (UW-S, ARP, and CAR)
Activity 4.	Develop video of proper measurement procedures. (CAR, ARP)
Activity 5.	Develop software to display body measurements and instructions for taking them. (CAR)
Activity 6.	Develop software for validating feasibility of each body dimension (ARP, CAR).
Activity 7.	Develop software for validating combinations of body measurements. (ARP, CAR)
Activity 8.	Develop software for recording order information and file input. (CAR)
Activity 9.	Integrate body measurement and order software. (CAR)
Activity 10.	Field test software. (CAR)
Activity 11.	Develop ANSI X12 841 order data mapping. (EIC)
Activity 12.	Develop EDI interface between the EOF and X12 841 order for different ordering activities. (EIC, CAR)
Activity 13.	Prepare DSC-P and government contractor to send and receive the X12 841 order. (EIC)
Activity 14.	Package, install, train, and test EDI order transmission techniques at pilot sites. (EIC, CAR)
Activity 15.	Commercialize for industry. (CAR)
Activity 16.	All-service demonstration. (CAR)
Activity 17.	Write final technical report on T1P2. (CAR, ARP, UW-S, EIC)

Organization of this Report

The bulk of this report concerns the activities leading to the development of error-checking algorithms. A separate section summarizes ARP's activities in support of the dimension descriptions, line drawings, and video clips. Since our role was not primary in those activities, we report only our supporting work. A comprehensive report of those activities will be in the final technical reports of the lead organization for each. Finally, we report on the development of the electronic order form in a stand-alone version for PCs. It was developed for those military installations that order special measurement garments but do not have access to the Internet.

VALIDATION SOFTWARE

Theory and a Brief History of Anthropometric Data Editing

Humans make mistakes. Much of psychological human factors work is directed towards minimizing human error in the well-known areas of aircraft and automobile operation. The specific types of errors made in anthropometry include: mis-measuring the subject (wrong measurement location, wrong landmarks, etc.), mis-reading the instrument, mis-recording the data on a paper form, or mis-entering the data into a data base or other computer software.

Anthropometric data have characteristics that lend themselves to editing. The two most important are 1) finite range and 2) relatively high correlations between certain dimensions. With respect to range, no anthropometric dimension is zero or less, for example. At the other extreme, no anthropometric dimension is greater than, say, 12 feet. Indeed, for most anthropometric dimensions we can narrow the range of possible values much further than 0 inches to 12 feet. With respect to relationships between dimensions, some dimensions are highly correlated because of the way the body grows. For example, upper leg length is very closely related to lower leg length; total leg length is closely related to arm length.

Anthropology Research Project, Inc. pioneered the editing of anthropometric data in the 1960s, with two FORTRAN programs designed to detect unusual patterns in the data (Kikta and Churchill, 1978). The first program, X-VAL, lists the 20 extreme values (10 highest and 10 lowest) for each dimension. This allows the data analyst to examine all the values at the tails of the distribution. It shows whether the highest value (or highest 2 or highest 3) is close in size to the rest of the values or whether it is well beyond the other values. The output from the program also shows the mean and standard deviation for the full sample, as well as the mean and standard deviation with the 20 extreme values removed. This gives the analyst an opportunity to understand what effect these values are having on the summary statistics of the whole distribution. The X-VAL program has been used as the first stage of data editing. It is best for identifying situations in which an extra digit has been added (18322 mm for stature, instead of 1832 mm), or if a digit has been removed (103 mm for waist circumference, instead of 1003 mm). After corrections for those obvious errors are made, the data are ready for the second stage of editing.

The second program developed by ARP is a more sophisticated editing tool. Called EDIT, the package is based on high correlations between anthropometric dimensions. The data analyst first identifies dimension triplets in which each dimension is highly correlated with the other two. Examples of such triplets might be *Stature, Cervicale Height, Shoulder Height*, or *Chest Circumference, Shoulder Circumference, Waist Circumference*. Then, when the program is executed, regressed or predicted values are compared against measured values within the triplets. For example, the measured value of stature would be compared against the value predicted by an equation using Cervicale Height and Shoulder Height as independent variables. In the same triplet, the measured value of cervicale height would be compared against the value predicted by stature and shoulder height as independent variables. If there are enough highly correlated dimensions, it is best to place each dimension in at least two different triplets. These calculations are done for all measured dimensions.

The output of the EDIT program consists of a list of those values in which the measured and predicted value differ by more than a preset multiple of the regression equation standard error. For each value, the program output lists the measured value and the predicted value for that dimension for all the triplets in which the dimension appears. The program output also identifies other statistics useful to the data analyst; these are detailed in Kikta and Churchill (1978). The EDIT program is useful for identifying cases of entries being 100 or 200 off (*e.g.*, 1706 mm instead of 1606 mm) or for cases of reversed digits (*e.g.*, 937 mm instead of 397 mm). Both of these are common errors easily detected by this approach. Prior to the advent of personal computers, data analysts used both the X-VAL and EDIT programs to identify, and in many cases, correct values which were either mis-read from the instruments, mis-recorded on a paper form, or mis-entered into a data base.

In the 1980's ARP made use of the data editing principles in X-VAL and EDIT to create a data entry software program which edits data as they are entered (Churchill et al., 1988). The software was designed to operate on the then-available portable computers ("lugables" by current standards), which allowed data entry to take place at the measuring location, thus eliminating the need for a paper form entirely. This approach had two advantages over previous methods. First, the data were available for analysis as soon as data collection was over. There was no need for a period of data entry. The second advantage is that when the editing routines identified a suspicious value, the subject in question was still available for remeasure. This was a significant improvement over the traditional use of X-VAL and EDIT that were used after data collection was over and, then, could only identify suspicious values. Remeasurement was not a possibility because the subject was no longer available.

The data entry program of 1988 had some minor operational differences from its predecessors, X-VAL and EDIT. Since the users of that software were measurers, and not experienced data analysts, it was important that decision-making not be left up to the users. Instead, the software itself contained decision-making algorithms that required input from the user. For example, the portion of the program that checked for extreme values checked whether the entered value was either the highest or the lowest for that dimension, rather than displaying the high 10 and low 10 values as in X-VAL. The required response on the part of the user was to either remeasure the value (the usual case) or to indicate that the individual was either extremely large or extremely small, in which case the suspicious value might be correct.

Another difference was in the operation of the regression check portion of the software. This operated with two main differences from its EDIT predecessor. First, the editing triplets were determined automatically, instead of with user input. The choice was based on the highest correlations among all the possible dimension choices. The second difference was that the software did not offer suggestions about possible alternative measurements, which would have required the user to select from among them. Instead, the software simply asked for a remeasure. The regression portion of the software differed from the extreme values check in that it was not invoked until all the data were entered. This is because the dimensions were entered in measurement order, not in the order needed to compute the regression equations. Thus, all the values needed to be present for use as independent variables in the equations before any of the equations could be calculated. The minimum and maximum portion of the program, by contrast, was invoked as soon as a value was entered.

The data entry program of 1988 was used in the U.S. Army's largest survey and showed the great potential of this general approach (Gordon et al., 1989). When subjected to X-VAL and EDIT after data collection was complete, the data resulting from that survey had fewer suspicious values than any prior survey. The success of the approach in that survey led to the application of data editing routines to the electronic order form.

There are a few operational differences between the1988 survey version of the editing routines and those used in the EOF. Primarily these differences relate to user acceptance. The measurers using the software in 1988 were ARP employees, and the project was managed by ARP professional staff. In that case, when an entered value was flagged as incorrect, the software requested a remeasure. If the new value was flagged, the software again requested a remeasure. An individual's dimensions could have been measured a total of three times before the software would move on to the next dimension. Since the users of the electronic order form are scattered over the globe, and are not under the direct control of a single authority, multiple measuring is not a realistic option. Thus, the current EOF version simply alerts the user that the measurement is not what was expected, letting the user decide whether to remeasure or to move on. We recognized that some control is lost with this approach, but felt that to insist on software control would have led to user frustration that would, in turn, reduce acceptance of the product.

The other operational differences are generally linked to improvements in computer technology in the period between 1988 and 1998. For example, dimension descriptions, illustrations, and video were not available in the earlier version due to the inability of computers of that era to hold data files of that size. Additionally, it is now much easier for the user to move about the form; the earlier version required the operator to execute tasks in a specific order. In all, the small sacrifice in data reliability achieved by mandating repeated measures is made up for in improved functionality and likely acceptance by a wide range of military and civilian users.

Software to Validate Individual Dimensions

As noted in the introduction, ARP's contribution to the software for validating dimensions was the creation of statistical algorithms based on our experience and previous data sets. In the case of the software to validate individual dimensions, the algorithms are simple minimum and maximum functions for each dimension. We presented these functions in a table format.

The challenging part of creating these particular algorithms was identifying the specific minimum and maximum values to use for this software which will have wide availability in the uniformed services. The most comprehensive recent data base is our anthropometric survey of the U.S. Army (Gordon et al., 1989). This survey represents over 130 anthropometric measurements on approximately 9000 regular Army uniformed personnel. Although it formed the basis for our work, the Army's minimum and maximum values could not be used without alteration for two reasons: 1) some of the potential customers of garments (new recruits, for example, or military retirees) do not fit within the standard body size norms of the military, and 2) some of the dimensions required by the electronic order form were not measured in the Army survey.

We began the analysis by examining the dimensions from a set of 218 recent special measurement orders to DSC-P. The goal was to understand the magnitude of the anthropometric differences between the special measurement population and the Army data base. For each dimension, the mean values of the special measurement sample were larger than the mean values for the Army data base. The differences between the special measurement mean values and Army mean values are shown in Tables 1 (females) and 2 (males).

TABLE 1

Differences in Mean Values: DSC-P Jacket Orders vs. Army Females
(weight in pounds, all other values in inches)

DIMENSION	DSC-P–ANSUR DIFFERENCE
Arm Length (calculated)	**1.7**
Biceps Circumference	**2.9**
Buttock Circumference	**8.6**
Chest Circumference	**7.9**
Height	**3.5**
Shoulder Circumference	**5.3**
Shoulder Length	**1.3**
Strap Length	**4.0**
Waist Back Length	**3.5**
Waist Circumference	**12.9**
Waist Circumference	**9.8**
Weight	**56.0**

TABLE 2
Differences in Mean Values: DSC-P Trouser Orders vs. Army Males
(weight in pounds, all other values in inches)

DIMENSION	DSC-P-ANSUR DIFFERENCE
Abdominal Circumference	15.4
Height	3.9
Knee Height	5.1
Thigh Circumference	5.2
Waist Circumference	13.3
Weight	96.8

For dimensions which were part of the Army data base, we used the highest and lowest values from the DSC-P order history to influence our judgement on where to set the EOF minimum and maximum values shown in Tables 3 (males) and 4 (females). It should be stated clearly, however, that these minimum and maximum values represent our *judgement*, based on many years of experience. Additionally, there were some dimensions (*e.g.*, men's arm inseam, or biceps circumference relaxed) which were new to the EOF, and therefore not part of DSC-P's order history, and which were also not measured in the Army survey. The minimum and maximum values for these dimensions were estimated based on closely related dimensions, and again were based on our judgement. We would recommend that EOF orders be evaluated after a year of operation and that the minimum and maximum values be adjusted according to the actual order history.

Software to Validate Dimension Combinations

ARP's contribution to the software to validate dimension combinations was, again, creation of the algorithms to flag unlikely values based on other measurements for that individual. These algorithms are based on regression equations in which each dimension being validated is compared to a predicted value based on two or more other measured dimensions. Ironically, the challenging aspect of this task was found in the mundane garment ordering section of the EOF. Recall that the specific measurements requested by the EOF are a function of which garments are ordered. For example, sleeve length is not requested if only trousers are ordered.

In the 1988 data entry and editing program on which these algorithms are based, the software computed a complete correlation matrix of all dimensions, and then selected the two with the highest correlation to the independent, or predictor, equations for each dependent variable. In this case that approach would not work, because it would rarely be the case that all dimensions would be measured. The algorithms will not function properly if one or more of the input values is missing. Indeed, only rarely would all possible dimensions be available. Instead, based on the selection of garments, one could have as few as eight dimensions available.

TABLE 3

Minimum and Maximum Values: MALES
(weight in pounds, all other values in inches)

DIMENSION	MINIMUM	MAXIMUM
Height	58.0	83.0
Weight	100.0	316.0
Arm Inseam, Right	14.5	24.4
Back Coat Length	23.6	38.8
Back Waist Length	13.2	24.5
Biceps Circ, Flexed	10.2	17.4
Biceps Circ, Relaxed	9.4	16.0
Bust Circumference	30.5	52.5
Chest Circ, Rlxd	30.5	52.5
Front Bust Length	11.7	17.7
Front Waist Length	16.6	25.1
Hip Circumference	31.7	55.0
Leg Inseam	26.6	43.0
Leg Outseam	35.8	58.1
Lower Abdomen Circ	25.8	48.9
Neck Circumference	11.1	18.1
Shoulder Circumference	39.7	60.3
Seat Circumference	31.7	55.0
Shlder Points Breadth	16.6	22.7
Thigh Circumference	18.0	35.0
Overthighs Circumference	29.5	57.3
Upper Abdomen Circ	25.5	45.8
Upper Chest Circ, Relaxed	31.8	52.3
Waist Circumference, Pref	25.5	48.1

TABLE 4

Minimum and Maximum Values: FEMALES
(weight in pounds, all other values in inches)

DIMENSION	MINIMUM	MAXIMUM
Height	56.0	75.0
Weight	90.0	250.0
Arm Inseam, Right	12.8	21.8
Arm Inseam, Left	12.8	21.8
Back Coat Length	22.4	35.0
Back Waist Length	11.1	16.4
Biceps Circ, Flexed	8.4	15.1
Biceps Circ, Relaxed	8.0	14.4
Bust Circumferece	28.0	47.4
Chest Circ, Relaxed	28.0	47.4
Front Bust Length	10.7	17.1
Front Waist Length	14.4	23.0
High Hip Circumference	31.0	57.0
Hip Circumference	31.0	57.0
Leg Inseam	23.4	37.0
Leg Outseam	32.1	50.7
Lower Abdomen Circ	24.0	45.5
Neck Circumference	10.7	15.0
Shoulder Circumference	41.3	55.4
Seat Circumferece	31.0	57.0
Shlder Points Breadth	13.9	19.2
Skirt Length	20.2	28.5
Thigh Circumference	17.9	31.9
Overthighs Circ	29.3	52.2
Upper Abdomen Circ	22.4	40.1
Upper Chest Circ, Rlxd	29.7	45.2
Waist Circ, Pref	22.4	40.1

Our solution to this problem was to create lists of dimensions specific to each possible garment order. These lists are seen in Tables 5 (males) and 6 (females). There are seven possible combinations for males, and eleven for females. We calculated separate correlation matrices for each of those sets of dimensions. For example, for a male trouser order, the correlation matrix would include: height, weight, leg inseam, leg outseam, waist circumference, lower abdomen circumference, seat circumference and thigh circumference. The greatest number of dimensions required would be for a female ordering a coat, trousers, shirt, and skirt. In that case, 29 dimensions would be available for the correlation matrix, and subsequently for the regression equations.

From each of these correlation matrices we calculated regression equations in which each dimension was, in turn, the dependent variable. Further, we calculated several different equations for each dependent variable, to account for the case in which different combinations of independent variables would be available. Some dimensions required as few as three equations (*e.g.*, biceps circumference, flexed), and others as

TABLE 5

Dimensions Required For Each Possible Garment Ordered: MALES

COAT	TROUSERS	SHIRT	COAT TROUSERS	COAT SHIRT	SHIRT TROUSERS	COAT TROUSERS SHIRT
Height	Height	Height	Height	Height	Leg Inseam	Height
Weight	Weight	Weight	Weight	Weight	Leg Outseam	Weight
Back Coat Length Length	Leg Inseam	Right Arm Outsd Full	Back Coat Length Length	Back Coat Length Length	Waist	Back Coat Length Length
Right Arm Inseam	Leg Outseam	Left Arm Outsd Full	Right Arm Inseam	Right Arm Inseam	Seat	Right Arm Inseam
Left Arm Inseam	Waist	Neck	Left Arm Inseam	Left Arm Inseam	Thigh	Left Arm Inseam
Around Arms & Body	Lower Abdomen	Chest Relaxed	Around Arms & Body	Around Arms & Body	Lower Abdomen	Around Arms & Body
Chest Relaxed	Seat	Chest Flexed	Chest Relaxed	Chest Relaxed	Right Arm Outsd Full	Chest Relaxed
Chest Flexed	Thigh	Biceps Relaxed	Chest Flexed	Chest Flexed	Left Arm Outsd Full	Chest Flexed
Upper Abdomen		Biceps Flexe	Upper Abdomen	Upper Abdomen	Neck	Upper Abdomen
Lower Abdomen			Lower Abdomen	Lower Abdomen	Chest Relaxed	Lower Abdomen
Seat			Seat	Seat	Chest Flexed	Seat
Biceps Relaxed			Biceps Relaxed	Biceps Relaxed	Biceps Relaxed	Biceps Relaxed
Biceps Flexed			Biceps Flexed	Biceps Flexed	Biceps Flexe	Biceps Flexed
Across Back Shldr Point			Across Back Shldr Point	Across Back Shldr Point		Across Back Shldr Point
			Leg Inseam	Right Arm Outsd Full		Leg Inseam
			Leg Outseam	Left Arm Outsd Full		Leg Outseam
			Waist	Neck		Waist
			Seat			Seat
			Thigh			Thigh
						Right Arm Outsd Full
						Left Arm Outsd Full
						Neck

TABLE 6

Dimensions Required For Each Possible Garment Ordered: FEMALES

COAT	TROUSERS	SHIRT	SKIRT	COAT TROUSERS	COAT SHIRT	COAT SKIRT	TROUSERS SHIRT	TROUSERS SKIRT	SHIRT SKIRT	COAT TROUSERS SHIRT SKIRT
Height	Height	Height	Height	Height	Height	Height	Leg Inseam	Leg Inseam	Rght Arm Outsd	Height
Weight	Weight	Weight	Weight	Weight	Weight	Weight	Leg Outseam	Leg Outseam	Left Arm Outsd	Weight
Back Waist Lg	Leg Inseam	Rght Arm Outsd	Skirt Length	Back Waist Lg	Back Waist Lg	Back Waist Lg	Waist	Waist	Neck	Back Waist Lg
Back Coat Lg	Leg Outseam	Left Arm Outsd	Waist	Back Coat Lg	Back Coat Lg	Back Coat Lg	Lower Abdomen	Lower Abdomen	Upper Chest Relaxed	Back Coat Lg
Front Bust Lg	Waist	Neck	Lower Abdomen	Front Bust Lg	Front Bust Lg	Front Bust Lg	High Hips	High Hips	Upper Chest Flx Flxd	Front Bust Lg
Front Waist Lg	Lower Abdomen	Upper Chest Relaxed	High Hips	Front Waist Lg	Front Waist Lg	Front Waist Lg	Hips	Hips	Bust	Front Waist Lg
Right Arm Insm	High Hips	Upper Chest Flx Flxd	Hips	Right Arm Insm	Right Arm Insm	Right Arm Insm	Thigh	Thigh	Biceps Relaxed	Right Arm Insm
Left Arm Insm	Hips	Bust	Thighs	Left Arm Insm	Left Arm Insm	Left Arm Insm	Rght Arm Outsd	Skirt Length	Biceps Flexed	Left Arm Insm
Arnd Arm&Bdy	Thigh	Biceps Relaxed		Arnd Arm&Bdy	Arnd Arm&Bdy	Arnd Arm&Bdy	Left Arm Outsd	Thighs	Skirt Length	Arnd Arm&Bdy
Upper Chest		Biceps Flexed		Upper Chest	Upper Chest	Upper Chest	Neck		Waist	Upper Chest
Upper Chest Fl				Upper Chest Fl	Upper Chest Fl	Upper Chest Fl	Upper Chest Relaxed		Lower Abdomen	Upper Chest Fl
Bust				Bust	Bust	Bust	Upper Chest Flx Flexed		High Hips	Bust
Upper Abdomen				Upper Abdomen	Upper Abdomen	Upper Abdomen	Bust		Hips	Upper Abdomen
Lower Abdomen				Lower Abdomen	Lower Abdomen	Lower Abdomen	Biceps Relaxed		Thighs	Lower Abdomen
Hips				Hips	Hips	Hips	Biceps Flexed			Hips
Biceps Relaxed				Biceps Relaxed	Biceps Relaxed	Biceps Relaxed				Biceps Relaxed
Biceps Flexed				Biceps Flexed	Biceps Flexed	Biceps Flexed				Biceps Flexed
Acrs Bck Shldr				Acrs Bck Shldr	Acrs Bck Shldr	Acrs Bck Shldr				Acrs Bck Shldr
				Leg Inseam	Rght Arm Outsd	Skir t Length				Leg Inseam
				Leg Outseam	Left Arm Outsd	Waist				Leg Outseam
				Waist	Neck	High Hips				Waist
				High Hips		Hips				High Hips
				Hips		Thighs				Hips
				Thigh						Thigh
										Neck
										Rght Arm Outsd
										Left Arm Outsd
										Skirt Length
										Thighs

many as six (*e.g.*, chest circumference). For example, there were four equations for male buttock (seat) circumference:

1. Buttock circ = 22.546 + 0.094 * weight
2. Buttock circ = 31.090 + 0.102 * weight – 0.145 * stature
3. Buttock circ = 35.678 + 0.115 * weight – 0.183 * stature – 0.316 * biceps circ
4. Buttock circ = 39.615 + 0.127 * weight – 0.208 * stature – 0.304 * biceps circ – 0.113 * chest circ

The standard error drops from 0.8664 inches with equation 1 to 0.7690 inches with equation 4. As would be expected, the equation with more independent variables produces a tighter estimate (*i.e.*, has a lower standard error). For any given garment order, the software is structured to select the equation with the lowest standard error, for which all the independent variables are available. Since stature and weight are always requested no matter what garment is ordered, there are always at least two equations to choose from.

A complete list of all equations is given in the appendix. The list includes, in the right-hand column, the standard error of the estimate. When these equations are used in validating the measured value, the acceptable range is calculated as the predicted value, plus or minus a multiple of the standard error of the estimate. If a value is outside the acceptable range, it is flagged for remeasure. In the EDIT program, and in the 1988 data entry program, this multiple of the standard error is user-determined. A larger number produces a wider range, and therefore a looser edit; a smaller number produces a smaller range, and a tighter edit. Based on our experience with the two earlier programs, we have recommended that the multiple for EOF be set at 4. This is a somewhat higher multiple than would be used for a population whose dimensions are more "normally" proportioned. It is appropriate here, however, in recognition of the fact that many individuals are in this group because of unusual body proportions. Constant prompts to remeasure are likely to be counterproductive.

The regression equations were calculated from the 1988 Army data set. The data available from the historic DSC-P orders were too few in number, and did not contain all the needed dimensions. While it is the best available, the Army data set remains an imperfect representation of the target population of individuals who require special measurement garments. We would recommend a recalculation of the regression equations using data from actual orders after about a year of EOF operation.

SUPPORT ACTIVITIES

Dimension Descriptions

Writing clear dimension descriptions that direct the reader to measure a dimension as intended by the writer is a matter of skill and experience. The task of creating textual measurement descriptions for the EOF fell to University of Wisconsin-Stout. That organization drafted descriptions for all the EOF measurements, and tested them using naïve high school students. Those activities are reported in the final report entitled "Data Collection/Verification: Improved Forms DD358 & DD1111" (Robeck, in press). ARP's task involved reviewing these dimensions for clarity, as well as for dimensional accuracy. For example, for neck circumference the initial draft called for the measurer to place the tape "at the Adam's apple", when in fact the pattern makers using the special measurement data would expect the measurement to be taken *lower* than the Adam's apple. Measuring at the wrong location on the neck could result in a shirt being 1 size too large for women, and 2 sizes too large for men. In all, we reviewed 56 dimensions and landmarks (men and women, various service-specific definitions, etc.), and made suggested revisions as appropriate. The completed measurement descriptions can be seen on the EOF web page.

Line Drawings

As with the dimension descriptions, University of Wisconsin-Stout was charged with preparing line drawings illustrating measurements and landmarks. Our task was to review the drawings and identify whether the lines and arrows correctly indicated where the measurement should be taken. For example, on the initial draft drawing for high chest, the line showing the measurement was too low. We reviewed all 56 drawings, and made suggestions as appropriate. It should be noted that, after University of Wisconsin-Stout's involvement, the drawings were revised at Clemson Apparel Research, as will be reported in the forthcoming Clemson final technical report on the EOF. We then repeated our work, and reviewed the new figures. The completed figures can be seen on the EOF web page.

Video

One of the most useful features of the EOF will be its ability to show video clips of each measurement and landmark. This should allow the novice measurer to minimize errors in tape placement and measurement technique. In order to provide those brief clips, however, full production video in a studio-like setting was required. Clemson Apparel Research arranged for the video production. ARP's contribution was to review the script for clarity and accuracy, advise on camera and model placement, and to provide the measurer model (Dr. Bradtmiller). The video clips will be available on the EOF web site in mid-1998.

OTHER ACTIVITIES: EOF LITE

During the early planning for the electronic order form, there was considerable discussion about what electronic state the new product should assume. EDI Integration Corporation led that discussion, and the decision process will be outlined in their final technical report. The resulting decision was to create a form that would be a "living" document on the World Wide Web. This approach has a number of advantages that will be outlined in the EIC report. The major disadvantage to the WWW approach, however, is that some potential users of the form do not currently have web access.

After a series of meetings with program management, DSC-P, and representatives of several groups of potential users, a decision was reached to produce a scaled-down version of the form that would be self-contained on an individual personal computer (PC) and not require access to the Internet for its functionality. As this decision was made in mid-1997, well into the development of the web version, it was possible to build on the programming that had already been done in order to create the stand-alone version (dubbed EOF Lite).

As ARP had previous experience with a seasoned freelance Microsoft Access® programmer, and as we were able, because of our small size, to sub-contract outside tasks relatively quickly, we volunteered to make arrangements to provide an initial draft version of EOF Lite. We used subcontractor Mark Wysong of Softstar, Inc. to code the Access® program. Within the limits of the Access® environment, he set up the order entry screens to mirror the web version. The inner workings of the error checking, both minimum and maximum and regression checks, are identical to the web version. The only functional difference, from the user's point of view, is that instead of transmitting the order electronically to DSC-P, the final information is printed out on a paper form, which can then be faxed or mailed to the special measurement office at DSC-P.

At the end of ARP's period of performance for this delivery order, the initial draft of EOF Lite was complete and was delivered to Clemson Apparel Research. The relationship with Softstar, Inc. was transferred to Clemson, where final modifications will be made. The completed deliverable from Clemson will include the software itself, on diskette, as well as a software user's manual.

CONCLUSION

The EOF represents a significant improvement in the military customer's ability to place an order for a special measurement uniform with accurate and complete information. It significantly improves the ability of Defense Supply Center-Philadelphia's special measurement office and military contractors to create patterns for these customers with some assurance that they are using complete and accurate measurement data.

The electronic order form project was a joint effort by several individuals and organizations. Anthropology Research Project, Inc. took the lead on developing the two error checking systems – minimum and maximum checks and regression checks. Based on our experience with previous data editing systems, and based on data gathered in 1988 for the U.S. Army, we supplied test functions to those actually writing the software for the electronic order form. We also supported other team partners in the activities on which they took the lead.

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APPENDIX

REGRESSION EQUATIONS FOR VALIDATION OF COMBINATIONS OF DIMENSIONS

Dependent Variable	Constant	Independent Variable 1	Coefficient 1	Independent Variable 2	Coefficient 2	Independent Variable 3	Coefficient 3	Independent Variable 4	Coefficient 4	Independent Variable 5	Coefficient 5	Standard Error Est
MALES												
TROUSERS												
CROTCH HEIGHT												
Crotch Height	= -7.797 +	Stature x	0.590 +	x	+	x	+	x	+	x		0.9544
Crotch Height	= -6.424 +	Stature x	0.618 +	Waist Circ, NI x	-0.101 +	x	+	x	+	x		0.9110
Crotch Height	= -6.210 +	Stature x	0.628 +	Waist Circ, NI x	-0.066 +	Buttock Circ x	-0.054 +	x	+	x		0.9087
Crotch Height	= -5.911 +	Stature x	0.649 +	Waist Circ, NI x	-0.064 +	Buttock Circ x	-0.264 +	Thigh Circ x	0.269 +	x		0.8908
SEAT												
Buttock Circ	= 22.546 +	Weight x	0.094 +	x	+	x	+	x	+	x		0.8664
Buttock Circ	= 15.704 +	Weight x	0.050 +	Thigh Circ x	0.610 +	x	+	x	+	x		0.6863
Buttock Circ	= 18.600 +	Weight x	0.057 +	Thigh Circ x	0.548 +	Crotch Height x	-0.077 +	x	+	x		0.6758
Buttock Circ	= 15.200 +	Weight x	0.050 +	Thigh Circ x	0.602 +	Crotch Height x	-0.163 +	Stature x	0.089 +	x		0.6690
Buttock Circ	= 11.843 +	Weight x	0.038 +	Thigh Circ x	0.634 +	Crotch Height x	-0.149 +	Stature x	0.112 +	Waist Circ, NI x	0.077	0.6620
STATURE												
Stature	= 28.574 +	Crotch Height x	1.230 +	x	+	x	+	x	+	x		1.3786
Stature	= 28.043 +	Crotch Height x	1.087 +	Weight x	0.030 +	x	+	x	+	x		1.1912
Stature	= 32.432 +	Crotch Height x	1.019 +	Weight x	0.048 +	Waist Circ, NI x	-0.159 +	x	+	x		1.1730
Stature	= 34.728 +	Crotch Height x	1.005 +	Weight x	0.055 +	Waist Circ, NI x	-0.113 +	Chest Circ x	-0.117 +	x		1.1661
Stature	= 40.644 +	Crotch Height x	0.965 +	Weight x	0.076 +	Waist Circ, NI x	-0.101 +	Chest Circ x	-0.144 +	Buttock Circ x	-0.194	1.1564
THIGH CIRCUMFERENCE												
Thigh Circ	= -5.161 +	Buttock Circ x	0.740 +	x	+	x	+	x	+	x		0.6971
Thigh Circ	= -1.113 +	Buttock Circ x	0.773 +	Stature x	-0.077 +	x	+	x	+	x		0.6720
Thigh Circ	= 8.871 +	Buttock Circ x	0.477 +	Stature x	-0.143 +	Weight x	0.035 +	x	+	x		0.6219
Thigh Circ	= 13.748 +	Buttock Circ x	0.480 +	Stature x	-0.190 +	Weight x	0.051 +	Waist Circ, NI x	-0.140 +	x		0.5941
Thigh Circ	= 13.936 +	Buttock Circ x	0.496 +	Stature x	-0.256 +	Weight x	0.050 +	Waist Circ, NI x	-0.129 +	Crotch Height x	0.112	0.5856
WAIST CIRCUMFERENCE, NI												
Waist Circ, NI	= 15.435 +	Weight x	0.102 +	x	+	x	+	x	+	x		1.5067
Waist Circ, NI	= 35.248 +	Weight x	0.122 +	Stature x	-0.336 +	x	+	x	+	x		1.3125
Waist Circ, NI	= 45.753 +	Weight x	0.159 +	Stature x	-0.430 +	Thigh Circ x	-0.443 +	x	+	x		1.2723
Waist Circ, NI	= 40.284 +	Weight x	0.142 +	Stature x	-0.423 +	Thigh Circ x	-0.626 +	Buttock Circ x	0.315 +	x		1.2542
Waist Circ, NI	= 39.176 +	Weight x	0.141 +	Stature x	-0.330 +	Thigh Circ x	-0.584 +	Buttock Circ x	0.275 +	Crotch Height x	-0.137	1.2485
WEIGHT												
Weight	= -189.266 +	Buttock Circ x	9.355 +	x	+	x	+	x	+	x		8.6657
Weight	= -288.474 +	Buttock Circ x	8.539 +	Stature x	1.892 +	x	+	x	+	x		7.3709
Weight	= -288.841 +	Buttock Circ x	5.831 +	Stature x	2.170 +	Waist Circ, NI x	2.602 +	x	+	x		6.1155
Weight	= -284.104 +	Buttock Circ x	2.510 +	Stature x	2.502 +	Waist Circ, NI x	2.630 +	Thigh Circ x	4.260 +	x		5.4056

UPPER BODY

BACK COAT LGTH (CERV-GLUT)																		
Cervicale Ht, Sit-Gluteal Furrow Ht	=	0.153 +	Stature	x	0.345 +		x	+		x	+		x	+		x		0.0345
Cervicale Ht, Sit-Gluteal Furrow Ht	=	0.226 +	Stature	x	0.292 +	Weight	x	0.059 +		x	+		x	+		x		0.0335
Cervicale Ht, Sit-Gluteal Furrow Ht	=	0.403 +	Stature	x	0.255 +	Weight	x	0.129 +	Biceps Circ, Flxd	x	-0.310 +		x	+		x		0.0326
Cervicale Ht, Sit-Gluteal Furrow Ht	=	0.381 +	Stature	x	0.249 +	Weight	x	0.126 +	Biceps Circ, Flxd	x	-0.313 +	Biacromial Br	x	0.075 +		x		0.0326
BIACROMIAL BREADTH																		
Biacromial Br	=	13.150 +	Weight	x	0.014 +		x	+		x	+		x	+		x		0.6142
Biacromial Br	=	8.269 +	Weight	x	0.010 +	Stature	x	0.083 +		x	+		x	+		x		0.5866
Biacromial Br	=	6.511 +	Weight	x	0.004 +	Stature	x	0.094 +	Chest Circ	x	0.048 +		x	+		x		0.5839
Biacromial Br	=	7.922 +	Weight	x	0.009 +	Stature	x	0.087 +	Chest Circ	x	0.043 +	Buttock Circ	x	-0.040 +		x		0.5832
BICEPS CIRC, FLEXED																		
Biceps Circ, Flxd	=	7.483 +	Weight	x	0.034 +		x	+		x	+		x	+		x		0.6821
Biceps Circ, Flxd	=	14.502 +	Weight	x	0.041 +	Stature	x	-0.119 +		x	+		x	+		x		0.6298
Biceps Circ, Flxd	=	20.512 +	Weight	x	0.060 +	Stature	x	-0.147 +	Buttock Circ	x	-0.193 +		x	+		x		0.6104
BUTTOCK CIRC																		
Buttock Circ	=	22.546 +	Weight	x	0.094 +		x	+		x	+		x	+		x		0.8664
Buttock Circ	=	31.090 +	Weight	x	0.102 +	Stature	x	-0.145 +		x	+		x	+		x		0.8056
Buttock Circ	=	35.678 +	Weight	x	0.115 +	Stature	x	-0.183 +	Biceps Circ, Flxd	x	-0.316 +		x	+		x		0.7808
Buttock Circ	=	39.615 +	Weight	x	0.127 +	Stature	x	-0.208 +	Biceps Circ, Flxd	x	-0.304 +	Chest Circ	x	-0.113 +		x		0.7690
CHEST CIRCUMFERENCE																		
Chest Circ	=	22.258 +	Weight	x	0.097 +		x	+		x	+		x	+		x		1.3267
Chest Circ	=	36.536 +	Weight	x	0.111 +	Stature	x	-0.242 +		x	+		x	+		x		1.2150
Chest Circ	=	45.104 +	Weight	x	0.139 +	Stature	x	-0.282 +	Buttock Circ	x	-0.276 +		x	+		x		1.1949
Chest Circ	=	43.322 +	Weight	x	0.137 +	Stature	x	-0.296 +	Buttock Circ	x	-0.266 +	Biacromial Br	x	0.180 +		x		1.1905
FOREARM CIRCUMFERENCE, FLEXED																		
Forearm Circ, Flxd	=	0.163 +	Biceps Circ, Flxd	x	0.588 +		x	+		x	+		x	+		x		0.02
Forearm Circ, Flxd	=	0.181 +	Biceps Circ, Flxd	x	0.453 +	Weight	x	0.043 +		x	+		x	+		x		0.01
Forearm Circ, Flxd	=	0.201 +	Biceps Circ, Flxd	x	0.463 +	Weight	x	0.055 +	Chest Circ	x	-0.026 +		x	+		x		0.01
Forearm Circ, Flxd	=	0.177 +	Biceps Circ, Flxd	x	0.466 +	Weight	x	0.051 +	Chest Circ	x	-0.026 +	Biacromial Br	x	0.044 +		x		0.01
NECK CIRC, BASE																		
Neck Circ, Base	=	0.473 +	Weight	x	0.132 +		x	+		x	+		x	+		x		0.02
Neck Circ, Base	=	0.430 +	Weight	x	0.105 +	Biceps Circ, Fl	x	0.144 +		x	+		x	+		x		0.02
Neck Circ, Base	=	0.349 +	Weight	x	0.091 +	Biceps Circ, Fl	x	0.154 +	Biacromial Br	x	0.151 +		x	+		x		0.02
Neck Circ, Base	=	0.330 +	Weight	x	0.079 +	Biceps Circ, Fl	x	0.144 +	Biacromial Br	x	0.152 +	Chest Circ	x	0.025 +		x		0.02
RIGHT ARM INSEAM (AXILLA-WRIST)																		
Axilla Ht-Wrist Ht	=	-0.104 +	Stature	x	0.308 +		x	+		x	+		x	+		x		0.0331
Axilla Ht-Wrist Ht	=	-0.055 +	Stature	x	0.332 +	Chest Circ	x	-0.073 +		x	+		x	+		x		0.0323
Axilla Ht-Wrist Ht	=	-0.113 +	Stature	x	0.303 +	Chest Circ	x	-0.095 +	Biacromial Br	x	0.275 +		x	+		x		0.0316
SLEEVE LGTH, SPINE-WRIST																		
Sleeve Lgth, Sprine-Wrist	=	0.140 +	Stature	x	0.453 +		x	+		x	+		x	+		x		0.04
Sleeve Lgth, Sprine-Wrist	=	-0.023 +	Stature	x	0.371 +	Biacromial Br	x	0.629 +		x	+		x	+		x		0.03
Sleeve Lgth, Sprine-Wrist	=	0.114 +	Stature	x	0.319 +	Biacromial Br	x	0.482 +	Weight	x	0.079 +		x	+		x		0.03
Sleeve Lgth, Sprine-Wrist	=	0.044 +	Stature	x	0.334 +	Biacromial Br	x	0.477 +	Weight	x	0.051 +	Biceps Circ, Fl	x	0.126 +		x		0.03
Sleeve Lgth, Sprine-Wrist	=	-0.014 +	Stature	x	0.345 +	Biacromial Br	x	0.468 +	Weight	x	0.025 +	Biceps Circ, Fl	x	0.121 +	Chest Circ	x	0.044	0.03
STATURE																		
Stature	=	58.978 +	Weight	x	0.059 +		x	+		x	+		x	+		x		2.2042
Stature	=	73.851 +	Weight	x	0.123 +	Chest Circ	x	-0.668 +		x	+		x	+		x		2.0186
Stature	=	95.260 +	Weight	x	0.212 +	Chest Circ	x	-0.673 +	Buttock Circ	x	-0.945 +		x	+		x		1.8455
Stature	=	102.408 +	Weight	x	0.244 +	Chest Circ	x	-0.558 +	Buttock Circ	x	-1.006 +	Biceps Circ, Fl	x	-1.115 +		x		1.6896
Stature	=	90.438 +	Weight	x	0.223 +	Chest Circ	x	-0.552 +	Buttock Circ	x	-0.915 +	Biceps Circ, Fl	x	-1.060 +	Biacromial Br	x	0.715	1.6342
SHOULDER CIRCUMFERENCE																		
Shoulder Circ	=	1.252 +	Weight	x	0.468 +		x	+		x	+		x	+		x		0.05
Shoulder Circ	=	0.776 +	Weight	x	0.394 +	Biacromial Br	x	0.920 +		x	+		x	+		x		0.04
Shoulder Circ	=	0.401 +	Weight	x	0.169 +	Biacromial Br	x	0.949 +	Chest Circ	x	0.410 +		x	+		x		0.04
Shoulder Circ	=	0.260 +	Weight	x	0.089 +	Biacromial Br	x	0.994 +	Chest Circ	x	0.352 +	Biceps Circ, Fl	x	0.575 +		x		0.03
Shoulder Circ	=	0.336 +	Weight	x	0.111 +	Biacromial Br	x	1.021 +	Chest Circ	x	0.335 +	Biceps Circ, Fl	x	0.548 +	Stature	x	-0.029	0.03
WAIST BACK LENGTH, NI																		
Waist Back Lgth, NI	=	0.077 +	Stature	x	0.206 +		x	+		x	+		x	+		x		0.03
Waist Back Lgth, NI	=	0.094 +	Stature	x	0.212 +	Biceps Circ, Fl	x	-0.061 +		x	+		x	+		x		0.03
Waist Back Lgth, NI	=	0.081 +	Stature	x	0.197 +	Biceps Circ, Fl	x	-0.215 +	Chest Circ	x	0.087 +		x	+		x		0.03
Waist Back Lgth, NI	=	0.006 +	Stature	x	0.215 +	Biceps Circ, Fl	x	-0.174 +	Chest Circ	x	0.118 +	Weight	x	-0.034 +		x		0.03
Waist Back Lgth, NI	=	-0.016 +	Stature	x	0.206 +	Biceps Circ, Fl	x	-0.177 +	Chest Circ	x	0.114 +	Weight	x	-0.036 +	Biacromial Br	x	0.092	0.03
WAIST CIRCUMFERENCE, OMPH																		
Waist Circ, Omph	=	0.533 +	Weight	x	0.661 +		x	+		x	+		x	+		x		0.07

Waist Circ, Omph	=	1.338 +	Weight	x	0.775 +	Stature	x	-0.347 +		x	+		x	+		x		0.06
Waist Circ, Omph	=	2.057 +	Weight	x	1.060 +	Stature	x	-0.497 +	Biceps Circ, Flxd	x	-1.260 +		x	+		x		0.06
Waist Circ, Omph	=	1.543 +	Weight	x	0.837 +	Stature	x	-0.411 +	Biceps Circ, Flxd	x	-1.300 +	Chest Circ	x	0.373 +		x		0.05
Waist Circ, Omph	=	1.635 +	Weight	x	0.843 +	Stature	x	-0.373 +	Biceps Circ, Flxd	x	-1.286 +	Chest Circ	x	0.391 +	Biacromial Br	x	-0.386	0.05
WAIST CIRCUMFERENCE, NI																		
Waist Circ, NI	=	-0.146 +	Chest Circ	x	0.943 +		x	+		x	+		x	+		x		0.05
Waist Circ, NI	=	0.087 +	Chest Circ	x	0.594 +	Weight	x	0.248 +		x	+		x	+		x		0.05
Waist Circ, NI	=	0.753 +	Chest Circ	x	0.441 +	Weight	x	0.406 +	Stature	x	-0.229 +		x	+		x		0.05
Waist Circ, NI	=	1.197 +	Chest Circ	x	0.465 +	Weight	x	0.582 +	Stature	x	-0.323 +	Biceps Circ, Fl	x	-0.838 +		x		0.04
Waist Circ, NI	=	1.241 +	Chest Circ	x	0.474 +	Weight	x	0.585 +	Stature	x	-0.305 +	Biceps Circ, Fl	x	-0.831 +	Biacromial Br	x	-0.184	0.04
WEIGHT																		
Weight	=	-189.266 +	Buttock Circ	x	9.355 +		x	+		x	+		x	+		x		8.6657
Weight	=	-201.030 +	Buttock Circ	x	6.670 +	Chest Circ	x	2.966 +		x	+		x	+		x		7.3010
Weight	=	-303.530 +	Buttock Circ	x	5.753 +	Chest Circ	x	3.050 +	Stature	x	1.949 +		x	+		x		5.5923
Weight	=	-312.050 +	Buttock Circ	x	5.173 +	Chest Circ	x	2.331 +	Stature	x	2.063 +	Biceps Circ, Fl	x	3.851 +		x		4.9112
Weight	=	-314.704 +	Buttock Circ	x	5.172 +	Chest Circ	x	2.300 +	Stature	x	2.008 +	Biceps Circ, Fl	x	3.824 +	Biacromial Br	x	0.514	4.9034

Dependent Variable	Constant	Independent Variable 1	Coefficient 1	Independent Variable 2	Coefficient 2	Independent Variable 3	Coefficient 3	Independent Variable 4	Coefficient 4	Independent Variable 5	Coefficient 5	Standard Error Est
FEMALES												
TROUSERS/SKIRT												
BUTTOCK CIRCUMFERENCE												
Buttock Circ	= 22.276 +	Weight x	0.115 +	x	+	x	+	x	+	x		1.0456
Buttock Circ	= 30.382 +	Weight x	0.126 +	Stature x	-0.149 +	x	+	x	+	x		0.9965
Buttock Circ	= 29.243 +	Weight x	0.121 +	Stature x	-0.136 +	Waist Circ, Omph x	0.032 +	x	+	x		0.9949
CROTCH HEIGHT												
Crotch Height	= -0.277 +	Stature x	0.583 +	x	+	x	+	x	+	x		0.0371
Crotch Height	= -0.214 +	Stature x	0.617 +	Buttock Circ x	-0.10 +	x	+	x	+	x		0.0361
Crotch Height	= -0.094 +	Stature x	0.593 +	Buttock Circ x	-0.189 +	Weight x	0.079 +	x	+	x		0.0359
SKIRT LENGTH												
Waist Ht, Nl-Knee Ht, Midpatella	= -0.065 +	Stature x	0.393 +	x	+	x	+	x	+	x		0.0296
Waist Ht, Nl-Knee Ht, Midpatella	= -0.021 +	Stature x	0.354 +	Weight x	0.055 +	x	+	x	+	x		0.0290
STATURE												
Stature	= 54.317 +	Weight x	0.072 +	x	+	x	+	x	+	x		2.1260
Stature	= 59.834 +	Weight x	0.131 +	Waist Circ, Omph x	-0.435 +	x	+	x	+	x		1.9205
Stature	= 69.833 +	Weight x	0.180 +	Waist Circ, Omph x	-0.392 +	Buttock Circ x	-0.473 +	x	+	x		1.8582
THIGH CIRCUMFERENCE												
Thigh Circ	= -0.122 +	Buttock Circ x	0.681 +	x	+	x	+	x	+	x		0.0290
Thigh Circ	= 0.044 +	Buttock Circ x	0.454 +	Weight x	0.183 +	x	+	x	+	x		0.0270
Thigh Circ	= 0.442 +	Buttock Circ x	0.362 +	Weight x	0.302 +	Stature x	-0.149 +	x	+	x		0.0243
Thigh Circ	= 0.563 +	Buttock Circ x	0.373 +	Weight x	0.382 +	Stature x	-0.187 +	Waist Circ, Omph x	-0.095 +	x		0.0232
WAIST CIRCUMFERENCE, OMPH												
Waist Circ, Omph	= 12.686 +	Weight x	0.135 +	x	+	x	+	x	+	x		2.0992
Waist Circ, Omph	= 35.714 +	Weight x	0.166 +	Stature x	-0.424 +	x	+	x	+	x		1.8963
Waist Circ, Omph	= 32.205 +	Weight x	0.151 +	Stature x	-0.407 +	Buttock Circ x	0.116 +	x	+	x		1.8933
WEIGHT												
Weight	= -128.725 +	Buttock Circ x	6.973 +	x	+	x	+	x	+	x		8.1246
Weight	= -214.680 +	Buttock Circ x	6.313 +	Stature x	1.732 +	x	+	x	+	x		7.0475
Weight	= -214.292 +	Buttock Circ x	4.611 +	Stature x	1.962 +	Waist Circ, Omph x	1.591 +	x	+	x		6.1431

UPPER BODY

BACK COAT LENGTH (CERVICALE-GLUTEAL)																		
Cervicale Ht-Gluteal Furrow Ht	=	0.127 +	Stature	x	0.357 +		x	+		x	+		x	+		x		0.0337
Cervicale Ht-Gluteal Furrow Ht	=	0.166 +	Stature	x	0.323 +	Weight	x	0.049 +		x	+		x	+		x		0.0333
Cervicale Ht-Gluteal Furrow Ht	=	0.256 +	Stature	x	0.300 +	Weight	x	0.097 +	Biceps Circ, Flxd	x	-0.176 +		x	+		x		0.0331
Cervicale Ht-Gluteal Furrow Ht	=	0.333 +	Stature	x	0.289 +	Weight	x	0.134 +	Biceps Circ, Flxd	x	-0.163 +	Chest Circ at Scye	x	-0.067 +		x		0.0330
BIACROMIAL BREADTH																		
Biacromial Br	=	5.403 +	Stature	x	0.138 +		x	+		x	+		x	+		x		0.5918
Biacromial Br	=	3.545 +	Stature	x	0.115 +	Chest Circ at Scye	x	0.095 +		x	+		x	+		x		0.5601
Biacromial Br	=	3.566 +	Stature	x	0.112 +	Chest Circ at Scye	x	0.179 +	Chest Circ	x	-0.077 +		x	+		x		0.5540
BICEPS CIRCUMFERENCE, FLEXED																		
Biceps Circ, Flxd	=	5.789 +	Weight	x	0.039 +		x	+		x	+		x	+		x		0.5407
Biceps Circ, Flxd	=	12.952 +	Weight	x	0.048 +	Stature	x	-0.132 +		x	+		x	+		x		0.4624
Biceps Circ, Flxd	=	15.931 +	Weight	x	0.061 +	Stature	x	-0.147 +	Buttock Circ	x	-0.098 +		x	+		x		0.4521
Biceps Circ, Flxd	=	17.954 +	Weight	x	0.068 +	Stature	x	-0.161 +	Buttock Circ	x	-0.111 +	Chest Circ	x	-0.045 +		x		0.4482
Biceps Circ, Flxd	=	16.596 +	Weight	x	0.063 +	Stature	x	-0.157 +	Buttock Circ	x	-0.101 +	Chest Circ	x	-0.088 +	Chest Circ at Scye	x	0.082	0.4432
BUTTOCK CIRCUMFERENCE																		
Buttock Circ	=	22.276 +	Weight	x	0.115 +		x	+		x	+		x	+		x		1.0456
Buttock Circ	=	30.382 +	Weight	x	0.126 +	Stature	x	-0.149 +		x	+		x	+		x		0.9965
Buttock Circ	=	37.415 +	Weight	x	0.150 +	Stature	x	-0.188 +	Chest Circ at Scye	x	-0.223 +		x	+		x		0.9656
Buttock Circ	=	42.363 +	Weight	x	0.169 +	Stature	x	-0.241 +	Chest Circ at Scye	x	-0.209 +	Biceps Circ, Flxd	x	-0.416 +		x		0.9467
Buttock Circ	=	43.846 +	Weight	x	0.175 +	Stature	x	-0.259 +	Chest Circ at Scye	x	-0.129 +	Biceps Circ, Flxd	x	-0.454 +	Chest Circ	x	-0.097	0.9419
CHEST CIRCUMFERENCE																		
Chest Circ	=	-1.848 +	Chest Circ at Scye	x	1.076 +		x	+		x	+		x	+		x		1.0837
Chest Circ	=	1.117 +	Chest Circ at Scye	x	0.892 +	Weight	x	0.025 +		x	+		x	+		x		1.0529
Chest Circ	=	10.521 +	Chest Circ at Scye	x	0.811 +	Weight	x	0.043 +	Stature	x	-0.140 +		x	+		x		1.0145
Chest Circ	=	15.254 +	Chest Circ at Scye	x	0.824 +	Weight	x	0.061 +	Stature	x	-0.190 +	Biceps Circ, Flxd	x	-0.398 +		x		0.9980
Chest Circ	=	15.919 +	Chest Circ at Scye	x	0.855 +	Weight	x	0.060 +	Stature	x	-0.160 +	Biceps Circ, Flxd	x	-0.401 +	Biacromial Br	x	-0.247	0.9887
CHEST CIRCUMFERENCE AT SCYE																		
Chest Circ at Scye	=	7.952 +	Chest Circ	x	0.755 +		x	+		x	+		x	+		x		0.9081
Chest Circ at Scye	=	10.490 +	Chest Circ	x	0.555 +	Weight	x	0.034 +		x	+		x	+		x		0.8302
Chest Circ at Scye	=	6.514 +	Chest Circ	x	0.567 +	Weight	x	0.027 +	Biacromial Br	x	0.310 +		x	+		x		0.8084
Chest Circ at Scye	=	4.209 +	Chest Circ	x	0.550 +	Weight	x	0.015 +	Biacromial Br	x	0.361 +	Biceps Circ, Flxd	x	0.351 +		x		0.7872
Chest Circ at Scye	=	5.814 +	Chest Circ	x	0.547 +	Weight	x	0.022 +	Biacromial Br	x	0.343 +	Biceps Circ, Flxd	x	0.346 +	Buttock Circ	x	-0.058	0.7850
FOREARM CIRCUMFERENCE, FLEXED																		
Forearm Circ, Flxd	=	0.155 +	Biceps Circ, Flxd	x	0.545 +		x	+		x	+		x	+		x		0.0133
Forearm Circ, Flxd	=	0.173 +	Biceps Circ, Flxd	x	0.386 +	Weight	x	0.054 +		x	+		x	+		x		0.0126
Forearm Circ, Flxd	=	0.136 +	Biceps Circ, Flxd	x	0.401 +	Weight	x	0.045 +	Biacromial Br	x	0.070 +		x	+		x		0.0125
Forearm Circ, Flxd	=	0.103 +	Biceps Circ, Flxd	x	0.429 +	Weight	x	0.034 +	Biacromial Br	x	0.056 +	Stature	x	0.016 +		x		0.0125
Forearm Circ, Flxd	=	0.086 +	Biceps Circ, Flxd	x	0.426 +	Weight	x	0.025 +	Biacromial Br	x	0.048 +	Stature	x	0.019 +	Chest Circ at Scye	x	0.017	0.0125
FRONT BUST LENGTH (1/2 STRAP LENGTH)																		
1/2Strap Length	=	0.168 +	Chest Circ	x	0.255 +		x	+		x	+		x	+		x		0.0256
1/2Strap Length	=	0.209 +	Chest Circ	x	0.171 +	Weight	x	0.079 +		x	+		x	+		x		0.0249
1/2Strap Length	=	0.253 +	Chest Circ	x	0.229 +	Weight	x	0.099 +	Chest Circ at Scye	x	-0.105 +		x	+		x		0.0246
1/2Strap Length	=	0.193 +	Chest Circ	x	0.248 +	Weight	x	0.088 +	Chest Circ at Scye	x	-0.128 +	Biacromial Br	x	0.138 +		x		0.0244
1/2Strap Length	=	0.140 +	Chest Circ	x	0.256 +	Weight	x	0.071 +	Chest Circ at Scye	x	-0.120 +	Biacromial Br	x	0.108 +	Stature	x	0.025	0.0244
FRONT WAIST LENGTH (1/2 STRAP LGTH+(CHEST HT-WAIST HT, O)																		
1/2Strap Length+(Chest Ht-Waist Ht, O)	=	0.620 +	Weight	x	0.212 +		x	+		x	+		x	+		x		0.0300
1/2Strap Length+(Chest Ht-Waist Ht, O)	=	0.426 +	Weight	x	0.175 +	Stature	x	0.091 +		x	+		x	+		x		0.0290
1/2Strap Length+(Chest Ht-Waist Ht, O)	=	0.211 +	Weight	x	0.133 +	Stature	x	0.065 +	Chest Circ	x	0.152 +		x	+		x		0.0278
NECK CIRCUMFERENCE, BASE																		
Neck Circ, Base	=	0.408 +	Weight	x	0.134 +		x	+		x	+		x	+		x		0.0184
Neck Circ, Base	=	0.335 +	Weight	x	0.120 +	Biacromial Br	x	0.153 +		x	+		x	+		x		0.0181
Neck Circ, Base	=	0.280 +	Weight	x	0.084 +	Biacromial Br	x	0.141 +	Chest Circ at Scye	x	0.071 +		x	+		x		0.0178
RIGHT ARM INSEAM (AXILLA-WRIST)																		
Axilla Ht-Wrist Ht	=	-0.105 +	Stature	x	0.314 +		x	+		x	+		x	+		x		0.0337
Axilla Ht-Wrist Ht	=	-0.056 +	Stature	x	0.327 +	Chest Circ	x	-0.058 +		x	+		x	+		x		0.0332
Axilla Ht-Wrist Ht	=	-0.100 +	Stature	x	0.293 +	Chest Circ	x	-0.073 +	Biacromial Br	x	0.264 +		x	+		x		0.0327
SHOULDER CIRCUMFERENCE																		
Shoulder Circ	=	0.372 +	Chest Circ at Scye	x	0.887 +		x	+		x	+		x	+		x		0.0344
Shoulder Circ	=	0.101 +	Chest Circ at Scye	x	0.789 +	Biacromial Br	x	0.722 +		x	+		x	+		x		0.0295
Shoulder Circ	=	0.084 +	Chest Circ at Scye	x	0.630 +	Biacromial Br	x	0.763 +	Biceps Circ, Flxd	x	0.487 +		x	+		x		0.0272
Shoulder Circ	=	0.178 +	Chest Circ at Scye	x	0.568 +	Biacromial Br	x	0.703 +	Biceps Circ, Flxd	x	0.354 +	Weight	x	0.086 +		x		0.0267
SLEEVE LENGTH, SPINE WRIST																		
Sleeve Lgth, Spine-Wrist	=	0.110 +	Stature	x	0.452 +		x	+		x	+		x	+		x		0.0344

Sleeve Lgth, Spine-Wrist	=	-0.023 + Stature	x	0.365 + Biacromial Br	x	0.624 +	x	+	x	+	x		0.0312
Sleeve Lgth, Spine-Wrist	=	-0.076 + Stature	x	0.356 + Biacromial Br	x	0.515 + Chest Circ at Scye	x	0.099 +	x	+	x		0.0303
Sleeve Lgth, Spine-Wrist	=	-0.027 + Stature	x	0.343 + Biacromial Br	x	0.521 + Chest Circ at Scye	x	0.065 + Weight	x	0.030 +	x		0.0303
Sleeve Lgth, Spine-Wrist	=	-0.001 + Stature	x	0.337 + Biacromial Br	x	0.506 + Chest Circ at Scye	x	0.114 + Weight	x	0.043 + Chest Circ	x	-0.059	0.0302
STATURE													
Stature	=	54.317 + Weight	x	0.072 +	x	+	x	+	x	+	x		2.1260
Stature	=	66.120 + Weight	x	0.151 + Biceps Circ, Flxd	x	-2.039 +	x	+	x	+	x		1.8183
Stature	=	75.029 + Weight	x	0.196 + Biceps Circ, Flxd	x	-1.846 + Chest Circ	x	-0.483 +	x	+	x		1.6750
Stature	=	90.689 + Weight	x	0.277 + Biceps Circ, Flxd	x	-1.854 + Chest Circ	x	-0.511 + Buttock Circ	x	-0.675 +	x		1.5201
Stature	=	79.715 + Weight	x	0.251 + Biceps Circ, Flxd	x	-1.722 + Chest Circ	x	-0.489 + Buttock Circ	x	-0.604 + Biacromial Br	x	0.678	1.4659
WAIST BACK LENGTH, NI													
Waist Back Lgth, NI	=	0.095 + Stature	x	0.188 +	x	+	x	+	x	+	x		0.0341
Waist Back Lgth, NI	=	0.067 + Stature	x	0.170 + Biacromial Br	x	0.133 +	x	+	x	+	x		0.0340
Waist Back Lgth, NI	=	0.090 + Stature	x	0.171 + Biacromial Br	x	0.164 + Biceps Circ, Flxd	x	-0.102 +	x	+	x		0.0338
Waist Back Lgth, NI	=	0.077 + Stature	x	0.167 + Biacromial Br	x	0.141 + Biceps Circ, Flxd	x	-0.214 + Chest Circ	x	0.061 +	x		0.0336
Waist Back Lgth, NI	=	0.079 + Stature	x	0.169 + Biacromial Br	x	0.167 + Biceps Circ, Flxd	x	-0.181 + Chest Circ	x	0.100 + Chest Circ at Scye	x	-0.067	0.0335
WAIST CIRCUMFERENCE, OMPH													
Waist Circ, Omph	=	-0.202 + Chest Circ	x	1.017 +	x	+	x	+	x	+	x		0.0801
Waist Circ, Omph	=	0.000 + Chest Circ	x	0.612 + Weight	x	0.382 +	x	+	x	+	x		0.0746
Waist Circ, Omph	=	0.785 + Chest Circ	x	0.437 + Weight	x	0.611 + Stature	x	-0.301 +	x	+	x		0.0709
Waist Circ, Omph	=	1.085 + Chest Circ	x	0.422 + Weight	x	0.769 + Stature	x	-0.377 + Biceps Circ, Flxd	x	-0.545 +	x		0.0703
Waist Circ, Omph	=	1.144 + Chest Circ	x	0.429 + Weight	x	0.776 + Stature	x	-0.345 + Biceps Circ, Flxd	x	-0.541 + Biacromial Br	x	-0.284	0.0700
WEIGHT													
Weight	=	-128.725 + Buttock Circ	x	6.973 +	x	+	x	+	x	+	x		8.1246
Weight	=	-165.729 + Buttock Circ	x	4.828 + Chest Circ at Scye	x	3.398 +	x	+	x	+	x		6.4148
Weight	=	-245.588 + Buttock Circ	x	4.281 + Chest Circ at Scye	x	3.277 + Stature	x	1.636 +	x	+	x		5.1564
Weight	=	-250.897 + Buttock Circ	x	3.452 + Chest Circ at Scye	x	2.196 + Stature	x	1.887 + Biceps Circ, Flxd	x	5.280 +	x		4.2825
Weight	=	-250.964 + Buttock Circ	x	3.236 + Chest Circ at Scye	x	0.914 + Stature	x	1.976 + Biceps Circ, Flxd	x	5.314 + Chest Circ	x	1.315	4.0554