Developing a framework for determining garment pattern functional ease

Keywords: pattern construction / functional ease / anthropometric measurement

Abstract

Analysis of garment construction methods shows patterns are created through the application of measurements and ease. Ease is shown to consist of comfort, functional and styling requirements, of which functional are the least subjective. Currently little objective guidance exists regarding ease and results of studies into dynamic changes are difficult to contextualise in the pattern. Historical methods and developing technology indicate that manual methods of measurement are still best suited to this type of research. Method is also an essential feature as this provides objective depth as well as minimising inter and intra subject variation and potential error. To support the development of the methods, database software was used to structure supporting information. Inductive methodologies were applied to determine key databases and fields for data presentation. Using these structured methods, important considerations regarding assessment of dynamic changes for functional ease and supporting reasoning could be investigated and developed. The databases successfully provided a framework from which to study dynamic measurement to determine functional ease and retain context in the pattern. Key areas were determined as anatomical landmarks to add measurement objectivity and postural descriptions to ensure less inter subject variation. Inclusion of this supporting data for the measurements and findings are important to allow for analytical depth and recognition of contributing variables. With technological development new approaches to pattern construction are becoming available and determination of functional ease requirements can be applied to provide garments with greater functional and performance characteristics.

Introduction

The provision of correct levels of functional ease within the garment allows for normal movement of the wearer (Daanen and Reffelrath 2007). However no sources exist informing academics and practitioners of functional ease allowances which can be contextualised and used in pattern construction. Provision of this data can be used to improve the development of functional and performance garments and can support the design of fashion garments. Currently environments are being developed for achieving more control over garment production and this data can help to ensure decisions required are objectively informed. Examples of functional and performance garments can be found in sports (Watkins 1977) or military applications (Todd 2007) and their efficacy can be compromised if functional requirements are not met. Ease can be generally classified as the additional dimensions added to a pattern above the dimensions of the wearer (Jay 1969; Aldrich 1997; Page 2003). Functional ease is the least subjective of these dimensions, related to dynamic movement. Though previous studies have developed individual terminology (Kirk and Ibrahim 1966; Chi and Kennon 2006) the following report will refer to 'dynamic change' of the person indicating 'functional ease' requirements of the garment. Functional ease is incorporated into block pattern construction (Davies 1986; Aldrich 1997), which provides the foundation for the majority of garments. Though these amounts are rarely directly stated some suggested ease allowances can be found within literature (Gioello and Berke 1979; Beazley and Bond 2003). These amounts generally relate to major dimensions, with no discussion or objective justification for their determination. This is further complicated as they are seen as an overall amount without discussion of their contributing variables.

It is the intention of this report to outline a method for determining levels of functional ease which can be incorporated into the pattern construction process. This will enhance the objective controls and reduce the costly trial and error of garment development, which often includes reverse engineering to gain the best results. Previous research (Kirk and Ibrahim 1966; Chi and Kennon 2006) indicates potential approaches and highlights limitations and difficulties which will be encountered. It is clear that pattern construction, anthropometric measurement and human movement must all be considered. Pattern construction is the process by which garment patterns are developed (Davies 1986; Aldrich 1997; Bray 2003), anthropometric measurement is the recording of a persons dimensions using objective and repeatable methods (Clauser et al., 1988; Lohman et al., 1988; Roebuck 1995; Beazley 1997) and human movement is the repositioning of the body in 3D space (Calais-Germain 1993; Greene and Heckman 1994). The following chapter highlights some of the current literature which supports development of this framework for determining functional ease from dynamic measurement.

Literature Review

Pattern construction requires anthropometric measurement to indicate initial dimensions (Roberts and Onishenko 1985; Davies 1986; Aldrich 1997). These are acquired by application of a measurement survey (O'Brien and Shelton's 1941; Kemsley 1957; Clauser *et al.,* 1988; Beazley 1997) which must provide sufficient descriptive depth to enable context and analysis. Pattern construction manuals often provide directions for measurement

(Davies 1986; Aldrich 1997; Bray 2003) and though lacking depth may be the only guides a pattern constructor has experience of. Analysis indicates the most detailed measurement guidance contain both descriptions and images (O'Brien and Shelton 1941; Bolton *et al.,* 1975; Kunick 1984; Clauser *et al.,* 1988; Beazley 1997). Illustrative images aid understanding, especially when descriptions are brief as in Bolton *et al.* (1975) which includes large and informative images, accompanied by details of measurements and equipment. The Wira Clothing Services (1980) survey has less detail though uses experimental equipment and includes suggestions for measurement abbreviations to aid computer application in analysis. Abbreviations are derived from the measurement nomenclature retaining intuitive indications of the measurements. The clearest method for measurement of male subjects is provided by Clauser *et al.* (1988). Developed for measurement of army personnel, methods and equipment are described, detailing landmarks and measurements accompanied by representative images. Predominantly measurements utilise a tape measure or anthropometer as staple devices for manual measurement. Unisex guidance on measurement is provided by ISO 8559 (1989) and BS 7231-1 (BSI 1990b) with the latter being more detailed, containing large images and clear descriptions. However the most appropriate documentation related to clothing measurement is provided by Beazley (1997). This contains clear images and concise measurement descriptions with clearly evident relationships between the measurements and the pattern; however details of anatomical landmarks are brief. To provide sufficient insight into landmarks requires consultation of medical literature (Basmajian 1983; Field 2001; Byfield and Kinsinger 2002), though varied terminology can be a barrier to quick comprehension.

Pattern construction which relies on these anthropometric measurements (Anderson 2005; Aldrich 2007) can be classified as direct, divisional or combination systems (Bray 2003; Aldrich 2007). This is dependent on the use of actual over derived dimensions with the most common combination systems using both. Modern construction methods produce block patterns and then apply styling (Kunick 1984; Davies 1986; Aldrich 1997), these include proportionally derived dimensions which are prone to error if applied to an ethnically diverse population (Simons 1933; Winks 1997). Pattern systems are also commercially available on CAD platforms, providing greater flexibility, control and reducing time consuming processes (Aldrich 1992; Gray 1992; Gray 1998). Both systems rely mainly on 2D methods due to its speed and accuracy, coupled with its repeatability and systemised controls (Hardakar and Fozzard 1998; Istook 2002). Whichever method is used guidance on ease allowances is still required (DeLong *et al.* 1993). Dissection of construction processes conducted by Koh *et al*. (1995) finds there is a heavy reliance on heuristic knowledge which limits flexibility and controls. Inclusion of ease is discussed by Beazley (1999) and though little data can be found regarding ease some definitions can be identified in literature and a table of suggested ease amounts is provided.

Automation of pattern construction using CAD is investigated by Kang and Kim (2000a) and automated drafting is proposed to reduce the skill required in pattern development. It is apparent CAD offers the opportunities to automate pattern construction (Kang and Kim 2000c) and the benefits are described by Istook (2002) for customisation of patterns to the individual. Each CAD system is found to allow some method of controlling pattern dimensions, however data must exist by which these controls can be utilised. Most recently developments in CAD pattern construction are presented by Beazley and Bond (2003). A clear pictorial description shows the dispersion of ease within a pattern compared to the mass of the subject to which it fits. This is accompanied by ease charts, though without discussion of how amounts were determined. Pattern block construction processes are brief and depict construction based mainly on direct measurement. This is in contrast to other construction methods which tend to abstract pattern construction using fewer direct measurements (Davies 1986; Aldrich 1997). Consultation of this work helps build understanding of the pattern, its construction and relationships.

Comfort and function have also been investigated related to the pattern. Adams *et al.* (1993) used a systematic approach to determine the effects of protective clothing on performance providing a framework for understanding garment effects on the wearer. Ashdown and DeLong (1995) investigated wearer perception of varied apparel ease in key areas on trousers, establishing that perceived variations could be quite low, dependent on the area. Using protective overalls Huck *et al.* (1997) investigated garment design and fit. Comparing a control garment against two with ease experimentally applied, inclusion of ease was found to be most effective local to where movement occurred, though may affect visual appearance. Fit is objectively evaluated of by Fan *et al.* (2004) reporting on the use of new technology and methods to evaluate and improve garment fit. Methods to determine fit are detailed and it is recognised as complex, with divergent descriptions and consisting of mainly subjective definitions. Ashdown *et al.* (2004) used scanning technology for garment fit analysis, scanning subjects wearing trousers and analysing resultant 3D images to determine fit issues. Fit judgment is further discussed by Ashdown and O'Connell (2006) recognising fit involves multiple factors including posture, fabric, proportions and garment size.

Kirk and Ibrahim (1966) collected some of the only objective data regarding dynamic change of the body by careful demarcation of the body at critical strain areas. Identified as the knee, seat, back and elbows, changes caused by controlled movements were recorded and presented as percentages. However amounts cannot be easily applied in pattern construction, especially as no context for the subject's initial dimensions is provided. Findings suggest changes vary little between men and women, though overall variation inter or intra-subject are not mentioned. Importantly no mention is made regarding other variables which may affect change such as subject age and this is not discussed elsewhere. Watkins (1977) studied movement's impact on the garment for developing protective hockey equipment, using application specific rather than standardised movements. Standard terminology was used to describe dynamic movement, for which there are a number of accessible sources (Calais-Germain 1993; Greene and Heckman 1994; Standring 2005). Again no equipment was used to control joint angles, which were estimated from observations of hockey players. This work supports the links between postural changes and garment comfort and function, though its results would be difficult to apply more generally. Watkins presents further details in her text book on clothing (Watkins 1984; Watkins 1995). A chapter is given to explaining the provision of mobility in clothing and refers to research conducted in this area. Several methods are presented for investigating movement's effect on the garment and the anatomy supporting movement is briefly described. Wearer mobility and its restriction within clothing were investigated in detail by Huck (1988). A series of movements are described which are appropriate to establish mobility of the clothed subject and are used to assess wearer mobility in different fire fighter jacket designs. Although highly detailed, results are limited to particular garment types; this research does suggest the need for functional mobility in performance wear and makes the case for structured guidance requiring functional needs.

Movement and Codification for its description is part of the focus of the study by Dong (1996). Repeatability of naturally extended body postures is discussed and a method of codification for dynamic posture change is presented to help determine its impact on the garment. Results are based on observations of body movement's effect on a specific garment type having controlled demarcation making garment deformation easier to observe. Importantly this research highlights the difference between natural and ergonomic postures, which is clearly presented pictorially. Natural movements are found to involve multiple joints, rather than ergonomic movements isolated to single joints and heavily controlled. Using isolated movement does make description and repeatability easier but will not accurately reflect natural movement which cause dynamic change. The difficulty of repeatability of natural dynamic postures is addressed here by a simple device to allow for repeatable movement of the arm. Although this would reduce repeatability error for this extended postures it would be unsuitable for other body movements.

Recently a study was carried out by Chi and Kennon (2006) measuring dynamic changes manually and using a body scanner. Change was restricted to the torso and focused on movement of the shoulder, measuring length changes between landmarks. Measurements are not those used for pattern construction making direct application of results difficult. One natural posture and five movement postures were used with movement's representative of full range of shoulder motion (Greene and Heckman 1994) excluding adduction. Thirteen anatomical points (Landmarks) were located and marked. Manual measurement accuracy was increased by drawing lines between landmarks for measurements to follow, whilst cone shaped markers were used for scanning. Manual measurement was time consuming taking 3 hours and required measurement repetition for precision. The measurement process was repeated using a scanner which was found to have a limited volume, smaller than some of the dynamic postures requiring subjects be moved off centre omitting non-measured body parts. Until scanners are developed with greater resolution and volume, manual measurement remains the most useful and valid method to measure dynamic postures. The observed changes reported and methods applied do provide guidance for future surveys; however application of the results to pattern construction would require careful contextualisation within the pattern.

It is apparent from literature that anatomy plays a large part in movement and it was essential to gain insight to enable a clear understanding of dynamic change. Texts were located to guide the research regarding movement and anatomy which would be accessible to the researcher in terms of style, depth and availability. Movement and Range-of-Motion (ROM) are detailed in the book edited by Greene and Heckman (1994). Clinical measurement of joint motion is described primarily for assessing correct ROM of subjects. The anatomy of movement is clearly described by Calais-Germain (1993) who also provides insight into the use of descriptive terminology. Measurement of joint motion using Goniometry is described by Norkin and White (2003). Though not as clear or insightful regarding anatomy, distinction is made between the types of end feel which limit movement at the joints. These distinctions are important regarding control of movements and their potential errors in repetition.

Methodology

During the literature review a number of methodologies were located for investigating functional ease (Kirk and Ibrahim 1966; McKinnon and Istook 2002; Chi and Kennon 2006). However none provided sufficient detail to enable their direct adoption, though synthesis of supporting data would allow an improved objective methodology to be created. It was clear that controlled dynamic movement would need to be contextualised in the pattern to overcome difficulties of the application of previous results.

Literature indicated manual measurement is still the most appropriate and accurate method for determining dynamic change (Chi and Kennon 2006). This is due to scanner accuracy and volume; shortfalls established during earlier research (Chi and Kennon 2006). Much of the supporting data regarding development of a survey could be found from secondary sources. However the analysis, storage and synthesis of this data needed to be conducted within a structured and flexible environment, which would be provided by database software. The organised and informative literature regarding measurement surveys was able to indicate suitable data for inclusion within the database structure. Filemaker 7 database software was chosen as this has a user friendly graphical interface. Databases could be easily designed and formatted without requiring high operator skill and the features and functions of this software were familiar to the researcher.

Analysis of equipment employed in previous surveys (Bolton *et al.,* 1975; Clauser *et al.,* 1988; Lohman *et al.,* 1988; Beazley 1997) coupled with retaining simplicity of survey application, formed the important criteria for measurement equipment selection. An Anthropometer and tape measure were selected to collect measurements as they have been used consistently since the development of large scale anthropometric measurement for clothing purposes (O'Brien and Shelton 1941). Further to this a short metal ruler allowed collecting of short heights not permitted by the Anthropometer and electronic scales for recording the subject's weight. Further equipment was required to enable completion of the survey, which included hypoallergenic skin marking pencils for demarcation of landmarks and could be identified from that used in previous surveys.

Landmarks are fixed points on the body surface which are found on all subjects as either surface features or palpable points, often relative to the skeleton. All manual measurement surveys utilise landmarks when defining measurement placement (O'Brien and Shelton 1941; Clauser *et al.,* 1988) though few provide suitable descriptions with any depth. Anatomical literature from medical sources was able to provide sufficient depth to add to the limited landmark definitions of location methods. To aid with landmark location a human skeletal model was observed to provide familiarity with the shapes which would be palpated on the subject. Landmark definitions were collected analysed and structured within the landmark database. This allowed for definitions to be developed through synthesis of a number of sources. The process of landmarking was defined and then practiced on a pilot subject. It was determined that landmarking should be conducted on the subject in a fixed posture so all recorded changes could be ascertained from this position. A variation on the anatomical position was selected for this purpose (Figure 3). This would reduce the impact of skin movement artefact, which is the naturally occurring displacement between the body surface and underlying skeletal structure (Cappello *et al.,* 1997; Rabuffetti *et al.,* 2002).

Once landmarks had been determined it was possible to select measurements which could rely on these stable points. Each measurement needed to either provide context for the subject in a wider population or be subject to change through movement whilst retaining context in the pattern. Context in the pattern was assured by consultation of pattern construction literature (Davies 1986; Aldrich 1997) and the effects of movement could be determined from literature related to this. (Kirk and Ibrahim 1966; Calais-Germain 1993; Greene and Heckman 1994; Chi and Kennon 2006). To enable change to occur to all measurements some were repositioned, though remained between points relatable to the pattern, this mostly affected measurement of the lower body. Measurements which had been considered were stored within the database and the most suitable were selected from these. Revision of the definitions and methods were made at this stage to enable their suitability for this survey. The measurement process was practiced and refined using pilot subjects to be assured of the greatest efficacy. A total of twenty six measurements were identified for the survey, half provided purely context with the other half being re-measured after dynamic change had occurred. Once defined these measurements could be ordered, copied, transferred or modified within the flexible electronic structure of the database.

Postures were the final variable within the survey and it was apparent that each must be repeatable inter and intra-subject with only the body’s natural controls. This could be supported by guidance from the measurer, the provision of visual prompts and a mirror to allowing for visual self assessment of their posture. These postures needed to be representative of normal movements and cause sufficient change to be measurable in the survey. Initial postures took inspiration from those used in previous surveys (Kirk and Ibrahim 1966; Pheasant 1990; Chi and Kennon 2006); however refinements needed to be made related to normal movements (Dong 1996; Dong et al., 1998). Fourteen postures were developed and defined within the databases, though only 9 were used in the survey. This included a posture chosen as the control posture, which was based on the anatomical position from which all body movements can be described (Calais-Germain 1993; Standring 2005). Each posture was stored separately within the database, including images, a written definition and a description using appropriate terminology (Calais-Germain 1993; Standring 2005).

Measurements and postures provided the fundamental aspects of the dynamic measurement survey. However data analysis and collection required the development of codified nomenclature, which has been shown to benefit analysis, especially when employing electronic resources (Wira Clothing Services 1980; Dong 1996; Liao 1997; Otieno 1999). Codification of measurements began with the landmarks on which they are reliant. Each was assigned a unique three characters abbreviated nomenclature bearing a direct relationship to the full name. A total of twenty one landmarks were used within the survey including the 7th cervical vertebrae, scye depth and waist level. Posture codification was simpler as this was limited to two characters; more variables were created by using an alphabetical character followed by a numeral. This would allow for up to 260 unique references, which are currently adequate for this survey. Measurements Codification was developed as a progression of the landmark and posture codes, based on combining both to form a unique eight character code. Measurements with more universally accepted nomenclature used this when appropriate. All codification was conducted within the confines of the databases, which used value rules to ensure unique codes by not permitting repetition.

Once the foundations of the survey had been established and measurements defined they were ordered for greatest efficacy. The process needed to be logical, without stress to the measurer and obtain results in the quickest time (Clauser *et al.,* 1988). Division of the body into anterior and posterior as well as working from top to bottom helped develop an appropriate measurement order. Piloting established that the process would take between 10 to 15 minutes and would become faster with familiarity and practice. Again ordering was conducted by creation of a field in the measurement databases and sorting of the records by this numeration. Piloting of the survey was conducted using two athletic male subjects in their early twenties with near identical proportions. This allowed for their use interchangeably and images of the subjects were used to populate the databases. These subjects were chosen as they would be representative of young male subjects who would require functional performance garments, an area which would benefit most from the results of this research. Pilot measurements were recorded a minimum of three times per subject and intra-measurement error assessment indicated that each could be repeated within tolerances close to those suggested by others (Clauser *et al.,* 1988; Beazley 1997). It has been identified as important to both prepare measurement tolerances and monitor them during a survey.

Results and Discussion

Secondary data was the most important contributor toward the development of a framework for establishing functional ease requirements. It was evident that sufficient detail for this was not contained within any one area. Guidance for clothing measurement was integral to establishing the important features of a measurement survey and suggested appropriate fields to be contained within the database. However these guides could not furnish enough depth to successfully define landmarks and this required the consultation of anatomical literature and tactile familiarity gained through piloting and observation of a skeletal model. It is important to note that variation in focus of the survey literature was impacted by the perceived application of the data. However this should be guided by pattern construction literature (Davies 1986; Aldrich 1997) which was able to provide insight into the process and the required dimensions. Previous results had been difficult to assimilate into the pattern construction process, though did provide grounding for this type of study (Kirk and Ibrahim 1966; Chi and Kennon 2006). The final and crucial area of literature was related to human movement. Although this had featured in previous studies the definitions and supporting knowledge was scant and required location of suitable guidance which was accessible to the researcher (Calais-Germain 1993; Standring 2005). The location of literature was a difficult process as no previous research had gathered all these important areas to support similar research. Within the literature difficulties were observed in the variation of nomenclature within and between the sources. This required the development of a field within each database where different terms could be stored when they were related to the same method or object. By combining the results of this secondary data the databases were furnished with sufficient detail to support the development and application of a measurement survey for determining dynamic change.

Primary research was conducted in the development of the databases and in piloting the measurement survey using the two male subjects. This was aided by a technician, whose familiarity with the developed process significantly quickened its application. The first area of piloting was location of anatomical landmarks. Demarcation was found to be best achieved by marking a cross using hypoallergenic skin marking pencils similar to those of previous studies (Figure 1 and Figure 2). Ethical issues and sensitive body areas discounted the use of some landmarks, especially around the crotch. This also affected the taking of some measurements which had to have methods revised to accommodate possible subject discomfort. The few existing landmark location methods helped provide an outline for the database and piloting; allowing for other location methods to be developed. Muscle tension was observed to impact on landmarking and so it was important the subject remained relaxed. Landmarking in a standard static posture proved to be successful and provided the foundation from which change could be established. Following are examples of landmarks of the upper torso identified as appropriate for use in this research.

Figure 1. C7 Landmark. Marked with a cross the 7th cervical vertebrae landmark provided a stable point for measurement at the nape of the neck.

Figure 2. Landmarks of the shoulder, this shows demarcation of the Acromion; acromioclavicular and side neck landmarks.

Figure type was found to affect location of landmarks, with both muscle and fat providing difficulties to accurate location. However the flexible storage environment of the database enabled changes to be made quickly and updating of methods in light of findings. Piloting of landmarks suggested the development of a field to store notes related to each landmark, providing more detail for further applications. Storage of the landmark data within the database showed they could be classified in a number of ways. Some are determined by palpation of underlying skeletal features; others by surface geometry (Shape, soft tissue) and some require the application of tools and can be related to other skeletal or soft tissue landmarks. A total of eight classifications were determined for landmark type, dependent on location method. Division of landmarks by their location method is not noted in other works, though structured storage in the database supports this development for searchable classification.

Piloting allowed for observations to be made which could be stored in the databases if they were deemed to be important. Assessment of measurement error showed postural achievement was repeatable using the subject's natural controls with some guidance from the measurer. Tolerances suggested by earlier works were able to provide a foundation from which intra-measurement tolerances could be devised for this work. Confidence in their use was determined through piloting. Reference to the anatomical position (Figure 3) allowed other postures to be defined and these included using the body as a natural limiter as is shown by the position of the arms in posture A2 (Figure 4).

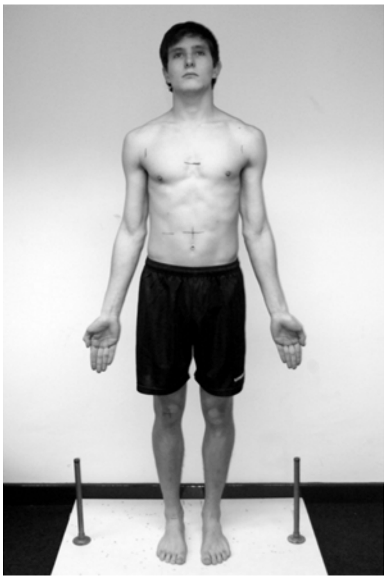

Figure 3. Anatomical posture, a variation of this posture was used as the control posture from which all change could be gauged.

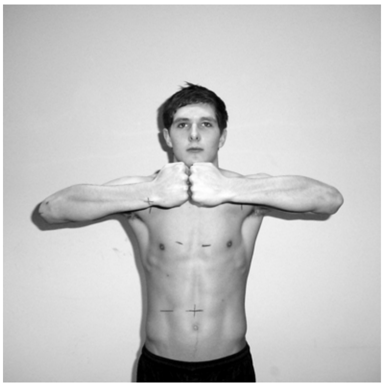

Figure 4. Posture A2, this posture allowed for change to be measured around the shoulder and down the arms.

Cooperation of the subject contributed toward the efficacy of the survey and helped to reduce the time for each set of measurements. Although it was requested that subjects wear close fitting underwear, this was not always followed and required that masking tape be used to fix underwear so it would not interfere with landmark location of measurement. This was especially the case for the measurement between the posterior waist and gluteal furrow shown in the following image (Figure 5).

Figure 5. Measurement from the posterior waist to the gluteal furrow in the static control posture.

Breathing was another factor which proved to impact on measurements and it was decided that they would be taken at specific points in the breathing cycle. This change was not as excessive as that reported on by McKinnon and Istook (2002) though changes between 2-5mm were observed to measurements on the upper torso. Measurements were also affected by movement of the subject to observe the process. It was decided as essential that subjects remain in the posture without variation for each series of movements. Skin creases which increased or decreased with movements were seen to impact on both observed change and the ease with which measurements could be taken. This would need to be factored in and supported the structured storage of observations with measurement definitions.

Application of the experimental methodology enabled the development of four main databases. Three were created to store and synthesise data related to measurement landmarks, dynamic postures and survey measurements. The fourth database was created to provide an electronic interface for recording the results of the survey. This database would be filled in by a technician whilst the survey was conducted. Each database took inspiration from available literature. The landmark database contained details of location method, demarcation and a clear image of the landmark. Nomenclature was an important aspect of the three storage databases and allowed for recording of alternative nomenclature to increase the potential application and understanding of the measurements. Images were easily stored within the database format and could be sized and adjusted to suit using appropriate editing software.

Conclusions

This preliminary research determined that a survey can be developed to establish dynamic changes which can be contextualised in the pattern. Sufficient details can be found in literature to enable recognition of the important features supporting this survey. However details of landmark location methods are difficult to locate and require development which needs to be tested prior to application. Filemaker 7 database software provides a suitable and easily developed graphical interface for creating a structured storage environment. Although literature indicates the major storage fields, others were developed which would add greater depth to the descriptions contained. The flexibility of this method of electronic storage allows for more fluid development as data requirements become evident. This was most important for landmark location which relied heavily on synthesis of varied literature.

Dynamic changes required in the survey could be repeatedly attained by the subjects with only minimal guidance, though breathing did impact on changes observed. The validity of the results could be seen by comparison of intra-measurement variation, which would also inform on possible intra-measurement tolerances. Utilising the database framework all the supporting details and notes for describing measurements and collecting them can be completed. This structure allows for flexibility and growth as well as revisions though these must be managed. The undertaking of this survey on a population will allow for increased details of functional ease requirements to be provided and suggest improvements which can be incorporated within the database structure.

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