

Jane LEDBURY

Manchester Metropolitan University, UNITED KINGDOM

Beyond Function: A Design Development Case Study

INTRODUCTION

Women are increasingly entering the exciting and punishing arena of outdoor pursuits and extreme sports as participants, competitors and professionals. Although high risk extreme sports remain heavily male dominated, women such as the American free climber Lynn Hill, and the British sailing legend Ellen MacArthur have demonstrated that it is possible not only to compete on an equal footing with male athletes and to rival men for bravery and endurance, but also to win. The perception therefore, that women are physically or mentally less capable of participating in any sporting activity or outdoor pursuit would no longer appear to be valid. (Foster, L. 2002)

Female professionals in outdoor pursuits, such as instructors, mountain guides, and in mountain rescue function in what is still considered to be 'a man's world'. As the minority sex in male dominated teams, women are expected to perform equally with their male counterparts, and often, to do so in men's clothing. Garments provided are generally in either men's or unisex sizes, which are structured predominantly for

men and therefore seldom fit properly (Hodgson, 1998). Clothing that is too loose promotes heat loss and over-long garments can be restrictive. Not only is ill fitting clothing uncomfortable, but also in the challenging arena of high performance activities it might be dangerous. It is crucial therefore, that women are able to wear garments that fit and function well in order to fulfill demanding roles and optimise performance.

Although provision of female specific outdoor clothing has improved dramatically over the last decade, it is not always on offer to women in the working milieu and does not necessarily meet the needs of female professionals. Current women's outdoor garments are marketed as both technical and high performance; however, in targeting females, outdoor clothing companies offer a hybrid of fashion and function that is not always compatible and therefore may not provide a viable option for the female professional. Women want products that perform and fit well, and are increasingly frustrated by the provision of female specific clothing, particularly for high-risk sports (Foster, 2002).

Aims and Objectives

Outdoor pursuit instructors and mountain rescue teams perform in harsh environments, and often in foul weather. Physical stress can be considerable; activities may span strenuous hill walking, trekking, rock climbing and abseiling. Clothing that protects the wearer from the elements, provides thermal comfort, fits

well, and allows a wide range of movement is essential to the high performance expected of the user. The purpose of this research project was to design a clothing system for professional females working in outdoor pursuits. The study had the following objectives:

1. To identify the need for gender specific clothing in high performance activities
2. To establish the user needs of females working in a mountain environment
3. To investigate textiles for thermal balance, protection, and mobility, and advanced manufacturing techniques for garment construction.
4. To employ a structured design process to address the user needs identified in objective 2
5. To look critically at and evaluate the clothing system, to assess its success in meeting aim and objectives

METHODOLOGY

Literature review was carried out to develop an understanding of design processes and functional needs related to outdoor clothing, primarily: thermal balance, fit, mobility, and associated textiles. The roles of women in sport were examined to provide a historical background. As issues emerged through primary research further study was conducted to gain an understanding of fit satisfaction, sizing issues and body-cathexis, particularly in relation to female athletes.

A structured step-by-step design process, with emphasis on analysis in the early stages in order to determine user needs and establish design criteria was followed, with continuous evaluation throughout the process in order to modify and improve design ideas. The aim of the research project was to gain a thorough understanding of the design problem and to appreciate the special user needs of the women interviewed; therefore qualitative methods of data collection were selected as qualitative methods are most suitable for research aimed at discovery (Blaxter et al, 2002).

In order to analyse user needs and define design problems it is important to formulate the demands from the user in the use situation, therefore considerable time must be spent on fieldwork in establishing relationships and gaining knowledge of the circumstances and conditions (Denscombe, 2003, Rosenblad-Wallin, 1985). Personal interviews and participant observation were used to gain an in-depth understanding of the issues and to determine user needs and wants.

The interviews were conducted with a purposive sample of twelve women working in outdoor education centers, mountain rescue teams and as guides in the Snowdonia National Park, North Wales. The sample of females was selected to provide a range of occupations and because they were likely to provide the most significant data for the topic of investigation. Personal interviews can be deemed to have high face validity (Casselmann-Dickson & Damhorst, 1993), however it must be noted that the

design process for functional clothing deals with specific identified problems, and therefore is not intended for generalization to a larger population.

LITERATURE REVIEW

Design Process

A disciplined, structured approach to garment design and development is required for the successful creation of functional clothing (May-Plumlee & Pittman, 2002). Parallels have been drawn with the engineering design process (Pitimaneeyakul, Labat & DeLong, 2004, Reagan, et al, 1998), with emphasis on the problem rather than the solution; the designer is required to present a sound understanding of the design conditions before commencing (Labat and Sokolowski, 1999). With research and analysis in the early stages of design, importance is placed on the initial analysis of the design situation.

A step-by-step process is needed from original concept through to evaluation of the final design solution (DeJonge, 1984). A seven-stage process was presented by Koberg and Bagnall (1981) and adapted by Watkins as follows: *accept, define, ideate, select, implement and evaluate*. Lamb and Kallal (1992) propose an apparel design framework, which further advances the design process in consideration of functional, expressive and aesthetic (FEA) needs. Common functional needs include thermal comfort, protection, fit and mobility (Rosenblad-Wallin, 1985) whilst

expressive needs relate to messages users wish to convey and involve self-esteem and aesthetic needs concern consumer's perceptions of beauty (Lamb & Kallal, 1992).

Rosenblad-Wallin (1985), introduced a user-oriented product development model applied to functional clothing design, with importance placed on the user in the use situation as a starting point and suggested that in analysing user needs, as described in the use situation, results may differ from those generated by traditional methods of design development.

Functional Needs

Women working in the Snowdonia mountain area are frequently subjected to changing weather conditions. Exercise can be strenuous, with arduous walks or climbs prompting sweating and heat stress followed by periods of inactivity causing post exercise chill. Functional needs therefore, include protection against the environment and must address thermal balance, mobility and fit.

Thermal Balance

The function of the regulatory system is to maintain an even internal body temperature while at rest and when exercising (Foss & Keteyian, 1998). As both

heat loss and heat production affect thermal balance it is critical that thermal balance be maintained for physiological comfort, and safety (Watkins, 1995). The body's adaptive ability is placed under additional stress when exercising in the heat, cold, or at altitude and fatigue occurs more rapidly as muscle cools (Wilmore & Costill, 1988). Women tend to get colder than men, both at rest and when exercising in cold environments, as their greater body surface area to body mass ratio and lesser muscle mass, facilitate body cooling, (Foss & Keteyian, 1998).

In addition to fluctuations in body temperature brought about by exercise, climatic conditions are subject to sudden change in mountain environments, a layered approach to clothing offers the wearer flexibility and an opportunity to maintain thermal balance by adding or subtracting layers as required. Textiles were examined in relation to the clothing system in order to establish appropriate materials.

Clothing Mobility

Clothing mobility is an essential requirement in the field of outdoor pursuits. Extreme movements and postures become the norm in activities such as mountain climbing; garments must be constructed to accommodate acute abduction of the limbs, and full manipulation of the joints. Movement requirements, and consequently design solutions, differ for each activity; therefore a difficulty exists in defining the required characteristics for mobility in clothing design. It is important, that the

designer gain as much information as possible about the activity and environment of the user, as the particular design methods of increasing garment mobility should be related to user needs (Watkins 1995).

Throughout movement, body dimensions increase and decrease in the area around the joints, clothing facilitates movement best if it accommodates these increases in dimension (Watkins, 1995). Two methods were used to study body expansion and contraction: anthropometric kinematics, a method devised by Kirk and Ibrahim (1966, cited by Watkins, 1995) of measuring over joints in a normal posture and again during flex to calculate the increases and decreases in dimension and a second method described by Watkins (1995) was used to measure where, and to what degree expansion occurred over the back and shoulder during movement.

Fit

Fit is one of the most complex factors in the construction of clothing and impacts on the functional, expressive and aesthetic needs of the user. Fit provides the functional aspects of clothing mobility and comfort, whilst the aesthetic factor of body/garment relationships are directly associated with the expressive aspect of self-esteem. A garment that looks good on the body is inevitably one that fits well; one of the most commonly reported problems with clothing is dissatisfaction with fit (Alexander et al., 2005). Clothing can create an improved perception of the body;

however, in order to increase body perception clothing has to fit (Feather et al., 1996).

Body Cathexis and the Ideal

LaBat and DeLong (1990) proposed that society creates an ideal body image, describing the ideal figure as symmetrical with balanced proportions, bust and hip girth being equal, and the waist 23-28cms smaller, thus creating the classic 'hourglass' body shape. Sizing for clothing is influenced by the ideal figure as proportion and balance are based on the ideal. Patterns are tested for fit on body forms manufactured to represent a symmetrical figure conforming to the hourglass shape, thereby adopting the social ideal. Few people conform to the ideal shape and many experience difficulty with fit based on that ideal (Alexander et al, 2005). A study by Davis in 1985 among female college students revealed that satisfaction (body cathexis) decreased the further their perceived body form deviated from the 'ideal' (Feather et al, 1996).

Clothing is related to body satisfaction (Feather et al., 1996). According to LaBat and DeLong (1990) sizing systems used by the clothing industry provide a measure of expectation for women, therefore, when a garment does not fit, comparisons to the ideal are inevitable, sending the message that, as the sized garment does not fit, 'their bodies are less than perfect'. Furthermore, women are more dissatisfied with their lower body, and in particular with the thigh, hip and buttocks, this relates

directly to dissatisfaction with fit as real women's body shape is incompatible with garments based on the ideal hourglass figure (LaBat & DeLong, 1990, Feather et al, 1996).

Body Forms

Athletes may be described by their somatotype (body shape and proportion), traditionally these falls into three types:

1. *Ectomorphs*, thin and linear
2. *Mesomorphs*, predominantly muscular
3. *Endomorphs*, soft, round and fleshy

(Watkins, 1995)

Johnson (1990), proposed that traditional body forms might not represent a fit (athletic) body and proposed the addition of *ecto-mesomorph*, a muscular, athletic, thin body and *endo-mesomorph*, a muscular, athletic, plump body, as two further bodyforms. The students in Johnson's study selected the ecto-mesomorph as the current ideal shape for women, thus providing a thinner, more athletic alternative to the hourglass ideal.

Although fitness shapes the body, this has not resulted in increased body cathexis (Feather et al., 1996 citing Cash, Winstead & Janda, 1986). Wheat and Dickson (1999), found in their study, that fit was mentioned most often (by 66%) of female

golfers as a cause for dissatisfaction in performance related criteria, thus highlighting that the complexities of fit are further complicated by the special needs of female athletes.

PRIMARY RESEARCH

The Design Process

The seven-stage process proposed by Koberg and Bagnall (1981) and adapted by Watkins was adopted for this study. In addition the apparel design framework proposed by Lamb and Kallal (1992) was used to prioritise functional, expressive and aesthetic (FEA) needs.

Stages 1 & 2 Acceptance and Analysis

The first stage of *acceptance* was in establishing the research project. North Wales, popular for mountaineering, rock climbing and hill walking provides a base for four mountain rescue teams, the National Mountain Centre and a proliferation of outdoor pursuits centres supported by a number of outdoor clothing stores, was selected as the research area for this study.

Observation

Participant observation was used to gather valuable data on the environmental conditions and activities of women working in a mountain environment. The researcher attended instructor's sessions and accompanied a Mountain Rescue Team on training exercises to simulate rescue situations and was able to observe and experience at first hand the environment, its hazards and constraints, and the implications for users in their clothing requirements. Activities were recorded on camera in order observe range of movement, the impact equipment may have on clothing and to note areas susceptible to damage. Observation provided data on functional needs and contributed towards a movement analysis to establish the range of mobility required in garments. Team members were able to discuss issues with clothing as they arose during the course of activity.

Interviews

Personal interviews can produce in-depth data, which deal with matters in detail, and reveal underlying feelings or beliefs on a subject (Blaxter et al, 2002). The interviews were conducted using a prepared list of questions, and provided the starting point for the design process.

Subject Profiles

The working environment of interviewees is the mountains, moorlands and forests of the Snowdonia National Park,. The rainfall in this area is higher than average for the British Isles and the women frequently work in heavy precipitation.

The twelve female participants included:

- 4 instructors at outdoor pursuits centres
- 2 mountain rescue
- 1 park warden/mountain rescue
- 1 adventure film maker/elite athlete
- 4 high level instructors/ elite athletes

Profiles of the users were developed and included physical characteristics; activities, preferences and personal views, in order to define the user and make their needs clear in light of the use-situation (Lamb & Kallal, 1992). The first interview conducted was used as a pilot and one interview recorded in the field was abandoned due to wind noise, both are excluded from further discussion. Valuable data was gathered from interviews concerning user needs and issues surrounding current clothing. A transcript was made and each user need and issue was noted and examined for commonalities. FEA needs were identified and placed in ranking order established by the number of users requiring the function.

Functional, Expressive and Aesthetic Needs

Aesthetic and expressive characteristics are important as well as the functional requirement for performance clothing (Cassleman-Dickson and Damhorst, 1993). Additionally, functional and expressive needs are interrelated, (Bye and Hakala, 2005) as fit, a functional need, has a direct bearing on the expressive needs of role and self-esteem. Essentially the participants' primary *functional* needs were: protection from the elements, thermal balance, a good fit and freedom of movement. Garments were required that were technical and cut to fit the female form.

Expressive needs concerned role and status, design criteria had to address appearance, particularly that of competence and professionalism, as women working in outdoor pursuits may experience prejudicial behaviour regarding their ability to perform 'male' tasks. The need to '*look the part*' was expressed; a participant noted that, as a female instructor training men, image, and looking competent was crucial. Members of rescue teams need to be easily identified during emergencies. Aesthetic needs included feminine styling and practical colours.

Emerging Issues

Clothing issues were analysed and the greatest emerging issues were those of poor fit and the lack of garments, which facilitated easy toilet stops in the field.

Data revealed that of the women interviewed:

- 90% thought the choice of women's clothing worse (lower technical spec) than men's
- 70% experienced problems of fit in trousers (small on the thigh)
- 70% experienced problems of fit in jackets (small/restrictive on the shoulder & torso)
- 60% expressed the need for a drop seat (DS) in trousers
- 40% mostly wear female specific clothing
- 30% wear men's clothing
- 30% wear 'unisex' clothing

These findings compare to those of Wheat and Dickson (1999), in whose study 60% of golfers expressed dissatisfaction with fit.

Body Cathexis

The fit problems detailed above may have a negative impact on self-image and self-esteem as some women expressed the view that men's garments fitted them better than women's due to their body shapes, which they considered 'not typically female'. The group of women interviewed were aged between 32 and 48 and ranged between 152 and 175 cms in height; their body forms were assessed by the researcher and categorized as follows:

- 8 *Mesomorph*, muscular, angular, hard shape.
- 1 *Ecto-mesomorph*, muscled, somewhat athletic thin body.

- 1 *Endo-mesomorph*, muscled, rounder full shape.

The women had a common muscularity, and were predominantly lean. The overall impression gained by the researcher was that of fit, healthy, women who appeared to be of average proportion. Interestingly however, when describing themselves, eight out of ten women perceived that they were not 'average' women, not 'the usual shape', or 'not particularly feminine', as may be seen in the following excerpts:

- *'While I'm not manly, I'm not particularly feminine'*
- *'I'm not your typical female'*
- *'Other women might have more women's shapes'*
- *'Probably me being strange', (referring to trouser fit).*
- *(I) 'May be abnormal compared to people on the street'*
- *(I'm) 'Not too feminine a shape'*
- *(I'm) 'Broad shouldered, a masculine shape, go straight down'*
- *'Big shoulders, larger proportioned than average'*

These comments arose from difficulties experienced with fit, which concurs with LaBat & DeLong (1990), who proposed that women might perceive that an ill fitting garment is an indication that their bodies are flawed. A lack of femininity arose in eight out of ten interviews; a feeling that men's clothes fit better on the subjects than it would other women was expressed. It is interesting to note that, despite women's body shapes becoming straighter and more androgynous (Feather et al, 1996, citing Morris, Cooper & Cooper, 1989), as has the body ideal (Johnson, 1990), these

women perceive their straighter shape, removed from the traditional hourglass, as being unfeminine.

Stage 3: Definition

User needs identified through interviews and observations during the analysis stage, became the generator of the design process. The data were used to *define* the design problems and develop design criteria in order to explore creative solutions in the ideation stage. Design criteria and garment features were categorised according to the FEA model. Primary functional needs included protection against the environment, fit to the female form, and cut for movement. Expressive needs surrounded size and fit appropriate for athletic females as well as those of role: professional appearance and status: Identifiable as instructor or rescue.

Stages 4 & 5: Ideation and Selection

During the *ideation* stage ideas were developed to established criteria; designs were considered on the basis of meeting the criteria in order to reach a solution, the deciding factor being those designs that successfully combined functionality and fulfilled expressive and aesthetic factors. A design was selected that combined few seams, with a contoured shape that would flatter the female form, whilst allowing for under-layers and optimum movement as well as promoting a professional image.

Stage 6: Implementation

Patterns were prepared for the selected designs in consideration of size, silhouette, and mobility. Mobility was of prime importance, as an extreme range of movement was the norm for end-users. A movement analysis was carried out in order to determine the degree of expansion in the areas requiring additional ease. Analysis showed a 40% increase in dimension at the area of greatest expansion across the back, whilst expansion over the knee increased by 46%, and over the elbow by 50%. The data contributed to design and pattern construction, in order to develop garments, which would allow optimum mobility.

Stage 7: Evaluation

The prototype jacket and trouser were fitted on two interviewees, who provided valuable feedback on comfort, size, fit, and mobility. The designer carried out fit tests for evaluation on the final jacket and trousers in standing and active positions, data were gathered through unstructured interviews and observation during the fittings. The model's opinion on fit and comfort was crucial, as the wearer is able to feel what happens when wearing the garment (Watkins, 1995). Evaluation was based on functional, expressive and aesthetic design criteria identified through primary research.

The implementation stage of the design process was re-visited in order to optimise fit, mobility and function for the suit; two further prototypes were tested on the same fit models. Evaluation based on expressive criteria established that the garments fit well and were flattering to the female form. The issue of femininity was addressed through the cut, extra ease in areas of muscular development ensured comfort, and prevented negative feelings of self-esteem associated with poor fit. The design provided the professional appearance needed to establish status, reflective lettering such as 'Instructor' or 'Rescue' identified the role of the wearer. The protective garments were deemed by the participants to have met the criteria determined by research in the early stages of the design process.

DISCUSSION AND CONCLUSIONS

The FEA consumer needs model enabled the designer to move beyond the functional aspects of design and offer improvements in the expressive values of outdoor clothing, which may not have been identified by traditional methods of fashion design.

Primary research, in the form of exploratory interviews, provided unexpected results. The hypothesis that women wore men's/unisex clothing due to lack of provision of women's garments was not substantiated, in contrast, results indicated that female professionals often choose to wear men's or unisex clothing as female specific clothing does not fit an athletic female body and is not considered to equal the

technical level of clothing offered to men. Women working in mountain environments have special user needs associated with clothing. Weighted heavily towards function along the aesthetic/functional continuum, the symbolic values of protective clothing would seem to assume little importance, however women are aware of how clothing affects the way they feel, and whether garments make them look good, (Weede, 1997), consequently expressive and aesthetic factors are fundamental to successful design.

This study identified significant issues of femininity associated with poor fit in women's outdoor clothing. Respondents perceived themselves as 'not particularly feminine', or 'not like other women' as female specific clothing did not fit and men's or unisex garments fit them better. The fact that women's clothing did not fit was interpreted as a fault with the body, rather than the garment. Women participating regularly in outdoor pursuits have well developed muscles leading to changes in body shape and dimension (Johnson, 1990), this needs to be recognized by manufacturers of women's outdoor clothing, in order to provide garments that fit well and increase self esteem.

A structured approach to the design process for functional clothing was followed. Thorough research in the early stages enabled the designer to meet functional, expressive and aesthetic criteria. This methodology, with rigorous research in the early stages, might also be related to the development of other garment types in order to inform manufacturers and more fully satisfy customer requirements.

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