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# 5 DISCUSSION AND CONCLUDING REMARKS

## 5.1 Were the aims of the study fulfilled?

Through an innovative approach which allowed an evolving and pro-active response to the requirements, this study fulfilled and surpassed its aims. For the first time in Africa, laser scanning technology was used to input 3-D weight-bearing anthropometric data on the female foot for the footwear industry. Certainly, no research collaboration of this magnitude between South African podiatric medicine and the footwear industry had previously taken place.

The results are all the more remarkable because of the successful accomplishment of developing a methodology and integrating a scientific academic study with industrial involvement, at the same time as implementing transfer of knowledge and technology between both realms. In addition, every other foot measurement study of this size in the world has been accomplished by large teams of researchers (Hawes *et al.*, 1994:187; Anil *et al.,* 1997:79; Krauss *et al.*, 2005:1) whereas the present study was conceived, coordinated and executed by a single researcher.

Part one of the study successfully developed and produced a low cost method of 3-D foot image input. The method not only provides for 3-D imaging, but also incorporates a means of obtaining linear measurements from points placed onto the 3-D image. Not only is the method reproducible and thus academically viable but as an intellectual property protected under patent (SA patents, numbers 2005/03824 and 2006/04167), the method can be commercialized by the University of Johannesburg.

It was the first time globally that software was specifically designed to integrate with foot anthropometry laser scanning technology. This software enables (albeit manually) the conversion of the negative of the sole impression scans into a positive, which can then be “stitched” together with the upper foot scans to produce a complete 3-D image of the foot (Appendix XV).

The second aim of the study was fulfilled as eight mean foot measurements of a sampled population were compared with the equivalent comparable eight measurements from a standard mass production last to determine what percentage of the sampled population would fit the footwear derived from such a last. The $H_0$ or null hypothesis that ‘the shoe does fit the foot’ could not be supported since four of the eight dimensions of the last were too disparate a fit for the majority of the measured sample, namely, three measurements were not suitable for more than 75% of the sample and one measurement was not suitable for more than 56% of the sample.

The corollary of this finding is that it highlighted those measurements or dimensions that need modification in last manufacture to produce shoes that more closely fit the majority of the sampled population.

Because the study successfully aligned itself to governmental Department of Trade and Industry criteria such as potential job creation, commercial potential, investment potential, capacity building, innovation and technology transfer, it qualified for TIPTOP (Technology Innnovation Promotion through the Transfer of People) placement of the researcher. This enabled the researcher to receive training in last bottom pattern design and footwear manufacture.

Using data gained from the study, it was possible to already begin new foot bed technology and new shoe design. Thus, new foot bed design was implemented in *Soul of Africa* sandals that were launched to consumers in September, 2006 (Appendix XVIII). New shoe design began development, with the launch of the first new closed shoe (based on the study data) scheduled for consumer launch in March, 2007 (Appendix XIX).

The comparison of means undertaken in the third part of the study was successful in showing that grading between sizes is proportional but linear in three planes. This suggests that grading between sizes should be equally three dimensional. In other words, there should be equal grading between length relevant measurements ($x$ axis); width relevant measurements (*y* axis) and height or girth measurements (*z* axis). Industry awaits receipt of new 3-D grading software that will ratify this result, now that 3-D data has been collected into a core database from which to conduct and verify further 3-D shape analysis.

The consistency of the forefoot data in this larger sample shows a similar pattern to previous work (Thompson & Zipfel, 2005:2). However, the data is a more accurate picture of the anthropometry of the population than previous published data due to the newly developed electronic method of data collection.

## 5.2 Impact of the results: toppling the "standard"

The results of the study have shown that the measurements that would now constitute a national average or "mother last" for South African women are substantially not the same as the measurements derived from UK standards as currently used by the South African footwear industry, both industrial and retail.

The measurement data obtained has provided invaluable insight into the inherent geometry within the 3-D morphology; knowledge that was previously non existent or only surmised and which is important for last model making.

This information has enormous relevance at a time when the South African Bureau of Standards in South Africa is collaborating with the International Standards Organisation based in Geneva, Switzerland on Standards and Sizing for Footwear. Britain has just released its recent measurement survey data that shows an average size 4 joint girth (weight bearing) of 227 mm for British women (Turner, 2006). Since the British population is now also a multi ethnic one, it is interesting to note the similarity to the present study in which the South African average joint girth (weight bearing) for the actual size 4 group is identical at 227mm, while it is 228mm for the group scaled down to size 4.

## 5.3 Implications of results for foot health and industry

It is important to discuss each of the instances where there was marked disparity between foot measurements and last measurements. This must be done both in terms of how the disparity impacts on foot health (in other words, what the consequences could be should the disparities not be addressed), and also how industry can produce lasts or make modifications to current practices that will accommodate these variances in such a way that foot pathology can be minimised.

### 5.3.1 Heel to ball length

It was apparent that the range of lengths for heel to the fifth metatarsophalangeal (MTP) joint for a size 4 varies from as proximal as 139mm to as distal as 170mm, with a similar range of lengths for the length from the heel to the first MTP joint. This is understandable if a lowered arch height extends the heel the ball length, while a higher arch shortens it.

As explained and illustrated in 1.7.5, mismatched fitting of feet to footwear may cause burning pain in people with a long heel-to-ball proportion (Figure 5.1).

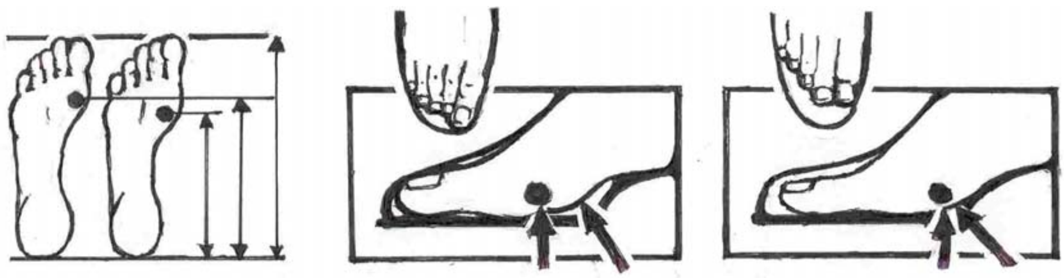


Figure 5.1: Fitting implications of heel to ball length variance. (After Rossi & Tennant, 1984:96).

If the ball of the foot rests in a mismatched position (A) compared to the bend at the ball of the shoe (B), then the muscles under the unsupported area of the foot (B) will tense, followed by spasm and pain. Ideally (A) and (B) should match as shown by (C) and (D).

If a heeled shoe is poorly fitted and the forefoot is thus able to slide forward, this will bend the toes, compressing them into the box toe and preventing the toes from effective function (Stamm, 1964:64), as well as lead to the risk of developing dorsal corns on the resultant bent and elevated interphalangeal joints.

One method of preventing “foot travel” forwards is to ensure that the footwear design incorporates a means of fixation across the dorsum or instep of the foot. This grip across the instep is seen in all traditional lace-up styles but can also be accomplished by means of positioning adjustable strap features across the top of the foot.

Another means of achieving a better fit is to produce “half sizes”. General practice in design is that last length should accommodate foot length in mm plus a minimum 10mm last allowance. The 3-D data is useful for more specific toe region information in calculating allowances when making half sizes.

In an ideal world not constrained by economics, one should have different lasts for different heel to ball ratio lengths. It is also necessary to educate the consumer to have a basic understanding of what to select in a shoe for their type of foot. An alternative to costly custom lasts can be found if innovative technology is used to cater for a range of heel to ball ratios within the same shoe.

For instance, to overcome the difficulty of setting a fixed heel to ball position in a shoe (suitable only for a limited group of individuals), new developments in tread grooves and inner engineering on the sole are possible. This will enable existing lasts to be used together with more flexible soling material to accommodate various heel to ball length ratios, and enable better pressure loading according to pressure studies (Bennett & Duplock, 1993:674)

A schematic to illustrate the principle of a new sole design with flex grooves to cater for the range of heel to ball ratios is shown in Figure 5.2. This is an example of a development direction resulting from the knowledge gained in the study.

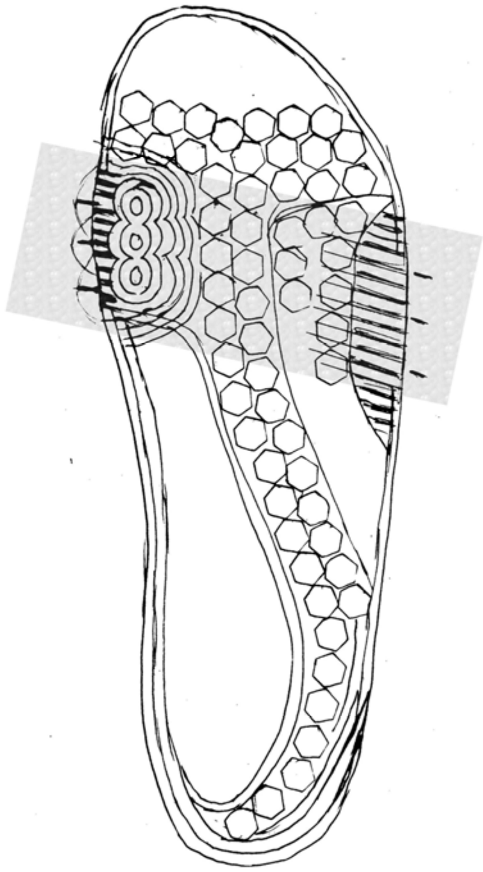

Figure 5.2: New sole design with band[a] of flex grooves.

[a]Indicated by grey band passing through minimum, mean and maximum values, so that flex band will cater for complete range of heel to ball ratios.

### 5.3.2 Tread width

Tread width in a shoe should never be so narrow as to create compression. From an anatomical and physiological viewpoint, footwear compression limits motion at the critical articulation of the metatarsophalangeal joints. As discussed in 1.7.2, the active and passive soft tissue or muscle stabilizer function would be lost. In addition, compression will impact on circulatory and neural networks in the metatarsophalangeal region. Consequent acquired deformities as well as impaired or altered motion would, in turn, impact on natural gait.

For a person with feet substantially narrower than the mean, it is important to prevent "foot travel" and friction within a shoe that is too wide. Certain styles are better suited to prevent forward "travel", such as T-bar styles and Mary Jane styles that have a dorsal strap or fixation method to hold the foot across the instep.

Since the data revealed that there were participants with narrower than average feet and also others with wider than average, this prompted the concept of a new shoe that, by means of removable and interchangeable foot bed inserts, can accommodate both markets (see Appendix XVIII)

A related finding was of immediate benefit to industry, namely significant correlation at the 0.01 level (2-tailed) between forefoot girth and both tread width ($p$ = 0.000) and hallux height (p = 0.002) in all ethnic groups. This has meant a revision of the previous allowance of 16 to 18mm for toe box height in a size 4 shoe to the new data mean of 22mm on new last developments.

Understandably, the process of amending footwear to the new data will be a gradual one, only to be implemented on new developments, since it would be very costly to scrap all existing lasts (except the extremely incorrect ones).

### 5.3.3 Fifth toe length

As stated in 1.7.2, free dorsiflexion of all toes is vital for foot functionality. Since the proximal phalanges are attached to the plantar aponeurosis as well as other connective tissue in the forefoot, free toe dorsiflexion promotes more efficient propulsion as well as improved blood circulation to the ball of the foot (Bojsen-Møller, 1979:10; Bojsen-Møller and Lamoreux, 1979:479).

This important aspect of efficient locomotion has direct bearing on footwear. Constrictive footwear or footwear that is unnaturally shaped in the toe area will, thus, prevent natural function of the foot. The correction needed on the last to accommodate the fifth toe is shown in Figure 5.3.

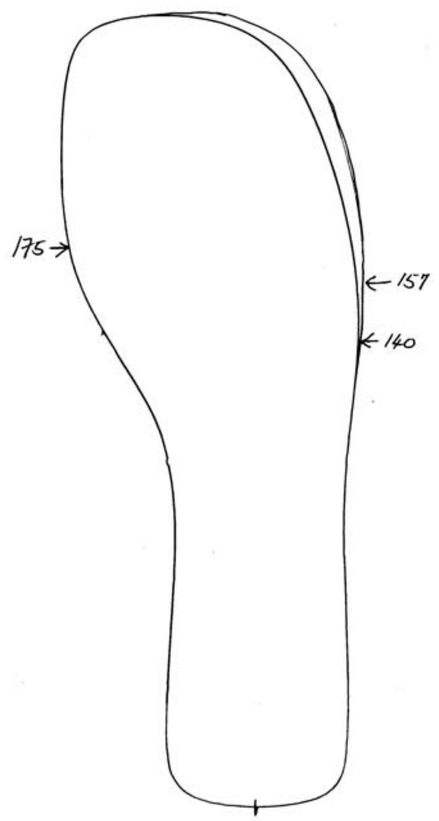


Figure 5.3: Last pattern (right foot) correction for fifth toe accommodation

Data from a previous anthropometric study of Black African and White African females revealed that 97% of South African women are unshod or partially unshod in childhood (Thompson & Zipfel, 2005:22). This phenomenon is directly linked to the climatic, social and cultural influences as well as lifestyle factors among all sectors of the South African population. Even amongst urban dwellers, unshod or partially shod behaviour in leisure time is commonplace (Thompson & Zipfel, 2005:23).

This study found that toe height of the hallux in 42.6% of the sample was greater than the average of 22mm (see 4.2.4.2.3). It also found that Minor Foot Length (Heel to tip of fifth toe) was longer than "standard" in 55.8% of the sample.

Taken together, these findings may relate to recent work by Trinkaus (2005:1523) in which anatomical skeletal evidence suggests that habitually shod have less robust halluces, and conversely, that partially shod behaviour can be deduced from the robusticity of both the lateral toes and halluces.

As indicated in 5.4.2 future last developments such as toe box and toe cone height should, thus, incorporate adequate allowances to accommodate these morphometric findings.

### 5.3.4 Body Mass Index

Results show a high number of participants (n = 125, or 27.6% of the total of 453) whose body mass index (BMI) was in excess of 30. A BMI index of 30 is the classification for clinically obese (WHO, 1998).

By ethnic group, BMI greater than 30 was displayed in 39.2% Coloured, 27.8% Black African, 27.0% Asian/Indian and 16.9 % White African. The high BMI average is visually apparent in Figure 5.4.

However, the BMI results in this study were less than findings in previous studies that documented 44% obesity among Black African females in the Cape peninsula in one study (Lean, 1988:22); and 40% obesity among Black African females and 23.3% among White African females in Gauteng province in another study (Thompson and Zipfel, 2005:25).

Pearson correlation coefficients showed negative correlation of BMI to height in Asians and Black Africans, indicating that higher BMI values were associated with shorter height yet taller height was associated with lower BMI values. Further extensive studies on obesity prevalence are needed since it appears that figures may be different according to geographical location and socio-economic level.

Increases in body mass showed a moderate to strong positive correlation in the Asian participants to an increase in foot dimensions of toe height, tread width, heel seat width and forefoot girth. In Black African participants, only forefoot girth showed a moderate to strong positive correlation to body mass, while among White African participants, there was no correlation between body mass and foot dimensions. This is in keeping with the findings of a previous study by Thompson and Zipfel (2005:22).

In the Coloured participants, an increase in body mass showed a moderate to strong positive correlation to only toe height, heel seat width and forefoot girth. Thus, no correlation exists in the Coloured participants between body mass and tread width. This may be due to genetic influences of their mixed heritage.

With regard to correlation in respect of stature or height, only Coloureds showed a mild positive correlation between height and major foot length. Since Major foot length can be influenced by the length of the longest toe, this warrants further investigation into toe length relationships in this group. Similarly, White Africans showed positive correlation between Height and Minor foot length. Since Major foot length is influenced by the length of the fifth toe, this indicates a strong relationship based on skeletal scaling: the taller the skeleton, the longer the fifth toe.

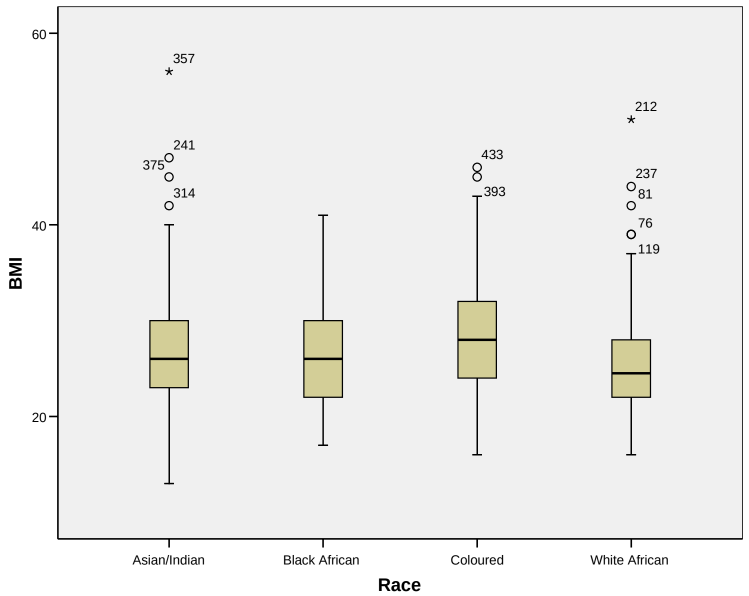


Figure 5.4: Means-on-spokes of BMI across the four CSID groups

The implications of these correlations show the need to consider BMI statistics when designing footwear. Further investigation into the data may suggest a method to cluster the differences in foot morphology into different foot “types”, so as to assist in the design process.

## 5.4 Outcomes of the study

Beyond the achievement of the aims of the study, namely, the invention of a method of 3-D input; the subsequent multi-ethnic 3-D metric study; the comparison of means to investigate scale and the compilation of a 3-D database of foot measurements, the anticipated outcomes were also brought to fruition.

By summarising the results in 4.2.4.2, and considering the sample of actual size 4 ($N$ = 129), one outcome was to find the percentage of the sampled population whose feet could be at risk of podiatric pathology by wearing footwear based on the measured last.

It was found that 72% of the sampled population would be at risk of lateral foot pathology (digital corns on 4$^{th}$ and 5$^{th}$ toes, vascular and neural compression, impairment of full muscle function, potential muscle imbalance) since measurement for minor foot length was longer than what the last allowed for.

Further, 55% displayed a big toe height that was larger than that allowed by the last, so that toe function and dermal pathology could result from friction and compression of the big toe.

Forefoot compression would be evident in the 96% of the sample that displayed a wider tread width than the last. In addition, 85% of the sample displayed a larger forefoot girth than the last. These two measurements together would cause compression of the interossei and lumbrical muscles that are essential to toe function in gait.

Heel compression would be evident in 99.2% of the sample that displayed a wider heel seat width than the last (even allowing for the additional 10mm due to the curvature for medial and lateral borders, as incorporated in the model last). Heel compression could cause skin chafing but further, a smaller heel seat than the physical heel pad would cause callus buildup on the heel edge where it would chafe against the rim of the smaller heel seat.

Both measurements for Heel to Ball 1 and Heel to Ball 5 were too long for more than 76% of the sample, which meant that the footwear would flex in an incorrect position for the function of the sampled feet. This could cause sliding forward of the foot which, through friction, could cause callus buildup under the ball of the foot.

To produce footwear that more accurately fits the South African female women's market, a model last would need to incorporate measurements derived from the data obtained in this study. Such a "mother" last (Ruby-AT) was produced that incorporates the means from the natural size 4 obtained from the multi-ethnic 3-D metric study data (Appendix XXI).

A further outcome of the study was to produce hardcopy prints suitable for development teams in non computerized SMEE industries showing foot morphology from side and top views, to increase visual awareness of different types of feet. Some examples of these can be seen in Appendix XIX.

In traditional last making, the creation of a last model begins with a Last Bottom Pattern that is supplied to the model maker, together with measurements of girth, width and length. Correction of the last used for comparison in the study was manually made once the study data was compiled (Appendix XVII). This process and knowledge can be applied to all last bottom patterns in future.

Developments in 3-D technology for rapid prototyping in a variety of industries now enable a 3-D "print" (in resin) to be constructed from any data set in the database (see Appendix XVIII). This is of great value as a visual aid to developers and designers in non-computerised sectors of the footwear industry, since the 3-D print is 1:1 size or can be scaled up or down in size before 3-D printing.

In the same way, by supplying a computerised last manufacturing plant with a data set in 3-D software format, a last model can be made direct from the digital information, resulting in a much faster last making process, free from the idiosyncrasies particular to each last maker's individual level of modelling art or skill (Appendices XVI and XVII). This process should enable potential cost savings to the industry by eliminating the need for expensive experimentation with lasts. It should also enable cost savings in terms of preventing poor selling ranges due to ill fitting by digitally comparing poor fit in the computer (Figure 5.5) before actual model and prototype making. Any amendments that are then found in the actual user wear trial process can be incorporated consistently and accurately into the digital last records for future developments.

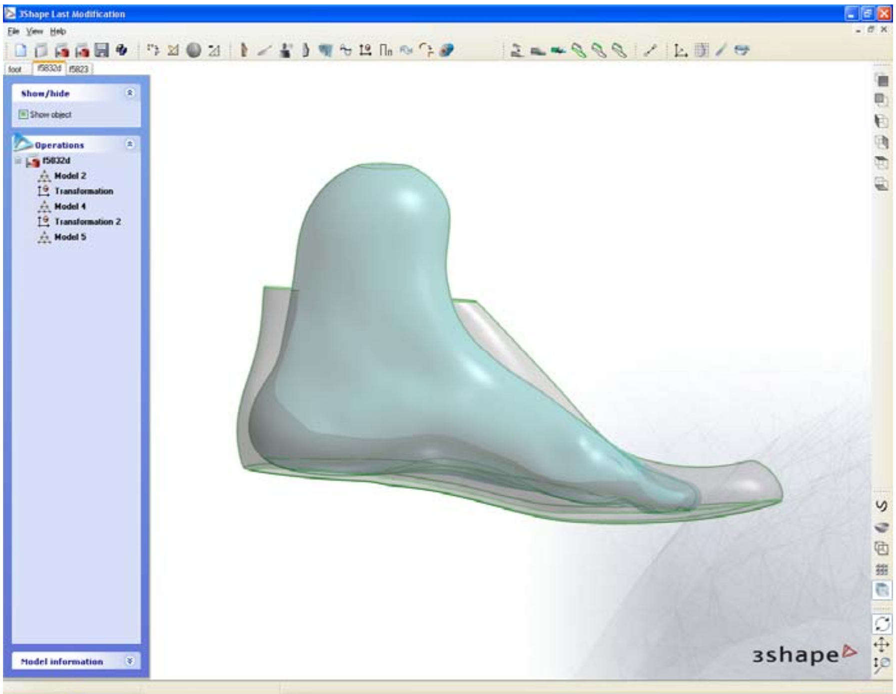


Figure 5.5: Digital comparison of foot data set to a model last

A further outcome of the study was that it resulted in the first South African post graduate podiatrist to qualify for the National Research Foundation's Technology Innovation Promotion through the Transfer of People (TIPTOP) program. The TIPTOP option represents a set of placement mechanisms to promote mobility of people participating in industry to effect transfer of knowledge from their "home" discipline to a new discipline and vice versa.

One result of the transfer of knowledge can be seen in Appendix XX in which a foot bed incorporating heel cupping and midfoot contouring was incorporated into a new sandal production for the *Soul of Africa* brand.

Another outcome of the study is that it has shown that imported footwear that is based on another population's measurements may be unsuitable for the South African female population. All possible efforts should be made to support industry in manufacturing a product specific to the population.

## 5.5 Shortcomings of the methodology

Because of the pioneering nature of this project, the amount of planning and testing that could be accomplished in the time available to complete a masters of technology study proved insufficient to predict the additional time consuming challenges that eventuated (Appendix XIV).

### 5.5.1 Research phases: time allocation versus actual duration

Insufficient provision in time was made for the unforeseen events that occurred during the project. Platform damage, laser equipment malfunction, and the delays in obtaining permission and logistical consensus from both academic and management authorities at the various data collection venues all absorbed time (see also Appendix V).

### 5.5.2 Physical ergonomics of data capture method

Because of the sample size, data collection entailed hundreds of hours during which the researcher used the equipment. Certain discomforts were experienced as a result of the data capture method, mainly as a result of the physical demands on a single operator. The limitation of standard ceiling height prevented further elevation of the measurement platform to a more comfortable level. Some physical discomforts were experienced by elderly participants due to their lesser physical ability to sustain a static posture.

These types of problems and concerns have implications for the developers, implementers and users of both the equipment and the software for future similar projects, in which it is strongly suggested that at least four persons are needed to form a data collection team.

#### 5.5.3 Design of hand-held input devices

As could be expected in a beta-test situation, ergonomic design of the hand-held input devices was not the optimum. The scanning device became very heavy to hold after a few hours of use. The push button on the stylus marker was most difficult to use – it required both a “pencil” grip of the stylus by the whole hand at the same time as an independent index finger muscle action to firmly depress the button near the tip of the stylus.

#### 5.5.4 Design of pyramid platform

In spite of being asked (as part of the procedure) whether they were comfortable before scanning commenced, some participants, notably those in the older age group (age 60 to 69) found that the posture caused some discomfort, mostly in the lower back. In some instances, to begin with, participants stated they were comfortable but shifted posture halfway through the scanning process, requiring that the process be recommenced or abandoned. The pyramid platform should be re-examined for improvement in future studies.

Where possible in future, the foam area should be masked off with a matte black cut-out, both to delimit the edge of the foam and to provide an edge to scan to. This will prevent missing data in the reverse scan remaining as an extraneous artifact after the clip procedure, requiring time-consuming manual post-processing “clean-up”.

#### 5.5.5 Impact of ergonomics on researcher

The researcher experienced dissatisfaction with the visual display since display resolution of, for example, the stylus points list, was too small to read at the required distance of two metres. This necessitated an assistant to sit at the computer terminal and call out instructions/confirmations to the researcher.

The design of the software was such that there was a lag in time before the stylus point would appear on screen (sometimes three points would appear at the same time after some lag). This often caused errors in the early stages of data collection, which, due to the pressure of participant appointments, were often only picked up at the end of a day's data collection. With practice, better collaboration and good scanning environments, this type of error became less frequent.

Ergonomic issues such as these resulted in suggestions to the software developers to incorporate such features as the use of a beep to confirm when a stylus point had been captured, in future release versions.

One of the reasons why it was not always apparent that stylus points were being distorted in 3-D space by metallic sources, was the fact that the drop-down stylus points list on the computer screen obscured the underlying scan of the foot. This required a mouse driven manipulation to move and examine the scan, with resultant time delay.

Throughout the data collection period, there was a fear of becoming "tangled" in the connecting cables. After the first equipment malfunction when it was found that the cables had malfunctioned, it became even more important to make sure that no person inadvertently stepped on the cables.

Indoor floor to ceiling height determined the height limits of the step up platform. Ideally, the step up platform should have allowed the researcher to collect data at waist level or higher to prevent lower back tension. However, magnetic interference with metallic ceiling strips had to be avoided. This resulted in a lower step up platform than ergonomically desirable. Ideal environments for scanning are ground floor double vaulted open areas, such as recreation halls or church halls.

### 5.5.6 Sample stratification

The project design called for a sample aged between 21 and 69 due to requirements from industry (see chapter 4.2.1.). However, this posed a challenge to finding groups of volunteers in the older age groups. Whereas old age homes provide easy access to measure groups of white Africans and Coloureds, it was more difficult to find old age homes for mobile and active black African, Asian, and Indian women due to their cultural tradition of having "Granny" remain within the family environment.

The current study was unable to sample subjects from the Tshivenda and isiNdebele language groups, simply because none were found during sampling in Gauteng and Kwazulu Natal provinces. Considering that a prior study (Thompson & Zipfel, 2005:26) suggested a tendency towards a narrower foot width rather than a wider foot width among subjects of Venda tribal origin, the data from this study may have been slightly altered if Tshivenda speaking subjects had been measured.

## 5.6 Future studies

The purpose of the detailed database collection is to enable further analysis of the data (see Appendix XVI), and to which subsequent data can be added. However, additional work must be carried out in order to achieve further refinements to the sizing and fitting standards for the South African female population.

Additional data that should be collected entails measuring feet at different heel elevations since it is podiatric knowledge that the medial longitudinal arch shortens on heel elevation. What has not been documented in the South African female population is by how much the arch shortens, according to whether the foot is a low arched foot or a high arched foot.

Future work should also explore the relationship of the medial longitudinal arch to the other 3-D foot dimensions and inherent foot geometry.

The method developed in part one of the study will enable other research teams in future to measure the male population as well as children and adolescents.

## 5.7 Future directions for industry

As designed in the study, and mindful of the disparities that exist in technological tools available within the footwear industry, aspects of the data can be used by both computer enabled factories as well as those that are not yet computer enabled.

Data can be incorporated into computer aided 3-D design systems for manufacture of lasts by footwear industry members that are 3-D computer enabled. Manual incorporation of data can be used by footwear SMME's whose design and manufacturing processes are not 3-D computerised, by means of hardcopy prints of a variety of foot scan views (Appendix XIX) via modelling software in conjunction with a screen capture software program.

The data (by ethnic group) may be combined with national census figures, as a subsequent study, to determine production types and figures by regions.

Modelling of the female foot at different heel elevations, and incorporation of data from current research work on pressure studies of the foot, will yield new ergonomically superior footwear designs that will fit and function better.

## 5.8 Concluding remarks

A cornerstone of podiatric training, when confronted by pathology, can be summed up in a single sentence… "*Find the cause and eliminate it*". For podiatrists who treat the intensely painful, disfiguring and often permanently crippling effects of wearing footwear that is not matched to the feet of the users, this can be a daunting task.

In the case of women's foot pathologies, it is acknowledged that there are enormous social, gender and psychological pressures to wear fashion footwear, often in disregard of whether the shoe fits. Compounded to this is the fact that when pathology sets in, conventional podiatric treatment measures often require finding footwear that has enlarged dimensions in order to accommodate the internal placement in the shoe of corrective inserts, or to accommodate therapeutic padding and strapping. Footwear that has these over-enlarged dimensions is often devoid of cosmetic appeal, even earning the name “orthopaedic footwear”.

In South Africa, the absence of measurement consensus and absence of comprehensive 3-D data for the manufacture of women’s footwear makes it imperative to address the need for population specific accuracy in last manufacture. This study has shown that it is possible to make a product that is cosmetically appealing yet is population specific in its 3-D form.

This represents a step forward in closing the gaps of knowledge regarding foot morphology in populations around the world.

The completion of this study comes at a time when local footwear production has fallen since 1990 from almost 55 million pairs to some 15 million pairs. Over 20,000 skilled jobs have been lost (Linde, 1999; PACSA, 2005).

Footwear production globally has shifted to Asia, whose ethnic populations possess different foot morphology to those on other continents. Footwear originating from outside South Africa, if not produced according to population specific measurements, can be harmful.

There is a growing concern highlighting the confusion between the five main sizing systems (North American, British, Continental, Japanese and Chinese) with other populations breaking away to create their own sub-versions (Australia, Ukraine).

With the completion of the core database on women’s foot measurements in South Africa, industry now has the data to be able to refine the locally manufactured product to more accurately fit the needs of the population. This becomes a competitive edge that can assist industry to recoup losses sustained in recent years, provided that this is accompanied by education at all levels within trade, industry, government, medical and public sectors.

The outcomes from this study have already begun to facilitate a better relationship between lasts and the target market's feet, enabling a better optimum-fit coverage. The key will be future public education, commercial marketing and implementation, supported by government policy and fair trade practices and not only within the policy of national reconstruction and development.

Podiatric research into accuracy of shoe fit has the potential to increase workforce productivity by decreasing footwear-related foot pathology due to poor fit and thus poor function. This will impact on the cost of national productivity as well as the cost of medical care.

Long-term results are anticipated in terms of benefits to the female population in terms of comfort and fit, decrease in footwear-caused pathologies, as well as monetary benefits to local trade and industry by the manufacture of a product made for its market. Improvements in fit may enable industry to reach more of its market and offer a competitive edge to the South African Industry, not only locally but to the rest of the export African market.

It is hoped that an educated consumer will create demand that will drive production and this, in turn, will create employment, growth and more revenue.

However, more than ever before, it is critical that further quantitative studies of foot morphology and internal 3-D geometry are correlated to biomechanical foot function within footwear. At the same time, the footwear industry globally needs to develop common ground to undertake consistent, comprehensive and globally standardized methods of measurement, sizing, design and manufacture.