한국운동역학회지, 2002, 제12권 2호, pp. 319-330
Korean Journal of Sport Biomechanics
2002, Vol. 12, No. 2, pp. 319-330

Last's biomechanical function changes analysis for Marathone shoes last development

박승범*·서국웅**·김용재***·유석주****, 이중숙*****

ABSTRACT

A toe spring and ball girth data ,when marathone shoes research, development, and production in Korea, is a important point in athlete shoe research. It is clear from the results presented that any differences between MA3 and MA1, MA4 in 70%. 80% session in forepart last comparision. Especially the more 70%-80% session getting wide, the more 90% session getting up. Also, To development for high performance marathones shoes last, in all session, in korean style, 70%, 80%, and 90% session part function changed. It is suggested that comfort of fit is largely determined by the match of last shape to shoe shape and consequently there is a need for normative last data that desribe foot, last shape, dimension. This leads to the conclusion that unique shoe lasts for both marathone shoes developmented last comparison are required for optimal marathone shoe comfort. The more ball girth construction will wide in forepart in last, the more comfort characteristic will development. But relative with performance ability, it is need to research. The further study of Korea marathoner forefoot measurements(70% session ~ 90% session) among toe spring's angular difference of marathone last to north american and Korea marathone shoes last is required to develop and improve athletes performance in an effective way of study and to prevent forefoot injury.

key words : Last, biomechanical function, Marathone shoes

본 논문은 2002 한국운동역학회 추계학술대회에서 최우수 논문상을 수여한 논문임.
2002년 11월 8일(금) 접수

* Corresponding author, 대학원 박사과정, 609-731 부산시 금정구 장전동 산30, 부산대학교 체육학과 대학원
연락처 : sbpark2@pusan.ac.kr, Tel : 011-214-1627
** 교수, 609-731 부산시 금정구 장전동 산30, 부산대학교 사범대학 체육교육과
*** 교수, 608-737 부산시 남구 대연3동 599-1 부경대학교 자연과학대학 해양스포츠학과
**** 차장, 607-060 부산시 동래구 온천동 1428-34 호성빌딩 7층 필라코리아 신발기획부 내수개발팀
***** 교수, 617-736 부산시 사상구 괘법동 산 1-1번지 신라대학교 자연과학대학 체육학부

I. Introduction

In modern society, sports have become religion and sporting equipment objects of devotion. Sports technology now pushes both professional and recreational athletes to levels of performance only recently thought to be insurmountable.

Today, athletic shoes evoke a fascination with power and style not unlike previous generations' obsessions with cars. Marathone shoes is the most important part of the athlete's equipment. In terms of footwear, it may also represent the highest form of the art of shoe making. Synonomous with its true international image and participation, the evolution of the running shoe has had contributions from many parts of the world. Technical progress in running shoes has been largely confined to the three countries that monopolize sports footwear at the present - Germany, Japan and the the United Stares. Progress in marathone shoe development and technology has taken runners through the vulcanized rubber flat-soled era of the mid-1800s, to the leather training shoes of the 1950s and 1960s, to our presentday nylon, rubber and polylefin conbinations. In this way the popularization in the late 1970s of the accient and fanatically traditional sport of running led naturally to the commercialization of a formerly small, craft-oriented athletic shoe industry. Because athlete shoes do deupon on function for credibility, shoe construction must yield optium performance. Most of the major method of shoe construction are also used in the manufacturing of functional sport shoes. In the process of manufacturing any athletic shoe, all upper work is done around the "last"- a three-dimensional form based upon the shape and movements of the foot. The last, therefore, determines the shape, size and dimensions of the shoe. To help accommodate variations in foot shape, which occur with different movements of the foot leg during sports activities, the last is designed with several special features. The two major ones are the Toe Spring and Heel Pitch, which affect the rocker or pivoting motion of the foot, particularly important in shoes.

Research and development with respect to the design and function of sport shoes in the past two decades have centred upon the sole to last. The centerpiece of the shoe, the last, draws relatively little attention. This may be due to the complexity of the problems involved or to the fact that the development of the shoe last lies almost entirely in the hands of companies who do not like to share their experiences with others too openly.

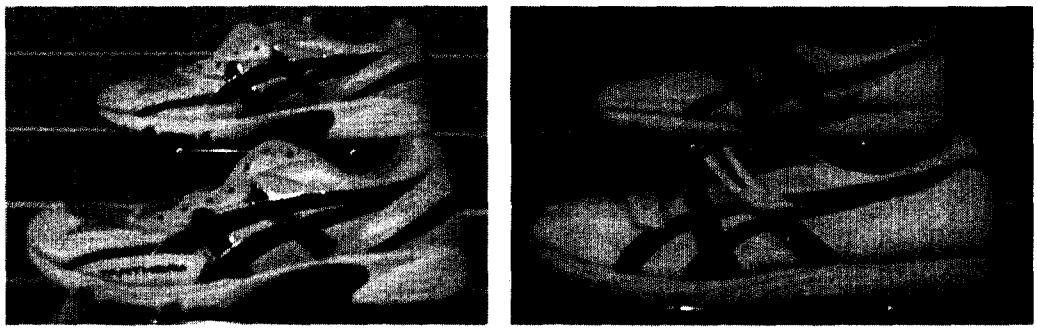
The word last originates from old english 'laesk', which means sole, footprint, or track. The first lasts were chiselled out of stone, and later, whittled out of wood. In the early 19th centry, the machine for shaping gunstocks was converted to become a last-turning lat(Rossi, 1980). Thus

it was possbible to form a last with a mchine, and the first last-making plant with lathes was established in Lynn, Massachusetts, in 1820. In 1969, the plastic last were developed by the Sterling Last Corporation, U.S.A. The form of the last has been a reason for complaints for centuries. The Greeks describes injuries which came from wearing shoes. Camper complained in 1783 that the same lasts were used for right and left shoes and hoped that his 'mockery' would help to improve the shoes. But the same 'straights' last were used until the end of the 19th centry. Von Meyer's shoes looked inflared or curved in comparison to the straight lasts that were used at that time. This started an argument about straight or vurved lasts which still continues today, although today's straight last has nothing to do with the straight last of the 19th century. When aligning the rearfoot of different running shoes(Cavanagh, 1980), even today's straight last looks curved. However, when connecting the two ends of the shoe sole with a line(toe-to-heel line), today's straight last 'looks actually straight'. Cavanagh(1980) suggested that the difficulty of explaining these curved or straight shoes lies in 'that the foot print resembles and inflared shoes, while the foot outline von Meyer's standard on today's shoes and find that probably none of these shoes would pass.

A marathone shoe must fit not only in overall length and ball width, but with respect to several other such as the instep, arch, top lines, and heel and toe curve. Each of these can be measured, but vary depending on the type of footwear, for example, jogging shoes, racing flats, fashionable shoes, and so on. Various small but important features are built into a last, for example, the toe spring and heel spring. The toe spring(often around 5mm) allows a slight rocking effect during take-off. It has to be carefully calculated, but in general, the higher the feel or the thicker the midsole, the more toe spring is required. The 'comfort of fit' characteristic has not been subjected to any great scientific scrutiny and largely been left in the hands of the last master, a highly skilled model maker who relies on and artistic sense of shape, size and proportion. Comfort of fit is arguably the most important aspect of sport design. Certainly, it is a major factor in the decision to purchase a praticular pair of shoes it is evident that good comfort of fit characteristic with mitigate against many common abrasion and pressure related foot conditions that often characterize the use of new shoes(Nigg et al 1986).

Examination of those elements that characterize comfort and fot suggestes that one of the most important factors is the closeness of match of the shoe shape to that of the human foot, while recognizing that foot shape will vary under different conditions of load, motion and himidity. Shoe shape is determined by a 'last' which can be thought of as a smoothed model of the foot around which the 'upper' material is stretched and stitched or glued to the sole fo the shoe

giving ti permanet shape. The match of the axis of the foot across the ball to to the axis of flex fo the shoe is a second important consideration for comfort of fit. The purpose of this study is to a Last's biomechanical function changes analysis for Marathone shoes last development, for design marathone shoes of the 'highest' quality. This research was supported by the Fila Korea, Hwaseung Co and Sunhyung Last Co.

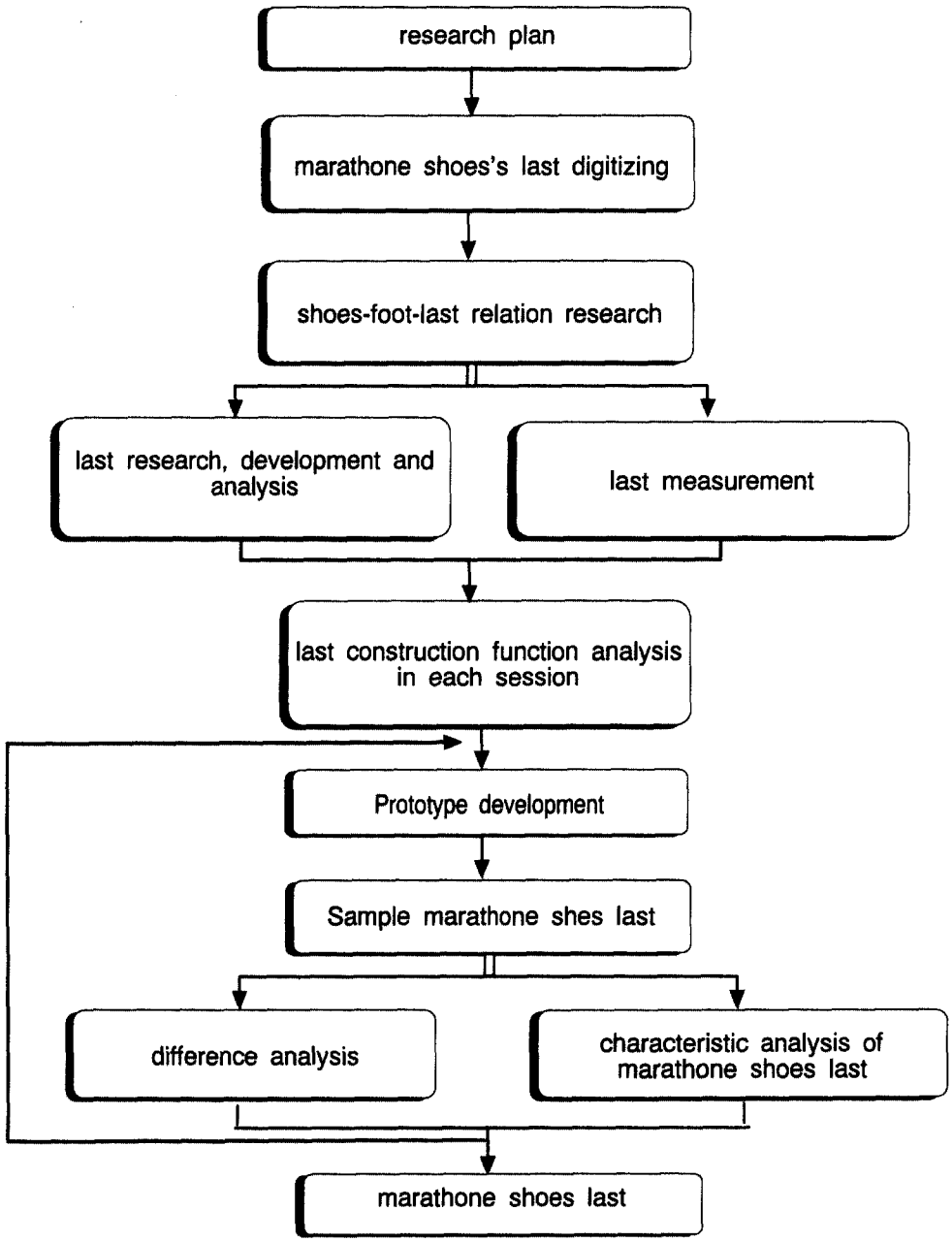


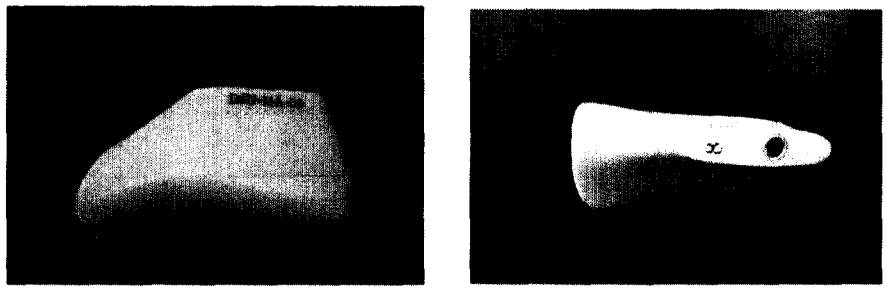
(A) (B)

Fig. 1. Marathone shoes (ASICS, 2000)

Fig. 2. ASICS Marathone shoes Outsole, Midsole, Upper(1993)

Ⅱ. Method


research plan
marathone shoes's last digitizing
shoes-foot-last relation research
last research, development and analysis
last measurement
last construction function analysis in each session
Prototype development
Sample marathone shes last
difference analysis
characteristic analysis of marathone shoes last
marathone shoes last



(last sideview) (last)

Fig. 3. Marathone shoes last

Ⅲ. Results & Discussion

4 different marathone shoes's last measured by the 3 dimentional digitizer. The 4 samples anr shown(table 1) to be similar in stature.

Table 1. Marathone Shoes Last Comparison (unit : mm)

	%	10%	20%	30%	40%	50%	60%	70%	80%	90%	length
MA1	mm	27.5	54.9	82.4	109.8	137.3	164.8	192.2	219.7	247.1	274.6
	height	101.0	100.9	100.3	102.5	90.9	68.9	49.3	37.7	31.6	
MA2	mm	27.6	55.3	82.9	110.5	138.2	165.8	193.4	221.0	248.7	276.3
	height	99.6	99.6	99.6	102.0	90.0	68.8	50.5	38.3	32.0	
MA3	mm	28.6	57.3	85.9	114.5	143.2	171.8	200.4	229.0	257.7	286.3
	height	99.6	96.8	96.3	96.5	85.8	72.8	53.1	37.7	28.9	
MA4	mm	27.4	54.8	82.2	109.6	137.1	164.5	191.9	219.3	246.7	274.1
	height	117.2	117.2	115.0	101.4	82.7	74.4	55.3	38.4	30.4	

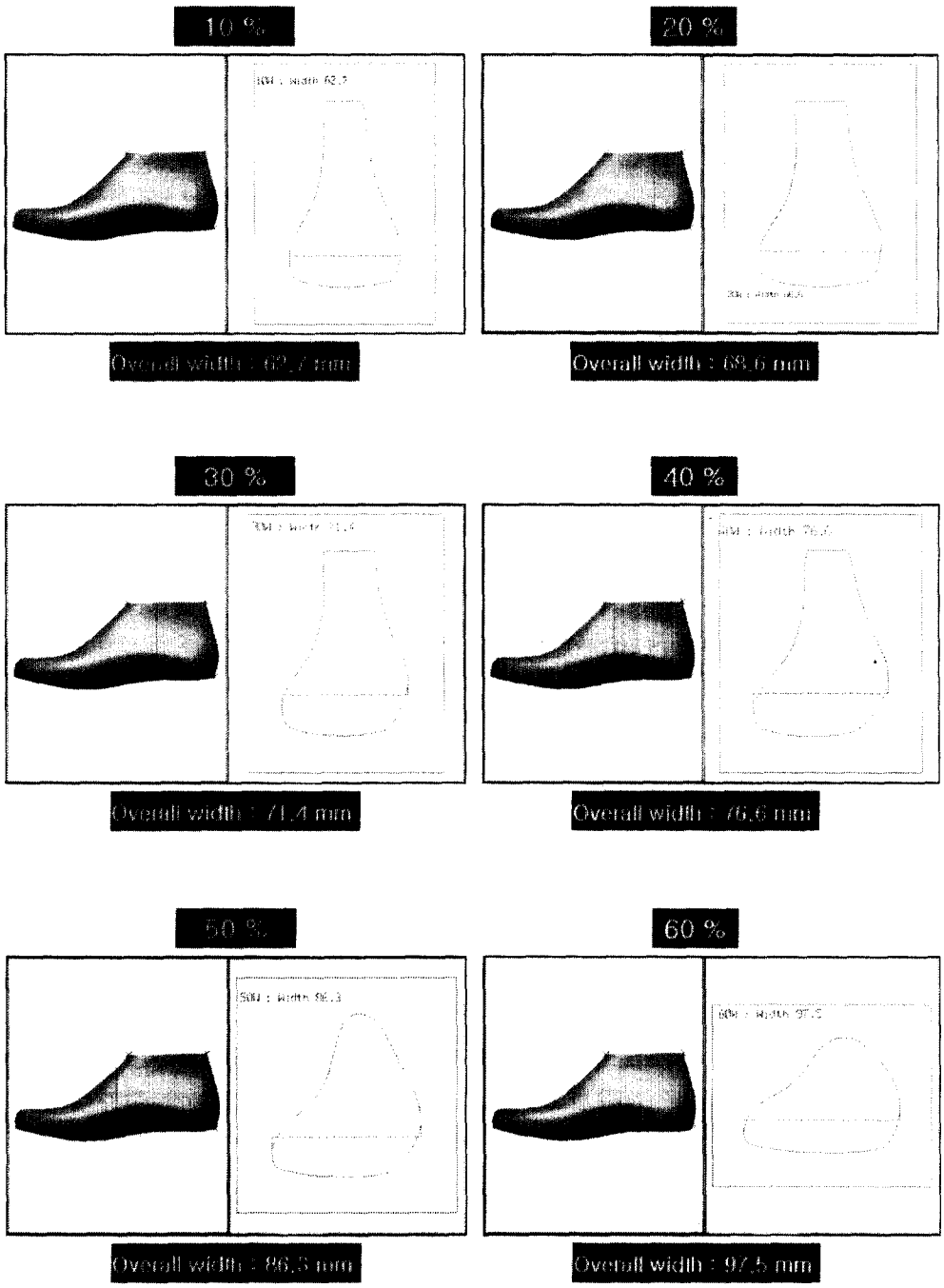


Fig. 4. A each session comparison in marathone shoe last

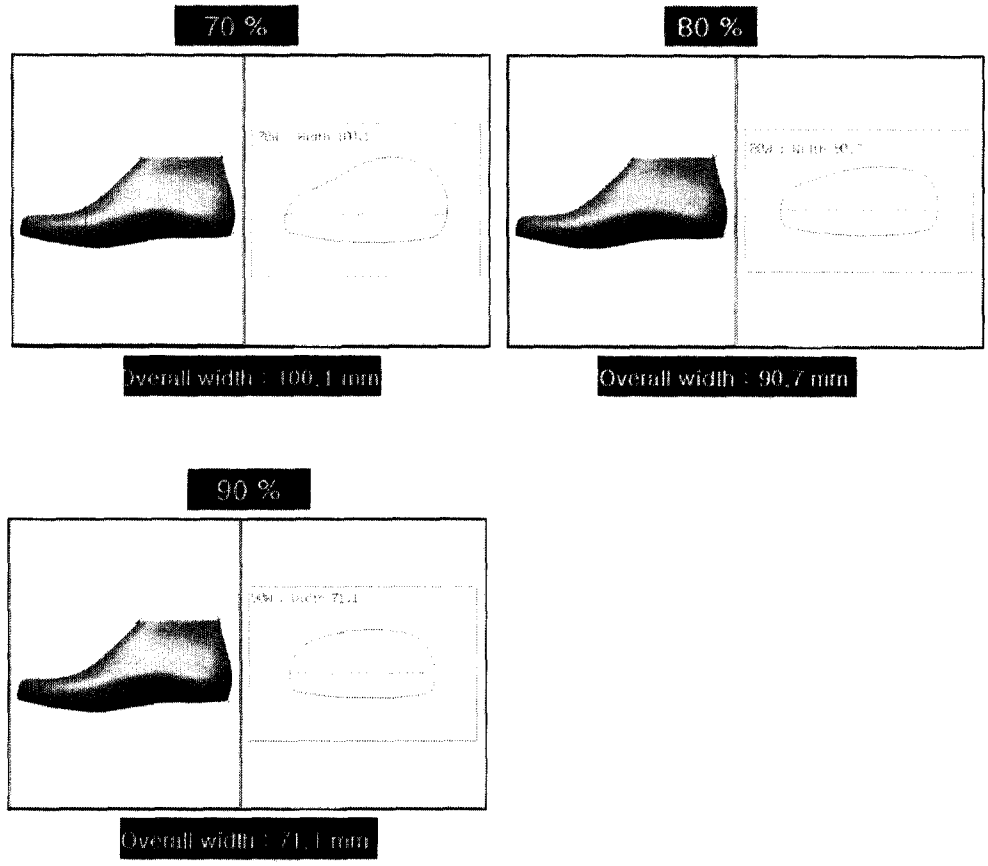


Fig. 4. A each session comparison in marathone shoe last

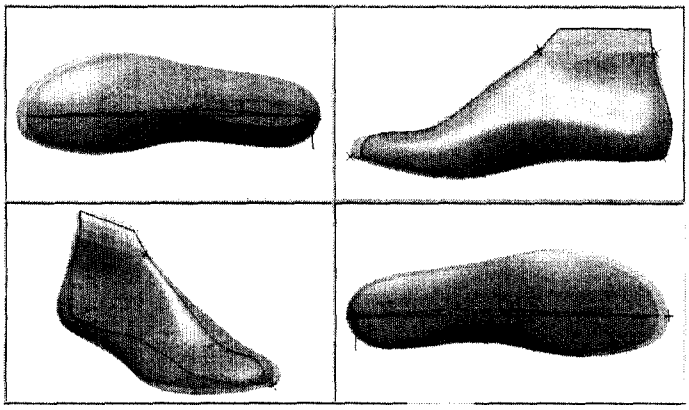


Fig. 5. determination of measuring points for marathore last

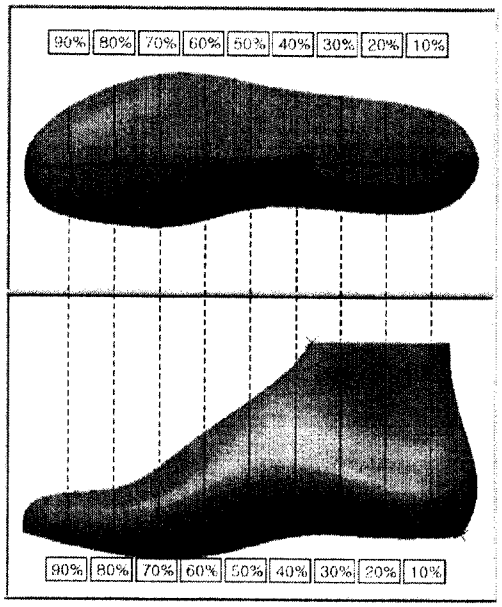


Fig. 6. marathone shoes last in each session

All of the measurements needed for developing lasts should be checked to determine whether they can be standardized. The most important areas of standardization are the heel, the contours of shank, the shank spring, the curvature of the heel seat, and the cross section of the heel seat

In modern shoe production, shoe lasts have to be standardized and coordinated if best results are to be obtained from certain manufacturing machines. Combining shoe component sizes in groups cuts down the cost in production. We recommend taking advantage of the experience of last and shoe-component specialists and advise against attempting to develop coordinates independently and with insufficient know-how. The following table and illustrations are only examples of possible introduction of Last norms. In section comparion, considering 705, 80% relative with flexibility in last, shown 100.1mm in 70% session(overall width), 90.7mm in 80% session80%. MA-2 was shown 101.0mm in 70% session, 91.6mm in 80% session. MA-3 was shown 95.2mm in 70% session, 88.7mm in 80% session. MA-4 was shown 92.5mm in 70% session, 83.8mm in 80%session. The first test battery in 1977 included five objective evaluations : heel shock absorption, forefoot shock absorption, upper durability, sole durability, and forefoot shock absorption, upper durability, sole durability, and flexibility. Both the regulat shoe industry and athletic shoe companies ahve used flexibility testing for many years. The flex path in the forepart of the shoe is an important feature.

Nike marathone last was shown in table 4(heel height :34mm, toe spring : 8mm, sock lining : 4mm, bottom width grade :1/12) indicate that althought there were statistical differneces between.

Mizuno last was shown(270size) in table 5(bottom length : 270, bottom width : 91.4, stick length : 281.2, 60-70% ball girth : 256, toe thickness: 27.6, toe spring : 24.6)

The major factors affecting shoe flexibility are : materials used in the sole/midsole construction, outer sole pattern, the amount of toe spring in the last, the lasting method and upper design.

For testing flexibility, the shoe is mounted on a hinged platform or on two separate platforms with both the rear and front portions clamped to the testing jig under a flxed amount of pressure.

The shoe is carefully aligned with the flex point positioed at 60 percent of the distance from the heel to the toe. Different options exist as to the orientation of the flex path relative to the long axis fo the front portion of the shoe. Some tests use a right angle while others have tried to establish an angle more compatible with the alignment of the metatarsal heads. In either case, once positining is completed, the shoe is repeatedly flexed with some sort of cam and push-rod mechanism to a fixed angle(usally between 10 and 45 degrees) for a number of cycles.

V. Conclusions

A toe spring and ball girth data ,when marathone shoes research, development, and production in Korea, is a important point in athlete shoe research. It is clear from the results presented that any differences betwen MA3 and MA1, MA4 in 70%. 80% session in forepart last comparision. Especially the more 70%-80% session getting wide, the more 90% session getting up. Also, To development for high performance marathones shoes last, in all session, in korean style, 70%, 80%, and 90% session part function changed. It is suggested that comfort of fit is largely determined by the match of last shape to shoe shape and consequently there is a need for normative last data that desribe foot, last shape, dimension. This leads to the conclusion that unique shoe lasts for both marathone shoes developmented last comparison are required for optimal marathone shoe comfort. The comfort fo fit characteristic has not been subjected to any great scientific scrutiny and has largely been left in the hands of last master.

The more ball girth construction will wide in forepart in last, the more comfort characteristic will development. But relative with performance ability, it is need to research.

The further study of Korea marathoner forefoot measurements(70% session ~ 90% session) among toe spring's angular difference of marathone last to north american and Korea marathone

shoes last is required to develop and improve athletes performance in an effective way of study and to prevent forefoot injury.

Acknowledgement

This research was supported by the Fila Korea, Hwaseung Co and Sunhyung Last Co.

References

노민희등(1994). 인체해부학, 고문사

대한체육회 스포츠과학연구소(1987). 달리기용 운동화 개선을 위한 연구 (한국과학기술원 스포츠과학 연구과제 종합보고서 II). pp. 163-236.

한국 신발, 피혁 연구소(1998), 스포츠화용 일체형 Sole 개발, pp. 295-297

한국신발연구소(1996), 마라톤화용 기능성 Sole 소재 개발, pp. 1-10

산업자원부(1998). 산업디자인을 위한 한국인 인체측정 및 활용 기술개발에 관한 연구(A Study on the Human Measure of Korean and Practical Use for Industrial Design). pp. 8. 62~67, 139, 220

이종각등(1992). 마라톤과 운동생리학. 한국체육과학연구원. pp. 313-320.

코오롱상사(1995). 신발과 인체공학. pp. 37~42

E.C.Frederick, T.E.Clarke and C.L.Hamill(1984), The effect of Running Shoe Design on Shock Attenuation」., In : E.C.Fredrick(ed) , Sport shoes and playing surfaces, Human Kinetics, Champaign, IL.

Martyn Shorten(1999), Biomechanically Driven Developments in sports shoe technology: the example of tuned air, In E. M. Hennig & D. Stefanyshin (Ed.), Fourth Symposium on Footwear Biomechanics, Canmore / Canada:

Melvyn P. Cheskin, Kel J. Sherkin, Barry T. Bates(1987). The complete handbook of athletic of Footwear, New york, Fairchild Publications. pp. 311~319, 173~199, 287~295

Michael R. Hawes, Daniela Sovak, Mitsumasa Miyashita, Sang-Jo Kang, Yasuo Yoshihuku and Shiro Tanaka(1994), 「Ethnic differences in forefoot shape and the determination of shoe comfort」, Ergonomics, Vol. 37, No. 1., pp. 187-188

P. Freychat, N.Bouche(1999), Dynamic arch deforamtion and its consequence on shoe design, In E. M. Hennig & D. Stefanyshin (Ed.), Fourth Symposium on Footwear Biomechanics, Canmore / Canada

Peter R. Cavanagh(1980). The Running Shoe. Anderson World, Mountain View, CA.

Praxmarer, N. (1994). Measurement of Foot Stiffness Distribution and Computational Simulation of Plantar Pressure Distribution. Symposium on The Biomechanics of Functional Footwear, Eighth Biennial Conference of the Canadian Society of Biomechanics

Sadayuki Ujihashi(1997), Method of Measure and Evaluation for the Mechanical Characteristics of Running Shoes, Basic Science and Engineering Vol. 1. No.1, pp. 271-277