# The Liberation of the Feet: *Demaking* the High Heeled Shoe for Theatrical Audio-Visual Expression

Alexandra Murray-Leslie
Creativity and Cognition Studios
University of Technology Sydney
PO Box 123 Broadway
2007 NSW Australia Alexandra.N.Murray-Leslie@student.uts.edu.au

Andrew Johnston
Creativity and Cognition Studios
University of Technology Sydney
PO Box 123 Broadway
2007 NSW Australia
andrew.johnston@uts.edu.au

## ABSTRACT
This paper describes a series of fashionable sounding shoe and foot based appendages made between 2007-2017. The research attempts to *demake* the physical high-heeled shoe through the iterative design and fabrication of new foot based musical instruments. This process of *demaking* also changes the usual purpose of shoes and associated stereotypes of high heeled shoe wear. Through turning high heeled shoes into wearable musical instruments for theatrical audio visual expressivity we question why so many musical instruments are made for the hands and not the feet? With this creative work we explore ways to redress the imbalance and consider what a genuinely "foot based" expressivity could be.

## Author Keywords
Sounding footwear, practice based research, wearable technology, fashion, performance art, new instrument design, demaking

## ACM Classification
H.5.2 [Information Interfaces and Presentation] User Interfaces – Prototyping, J.5 [Arts and Humanities] Performing arts (e.g., dance, music).

## 1. Introduction
We can use our feet for more than just walking around and some people actually develop "extraordinary dexterity with their feet, not only using them to do everyday tasks, but even activities like painting or playing an instrument" [1]. Through training, it is possible for the feet to carry out complex creative tasks, beyond their normal everyday job as 'stepping machines' [2]. Ingold suggests that a more grounded approach to the way we move as humans can open up new terrain in the area of embodied foot-based skills. We explore the development of these skills in the area of audio-visual performance and the related creation of audio-visual instruments created specifically for the feet.

The subject of bias against the feet was adopted by surrealists in their work, such as French philosopher Georges Bataille, who explored the conflicted relationship humans have with their feet in "The big Toe" [3]:

> "The play of fantasies and fears, of human necessities and aberrations, is in fact such that fingers have come to signify useful action and firm character, the toes stupor and base idiocy" [3].

Such attitudes towards the feet, explain perhaps why so little care has been taken to create shoes that are good for the feet and do not restrict, deform or torture them.

If shoes are able to deform and pain our feet, then this un-free experience will affect a performer's sensory perception and influence their actions on stage. With more sensorial experience, the feet will be in a more expressive state. Shusterman's proposal of somaesthetics [4] describes the beauty of experiencing one's own body and to aesthetically pay attention to it, which will lead to a greater level of well-being and overall ability. We suggest, the "aesthetic experience" [4] of the body can also be focused on the feet, a possibility we have explored through the creation and use of a series of computer enhanced shoes and foot appendages, in different modes of performance. The aim is to find out which foot-wearables and context will best provide radical novelty in footwear design coupled with sound and movement.

The feet have also been neglected in the field of new interfaces for musical expression, with most musical instruments being designed for the hands. NIME tends to focus on practicalities for musical instruments, but we argue that fashion is another area which brings a rich history and range of techniques to bear. The appearance of a wearable instrument along with the social resonances of fashion objects such as high-heeled shoes brings another dimension to instrument design that we believe has been neglected. Performers feet and shoes are rarely seen on stage, often obscured by fold back monitors and other equipment. In order to address this imbalance and find new avenues for creative expression we seek to bring attention to the audio-visual expressivity of the feet with fashionable self made musical instrument shoes and temporary appendages.

## 2. Background
The literature shows that shoes have important cultural, religious and social significance [5]. The creative practice presented in this paper, undertaken over the last 10 years, draws on aspects of this understanding of shoes in our society. This project explores the creation of bespoke, footwear-based musical instruments for use in live-art performance, opening up new cultural and creative dimensions of footwear. We liken the process to "demaking" the high heeled shoe in order to give it a new purpose and create new experiences for the wearer. This builds on the traditional uses of footwear as a means of protection, status, fetish object or one with religious overtones (such as the pope historically wearing red shoes).

Deleuze discusses the notion of changing the purpose of the hands to the feet. The below quote summarises how this can result in the 'composition' or rearrangement of, "the overall assemblage" [6], which we term "Demaking" the original artifact. Deleuze's character Slepian gets the idea of using shoes to change his identity to a dog using the artifice of shoes.

> "If I wear shoes on my hands, then their elements will enter into a new relation, resulting in the affect or becoming I seek. But how will I be able to tie the shoe on my second hand, once the first is already occupied? With my mouth, which in turn receives an investment in the assemblage, becoming a dog muzzle, insofar as a dog muzzle is now used to tie shoes. At each stage of the problem, what needs to be done is not to compare two organs but to place elements or materials in a



*NIME'17,* May 15-19, 2017, Aalborg University Copenhagen, Denmark.

relation that uproots the organ from its specificity, making it become "with" the other organ" [6].

Macfarlane suggests "we don't intuitively imagine the foot to be an expressive or perceptive body part, it feels more of a prosthesis, there to carry us about, rather than to interpret and organize the world for us. The hand always out skills the foot: We speak of manipulation but not pedipulation" [7]. T.Hashimoto et al. [8] indicate that early hominids developed finger dexterity and tool use ability before the development of bipedal locomotion, further supporting ideas that the hand developed finger control for tool use, vs the big toe evolved for balance and bipedal locomotion. This could explain the lack of focus on feet and their tools, and the comparative lack of recognition of the foot being able to carry out complex tasks like playing a musical instrument. We could also say that the deeply enculturated bias towards the hands has, perhaps, led us to prioritise *manual* (hand based) dexterity and control in creative and expressive practices such as music and art.

## 2.1 Shoes and Sound

Tap shoes, also known as character shoes, are perhaps the best-known popular example of using shoes to make sound. Tap dancing emerged from the dances of African-American slaves in the seventeenth and eighteenth centuries, blending dance with percussive sound to make a distinct art-form with its own rich and complex range of practice.

### *2.1.1 Computational Footwear*

Technology enhanced examples include the sound producing dancing shoes by J.H. Smith, (1930) or the world's first wearable computer on a belt attached to a shoe by Edward Thorp in 1961 [9]. The foot and its modified shoe were also an input device for a system to beat Roulette. The invention comprised of Twelve transistors, and a cigarette-pack sized computer which was fed data by switches operated by the big toes. One switch initialized the computer and the other was for timing the rotation of the ball and rotor. The computer predictions were heard by the computer wearer as one of eight tones via an earpiece.

Joe Paradiso and Eric Hu made *Expressive Footwear* in 1997 [10] using a commercially manufactured Capezio 'Dansneaker'. Later they created the "Cyber Shoes" [11] with circuits mounted on the side of the 'Nike Air Terra Kimbia'-chosen because they matched the costumes they had chosen for choreographers. *Expressive Footwear* functioned primarily as music controllers to drive synthesizers during computer-augmented dance performances [10]. The shoes themselves were store bought and then modified - the focus being on the use of the shoes as controllers rather than on the aesthetics of the footwear as a fashion object.

More recently, mappings for gestures for foot-input systems used in augmented reality, mixed reality and virtual reality are many and varied. For example, *ShoeSoleSense* [12] is a wearable foot interface for real and virtual environments which uses pressure sensors mounted in an insole to enhance regular shoes.

Contemporary uses of shoes as sounding devices include Nike's music shoes from 2010, which were featured in a promotional video for the launch of their flexible free run+ running shoes. The models featured were Nike sneakers which had flex sensors and accelerometers embedded in the inner soles. The shoes were played with the hands.

Ricardo O'Nacsimento from POPKALAB, together with Phonotonic and Stephane Gontard created *Sound Steps*[1], a pair of multi-tech shoes in 2015-16 that allow the wearer to create sounds and music through their own movements, such as heel strikes triggering one-shot samples. The device enabled the wearer to create sounds that were broadcast through an inbuilt speaker, synchronised with foot movements, changing the sound of footsteps through a bank of preset sound loops. The technology was hidden inside a large added "tongue" above the shoe laces on a design that resembles Adidas "originals". The shoes are activated by the wearer's movements in contact to the ground, like modern tap shoes in a sense. The shoes were made as prototypes and featured in the fashion film *Sound Steps* in 2016.

Converse's Chuck Taylor All Stars and music have always had a connection, with music groups like the Ramones in the 70's and 80's or Nirvana's Kurt Cobain in the 90's making the shoe part of their signature style. Converse created the *All Wah* first in 2013 with Critical Mass and later with Cute Circuit in 2016. The *All Wah* uses a gyro sensor to measure the toe of the shoe going up and down in the air. The motion data is sent via Bluetooth to a Wah Box effect applied to a guitar. Again the design of the shoe was not altered much from the original Chuck Taylor sneaker, a new type of sneaker wasn't developed around the technology – the electronics were simply hidden in the sole of an existing design. These sneaker-based instruments are not really capable of being musical instruments in the traditional sense, but rather act as acoustic accessories or sound effects added to the movements of the wearer.

### *2.1.2 Shoes for Performance*

A key example of shoes being modified to affect the movement and height of a performer are the shoes conceived by May West (see figure 1).

**Figure 1. Mae West's "Double Decker" heels, 1950's, image courtesy of FIDM archive, Los Angeles, 2016.**

These 9.5-inch, "Double Decker" customized shoes feature a top-set platform designed to be hidden by a skirt hemline. They changed the meaning of the original high heeled shoe and its functionalities.

# 3. MUSICAL SHOE INTERFACES TO LIBERATE THE FEET IN PERFORMANCE 2007-2017

The 'liberation of the feet' we are pursuing in this work is about turning stereotypes associated with high heeled shoe wear upside down by developing new playing styles and designing new physical types of computer enhanced shoes and temporary appendages.

[1] *Sound Steps*: https://vimeo.com/148461186

## 3.1 *We Don't Play Guitars*: Song, Instruments and Playing Styles (2007)

The song, *We Don't Play Guitars*, written and performed by *Chicks on Speed*[2], parodies (male) 'guitar hero' oriented rock bands and performances. The first musical shoe interface, the *High Heeled Shoe Guitar* (see Figure 2), was created to use on stage during performances of this song[3]. This deliberately lo-fi instrument was based on a ready-made shoe purchased from fast fashion store Zara which was retrofitted with a pickup, mono jack output and guitar strings.


**Figure 2 . *High Heeled Shoe Guitar* by Alex Murray-Leslie (Chicks on Speed) commissioned by Contemporary Art Centre, Vilnius, Lithuania. Photo Gilmar Ribero, © Chicks on Speed, 2007.**

Carrie Smith-Prei and Maria Stehle argue that the *Chicks on Speed* use the *High Heeled Shoe Guitar* to provoke and upset established socio-political structures. In this case, the intended use of the high heeled shoe is hijacked, and is given a new purpose and meaning as a musical instrument for the feet [13].

> "Their High Heeled Shoe Guitar offers an example of their mixed media approach to fashion, art and music. A lady Gagaesque shoe that appears in some of their performances & exhibits is musical instrument, fashion and fetish object & art and sculpture in one….the shoe guitar wilfully combines (high) fashion and design in a different function, here to become an instrument that is closely associated with a history of rebellious self-expression…" [13].

In performances the high heeled shoe guitar is played using readymade Fender or Marshall amplifiers, so as to create a direct visual link to a certain rock/metal pose (guitar solo) associated with some types of 'authentic' guitar playing. Alexandra Murray-Leslie wanted to disturb this image by creating an alternate one (using a high heeled shoe as a guitar) and support this notion of questioning the male guitar solo pose, by also developing an upside down playing style called "Head over Heels" (see Figure 3).

Charles Darwin in The Descent of Man, "drew particular attention to what he called the 'physiological division of labour' by which the feet and hands came to be perfected for different but complementary functions, of support and locomotion on the one hand, and of grasping and manipulation on the other" [2]. By performing with the shoes and feet inverted, we question this notion by playfully 'empowering' the feet with their own musical tool for creative expression.

It is interesting to note the order in which each element of the *We Don't Play Guitars* scene was created. First came the song, then the high heeled shoe guitar as purpose-built instrument, followed by the playing style "head over heels". All the elements - song, instrument and choreography - support the overall creative concept. The instrument becomes more than just a conduit for pure sonic expression, and becomes part of a larger overarching oeuvre or gesamtkunstwerk (all encompassing art work).

**Figure 3. Performing "Head over Heels" with the *High Heeled Shoe Guitar* and *Computer Enhanced Footwear*, Chicks on Speed live. Top left: *The Fashion World of Jean Paul Gaultier,* National Gallery of Victoria, 6th Feb, 2015. Image top right: Volksbuhne, Berlin, 31st January, 2016. Image bottom: Pohoda festival, Slovenia, 7th July, 2016.**

The high heeled shoe guitar provided a surprise spectacle on stage, and was certainly a novel musical instrument but it was, of course, limited as an instrument as it only had three short strings, which meant the range of pitches available wasn't widespread and it ended up being used with a chain of guitar effects pedals to enable it to create more diverse sounds. With seven analogue guitar pedals attached (pitch, reverb, delay, looper, ring modulation, distortion and modulation) it is useful in an improvisational session with other instruments, adding an unpredictable and surprising element when played alongside more traditional instruments such as analogue drums, trombone and saxophone. When played upside down, plucking the strings, with the shoe being hit and dragged across the front of the guitar amp (see Figure 3), it made powerful and distorted sounds and delivered solos with the energy of a real electric guitar solo on stage.

## 3.2 Digital E-Shoe (2010)

In order to extend the *High Heeled Shoe Guitar,* and address some of its limitations, the *E-Shoe* was developed.

---

[2] *We Don't Play Guitars* Music video: https://www.**youtube**.com/watch?v=sK9XQLSpFBA

[3] *We Don't Play Guitars performed by Chicks on Speed live, Dundee Contemporary Arts, 2010* https://vimeo.com/43260701

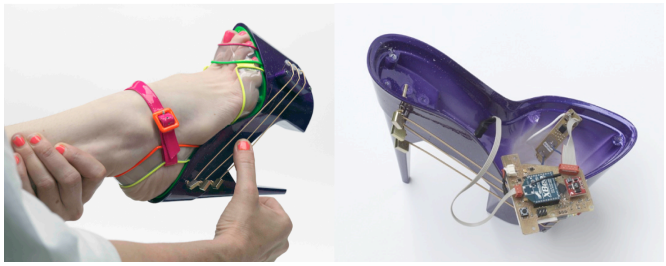

**Figure 4. *E-Shoe* by Chicks on Speed (Alexandra Murray-Leslie, Melissa Logan) & Max Kibardin, photo Gilmar Ribero © Chicks on Speed 2012.**

The aim was to create a more complex musical instrument that would provide a wider range of sounds, be more flexible on stage, have more polished design and construction and influence choreography on stage[3]. The shoe itself was designed by Alexandra Murray-Leslie and Max Kibardin [14] and, as footwear, was striking and beautifully constructed – to the extent that it was worn by model Kate Moss in a photo-shoot to celebrate Vogue Brazil's 36th anniversary (see Figure 5).

**Figure 5. Kate Moss wearing *E-Shoe*, Vogue Brazil, photo Mario Testino, 2012.**

While in many ways the *E*-Shoe was a significant advance on the *High Heeled Shoe Guitar*, it also had several limitations. Sonically, the guitar strings were used to trigger one-shot samples, meaning it could produce any number of pre-recorded sounds and therefore be used in a wider range of musical contexts. However, this also meant that the instrument was reduced to a trigger and some of the more nuanced expressive possibilities were lost.

As a fashion item, the shoe was impressive and was very effective as an on-stage critical costume item. It was also shown as an artwork in an institutional context at the Victorian and Albert Museum where the shoe was exhibited in a vitrine as part of the exhibition "Power of Making" curated by Daniel Charny in 2011. While this is a testament to the level of interest in the themes explored, it did mean that the hands-on practical element of the shoe as an instrument was lost.

Finally, the shoe was extremely delicate and easily scratched, meaning it was expensive to maintain, It wasn't robust enough to hold up to the wear and tear of live performance on stage, and so it became more an exhibition artefact or remnant souvenir of the *Chicks on Speed* live performances - ironically a 'dead' instrument rather than the 'living' one it was intended to be.

## 3.3 Shoe Tuning (2013)

The next phase of this project began with a workshop between an artist, technologist and group of five dancers. The workshop group experimented with a shoe, designed by Bruno Magli specifically for the performances, with a heel made from mylar coated hollow wood, which conducted the sound effectively of the dancers' movements when they came into contact with the wooden floor and other stage props, or shoes hitting each other in the air [15] [16].

A contact microphone was mounted inside the shoe heel and connected to a wireless microphone transmitter. The five pairs of shoes all transmitted to a single sound card connected to a laptop running Max/MSP. The dancers' data was mapped to various FM synthesis parameters in order to produce a range of sounds which were continuously linked to the performers' gestures.

As with the *High Heeled Shoe Guitar,* the shoes were made for a particular song, *We Are Data,* by Chicks on Speed and again acted as something other than an 'expressive musical instrument' in the traditional sense. While they had the potential to be used as musical instruments, equal emphasis was placed on the appearance and theatrical use of the shoes. The theme of the song was amplified as the performers' movement data was sonified and incorporated into the work.

## 3.4 Computer Enhanced Footwear (2013)

The *Computer Enhanced Footwear* (CEF) was a further iteration of the high-heeled shoe instruments. A circuit board featuring accelerometer, gyroscope and force sensitive resistor and compass was selected and mounted in a 3D printed heel which was attached to a pair of ready-made high-heeled shoes (see Figure 6). The heel was printed with standard white PLA filament, which was strong enough to bear the weight of the wearer. The upper of the shoe was covered with white duct tape. Duct tape is a material commonly used on stage to tape down electronic instruments in windy outdoor situations or bouncy stages or to guide performers around dimly lit stages, also holding a meaning of musical stage performance for those who are familiar with these contexts. This gives the shoes the meaning of being covered with something practical, a tool of the trade, inexpensive, rather than a decorative, expensive coating of some sort. Duct tape is also (usually) temporary, giving the CEF a more DIY aesthetic like the original *High Heeled Shoe Guitar*.

Working with sports scientists, a basic taxonomy of foot gestures was identified including: eversion, inversion, dorsiflexion, plantar flexion, abduction, adduction, supination and pronation [17]. As with the *Shoe Tuning* instrument, the range of each gesture was mapped to FM synthesis parameters in a Max/MSP patch. This more nuanced approach to data capture and mapping resulted in a foot-based instrument which provided a wider range of controllable sounds. The movement data was also able to be used in visualisations projected on stage.

A downside of the CEF, as with many purely electronic instruments, was that the sounds it produced were heard through an on-stage PA system, which meant that the physical gestures seemed dislocated from the sounds they were triggering.

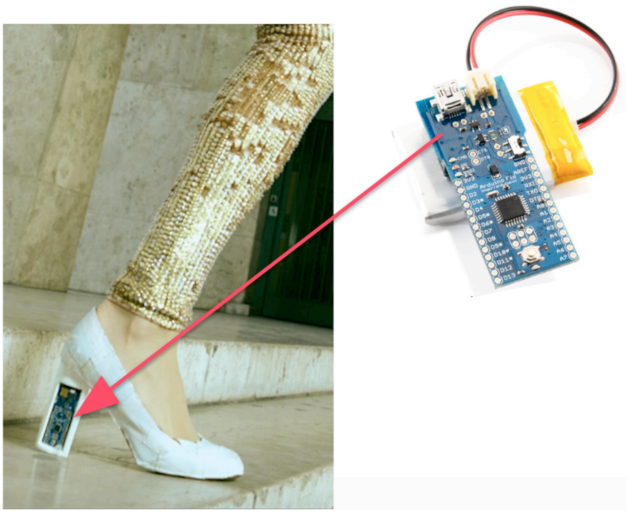

**Figure 6.** ***Computer Enhanced Footwear,***
**photo Wolf Dieter-Grabner © first Author, 2015.**

To combat this feeling, in performance the computer enhanced footwear was sometimes used in combination with the high heeled shoe guitar in the "head over heels" style (see Figure 3), using both hands and feet to perform the 2 instruments simultaneously. This provided a balance between digital musical instrument and analogue instrument, compensating for this feeling of the CEF not being live and at the source.

## 3.5 Open Source Strides (2015-17)

*Open Source Strides* (OSS) *prototype 1* (see Figure 7) and *prototype 2, Holografic Wedges* (see Figure 8) 3d rendered and printed by Alexandra Murray-Leslie, were created using the same circuits from the *Computer Enhanced Footwear* but significant changes were made both to the shoes themselves (temporary appendages attached to the feet with kinesiology tape and straps) and the associated gesture-sound mappings[4]. The Wekinator mapping system [18] was used in connection with Reactor. In addition a timeline system was created in Max/MSP which allowed the bank of sounds to be changed at certain intervals – meaning the system was predictable up to a point, but also displayed variation during extended performances.

The notion of control in performance is an interesting one when attempting to 'liberate' the feet as we are doing here. We believe that 'control' with the feet might be conceived of differently to 'control' with the hands, which is about particular kinds of precision and dexterity. Through this project we are exploring what an 'expressive' foot-based instrument might be. In our work to date this has led us to realise that the appearance and fashion/social context of footwear can, at least at times, trump control and traditional notions of expressivity as they are applied to instruments controlled primarily by the hands.

[4] Choreographer Kroot Juurak performing *Open Source Strides prototype 1* at finnisage of "Karl Lagerfeld Modemethode", Bundeskunsthalle, Bonn, September 12th, 2015. http://www.vogue.it/vogue-talents/video-lab/2016/03/04/artstravaganza-by-chicks-speed/

**Figure 7.** ***Open Source Strides, Prototype 1,*** **2015.**

**Figure 8.** ***Open Source Strides, Prototype 2 (Holographic Wedges),*** **Octolab, Autodesk, Pier 9, San Francisco. Photo Alexandra Murray-Leslie.**

## 4. Conclusion

In this paper we have described an approach to new instrument design that gives prominence to the feet instead of the hands when interacting with digital self made musical instruments. We contend that the physical (fashion) design of new footwear as musical instruments is as important as the sound and playing style. We continue to explore how this perspective explores and provokes the 'meaning' of high heeled shoes by introducing circuits, sensors and audio mappings. The development of these fashionable, digital musical instruments involved numerous stages of designing, fabricating, testing and iteration over a period of 10 years.

We argue that elevating the importance of the physical appearance of a new musical instrument can open up new avenues for broader notions of expression in live performance, beyond traditional, instrumental approaches which prioritise sound and purely 'musical' expression. Making instruments which look fashionable and have political resonances, can add to the complexity of dramaturgy in a performance and become part of a greater "gesamtkunstwerk" around the digital musical instrument - incorporating the sounds the instrument makes, the design of the physical artefact, the way it is played and the costumes made to wear with it.

## 5. ACKNOWLEDGMENTS

Our thanks to Rebecca Fiebrink and Embodied AudioVisual Interaction (EAVI) group, Goldsmiths University of London for the series of collaborative workshops with the *Computer Enhanced Footwear* and Wekinator software. Thanks to Steve Mann for your critical and daring contributions to the field of wearable technology. *Open Source Strides, Prototype 1*, made in conjunction with Dr. Sam Ferguson, Creativity and Cognition Studios, The University of Technology Sydney, NTU, Centre for Contemporary Art & Jeffrey Hong, Nanyang Technological University Singapore. *Open Source Strides,*

*Prototype 2 (Holografic Wedges)* generously supported by Autodesk, Pier 9, San Francisco and 3d print shop lead, Gabrielle Patin. I express my gratitude to Dr. Peter Mcneil for his introduction to Kevin Jones and Cristina Johnson and their generosity and time to present me Mae West's "Double Decker" shoes at the FIDM archive, Los Angeles. Sincere thanks to Dr. Jonas Rubenson for his initial collaboration in the biomechanics laboratory, The Pennsylvania State University and to Oron Catts and Ionat Zurr, SymbioticA, The University of Western Australia for mentoring the first steps of the project. The E-Shoe was commissioned by Dundee Contemporary Arts for the exhibtion "Chicks on Speed ~~Don't~~ Art, Fashion, Music", curated by Dr. Judith Winter.

## 6. REFERENCES

[1] G. Downey. 2009, 'Loose your shoes: Is barefoot better', https://neuroanthropology.net/2009/07/26/lose-your-shoes-is-barefoot-better/ accessed, 20th September, 2014.

[2] T. Ingold. Culture on the ground, The World Perceived through the Feet. *Journal of Material Culture,* 9, 3 (2004), 315–340.

[3] G. Bataille. *Visions of Excess: Selected Writings, 1927-1939 (Theory and History of Literature Vol 14).* University of Minnesota Press, Minneapolis, 1985.

[4] R. Shusterman. Somaesthetics: A Disciplinary Proposal *The Journal of Aesthetics and Art and Criticism*, 57, 3 (summer 1999), 299-313.

[5] M. Demello. *Feet and Footwear: A Cultural Encyclopedia.* Greenwood Press, Oxford, 2009.

[6] G. Deleuze and F. Guattari. *A Thousand Plateaus: Capitalism and Schizophrenia.* University of Minnesota Press, Minneapolis, 1980.

[7] R. Macfarland. Walk the Line, *Guardian Review* (23 May, 2009), 16-17.

[8] T. Hashimoto, K. Ueno, A. Ogawa and A. Iriki. Hand Before Foot? Cortical somatotopy suggests manual dexterity is primitive and evolved independently of bipedalism. *Philosophical Transactions of the Royal Society B Biological Sciences*, (Nov, 2013), 1-13.

[9] E.O. Thorpe. The invention of the worlds first wearable computer. *In Digest of Papers, Second International Symposium on Wearable Computers: Digest of Papers,* (IEEE Computer Society 1998) 48.

[10] J. Paradiso and E. Hu. Expressive footware for computer augmented dance performance. *In Proc. ISWC 1997 (*IEEE Computer Society Press 1997) 165-166.

[11] J. Paradiso, E. Hu and K. Hsiao. The CyberShoe: A Wireless Multisensor Interface for a Dancer's Feet. *In Proc. of International Dance and Technology 99* (Tempe AZ Feb. 26-28, 1998).

[12] D.J. Matthies, F. Mueller, C. Anthes and D. Kranzlmueller. ShoeSoleSense: Proof of concept for a wearable foot interface. *In Proceedings of the 19th ACM Symposium on Virtual Reality Software and Technolog* (Singapore, October 06 - 09, 2013) 93-96. ACM Press, New York, NY, USA.

*[13]* C. Smith-Prei and M. Stehle. *Akward Politics: Technologies of Popfeminist Activism.* Mcgill-Queen's University Press, Montreal, 2016.

*[14]* A.Murray-Leslie, M.Logan and J. Winter. *Chicks on Speed: ~~Don't~~ Art, Fashion, Music.* Booth_Clibborn Editions, London, 2010.

*[15]* A. Murray-Leslie. 2016, 'High Techne Fashion Design', *https://issuu.com/designfriends/docs/alexandra_murray-leslie* accessed, 14th February, 2017.

[16] A. Murray-Leslie & S. Ferguson. Fashion acoustics: Synthesizing wearable electronics and digital musical instruments for performance. *Critical Studies in Fashion & Beauty*, 5, 1, (2014), pp. 141 – 161.

[17] S. Stearne, K. Mcdonald, J. Alderson, I. North, C. Oxnard and J.Rubenson. 2016, The Foot's Arch and the Energetics of Human Locomotion. *Scientific Reports 6*, article number 19403, http://www.nature.com/articles/srep19403#auth-1

[18] Fiebrink,R.&Cook,P.R.2010,'TheWekinator:a systemfor real-time, interactive machine learning in music', *in Proceedings of The Eleventh International Society for Music Information Retrieval Conference* (ISMIR 2010)(Utrecht).