Contributions for a new body representation paradigm in pattern design

Generation of basic patterns after the mobile body

Volume I

Inês da Silva Araújo Simões

Tese apresentada à Faculdade de Arquitectura
da Universidade Técnica de Lisboa
para obtenção do grau de Doutor em Design

Orientador
Prof. Doutor Luís António dos Santos Romão

Co-Orientador
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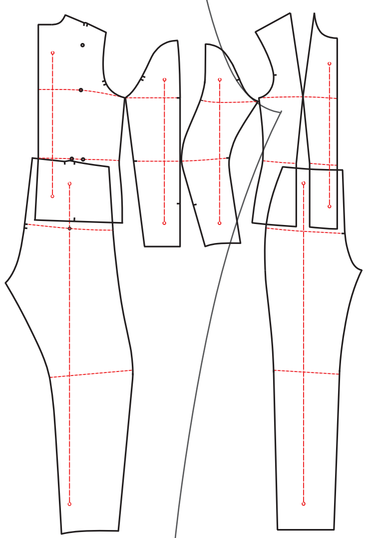

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Lisboa, Junho de 2012

Projecto financiado pela Fundação para a Ciência e Tecnologia

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Special thanks to Francisca Manuel for her willingness to capture the plain-portraits and self-portraits, not counting the videographic, exploratory, material that was excluded from the dissertation; to Luísa Barreto for her eagerness to photograph the generated basic patterns and wear-trials and to do the document's graphic design.

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With patterns, there is always more than meets the eye, and giving shape to a garment after understanding the mechanisms at play is an even more profound experience.

Tomoko Nakamichi
In Nakamichi, Tomoko (2011[2007]), *Pattern Magic 2*, London: Laurence King Publishing, p. 104

Abstract > Keywords

The emerging acknowledgment that the theory and practice of pattern design lays on a paradox – i.e., the depiction of the static body – is the driving force behind the research reported in this thesis.

The aim to translate the body's deformable quality into a set of basic patterns –made for Euro size 38 and meant for women's nonspecific clothing made of non-stretch woven fabrics – required that the research be carried out trough practice.

Implicitly the research is framed by body/product physical interaction concerns for the myriad positions assumed by the dressed body are among the factors that cause clothing pressure to increase to such degrees as those leading to the perception of discomfort.

Although the main characteristic, or purpose, of practice-led researches is not the employment of a particular method or methods, as Biggs pointed out (2002), the devised methodology became as significant as the created artifact itself.

Actually the search for an answer determined that the creation of the artifact included the development of a tangible mannequin that served as the building block of the two-dimensional formal solutions representing the mobile body.

Integrating varied procedural techniques borrowed, or adapted, from the social sciences, fine arts and clothing engineering – i.e., **(i)** self-portraiture combined with theoretical sampling, **(ii)** visual somatometry combined with a method of averaging body shapes, **(iii)** two- and three-dimensional pattern design, and **(iv)** wear trials –, the process of creating and validating the twofold artifact applied the principle of learning by doing along with the method of trial and error.

Regarding the creation of the alternative mannequin, the outlines of the commissioned self-portraits allowed to **(a)** determine the properties and dimensions of the deformations that emerged out of movement – in brief, the forward inclination of the torso, the

curved/angled shape of the arms, and the curved/angled shape of the legs –, **(b)** redraw the asymmetric silhouettes so they reproduced only the result of movement in its full potential, **(c)** pair the front and lateral silhouettes of the self-portraits on grounds of closest similarity and find the average contours by drawing bisecting lines pair after pair until one remained.

Regarding the creation of the alternative slopers no parametric equations were utilized or worked out to derive their forms since they were the result of the pragmatic approach commonly known as draping.

From the perspective of visual representation the patterns molded on fabric validate not only the submitted interpretation of the mobile body but also the developed interpretative methods, as they yield the illusion of the body in the act of moving. From the perspective of the dressed body the basic patterns with 'distorted' contours embody the mobile body, as they enhance action comfort and fit.

Ultimately, the idea of the mobile body shows potential providing manufacturers and designers are prepared to embrace an alternative paradigm.

Pattern Design | Basic Patterns
Mobile Body | Static Body
Paradigm | Paradox
Lineament | Visual Representation
Qualitative Procedural Techniques| Pragmatic Approaches

Resumo > Palavras-Chave

O reconhecimento emergente de que a teoria e a prática do design de moldes assentam num paradoxo – i.e., na representação do corpo estático/vertical – é a força motriz da investigação relatada nesta tese.

O objectivo de traduzir a deformação do corpo num conjunto de moldes básicos – planeados no tamanho standard 38 para a construção de vestuário genérico de mulher manufacturado com tecidos sem texturização – implicou o desenvolvimento de uma investigação prática.

Implicitamente a investigação é enquadrada pela questão da interacção física corpo/produto uma vez que as inúmeras posições adoptadas pelo corpo potenciam a pressão que o vestuário exerce sobre si, facto este que dá origem à percepção de desconforto.

Embora Biggs (2002) tenha referido que a característica ou objectivo principal das investigações práticas não seja a aplicação de um método ou métodos específicos, a metodologia desenvolvida é tão relevante como o próprio artefacto criado.

Com efeito, a procura da resposta à questão de investigação determinou o desenvolvimento de um manequim tangível de onde se extraíram as soluções formais bidimensionais do corpo móvel apresentadas.

O processo de criar e validar o artefacto assentou no princípio da aprendizagem pela prática e no método de tentativa e erro e integrou várias técnicas processuais 'emprestadas' ou adaptadas das ciências sociais, das artes plásticas e da produção de vestuário – i.e., **(i)** o auto-retrato combinado com a amostragem teórica, **(ii)** a somatometria visual, combinada com o cálculo da média de diferentes silhuetas de corpo, **(iii)** o design de moldes bidimensional e tridimensional, e **(iv)** a 'prova' dinâmica, ou teste, de vestuário.

Para o desenvolvimento do manequim alternativo, as silhuetas dos auto-retratos 'encomendados' permitiram **(a)** determinar as propriedades e dimensões das deformações

resultantes do movimento – resumidamente, a inclinação do tronco para a frente, a forma arqueada dos braços, a forma arqueada das pernas –, **(b)** redesenhar as silhuetas assimétricas para que retratassem o pleno potencial do resultado do movimento, **(c)** conjugar os conjuntos de silhuetas frontais e laterais segundo graus de afinidade e ainda encontrar a forma média de cada par através de bissectrizes até restar uma silhueta frontal/lateral.

Para o desenvolvimento dos novos moldes básicos não se utilizaram equações paramétricas porque as suas formas derivam da utilização da abordagem pragmática conhecida como *draping*.

Na perspectiva da representação visual, os moldes em tecido permitem validar a interpretação do corpo móvel apresentada bem como os métodos interpretativos utilizados, uma vez que dão a 'ilusão' do corpo em movimento. Na perspectiva do corpo vestido, os seus contornos 'distorcidos' encarnam o corpo móvel e por isso proporcionam maior conforto mecânico.

No todo, a ideia de corpo móvel desenvolvida é promissora, ainda que dependa da vontade dos designers e industriais de abraçar o paradigma alternativo proposto.

Design de Moldes | Moldes Base
Corpo Móvel | Corpo Estático
Paradigma | Paradoxo
Lineamento | Representação Visual
Técnicas Processuais Qualitativas | Abordagens Pragmáticas

Volume I

List Of Figures

Introductory Note

All my life I wanted to wear garments that feel comfortable throughout body movement. Not that I was ever a tomboy...

In the 1960s and 70s, in Portugal, our wardrobes were basically custom-made; even so I complained about the fit of woven clothing around the joints, and so, every time I was given the option, I wore knits as they moved together with me.

In the 1980s I added fashion design into my interest in painting; depending on seamstresses to translate my ideas into actual clothes I complained about their inability to do so; providentially I was given the opportunity to learn the practice of pattern design in New York City.

In the early 2000s I began researching into the representation of the body in pattern design in general and into the possibility of woven clothing patterns to cater for the movement of the body in particular. That's why in my Master's thesis I focused on Madeleine Vionnet's *œuvre* and the Levi's *engineered jeans*, as the French designer and the American label epitomize an alternative way of looking at the body.

Soon after I was given the chance to continue researching into this subject from the perspective of the maker not the viewer. So I concentrated my attention on *the lineament of the mobile body*, i.e., the two-dimensional representation of the multi-dimensional body, a body that is deformable not rigid, a body that is by no means immobile as it is always in motion.

As a result, this PhD thesis unfolds the process of thinking behind the creation of a twofold artifact, i.e., a tangible mannequin and a set of basic patterns for women's woven clothes.

Structured in the same way as the practice-led research developed, the written text is organized in six parts:

> Part One, entitled Conceptual Framework, functions as an introduction. It provides the general context for the research and its theoretical background; it states the problem, or research question, and gives details of the devised methodology; it outlines the applications of the research, and states its relevance and the aims.
>
> Part Two presents a critical review of the Antecedents Of The Research, namely the relationship between the body and its portrayal in the fields of science, visual arts and design; it also draws attention to the achievements as well as the limitations of previous work.
>
> Part Three presents the Preliminary Steps Toward The Artifact's Creation. It provides the reasons for the selection of the textile, size and pattern of the medium through which the amalgamation of all body positions became visible.
>
> Part Four presents a detailed description of the experimental work undertaken; accordingly it points out the varied procedural techniques that were implemented for the Creation Of The Artifact.
>
> Part Five, entitled Form Follows Action, presents the results and a discussion of their significance from the perspective of the dressed body and within the perspective of visual representation.
>
> Finally, Part Six presents the overall picture, i.e., the major Conclusions that can be drawn from the findings of the research; it also makes recommendations for further research.

1 Conceptual Framework

Introduction

To state that this doctoral research fits into the category of creative practice implies that its development includes the creation of an artifact in addition to this dissertation. To state that the created artifact is situated within the fields of clothing design and construction does not mean that this thesis discards the notion that the created artifact is also placed within the territory of visual representation.

The ambivalence shown above about how the generated artifact is, or should be, understood by all is, primarily, a consequence of the ambiguity owned by the type of artifact that was created. For if basic patterns,[1] taken as a whole, are intended for the projection of clothing patterns, and the designed alternative set regards the development of women's nonspecific clothes assembled with non-stretch woven textiles, they're so because they correspond to **(1)** two-dimensional drawings of the body – specific or anonymous, customized or standard in size –, that **(2)** deprived of all design features – such as plackets, pockets and waistbands –, are **(3)** fragmented into several pieces, each one reproducing the contour of a body segment – i.e., the trunk, arms and legs.

However, more than being a starting point, basic patterns represent the knowledge pattern designers gained of the portrayed entity throughout time: **(1)** the key body landmarks and the essential linear measurements that best translate

[1] Also referred to as *foundation* patterns, *blocks* or *slopers*.

its size and shape through points and lines, **(2)** the crucial joints of the body's structure that are converted into pattern boundaries to best cater for its movement.

This act of drawing accurately the body "generates a beauty of its own," a beauty that involves the awareness of the patterns' significance in the sense that, "[…] in our time, creating structure is itself perceived as an eminently human activity, the ultimate cultural *modus operandi*" (Lauwaert 2003: 42).

For this reason it is defended that patterns can no longer be seen as artifacts "exhibiting […] mere utility" – as read in the definition of the entry word "utilitarian" of the *Merriam-Webster's Collegiate Dictionary* (2003: 1379) – or as a class of objects that are "designed primarily for practical use rather than beauty" – like the thesaurus of the software *Microsoft Office 2004* indicates *a propos* the same adjective.[2] Instead, it is proposed that basic patterns be regarded *qua* artwork.

Accordingly, in the first section of Part One, Representation In Patterns: An Aesthetic Perspective, some perspectives on the *definition of art* are outlined and the concepts of *beauty* and *illusion* are developed so as to prove that "traditional boundaries between utility and high art are no longer applicable" (Clark and Brody 2009: 147). Effectively, though aesthetic *criteria* have usually been unused for the appreciation of design products, making use of them definitely brings forth a new understanding about authorless everyday objects, a category in which patterns belong.

Coming upon the fact that the notion of beauty can be linked with the notion of *truth*, two complementary senses in which the latter can be regarded with respect to theory making are presented. No less important is the idea of *paradigm*, as it provides the grounds on which to consider the commitment to follow a particular way of thinking that generation after generation of pattern designers have shown to have.

[2] The decision to quote these sources considered the fact that, aimed at everyone, they are easily available, a circumstance that shapes the meanings the great majority makes out of words and concepts.

Notwithstanding the assurance a paradigm gives, there is a developing agreement that the features of the body that pattern design has continuously chosen to heighten – i.e., its ability to stand on two legs and to move from one place to another using only those limbs – result in a paradoxical representation of the entity giving meaning to the discipline. In reality, the quality of being deformable manifests itself in the body's ability to undergo shape change while it breathes, walks, sits, kneels, squats, *etc*.

Thus, in the second section of Part One, The Paradox In Pattern Design: An Epistemological Perspective, an explanation of the meaning and implications of the concept of *paradox* is proposed. Picking up on the idea that paradoxes can help disciplines move forward – on condition that their inadequate concepts are revised –, David Bohm's model on the range of imagination (2006[1996]) is incorporated, as it describes the four intertwined mental actions that enable one to go beyond a mechanical mode of operation.

Matching the aptitude to overtake conservative views is the concept of *creativity*. For that reason, it's added in an overview on this concept, which, presented in the order in which it has been understood through time, is centered on the relationship between newness and production.

Lastly, the third section of Part One, Research Through Creative Practice: An Empirical Perspective, starts out with an account of the conceptual development of this research based on Bohm's model, as it lent it a motivating structure. The subsequent description of the concrete actions involved in this doctoral research makes clear that it agrees with the category of research *through* art and design.

To substantiate the idea that those two types of research can coexist in the same work, a list of the main points characterizing both is supplied. In practical terms, if the chief prerequisite for a doctoral research is that it contributes to knowledge, other mandatory *criteria* are the identification of the methodology framing the search, the question guiding it, and the implemented techniques and procedures giving it a tangible form and meaning. In this case, if making the alternative basic patterns has functioned as a research tool, the *nexus* between theory and practice, between dissertation and artifact, is the original contribution of this research.

Representation In Patterns

[*An Aesthetic Perspective*]

To declare that patterns fit in the territory of visual representation is to say that, before anything else, patterns correspond to diagrams of the body. In fact, W. H. Hulme confirms this view in *The Practice of Garment-Pattern Making*[3] when he says, “the pattern-maker stands to his drafting board. Before him lays a piece of flat paper: out of this he is to make his pattern. He has beside him a number of measurements, and in his mind there is an exact idea of the figure he is drafting for; how it stands and moves, its posture and action” (1945b: 23).

Shortly after this description Hulme elucidates that the awareness of the body designers have is fully embodied in a basic pattern, as he writes, “this is the type of pattern that faithfully reproduces the part of the body to be clothed” (1945b: 23). Owing to this characteristic, the professor and pattern designer adds that basic patterns are utilized as a foundation from which the patterns depicting the clothes we actually wear are developed (Hulme 1945b: 23).

What Hulme hints at is that, in practical terms, the correspondence created between the anatomical points and the basic patterns lines is secured when their surfaces are divided into panels and yokes, their boundaries are stretched out to house design details like plackets and collars, or when other styling features – such as lapels and pockets – are built-in.

Bringing to an end the distinction between these two types of patterns, Hulme lets know that the act of drawing them involves a different mental approach: basic patterns count on “a sound knowledge of the human form” and clothing patterns depend on “good draftsmanship, a sense of line” (1945b: 23-24). Because of this characterization we’re led to think that a designer needs to have artistic talent to create clothing patterns and, in contrast, a designer is required to possess a scientific attitude to generate basic patterns.

Owing to, or despite this scientific exigency, inherently neutral and objective, it could be said that, within the context of visual representation, basic patterns are more than “faithful” depictions of the body – to use Hulme’s word once more – for

[3] A book pairing off *The Theory of Garment-Pattern Making*, both published in 1945, aimed at designers, teachers and senior students.

the reason that they also portray the knowledge designers have about the body. In fact, in his PhD thesis, Daro Montag sustains this perspective by enunciating, “the act of creating a picture need not simply depict or represent, in a different form, that which is already known. Instead, the work of art can actually help to shape that knowing” (2000: 7).

The history of art fully illustrates this instance, as the art historian Ernest Gombrich (1909-2001) confirms by saying that the classical historian “Pliny told the history of sculpture and painting as the history of inventions, assigning definite achievements in the rendering of nature to individual artists: the painter Polygnotus was the first to represent people with open mouths and with teeth, the sculptor Pythagoras was the first to render nerves and veins [...]” (2002[1960]: 9).[4]

The importance given to these innovations in visual arts is not merely because they correspond to skill improvements – on the artists’ side –, but because they clearly correspond to a conquest of perception – on the part of artists and viewers alike –, as the painter John Constable (1776-1837) remarked, “the art of seeing nature [...] is a thing almost as much to be acquired as the art of reading the Egyptian hieroglyphs” (Gombrich 2002[1960]: 12).

Nineteenth century pattern designers – sharing, undoubtedly, what Gombrich refers to as “the new interest in factual observation” contemporaneous artists had (2002[1960]: 12) – were the first to portray the body by converting its convex and concave surface into various flat shapes taking the same measurements of the body sections they stood for. Although the practical value of these artifacts was – and still is – huge for the trade, their significance was also – and should still be – perceived as the accomplishment of an accumulated knowledge, or as the materialization of an enhanced awareness.

Providing we agree with Montag when he concludes that a work of art “is therefore not a passive portrayal of the world but actively contributes to the process of classification and sorting” (2000: 7), the combination of the theoretical and practical implications of the unique representation of the body created by pattern

[4] Polygnotus and Pythagoras were Greek, the first having lived in the fifth century BC, and the second between c. 580-572 and 500-490 BC. Pliny was a Roman historian, born in 23 AD.

designers entitles one to regard patterns *qua* artwork – or at least, as if they are artwork.

For the sake of argument, before expounding how the consideration of the nature and purpose of art – or the condition for something to be valued as a work of art – assists the proposed view about patterns,[5] one of Kaat Debo's observations[6] is brought up, as it spells out that, "from a technical standpoint, the pattern is a two-dimensional transition between the three-dimensional body and the finished piece of clothing" (2003: 9).

By these words Debo seems to declare that patterns are nothing but a means to an end. Within this perspective the previous claim that patterns can be regarded as an art form is not valid, particularly if one accepts one or both of the contemporary philosophical approaches to the definition of art, specifically the functional and the procedural views,[7] which – in very succinct terms – propose respectively that a work of art is only a work of art **(1)** if it provides a pleasurable aesthetic experience, and **(2)** if it is submitted to the artworld for aesthetic/artistic appreciation (Davies 2005: 230).

To understand better the implications of the concept of *artworld* introduced by Arthur Danto (b. 1924) in 1964 – and adopted by the institutional theory, the foremost example of a procedural definition of art (Davies 1991: 78) –, we must first consider the idea that an artwork has to be seen against the historical and social context within which it was created. Encompassed in this notion is the view that *context* is a product of "the changing practices and conventions of art, the heritage of works, the intentions of artists, the writings of critics, and so forth" (Davies 1991: 81) which, all together, form the artworld.

To return to this thesis, what if we go beyond Debo's view and perceive a pattern in the same way as Christian Dior (1905-1957) regards a fashion sketch, i.e., "effectively, it really is a starting point, but at the same time it's an end for the reason that the drawing crystallizes the reflection and represents what is imagined

[5] In particular about basic patterns, since they are the focus of the research.

[6] Kaat Debo is the director of the Mode Museum (MoMu) in Antwerp.

[7] Advocated by Monroe C. Beardsley (1915-1985) and George Dickie (b. 1926), respectively.

in quite a precise manner" (2003: 42)?[8] Considering the views of the philosophical approaches referred to before, is it easier to accept that patterns are able to supply enjoyment or be approved by curators, critics and public?

The doubt remains the same given that patterns are not "manufactured with the specific intention that they be artworks," as Stephen Davies says works of art "typically" are (1991: 37). An additional reservation comes from the circumstance that the possibility to experience patterns – or the enjoyment deriving from experiencing them – is usually restricted to a few people: basic patterns are only intended for pattern designers, and clothing patterns for pattern designers, graders, markers and – at best – amateurs.[9] Thus, the access to patterns is typically confined, as they are either kept within the workplace or divulged in specialized magazines and stores.

As it happens, patterns are rarely the focus of museum and art gallery exhibitions.[10] We may ask if this absenteeism is caused by a visual construction that reveals itself through "an abstract code with a draughts-man's language all its own, accessible only to the initiated" (Debo 2003:9) – which makes this type of representation unfit for the admiration of outsiders –, or because of the attention the artworld members and the academic community devote only to clothing – which, intentionally or not, causes the public to undervalue patterns as an art form.

If we accept the institutional definition of public as "a set of persons who are prepared in some degree to understand an object that is presented to them" (Davies 1991: 84), we actually have to consider – as providing an explanation for this seeming disinterest in patterns – the possibility that the great majority of people aren't ready yet to appreciate them, neither as technical creations nor artwork.

What is more, if we take Debo's allegation that "in the context of a museum, therefore, [patterns] can only be of interest for research purposes" (2003:9), the

[8] Freely translated from "C'est bien en effet un point de départ, mais c'est en même temps un terme, car le dessin cristallise la réflexion et représente ce qui est imaginé de manière assez précise."

[9] Graders scale the patterns created by designers to different sizes, and markers lay the resulting graded patterns on cut plans.

[10] Rare examples of exhibitions addressing this discipline are *Geometrie* and *Patronen/Patterns*, organized and presented by the Mode Museum of Antwerp (MoMu) in 1999 and 2003 respectively.

suggestions placed in the fourth from the last paragraph appear to indicate that this type of drawings isn't created with the aim to afford a pleasurable aesthetic experience to people outside the garment industry. On the other hand if, as Dirk Lauwaert suggests, "the pattern invites us not to look, but to do" (2003: 42),[11] an alternative question comes up: can patterns provide a pleasurable aesthetic experience to those who are directly involved with the construction of garments?

Answering this particular question involves considering, first of all, that an aesthetic experience is triggered either **(1)** by the artifact's formal aesthetic properties – intrinsic to the object under appreciation –, or **(2)** by the artifact's non-formal aesthetic qualities – indicating that the object's production and appreciation is context dependent (Goldman 2005: 257; McMahon 2005: 308; among others). Nevertheless, to put it boldly, whatever the case may be, an aesthetic experience depends on one's responsiveness to beauty (Goldman 2005: 255; McMahon 2005: 308; Armstrong 2005[2004]: 51; among others).

Going along this postulation, to admit that patterns possess beauty – or hold what eighteenth century philosophers termed as "relative beauty," an attribute that involves "considering appearance in relation to the object's function" (McMahon 2005: 308), be it people or works of art – implies recognizing that their beauty doesn't lie in the way their lines are drawn – in terms of the quality of their brushstrokes –, but in the way their lines are arranged – in terms of what they represent. The beauty of patterns doesn't lie either in the uniqueness of their authors' sketches – since patterns reflect "a system of drawing with conventional symbols for buttons, stitches, pleats, and darts" (Lauwaert 2003: 46) –, but in their authors' artistry to project "a three-dimensional object onto a flat surface" (Lauwaert 2003: 46).

Actually, by going back to Debo's paper another time – or by looking into what is implied in it – we realize that the author is undeniably aware of the fact that "every pattern carries within it the potential garment and, therefore, the potential body" (2003: 9). Within this perspective, aside their practical value – which concerns their role in the production of clothing –, patterns are understood as enclosing in themselves the body, a body that is continually being reinvented.

[11] The author implies that a pattern conveys a thought process leading to the production of garments.

Indisputably at the service of fashion – a phenomenon "whose very essence is change" (Debo 2003: 9) –, garments conform to the body or redefine its shape; in either situation, to bring about these morphological manipulations, patterns require the designers' perception. By this assertion it is conveyed that the willingness to reshape the body's external configuration has claimed a construction of knowledge concerning human anatomy at large, and anthropometrics in particular.

Grounded in the analysis of the comparative proportions between different body parts, this knowledge has been converted into rules favoring the geometrical representation of the body. If this geometrization is particularly patent in a basic pattern – or in a "body-pattern," as the nineteenth century North American tailor Charles Hecklinger designated this tool[12] (Hecklinger 2002[1880, 1883]: 35) –, the same can be said about the garment patterns designed before the twentieth century, as they also included what Christoph De Boeck refers to, in his definition of a pattern, "an abstraction of corporeality in which a body is represented on the basis of objective and quantifiable properties" (2003: 103).

As long as it is acceptable to simplify the history of pattern design, this quantification made a start with two body dimensions, its height and breadth, which established the length and the width of the woven material that covered it (Hollander 1993[1975]: 5). Later, the shift from unstructured garments to shaped clothing[13] – causing the fragmentation of the patterns into several pattern pieces conforming to different body parts – asked for the integration of additional body measurements such as the bust, waist and hip girths, the torso, arm and leg lengths.[14]

Then, as "it gradually became clear that a great many men [or women and children] with a particular chest measurement would be likely to have similar width of shoulder, a similar waist size, and a similar distance down the centre of the back between neck and waist, and similar lengths of arm and leg" (Hollander

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[12] Hecklinger is accepted as having been the originator of the concept of basic pattern, which, from 1880 onward, brought to light a whole new method of designing clothing patterns (Aldrich 2002: 16).

[13] Even though Anne Hollander mentions that the seventh century BC's clothes were "especially woven to fit closely" the body, they remained seamless until the early medieval period (1993: 17), hence the use of the expression *unstructured garments*.

[14] See Simões (2005: 63).

1994: 105), it became possible to move from designing patterns for a specific customer into planning patterns for an anonymous consumer.

This paradigm alteration, i.e., the standardization of the body, is directly interrelated with the empirical investigations pattern designers carried out throughout time, which led to the improvement of their awareness of the body.[15] As a matter of fact, we know from Henry Wampen (1863) and Edward B. Giles (1987[1896]) that the perception of the body increased as the input of other areas of knowledge was embraced, namely, mathematics, anatomy and anthropometrics; correspondingly, the integration of information supplied by outside fields helped pattern designers – in the role of the perceivers – to materialize the inferences they arrived at through practice.

And if the preceding paragraph sounds like an appropriation of Mark Rollins' passage appearing in his account on how the psychology's constructivist approach understands visual perception,[16] "perception depends on inference, which in turn depends on knowledge possessed by the perceiver" (2005: 390), it's because the above rewording falls in with the development of this approach into Gombrich's "illusion theory of pictorial art" (Rollins 2005: 391), a theory that considers that both the maker and the viewer employ the same perceptual psychological mechanisms to convey or interpret the content of an artwork.

To put it briefly, according to Gombrich, the recognition of an image with its object – or the process of "matching the visual stimulus to familiar forms" (Rollins 2005: 391) – depends on the artists' selection of the concept or prototype "to be adapted to the task of serving as [its] portrait" (Gombrich 2002[1960]: 62). Then, as highlighted by Rollins, if the depiction is read as corresponding to the object it portrays – which confirms that the adjusted scheme is shared by the maker and the viewer –, illusion can occur (2005: 391). All the same, Gombrich makes clear that this result depends on the clues laid down by the artist as well as the perceiver's conceptual knowledge and power of expectation (Gombrich 2002[1960]: 185-188).

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[15] According to Aldrich (2000: 164), "the production of ready-to-wear and 'mass produced' made-to-measure clothing for men and women owes a debt to the cutting and sizing methods created by early nineteenth-century tailors."

[16] Known as the New Look psychological movement (Rollins 2005: 390).

The importance assigned by Gombrich to these competences – particularly to visual anticipation – relates to the way they influence perception, or the role they play in the illusion's emergence (Gombrich 2002[1960]: 171). Yet, the produced illusion is recognized as an artifice that just fools the eye given that "the perceiver ordinarily does not believe that the picture is the object he sees it as" (Rollins 2005: 391).

Taking advantage of Gombrich's view – for it sustains the stance that basic patterns can be viewed *qua* artwork –, and bearing in mind that pattern designers strive for realism when they describe the body, it should be checked, at this point, if basic patterns do develop into an illusion. To begin with, verifying this hypothesis implies recalling that, in pattern design, the maker and the viewer are – usually – one and the same. Lastly, the corroboration of this proposition involves acknowledging that the illusion at issue does not deceive whoever comes upon it, much less their creator.

To be frank, to see the body within a basic pattern – or to say it differently, to distinguish it – is a challenging deed. The difficulty presented by the identification of the pattern's subject lies in the fact that the represented body has – for some centuries – been disassembled into pattern pieces corresponding to different body parts – i.e., the torso, the arms and the legs, which can all be further subdivided into their front, back, top, bottom, and side views –, as mentioned earlier. This circumstance should, by itself, lead us to admit that basic patterns cannot turn into an illusion.

On the other hand, if we accept that this type of patterns correspond to representations of the body, and if we believe that the body within them is correctly represented – which are prerequisites for an illusion to come about and to be taken as such –, we are able to admit that the produced illusion does not misinform their creator since, as Debo points out, "the pattern is not [...] a direct reproduction of that body. Its surface seems larger than the body for which the garment is to be made" (2003: 9).[17]

[17] According to Mark Rollins, "this sense of 'illusion' can be understood in terms of Karl Popper's principle of falsifiability, which Gombrich explicitly adopts. On that view, in so far as pictures represent correctly, a perceiver will derive no false information from them. One may properly apply

The corroboration of this inability to be deceived is clearly expressed by Lauwaert when he writes that, even if the designer's sketch "appears to be figurative and analogous" (2003: 46), "his [or her] pattern does not translate a visual impression [of the body], but sets a geometric reality of distances, spaces, and relationships into razor-sharp, meticulous descriptions for the material to be employed" (2003: 43).

Consistent with Lauwaert's assertion is the notion that patterns, in the end, materialize into clothing, a circumstance that's always present in the designers minds: all the drawn peripheral lines of patterns, as well as a few internal ones, turn out to be seams that'll piece together the fragments of the anticipated image. Admittedly, it is specifically this expectation of a three-dimensional object represented in two-dimensions, in black and white, and rather minimally – in terms of its rendering –, that pattern designers and researchers take as an illusion.

As it happens, Dior has acknowledged the occurrence of this very phenomenon because, in a lecture he gave at la Sorbonne in 1955, he defended that "the sketch, translating what appears in imagination, favors the execution – it's what it's told to me by all those that are called '*premières d'atelier*'[18] who, they, make the dresses; since there's there a kind of anticipation and for a dress to turn out well, one must have the idea of how it will be in the movement of life" (2003: 42-43).[19]

To look at patterns is, then, more than seeing shapes – indicating the type and style of garments they will turn into – for the reason that patterns dare us to perceive the body within them. This awareness is attained through the clues left by their maker, which allow us to imagine where the patterns' lines divide the space of the body and how the patterns' flat area is distributed around the body. Just then, by acknowledging the correspondence created between the sketch and the body, we become conscious of the patterns' beauty.

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certain concepts to the picture and see it as the sort of object it represents. Art is thus illusion, in one sense of the word" (Gaut and Lopes 2005: 391).

[18] "The premières have the matter of making the dress, contemplating the drawing, looking for the form, the intonation, the allure, the fabric. It is after the model is executed, following the sketch, that the design is finally defined" (from 1910's *Les Créateurs de la Mode*, by Roger Milas, as quoted in Kirke 1998[1991]: 28).

[19] Freely translated from "Et le croquis, traduisant ce qui apparaît à l'imagination favorise l'exécution – c'est ce que me dissent toutes celles qu'on appelle les 'premières d'atelier' qui, elles, font les robes; car il y a là une sorte d'anticipation et pour qu'une robe soit réussie, il faut avoir l'idée de ce qu'elle sera dans le mouvement de la vie." I believe that when Dior says *movement of life*, he is alluding to the look of a dress in each point in time it'll be on a lively body.

The character of this ensuing aesthetic experience is regarded differently by philosophers of art like John Armstrong (b. 1966), or by quantum physicists like David Bohm (1917-1992).[20] Encountering beauty is, for the former, a subjective response, "for it is the way the object affects us – not just how it is in itself – that is at stake when we call something beautiful" (Armstrong 2005[2004]: 56). However, the perception of beauty is grasped by the latter as surpassing "a subjective response of man, based on the pleasure that he takes in seeing what appeals to his fancy" (Bohm 2006[1996]: 39).

Issued from Bohm's line of reasoning is the notion that the discernment of the patterns' beauty is an objective response to the orderliness, coherence and harmony displayed in them (2006[1996]: 39). Intriguing as it may sound, Armstrong also reveals that it is the "purity, perfection, harmony and order" embodied – lets say – in the patterns being assessed, as these are qualities that we seek to find in ourselves (2005[2004]: 72).

Thus, consistent with Armstrong's perspective is the idea that taking pleasure in seeing a pattern is a matter of recognizing a relationship, not solely between the drawing and the represented body – as an abstract or unfamiliar entity –, but between the sketch and ourselves – as we are intimate with our physical bodies. But although Armstrong's view is appealing, Bohm's standpoint is more convincing as it suggests that taking pleasure in seeing a pattern implicates more than being knowledgeable about our bodies: it involves being familiar with the logic behind its construction, a competence that facilitates detecting that "all [its] parts [are] generated naturally from simple principles, and with these parts working together to form a unified total structure" (Bohm 2006[1996]: 39).

Concurring with Bohm's way of thinking is the functional philosophical approach to the definition of art, as its supporters admit that the experience an artwork provides may be – more commonly than not – "variously and complexly cognitive,

[20] According to Leroy Little Bear – the author of the preface of *On Creativity*, a compilation of the physicist's lectures on this issue, edited by Lee Nichol –, David Bohm is one of the few people that "associate aesthetics with science" (Bohm 2006[1996]: viii).

and the pleasure that goes with [this] experience is the pleasure of understanding a pattern,[21] of solving a puzzle, of grasping connections" (Davies 1991: 59).

Going roughly into specifics, the theory of pattern design is built on the identification of **(1)** the body's key landmarks – acting as the points from which the draft is organized –, and **(2)** the body's key measurements – converted into algorithms settling the distances between the sketch's lines –, which respectively decide **(1a)** the clothing's equilibrium on the body throughout movement, and **(2a)** the relationship between the size of the body and the garment's scale.

But in the end, the theory of pattern design goes beyond the establishment of **(1)** the exact spacing between the patterns lines – making possible that seams rest on the joints of the body –, **(2)** the correct direction of the patterns lines – making possible that the seams separate the front and back, the left and right sides of the body –, and **(3)** the quantitative correlation between the lines of the different pattern pieces – making possible that a neat and smooth appearance is conferred to the potential garment. The formation of a "unified total structure" – to reuse Bohm's expression – relates, then, to the truth created between the body and its representation, and between the naked body and the body dressed in clothes fitting the activities it performs.

Clearly this idea of truth has grown to be more and more factual as **(1)** the representation of the external anatomy of the body became systematized, and as **(2)** the diversity of body shapes and dimensions were differentiated and classified into somatic types and sizes. Yet, in the same way as "there has been in physics a gradually increasing awareness that scientific theories cannot be mere reflections of nature" (Bohm 2006[1996]: 41), there is a developing understanding in fields dealing with clothing that the reasoning sustaining pattern design's representation of the body does not consider the true nature of this entity (Crowther 1985; Ashdown 2011; among others).

This is not the same as saying that the theory of pattern design rests on untruthful grounds; on the contrary, it is the same as proclaiming that pattern design's

[21] When Stephen Davies uses the word *patterns*, he's not referring to basic or clothing patterns; he's alluding to art *structures*, formed with colors or sounds, textures or words, etc, at which "[the audience] looks for connections and contrasts among [their] formal, semantic, and whatever other elements there might be; looks at the artwork under one aspect, then under another, and so on" (1991: 60).

interpretation of reality leans on a paradigm, as the philosopher of science Thomas Kuhn (1922-1996) suggests happens with scientific theories (Kuhn 1996[1962]; Bohm 2006[1996]: 41; Klein 1996[1994]: 114). Consistent with Kuhn's point of view, in spite of the fact that pattern design is usually viewed as a mere technology sustaining a cultural practice,[22] the aspiration this discipline and other scientific disciplines have to understand the world – each one focusing attention on specific phenomena – allows to establish a link between them.

The possibility of connecting pattern design to disciplines like chemistry, geology, or astronomy, is also backed by the fact that it is their – individual – acceptance "of a paradigm that transforms [each] group previously interested merely in the study of nature into a profession or, at least, a discipline" (Kuhn 1996[1962]: 19). Aside the influence paradigms have toward the recognition of professions and disciplines as such, the impact that the accepted models have on scientific research is associated with the "promise of success" they bring about, as their achievements depend on the expansion of "the knowledge of those facts that [each] paradigm displays as particularly revealing" (Kuhn 1996[1962]: 23-24).

Consistent with this perspective is Bohm's idea that a paradigm is, in its essence, the disclosure of "the essential relationships that are significant for observation and experiment" (2006[1996]: 41), a definition that also matches Gombrich's position in relation to the tendency artists have to turn to archetypes – as we have understood previously.[23]

Effectively, in the same way as painters characterize an object "by heightening certain features and simplifying others" (Bohm 2006[1996]: 41), pattern designers have opted to depict the body standing still. The motivation behind this long-lasting decision may be **(1)** of a technical type, to the extent that patterns can be compared to architectural drawings – more exactly to the geometric representation of buildings' elevations –, or **(2)** of a conceptual sort, to the degree that our mental representations of objects correspond to their concise images – as the example given by linguists illustrates, "dogs bark. But the concept of 'dog' cannot bark or bite" (Hall 2002: 17) –, or even **(3)** of a metaphorical kind since, by

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[22] That is, fashion or, as referred by Joanne Entwistle (2000: 4), the production of discourses on the body.

[23] See p. 10.

planning the body standing still, pattern designers draw attention to a distinctive aspect of this entity: its skill to maintain an upright position.

The Paradox In Pattern Design

[*An Epistemological Perspective*]

If, for pedagogues like Georges Stobbaerts (b. 1940),[24] our verticality – an anatomical, genetic, trait – "symbolizes the vital energy and the dignity of the human being" (2002: 42), for authors like Erwin W. Strauss (1891-1975) our ability to stand on two legs and feet has a great effect on the way we perceive the world. Irrespective of the fictional style Strauss gives to his paper "Born to See, Bound to Behold," the neurologist, psychiatrist and philosopher differentiates quadruped animals and humans according to the opportunities brought about by their respective postures: because their bodies stay parallel to the ground throughout motion, "the horizon of animal interest is pulled down very low and limited to a narrow territory just ahead" (1970: 341); conversely, since our bodies remain perpendicular to the floor as we move, "the world is opened up for the human look" (1970: 341).

Our vision, turning into the "distance sense par excellence" (Strauss 1970: 341), enables us to see things without having to touch them with our hands, or smell them with our noses, or hold them in our mouths. As a result, the space that separates us from objects – enabling us "to behold them in a plane perpendicular to the direction of our gaze" (Strauss 1970: 342) or to gaze at them in a plane "'fronto-parallel' to the upright body of the viewer" (Krauss 1993: 93) – becomes our means to consider the world in a contemplative way.

This concurrence of planes in which the viewer aligns the viewed, this hanging together with which the observer considers the observed, is the starting place of our tendency "to project coherence in a mirroring of [our] body's own shape," as Rosalind E. Krauss (b. 1941) writes (1993: 93-94). Although the art critic and theorist is alluding to the way visual works of art are likely to be structured to match our bodies' configuration – namely, "heavier at the bottom, lighter at the

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[24] For the past forty years the biochemist has been researching into body movement and posture as well as teaching theater anthropology, Aiki-Do and Yoga.

top" (Krauss 1993: 94) –, the philosophers George Lakoff (b. 1941) and Mark Johnson (b. 1949) refer that we are, in fact, instinctively inclined **(1)** to use bodily projections to make sense of the things we – simply – look at and to define spatial relations among/within them (1999: 34-35).

Correspondingly, "rooted in the human regard and therewith in the upright posture" (Strauss 1970: 343), derived from our sensorimotor apparatus and with that the way we perceive, move and manipulate (Lakoff and Johnson 1999: 17), based on the distinctive nature of our bodies and, along with it, our brains' neural structures (Lakoff and Johnson 1999: 16-17), is also our disposition to **(2)** conceptualize and categorize the things we take in so we can characterize them as well as tell them apart (Lakoff and Johnson 1999: 17-20, 27-28), **(3)** automatically and unconsciously structure our way of thinking and communicating using primary conceptual metaphors (Lakoff and Johnson 1999: 47),[25] and – given the focus of the developed research – to **(4)** capture the essential qualities of the things we notice in a medium such as drawing or painting with the aim of adding to reality (Strauss 1970: 343, 349).

All of the above predispositions – or actual embodied mind mechanisms – explain **(2a)** why basic patterns are delineated in the same way as the mental image we get of a pattern altogether: since the shape of this type of patterns bears the underlying features that stand for pattern design's representation of the body, they are more easily associated with the portrayed entity than the outline of any clothing pattern does, **(1a)** why basic and clothing patterns are planned in the same way as we experience our own bodies: corresponding to a bodily projection, patterns have definite and recognizable fronts and backs and sides, patterns have explicit and identifiable top and bottom parts, **(3a)** why basic and clothing patterns are designed in the same way as we feel and deem our own bodies: in line with the metaphor *Happy Is Up*,[26] patterns are organized around vertical axes as this orientation stands for a heightened sense of being alive, and **(4a)** why patterns, basic and clothing, describe the body the way they do: even though they

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[25] According to Lakoff and Johnson, a "conceptual metaphor is what makes most of abstract thought possible [...] it is the means by which we are able to make sense of our experience" (1999: 129).

[26] Which, in English language, is present in expressions like *I'm feeling up*. Although they're also based on bodily orientation and particularly on the upright posture, the Portuguese expressions *sinto-me em baixo*, *estou de rastos*, rotate the metaphor 180º– or the physical stance that distinguishes humans from quadruped animals – to convey the opposite feeling.

appear to be crude schemas of the body, patterns – indisputably – embody the designers' particular understanding of the world.

As much as all these explanations give good reasons for the paradigm taken on by pattern design, what if we choose to disregard the metaphorical and conceptual *criteria*? The truth of the matter is that a pattern is a two-dimensional representation, a means that makes it problematical to render various body positions in one single line. But even if we prefer to justify the adopted representation paradigm strictly from a technical point of view, it is fair to say that, by exposing or focusing on "a 'typical' aspect" (Bohm 2006[1996]: 42) of the body being represented, pattern design stumbles over a paradox.

Before going in detail about the consequences this paradox has on the dressed body experience, it must be mentioned that, in general terms, "a paradox can be an apparently true statement or group of statements that leads to a contradiction or a situation which defies intuition" (en.wikipedia.org/wiki/Paradox). In accordance with the two instances identified above, it is proposed that the paradox in pattern design corresponds to **(1)** the theory's leading premises from which its practice is derived – namely the representation of the body in a static behavior, plus the description of this immobilized body through quantification –, assumed as true in isolation and to the degree that they complement one another, actually bring about a contradiction since patterns do not reflect the lively quality of the body.

Correspondingly, taking into consideration that the intuitive interpretation of the body by pattern design depends on the formation of diverse pattern pieces, each representing a single perspective of one body part,[27] **(2)** the alternative solution of merging onto a single plane the different shapes the various body parts acquire throughout movement – as a way of manifesting this entity's real dimension – creates a difficulty of a technical sort on top of presenting a problem in conceptual and metaphorical terms, a choice of obstacles pattern designers instinctively never dealt with so as to resolve the paradox.

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[27] Which, in the end, depicts a fraction of a garment.

Drawing on the physicist Étienne Klein's (b. 1958) *Conversations with the Sphinx: Paradoxes in Physics*,[28] Terence Love states that "the problems [...] in research, theory making and knowledge creation" (2002: 2) are generally attributable to common sense. Klein himself defines common sense as "the geometrical place of our preconceptions" (1996[1994]: 55), as he believes that our perception of things is for the most part oversimplified and simplistic, as well as thinking that once a concept, theory or solution – albeit their inadequacy – becomes common knowledge we tend to accept them as indisputable. In the end, our trust in them yields stagnation.

From this point of view, if we take into consideration the way pattern design has evolved – from spontaneous representation to its systematization (Kidwell 1979) –, if we take into account the limitations presented by technical representation – or the impossibility to amalgamate various perspectives in the drawings representing the elevations of the body –, we realize how comfortable it is for pattern design to stick to the representation paradigm found intuitively and sustained empirically, or how comfortable it is to subtract from the body – the entity that justifies the existence and reasoning of pattern design – its liveliness.

Regardless of the abstaining approach chosen by pattern design – or in spite of what has been accomplished by the elected paradigm of representation –, the paradox in pattern design implies bearing in mind that patterns are artifacts developing into other artifacts that cover the body or, to say it differently, patterns are artifacts developing into products that are in direct contact with the body – as clothes are placed on its skin – while the dressed body moves about. Then, as the body – dressed or unclothed – walks, sits, stands, holds, *et cetera*, its structure noticeably expands and contracts, multiplying itself into numerous shapes.

With great significance is also the idea that the paradox in pattern design involves the aspect that the body and clothes – understood as a system – go through various interactive deformations as formulated by Ming Zhang, Yi Li and Ruo-Mei Wong: "first, the garment is stretched to fit the human body, which induces pressure on the body. Secondly, the pressure compresses the elastic components of the body and makes soft tissue flow or redistribute, and the skin is stretched

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[28] This book is included in this dissertation's Bibliography in its Portuguese edition.

accordingly. Thirdly, the rigid bone restrains the deformation of the skin and the soft tissue" (Li and Dai 2006: 310).

If, on the basis of the above description, the relationship established between body and garment appears to be quite untroubled, Li and Wong urge us to recall that – during wear – the positions assumed by the body are among the factors causing clothing pressure to increase to such degrees as those leading to the perception of discomfort (2006: 34-35).[29] Taking into consideration that this adverse perception can develop from the limitation of the physiological functioning – as a result of a considerable deformation of the body tissues (Moes 2004; Li and Dai 2006: 151) – , to prevent the occurrence of this negative aspect the performance of garments has to – or ought to – meet, at all times, the kinetic behavior of the body.

In view of that, despite the fact that it's been previously suggested that the theory of pattern design is "true to itself"[30] – in the sense that the distances, directions and measurements of the patterns lines are planned to match up the deep-rooted fragmented surface of a body made static –, it is not a contradiction to claim that the premises concerning the physical characteristics and capabilities of the body on which pattern design builds its reasoning bring forth a paradox.

When we learn from Klein that a paradox is – for all purposes – anything that deviates from common sense, can't be proven right or wrong, or is contrary to the safest intuitions (1996[1994]: 30, 32, 38), it looks as if this thesis is invalid. But if we draw a parallel with Klein's definition of the types of paradoxes in physics – namely **(1)** "those that result from a contradiction or an internal inconsistency in the theory," implying that mathematical logic isn't always capable of translating reality, **(2)** "those that put in evidence the discrepancy between a theory and a specific experiment, or between several competing theories," denoting that the theory sustaining the paradox must be revised, **(3)** "those that translate an amazing fact that shocks common sense," indicating that almost all scientific

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[29] Although the aim of this research was to validate the created artifact through a qualitative approach – therefore the participants' perception was converted not into numbers but into adjectives –, other researchers are looking into the perception of comfort/discomfort in terms of quantitative parameters. Li and Wong (2006: 35), for instance, reported that, in 1993, Makabe *et al.* concluded that when clothing pressure is between 15-25 gf/cm2 the body perceives it as inconsequentially or slightly uncomfortable, and when clothing pressure is above 25 gf/cm2 it's deemed as extremely uncomfortable.

[30] Indicating coherence within a theory, this expression corresponds to the second meaning Bohm gives to the word *true*, the first being the reasoning based on facts (2006[2004]: 39-40).

results go against familiar concepts (1996[1994]: 39-40)[31] –, it can be proclaimed, once more, that pattern design's paradigm of representation is paradoxical.

Acknowledging also Klein's assertion that, in physics, a paradox is actually a combination of the three forms described above (1996[1994]: 41), an analysis of the paradox in pattern design involves bringing together the very same categories. Accordingly, the review considered that **(1a)** the contributions toward the geometrization and classification of the body that other areas of knowledge gave – and continue to give – do not change the fact that the paradox in question has to be resolved within the territory of visual representation, as this is the territory pattern design fits in, **(2a)** the unusual outline of the patterns resulting from experimental investigations – carried out by the garment industry[32] – corroborates the fact that the conventional representation of a sole body position is starting to be declined as an adequate approach, and **(3a)** in spite of this emerging way of thinking, a representation that amalgamates all body positions is inconceivable by a theory of pattern design that, having evolved in a linear manner, still reflects the conventional way of coping with flat representation.

But since the body is not a rigid object but rather a deformable entity, it is fair to ask once again:

Why does pattern design remain faithful to a deficient construct?

The first explanation that can provide an answer to this crucial question is derived from Kuhn's conclusion upholding that, because beginners learn "the bases of their field from the same concrete models" (1996[1962]: 11) their predecessors have studied from, it is natural that generation after generation of practitioners become dedicated to the principles and rules they gained knowledge of. In consequence of this shared commitment, theories expand in a consensual way, guaranteeing the "continuation of a particular research tradition" (Kuhn 1996[1962]: 11).

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[31] Freely translated from "aqueles que resultam de uma contradição ou de uma incoerência interna da teoria; aqueles que põem em evidência um desacordo entre uma teoria e uma determinada experiência, ou entre varias teorias concorrentes; aqueles que traduzem um facto surpreendente que choca o senso comum."

[32] An example of an experiment involving pattern design is the one *Levi's* has been carrying out since the 1990s, under the label *Engineered Jeans* (Simões 2005).

The same question suggests other answers explaining the three forms of the paradox in pattern design previously submitted. To this effect, regarding the first one, the following explanation is found in Bohm: “When a theory has been given a more or less axiomatic form, the resulting appearance of precision, fixity, and perfect logical order has often given rise to the impression that knowledge has finally arrived at a kind of ultimate truth. And so the axiomatic form can act as a set of ‘blinkers’ preventing people from looking in new directions, rather than as a set of hints and clues pointing to contradictions and inadequacies in existing lines of thought” (2006[1996]: 66).

Regarding the second form of the paradox at issue, Kuhn is referred to again, as he emphasizes that “paradigms gain their status because they are more successful than their competitors in solving a few problems that the group of practitioners has come to recognize as acute” (1996[1962]: 23), an explanation that reinforces the conviction that, regardless of the results presented by daring researchers, pattern design seems unwilling to accept a representation that combines all body stances in a single shape.

With regard to the third form of the paradox in pattern design, to be fair to this discipline its attempt to improve the correlation between body and clothes, or to fit the clothes to the body in a more effective way, brought on another strategy referred to as *ease*, a strategy that supplements the conventional paradigm of the body’s representation. Understood as the difference between the dimensions of the body and the clothing’s measurements, the extra amount incorporated in a pattern is thought to allow for body movement while the “garment hangs smoothly and evenly on the body with straight seams, no fabric distortion nor pulling, and no gaping” (Branson and Nam 2007: 265).

Even though wearing ease is distributed unequally around a pattern[33] – each additional measurement depending on each body location propensity to undergo volume change –, Yi Li, Xin Zhang and Xiao-qun Dai draw attention to the circumstance that body movement can cause the space between the body and the clothing – made from patterns – to shrink (Li and Dai 2006: 12). Correspondingly,

[33] This type of ease is differentiated from “design ease,” a garment industry’s expression denoting the additional room given for style purposes (Branson and Nam 2007: 266).

Li and Wong stress that, as ease diminishes during motion, excessive pressure may be exerted on some body locations leading to physical distress (2006: 143).

Actually, to neutralize – or to lessen – the chain reaction described previously, designers can supply extra wearing ease to garments by means of **(1)** placing their pattern pieces on the bias – to make the most of the fabrics' ability to stretch –, **(2)** inserting gussets and/or other design features – to extend the clothing's surface on some body locations –, **(3)** choosing textiles with specific fiber contents, yarn forming or weaving techniques – to take full advantage of their elastic behavior (Branson and Nam 2007: 267).

Although these strategies help designers to create a "well-fitting garment" (Branson and Nam 2007: 267) or, in other words, to erect a close relationship between body and clothing – through an approach that, almost certainly, attempts to overcome a mere quantitative correlation as it adopts a qualitative approach –, the paradigm these strategies develop from is still the upright and static body. Implied in this assertion is the corroboration that all the mechanisms listed above depend solely on the attributes of fabrics, rather than relying on the construction of an analogy between the mechanical behavior of the body's tissues and the mechanical properties of the clothing via patterns.

As it happens, the absence, in the patterns, of a description corresponding to the deformable body results in garments that, as Elizabeth M. Crowther emphasizes, "represent a typical paradox of modern dress – an abstract shape, the tube, superimposed on organic shape, the [body]" (1985: 327). In addition, knowing that "a significant proportion of modern consumers [...] demand apparel products with higher added values in terms of functional performance" (Li and Dai 2006: 3) since they're assigning more and more importance to the wearing experience (Li and Wong 2006: 1), it is rather odd that the paradigm of representation chosen by pattern design remains as static as the body it portrays is kept inactive.

We have understood earlier that this determination is, to Kuhn, a reflex of the assurance given by a paradigm that succeeding generations conform to and, to Bohm, a consequence of the inhibiting characteristic possessed by a universally accepted theory.[34] But if Kuhn and Bohm expose the drawbacks caused by

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34 See pp. 21-22.

paradigms, Klein guarantees that only theories that are reasonably formulated and supported by plausible results – a category in which pattern design is placed – can offer the opportunity to question or oppose the developed solutions, if not the conceptual framework they're based on (1996[1994]: 10, 109).

In combination with this willingness to give up fixed concepts and solutions is a disposition that ultimately enables us to notice things that others don't see; accordingly, we become conscious of the significance of paradoxes, as they actually encourage science to progress (Klein 1996[1994]: 10). A firm endorser of this thesis, Klein proclaims that "addressing, understanding and resolving a significant paradox builds better theory, and moves a discipline onward by revising inadequate concepts, preventing the establishment of dogma, and avoiding cultural fixation" (Love 2002: 2).

But as Klein and particularly Bohm let know, at the outset of resolving a paradox intuition must replace deduction; imagination must supplant knowledge. In fact, Klein upholds that most of the time imagination is the decisive push for fresh ideas to develop (1996[1994]: 135), and Bohm says that "the power to imagine things that have not been actually experienced has [...] commonly been regarded as a key aspect of creative and intelligent thought" (2006[1996]: 50).

Admitting that creativity is indispensable to surpass conservative perspectives – whatever their area of concern might be –, the following paragraphs are drawn on Bohm's reflection about the relationships between imagination and rationality – incorporated in *On Creativity*'s third chapter, titled "The Range of Imagination" (2006[1996]: 50-75)[35] – since the quantum physicist considers that these perceptual qualities are fundamental to intelligence.

To begin with, Bohm vehemently defends that intelligence should be regarded as "an *art* – the art of perception through the mind" (2006[1996]: 75) because, for him, this mental faculty depends on pure insight rather than on gained experience. To the same extent, the quantum physicist believes that intelligence is diametrically opposite to thought, as he considers that thought is a simpler and more embedded modus operandi that developed from the profound impact "the

[35] This chapter corresponds to an essay originally written in 1976.

eternal recurrence of day and night, or of the seasons" (Bohm 2006[1996]: 69) has on the human mind.

Recognizing two different patterns within this lesser form of awareness, i.e., the reactive and reflective thought (Bohm 2006[1996]: 69-70), the quantum physicist finds in the first one an explanation for all the physical and mental operations rooted in repetition that are – consciously or unconsciously – engaged in habitual or unchanged situations and in the second a justification for the way we "*respond beyond the framework of* [the previously described] *mechanical mode of operation*" once external circumstances change (Bohm 2006[1996]: 71).

In view of that, Bohm suggests that reflective thought acts to restore stability, which, when attained, is replaced by reactive thought, as this passive mode is "once again adequate to meet the situation in which we find ourselves" (2006[1996]: 70). But even if, ideally, reflective thought searches for solutions to unprecedented situations, in reality this mode of operation has a propensity "to fall under the domination of a mechanical pattern" (Bohm 2006[1996]: 71), as it only attempts to adjust the standard functioning of reactive thought until the anomaly is assimilated.

For that reason, Bohm is sure that the challenge to find a very complex solution outside our memory patterns generally impels a higher stage of thought to take form, which involves the activities of the mind moving within the range of fancy (2006[1996]: 72). Given that this last category integrates Bohm's model as to the mental actions engaged in creative and intelligent thought, we must now look into the physicist's proposal.

Within this model, the spectrum of mind activities is broken down into two sorts, namely imaginative insight and imaginative fancy, each one of them evolving respectively into two complementary activities, termed rational insight and rational fancy. Going from imaginative and rational insight to imaginative and rational fancy, this sequence – however intertwined it seems to be – converts intuitive perception into logical reasoning.

Intelligent thought, thus, can be compared to a path beginning "in creative and original acts of insight, the content of which is then further unfolded and developed in the domain of fancy" (Bohm 2006[1996]: 67). A simplified description of what happens throughout this process is: **(1)** a new way of looking at a problem, appearing all at once, is immediately followed by **(2)** the implicit orderly display of the recognized relationships between its basic features, which trigger **(3)** their association with mental images existing in other contexts; the resulting links, enabling to test different aspects of the creative insight, lead then to **(4)** the explicit and systematic display of the original image's basic features, followed by the developing of inferences (Bohm 2006[1996]: 54-65).

By looking carefully at the implications proposed by Bohm's model, "we are led to distinguish between *imaginative* and *rational insight*, which is the primary act of perception through the mind, along with its immediate display, and *imaginative* and *rational fancy*, which is the construction or putting together of known concepts and images in a logical order" (Bohm 2006[1996]: 64-65).

But the idea that there are two qualitative modes of operation within imagination doesn't mean that these two poles of activity are separated; rather, it means that creative and intelligent thought moves along the domains of intuitive perception and logical reasoning, shifting from one to the other in downward and upward motions.

According to Bohm, then, imagination, seen as a single activity, is "mainly [differentiated] according to the order of its *content*" (2006[1996]: 52). As it happens, a notion that turns up through creative imagination develops through constructive imagination when, as a result of its mental processing,[36] the implicit features contained by this new image are linked to stored images. Likewise, the process of unraveling the contradictory aspects contained by the new notion, belonging to the domain of constructive imagination, gives rise to new perceptions since the recognition of the meaning of facts lying before us involves "a considerable degree of insight" (Bohm 2006[1996]: 56).

After reviewing Bohm we surely realize that the key point of his model is how fundamental creative and original insights are to surmount and solve the conflicting aspects within a specified problem (Bohm 2006[1996]: 54) – or to overcome the limited solutions given by fixed paradigms. But, apart from the

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[36] Carried out in a similar way as the construction of sentences by way of putting together words according to specific rules.

uniqueness that distinguishes Bohm's model,[37] we must also acknowledge that the underlying idea it conveys is not exclusive to the quantum physicist, at least in terms of its general consideration; in fact, when Klein – among other thinkers[38] – declares that there is no creativity without imagination, he is referring to the circumstance that a simple image – however flashing or recurrent it may be – is often at the basis of great findings (1996[1994]: 136).[39]

In light of the substantiated actuality and significance of this occurrence, it seems intriguing that imagination – understood as the ability to form images and ideas in the mind, especially of things never seen or never experienced directly – and to the same extent creativity – considered as the ability to use imagination to develop new and original ideas or things – were until quite recently looked upon as aptitudes belonging only to poets (Klein 1996[1994]: 136; Tatarkiewicz 1988[1975]: 280-283).

Opportunely, Wladislaw Tatarkiewicz (1886-1980) helps figure out why, for a long time, creativity and by the same token imagination were altogether excluded from the artistic and scientific domains (1988[1975]: 282, 288). By going briefly into the philosopher and art historian's review of the understanding of creativity in art throughout time, we first learn first that this concept has always been associated with "the liberty of action" (Tatarkiewicz 1988[1975]: 279).[40]

We gather, then, that this kind of freedom implies that one is be able to create something without any sort of constraints. If in ancient Greece only poets were conferred this type of autonomy – seeing that the visual artists' work was regarded

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[37] Which could be described as the way he explains how an insight develops into an inference owing to a process that involves two interpenetrating activities of mind.

[38] Such as the philosopher Emmanuel Kant (1724-1804), who, being truly convinced that the formation of new ideas is inevitably found inside a mental mode of operation that is no longer mechanical, as it is intuitive, was the first one to draw attention to the decisive role imagination plays in science (Klein 1996[1994]: 136).

[39] On the word of the physicist Étienne Klein, the mathematician/physician Jerome Cardan (1501-1576), the mathematician/astronomer Johannes Kepler (1571-1630), the mathematician/physicist Isaac Newton (1643-1727), the chemist Friedrich Kékulé (1829-1896), the mathematician/theoretical physicist Henri Poincaré (1854-1912), and the theoretical physicist Albert Einstein (1879-1955) have proven the legitimacy of this claim (1996[1994]: 136-137).

[40] Freely translated from "[...] la libertad de acción." On this very acceptation of creativity we're reminded of Albert Einstein as he said, "the quest of a faithful image of the world can only emanate from an act of liberation as to all information that situates and constrains us" (Klein 1996[1994]: 137); this quote is freely translated from "[...] a demanda de uma imagem fiel do mundo só pode nascer de um acto de libertação relativamente aos dados que nos situam e nos constrangem."

as the dexterous application of a set of laws and rules in order to imitate nature –, in the Renaissance, painters, sculptors, architects and musicians, claimed that their work was definitely the product of their creativity and self-determination; furthermore if in the 1800s the word *creativity* became a synonym of *poet* and *artist*, in the twentieth century the idea of novelty was recognized as existing in all areas of cultural activity, be it art, science, politics or technology (Tatarkiewicz 1988[1975]).

According to Tatarkiewicz the concept of creativity has evolved, thus, from meaning **(1)** the creation of something new that arises from nothing – which, in the Middle Ages, agreed with God's doings, not people's accomplishments (Tatarkiewicz 1988[1975]: 282) –, to its contemporary adaptation, which – on account of having become accepted as an attribute of artists, scientists and so forth – corresponds to **(2)** the production of something new (1988[1975]: 288).

Although it appears simplified, the modern signification of creativity purports an extensive variety of manifestations comprising different qualitative categories, which are conferred diverse degrees of creativeness. Going over a few of the alternatives identified by Tatarkiewicz, in any kind of human production the qualification of novelty comes into view by way of new forms, models and processes, and, in art, by means of a new work within a certain style, or of a new style *per se*; in general terms, the idea of novelty implies that the new piece introduces an aspect that was missing in former productions or, more modestly, combines the features presented in earlier creations in an unfamiliar way (1988[1975]: 293).

Regardless of the fact that the current notion of creativity accepts a vast amount of possibilities, the old meaning of creativity is reclaimed – or more properly said, reviewed –, but now from an atheist point of view. Within this perspective, to think that the creation of something new can originate from nothing is not an outrageous postulate after all, especially if it is associated with Bohm's view on creativity.

To begin with, as odd as it may seem, Bohm believes that creativity does not depend on a special talent but rather on originality;[41] the sense in which Bohm understands originality comprises the prerequisite of one's willingness to consider a new situation without any preconceptions, as one faces the possibility that the ideas he/she is accustomed to cling to are unsound (2006[1996]: 4). Behind this consideration is a conception of originality that – furthering Tatarkiewicz's characterization of creativity as novelty – enfolds a twofold purpose: the "fundamental need to discover and create something new that is whole and total, harmonious and beautiful (Bohm 2006[1996]: 3).

It is pointless to weigh up if to create something new is a basic need, as the quantum physicist suggests, or a cultural response, like the followers of the functionalist school of anthropology advocate;[42] what's relevant is to trust Bohm when he says that the drive to create something whole, fitting and beautiful demands that whoever does creative work adopts a creative state of mind (2006[1996]: 20).

As we have learned before, this kind of action – no longer drawing on the mechanical mode of operation we fall back on when dealing with customary situations, no longer drawing on acquired knowledge – may start with an original act of insight, so pure that it doesn't contain any vestiges of former images. It's precisely on the basis of this quality that it is upheld that to create something *out of nothing* is a faculty of people; with Bohm, this opportunity is definitely granted to us, providing we do not limit ourselves with preformed notions.

Research Through Creative Practice

[*An Empirical Perspective*]

To make the most of David Bohm's model, the following description is about the mental development that sustained this doctoral research, an investigation that is

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[41] Bohm sustains his belief by saying that "clearly, it is not *all* a matter of special talent. For there are a tremendous number of highly talented people who remain mediocre. Thus, there must have been a considerable body of scientists who were better at mathematics and knew more physics than Einstein did. The difference was that Einstein had a certain quality of *originality*" (2006[1996]: 4).

[42] According to Bronislaw Malinowski (1884-1942), the founder of functionalism, an example of the first is the need for body comfort, to which the creation of different types of shelters is the corresponding response (Polhemus and Proctor 1978: 9).

based on the assumption that pattern design could do with a new way of considering the body and its representation. The option to use the present tense to impart the series of mental actions that took place in the past reflects the belief that this format conveys better the research's progression as it was evolving in the mind. In light of this information, it's recalled that,

> **(1)** *Spellbound by the possibility to reflect the liveliness of the body on the patterns' contours, the lineament of the mobile body comes to the mind, still as an undeveloped image.*[43]

On the one hand, the challenge presented by this original insight rests on the fact that patterns are drawings, and by being so they are nothing but two-dimensional descriptions that portray one moment in time of a rigid body; on the other hand, the body is more than a three-dimensional entity since, during motion, its height, width and depth cease to be fixed.

The ability of the body to undergo shape change – and to return to its original appearance, which is what characterizes this entity as elastic (Özkaya and Nordin 1999: 4) – is, to say the least, the result of the mechanical properties of its bone, skeletal muscle and skin tissues, the way they are stacked one on top of another, and the structure-function relationship each of these tissues – viewed as a system – bears: if muscles generate force, bones distribute it and skin accommodates it, enabling movement to set off and to go on.

On the word of the reviewed authors, muscles are "the main internal motors and brakes for human movement" (Knudson 2003: 49), bones "act as a lever system to transfer muscle forces" (Enoka 2002: 211), and skin "conforms to the [mechanical behavior of the] underlying bones and muscles" (Moes 2004: 70). But for force to be generated, peripheral nerves have to stimulate skeletal muscles to work in synergy with their antagonists, by shortening and lengthening their fibers (Tsiaras and Werth 2004: 32, 98); then, as a muscle shortens, it "[pulls] bones together, causing movement at the joint it crosses," as John Zaller explains (2006: 4).

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[43] The acceptation of the concept of *lineament* it is fully expounded in Lineament Vs. Representation, a section integrated in Part 2, entitled Antecedents Of The Research, as its meaning and implications deserve a section of its own.

In spite of the conciseness of the previous description, it is possible to conclude that body movement – whatever the external circumstances are – is a product of the energy coming from within the body; nonetheless, the display of this inner energy is not merely discernible underneath its surface, as it is quite perceptible on its exterior. Thus,

> **(2)** *The intrinsic meaning of the original insight becomes gradually unfolded, as it is recognized that the lineament of the mobile body involves disclosing the liveliness of the body's subsurface embodied in its outer shell.*

Let it be said once more that muscles contract and, in response, bones glide and skin stretches around the synovial joints: the interactive doings of these tissues allow the body to perform actions like walking, holding, sitting, standing, donning and doffing. Evolving through time and space, those activities comprise sequences of movements that are either cyclical or not. But regardless of their progression, they are all performed every day, no matter what the occupation of a person is.

Hence, those activities must be accounted for in terms of their frequency as well as their duration, which signifies that the number of times they are executed throughout the day, plus the periods of time they last, have to be determined. The allocation of those activities to categories according to the dimension of time does not indicate that it's intended to select one action over the others and use one particular body position that – symbolizing all, given its prevalence – can replace the upright and static body posture adopted by the long-established paradigm of representation.[44]

On the contrary, through analyzing the frequency and duration of those activities, the objective is to be able to correlate the shape of the alternative basic patterns with the routine of the body, an action that'll result in the integration of the dimension of time along with the incorporation of the aspect of energy – formulated previously – as relevant parameters to pattern design. Since these two factors are clearly associated with the spatial dimension, it is also necessary to assess the amount of body movement that occurs at the joints, as well as the

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[44] With such an approach the research would fall back on the kind of logic that sustains the theory of conventional pattern design, which is something not desired.

corresponding magnitudes of the implicated skin/muscle tissues emanating from the physical actions performed on a daily basis by everyone. However,

> **(3)** *To confirm the actual implications of the insight the lineament of the mobile body must be approached in a manner that the deformations undergone by the body throughout movement become imprinted on clothing while they are worn.*

In view of this, it seems pertinent to utilize people dressed in clothes tailored to fit their bodies closely and assembled with a textile material that, having a plastic behavior, undergoes permanent deformation. The amalgamation of all body positions – assumed throughout the physical actions performed by everyone on a daily basis – into one single shape is thus formed through the synchronized coordination of the elements of time, space and energy.

After this stage of the artifact's creation, the used garments are examined to see which features of the deformed separated components are significant to include in the flat paper drawings that will correspond to the alternative basic patterns. Trusting that the structure of clothing has a major influence on the perception of comfort, the features that will be looked into are **(1)** the way seams run on the body, and **(2)** the orientation of the center of the pattern pieces in relation to the fabric's warp direction or grain.

The generation of these alternative basic patterns – reflecting in their lines the synthesis of all body positions comprised in ordinary movements – involves evaluating the improvement of body movement comfort or action comfort, i.e., to evaluate if the basic patterns' design awards "a higher degree of freedom of movement without undue pressure or friction on the skin" (Watkins 2011: 248). Bringing into play participants wearing clothing constructed with the new basic patterns as well as clothes assembled with conventional basic patterns, the two patterns are judged against each other. In the end,

> **(4)** *The results ascertained through the implemented wear-trials validate the assumption that it's possible to create a connection between the body's dynamic makeup and its flat representation.*

The previous description of the mental evolution behind this doctoral research suggests, without expressly stating it, that the generation of the alternative basic patterns called for an approach that complies with the category of research *through* art and design, a designation introduced by Christopher Frayling (b. 1946) in 1993, when he proposed a tripartite model for the research in art and design practices (Durão and Vasconcelos 2007: 4; Horváth 2008: 67; Montag 2000: 9).

Clearly differentiated from the categories of research *into* art and design and research *for* art and design – in the same way as these two are unrelated to one another given that the former looks at art and design work in terms of their historical, aesthetical and theoretical implications, and the latter corresponds to the creative processes connected with the production of works of art and artifacts of design –, research through art and design is described as the type of investigation **(1)** in which "the researcher works in practice within the field of interest but also reflects and contextualizes it" (Durão and Vasconcelos 2007: 5), **(2)** that involves "pursuing abstractions and generalizations from the practice of design" (Horváth 2008: 67), or **(3)** that is related to "the taking of something outside of the art and translating it through the artistic medium" (Montag 2000: 10).

To the same extent, the position of the researcher within each category of research also varies. Research into art and design is led from an external standpoint as the researcher isn't – in all probability – the artist or designer who generated the work under consideration; research for art and design, being carried out by the artist or designer, reflects the investigator's perspective on the researched subject; and in research through practice, the artist or designer developing the study imparts a viewpoint that is simultaneously internal and external to the subject of research (Montag 2000: 9-10).

As Montag suggests in his reflection on "the contribution that the visual arts can make to knowledge" (2000: 5), the fact that the process of thinking behind the creation of an artifact is embodied in it – through the translation of a concept into a tangible and visual form, through the techniques, materials and colors used in its formation, *et cetera* – demonstrates how research is "vital to the production of some original artworks [but] it does not necessarily imply that the artifact makes an original contribution to knowledge" (2000: 10).

In Frayling's view this aspect alone determines that research for art and design is the only category failing to meet the requirements of doctoral research (Montag 2000: 10; Durão and Vasconcelos 2007: 5) since this particular level of academic inquiry demands the systematic production of new knowledge as well as its verbal communication (Montag 2000: 8; Durão and Vasconcelos 2007: 4).

To go into detail about this dual-purpose yet general stipulation, Maria João Durão and Maria Constança Vasconcelos remind us that to fulfill a PhD research "it is necessary to define objectives, research questions or problems to be addressed as well as to state the importance to the advancement of knowledge and understanding in the area. It is also necessary to specify research methods and justify why they are appropriate to the foreseen outcomes" (2007: 5). In so doing, a researcher aiming for a doctorate[45] is clarifying which framing methodology guided him/her throughout the developed inquiry.

Shedding light on this last decisive *criterion*, Imre Horváth writes, "a framing methodology is a construct that defines the way of reasoning, the methodological approach, and the process flow of concrete research projects" (2008: 66). With reference to design research in general, Horváth says that framing can be described as "a holistic process of selectively using mental structures" to generate a particular image, to assist thought, or to choose methods and tools (2008: 66); in the specific case of research through design, Horváth declares that "it is believed that when [this category] is applied as a framing methodology," the artifact being developed functions as a research tool (2008: 67).

Going along this statement, the instrumental evolving artifact – symbolizing the intuition the designer has about the problem being dealt with – is a means to move toward answering the research questions. As the artifact is tried out, it expresses a relationship of cause and effect that enables the researcher to build "a context-related body of knowledge" (Horváth 2008: 67).

Within this perspective, research through creative practice "opens up doctoral research for the creative disciplines" (Montag 2000: 10) since the researcher's contribution to knowledge reveals itself in the connection found between theory

[45] Developed in any area of study within any realm of knowledge.

and practice – or, as Montag puts it, in the link he/she establishes between the "written text and [the] artifacts" described in the thesis (2000: 11).

So that the framing methodology of this doctoral research is fully understood, the addressed problem or research question is now identified:

> *How can an alternative set of two-dimensional basic patterns be generated after the lineament of the mobile body*?

Furthermore, the framed problem or research question implicated asking:

> *Do the generated basic patterns have a positive effect on the perception of comfort during wear?*

The structural objectives just advanced convey the idea that the purpose of creating an artifact is consistent with the fundamental nature of design, an activity that, according to Herbert A. Simon (1916-2001), is about the conception of "courses of action aimed at changing existing situations into preferred ones" (1996[1969]: 55). The definition given by the political scientist, economist and psychologist embraces the notion that artifacts amount to "interfaces" (Simon 2009: 108), as their performance results from the dialogue kept between their inner an outer environments, which is the same as saying that the functioning of artifacts necessarily conforms to the natural laws existing inside and outside them (Simon 1996[1969]: 57-58) – that is, mechanical, gravitational, and so on.[46]

By looking at the problem or research question previously outlined it becomes clear that the focal point of this doctoral research congregates two essential entities, i.e., the body and its representation in pattern design, for they are implicitly related. Also noticeable is that this practice-led research is framed by body/product physical interaction concerns, for mechanical sensations – among others – "play an important role in determining the comfort status of the wearer" (Li and Wong 2006: 4).

In agreement with Simon's proposition and Li and Wong's assertion, the functional aspect of the alternative basic patterns is brought about by a tripartite

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[46] Simon offers these examples: "Whether a clock will in fact tell time depends on its internal construction and where it is placed. Whether a knife will cut depends on the material of its blade and the hardness of the substance to which it is applied" (Clark and Brody 2009: 108).

relationship (Simon 2009: 107): **(1)** the character of the artifact, or the synthesis of all body positions comprised in ordinary movements, **(2)** the purpose of the artifact, or the improvement of body movement comfort, and **(3)** the environment in which the artifact performs, or the body. But to ensure that these three elements teamed up, the standard body – a concept implying that everyone is biologically alike, everyone has the same body segments, everyone does similar movements, *etc* – had to act as a mold. In this manner, the created artifact – designed for the development of portable environments, as Susan A. Watkins refers to clothing (1995) – adapts to the foremost and remarkably deformable environment, the actual body.

The logic behind the creation of the artifact reveals that its formalization was based on reciprocity, as it was done for the body through the body. The aim to change an existing situation into a preferred one by way of altering the representation of the body standing still into the lineament of the mobile body – as an alternative representation paradigm for pattern design –, along with the decision to design the artifact from the inside out – as an alternative process toward the problem's solution –, implicated a reasoning that can be somewhat compared to the logic of the optimization methods the area of design practice has borrowed from theoretical and scientific disciplines (Simon 1996[1969]: 60).[47]

'Somewhat' because, contrasting with the calculations taking part in those methods, the operations involved in finding the best solution to the design problem that was chosen to be addressed were not mathematically computed. Notwithstanding, the carried out operations were diagramed in line with Simon's "Diet Problem" example (1996[1969]: 61) before the artifact's creation started out [*Figure 1*].

The reasons behind this decision were **(1)** on the one hand, the impossibility to know in advance the values of the matters implicated in the "optimization problem," and **(2)** on the other hand, working as a repository of thought (Corbin and Strauss 2008: 118), to draw the "optimization problem" in advance has actually displayed the best mode to disclose the ensued findings.

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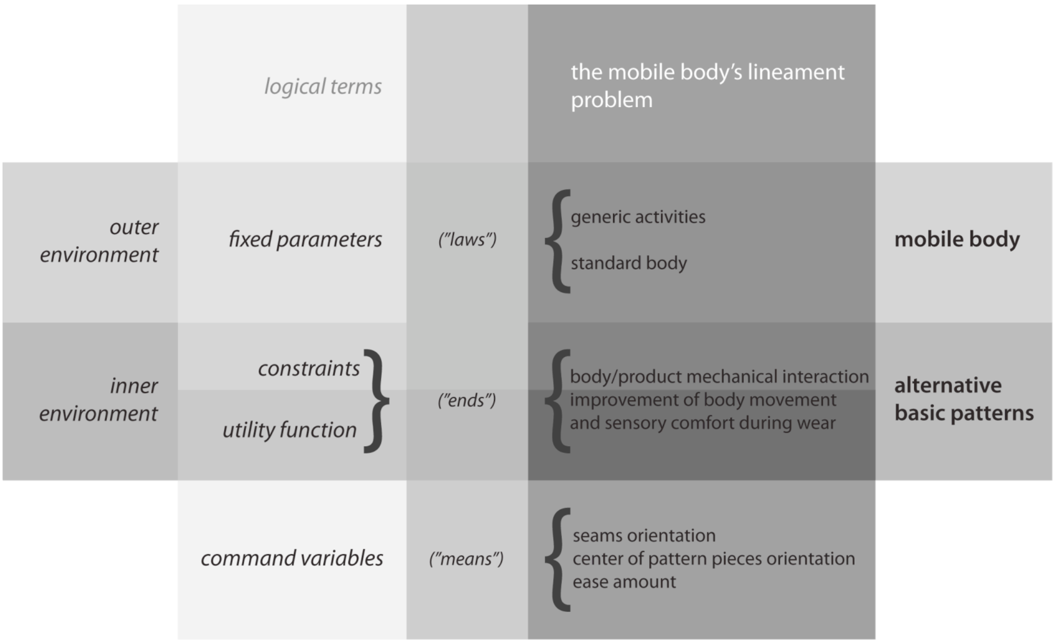
[47] Originally "developed in statistical decision theory and management science," these methods have been utilized in the areas of design practice "where standards of rigor in inference are as high as one could wish" (1996[1969]: 60).



[*Figure 1*]
The Logic Behind The Created Artifact, diagram adapted from Herbert A. Simon's "The Paradigm for Imperative Logic" (1996[1969]: 61)

In this diagram, the problem of the mobile body's lineament is presented in five columns spread into four rows: three columns and respective rows are written in italic, as they replicate exactly the words used by Simon; two are written in regular font style, as they comprise the information concerning the problem under consideration [*Figure 1*]. The top row contextualizes the following ones, placed right below it; the realms of the inner and outer environments are characterized in distinctive rows: the latter deals with fixed parameters, or 'laws,' as it concerns the mobile body; the former contends with the constraints and utility functions, or 'ends,' as it is related to the created alternative basic patterns; the last row represents the command variables, or 'means,' incorporated in the artifact.

Based on the previous account, the logic behind the created artifact [*Figure 1*] should be read as follows: **(1)** the problem is optimized when **(2)** the seams, ease and center of each pattern piece, integrating the alternative basic patterns are determined – in terms of their respective angles and measurements – so as to **(3a)** minimize the down side of clothing pressure and **(3b)** maximize the wearer's ability to move – in terms of the force applied by the former along with the time, energy and space taken by the latter while moving about. Implicit in the solution is that **(4)** the multi-dimensionality of the mobile body has to be taken into account

– i.e., the static description of the standard body in terms of girth, length and width measurements, the largest dimensions the body segments reach throughout changes of position, and the description of body positions and change of position identified in quantitative and directional terms –, as the design problem at issue is focused on the generic, or universal, activities performed by everybody on a daily basis.

Even supposing all this information was available somewhere, the complexity of working out the immense amount of numerical data connected with the parameters, constraints, variables and respective correlations – alluded to in the preceding paragraph – required that “an open and creative approach to research methodology” was adopted, as “research problems generated by art and design practice are likely to demand” (Darren Newbury, professor of photography, as quoted in Montag 2000: 11).

Consistent with Newbury’s proposition, the first part of the twofold problem or research question chosen to be addressed gave rise to a tripartite action that, favoring a qualitative approach and focusing on theory building, involved **(1a)** to allow the formation of the visual representation of the mobile body to happen in an unrestrained manner, as – through repeated wear – the flat shapes of the source pattern pieces developed gradually into volumetric planes with distorted outlines, **(1b)** to draw together the resulting deformations into the body position that corresponded to the amalgamation of all positions, and **(1c)** to mold the alternative basic patterns on the created tangible mannequin to determine the contour, grainline and ease of the various pattern pieces forming them.

Also in agreement with Newbury’s suggestion, the second part of the twofold problem or research question chosen to be looked at gave rise to a biphasic action that, favoring a qualitative approach and focusing on the validation of the formal solutions, implicated **(2a)** to build an interdisciplinary body of knowledge on body movement, perception of action comfort, clothing fit and wear trial techniques, and **(2b)** to examine the relationship between the generated basic patterns and the dynamics of wear, an act that combined direct observation with interviewing – both of these techniques reporting to the experience of users performing their usual daily activities in their usual environment.

The brief description of the various moments performed through time shows that the research advanced in a circular process, as it relied considerably on interpretation and conceptualization and yet again interpretation. And if the interest in the visual representation of the mobile body motivated to create an artifact – a project comprising actions **(1a)**, **(1b)** and **(1c)** –, the selected approach to originate its shape took an original set up that reflected itself in the way data was collected and analyzed.

The reasons for choosing such a strategy relate to the fact that measuring the body – a step on which the organization of patterns depends (Hearn as quoted in Giles 1987[1896]: 100; Hulme 1945b: 33; Bridgland 1933: 3; among many other authors) – is a very difficult preparatory task to perform, as the teacher and pattern designer Natalie Bray emphasizes (1986[1961]: 12).

Besides the unreliability of taking direct measurements, two other aspects justify the technique that was adopted to gather data for the artifact's creation: **(a)** the conviction that the amount of body dimensions that is required to make a replica of the deformable body is much bigger than the quantity that's considered necessary to plan the rigid body,[48] as well as **(b)** the trust in Bray's judgment[49] when she stresses that the incorporation of a smaller set of dimensions reduces the probability of describing the deformable body in a mechanical manner (1986[1961]: 12-13).

All things considered, measurements were indirectly taken with regard to the qualitative characteristics of the body not its quantifiable attributes. However this indirect method toward measuring the body is by no means less accurate than a direct one, as this entity was taken in all its complexity, studied it in its usual context. But instead of seeing the body as an object it was admitted as a key player, and so, in phase one – previously identified as action **(1a)** – the participants that accepted this role carried out their everyday physical actions in their own settings while wearing the fitted garments supplied by us. In this way, the physical contact between skin and clothing compelled the body deformations to become reflected

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[48] For instance, Winifred Aldrich derives all the measurements necessary to plan women's basic patterns, i.e., the skirt, bodice, sleeve and pants, from four, nine, two/three and four body measurements respectively.

[49] As it is based on a solid professional experience.

on the employed nonwoven fabric;[50] and in so doing the direct measurements that weren't taken earlier became accessible.

Knowing that the reason for which basic patterns are made is to support – in an efficient way – the development of clothing for a large number of consumers within a specific market genre,[51] it made sense to "identify the similarities and differences" (jpmats.com/Theoretical_Sampling.aspx) among the participants of the selected group in terms of the relationship between **(a)** the deformations undergone by the body as it was in motion, and **(b)** the deformations the conventional pattern pieces went through as a result of body movement.

With this intention in mind, it seemed appropriate to resort to a procedural technique based on theoretical sampling.[52] 'Based on' because the objective was "not the representative capture of all possible variations" (bookrags.com/wiki/Theoretical_sampling) existing in the totality of consumers "of a certain age, size and gender" (Seivenwright 2007: 13) – as intended with probabilistic sampling handled by quantitative approaches –, but to expand the understanding of the case in question (Sandelowski 1995: 180; bookrags.com/wiki/Theoretical_sampling). 'Based on' because the object of study was "not people *per se*" (Sandelowski 1995: 180) but the relatedness between the mobile body and its visual representation in pattern design; so it was people's everyday actions that were sampled or, to be more precise, what was sampled was the reflected image of the ordinary movements performed by people on the employed close-fitting clothes.[53]

Since the goal of the exploratory work carried out in phase one was to determine if there was a deformation pattern that could be used in the lineament of the mobile body carried out in phases two and three – previously designated actions **(1b)** and **(1c)** –, it was essential that the collected and analyzed data yielding this possibility reached theoretical saturation. Viewed as "the point when no new categories, concepts, dimensions or incidents emerge during the theory development process"

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[50] See the description of the selected textile material in Preliminary Steps Toward The Artifact's Creation, pp. 121-131.

[51] The three market genres in fashion are the Womenswear, Menswear and Childrenswear (Seivenwright 2007: 136).

[52] Termed by Barney Glaser (b. 1930) and Anselm Strauss (1916-1996) in 1967, this technique is typical of qualitative projects that, within the social, behavioral and health sciences, employ *grounded theory*.

[53] Made of a plastic textile material.

(jpmats.com/Theoretical_Saturation.aspx), confirming this matter implicated that the sampling process was reiterated until the garments worn by eleven participants – wearing the same clothing size – showed corresponding degrees of distortion in the same body locations, respectively.

It must be added that the choice to focus on a group formed by women wearing Euro size 38, or to narrow the scope of the research, had to do with the fact that **(a)** the apparel industry has globally elected the Euro size 38 – or its US, UK, *etc*, counterparts – as the size with which the patterns of prototypes are created;[54] furthermore **(b)** by reducing the variables integrating the sample, the key features leading to the lineament of the mobile body would be easier to perceive.

To return to this account, from theoretical sampling to theoretical saturation, the creation process **(1)** started with a three-dimensional approach toward the visual representation of the body where the participants assumed the role of the artist – as it was the body, not the researcher, that generated its own image –, and **(2)** proceeded with a three-dimensional approach toward the visual representation of the body where the researcher – taking control of the process – translated the clues left on the clothing into drawings bringing forth the intended illusion.[55]

As it happens, the alternative basic patterns were the outcome of a process by which the collected self-portraits were converted into a compound portrait. But if the created artifact followed as a consequence of the first action mentioned above, a further action had to be implemented to check if the interpretation of the self-images produced by the participants seemed right. In the context of this thesis, to seem right means that the aesthetic aspect of the alternative basic patterns – their beauty – only makes sense if its functional aspect is manifest, that is if drawing, body and movement, merge into a unified whole.

In view of that, a series of wear trials were utilized – previously designated action **(2b)** –, as this type of validation technique is "one of the most widely used methods to observe subjects immediate responses in clothing under different [...]

[54] In agreement with the worldwide inclination are the Portuguese clothing industry and the Portuguese independent fashion designers, as shown in Preliminary Steps Toward The Artifact's Creation, pp. 133-138.

[55] I decided to write the word *researcher* in this paragraph to emphasize the contrasted positions of researchers and participants in terms of the contribution/responsibility each had for the interpretation of data, the communication of knowledge, the establishment or revision of theories, and the like.

conditions and activities" (Li and Wong 2006: 286). Coinciding with the authors' assertion, this specific experiment demanded that a group of participants performed generic activities, such as walking, holding, sitting, standing, donning and doffing, for a second time.

Following a predetermined protocol, the implemented wear-trials **(a)** were carried out in two controlled environments, as the chosen testing conditions maximized **(b)** the participants' perception and **(c)** the analysis of the collected data; to facilitate the interpretation of the results **(d)** the participants and researcher agreed on the actions that elicited **(e)** the localized sensory responses they noted down on evaluation sheets; to facilitate the participants' judgment **(f)** the prototypes made from the alternative basic patterns were tested against prototypes made from conventional slopers, and to minimize potential bias **(g)** the two sets of prototypes were tried in reverse order in different days.

However concise the description of the processes leading to the artifact's creation and validation was given in this section of the thesis, it shows that this research moved from intuitive to empiric approaches, from interpretive to analytic methods. But it also shows that the research formed, from beginning to end, a goal-seeking system[56] since, according to Simon, "the condition of any goal-seeking system is that it is connected to the outside environment through two kinds of channels: the afferent, or sensory, channels, through which it receives information about the environment; and the efferent, or motor, channels, through which it acts on the environment" (1996[1969]: 66).

In point of fact, if the process counted on the possibility that the garments leading to the artifact's creation received information about the body, the process also counted on the possibility that the garments made from the generated basic patterns acted on the body. Conveyed in the previous sentence is the idea that, if the first garments have acquired their idiosyncratic shape as the textile they were made of integrated the input of the body, the resultant artifact embodies the desired situation as the answers to the twofold problem or research question merged into one.

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[56] See the division of the framed problem or research question into various actions presented in p. 38.

Furthermore, if the participants were quite important contributors for the artifact's creation, they were also very important for its validation. Their significance lies in the fact that the body gathers and relays information about the outside world through the contact senses that – engaging countless sub-microscopic sensory receptors located at innumerous sites – extend from the central nervous system (Tsiaras and Werth 2004: 57); in response to the received physical stimuli, the central nervous system conducts outward information, which enables the body to take action.

Perception, thus, corresponds to the mental images formed within the body that develop from the temporary change of activity taking place at specific sensory receptors. When objects, like clothing, are directly in contact with the skin, the brain generates images relating to their shape, texture, weight, *etc*; combined with these images, the brain produces maps about the state of the body as it becomes aware of the automatic emotions those objects aroused (Damásio 2003: 105, 133, 220).[57] Ultimately, throughout this process, the body perceives itself under a particular condition and perceives the thoughts matching the type of emotions being felt.

Given this particular aptitude of the body, it's no wonder, then, that the final stage of the research relied on the participants' ability to verbalize their feelings for the created artifact rather than counting on some form of quantification of the pressure induced by the second garments on the body tissues. The option to depend on subjective perspectives to arrive at the findings was, by no means, a way to avoid the rigor a doctoral research is expected to have. Quite the opposite, since qualitative researches – a category in which the developed research fits – achieve rigor by incorporating the meanings formulated by participants about a phenomenon and by comparing them against the advanced theoretical construction, among other *criteria* (Corbin and Strauss 2008: 299).

Actually, allowing the participants to guide the process throughout this practice-led research brought about the possibility to solve a problem: the lineament of the mobile body. Again, the deliberate decision to do qualitative research brought on the possibility to generate a theory grounded in data, an occurrence that called for

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57 For example, pleasure or pain.

the integration of findings so “an overarching theoretical explanatory scheme” was formed (Corbin and Strauss 2008: x).

An additional action was carried out,[58] bringing into play the knowledge of disciplines like physics and history of science, art history and criticism, physiology and neurophysiology, science of clothing comfort and clothing engineering. In conjunction with the contextualization it provided the addressed problem or research question – regarding the implicated concepts, scope and techniques –, reviewing technical literature permitted to substantiate the findings and “to illustrate where the literature only partially explains [the] phenomenon” in question (Corbin and Strauss 2008: 37).

But above all, the validation of the grounded theory that was developed within the field of pattern design and the territory of visual representation demanded that the created artifact was submitted for aesthetic appreciation. Acting as a museum or gallery, the wear-trials were the right means for the participants to comment upon their experience, an experience in which beauty is taken as a “sensitive emotional indicator” (Bohm 2006[1996]: 45) of the truth established.

Certainly it is not being conveyed that the interpretation of the collected data for the artifact’s creation is the only conceivable interpretation anyone could form from it. What is conveyed is that the first garments were regarded as having the potential to present *a* solution that was “already implicit in its premises” (Simon 1996[1969]: 77).

In fact, the first garments disclosed the kernel of the change the conventional basic patterns had to undergo, as the amalgamation of all body positions – having given a tangible form to the mobile body – already implicitly displayed the shape the alternative basic patterns ended up having.

The diagram presented in [*Figure 2*] represents the flow of the research as well as the main features and phases that characterized its progression.

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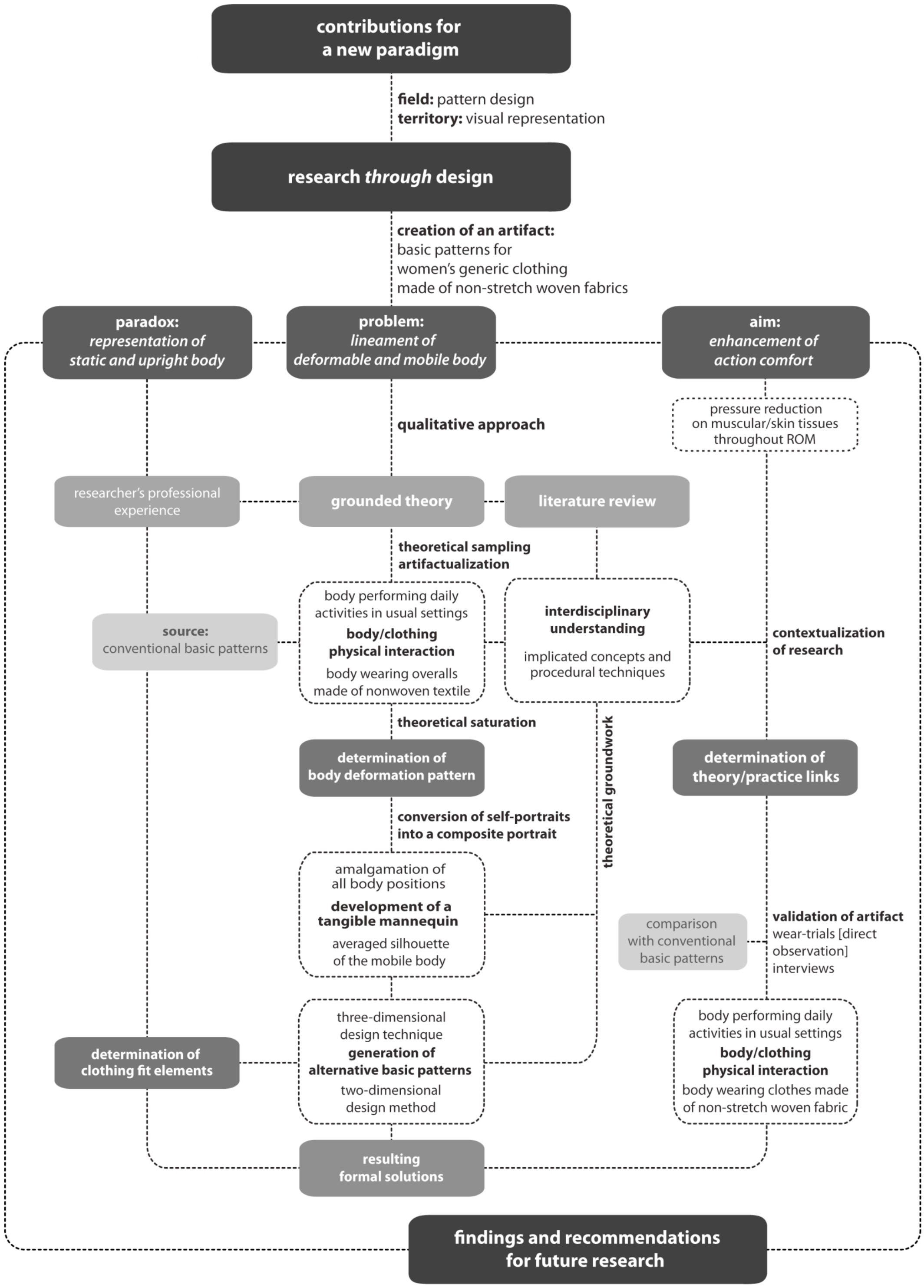
[58] Previously called action **(2a)**. See p. 38.



[Figure 2]
A Portrait Of The Research

Summary

In Part One three major issues are covered, namely, **(1)** the representation in patterns, **(2)** the paradox in pattern design, and **(3)** the research through creative practice, that reflect three different angles respectively: **(1a)** an aesthetic perspective, **(2a)** an epistemological perspective, and **(3a)** an empirical perspective. Viewed as a whole, they make up the conceptual framework of this research; viewed as a sequence, they begin by raising the meanings and implications of the object of research, and end by focusing on the process toward the accomplishment of this doctoral research.

Correspondingly, in Representation In Patterns, it is proposed a reflection about pattern design based on two complementary views: the fact that patterns are useful tools for the production of garments is a condition that doesn't dispossess them of beauty; the fact that patterns use a drawing language of their own doesn't mean that their rigorous lines cannot yield an illusion. In this sense, more than seeing the way patterns are going to be assembled, we see them as the clothing they represent; more than seeing how patterns are put together, we see the body represented in them.

Then, in The Paradox In Pattern Design, it is suggested that the elected paradigm of representation in pattern design stumbles into a paradox. This allegation involves considering that even if we realize how perceptive and skillful pattern designers have been, the truth of the matter is that patterns are two-dimensional drawings portraying one moment in time of a rigid body; even if we try to justify that the paradigm of representation is a product of our technical, conceptual and/or metaphorical way of thinking, the truth of the matter is that patterns do not reproduce the true nature of the body; even if we acknowledge that pattern design has incorporated the input of mathematics, anatomy and anthropometrics into its theory, the truth of the matter is that the paradox in question should be solved within the territory of visual representation.

Lastly, in Research Through Creative Practice, it is highlighted that this search was done for the body through the body. By presenting the design of this doctoral research, it was made clear that it began with no predetermined image of how the created artifact would or should look – so it would translate the ability of the body to constantly change its shape and, at the same time, to enhance body movement comfort –, a situation that demanded to fall back on a few exploratory steps that were triggered by insight and shaped by perception “gained through interaction with data” (Corbin and Strauss 2008: 12).

Favoring a qualitative approach, resorting to procedural and validation techniques like self-portraiture, theoretical sampling and wear-trials, opting to design the artifact from the inside out, the lineament of the mobile body – viewed in abstract – was the addressed problem; in practical terms, an alternative basic patterns set was generated in view of their prospective functional aspect as well as their potential aesthetic quality.

All in all, the aim of this practice-led research was to see how body, movement and drawing, can become one. And so in Part Two a multidisciplinary view on the *body* is imparted, as this entity is a fascinating, kaleidoscopic, subject of representation, as well as on *lineament*, as this concept embodies a way of thinking that surpasses that of the conventional notion of two-dimensional representation, particularly when it’s classified under ‘technical representation.’

2 Antecedents Of The Research

Introduction

Considering that the body is the subject depicted by pattern design, considering that the body was vital to the outcome of the generated artifact, the second part of this doctoral thesis is dedicated to this entity as a token of appreciation. However, to understand the meaning and importance of the body in the context of the developed research implicates recognizing, first of all, that it is the body that describes itself, whichever its motivation to do so is, whichever its focus is.

Resolutely artists and scientists' undertakings draw on the body, either taking it as a medium of self-expression or as a means of studying its structural design. Whichever way, the body is a standard against which bodies are compared: the detection of an illness is dependent on knowing how the healthy body works, the recognition of individuality is dependent on knowing what distinguishes one person from another, the identification of the atypical is dependent on knowing what is the expected pattern.

Wanting to highlight the similarities that bind everyone together rather than the differences that separate each one from the others, the focused body is the universal body. The reason for this preference has to do with the fact that everyone shares a number of features – such as the internal cavities, ducts and organs inside the body – that affect the way we breathe, move, feel, age, *etc*. Strauss states that the way the parts of the body work together, affecting everyone, yield "a particular mode of being-in-the-world" (1970: 338), meaning that the way we move becomes the way we see, the way we see becomes the way we observe ourselves in the world. The interest in the body is, then, universal; and so is the way of displaying this interest: the portrayal of the body.

Accordingly, Antecedents of The Research deals with the ubiquitous attentiveness toward the body by presenting the related work carried out within the realm of science and the domain of art. Even if some of the reviewed approaches appear to be unrelated to this thesis or in confliction with its own perspective, their critical assessment helps contextualizing the created artifact and the series of actions directed toward its creation within the territory of visual representation.

So, in the first section of Part Two, various images of the body created by painters, physicians and clothing researchers are discussed, as they show the many forms by which The Interest In The Body becomes visible. Divided into two subsections, the first one focuses on Self-Modeling, a practice that is brought in so as to offer depth to the self-portraits that eleven participants shaped for the developed research – namely during phase one of the artifact's creation – and to place them within a suitable, related, context. As the history of western self-portraiture produced by women was skimmed through, two examples from the twentieth century became particularly striking, as they have a particular connection with the method of doing the commissioned self-portraits and the manner they must be looked at: the way Esther Ferrer and Ana Mendieta use their own bodies to transcend the exclusive interest in the self.

In Modeling The Other, the second subsection of Part Two, the challenge to explain the body in scientific terms – that "dates back to ancient times" (Tsiaras and Werth 2004: 9) – induced to present an overview of the instruments used in medicine to capture the inner body, such as x-rays and MRIs; then, the aim of the ready-to-wear trade to check how the body and clothing affect one another demanded that the leading *a priori* tools and the foremost *a posteriori* devices that are used since the nineteenth century were reviewed, for example the tangible mannequins, and the ones that were launched more recently, like the 3D body scanners and the computer pattern design systems.

The critical assessment of the various forms of modeling the body aimed at the design and appraisal of apparel acted as a stimulus from which the idea of Lineament Versus Representation, presented in the second section of Part Two, is developed and defended. The possibility of reproducing the mobile body on the basic patterns implicated that the body be described from the bones to the skin, from the musculoskeletal system to the nervous system, as these tissues are accountable for the visible shape distortions and volume changes the body experiences through movement.

By bringing up the respected experimental research developed by W. Kirk and S. M. Ibrahim in 1966 – as well as W. A. Lotens', submitted in 1989, and Choi and Ashdown's, released in 2010 – relating to the changes in skin dimensions that naturally occur as the body switches positions, it was also crucial to highlight the projects of *Levi Strauss Europe*, Madeleine Vionnet, Aitor Throup and Dava Newman, as – regardless of the purpose of their searches and the point in time they're linked to – the clothing they've designed or are designing include the movement of the body in the act of moving, that is, they're able to expand and shrink as the skin does.

By referring to the specific researches carried out by Susan P. Ashdown and Richard W. Vorder Bruegge at the end of the twentieth century that address the way the creases of clothing acquired during wear disclose the hidden relationship between the wearer and garment, it was also essential to present the concept of the *fold* developed by Gilles Deleuze. With the philosopher, the fold represents the essence materialized as substance, the variation appearing through movement, the point that becomes a point of view.

From an understanding of the fold that allows for a multitude of points of view included in the body and from which it must be considered, a tripartite meaning of *lineament* is proposed based on the acceptations it has in architecture and geology: **(1)** a verb, as it conveys the act of drawing, **(2)** a noun, as it stands for to the product of that action, and **(3)** an adjective, as it qualifies the product of that action. In the context of the developed research lineament is then **(1a)** the process of dealing with an alternative representation of the mobile body, **(2a)** the alternative set of basic patterns themselves, which, in contrast to the conventional ones, **(3a)** are characterized by their distorted contours.

The Interest In The Body

[*Self-Modeling: An Outline Within The Field Of Pictorial Art*]

Myriad descriptions of the body by the body have continuously been made, some putting the accent on objectivity, others on subjectivity. Fitting the realm of science and the domain of art, some are concerned with the description of the architecture of the body – i.e., "how we are built and what we are made of" (Tsiaras and Werth 2004: 10) – and some aim to represent it as "an intimate record of [its] personality" (Cheney, Faxon and Russo 2000: xxii).

Both these types of descriptions are of great consequence to this thesis because the research involved looking at the relationship between body and clothing – thus between body and patterns –, especially as regards how they affect one another. The integration of their reciprocal action into the creation of the artifact resorted, first, to a technique that, bordering on self-modeling, yielded the effect of *bodyprints* – insofar as the body left the impression of the combined work of its bone, muscle and skin tissues on a close-fitting garment made of a nonwoven material. Then, seeing that the physical signs left by eleven bodies on eleven overalls were identical, they were combined into one portrait representing no one in particular, yet each and every one of us.

Although the artworld may perhaps dispute that the collected imprints fit the genre of self-portraiture, the relevance of these eleven bodyprints to the process by which the created artifact took a particular shape served as a stimulating reason for looking at the history of western pictorial self-representation, women's in particular. It is certainly debatable to consider the used eleven one-piece garments as self-portraits because, however cursorily the history of self-modeling is studied for, when we see how painters have been articulating the dual function of viewer and the viewed and why they have done it – particularly since the Renaissance period, when the interest in this genre seriously flourished (Ramirez 2003: 28; Borzello 1998: 22; Cheney, Faxon and Russo 2000: 28) –, we see intention taking place, we see purpose in mind.

On the other hand, when we see that artists sometimes represent themselves because they're the handiest models they can get – accordingly they're "cheap, willing and inherently obedient to the creator's demands" (Ramirez 2003: 28) –

and that this operative availability enables them to give a physical form to themes that deviate from the customary construction of identity, calling self-portraits to the eleven bodyprints may well not be an extravagance after all.

Indeed, self-images are anything but "innocent reflections of what artists see when they look in the mirror," as maintained by Frances Borzello (1998: 17). In actual fact, self-images are one of the means adopted by artists to reveal what they believe in, as people, and what they're capable of, as artists (Borzello (1998: 17; Cheney, Faxon and Russo 2000: xxii). With reference to women artists, self-portraits expose, on the one hand, their desire to be recognized, accepted and valued for their creativity and inventiveness, or even their beauty (Cheney, Faxon and Russo 2000: xxiii); on the other hand, self-portraits translate the once quest of women artists for visual truth and their current search for inner truth, "irrespective of how honest or painful" it is (Cheney, Faxon and Russo 2000: 209).

Regarding the women's longing for recognition, approval and praise, it involves considering that even though they have been portraying themselves since classical antiquity (Cheney, Faxon and Russo 2000: 207), until recently women painters were regarded as an exception to the rule, as the role of the artist was typically allocated to men (Borzello 1998: 27). Longing for recognition, approval and praise at a time when the "notion of woman depended on the ancient perception and definition of *femina* as 'inferior male'" (Cheney, Faxon and Russo 2000: 27) was a delicate affair: up to the end of the sixteenth century women were excluded from the guilds and were, consequently, forced to work from home (Cheney, Faxon and Russo 2000: 29).

In practical terms, unless the father of a woman with talent owned a studio (Borzello 1998: 29), developing artistic skills and applying them was, more often than not, confined to monastic training and duties (Cheney, Faxon and Russo 2000: 28, 31). According to Liana Cheney, Alicia Faxon and Kathleen Russo, this circumstance alone may explain why female self-portraiture appeared predominantly in illuminated manuscripts until the Mannerist period, while male artists were already painting on canvas and wood panels since the Quattrocento (2000: 31, 38).

The delay women experienced in relation to the type and size of the painting surfaces they used, and the type of paint and painting tools they employed, didn't stop them to become proficient, prolific and singular as artists. Resolutely endorsing this point of view, Borzello declares that, even if art schools only began to take female students in the second half of the nineteenth century, women still learned (1998: 29); even if until the end of the nineteenth century most women artists were bound to deal with genres holding far less status than those requiring the mastery of the figure,[59] they made the most of it and "extended and inflected the range of self-portraiture" (1998: 35).

Signaling the end of a compulsory seclusion and the end of an impoverished training, twentieth century female artists began to use materials and practices that are traditionally viewed as feminine, e.g. needlework and quilt-making, textiles and yarns.[60] This liberation from a constrictive notion of 'high art' – that assisted all artists, male and female, from the twentieth century on – enabled women to employ techniques they are ancestrally familiar with to express their "'femaleness' more forcefully than by using canvas and oil paint," as stated by the artist Heather Dorrough (Cheney, Faxon and Russo 2000: 189).

To be fair, from the very beginning men and women have undoubtedly accepted their part as artists (Cheney, Faxon and Russo 2000: xxiii-xxiv): in antiquity, they knew their task was to imitate nature; in the Middle Ages they viewed their work as reflecting God's artistry; in the Renaissance, they won the status of creators by rights; from the nineteenth century on, they consciously committed themselves to specific movements like neo-classicism, impressionism, expressionism – to name just a few.

Accordingly, as the interest in self-representation began to grow in the fifteenth century and increased enormously in the seventeenth and eighteenth centuries (Borzello 1998: 21-22), painters moved from mirroring the "colors and features and expression of [their] face" (Borzello 1998: 20) to indulge them by improving on nature itself and, later on, to focus on their inner qualities, rather than on their appearance (Cheney, Faxon and Russo 2000: xxiv).

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[59] Such as self-portraiture and still life that could do without the artist's anatomical training necessary to depict the human figure, a core element in biblical, mythological and historical representations (Borzello 1998: 29).

[60] Faith Ringgold (b. 1930), Lurdes de Castro (b. 1930), Heather Dorrough (b. 1933), Ana Pérez-Quiroga (b. 1960), are among the artists that every so often make use of these type of media in their work.

But acknowledging their role also meant that male and female artists internalized the artistic rules of the period they lived in to avoid being misread by the artworld (Borzello 1998: 19, 32). As an example, in the eighteenth century conventions on dress and body language dictated how women should present themselves and be represented in paintings: they "could not show their teeth, could not show their hair unbound, could not gesticulate and certainly could not cross their legs" (Borzello 1898: 32); with regard to painting men, the French painter Elisabeth Vigée-Lebrun (1775-1842) let know, "if you were to sketch him sitting down, the body would not appear as elegant and the head would appear too close to the shoulders. This is particularly necessary for men since we are more used to seeing them standing than seated" (as quoted in Borzello 1998: 34-35).

In all fairness, men and women artists share a number of motives regarding self-representation. Self-modeling may be done for practice and self-promotion, as the captured likeness between the painters and the painted assures prospective clients of the artists' skills (Borzello 1998: 26). But artists also depict themselves "to boast their status, [...] to emulate past masters, [...] to give reign to the wit not required by customary subject matter," not counting the – previously alleged – drive "to publicize one's artistic believes," as identified by Borzello (1998: 17-18). Cheney, Faxon and Russo equate the reasons behind male and female self-portrayal as follows: both have represented themselves as painters, as aristocracy – thus enhancing their social façade or qualities –, with their spouse, family, parent or child, and with notable figures (2000: 207).

However, according to the reviewed authors women's self-portraits differentiate from men's in several ways. Having to do with a specific point in time, Cheney, Faxon and Russo, give emphasis to **(1)** women's personification of allegorical figures, like Painting and Poetry, **(2)** women's portrayal of them as teachers and with a teacher, male or female, exemplifying the bond existing between two generations of artists, **(3)** women's depiction of their twofold role as creators, as they bring into existence art in addition to offspring, and **(4)** women's identification with deity, as a form of empowering themselves (2000: 207-209). Clustering the uniquely female subtypes of self-portraits differently, Borzello divides this genre into images associating women artists with **(a)** musicianship, a strong topic in the sixteenth century, **(b)** motherhood, a theme that came to light at the end of the eighteenth century, **(c)** pregnancy, sexuality and race, issues that surfaced in painting in the twentieth century, and **(d)** aging, a issue that, having come forward in the eighteenth century, is dear to present-day female artists (1998: 18, 35).

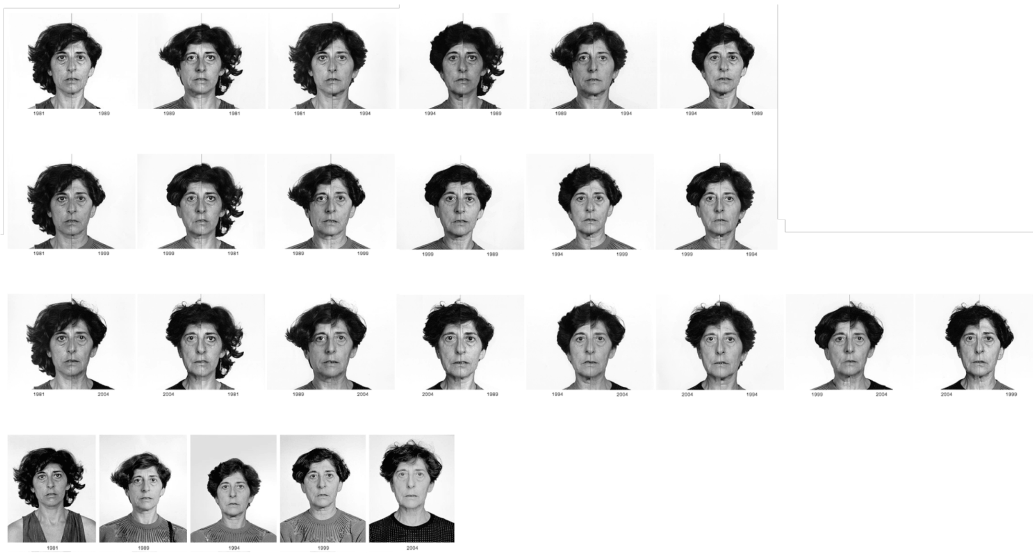
Certainly there are many other classifications of the visual discourses produced by women about themselves, but it's pointless to review them all. The seeming inattention has to do with the fact that it suffices – to any of us – to glance through a few self-portraits from different centuries to realize that the idea of self-representation has evolved and changed. If the material of expression in self-portraiture was, in the past, drawing, painting and sculpture, the range of expressive possibilities has expanded and includes, today, photography, performance and installation, among other artistic media. At present, if the produced self-portraits mostly focus on the artists' essential character, occasionally the artists' work is devoid of egotism.

Esther Ferrer's (b. 1937) pieces called *The book of heads* and *Self-portrait in time*[61] are perfect examples of a stance in which the artists' focus on the self is nonexistent. When, in 2008, she displayed twenty-five self-portraits pertaining to an extensive series of photographs taken every five years since 1973, she wasn't imparting the characteristics that she recognizes – or wants others to recognize – as belonging uniquely to herself; on the contrary, she was conveying the idea of "the ironic fate of the passage of time upon us" (Olivares 2003: 36).

By looking at the five – giving the impression of – passport photos that Ferrer reproduced, halved, combined and recombined around vertical axes [*Figure 3*], it's easily noticeable that the face of the artist could be the face of any person since the produced arrangements bluntly show the bodily alterations we all experience.

Thus, apart from the meaning intended by the artist – or the interpretation the artworld makes of it –, "the use [Ferrer] makes of herself is strictly functional" (Olivares 2003: 36). "Strictly functional" because who else would be readily available and disposed to be photographed by her during three decades, or more?

[61] Translated from *El libro de las cabezas* and *Autorretrato en el tiempo*, as presented in the site of the art gallery Àngels Barcelona.



[*Figure 3*]
Esther Ferrer: Self-Portrait In Time, exhibited in 2008 (www.angelsbarcelona.com)

But even if the circumstances of an ongoing project explain why Esther Ferrer – better than anybody else – is her own sitter, we could ask how much this using herself is merely functional, as the editor Rosa Olivares proclaims. This conceptual doubt arises because the moment an artist places her or himself in front of the camera – or any other device, for that matter – she or he becomes a model. The juxtaposition of the roles of the viewer and the viewed existing in self-modeling is by no means simple, as "the very idea of the existence of a 'model' implies the supposition that that being does not represent himself [or herself] but rather *another* more or less imaginary being, the model of something or someone, that is to say, the ideal incarnation of a separate personage or being" (Ramírez 2003: 28).

In this sense, the artist in the role of the viewer does not capture "the supposedly true and objective image of the other" (Ramírez 2003: 28), even if the other just happens to be him or herself; the part the artist assigned to him or herself in the role of the model is what he or she captures. This paradoxical situation is particularly perceptible in works of artists who have represented themselves many times (Ramírez 2003: 30): Cindy Sherman (b. 1954), for instance, looks always different – in terms of identity – in all her photographs, though it's always her – physically – who's portrayed [*Figure 4*].[62]

[*Figure 4*]
Cindy Sherman: Untitled #209, #132, #153, #471, #477, #150, created between 1984 and 2008 (www.artnet.com)

To go back to Esther Ferrer as well as to the concept of model and its implications – as exposed by the art-historian Juan Antonio Ramírez (1948-2009) –, it could be concluded that, despite the practical purpose of modeling herself, Ferrer isn't conceptually representing the artist but she is knowingly portraying another being – i.e., any other person. Lending her face to a model that plays a role known to us all, Ferrer's interest in the body – being centered on the effect of time on its outward appearance – is matter-of-fact, as it deals with facts, not emotions.

Diametrically opposed is the interest Ana Mendieta (1948-1985) has in the body. Breaking the way self-portraiture is customarily done or the conventions that are traditionally associated with this genre, in the *Silhouette series* there is no face behind Mendieta's work or even – in most cases – a tangible body for others to see. Here, what interests Mendieta is to document in photography the physical traces her body left on sites like beaches, creeks and groves [*Figure 5*].

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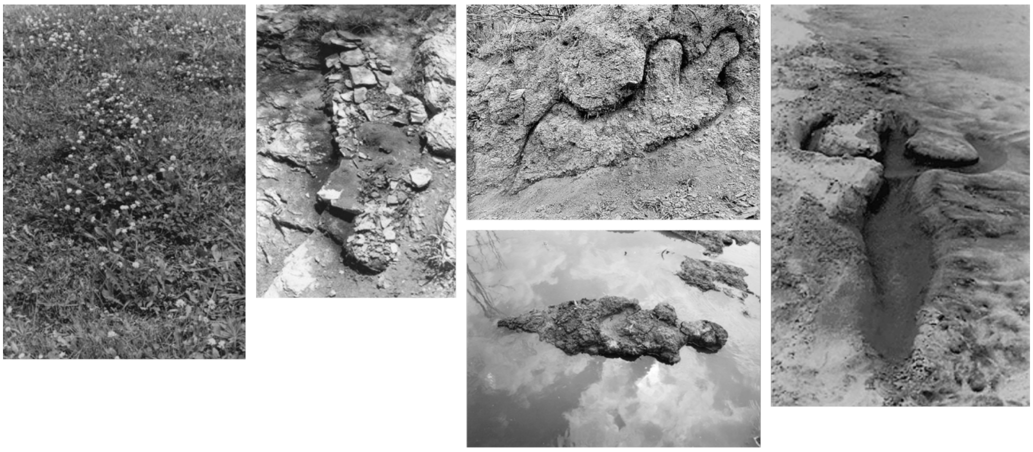
[62] According to Ramírez, Sherman is one of the most well known "postmodern creators who have played with the de-multiplication of identity" (2003: 30).



[*Figure 5*]
Ana Mendieta: The Silhouette Series, created between 1973 and 1978 (www.flickr.com)

Nevertheless, the physicality existing in Mendieta's work is difficult to understand, thus the word 'tangible' written in the previous paragraph: her being there is unlike the presence other artists offer for appraisal.[63] This difficulty has to do with the fact that when we're before an artwork, the two moments we know it represents – **(1)** the time of creation, affecting the past, assumed to belong to the artist, and **(2)** the time of presentation, involving the present, assumed to belong to the audience – seem to be juxtaposed, enabling us to think we experience them at the same time. The uneasiness we feel when we set eyes on Mendieta's self-portraits relates to the somewhat abstract and anonymous character they're endowed with or the residual quality they possess, which are aspects that contribute to her presence being sensed as absent – an absence that's truly deceiving because the time of self-construction is unquestionably offered for sight, corroborating that the artist was there at one point.

But not all Mendieta's work provokes this particular feeling. In *Body tracks*, the artist presents herself to an audience in the act of "smearing her arms with blood and red tempera paint" (Cheney, Faxon and Russo 2003: 193) and by witnessing it we see the artist in the role of the model: it doesn't matter if the resulting marks left by Mendieta's body could be anyone else's, or perhaps it's exactly because we recognize ourselves in them that we take the resulting paintings as self-portraits [*Figure 6*].

[63] For instance, Esther Ferrer and Cindy Sherman, to mention the examples discussed before.

[*Figure 6*]
Ana Mendieta: Body Tracks, created in 1982 (www.flickr.com)

In *Body tracks*, through the medium of blood mixed with paint – i.e., making use of a vital life force –, and in the *Silhouette series*, through the medium of mud, shrubs, *etc* – i.e., using the four elements from which everything is supposedly made –, the artist conveys the idea of the transitory and poignant aspect of life. Through confronting us all, including her, with our mortality, Mendieta's interest in the body is all about emotions, though the way it turns out in the end – particularly in *Body tracks* – is as factual as Ferrer's.

Regardless of how emotional she seems to be, the interest in Ana Mendieta, or the relevance her self-portraits have to this thesis, relates to her approach toward visual representation, as she chooses to project a three-dimensional reality, her physical body, on the plane (Ramírez 2003: 32), be it vertical or horizontal. Then, the interest in Esther Ferrer, or the significance her self-portraits have to this thesis, is about her unbiased approach toward the body, as she accepts time to run the process, thus allowing whichever collateral effects to occur while she's systematic about recording its inexorable course.

What's more, the interest in these two artists concerns the logical connection their approaches to self-portraiture have – when merged – with the three-dimensional preliminary steps toward the body's visual representation taken in phase one. As it happens, assuming the role of the artist, the participants became involved in self-modeling by **(a)** projecting their bodies on the plane of the nonwoven textile **(b)** without controlling the degree of deformation the garments progressively gained **(c)** for – approximately – forty hours of wear.[64]

[64] The extent to which the first garments are seen as self-portraits and the basis on which this view is substantiated are developed in Other Tools And Techniques [*Drawing On Purposeful Sampling*], a section integrated in Part 3, entitled Setting Up The Experiment.

Despite the differences that clearly exist between Esther Mendieta and Ana Ferrer – the way each copes with life[65] and deals with her body as an instrument of subjectivity –, the work of these two artists make evident a quality they both possess: the respect toward the inevitable, as something that wraps everybody into the same package. Perhaps Ferrer takes the part of *any other* more consciously than Mendieta, but the fact that the physical signs showing the former presence of Ana Mendieta on various sites aren't different from the traces anyone else would leave on similar locations suggest that she lets herself be seen as carrier of the identity of any or every person we could think of.

If both artists are aware of this aspect – or if they intended it – is beside the point. What's relevant is that Mendieta and Ferrer's works admit this kind of reading in the same way as any artwork "invites different, even contradictory, interpretations, and does so not because [it] is confused, but rather because artworks are multi-interpretable" (Davies 1991: 188).

The permission for multiple/concurrent interpretations of an artwork given by art does not mean that the aesthetic experience isn't richer if one has knowledge of certain matters that lie beyond the boundaries of the work itself such as, **(1)** the historical context within which it was created, **(2)** the genre, style, movement, *et cetera*, within which it's placed, and **(3)** the account of irony, allusion, allegory, *et cetera*, intended by the artists (Davies 1991: 182, 185-187). However influential all these external factors are to art's appreciation, they don't diminish the legitimacy of the alternative interpretations an audience may extract from the artworks, particularly if they are as plausible as the readings proposed by artists or if the artists' readings are unknown to the audience (Davies 1991: 188-189).

Following the approach to art's appreciation proposed by Stephen Davies – that goes against the "intentional fallacy" based on "one's taking the artists' intentions to be determinative of their works' interpretations" (1991: 186) –, it's reasonable to view the *Self-portrait in time*, *Body tracks* and the *Silhouette series* as portraits that do not solely reflect the artists' selves, even if we know that the first is a collection that Ferrer produced by pointing a photographic camera at her and the second and third are images that Mendieta created by impressing her body on the paper or ground respectively.

[65] For the record, Mendieta committed suicide at the age of thirty-six.

In spite of Ana Mendieta and Esther Ferrer's intentions, this reading of the *Self-portrait in time*, *Body tracks* and the *Silhouette series* is acceptable because **(1)** if we assent that one's interpretation of an artwork, or the meaning one gives to it, is "irremovably embedded in a historical/social context" (Davies 1991: 195) and **(2)** if we know that Mendieta and Ferrer were born, lived and worked in the twentieth century – and that Ferrer is still living and working now –, **(3)** it's reasonable to think of them as truly contemporary women artists since they disclose an "awareness of their problems and powers, combined with a fashionable outspokenness" (Borzello 1998: 199).

Furthermore, unless we're very naïve, we intuit that these images – that both artists developed through techniques that are "entirely based on the impression of light on the surface of the negative" or that "evoke[...] the peculiar photographic analogy" (Ramírez 2003: 32) – go beyond the constraints of mirroring the self that were once imposed by artistic conventions and values (Cheney, Faxon and Russo 2003: 209). And so, despite the objective likeness existing between the person who represents and the person who is represented, we assume that Ana Mendieta and Esther Ferrer's works stand for portraits of models playing the roles assigned by the artists, i.e., they stand for portraits of anonymous people among whom we see ourselves.

[*Modeling The Other: A Multidisciplinary Overview*]

In the previous short account on self-modeling it was mentioned that the interest in the body has caused some artists to occasionally draw, etch and paint themselves to feed their minds when other models aren't available or, at times, they self-model "for study and improvement," as the husband of the seventeenth century painter Mary Beale (1633-1699) wrote down *a propos* her extensive production of self-portraits (Borzello 1998: 26).[66] But whichever reasons for portraying oneself, in the territory of art the body deserves an attention that is phenomenological in nature.[67]

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[66] One of the most important English Baroque portrait painters, Beale has painted forty-two self-portraits.

[67] As exposed before, these two motives are nothing but a tiny amount among the motivations behind self-representation.

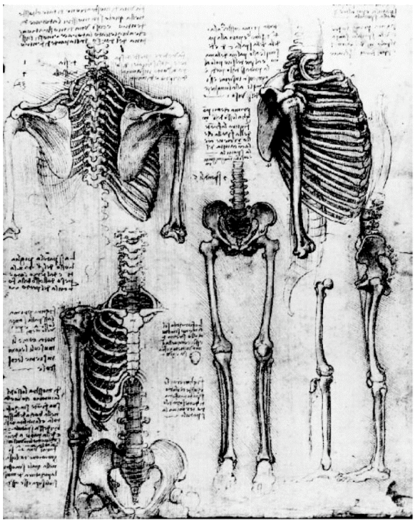
Indeed, how better can artists reflect a sense of being than through "the performative product of the very act of vision, of representation" (Brea 2003: 95)? What better can artists do than to look at them, first, so they can understand the world? Almost for this reason alone, José Luis Brea defends that portraits are a sub-genre of self-portraiture, going against the usual categorization that places the self-portrait under portraiture (2003: 95).

In contrast, in the sphere of science the interest in the self is determined by the description of the universal body. As it happens, any condition one is in at a particular time deviating from the normal is regarded as pathology. To the expected extent, science has set itself to describe the general body from the skin to all other organs within it, to analyze the body on the macroscopic level as well as the microscopic, and to scrutinize the body from the electrical, chemical, and mechanical points of view.

Actually, "the desire to explore our inner cosmos dates back to ancient times," as Tsiaras and Werth write (2004: 9). When human dissections were still forbidden, the appeal to study the relationship between the body's structure and its functioning drove Aristotle (384-322 BC) to dissect hundreds of animals and plants; the physician Herophilus (335-280 BC) was the first to record his discoveries – among them the differentiation between sensory and motor nerves – , as Greek truth-seekers needed an additional century as well as to move to another country like Egypt[68] to be able to perform dissections on the human body.

Ultimately a true "culture of dissection" emerged during the Renaissance, a trend that, according to the historian Jonathan Sawday, had a huge impact on the creative arts such as poetry, painting and architecture (Tsiaras and Werth 2004: 10). The personification of this influence is by rights Leonardo da Vinci (1452-1519), as he used "'see-trough' images, exploded views [and] drawings from different vantage points" (Tsiaras and Werth 2004: 10) to render the complexity of the human body with an immense artistic, as well as scientific, quality [*Figure 7a*].

[68] Where this practice was permitted and carried out in public, in some cases.



[*Figure 7a*]
Leonardo da Vinci: Anatomical Drawing With Notes Written In Reverse, created c. 1500 (www.stumbleupon.com)

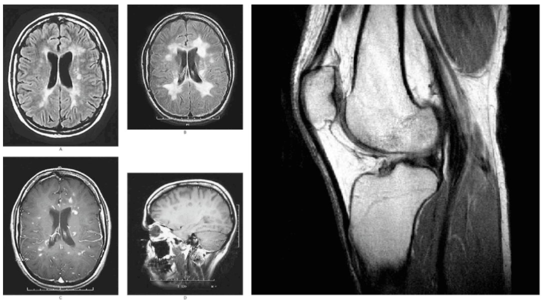
[*Figure 7b*]
Wilhelm Röntgen: The Physicist's First X-Ray, created in 1895 (www.en.wikipedia.org)

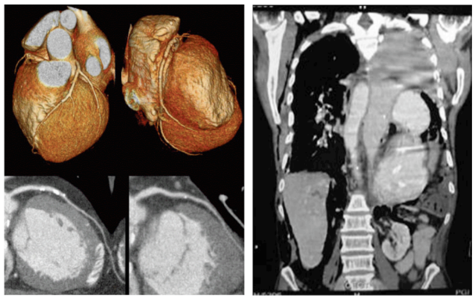
Further advances in the study of the human body were made in 1676, when the scientist Antoine van Leeuwenhoek (1632-1723) created the optical microscope, adding a magnifying device to the existing scalpels and slide rules; enabling Leeuwenhoek to see objects too small for the naked eye, the scientist examined and described the interior construction of living tissue – like muscle fibers and blood cells – for the first time in history.

In 1895, the physicist Wilhelm Röntgen (1845-1923) detected electromagnetic radiation in a wavelength range known today as x-rays, contributing thus to the diagnostics art; through exposing the living body to x-rays, the penetrated solid masses – for example bones – reflect their images on photographic film [*Figure 7b*].

Additional methods using electromagnetic radiation emerged at the second half of the twentieth century: in 1952, the discovery of nuclear magnetic resonance by the physicists Felix Bloch (1905-1983) and Edward Purcell (1912-1997) underlies the magnetic resonance instrument commercialized in the 1980s; in 1972, the electric engineer Gedfrey Hounsfield (1912-2004) and the physicist Allan McLeod Cormack (1924-1998) devised the computerized tomography.[69]

Strengthening the possibility to observe in a noninvasive manner the innermost structures of a living body, both MRI [*Figure 8a*] and CT [*Figure 8b*] generate three-dimensional reconstructions of a "brain or a heart valve or a 10-year old human embryo or a hemoglobin molecule" (Tsiaras and Werth 2004: 8) from a range of cross-sectional images. Capable of reproducing soft tissues in detail – including the abnormal uncontrolled masses of body cells that have no physiological functions, like malignant and benign tumors –, both scanning techniques are ultra powerful surveillance tools for the identification of structural and biomechanical disorders.[70]





[*Figure 8a*]
Cross-Sectional And Sagital MRI Images Of Brain and Sagital MRI Image Of Knee (www.invivonmr.ualberta.ca and www.en.wikipedia.org)

[*Figure 8b*]
CT Images Of Heart Showing Calcified Plaques and CT Image Of Thorax (rpop.iaea.org and www.ispub.com)

Depending on a high level of expertise, only specialized physicians are able to read the results of x-rays, MRI images and CT scans to the fullest extent; all the same, they are as dependent on interpretation as any work of art is. Needless to say life isn't at stake if one is unaware of the normative standards for "correctness and completeness" of the aesthetic experience (Davies 1991: 63); yet the proper approach to art, being clearly structured in terms of historical factors and social

[69] Also known as MRI and CT respectively, the corresponding Portuguese designations are RM and TC. Unlike CT, which subjects the body to x-rays, MRI exposes the body to radio waves that, when withdrawn, cause the nuclei of certain atoms – especially those of hydrogen – to return to their regular positions (encyclopedia2.thefreedictionary.com).

[70] Although more imaging techniques are currently in force for the purpose of medical examination – such as echography, which creates images by means of ultrasound –, they were excluded from this account on the representation of the body by science for no other reason than to keep it brief.

conventions, is unwilling to rest on one's – *naive* – phenomenological knowledge (Davies 1991: 63-64). And so, in the same way as proper diagnoses imply weighing MRI, CT scans or x-rays of a specific body against normative standards – i.e., the healthy body –, the correct and complete interpretation of an artwork involves weighing it against other works of the same period, movement, style, genre, *et cetera*.[71]

Surely the descriptions of the body made by artists lay emphasis on subjectivity and the descriptions of the body made by medical doctors focus on objectivity. But in both situations interpretation is our means to make sense of the elements before us in an attempt to explain, not just visually but also intellectually, the object under study, be it the body – healthy or ill –, a work of art – for example, a self-portrait or a portrait, or anything viewed as if it is an artwork, for instance, a basic or a garment pattern.[72]

Effectively, the eagerness to interpret the body hasn't only been the concern of science or art for that matter. In areas related to clothing engineering – a choice of words that conveys the series of operations garments go through, from their design to the final result –, modeling the body as objectively as possible has been a persistent approach to cater for its experience as a dressed body.

Tangible mannequins, shadow moiré topography, clothing waveform, graphic somatometry, three-dimensional body scanners and computer pattern design systems, although dissimilar in age, nature and function, are among the technological devices that have been developed for the design and appraisal of apparel. Some are applied in the pre-production stage of the clothing assembly – thus they are categorized as *a priori* techniques; others are employed after the garments are produced and before they go into retail – therefore they are named as *a posteriori* devices.

Continuously undergoing improvement, all these tools converge to a dual purpose: the fit of the garments and the appearance of the dressed body (Fan, Yu and Hunter 2004: xvii). The extent to which these two concepts are closely related – or

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[71] See p. 61.

[72] This category is added for the reason that, throughout his text, Davies (1991) gives us the chance to regard artifacts *qua* artwork in general.

the extent to which they are regarded as such – is patent in many definitions of *fit* given by various authors from the middle of the twentieth century on.

Contributing to this diversity of conceptions is the fact that, according to Jintu Fan, Winnie Yu and Lawrance Hunter, the principles of fit haven't been clearly identified because they "vary from time to time, and depend on the fashion culture, industrial norm and individual perception [...]" (2004: 31).[73] Despite the momentary trends, *criteria* and the users views, L. Shen and J. Huck stressed in 1993 that "clothing which fits, provides a neat and smooth appearance and will allow maximum comfort and mobility for the wearer" (as quoted in Fan, Yu and Hunter 2004: 31).

Around the same time, Susan P. Ashdown defined fit as "the relationship of the garment to the body" (Watkins 1995: 264).[74] To complement her straightforward definition, Ashdown clarifies that this relationship is connected with the concept of ease[75] and that the appropriate ease amounts of a garment depend on **(1)** its function, **(2)** the properties of the materials used for its assembly, and **(3)** the area of the body being covered. To conclude, the author points out that the wearer's perception of clothing fit results from his/her kinesthetic experience and aesthetic preferences (Watkins 1995: 265).

Earlier – in 1969 –, M. D. Erwin and L. A. Kinchen presented an understanding of fit proclaiming that this concept combines five factors, i.e., ease, line, grain, balance and set (Fan, Yu and Hunter 2004: 31). In total agreement with these authors, three decades later Mário de Araújo describes the meanings of the five factors as follows (1996: 119-122):

> **(1)** Understood as the difference between the garment measurements and the body dimensions, *ease* is believed to be the catalyst of body movement.

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[73] An example of this variance of standards is the fact that, in France, garments are designed to fit the body more tightly than in any other European country as reported by John Winks (1997: 1).

[74] Watkins comprises in her book *Clothing: The Portable Environment* three sections written by Ashdown, namely "The Fit of Clothing," The Sizing of Clothing" and "Fit Testing," the first of which is included in this thesis's literary review.

[75] See Conceptual Framework, p. 22.

(2) *Line* is associated with the way the garment's seams run on the body and, to appear vertical they're normally positioned to rest on joints – like the shoulders and waist.

(3) *Grain* designates the linear relationship between the pattern and the textile material – or the direction assigned to each pattern piece's center in relation to the fabric's warp direction –, normally placed on each body part along its height.

(4) *Balance* is viewed as the way garments drape on the body and, ideally, their entire surface parts the same distance all around the body – or hangs down symmetrically on all sides of the body.

(5) Determined by the shape of the body, *set* is defined as the way garments cover it without wrinkles – an undesired feature that is caused by an insufficient incorporation of ease causing the garment to pull along the garment seams and the body joints.

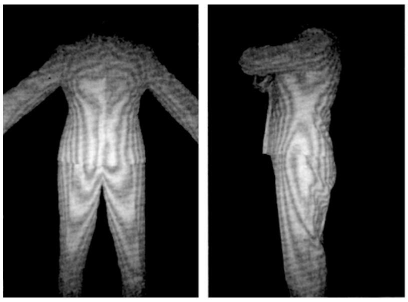
Many other authors have defined clothing fit. However differently they are formulated, they all imply that garments must "conform correctly to the shape or size [of the body]" and, simultaneously, be suitable "to the requirements or demands [for example, for] camping," as read in two definitions of the entry word "fit" of the *Merriam-Webster's Collegiate Dictionary* (2003: 473).

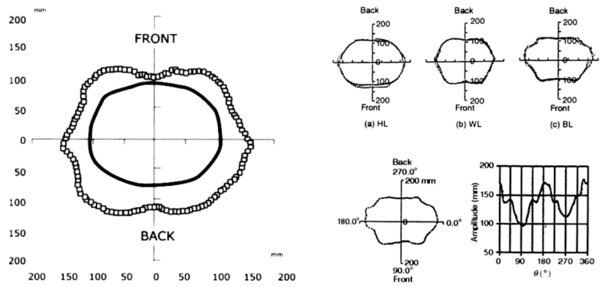
However diversely individual bodies perceive clothing fit and however diversely the concept is conceived in different countries, researchers and designers from various national origins have been trying to evaluate it in relation to body shape, some through qualitative approaches – scaling sensory descriptors like 'tightness' and 'looseness' –, others via quantitative methods – computing the space between body and clothing (Fan, Yu and Hunter 2004: 72).

Positioned within the second category of the reviewed strategies, N. Suda and T. Takahashi adopted in 1983 a technique for the measurement of clothing fit that doesn't fall back on contact methods (Fan, Yu and Hunter 2004: 72).[76] Using shadow moiré topography – a procedure that is normally used for analyzing spinal deformities –, the researchers captured the three-dimensional dressed body

[76] The reasoning behind this decision has to do with the fact that garments are unstable objects that deform easily.

shapes on a two-dimensional fringe pattern [*Figure 9a*]. Because clothing drape, bagging, wrinkling and body shape are presented all at once, part of the assessment is based on the visual interpretation of the fringe pattern – for example, round and symmetrical contour lines indicate a good fit, distorted ones denote a poor fit – and the other is based on the coordinates of digitized sectional profiles (Fan, Yu and Hunter 2004: 76-77).





[*Figure 9a*]
Moiré Topography: Anterior And Side Images Of Outer Suit (Fan, Yu and Hunter 1998: 78)

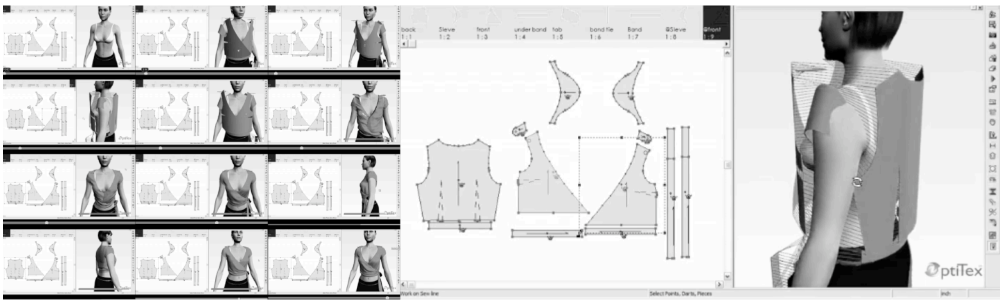
[*Figure 9b*]
Clothing Waveform: Cross-Sectional Profiles Of Body And Clothing, Cross-Sectional Clothing Shape And Waveform Chart (Fan, Yu and Hunter 1998: 81, 83)

Also positioned within the second category, Y. Taya, A. Shibuya and T. Nakajima submitted, in 1995, a process for assessing clothing fit that combines various methods, such as Pickover's acoustic theory, probability density spectra and symmetrized dot pattern (Fan, Yu and Hunter 2004: 80-83). Digitizing the coordinates of grids marked on a dressed mannequin, the researchers reconstructed the cross-sectional profiles of the three-dimensional unit formed by the body and clothing at every height; after quantifying the space between the two entities at various body sites, the researchers converted the cross-sectional clothing shapes into waveform charts [*Figure 9b*].

In addition to the spatial evaluation of clothing shape and fit granted by the two *a posteriori* non-contact methods described above, the pressure applied against the body's soft tissues by clothing has also been subject to research. Computer simulation is among the instigated *a priori* techniques that are being utilized to evaluate the pressure distribution of the garments along the body, as well as to compute the body-garment dynamic interactions during wear.

Expanding the scope of the pattern design systems that were developed in the 1980s for the ready-to-wear trades,[77] the applications launched in the past decade by the leading software companies – namely the American *Gerber Technology*, *Optitex*, *PAD System Technologies* and the French *Lectra* – focus on the three-dimensional virtual prototyping and visualization of clothing fit. Allowing evaluating the clothing patterns dressed on a virtual body before the garments are actually cut and sewn, the dual purpose of these new programs is to decrease, all the more, the time of product development and related costs.

By enabling apparel companies to do without concrete prototyping, the virtual three-dimensional fit applications **(1)** import the pattern pieces created in the two-dimensional program, and, after **(2a)** analyzing the topography of the pattern and **(2b)** noting the joint points of the pattern pieces, **(3)** seam together the components around a parametric mannequin rendered in three-dimensions [*Figure 10*].



[*Figure 10*]
Optitex Pattern Design System: 3D Visualization of 2D Patterns, frames extracted from promotional video (www.youtube.comwatchv)

To evaluate the potential fit of the garment with increased clarity, some systems like *Lectra*'s "Modaris 3D Fit" have added a function to the menus of these programs that displays the skin of the virtual body appearing through where the measurements of the garment are smaller than the dimensions of the parametric mannequin (Fairhurst 2008: 112).

[77] Based on the principles of computer-aided design (CAD). Two-dimensional pattern design applications became a vital tool to industry professionals dealing with pre-production design activities by "assisting in much of the repetitive tasks associated with patternmaking" (Anderson 2005: 2) – such as the patterns creation, modification, filing and storing (www.explore.cornell.edu) –, as well as the time consuming work associated with grading, marker making and cutting processes.

Other attributes of this type of software applications comprise **(4)** the mechanical simulation of the garment drape, a representation that involves the allocation of each pattern piece's grain and the characterization of the textiles properties, plus **(5)** the spatial evaluation of the clothing fit, represented through the ease amounts – existing along the entire area the virtual garment covers the virtual body – displayed on a chart.

In 2005, Andrei Tilin, the marketing manager of *PAD System Technologies*, imparted that "the next step in development will be the reverse engineering process, from 3D to 2D" (Anderson 2005). Having already occurred, this move is based on the idea that computerized three-dimensional pattern design allows designers to assess body shape in a more effective way (Anderson 2005) – and possibly "to develop and try out new ideas and forms" (Duburg and Van der Tol 2008: 14), as it's characteristic of its haptic counterpart technique commonly known as draping.

Notwithstanding the achievements made so far in computer graphics, the viability of reverse engineering is highly dependent on the programmers' ability to improve on the simulation of the deformable body and clothing. Actually, B. Wentzel points out that "the imagery of the virtual 3D sample is still flat; the stand and garment look somewhat sterile" (as quoted in Fan, Yu and Hunter 2004: 131) and Li, Zhang and Dai accuse this type of applications of assuming, erroneously, the body to be rigid and acting "as a geometrical constraint for the garment to drape or closely fit on it" (Li and Dai 2006: 7).

With reference to fabric drape, the downside of the existing computer-generated descriptions is, for Fan, Yu and Hunter, that, "owing to the complexity and high polygon calculation, it takes a long time to achieve accurate performance of 3D animation" (2004: 131). Regarding the human body's modeling, Mehmet Sahin Yesil calls attention to an ongoing twofold difficulty: firstly, the body itself "is so complex that no current model comes even close to its true nature," secondly, "the sensitivity of our eyes to human figures is such" that it is easy to detect how unrealistic the simulated body shapes and body motions are as soon as they are looked at (2003: 1).

Ten years earlier, Francisco Azuola and his team have mentioned in a paper addressing the creation of virtual human models that "knowledge of body size variability within a particular design population is critical if an item of clothing [...] is to be designed to accommodate its intended users" (Azuola *et al*. 1994: 1), implying that to render a virtual human model realistically is also very important to get hold of the necessary anthropometric information.

To tell the truth, to accommodate the variety of body shapes and sizes – that make up the mass of customers – has always been difficult to deal with; actually, industry designers and apparel researchers recognize that the relationship between body and clothing patterns – not to mention the relationship between those two and the fabric properties with which the garments are assembled – "can create an exponential number of possible fitting issues to be resolved," as maintained by researchers at the Cornell University (www.explore.cornell.edu).

The fact that the creation of patterns depends on the measurements taken on the body is the root of this difficulty, an initial task that, on the word of designers and researchers, is rather complicated to perform:

(1) The intricacy of finding the exact location of the body landmarks "from which or between which one could measure with anything like the accuracy expected in drafting" (Bray 1986[1961]: 12).

(2) The disparity on the body's dimensions **(2a)** from one day to the other due to "the physical state, even the mood of the person" being measured (Bray 1986[1961]: 12), or **(2b)** in the same day, as a person can be a 1.5cm taller in the morning than at night (Croney 1971: 71) and his/her "waist circumference may vary as much as 2 in (51 mm) during a single day" (Gazzuolo *et al*. 1992: 162).

(3) The discrepancy between the actual body posture and the posture it adopts while being measured since, throughout the process a person tends to stand more erectly than normally or to place all his/her weight on one leg (Giles 1987[1896]: 77; Kidwell 1979: 18).

(4) The unreliability of the method itself as skeletal muscles contract once a measurement instrument touches the person being measured (Gazzuolo *et al*. 1992: 162).

Besides the degree of inaccuracy of the body dimensions collected via measuring tapes or calipers, traditional measuring methods have also the inconvenience of being invasive and time consuming. On this last point Cynthia L. Istook refers to an anthropometric survey conducted in 1988 to the US Army personnel that “required four hours to physically landmark, measure, and record the data of one subject” (Fairhurst 2008: 94).

In contrast, three-dimensional scanning systems are capable of generating fairly accurately an unlimited number of linear and non-linear body measurements[78] at a speed that was unthinkable until they were launched in 1987 (Fan, Yu and Hunter 2004: 135, 143; Fairhurst 2008: 95, 103; Ashdown 2007: 238; www.explore.cornell.edu).

Depending on the aimed purpose, three-dimensional body scanners are an *a priori* tool as well as an *a posteriori* means. The reason why they can integrate either the pre- or post-production phases is that the applications of body scanning range from **(1)** size surveys for mass production, **(2)** pattern generation for mass customization,[79] **(3)** evaluation of clothing fit and body appearance, to **(4)** tailor-made mannequins for target markets (Gazzuolo *et al.* 1992: 161; Fairhurst 2008: 109, 111-112; Fan, Yu and Hunter 2004: 135; www.explore.cornell.edu).

Granting the possibility to capture data without physical contact with the body (Fairhurst 2008: 95; Fan, Yu and Hunter 2004: 145), body scanners take about 20 seconds to collect information and about 45 seconds to transfer it to a computer [*Figure 11*]; the software attached to it takes, then, about one minute to locate body landmarks and to generate measurements (www.explore.cornell.edu).

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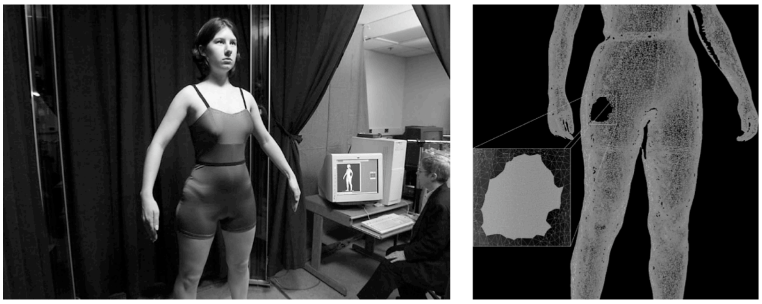
[78] Linear measurements involve measuring the distance between two points independently of how curvy the line being measured on the body is; non-linear measurements require getting a constellation of points to translate the convex/concave surface of the body.

[79] Mass customization is a branch of mass production aimed at meeting personal fitting requirements via – normally – the alteration of patterns created for standard sizes.



[*Figure 11*]
Three-Dimensional Body Scanning: Woman Being Scanned And Detail Of Resulting Image, created at Cornell University, USA (www.bodyscan.human.cornell.edufeature)

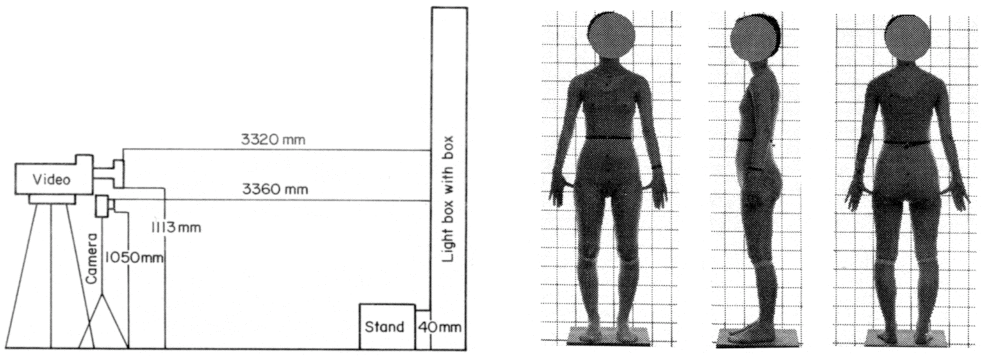
Despite the capacity some body scanners have to calculate "approximately 1.5 million points [...] to describe the entire body" (Fan, Yu and Hunter 2004: 152), all the current scanning systems still have difficultly in obtaining data from some body areas such as **(a)** under the bust (Fan, Yu and Hunter 2004: 165), **(b)** the top of the shoulders (Fairhurst 2008: 105) and **(c)** the crotch at the junction of the legs (Fan, Yu and Hunter 2004: 165; Fairhurst 2008: 105).

Additional disadvantages of these high-tech devices include the generation of incorrect measurements due to the loose or too tight clothes a person wears during the process (Fairhurst 2008: 105) and, despite the speed of the whole process, the influence body movement has on the overall data accuracy and scanning quality. On this last point W. Yu writes, "the human body is constantly changing, even when standing still. Movement due to swaying, breathing and posture changes during scanning can readily affect measurements, such as the chest circumference" (Fan, Yu and Hunter 2004: 165).

Because the arrival of three-dimensional body scanning is recent, the cost associated with this technology not counting the difficulty to gain access to it,[80] alternative methods of collecting body measurements were developed in the area of pattern design from the mid 1980s to the mid 1990s, based on the photographic techniques used by physical anthropologists from the 1940s to the 1970s (Gazzuolo *et al.*1992: 162).

[80] In effect, only some institutions possess three-dimensional body scanner systems, a circumstance that makes it hard for private use.

Similar to visual somatometry,[81] this type of *a priori* techniques are fast, low-cost, non-intrusive besides offering “a permanent record of information which can be studied at leisure,” as defended by the diagnosis researchers L. M. Bayer and N. Bailey in 1976 (Gazzuolo *et al.* 1992: 162). Edith Gazzuolo and her team, for instance, used this approach in combination with planar methodology to predict garment pattern dimensions from photographic/video data [*Figure 12*] and planar measuring devices – i.e., nonwoven textile surfaces marked with a grid draped on the body – with the aim of evaluating their reliability against linear anthropometric data obtained with measuring tapes (1992: 161-171).



[*Figure 12*]
Graphic Somatometry: Photo And Video Set-Up Plus Anterior, Lateral And Posterior Views Of Subject, diagram and photos by Gazzuolo *et al.* (1992: 164)

By comparing the traditional and the alternative measuring methods, the researchers concluded that the linear anthropometric data are slightly better for predicting some pattern dimensions – such as, the front and back bodice lengths and the front shoulder and arm scye widths – and the photo measurements and planar data are better for predicting pattern angles, such as the front and back shoulder angles and the bust dart angle (Gazzuolo *et al.* 1992: 167-170).[82]

Seeing that pattern design is “one of the earliest steps in the development of a garment” on which its appearance and fit depends on (Anderson 2005) – a circumstance that “can determine [the garments’] retail success or failure” (Faerm 2010: 125) –, tangible mannequins are indispensable *a priori* tools as well as *a*

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[81] A term derived from a combination of words coined by Helen Douty in 1968, as the researcher invented and developed ‘human somatometry’ for the classification of body types in relation to clothing.

[82] Realizing that the somewhat blurred images resulting from the video capture didn’t allow for accurate measurements, Gazzuolo and her team decided to do without them (1992: 164).

posteriori ones. The older of the reviewed devices related to modeling, garment fitting forms were initially only used for window-display purposes – a practice that dates from 1797 (Duburg and Van der Tol 2008: 30) – but from the mid nineteenth century on they were also employed for draping purposes and to check the fit of prototypes (Duburg and Van der Tol 2008: 30; Aldrich 2000: 193).

Although their shape has evolved according to each period's conception of the body,[83] mannequins represent traditionally one single body standing vertically and their structure is usually built with compact unyielding materials – such as, iron wire, *papier mâché*, wood or glass reinforced polyester – coated woven or knitted fabrics – for example, horsehair, linen or cotton canvases and jerseys – or nonwoven materials – like felt – for pinning purposes.

Despite being unclear the role assigned to garment fitting forms by the tailor Alexis Lavigne – or at what stage he used them –, in 1849 he "patented a method of creating a *buste* [mannequin] in any set of measurements in six minutes" (Aldrich 2000: 193) so it could be changed not into different body positions, but into different body sizes.

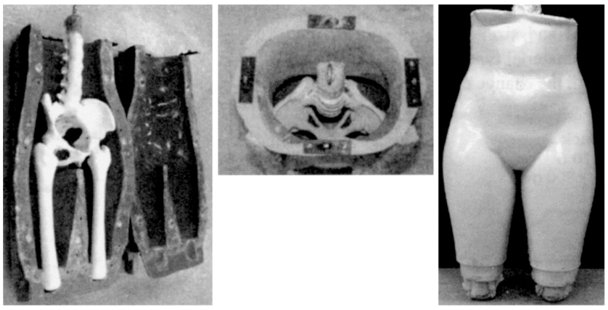
Designing clothing wholly by draping, from 1912 until 1939 Madeleine Vionnet utilized the same wooden mannequin fine art students used (Demornex 1991: 55; Kirke 1998). Truly concentrated on preserving a coherence between body and garment throughout body movement, the small scale of her mannequin – about 60cm tall –, its articulated arms and legs and its rotative stand [*Figure 13*], let Vionnet check the fit of her creations the whole time the process lasted (Simões 2005: 111).

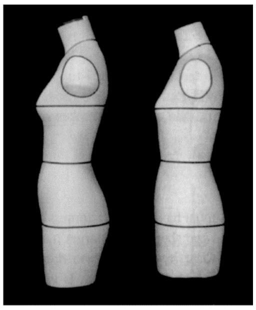
[83] For instance, in 1900 the female body was represented "with the tiny waist and accentuated bustle and bust," in 1920 "with the compressed torso and emphasis on the linear shape," as read in the catalog of the Wolf Form Company, one of the leading form manufacturers since the beginning of the twentieth century.

[*Figure 13*]
Vionnet At Work, photo by Thérèse Bonney, ca. 1923-26 and photo published in *Harper's Bazaar*, Oct. 1934 (Kirke 1998: 6, 80)

Based on the idea that conventional garment fitting forms do not look real, the Digital Human Laboratory and the Bunka Fashion College have been developing a new type of tangible mannequins since 1996 (Fan, Yu and Hunter 2004: 35). The shape of these rigid mannequins represent more convincingly the normal alignment of the spinal column, thoracic and abdomen areas of a woman's body [*Figure 14b*], as it actually corresponds to "the average dimensions of the target population measured by an optical 3D body scanner" (Fan, Yu and Hunter 2004: 35).

In 2002, W. Yu, J. T. Fan, X. M. Qian and X. M. Tao "developed a soft mannequin to simulate the [lower torso of the female] body for measuring contact pressure" (Fan, Yu and Hunter 2004: 84). Seeing that the pressure exerted by the dressed garments on the body affects the perception of clothing fit and, thus, its assessment (Fan, Yu and Hunter 2004: 84), the soft mannequins comprise three layers molded with different materials – like flexible polyurethane foam and silicone rubber – that copy the behavior of the rigid and soft tissues of the body: **(1)** the bone skeleton, **(2)** the soft tissues – i.e., the skeletal muscles, adipose tissue, *etc*, as one –, and **(3)** the skin [*Figure 14a*].





[*Figure 14a*]
Soft Mannequin: The Fixed Bone Skeleton, Inside Tissue Mould and Skin (Fan, Yu and Hunter 2004: 84)

[*Figure 14b*]
New And Conventional Rigid Mannequins (Fan, Yu and Hunter 2004: 36)

As much as the outlined methods and tools – attempt to or – act for the body in terms of its experience, all but Vionnet's give prominence to the body's verticality. The researchers' commitment to follow the enduring paradigm taken on by pattern design – a discipline that implies the stages of making and appraisal (Simões 2005: 142) – is manifest, as:

> **(1)** Even the tangible mannequins that have yielding builds or have a similarity in appearance to real women depict the body standing still.
>
> **(2)** Even the methods of moiré topography and clothing waveform that seek to improve knowledge related to clothing fit describe the dressed body in the upright position.
>
> **(3)** Even the approaches developed from graphic somatometry obtain anthropometric data from photographs of the body in a pose resembling the anatomical position.[84]
>
> **(4)** Even the most recent computer pattern design applications for virtual prototyping incorporate algorithms based on the representation of the erect body.
>
> **(5)** Even the body scanning systems that generate a million linear and non-linear measurements reconstruct the three-dimensional body fixed in the vertical position.

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[84] To quote the anthropometrist John Croney, "the anatomical terms of position assume that the body is standing upright [...] with the arms hanging by the sides with the palms of the hands facing to the front" (1971: 11). See [*Figure 48*], p. 165.

The criticism about the reviewed approaches – and, to the same extent, their supporters – relates to how much they are influenced by the fashion designers' tendency to highlight, above all, the static appearance of the created garments. The major fault of the outlined strategies – hence, of the researchers behind them – is that, by focusing on guaranteeing "the total visual effect, rather than the working beauty of the garment in wear – to emphasize the apparition, not the organism" (Hollander 1994: 133), they fail to notice the mechanical aspect of fit, i.e., how clothing may or may not contribute to ease of movement.[85]

As early as 1945, Hulme stressed that "the maker of clothing uses plastic material to clothe a plastic body" (1945a: 66), proclaiming that the degree of accuracy of the clothing dimensions is determined by the rigidity/extensibility of the materials with which they are assembled. Even though Hulme should not have characterized the body as a *plastic* entity but as an *elastic* one,[86] he is drawing attention to what – or who – is the dominant material of clothing design and related areas: the body and its deformable behavior.

In 1972, M. J. Denton bluntly stated that "the problem [regarding the provision of ease of movement] is a complicated one because the suitability of a garment for a particular purpose depends on the operation to be performed" (1972: 14). Twenty-three years later, Susan M. Watkins emphasized how much body movement is critical to function, telling that clothing "that moves with the body is prized by athletes," firefighters and astronauts, "whose livelihoods depend on their [equipments'] ability to move quickly and precisely" (1995: 218).

The extent to which functional clothing facilitates a worker's job efficiency, his/hers health and safety, *etc* (Watkins 1995: xvi) or, by the same token, the extent to which recreational and nonspecific clothes enhance or decrease body function, made R. M. Laing and G. G. Sleivert accentuate, in 2002, how vital is to direct attention to the performance of the wearer rather than concentrating solely on the performance of the garment (2002: 2). The authors' suggestion is especially pertinent because clothes that fit well in one position may become poorly fitting the instant the wearer bends his/her arms, legs or trunk, as Denton has remarked thirty years earlier (1972: 14).

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[85] See p. 66.

[86] See Conceptual Framework, p. 30.

According to the classification of clothing types presented by Li and Dai (2006: 75), even perfect fitting garments – expressed mathematically by the equation [$F \geq O$], meaning that the clothing area [F] is equal or slightly larger than the body area [O] – may exert pressure during wear because the space between them and the body decreases on account of movement.[87]

W. Kirk and S. M. Ibrahim, in 1966, and W. A. Lotens, in 1989, called attention to the extensibility of the body, demonstrating that the dimensional changes occurring at the arms, legs and trunk, while the body moves about are quite considerable when compared with their measurements in the neutral position – i.e., the body standing upright.

Going along Hulme, Denton, Watkins, Laing and Sleivert, Kirk and Ibrahim, and Lotens, it doesn't matter **(1)** how much the space between body and garment is quantified by moiré topography and clothing waveform, **(2)** how much linear and non-linear measurements are collected via body scanners, **(3)** how much body data collected through graphic somatometry is appropriate, **(4)** how much computer pattern design applications display the insufficient measurements of the garments dressed on rigid models, and **(5)** how much tangible mannequins are yielding or look real; going along those authors, researchers and designers – whichever way they pick to look into the bipartite problem of garment fit and body appearance – should embrace a paradigm shift.

To refer to Kirk and Ibrahim in support of this thesis, if "garments can be cut more neatly in appearance and [...] conform better to the body" throughout "the wearers' dynamic movements" (1966: 37), then, the shape changes that the body parts of a single body go through during the day should be incorporated into the basic and clothing patterns and the subsequent appraisal of the garments' fit.

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[87] See p. 23. The authors' classification comprises two other types of garments, namely those designed to be smaller than the body area – such as foundation garments –, expressed by the equation [$F < O$], and those designed to be much bigger than the body area – such as overcoats –, expressed by the equation [$F >> O$] (Li and Dai 2006: 75).

Lineament Vs. Representation

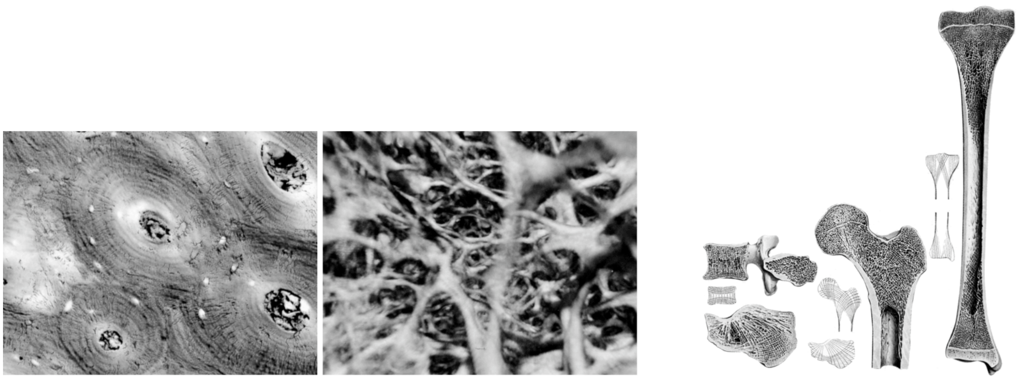
[*A Convergence Of Points Of View*]

Through science we know that the energy of the body arises out of its architecture. All contributing to its dynamic nature, the skin, skeletal muscles and bones – just to mention the body tissues Zhang, Li and Wong consider relevant to "describe the interactive mechanisms between a deformable human body and a garment" (Li and Dai 2006: 308) – along with nerves, have specialized structures that match their specific functions.

As long as the description of the body's structural design can be condensed, the starting point of this shortened version is the cell, the smallest independently functioning unit within the body or, as Ameersing Luximon and Ming Zhang write, "the basic unit of structure and function in an organism" (Li and Dai 2006: 93). Made up of one or more nuclei surrounded by cytoplasm and enclosed by a viscous translucent membrane called protoplasm, similar cells join together to form varied body tissues. Classified into four main types, the epithelial, connective, muscle and nervous tissues are assigned distinctive roles: **(1)** epithelial tissues form a thin protective layer on exposed bodily surfaces as well as forming the linings of internal cavities, ducts and organs, **(2)** connective tissues support, connect and surround organs and other body parts like cartilages, tendons and bones, **(3)** muscle tissues enable movement by means of repeated contraction and relaxation and maintain tension between body parts, and **(4)** nervous tissues transmit nerve impulses to the brain, spinal cord and peripheral nerves, and *vice versa*. Working in concert, different kinds of tissues may form an organ, a complete part of the body – such as, the skin, brain and eyes – performing a particular function. Functioning together, several organs can create a system, for example, the skeletal, the muscular and the nervous systems; ultimately, all the systems team up, equipping the body with many faculties that can be carried out at the same time: we're able to talk while we eat or walk, we're able to read while we listen to music and digest a meal, and so on and so forth.

Less succinctly, the following pages focus on the construction of the body, describing it from the bones to the skin, from the musculoskeletal system to the nervous system. The aim is to illustrate that modeling the body as a solid entity rather than a shell – as Dai, Li and Zhang affirm garment simulation techniques mostly do (Li and Dai 2006: 125) – or, to rephrase the above sentence, the aim to illustrate that looking at the body, i.e., the core of the body/clothing system, from various points of view rather than a single one – a perspective clothing designers and researchers have traditionally chosen to adopt – would promote the well-being of the clothed body since the result of a convergent representation, *qua* a tectonic approach, would incorporate the internal forces that produce movement and deformation of the body's outer layer.

Beginning this rendering with "the primary structural element of the human body" – as written by Nihat Özkaya and Margareta Nordin (1999: 206) –, the bones amount to approximately two hundred and six, in adulthood, and form only fourteen percent of the body's total weight. Having unique structural properties that enable them to carry out different functions, the bones support the body, protect the internal organs and provide kinematic links in addition to muscle attachment sites.



[*Figures 15a* and *15b*]
Macroscopic Structure Of Cortical Bone Tissue And Cancellous Bone Tissue (Tsiaras and Werth 2004: 94)

[*Figure 15c*]
Distribution Of Tissues In A Long Bone (Rigutti 2007: 39)

The building blocks of the skeletal system, all bones consist of two types of tissues, namely, **(1)** the cortical or compact bone tissues that shape the outer layer – a dense laminar structure with minimal gaps and spaces between the interspersed plates [*Figure 15a*], and **(2)** the cancellous, trabecular or spongy bone tissues that form the inner layer – an open cell porous network [*Figure 15b*]; additionally, a dense fibrous membrane called the posterium surrounds the entire bone area except for the joint surfaces, which are covered by articular cartilage (Özkaya and Nordin 1999: 207).

Offering bones the strength and stability as well as the flexibility and resilience "necessary to resist everyday compressive forces" (Zaller 2006: 11), the differing structures of the tissues within this composite material confirm the idea that "function presupposes structure," as maintained by D'Arcy Thomson (Tsiaras and Werth 2004: 6).[88] Shaped symmetrically or asymmetrically, the bones in the human body are categorized into five types, i.e., **(1)** the long bones, like the femur [*Figure 15c*], **(2)** the short bones, such as the carpal, **(3)** the irregular bones, like the vertebrae, **(4)** the flat bones, such as the scapula, and **(5)** the sesamoid bones, like the patella.

Forming together a flexible framework that bends and turns along an S-shaped central axis,[89] the vertebral column is regarded as "the most complex part of the human musculoskeletal system" (Özkaya and Nordin 1999: 95). Housing and protecting the spinal cord, supporting the head, neck and upper limbs, transferring loads from the head and trunk to the pelvis, and allowing the body to perform numerous movements, the spine's thirty-thee or thirty-four irregular bones[90] are arranged in five regions: **(1)** the cervical section, comprising seven vertebrae, frames the neck, **(2)** the thoracic section, comprising twelve vertebrae, framing the chest, make up the trunk, in partnership with **(3)** the lumber section, comprising five bigger vertebrae, framing the lower back, **(4)** the sacral section, consisting of five merged vertebrae, and **(5)** the coccygeal section, consisting of four or five vertebrae combined into one – both, the sacral and coccygeal sections, being united with the pelvis.

Interposed between each vertebra, the intervertebral disks are endowed with great elasticity, provide considerable stability to the fragmented structural core, act as shock absorbers and eliminate vertebra-to-vertebra collision (Özkaya and Nordin 1999: 95-96; Kelley 1971: 254-255). Varying in size to match the functions their

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[88] The 1917 phrase of the Scottish biologist (1860-1948) appears to be an adaptation of the well-known phrase *form follows function*, coined by the American architect Louis Sullivan (1856-1924) in his article "The Tall Office Building Artistically Considered" published in 1896.

[89] Actually, the four anteroposterior curves that characterize an adult column develop from the C-shaped spine presented in early, fetal, life (Kelley 1971: 252).

[90] Authors like Nihat Özkaya and Margareta Nordin (1999: 95) mention that the vertebral column consists only of 24 vertebrae, as they leave out the sacral and coccygeal vertebrae.

individual locations demand, their actions grant access to **(1a)** the free rotation, flexion, extension, hyperextension and lateral flexion movements of the cervical region, **(2a)** the limited rotation, flexion, extension, hyperextension and lateral flexion movements of the thoracic region, and **(3a)** the flexion, extension, hyperextension and lateral flexion movements of the lumber region. Essentially, the considerable magnitude of the movements the vertebral column is capable of is the product of the small movements taking place between various pairs of vertebrae (Kelley 1971: 259).

Situated within the body's trunk segment, the bones of the shoulder and pelvic girdles connect the thoracic and the sacral/coccygeal regions of the spine to the arms and legs respectively. Structured similarly, the upper and lower limbs comprise one long bone placed on the top, two shorter ones sited in the middle and a collection of yet smaller ones positioned on the end – forming the hands and feet respectively.

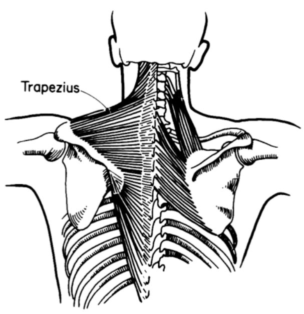
Although "the pelvic girdle is not designed to allow movement between its parts" and although "all pelvic movements necessitate changes in the vertebral column directly above" (Kelley 1971: 247, 250), the lower limbs are able to move independently of each other and yet be coordinated with the motions of the trunk. In comparison with the pelvic girdle – which assists in forward tilts of the pelvis, the flexion of the hip joint, the outward rotation of the thigh and the extension of the knee joint –, the sternoclavicular, acromioclavicular and shoulder joints, all forming the shoulder girdle, work together to execute abduction and adduction movements, elevation and depression movements and upward and downward rotation movements.

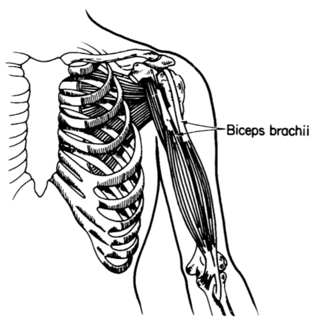
The range of motion, or ROM, reached by the body is in part, an effect of the degree of freedom possessed by the articulations that connect the bones; if the cartilaginous joints sited in the intervertebral disks are only slightly movable, the synovial joints are freely movable. Owing to their design, the various types of synovial joints allow contiguous bones "to slide by each other in passing" (Tsiaras and Werth 2004: 88) – for instance, the ulna by the humerus and the tibia by the femur – as well as "permitting one body segment to rotate about another" (Enoka 2002: 216) – for example, the humerus around the scapula.

On the other hand, if the skeletal muscles were not able to convert chemical energy – “initially derived from food” (Enoka 2002: 219) – into force and to apply it to bones and joints, movement would never occur. Classified into voluntary and involuntary muscles – the first type indicating their capacity to be put into action controlled by will, as when we walk and sit, and the second, their contribution to automatic processes like digestion (Tsiaras and Werth 2004: 102) –, skeletal muscles amount to more than six hundred pulling devices that “line and wrap nearly every square inch of our body” (Zaller 2006: 17).

Each muscle is attached to the skeleton at two points, namely **(1)** the immovable end, its point or points of origin, which is connected to a bone or bones situated nearer to the axis of the body, and **(2)** the movable end, its point or points of insertion, which is connected to a bone or bones positioned further away from the spinal column – the trapezius muscles, for instance, originate at the cervical and thoracic vertebrae ending, then, at the posterior border of the clavicle [*Figure 16a*].

With well-defined striations and making up around twenty-three percent of the female body weight and approximately forty percent of the male’s, skeletal muscles are made of many distinct bundles of muscle fibers called fascicles, whose “specific arrangement [...] has a dramatic effect on the force and range-of-motion capability of the muscle” (Knudson 2003: 46).





[*Figures 16a* and*16b*]
Origin And Insertion Of The Trapezius And The Parallel Architecture Of The Biceps Brachii
(Kelley 1971: 285)

[*Figure 16c*]
The Pennate Arrangement Of The Pectoralis Major (Tsiaras and Worth 2004: 107)

Effectively, aligned parallel to the long axis of a muscle – for example, the biceps brachii, a spindle-shaped fusiform muscle [*Figure 16b*] – or at an angle on both sides of the long axis of a muscle – for instance, the pectoralis major, a feather-shaped pennate muscle [*Figure 16c*], the two arrangements of muscle fibers serve distinct aims: **(1)** "muscles with a parallel architecture favor range of motion over force development" (Knudson 2003: 47), while **(2)** pennate muscles are able to create greater force but less range of motion.

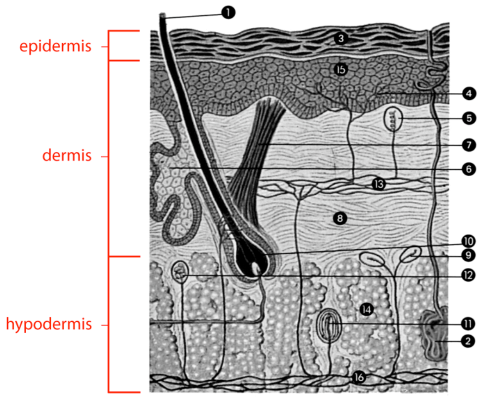
Working in synergy to create a specific movement, different skeletal muscles perform different roles: within the same body part **(1)** the muscle responsible for the movement – of the forearm for example – is the agonist, **(2)** the muscle providing opposition for the selected agonist is the antagonist; in contiguous body parts, **(3)** the muscle attached to a bone or segment – the forearm for example – on which an adjacent bone or segment moves – for example, the arm – is called the stabilizer.

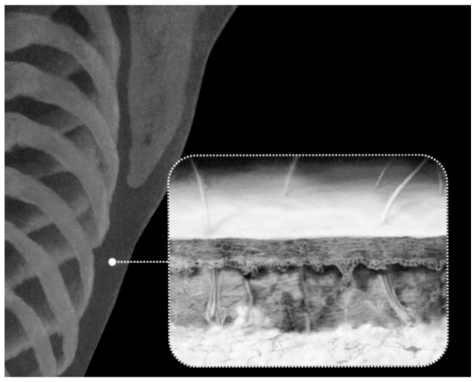
What happens "when the triceps contracts [is that] the biceps relaxes, moving the forearm away from the arm" (Li and Dai 2006: 98); said differently, the muscle fibers of the agonist shorten – an action called concentric – while the muscle fibers of the antagonist keep their resting length – an action termed eccentric. To produce the opposite movement, the agonist becomes an antagonist and the antagonist becomes an agonist, as "when the biceps contracts, the triceps relaxes, moving the forearm toward the arm" (Li and Dai 2006: 98).

The majority of the movements performed every day involve the coordination of various body segments, thus the activation of multiple muscles. As the neurophysiologist William A. Mackay (2006[2003]: 156-161) proclaims, biped animals – such as humans – use the arms for walking and running, even if it is believed that they only employ the legs for locomotion. In effect, the rotation of the arms together with the compensatory movements of the trunk – constantly adjusting to the alternate extension and flexion of the legs – are decisive to maintain bodily stability while we, bipeds, move from one place to another.

Clearly skeletal muscles are accountable for the visible shape distortions and volume changes going on in the limbs and trunk segments as we walk, sit, don, doff, *etc*, and in the abdomen and thorax areas as we breathe and digest. But as voluntary and involuntary muscles pull the inner tissues of the body causing it to move, the outer shell of the body – i.e., the skin – stretches in tandem. Approximately two square meters in surface area and about fifteen percent of the body's weight, the skin is the largest organ in the human body.

A crucial anatomical boundary between the internal and external environment, this organ is a sensory receptor and a regulator of body temperature. While protecting the tissues underneath it, the skin is required "to remain tense but allow free motion at the joints" (Serup 2002: 44).





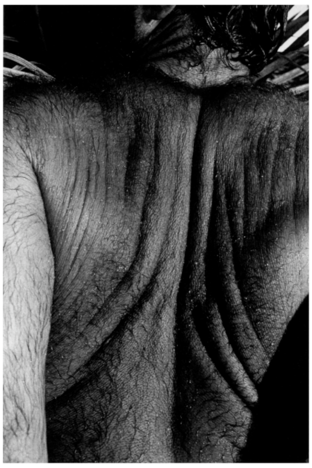
[*Figure 17a*]
Underlying Architecture Of The Skin, adapted from illustration by A. Ghermana and O. Cetverikova (Rigutti 2007: 104)

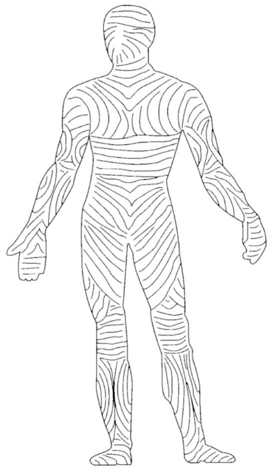
[*Figure 17b*]
Cross Section Of Skin On The Trunk (Tsiaras and Werth 2004: 17)

A composite tissue "with entirely different structures, functions, and mechanical properties" (Serup 2002: 41), the skin [*Figures 17a* and *17b*] incorporates **(1)** an outer layer, the epidermis, a low-humidity non-vascular stratum made of densely packed keratin, which is quite resistant, **(2)** a twofold layer below the epidermis, the dermis, a cellular stratum containing clusters of small blood vessels surrounded by connective tissue, which is soft and pliable, followed by a reticular stratum composed of collagen bundles and elastin fibers, which is highly mechanically resistant, and **(3)** a subcutaneous layer, the hypodermis, made of connective and adipose tissues.

In addition, **(1a)** the epidermis, acting as a nonslip interface when we hold or lift things, walk or sit, *etc*, provides protection of mechanical injury and water loss, **(2a)** the dermis, endowed with specialized nerve cells, detects thermal and mechanical changes, such as pressure and vibration, and **(3a)** the hypodermis, regarded in most cases as part of the dermis, offers insulation and stores fat as well as energy.

Exhibiting great elasticity and resilience, when joints are bent the skin adjusts itself in response to specific needs. Biologically speaking, the mechanical behavior of this organ combines the abilities **(1)** to undergo distension or strain under the influence of stress, and **(2)** to retract to the original state upon the removal of pressure (Serup 2002: 41). Surprisingly, the skin's elasticity is inversely correlated with its thickness, a feature that varies from site to site; in fact, "the thinner and more echodense skin of extremities is less distensible compared with the thicker skin of the trunk" (Serup 2002: 44).





[*Figures 18a* and *18b*]
Pattern Of The Skin Folds, *Marilou*, photo by Pierre Radisic from 1984, and *Wrinkles in Back*, photo by Ernestine Ruben from 1984 (Ewing 1994: 162, 163)

[*Figure 18c*]
The Langer Lines, diagram by Jason Tak-man Cheung and Ming Zhang (Li and Dai 2006: 113)

Mapping the whole skin, the directional pattern of the crease lines – or Langer's lines, as they became known[91] [*Figures 18a*, *18b* and *18c*] – manifestly respect the free motion of rotator and hinge joints, as Jørgen Serup writes (2002: 45). 'Respect' because these folds, having less flexibility than the skin surrounding them (Li and Dai 2006: 113), provide the means to counterbalance the constant pulling of tissues located in the region of movable joints.

Imbedded in the epidermis and dermis as well as in skeletal muscles, countless sensory receptors are truly "listening" devices (Tsiaras and Werth 2004: 62). Categorized into various types, each receptor is specialized in one or another

[91] Named after the Austrian anatomist Karl Langer (1819-1887), the first to note that the circular punctures made on cadaver skin, turning time after time into ellipsoid wounds, corresponded to the natural orientation of the collagen fibers in the dermis.

aspect of sensitivity, namely **(1)** the Krause's end bulbs and the Ruffini cylinders act in response to thermal stimuli – the former to cold, the latter to heat –, **(2)** the Meissner's corpuscles and the Merkal's disks respond to tactile stimuli – the former to slight changes in touch, the latter to continuous alterations –, **(3)** the Paccini's corpuscles react to pressure and vibratory stimuli, and **(4)** the free nerve endings detect pain. "Named after their discoverers" (Cholewiak and Collins 1991: 27), all these receptors are capable of converting mechanical, thermal, chemical or electrical energy into neural signals.

Extending to the whole body, approximately fifty thousand kilometers of nerves branching from the brain and the spinal cord make up the peripheral nervous system, which in company with the spinal cord and the central nervous system is part of the nervous system [*Figures 19a* and *19b*]. Individual nerve fibers – some as long as one meter (Cholewiak and Collins 1991: 35; Tsiaras and Werth 2004: 50) – carry the information collected by the various types of receptors scattered throughout the body towards the spinal cord.

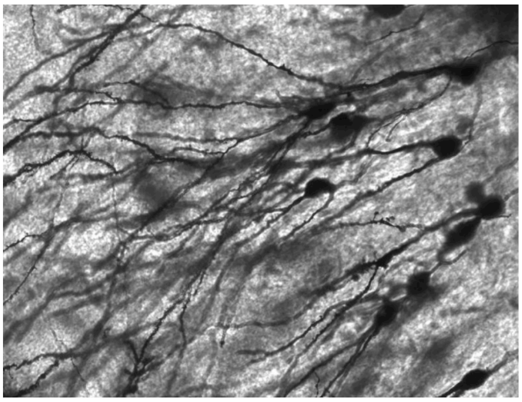
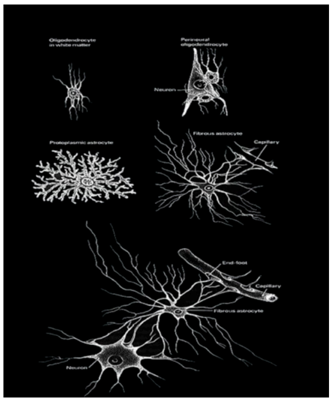
[*Figure 19a*]
The Whole Nervous System, illustration in George W. Hunter's *Elements of Biology*, published by the American Book Company in 1907 (www.textbookhistory.com/?tag=george-w-hunter)

[*Figure 19b*]
A Fraction Of The Nervous System, adapted from photo in *Bodies: The Exhibition* (Zaller 2006: 28)

Before entering it, the nerve fibers gather at each side of the vertebrae to form single nerve trunks; inside the spinal cord, they divide into two major groups according to their function: **(1)** the smaller nerve fibers, carrying information related to pain and temperature, make one, and **(2)** the larger nerve fibers, carrying information concerning mechanical pressure and tissue distortion, create another.

Forming neural pathways running up and down “the main conduit between the brain and the body” (Zaller 2006: 22), i.e., the spinal cord, millions of nerve impulses traveling as fast as one hundred and twenty meters per second are conducted to the central nervous system by afferent or sensory nerves and from the central nervous system by efferent or motor nerves. When the information collected by the skin and other organs reaches the brain, twelve billion cells process it; as soon as the appropriate response is determined by the brain cells, instructions are sent back to a specific body part or parts (Zaller 2006: 22).

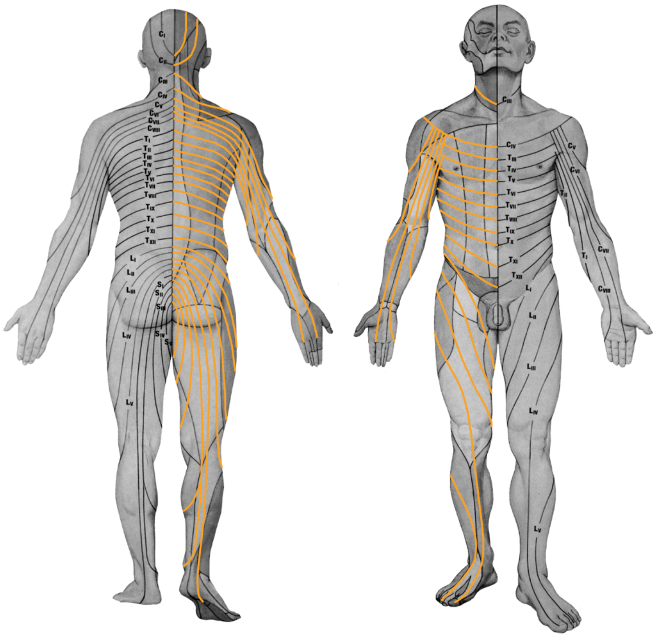
Despite the briskness of this two-way process, its efficiency depends on the communication taking place at microscopic gaps, i.e., synapses, linking – one after another – electrically excitable cells, i.e., the neurons [*Figure 20a* and *20b*]. The number of neurons contained by the whole body is inestimable since only in the human brain they amount to one hundred billion making one hundred trillion synaptic connections (Lakoff and Johnson 1999: 18).

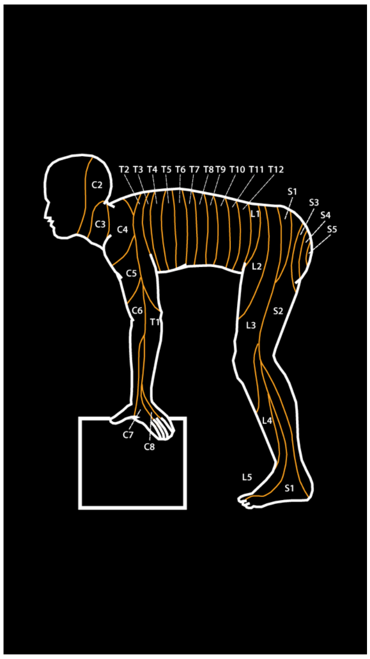



[*Figure 20a*]
Neurons In Human Hippocampal Tissue, image of Golgi-stained neurons (en.wikipedia.org/wiki/Neuron)

[*Figure 20b*]
Diagram Of Neurons And Their Branched Extensions, adapted from www.mcb.berkeley.edu

Viewed as the core element of the nervous system, neurons are classified into three sorts, namely, **(1)** the sensory neurons are the type of neurons that, situated outside the central nervous system, convert the external stimuli – such as touch, sound, light and temperature – affecting the cells of the sensory organs into internal stimuli, **(2)** the motor neurons are the type of neurons that, located inside the central nervous system, cause muscle contractions and affect glands, and **(3)** the interneurons are the type of neurons that, also positioned inside the central nervous system, connect afferent to efferent neurons.





[Figure 21a]
Dermatomes Pattern In The Body Standing Straight, adapted from illustration by A. Ghermana and O. Cetverikova (Rigutti 2007: 104-105)

[Figure 21b]
Dermatomes Pattern In The Quadruped Position, adapted from illustration in Levy, Koeppen and Stanton (2006[1992]: 94)

Although this network is set inside the body, its organizational chart is "tattooed invisibly on our skin" (Tsiaras and Werth 2004: 49). As it happens, the peripheral nerves subdivide the body into twenty-nine pairs of regions, called dermatomes,[92] arranged horizontally around the trunk and vertically along the limbs. The peculiarity of their pattern distribution *[Figure 21a]* relates to the fact that, during embryological development, **(1)** the lengthening of the dermatomes as the limb buds turned into arms and legs (www.apparelyzed.com/myo-dermatomes.html), **(2)** the rotation undergone by the upper and lower limbs as they were being formed (Levy, Stanton and Koeppen 2006: 94), and **(3)** the vertical position taken

[92] The areas of skin that emanated from somites distributed along the neural tube of the developing vertebrae embryo; besides generating a specific area of skin, each somite also yields a myotome, i.e., a particular group of muscles, and a sclerotome, i.e., a single bone or a cluster of bones.

on by the body after birth, to stand, walk, *etc*, as it's proper to humans (Levy, Stanton and Koeppen 2006: 94). As shown in [*Figure 21b*], in the womb – or outside it, when the body leans down – the dermatomes are fairly parallel.

Knowing about the body's superimposed and interconnected makeup, medical doctors have resorted to the dermatome map as an instrument for diagnoses. Aware that each skin area is supplied by a single spinal nerve and that the general pattern of the areas of innervation is similar in everybody, neurologists – in particular – draw on the dermatome map to locate damages to the spine by "mapping the skin with needle pricks" (Tsiaras and Werth 2004: 49); however, this type of tests only provides an approximation since, albeit being sharply defined in diagrams, in reality adjacent dermatomes overlap one another (Tsiaras and Werth 2004: 49; Cholewiak and Collins 1991: 36).

Much more could be said about the body and its physical, multilayered, construction; much more could be mentioned about this singular, integrated, organism (Damásio 2003: 21) that's furnished with various tissues, organs and systems, working together; much more could also be told about the various structures within the brain that are constantly mapping the body endowing it with the faculty of perceiving the condition it's in at any particular time.[93]

But, hopefully, the previous account highlighted **(1)** that the liveliness of the body depends on movement (Greenfield 2002: 47) – such as the movement of the stimulatory signals down a long string of neurons to ultimately cause the contraction and relaxation of muscles, *etc* –, **(2)** that part of the movement going on inside the body causes the deformation of its surface, and **(3)** that the degrees of tissue deformation have an impact on the body's – more or less conscious – perception of comfort.

As unacquainted with the specifics about the kinetic mechanisms of the body as the team of *Levi Strauss Europe* may be – led by the designer Rikke Korff –, the former director of this division, Peter Ingwersen, announced in 2000 that the concept behind the *Engineered Jeans* [*Figure 22*], launched in 1999,[94] was based

[93] Effectively, as the Portuguese neuroscientist António Damásio elucidates, "the muscular structure of muscles under strain is different from that of relaxed muscles, their mapping is correspondingly different" (2003: 105).

[94] The label that followed the *Levi's Red* collection.

on the portrayal of the movement created by the body as it walks, rides a bike, car and skateboard (Rickey 2000).

[*Figure 22*]
Levi's Engineered Jeans #001 Standard Fit With Highlighted Seams, adapted from Simões (2005:2005: 128)

Before looking at how *Levi Strauss Europe* represents the mobile body, it must be referred that the way the *Engineered Jeans* look when they're undressed [*Figure 22*] – or before they are put on for the first time – is analogous to the way the first garments worn by the eleven participants that took part in this research ended up looking.[95] The significance of their likeness to this thesis relates to the fact that the volumetric and distorted figure acquired by the first garments corresponds to, as it is defended, the amalgamation of all the body positions everyone assumes day after day.

With respect to the *Engineered Jeans* and their configuration, the relationship between them and the mobile body is made through the orientation of the products' seams that, no longer straight – as it's customary with this type of garment [*Figure 23*] –, divide the front and back of the body in an unusual way. Intentionally or coincidentally, the course of the seams of the *Engineered Jeans*

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[95] See section The Self-Portraits, integrated in Part 4 entitled The Creation Of The Artifact.

gives the impression of resting on the boundary between two lumbar dermatomes.[96]

[*Figure 23*]
Levi's 501 Jeans With Highlighted Seams, adapted from Simões (2005: 128)

If the comparison between the lines piecing the *Engineered Jeans* and the lines bonding the skin areas is consistent with facts or is pure speculation is not known,[97] but the truth of the matter is that, in terms of active comfort, the twisting effect brought about by the atypical outline of the back pattern piece causes the wearer to feel physically unrestrained, particularly around the crotch area (Simões 2005: 134). On this very subject, the fashion journalist Melanie Rickey wrote, "try these jeans on, [...], and you will be seriously hooked" (2000).

About the perception of comfort during wear, a group of researchers from Hong Kong conducted a survey in 2000 to identify the important attributes for the ideal pair of jeans, for which they asked 153 people to rank ten attributes of denim pants, ranging from price and quality to comfort and aesthetics. In view of the research question of this thesis, only the results concerning the assessment of garment pressure comfort at different body locations are brought up, a circumstance that the surveyed people estimated as being **(1)** satisfactory and very satisfactory at the thigh girth, knee, side waist, back waist, hip, side hip and trunk locations, and **(2)**

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[96] Compare with [*Figure 21a*] in p. 91.

[97] In fact, in 2004, all the attempts to contact the design team of *Levi Strauss Europe* that were made in the ambit of my Master's research were unsuccessful.

satisfactory and unsatisfactory at the front waist, pelvis and crotch locations, particularly when subjects “sat on the floor with their knees bent” (Li and Wong 2006: 342) in contrast to walking, which, according to the subjects, was the activity that “provided least clothing pressure discomfort” (Li and Wong 2006: 342).

Everything considered, the researchers concluded that pressure comfort is different in each type of body position assumed – and, it could be added, in each type of movement performed. Accordingly, the researchers inferred that the relationship between the “design cut” of a garment and the pressure it exerts has a significant impact on the wearer’s perception of comfort (Li and Wong 2006: 343). Said differently: constraint of movement is a hindrance created by clothing that doesn’t stretch as much as the body.

The rephrasing of the researchers’ conclusion – comprising all partial inferences – demands to go back to the issue of the skin’s flexibility. Even though Serup states that “elasticity measurement suffers a low status in the medical community” (2002: 47), the extent to which this organ is capable of distending has been the issue of some experimental researches carried out in the fields of textiles and clothing engineering.

For example, W. Kirk and S. M. Ibrahim, focused on “minimizing garment resistance to body demands in motion” (Kirk and Ibrahim 1966: 39), measured the changes in skin dimensions on four critical strain areas of the body – i.e., the knees, elbows, seat and trunk – while twenty women and twenty men of different shapes, weights and sizes, moved from the standing posture into specified positions as met in ordinary and sports movements.

The researchers concluded that **(1)** the skin has a high level of two-way stretch, and **(2)** the localized percentages of skin stretch do not vary much from women to men; accordingly, Kirk and Ibrahim summarized the collected data as follows [*Figure 24*]:

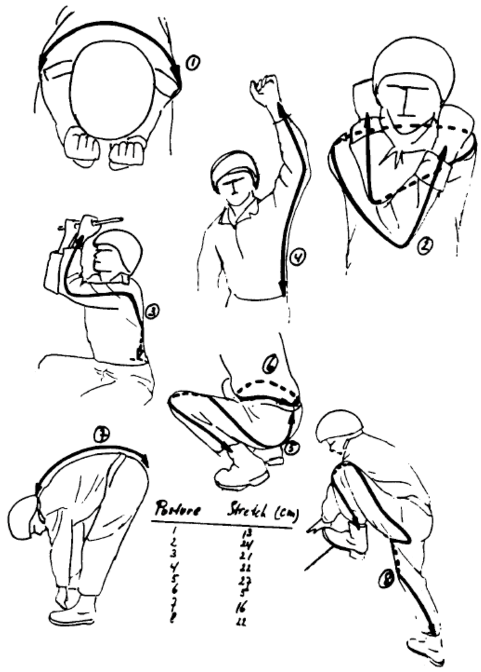
Body Element	Body Movement	Local Skin Strain (Horizontal) Men	Local Skin Strain (Horizontal) Women	Local Skin Strain (Vertical) Men	Local Skin Strain (Vertical) Women
Knee	Stand-Sit	21%	19%	41%	43%
	Stand-Deep Bend	29%	28%	49%	52%
Elbow	Straight-Full Bend	24%	25%	50%	51%
Seat Area					
(Hip to Hip)	Stand-Sit	20%	15%		
	Stand-Bend	21%	17%		
(Crotch)	Stand-Sit	42%	35%		
	Stand-Bend	41%	37%		
(Overall)	Stand-Sit			27%	27%
	Stand-Bend			35%	34%
(Buttocks)	Stand-Sit			39%	40%
	Stand-Bend			45%	45%
Trunk	Straight-Forward Raised Arm			33%	31%
	Straight-Elbows on Table			28%	28%
	Straight-Elbow Bending			14%	16%
	Straight-Shoe Tying			47%	47%

[*Figure 24*]
Percentages of Skin Stretch, adapted from tables III, IV and V presented by W. Kirk and S. M. Ibrahim (1966: 40)

Another researcher, W. A. Lotens, checked how much the skin stretches relative to the standing position[98] in several extreme body positions identified by him (2007[1989]: 299) – or, more correctly, how much body tissues, like the skeletal muscles and skin, expand as one –, as he recognized that the freedom of movement of the dressed body is dependent on clothing construction.

The arrows included in the illustration presented by the researcher (2007[1989]: 299), standing for the areas over which clothing has to stretch to accommodate body movement, are the lines over which Lotens measured the body [*Figure 25*].

98 That is, the position chosen by pattern design.



[*Figure 25*]
Seven Extreme Positions, illustration with notations by W. A. Lotens divulged in 1989 (Lotens 2007[1989]: 299)

In contrast to Kirk and Ibrahim's approach to sampling, the dimensions communicated by Lotens "are obtained from relatively lean young males and could considerably be exceeded with fat persons" (2007[1989]: 299). Even though the researcher doesn't also convey the sample size, he assures that, generally, there is

> **(1)** An increase of thirteen centimeters from shoulder to shoulder, measured at the back, when the hands are close to the face,
>
> **(2)** An increase of twenty-four centimeters from wrist to wrist, when the arms are crossed and the hands are on the shoulders,
>
> **(3)** An increase of twenty-one centimeters from waist to wrist, measured along the side, when both arms are raised just above the head and the hands are close to the face,
>
> **(4)** An increase of twenty-two centimeters from waist to wrist, measured along the side, when one arm is considerably raised above the side of the head,
>
> **(5)** An increase of twenty-seven centimeters from center back waist to ankle, measured over the knee, when the legs are fully bent,

(6) An increase of five centimeters, measured around the waist when the legs are fully bent,

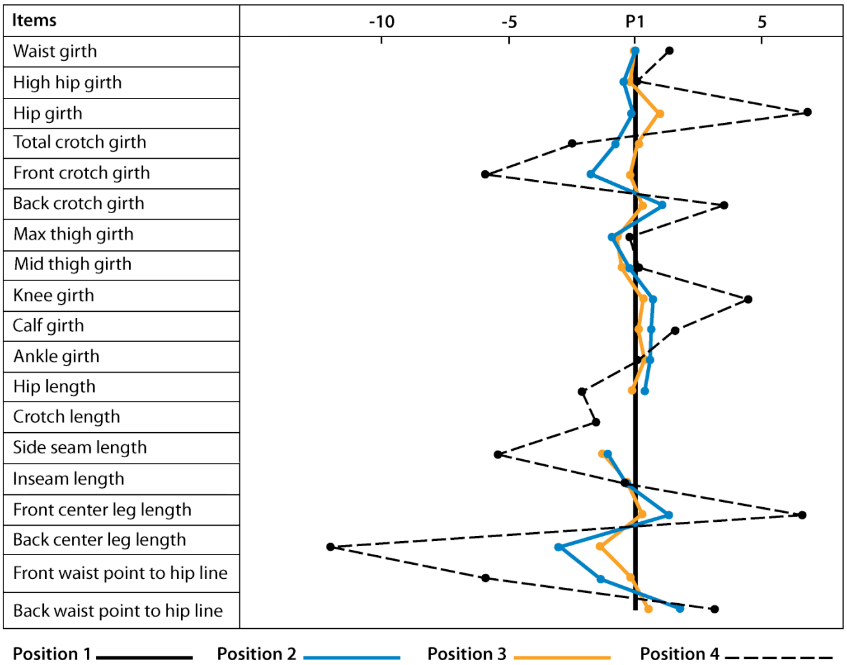
(7) An increase of sixteen centimeters from neck to hip, measured at the center back, when the trunk is fully bent,

(8) An increase of twenty-two centimeters from ankle to ankle, measured from the inside to the outside and over the knee, when one leg is fully bent with the foot on a surface that's far above the ground.

By drawing attention to these body dimensional changes, Lotens emphasizes the importance of optimizing "the design [of protective clothing] in a rational way" (2007[1989]: 292). Likewise, Sunyoon Choi and Susan P. Ashdown (2010) have recently developed a study based on the idea that designers must know how much body measurements increase/decrease at different body landmarks so they can create "garments that will move and fit well for many different activities" (Choi and Ashdown 2010: 89).

Focusing on the lower body and using 3D body scans of twenty-five women – aged 18 to 24, wearing US standard sizes 10 and 12 – positioned in the archetypal, upright, posture and in three active postures frequently used in daily life – i.e., a standing position with a 120º knee bend, a stepping position, and a sitting position with a 90º knee bend –, Choi and Ashdown obtained nineteen dimensions from thirty-one markers placed around the waist, high hip, hip, crotch, maximum thigh, mid thigh, knee, calf and ankle.

Compared with the counterpart values for the standing position, the analysis of the comparative measurements showed that "14 of the 19 items [listed in [*Figure 26*]] had significant changes" (Choi and Ashdown 2010: 89), particularly in Position 4, the sitting position; less significant were the changes disclosed by Position 2, the standing position with bended knees, and by Position 3, the walking position, which were minimal.



[*Figure 26*]
Body Surface Change In Four Different Positions, adapted from graph presented by Sunyoon Choi and Susan P. Ashdown (2011: 84, 86, 89)

According to Choi and Ashdown (2010: 90-91), the actual percent change in body measurements for the three active positions are respectively:

(1) For Position 4 [*Figure 26*], the hip girth increased about 7%, the front crotch girth decreased about 16% and the back crotch girth increased about 9%, the knee girth increased about 12%, the hip length decreased about 10%, the side seam length decreased 5.5% and the inseam length decreased less than 1%, the front center leg length increased about 10% and the back center leg length increased about 19%, the front waist point to hip line decreased about 28% and the back waist point to hip line increased about 15%.

(2) For Position 2 [*Figure 26*], the front crotch girth decreased about 3%, the front waist point to hip line decreased about 3% and the back waist point to hip line increased about 3%, the back center leg length decreased about 5%. All other measurements either increased or decreased something like 1%.

(3) For Position 3 [*Figure 26*], all measurements increased or

> decreased less than 1%, except the back center leg length that decreased about 2.2%.

The team summarizes the findings by writing, "based on multiple comparisons among all postures the back center back length showed the greatest change in dimension in the active postures. Front waist point to hip line length, front crotch girth, knee girth, hip girth, front center leg length, and back crotch girth also exhibited large changes [...]. Areas that exhibited little or no change [...] were high hip girth, thigh girths, ankle girth, and inseam length" (Choi and Ashdown 2010: 89).

In a brief survey of related work – comprised in her contribution to *Improving Comfort in Clothing* –, Ashdown lets know that body surface increase changes have been quantified from **(1)** 13% to 16% across the shoulders, **(2)** 4% to 6% in buttock width, **(3)** 35% to 45% in arm and leg lengths, and **(4)** 12% to 22% in elbow and knee diameters (2011: 281-282).

If the aim of studying the change in body measurements is to show that clothing should accommodate the body's deformation, Aitor Throup is indisputably a recipient of this concern, as the fashion designer is wholeheartedly committed to finding solutions to the problem of the mobile body's representation.[99]

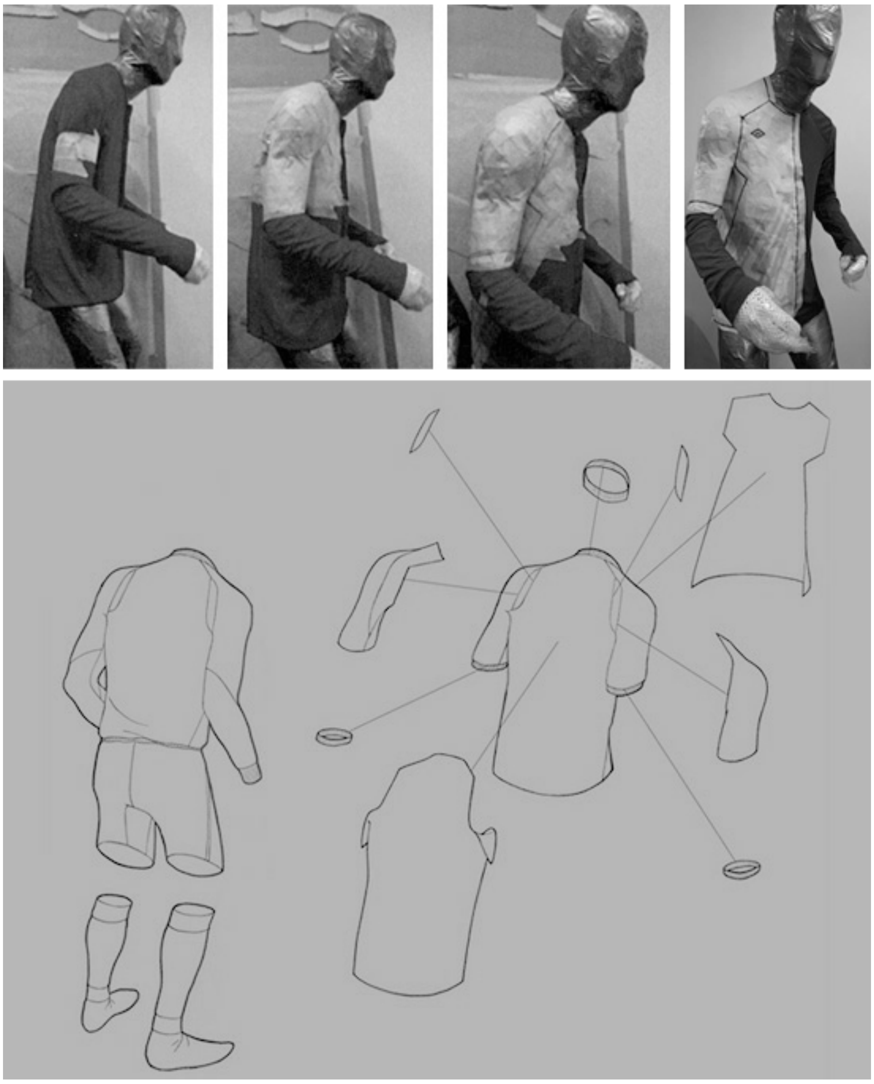
Stating that his approach relates more to traditional sportswear than traditional fashion, Throup explains that he studies how the body moves in a specific activity – whichever one is involved in the project he's developing at a particular time, for example, football [*Figure 27*] –, and then, by incorporating the activity's distinctive movements into the garments he designs, the performance of the clothing becomes one with the performance of the body.

In his words, the materialization of this *symbiosis* reveals itself through articulated garments with surface areas growing and shrinking as the skin does (www.designboom.com). The strategy of segmenting the clothing in unusual ways – a feature that became Aitor Throup's trademark – issues from the "construction process" the fashion designer devised, "which utilizes his own sculptures of the

---

[99] Born in 1980, the Argentinean moved to England in 1992, where, in 2004, he completed a BA in Fashion Design at the Manchester Metropolitan University and, in 2006, an MA Postgraduate Degree in Fashion Menswear at the Royal College of Arts, in London (www.aitorthroup.com/Aitor_Throup_biog.pdf).

human body [*Figure 27*] as a system for blocking garments" (www.changethethought.com).



[*Figure 27*]
'Tailored By Umbro' Football Kit, photos by unspecified author and illustration by Aitor Throup, 2008 (www.designboom.com)

By electing the three-dimensional method over the two-dimensional system of pattern design, Throup has actually broadened the potential of this pragmatic, intuitive, technique.[100] By using mannequins that portray body positions very

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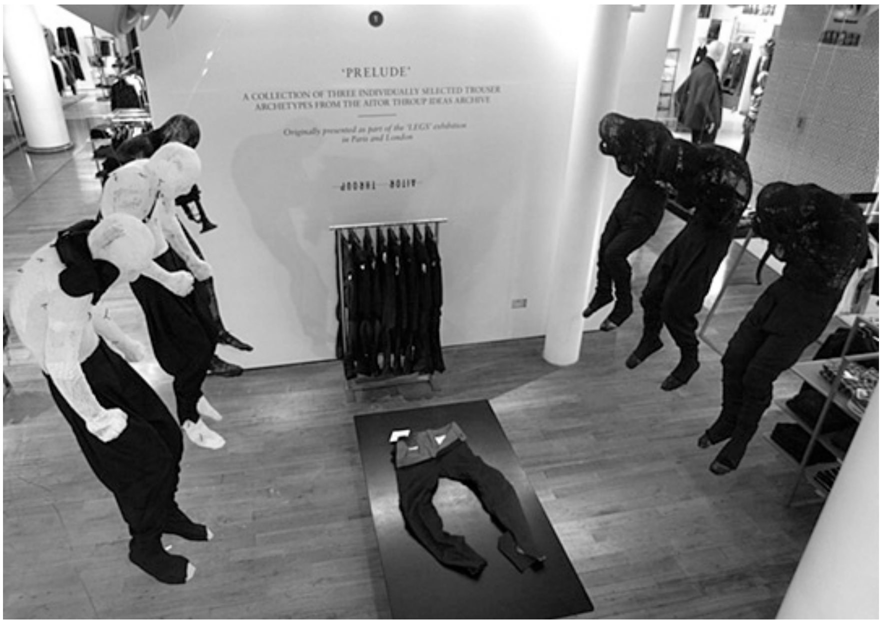
[100] In the absence of a better word, the term "intuitive" purports the attribute of three-dimensional pattern design, a technique that doesn't depend on establishing relationships among numbers and shapes. Because of that, this method was the only one accessible to the – unschooled – eighteenth century women who strived to become recognized as tailors, a title that was finally awarded to them in 1765 (Simões 2005: 65).

distinct from the posture conventional dress forms depict – i.e., the upright body, as commented in the previous section –, the fashion designer is able to deviate from the enduring paradigm of representation – i.e., the body standing still.

The extent to which his deviation amounts to is so great that, if Throup's work displays a continuing "search for new 3-dimensional garment solutions" (www.designboom.com/), his work has to be displayed in ways so as to highlight the working beauty of the garment in wear, rather than the total visual effect, so as to emphasize the organism, not the apparition [*Figure 28*] – to reverse the order of Anne Hollander's wording,[101] a change that assures that Aitor Throup meets the art-historian's yearning.



[*Figure 28*]
'Prelude' Collection Displayed At The Selfridges, photo by unspecified author, 2010 (www.selectism.com)

At the moment Aitor Throup is, probably, the prime example of a fashion designer that contributes, rather successfully,[102] to an alternative body representation paradigm in pattern design. However, the precursor of this movement – if indeed it is a movement – is indisputably Madeleine Vionnet (1876-1975); in fact, seven

[101] See p. 79.

[102] To highlight a few points of his résumé, in 2007 the fashion designer won awards from Levi's, Umbro, Evisu and The Royal Society of Arts; in 2008, he collaborated with Stone Island and began working as a creative consultant with the British football brand Umbro (www.aitorthroup.com/Aitor_Throup_biog.pdf).

decades ago, the couture designer retired, leaving behind an astounding amount of creations that reflect her unique way of viewing the relationship body/clothing.[103]

In conceptual terms, the couture designer perceives the body as a "subject," not an object, a status that determines "the garment to be [consequently] at the body's service, helping it to express its individuality" (Kamitsis 1996: 9).[104] In practical terms, the French designer sees the body as a sequence of concave and convex areas, not as distinct, independent, surfaces, like the conventional understanding sees it.

Appropriately, Vionnet "extends one part [of the garment] to the next at a common side [*Figure 29a*]" (Kirke 1998: 233); suitably, she represents the body through triangles, squares, circles, *etc* [*Figure 29b*] – "as if this entity is decomposable into plane figures" (Simões 2005: 110);[105] resourcefully, she employs the fagoting technique to join several seams [*Figures 29c* and *29d*], as the gap left between two components allows garments to move smoothly across the surface of the mobile body and uses insets [*Figures 29c* and *29e*] to create contour shaping (Bryant 1993: 28, 37) as well as to stabilize the two sides of a seam; ingeniously, she cuts the whole garments on the bias [*Figures 29f* and *29g*], as she realized "that if [she] turned the fabric on an angle… it gained elasticity" (Kirke 1998: 36).

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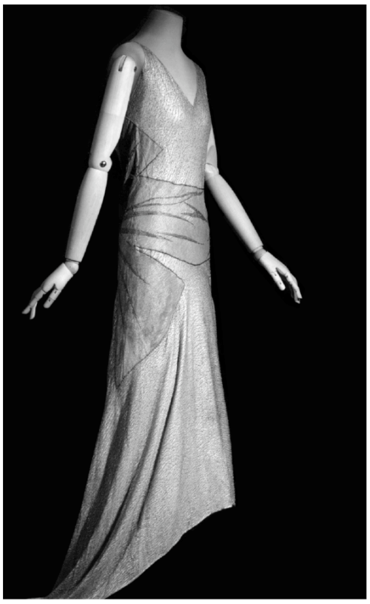
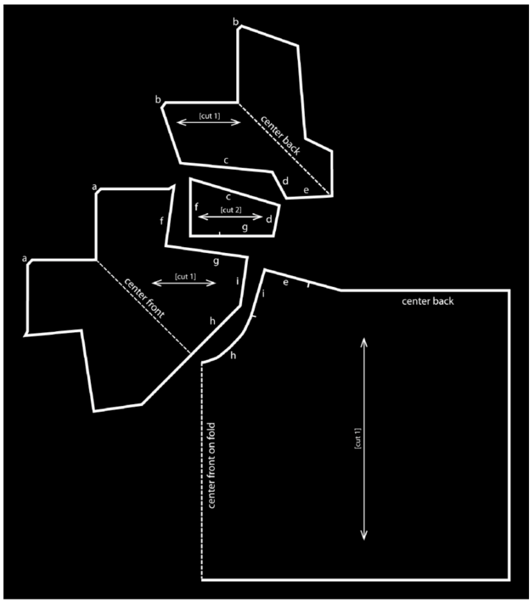
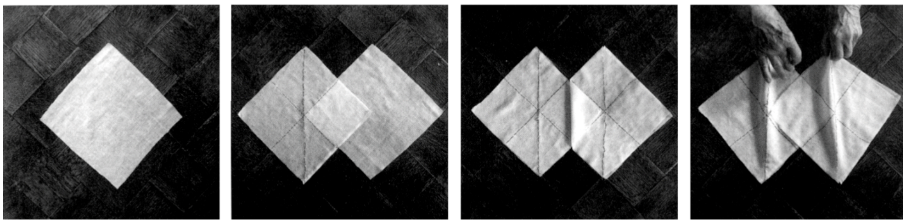
103 From 1912 to 1939, Vionnet presented annually more or less three hundred different styles (Simões 2005: 108).

104 Freely translated from "Le corps comme sujet […]. Le vêtement au service du corps, l'aidant à exprimer sa singularité."

105 Freely translated from "[…] Como se este fosse decomponível por figuras geométricas."







[*Figures 29a* and *29b*]
Decomposition Of The Body Into Plane Figures, adapted from photo of evening dress designed in 1932 (Golbin 2009: 117) and from diagram of its pattern (Kirke 1998: 61)

[*Figures 29c*, *29d* and *29e*]
The Technique Of Fagoting And The Use Of Insets, adapted from photos of day dress designed around 1920 and details of its sleeve (Martin 1999: 84, 85)

[*Figures 29f* and *29g*]
Cutting On The Bias, photos of “Handkerchief Dress” designed in 1918 (Golbin 2009: 87) and its construction as shown by Jacques Griffe (Loppa 1999: 65)

Merging these four strategies – i.e., the simplification of shapes, the manipulation of gravity and the dislocation of seams together with their gliding property –, Vionnet's approach brings about an unparalleled orderliness, coherence and harmony between body and clothing; working together, those strategies give rise to a unified total system, as the "'destructured' form" of Vionnet's creations – as termed by the fashion researcher Jacqueline Demornex (1991: 31) – mold onto the anatomy of the body and enhance its movement [*Figure 30*].

[*Figure 30*]
'Bas-Relief,' photo by Hoyningen-Huene published in *Vogue*, in November 1931 (Kamitsis 1996: 38-39)

Like her successor Aitor Throup, the process of design conceived by Madeleine Vionnet is anchored in the three-dimensional technique of pattern design – hence, she refers to it as a system of cutting rather than a design method (Kirke 1998: 225).[106] Like her follower Throup, Vionnet was convinced that searching for solutions to the problem of the mobile body's representation implies working within the problem, that is to say, involves designing on the mobile body rather than on the body standing still.

It is exactly this decision that differentiates Vionnet and Throup from other designers working within the territory of fashion – an area centered on the

[106] See p. 76.

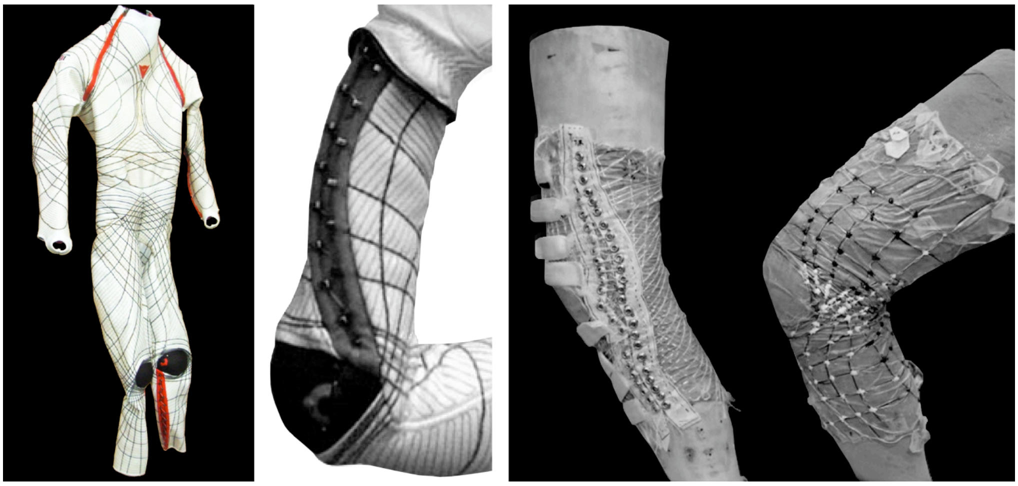
creation of nonspecific wear.[107] Within the territory of functional clothing – a field focused on the production of equipments for sports, defense, space, *etc* –, the option to design on the mobile body or, at least, to consider its mobility as the source of the design process, is common practice.

Actually "some of the most-fascinating provisions for movement can be found in the pressurized garments worn for space exploration or high-altitude flight" (Watkins 1995: 260). For a decade now, Dava Newman, a professor at the Massachusetts Institute of Technology, together with the NASA Institute for Advanced Concepts, is developing a mechanical counterpressure garment, the BioSuit, with the aim of enhancing, all the more, the extravehicular activities undertaken by astronauts (www.flickr.com/photos/cdevers/4455687937/).

Based on the idea of providing a second skin, the BioSuit conforms to the body rather than being an inflated, solid bubble, within which the body must move – a solution considered by NASA in the 1960s (Judnick 2007: 17). An improved version of the 1971 Space Activity Suit – "a complete leotard of elastic cloth, covering fingers, toes, hands, feet, arms, legs, and torso" (Webb 1968: 377) –, the design and construction of this new spacesuit employs various advances in engineering and measurement.

To gather relevant biomechanical data, Newman chose to **(1)** paint numerous circles on a clothed body, **(2)** record where the painted circles held their original shape and where they deformed into ellipses **(3)** at the same time as the wearer simulated the movements of extravehicular activities; then Newman **(4)** mapped the moving and stationary points of the circles and ellipses over the entire body, obtaining a series of lines that she termed *lines of non-elongation* [*Figures 31a*, *31b* and *31c*] – as she noticed, after measuring them, that they were scarcely affected by body movement.

[107] Even though daywear and eveningwear demand different approaches from a designer, they're grouped under the same umbrella, that of nonspecific clothing.



[*Figure 31a*]
BioSuit Mock-Up, full view of the tight-fitting elastic garment (Judnick 2007: 21)

[*Figure 31b*]
The BioSuit's Sleeve, close-up showing the lines of non-elongation and closure mechanism (www.humanitecture.com/tectonics.html)

[*Figure 31c*]
Leg Prototype, adapted from photo by Volker Steger showing the lines of non-elongation (mvl.mit.edu/EVA/biosuit/index.html)

As a result, the experimental BioSuit – assembled with different materials, such as nylon-spandex, elastic and urethane-painted foam – complies with the mechanical behavior of the body: in the same way as the lines of non-elongation remain stationary, or nearly stationary, as the body moves (Judnick 2007: 20), the elastic cords placed along them don't stretch, "at least in normal movements, whatever pressure they provide" (www.flickr.com/photos/cdevers/4455687937/).

Endowing the BioSuit with uniform pressure distribution, the built-in elastic narrow pieces prevent "adverse physiological consequences such as edema and pressure sores" (Newman 2005)[108] while they maximize mobility at joints, as corroborated by the researcher herself: in deep knee squat, for example, a subject is able to reach " a knee flexion angle of approximately 150º, significantly higher than the ~80º achieved in previous leg garments" (Newman 2005).[109]

Noticeably, NASA's quest to provide full mobility for space exploration led Newman to create the BioSuit on the mobile body. By adopting this approach, the

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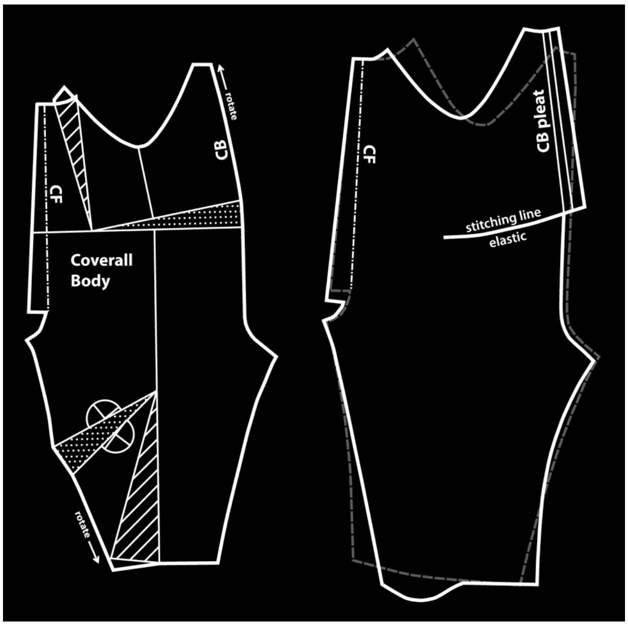
[108] As well as the disintegration of the body seeing that, in space, if no pressure is applied, the gases and fluids within it "would migrate into the relatively less pressurized atmosphere of space" (Watkins 1995: 260).

[109] Dava Newman refers specifically to the 1971's Space Activity Suit.

researcher generated a garment that doesn't hang straight when it's not being worn – as nonspecific clothes do, at least the unused, or relatively used, ones –; in fact, on a hanger, the arms and legs of the BioSuit are flexed, its arms resting away from the trunk and its legs not touching one another [*Figure 31a*]. In this manner, even before having – ever – been worn, the created spacesuit is truly the embodiment of its future wearer, i.e., the mobile body.

Clearly not all types of functional clothing require working at the intersection of engineering, design and medicine like the BioSuit does (mvl.mit.edu/EVA/biosuit/index.html); nonetheless, their creation demands that the designer bears in mind the safety of the users on top of having to focus on enhancing their mobility via garment performance. As it happens, when Susan P. Ashdown was asked, in 1989, to redesign the disposable coveralls worn by asbestos abatement workers, she dealt with all these matters simultaneously by taking on an approach that comprised **(1)** observing the kind of folds the original one-piece suits acquired during wear, and **(2)** translating the gathered data into the contour of the coveralls' pattern [*Figure 32*].



[*Figure 32*]
Asbestos Abatement Disposable Coveralls: Original And Redesigned Pattern, adapted from diagram by Susan P. Ashdown (Watkins 1995: 254)

The following points explain how and why Ashdown altered the pattern of the disposable coveralls (Watkins 1995: 253):

(1a) The horizontal and tight diagonal folds appearing across the back and knees respectively indicated Ashdown that the original garment was too tight in those areas. **(2a)** Accordingly, she slashed and spread the pattern – the amounts corresponding to the dotted parts in [*Figure 32*] – to accommodate the torso's forward movements and knee flexion.

(1b) The vertical and loose diagonal folds appearing at the front neckline and below the knees respectively indicated Ashdown that the original garment was excessively wide and/or long in those areas. **(2b)** Accordingly, she slashed and overlapped the pattern – the amounts corresponding to the stripped parts in [*Figure 32*] – to provide the proper fit during the torso's forward movements and knee flexion.

(3) While truing the pattern,[110] Ashdown inserted a box pleat along the torso's center back, lengthened the ankle at the front and put an elastic into the back waist, so the disposable coveralls conformed to the working position of the asbestos abatement workers, i.e., their "most frequently taken position" (Watkins 1995: 250).

By laying the original pattern on top of the redesigned pattern – the former represented by a dashed grey line, the latter by a continuous white line, as seen on the right of [*Figure 32*] –, Ashdown makes it able for anyone to see not only the difference between the two patterns' contours, but also that "the most effective way to create more mobile garments is often not to add ease, but to change the contour or cut of a garment so that it can easily follow the body movement during specific activities" (Watkins 1995: 253), corroborating the thesis advanced by Susan M. Watkins with reference to mobility in clothing.

Providing Watkins' proposition is true, providing its feasibility is extensible to nonspecific garments – as the patterns of the *Engineered Jeans* substantiate, being different from the outlines of other jeans' patterns, for example, the *Levi's 501*'s [*Figure 33*] –, Ashdown's approach – however simple it seems to be – is

[110] This expression stands for the final stage in patterns development, a process that includes balancing the length of the two sides of each seam, smoothing the lines of each seam and adding information for grading, marker making and sewing – for example, seam allowances, notches, grainline, *etc* – to the final pattern.

noteworthy since, by looking at the clothing folds, a designer is actually seeing the folds within the body.

[*Figure 33*]
Superimposed Patterns Of Levi's Engineered Jeans #001 Standard Fit And Levi's 501 Jeans, adapted from Simões (2005: 131)

This point of view is backed up by Richard W. Vorder Bruegge (1998), a specialist in individuating properties of worn denim jeans at the Special Photographic Unit of the FBI, when he describes how he contributed to the positive identification of Charles Barbee, one of the four suspects of the robberies that took place in the Spokane area of Washington, in 1996.

Consistent with Vorder Bruegge's paper,[111] although Barbee had obscured his body and face from the cameras by "wearing a dark mask, parka, athletic footwear, and denim trousers" (1998: 617), the folds, creases, and puckering in the left inseam, right outseam and hems of his jeans – particularly visible on the black-and-white bank surveillance film – were all the forensic investigator needed to identify the suspect, as these "individual identifying characteristics [...] manifest themselves as high and low areas ('ridges and valleys')" (1998: 613).

In fact, after having compared twenty-seven pairs of jeans belonging to the suspects

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[111] That followed his presentation at a meeting of the American Academy of Forensic Science, in February 1998 (Houser 2005: 155).

side-by-side with the jeans depicted in the footage, Vorder Bruegge proved that one of them had been worn by Barbee at the robbery, as both pants possessed the same features: **(1)** a bright line, running upwards from the hem, parallels the left side of the inseam for a short distance, then angling away from it, **(2)** a connected set of dark lines in the shape of an "H," resting on the left inseam-hem intersection, **(3)** a bright pair of lines shaped like a "V," tilting to the left, its base placed on the hemline, and **(4)** a pair of bright marks resembling the Greek letter π, situated along the hem to the right of the "H" shape (1998: 617).

The exhibits presented by the forensic investigator – that have led to the successful prosecution of Barbee –, sustain the idea that, at the very least, "clothing is particularly prone to changes in shape while being worn, as the material is stretched, folded, or bunched" (Vorder Bruegge 1998: 614). Utterly, the significance of the wear-marks noticed by Vorder Bruegge – or, to the same extent, the tension folds identified by Ashdown and the intact and distorted circles recorded by Newman – is that they disclose the hidden relationship between garment and wearer (Houser 2005: 164).[112]

What appears out of this hidden relationship is the fold,[113] a trait that – to abridge Gilles Deleuze's (1925-1995) words – "is not only in clothing, but includes the body" (2006[1988]: 38). Drawing freely on the French philosopher,[114] the fold is an operative concept by which everything it includes is materialized: through the interplay of folds – fold after fold, fold over fold –, shape and depth are conferred, scale and direction are determined, softness and hardness are rendered, light and shade are delimited, void and full are demarcated, background and foreground are defined (Deleuze 2006[1988]: 38-42).

Again, through the interplay of folds – continuously folding, unfolding, refolding, the two sides acting and reacting on each other –, the inner movement of everything they include is thrown forward. However, the movement that surfaces is not the finished movement, it is rather the movement in the act of moving, the event itself blending seamlessly each change into the other (Deleuze 2006[1988]: 62-63); in

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112 Not to mention the maker, as Vorder Bruegge has also ascertained (1998: 615-616).

113 Although the singular grammatical form is used, this term refers to a plurality.

114 Who, in turn, has developed the concept of the fold invented by Leibniz (1646-1716), a concept that the German philosopher drew from the art of the Baroque period.

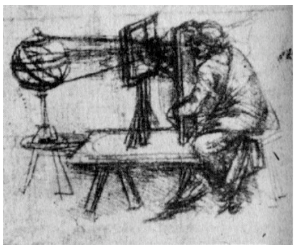
this sense, the fold counts on the interpretation of "the effort or tendency by which the following condition itself ensues from the preceding 'by means of a natural force'" (Deleuze 2006[1988]: 83).

With the fold, thus, we're before the idea of a perpetual displacement of contour that originates in the projection of the essence into substance, a projection that could be regarded as matching the process realized in the brain and other parts of the body through which actions like walking, speaking, and so on, become actual. With the fold, thus, we're assured that **(1)** a point is no longer a geometric element whose location in space is defined solely by two coordinates, **(2)** a line segment is no longer a straight geometric element bounded by two distinct end points, **(3)** a surface is no longer a continuous area definable in two dimensions.

On the contrary: to the extent that the fold represents variation in itself, any point it includes is intrinsically an elastic point, a line that spreads out from other lines, and in this way each point becomes a point of view (Deleuze 2006[1988]: 15, 20-21). Consistent with a conception that allows for a continuum of change governed by movement, a point of view "is not a variation of truth according to the subject [apprehending a variation], but the condition in which the truth of a variation appears to the subject" (Deleuze 2006[1988]: 21).

Issued from this perspective, the long-established option taken by pattern design to represent the mobile body standing vertically by the use of the two-dimensional system of gridding, does not count as a point of view.

Certainly this type of organization ensures that a spatial correlation between the body and drawing is established since each point is defined according to coordinates of latitude and longitude. In all probability pattern designers borrowed this way of mapping the body from the Renaissance perspective frames or veils [*Figures 34a* and *34b*], as they try to achieve the – presumed – geometric rigor that Renaissance artists have strived to accomplish.



[*Figure 34a*]
'Draughtsman Using A Perspective Frame To Draw An Armillary Sphere,' drawing by Leonardo da Vinci, unspecified date (Kemp 2001: 56)

[*Figure 34b*]
'Draftsman Drawing A Reclining Nude,' engraving by Albrecht Dürer, 1538 (Crosby 1997: 188)

To be fair, the principle that underlay the perspective frames and veils misled artists – and pattern designers alike – since these devices "enabled the painter[s] to quantify not reality, but something more subtle: the *perception* of reality" (Crosby 1999[1997]: 184). The repercussions to art related to the discrepancy between the *actual reality* and *construed reality* resulting from setting up a perspective frame or veil between the painter and the subject to be painted – as Leon Battista Alberti (1404-1472) advised his readers to resort to (Crosby 1999[1997]: 184) – were nonexistent;[115] in fact painters like Leonardo da Vinci and Albrecht Dürer (1471-1528), who have been conventionally regarded as two of the greatest painters of all time, believed that painting "deals with the motions of bodies in the briskness of their actions," as stated by Leonardo himself (Kemp 2001: 18).

The consequences to pattern design aren't caused by the approach itself; they're brought about by a point of view that doesn't display the "truth" about the subject to be represented, i.e., the fact that the body is "essentially elastic" as Deleuze points out (2006[1988]: 6); in fact, by choosing to look at the body standing at right angles to the plane of the pattern designer, the body construed by pattern design is deprived of its folds, i.e., of the vital force rooted in movement that characterizes the body as a body. As concentrated as pattern designers are on depicting the body rigorously, they decline – inadvertently, to be sure – a qualitative conception of the body.

In all fairness, designers like Vionnet and Throup and researchers like Ashdown and Newman have looked at the body not as an unchanging subject, but as an

[115] And still are, as this kind of device has been used ever since their Renaissance counterparts were launched.

expressive entity; irrespective of the specificity of their searches – i.e., the creation of nonspecific clothing or the design, or redesign, of a functional garment –, the outcome of Vionnet, Throup, Ashdown and Newman's readings goes along the aim of painting – as defined by Leonardo – since the garments they're designing, have designed, or redesigned, include the movement of the body in the vigor of its actions.

Following the lead of these designers and researchers, the possibility to generate a set of basic patterns – i.e., the drawings from which all clothing patterns are developed – followed from looking at the body from various points of view. The result that's brought about by this willingness to incorporate the continuum of variation that characterizes the body – as the *raison d'être* of pattern design – into a single contour is precisely what it was previously referred to as lineament.[116]

Choosing this older, obscurer, term (Brandão 1964: 81) instead of the – no less ambiguous – word that prevails nowadays, i.e. representation, is by no means arbitrary. Sustaining this choice are the definitions put forward by the *Merriam-Webster's Collegiate Dictionary* (2003), and the meanings conveyed by Gerard Schmitt and Werner Oechslin, the authors of the paper "Computer Aided Architectural Design Features" (1992), and by Augusto Pereira Brandão, the author of the dissertation *L. B. Alberti: Retrato de um Arquitecto Renascentista* (1964).

Having developed from the Latin word *lineamentum*, lineament means literally **(1)** a line or collections of lines. Derived from the original sense, lineament also means **(2)** to draw a line, as recorded in the dictionary mentioned above; to an even greater extent, it stands for **(3)** a distinguishing or characteristic feature – abstract or concrete –, or **(4)** an outline, feature, or contour, of a body or figure, or even **(5)** a linear topographic feature that reveals a characteristic of the subsurface structure, such as a fault-aligned valley, a series of fold-aligned hills or fracture zones (2003: 723).

In connection with architecture, the sense given to lineament by the Roman philosopher Cicero (106 BC-43 BC) as an attribute of geometry – along with form, interval, size, *etc* – suggests the architectural significance it gained from then on

[116] Specifically in the description of this doctoral research's mental progression organized around Bohm's model. See pp. 31-33.

(Schmitt 1992: 10). In fact, throughout the era of humanism, lineament stood for **(6)** "a visual representation where, by means of 'angles and lines,' the various parts of buildings become harmonized, interrelated" (Brandão 1964: 82).[117]

For this reason – and according to the short historical perspective on lineament presented by Schmitt and Oechslin (1992: 10-11) –, Alberti fervently defended that the architectural drawing was virtually the same thing as the design process. From this notion of equivalence, two quests emerged in the Baroque period, namely **(a)** to achieve coherence and compatibility between projections – i.e., between the building's ground plan, elevations and sections – through its delineation in perspective with gradations of light and shade, and **(b)** to search for new architectural possibilities, as those proposed by the oblique architecture – exemplified by the Spanish polymath Juan De Caramuel's (1606-1682) –, which, similarly to pictorial anamorphosis, used perspective distortions "to preserve proportional coherence in vision" (Ortiz-Iribas 2005: 152). Moving away from these directions, the period after the French revolution is defined by **(c)** "the attempt to simplify complex drawing processes and by the reduction of means to a minimum" (Schmitt and Oechslin 1992: 10) – i.e., leaving the architectural drawing to its fundamental linear quality and resorting to a system of design using simple modular elements –, as proposed by the French architect Jean-Nicolas-Louis Durand (1760-1834); from the nineteenth century onward, the attempts at systematic formalization corroborate the continuing relation between geometry and architecture, no matter what this relationship emphasizes: straightness or obliqueness, simplicity or intricacy, and so on.

The point conveyed by Schmitt and Oechslin seems to be that if lineament is an expression of the aesthetic dimension of an architectural artifact, if that dimension is searched through the act of drawing, the architectural drawing is therefore an instrument of scientific research. Perhaps an identical syllogism could be applied to the fifth sense submitted earlier – i.e., the acceptation of lineament in geology, hydrogeology, and the like –,[118] but it suffices to say that the general idea obtained

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[117] Freely translated from "[...] um traçado gráfico onde, por meio de 'ângulos e de linhas' se conseguem harmonizar, interligar os diversos membros dos edifícios."

[118] Based on Per Sander's paper "Lineament in Groundwater Exploration: A Review of Applications and Limitations" (2007) – in *Hydrogeology Journal*, 15, pp. 71-74–, the implicated premises and conclusion could be: if a lineament is an expression of an underlying geological structure formed by

from the multiple meanings brought forward by the reviewed authors and dictionary is that lineament can be taken as **(1)** a verb, as it conveys an action, **(2)** a noun, as it stands for to the product of that action, as well as **(3)** an adjective, as it qualifies the product of that action.

Following this line of reasoning, in the context of the developed research lineament is understood as **(1a)** the very process of dealing with an alternative representation of the body in pattern design, **(2a)** the artifact itself, i.e., the alternative tangible mannequin and set of basic patterns, **(3a)** which are characterized by their angled, distorted contours.

Combining these three functions, lineament stands for the pictorial conception of a multi-dimensional body, a body that is deformable not rigid, a body that is by no means immobile as it is always in motion; it purports the decision of a designer to play a part in the process, to be included, by positioning himself/herself at various angles and distances from the body while it's being depicted – a determination that, reminiscent of Albertian perspective, assures the reverse of a "projection [that] is, one might say, viewed from nowhere," as it happens in the cartographic context (Woodward 1987: 70).

In the context of the developed research, lineament corresponds to all the "perspectival appearances" of the body moving in its action space – to use Strauss' definition (1970: 352) – since they aren't considered relative to the distance separating the viewer and the viewed, nor the location each one is in at a specific time. Converging innumerable points of view, the lineament of the mobile body refers to an oblique depiction of the body, a depiction that appears normal, or makes sense, when the second garments – assembled from the generated basic patterns with skewed contours – are on the moving body.

Ultimately, lineament is a drawing that captures the complexity of a body arranged in layers, which fold and unfold incessantly. Taking the form of basic patterns, the rendering of the body displays simplicity: the outlines of all the body positions assumed in generic activities are merged in a single line; converted into basic patterns, the portrayal of the body displays harmony: the segmental organization

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regional tectonics, if the process of drawing a geological map involves understanding the meaning of the linear features, the geological map is then an instrument of analysis and inference.

of the whole body – inside and outside – is made consistent throughout all the pattern pieces.

Hopefully, the syllogism that applies to pattern design is: if lineament is the outward appearance of the body's internal doings, if the creation of basic patterns involves the interpretation of a body formed by several interlocked tissues – that join forces to produce movement – and by various jointed segments – that team up to produce a multiplicity of shapes –, basic patterns are thus an instrument of scientific research.

Summary

In Part Two, the relationship between the body and its portrayal is surveyed. By focusing on some of the ways this relationship is dealt with in the realms of science, art and design, it is suggested that it surpasses the appreciation of the created images themselves, as it also involves the ability to think about the act itself of depicting so that the desired outcome is achieved. Together, they make up the antecedents of this research.

Accordingly in the first section of Part Two, the practices of **(1)** *self-modeling* in the visual arts, particularly women's, and of **(2)** *modeling the other* in diagnostics and clothing engineering are reviewed, as they're truly indicative of The Interest In The Body the body has always had. Divided into two subsections, the critical assessment of a variety of ways of using the body for **(1a)** expressing individual ideas, **(2a)** observing its innermost structures, and **(2b)** catering for its experience as a dressed body, helps **(i)** supporting the claim that the created artifact is placed within the territory of visual representation, specifically within the genres of self-portraiture and portraiture, **(ii)** strengthening the idea that however accurate a portrayal of the body is, as indeed the representations of the living body produced via imaging are, decoding it depends always on interpretation, and **(iii)** reinforcing the view that the leading *a priori* and *a posteriori* technological devices used for pattern design and clothing evaluation overlook, more often than not, the sensorial, mechanical, aspect of fit.

Then, in the second section of Part Two, **(1)** the structural elements of the body that are involved in the production of movement, **(2)** the strategies that designers

and researchers have come up with to provide for the mobile, deformable, body, **(3a)** the notion of the *fold* as the outwardly projection of the body's inner movement in the act of moving, and **(3b)** the multiple meanings given to *lineament* throughout time, are discussed. Although they are presented sequentially, the reviewed understandings work together to back the proposal of Lineament Vs. Representation, as an enhanced way of reflecting the mobile body on the basic – and clothing – patterns.

The fact that the term *lineament* was chosen over the word *representation* – or the fact that an obscure expression was selected over a familiar one – doesn't mean that the latter is rejected altogether: it only means that the intension was to differentiate the prevailing, long-established, allegiance of pattern design to describe the body as a shell – i.e., a flat surface that contains nothing – from an emerging approach that is committed to depict the body as a solid entity made of superimposed tissues and interconnected parts that fold and unfold incessantly. Lineament, thus, furthers the concept of representation as it implicates **(i)** working on the mobile body rather than on the body standing still, in an attempt to **(ii)** look at the mobile body from various points of view instead of viewing it from 'nowhere,' and **(iii)** to notice where the mobile body's swerving points, yielding lines and pliant layers, converge into a single, coherent, outline.

Stressing once again that the reviewed approaches toward self-modeling and the portrayal of the mobile body are, to some extent, comparable to the strategies that were drawn attention to – particularly Ferrer, Mendieta, Vionnet, Newman, Korff and Throup's –, Part Three presents the preliminary steps in the development of the artifact or, to be more precise, it expands on the matters that were considered and implemented so as to bring the narrative to the picture.

3 Preliminary Steps Toward The Artifact's Creation

Introduction

The concretization of an intuition – namely, the possibility of reflecting the mobile body in the patterns' contours – depended greatly upon the act of self-modeling thought up for phase one.[119]

But to equip the body with the proper means to portray itself, three interrelated matters had to be carefully considered, namely **(1)** who was going to act on behalf of the body, or *who* – according to the clothing industry – *would play best the role of any other* **(2)** which body segments were going to be planned jointly, or *what would be the extent of the plane on which the body would project its reality* **(3)** what was the best medium to record the marks left by the body on a plane, or – like the light-sensitive photographic film in a camera – *which material was utterly 'body-sensitive.'*

Only after these questions were answered could the garments designed for phase one be provided with **(1a)** an exact size, **(2b)** a specific pattern, and a **(3c)** particular textile.

In fact each of these three aspects alone served a useful purpose for the formation of The First Garments; as one, they definitely had an influence on the outcome of

[119] An act that is described in The Self-Portraits, the first section of Part 4, entitled The Creation Of The Artifact.

the proposed form of self-portraiture: for these two reasons, Part Three is exclusively dedicated to them. Furthermore, the actions that led to the selection of The First Garments' textile, size and pattern required that they'd be fully accounted for in Part Three.

To that purpose, in the first section, the reasons for choosing a *nonwoven textile* rather than a woven fabric are presented, a decision made on the basis of their capacity to acquire – and keep permanently – the shape of the deformable body, as a result of the pressure and moisture exerted through movement.

To be frank, Determining The Appropriate Nonwoven Textile involved not only to collect information about fabric mechanical properties from textile science books – in addition to how to estimate them on the basis of touch –, but mainly **(1)** to test various sample yardages of felts **(2)** obtained from national and foreign manufacturers, **(3)** through wear, and **(3a)** to analyze the three-dimensional shapes acquired by the prototypes during wear against the original two-dimensional shapes of the patterns by **(3b)** assessing the amounts that the back and front pieces had lost or gained in relation to the original linear measurements.

Then, in the second section of Part Three the process of Ascertaining The Applicable Base Size is covered. The aim to create an artifact in agreement with the Portuguese reality demanded that the Euro standard size that is typically used by the Portuguese Womenswear manufacturers and independent designers to produce sample garments be determined.

Besides the functionality of choosing a base, standard, size – for it facilitated drafting the pattern and make it fit all the study participants –, the idea of a *standard body* – founded on the principles of consistency and equality, treasured at the beginning of the twentieth century and sustained up to now – is brought up tied in the idea of a universal body – in terms of it is make up and functioning – as well as the idea of universal, everyday, movements. Also linked to the concept of standard sizing is the systematization of the complex geometry of the body devised by pattern designers, as the fairly recent opportunity to group people according to shared measurements developed from the awareness of the body gained empirically throughout time.

Justifiably the third section of Part Three illustrates how the pattern of the one-piece garment – dressed by eleven women in phase one – was drafted by combining three basic patterns, i.e., an easy fitting bodice block, a sleeve block and a jeans block. Because they were constructed according to algorithms presented in three books deliberately written for fashion design undergraduates – or anyone that's interested in pattern design –, Deciding On The Source Pattern also attempts to untangle their construction rationale, as the reasoning that underlies the calculation of each point in the patterns contour became lost through time.

So this process drew mostly on Hulme's *The Theory of Garment-Pattern Making* (1945a) and *The Practice of Garment-Pattern Making* (1945b) because – though both books were written more than fifty years ago and have been out-of-print for quite some time now – the author is among the few academic pattern designers that has thoroughly tried to demystify the theory underlying the practice. Actually Hulme validates the need for this kind of enterprise by explaining that "in the past [and unfortunately in the present day, as it has been said], more emphasis has been laid on the mechanical application of principles by systems of pattern-making than on a clear understanding of the principles themselves" (1945a: v).

The First Garments

[*Determining The Appropriate Nonwoven Textile*]

Bearing in mind how vital it was to this research that the clothing made with the source pattern would disclose the amalgamation of all body positions, the search focused on textiles that **(1)** mold to the body easily, as well as **(2)** having very poor shape memory. In other words, the paramount criteria toward the selection of the material were its mechanical properties and, consequently, its mechanical performance.

Subordinate but not less important was the aesthetic appeal of the textiles, i.e., their subjective perception to the eye and hand. Not less important because the acquired information about a fabric obtained through touch – like its stiffness, smoothness and fullness – has been viewed as providing a good basis for the estimation of fabric mechanical properties such as bending, shearing, tensile, thickness and weight (Li and Wong 2006: 51-54).[120]

In consideration of the criteria identified previously, I trusted my intuition and decided to disregard woven textiles altogether and look for a nonwoven. This choice is founded on the fact that "the mechanical properties of [woven fabrics] are shown to be much better" (Dubrovski and Cebasek 2000: 1) than those of nonwoven textiles. However vague the statement of these textile researchers appears to be, it reinforces the idea that "higher strengths and greater stability can be obtained from woven fabrics than from any other fabric structure using *interlaced yearns*" (Dubrovski and Cebasek 2000: 1)[121] or, like Jenny Udale phrases, it's advisable to use a woven fabric if a garment needs structure and stability (2008: 69).[122]

Strength and stability are, in conclusion, an effect of the textile structures that are created **(a)** in woven fabrics, through interlacing two or more sets of yarns at right angles to each other – i.e., the warp ends run vertically and the weft picks horizontally –, **(b)** in knitted materials, by way of intermeshing loops of yarn, and **(c)** in nonwoven textiles, by putting small fibers together and then binding them mechanically, thermally or chemically.

Not being woven or knitted, the third type of construction gives rise to fabrics – such as felts – that "may be cut without fear of threads becoming loose and the fiber unraveling" (www.madehow.com/Volume-7/Felt.html), a characteristic foreseen as bringing out the possibility to construct clothing without having to hem them or insert facings. Thus, becoming less rigid, the garments would be able to reflect the body deformations more easily.

At the same time as the generic information about nonwovens was being collected, attention was directed to the twofold capacity of garments to closely fit the body and acquire its shape. Even though felt companies advertise that this type of product "is highly resilient, retaining its strength and unique properties for

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[120] Tensile, shearing and bending deformations relate to the elongation, slippage and curving of the fabric's threads in response to applied forces (Li and Dai 2006: 54-56).

[121] Actually, Polona D. Dubrovski and Petra F. Cebasek paraphrase Horroks, A. R. and Anand, S. C. (eds.) (2000: 62), "Technical Fabric Structures – 1. Woven Fabrics" in *Handbook of Technical Textiles*, Cambridge: Woodhead Publishing. Here *interlaced yearns* stands for the *interlocked fibers* used in nonwoven fabrics structures.

[122] On the basis of this explanation, it can be presumed that the opposite situation is true: when a garment could do without structure and stability a nonwoven fabric may be used.

decades" (www.aetnafelt.com/felt_advantages.htm; among many other), felt is known to be a plastic material because its surface can be molded into to a contoured shape by – for example – placing it on a mold and applying heat and pressure (www.freepatentsonline.com/3673611.html).

After contacting National and foreign mills producing pressed felts, five samples bearing different characteristics, fiber contents and surface appearances, were obtained. Relying on the feedback that a small group of people – made up of suppliers and potential participants – gave about the five acquired felts, three were selected to undergo close evaluation regarding their **(1)** visual appeal, **(2)** fabric hand, **(3)** thermal elicitation, and **(4)** dimensional stability.

On the whole, this process was based on observation and experiment rather than on theory since textile science is neither the field nor the area within which this PhD research was developed. Accordingly, the first and second aspects were determined through *synthetic* touch, as only an overall impression about the fabrics' features was detected (Li and Wong 2006: 51).[123] The third and fourth attributes of the felts were verified more dynamically, as – albeit the fact that their judgment was passively formed, according to the definition advanced by textile researchers – by incorporating wear trials in the process of fabric selection it was possible to check how much the felts structure elicited thermal and moisture sensations.

Effectively, to make sure that the most appropriate fabric was picked – as well as to know personally what the participants would experience while wearing the first garments – five prototypes were tried out – namely, four pants and a one-piece garment – assembled with the three elected textiles for thirty to forty hours apiece [*Figure 35*].

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[123] Various researchers proposed a distinction between *active* and *passive* touch, asserting that the perception of touch during wear "is passive [because] the wearer does not move with the intention of getting information about the clothing; the information is essentially imposed on the skin" (Li and Wong 2006: 51). Agreeing to this distinction, Heller and Schiff differentiated *synthetic* touch from *analytic* touch, claiming that the latter is employed when someone wants to acquire detailed information about the characteristics of the object being handled (Li and Wong 2006: 51).

[*Figure 35*]
Testing Nonwoven CMLXX400-008, photos by Maria João Melo

Throughout this testing process – which ran parallel to the process of deciding on the source pattern –, the following information concerning each piece of clothing was recorded in a log: **(1)** the manufacturer of the employed nonwoven, its designation and attributes, **(2)** the garment's typology and the pattern's method of construction, **(3)** the dates and time span of the wear trial, **(4)** the specification of the activities undergone while wearing the garment, and **(5)** the fabric's behavior and/or the pattern's fit.[124]

The notation of the periods taken by each trial was important because when the prototypes were doffed and hung freely betweentimes it was visible that all of them were increasingly able to reflect the shape of the body. This circumstance, happening quite rapidly, led to determine that forty hours were sufficient.

Particularly pertinent to the upcoming decision was the fact that indoor and outdoor activities were carried out, as the influence each environment has on gait itself is certainly different: slow-walk is used inside, fast-walk outside. Actually the gait-literature corroborates what anyone knows through experience: "the natural speed of a human is very dependent on the environment. Average adult walking speed can range from 0.8m/s in small village to 1.7m/s in large cities. Studies have also shown that variation in natural speed in long vs. short walkway, indoors vs. outdoor, walking on treadmill vs. natural surface" (Lee and Krovi 2009: 5).

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124 See Appendix One for the complete [*Preliminary Tryouts Log*].

In view of the fact that the amplitude of leg movement characterizing the way people walk in varied situations is different, it's reasonable to infer that their combination has a greater influence on the degrees of deformation the first garments go through in phase one – certainly greater than if only indoor activities would be carried out –, a fact that ensures the legitimacy of the experiment.

The comprised observations about the fabric's behavior and/or the pattern's fit were also essential. In fact throughout the experiment it became evident that **(a)** the patterns should exclude ease allowances, as all the garments assembled with the felts stretched at the same time as the body moved, principally at the crotch area, and **(b)** the strength of the felts varied, as some tended to rip at certain strain areas, particularly at the crotch and the knee areas.

Following this preliminary experiment, data was registered with reference to the dimensional stability of each tested nonwoven, before and after using the prototypes: **(1)** the linear measurements of the total height, hip line, knee line and crotch line on the back and front pieces, **(2)** the stretching/shrinking percentages occurring at the same sites, and **(3)** the photos of the two-dimensional and three-dimensional front and back pieces.[125]

Succeeding the analysis of the data concerning dimensional stability – which was viewed as inconclusive in isolation –, the final decision about the appropriate textile was made based on **(a)** the ability of each felt to mold itself into the shape of the body – or, to be precise, to disclose and preserve the amalgamation of all body positions – in conjunction with **(b)** the technical characteristics of each felt and the effect they produce on the wearing experience.

Consequently, after considering all possible choices the nonwoven S. 11803, an under collar felt produced by *Textil Olius S.A.* was selected, as the way it blended the three parameters mentioned previously – i.e., its molding capacity, dimensional stability and technical characteristics – appeared to be especially well suited to the experiment carried out in phase one.

Before giving further details about the implications of this choice – which includes the comparison of S. 11803's attributes with those of the other felts, as it

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[125] See Appendix One for the [*Dimensional Stability Tables*].

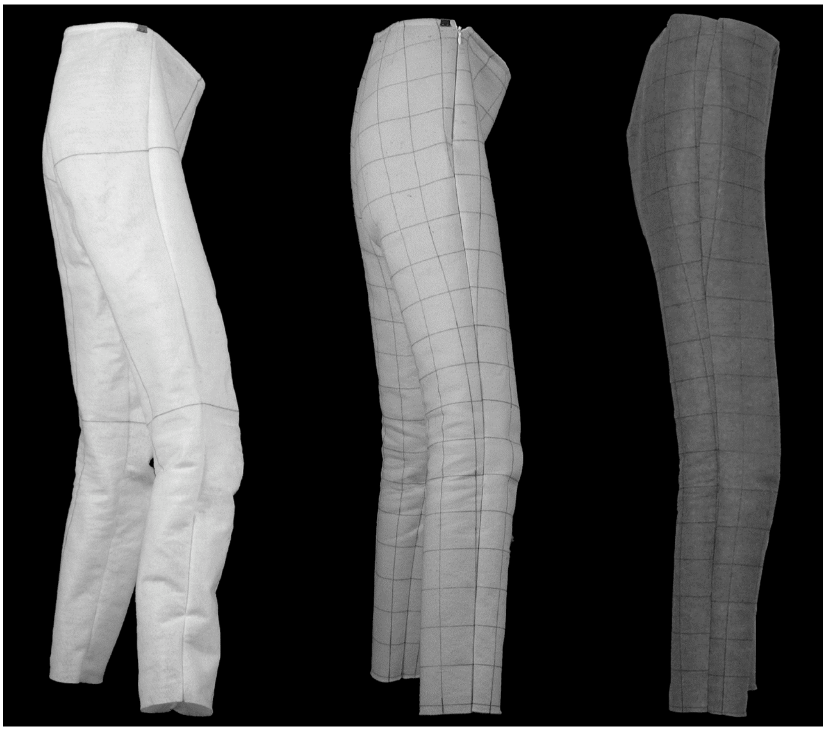
progressed –, the four factors that were, in fact, quite influential were: **(1)** the fiber content of the under collar felt, i.e., 50% Wool/50% Viscose, **(2)** its weight, i.e., 180gr/m², **(3)** its thickness, i.e., 0.95mm, and **(4)** its color, i.e., light brown with two shades.

To be fair, nonwoven CMLXX400-008 – a feltina also produced by *Textil Olius, S.A.* – was for some time viewed as an alternative material. However, given that it is 60% Wool/40% Viscose, 1.1mm thick and weighs 400grs/ml the garments assembled with it would become definitely warmer, heavier and stiffer than if they were put together with the selected under collar felt, as Li and Dai elucidate (2006: 201). Added to the unpleasantness originated from thickness and weight alone, the mixture of properties characterizing the feltina is very likely to generate more moisture than the under collar felt's, a circumstance that "has been widely recognized as one of the most important factors contributing to discomfort sensations" (Li and Wong 2006: 104).

On the subject of thermal sensations, in view of the fact that there is "a significantly higher rate of temperature rise" in polyester fabrics than in wool fabrics (Li and Wong 2006: 94), nonwoven CALFEX C 120 GAT 7, a 100% polyester matted material produced by *IPETEX, S.A.* was ultimately discarded. Again, because of its fiber content this specific nonwoven is likely to intensify the associated discomfort sensations of prickliness and itchiness (Li and Wong 2006: 107), a possibility that was not wanted to be imposed on the subjects participating in phase one.

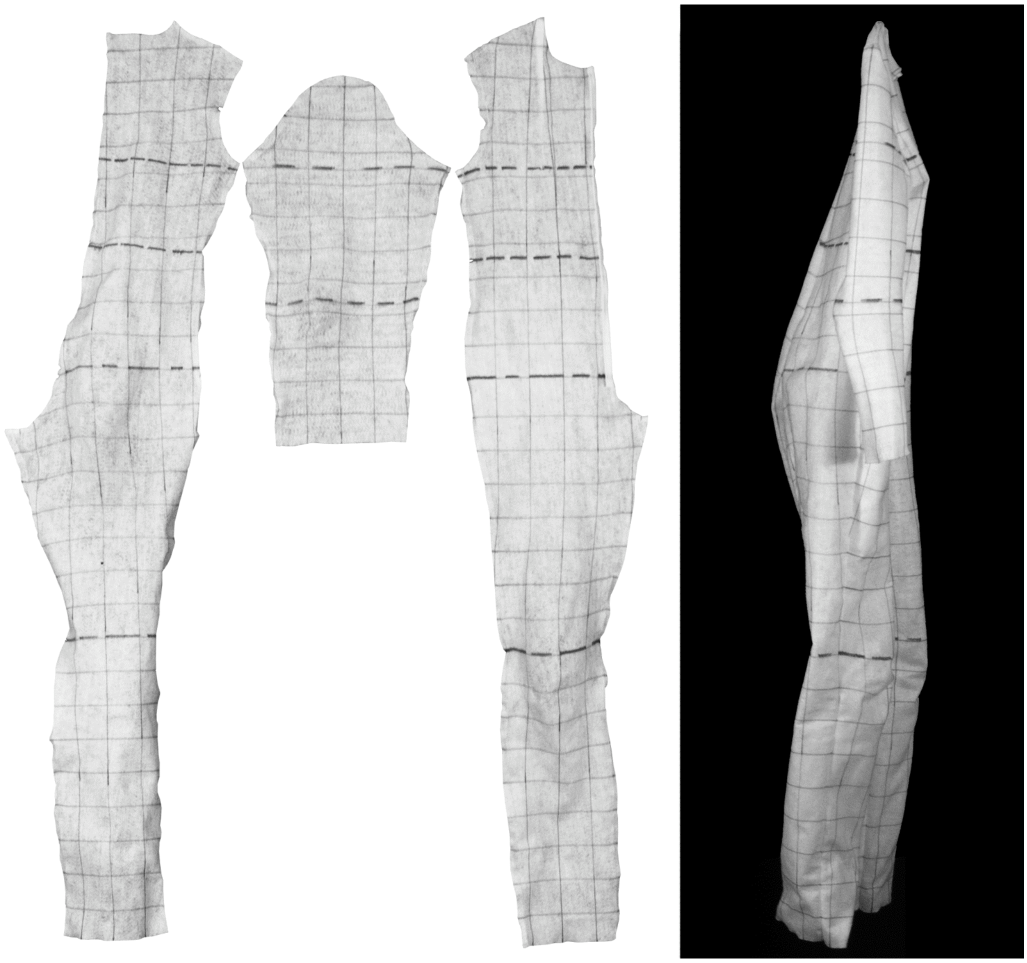
Even if no notice of these negative aspects was taken, even if nonwoven CALFEX C 120 GAT 7 was ranked highly because it took fewer hours to get deformed than the other two materials – an advantage that is closely connected with its thickness, i.e., 0.14-0.18mm –, the truth of the matter is that its visual appearance is not pleasing – a weak point that issues from it being intended for the car industry not the fashion industry –, which is another feature that was not wanted to be imposed on the subjects participating in phase one, as they were asked to wear the first garments outdoors.

Apart from the above arguments either pro or against the tested nonwovens, the factor that determined the selection of nonwoven S. 11803 was its aptitude to hold the shape of the body acquired during wear. The relevance of this aspect lies in the fact that each one of the three tested nonwovens keeps the shape of the mobile body differently [*Figure 36*].



[*Figure 36*]
Side Views Of Jeans Assembled With
CALFEX C 120 GAT 7, CMLXX400-008 and S. 11803, photos by Francisca Manuel

With respect to nonwoven CALFEX C 120 GAT 7 – at the left of [*Figure 36*] –, although this material appeared especially apt throughout the preliminary experiment, it proved being too unstable, as its shape gets distorted the instant it's handled and cut. The gathered data about the two prototypes assembled with this felt – i.e., the measurements of the two- and three-dimensional back and front pieces of the pants and one-piece garment, plus the corresponding photos – corroborated that it becomes too stretched and wavy [*Figures 36 and 37*], a combination of occurrences that, if there were still had any doubts, demanded that it be rejected once and for all.

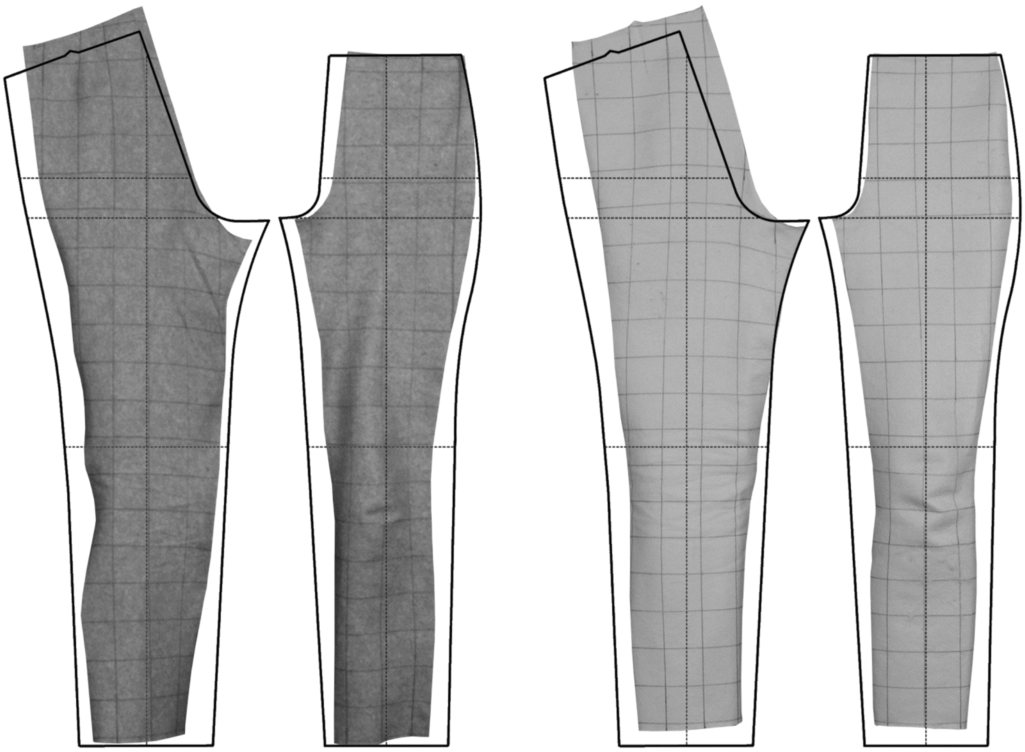


[*Figure 37*]
CALFEX C 120 GAT 7: Three-Dimensional Back, Front And Sleeve Pieces
Plus Side View Of One-Piece Garment, photos by Francisca Manuel

After having discarded the polyester felt, feltina CMLXX400-008 – at the center of [*Figure 36*] – was thought to be the strongest choice, as the under collar felt S. 11803 – at the right of [*Figure 36*] – looked as if it doesn't hold the shape of the body acquired during wear as easily as the feltina does. However, when the garments assembled with these two textile materials were taken apart, it was visible that the under collar felt had reacted more coherently to body movement – or the substance functioning as a catalyst – than the feltina had done.

In other words, compared with the flat pattern shapes, the three-dimensional pieces cut out in S. 11803 – at the left of [*Figure 38*] – became **(a)** contorted at the back, especially below the knee level, **(b)** longer at the back crotch area, and **(c)** slightly narrower at the front, although its height didn't change. On the other hand, the three-dimensional pieces cut out in CMLXX400-008 – at the right of

[*Figure 38*] – **(a)** shifted along the back body rise area, **(b)** became much shorter along the total length – except for the back crotch area –, and **(c)** remained very stable – except for the front piece's knee area, whose profile curved inward as that area became convex.



[*Figure 38*]
S. 11803 and CMLXX400-008: Three-Dimensional Back And Front Pieces With Overlaid Flat Pattern, photos by Francisca Manuel with superimposed pattern pieces

The receptiveness of the under collar felt is also demonstrated as, in terms of linear measurements, the three-dimensional pieces cut out in S. 11803 remained similar, except for the crotch line – which increased a great deal, especially at the back. In contrast, the three-dimensional pieces cut out in CMLXX400-008 **(a)** decreased lengthwise – almost the same amount at the back and front –, **(b)** decreased or remained the same at the knee level – respectively at the back and front –, **(c)** increased at the hip level – almost the same amount at the back and front –, and **(d)** decreased or increased at the crotch line – respectively at the back and front.

The following table displays the numerical values that the back and front pieces of the jeans assembled with these two textiles lost or gained after wear, relative to the pattern's linear measurements:

Linear Measurements	2D Pattern (Jeans Block)		3D Pattern S. 11803 (Increased/Decreased Values)		3D Pattern CMLXX400-008 (Increased/Decreased Values)	
	Back	**Front**	**Back**	**Front**	**Back**	**Front**
Length	100.0cm	95.5cm	*0.0cm	*0.0cm	-2.0cm	-1.5cm
Hip	24.7cm	22.9cm	*0.0cm	*0.0cm	+0.3cm	+0.1cm
Knee	23.0cm	20.6cm	*0.0cm	+0.4cm	*0.0cm	-0.3cm
Crotch	35.0cm	27.0cm	+4.0cm	+1.0cm	+2.5cm	-0.2cm

Of no great concern was the fact that, in both textiles but especially in S. 11803, the crotch linear measurements – gauged on imaginary diagonal lines linking the waist and body rise levels – increased considerably during wear. In actual fact, to provide extra ease in the back rise area the back pattern piece of the prototypes had been "cut along the hipline and opened a wedge [exactly] 3cm wide at the back crotch line" (Aldrich 1997: 78) – a strategy that accommodates the vertical and horizontal stretching that takes place at the hip, crotch and buttocks when the body seats, bends down or crouches. Though, since felts are extremely adaptable it was concluded that the pattern designed for phase one didn't require this manipulation.

Everything considered, the structure of nonwoven S. 11803 allows it to adapt to the deformable body while its surface doesn't get larger. Conversely, the surface of nonwoven CMLXX400-008 becomes changed, as it shrinks and expands to accommodate the shape of the deformable body. And because, in phase one, the aim was that the pattern pieces' flat shapes develop into volumetric surfaces symbolizing all body positions – as opposed to flat shapes that outstretch and shrink into curved surfaces – the nonwoven S. 11803 was chosen.

Within the overall picture, resembling an artist's paint and paintbrushes, wood and chisels, the first garments were used as an instrument toward a new body representation paradigm in pattern design as much as the under collar felt they are assembled with was the medium picked to disclose the body's dynamism.

[*Ascertaining The Applicable Base Size*]

In the same way as the nonwoven textile – with which the first garments were assembled – had to be determined, the standard size – after which the source pattern was constructed – had to be ascertained. But before describing the actions that were taken to find out which base size was the most appropriate for this doctoral research, the sense in which the adjective *applicable*[126] is understood in light of this thesis' perspective must be conveyed.

As it happens, more than the applicability of a specific body/clothing size to the wear trials that played a part in the creation and evaluation of the artifact, the chosen adjective symbolizes the legacy nineteenth century pattern designers left us, as their awareness of the body brought forth the recognition of the similarities affecting a group of people that possess, if not exactly the same body shape, a considerable amount of similar body measurements.

Strengthening this attentiveness, the acceptance of the standardization of measurements – either based on the yard, a unit of length that developed, in Britain, in the twelfth century, or founded on the meter, a unit of length that emerged, in France, in 1799 –, bringing about the adoption of the tape measure – a printed ribbon with subdivisions of the inch or centimeter –, "provided [early nineteenth century] tailors with the means to create tables of body measurements and to use algorithms to create patterns" (Aldrich 2007: 6).

Thus, to an even greater extent *applicable* stands for the result of a long struggle carried out by pattern design, as the profusion of cutting and sizing methods that were developed since the 1800s enabled tailors to ultimately produce "ready-made and 'mass produced' made-to-measure clothing for men and women" (Aldrich 2002: 10).[127]

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[126] Featuring the title of this section.

[127] Several researchers have reported that the ready-to-wear industry began in the seventeenth century with the need to cater military uniforms (Lemire 1984; Fowler 1997; Godley 1997; Aldrich 2007). In the eighteenth century this practice started to accommodate civil clothing as well, but "most of these

The possibility to construct patterns for an unknown, unmeasured, consumer is by no means synonymous of a limited outlook regarding distinct attributes – or a viewpoint that longs for an idealized, abstract, body –, but a stance that takes into account that almost all individuals share, as a minimum, one concrete and elemental aspect: one head, one trunk, two arms, two legs, and so forth. Each body segment is identically laid along the axis of the skeleton; having a similar underlying structure, all bodies own layers of muscles and skin that coat this frame in the same way.

Regarding this shared disposition, Hulme is recalled as he clearly upholds that the theory of pattern design applies to women's garments just as it applies to men's: "a garment, as such, knows nothing of sex: variations in size and shape are the only criteria; and these are differences of degree and not in kind. [...] The shape of a man differs in detail from that of the female form, thus involving variation in the pattern; but these should be recognized for what they are – namely, differences in detail, not in principle" (1945b: v).

Besides the feasibility to plan the male/female body derived from the same precepts, the idea of standardization is founded on the principle of consistency, as it brought forth "the delicious knowledge that each example is automatically made to the same high standard of technical perfection" (Hollander 1994: 141), be it light bulbs, railroads or clothing.[128] The idea of a *standard body*[129] is based on the principle of equality, as it "gave the majority of [consumers] the opportunity to be fashionably dressed in clothes that fit" (Kidwell 1979: 1) at all times of everyday life, be it at work or at leisure.

Aside the commercial value of manufacturing clothes for the standard body – and the reliability its practice has been giving –, the phenomenon of standard sizing should be, first and foremost, recognized as the capacity pattern designers have to solve puzzles, or as their capability – pairing that of artists – to make sense of "the

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early ready-made garments were only able to be very loose fitting, where the cut gave little shaping" (Godley 1997: 4).

[128] Regarding clothing in particular, the idea of standardization is to "assist manufacturers in the development of patterns and garments that are consistent with the current anthropometric characteristics of the population of interest" (an excerpt of the ASTM standard for men's sizes D6240 as quoted in LaBat 2007: 92). The American Society for Testing and Materials (ASTM International), launched in 1898, is one of the largest organizations addressing the standardization needs of the global marketplace.

[129] Which definitely is not to be read *able-bodied*.

apparent chaos and haphazard appearances of nature [and to translate them into] classical mathematical order" (Kidwell 1979: 7).

At the same time as it became possible for an industry enduringly seeking efficient production to codify the set of body dimensions describing each representative consumer into different standard sizes (LaBat 2007: 88), it became possible for each manufacturer inside the clothing industry to elect the base size that, within the entire size range produced, represents the measurements of the majority of consumers (Armstrong 1987: 30).

More factually than Helen Joseph Armstrong, Patrick J. Taylor and Martin M. Shoben inform that, through anthropometric surveys carried out in the 1980s, it was ascertained that the bulk of the female population was "either [UK] size 12, 14 or 16 in the medium height range" (1990: 13). Two decades later Nancy A. Schofield lets know that the base size adopted by the apparel industry is usually the intermediate size between the small and medium sizes, and accordingly "fit models are typically in the size range 8-10 in US misses sizes with bust approximately 34½ to 36in [that is, 86 to 90cm]" (Ashdown 2007: 158).

Relying on the reviewed literature, base size garments – i.e., sample garments or prototypes – and the corresponding patterns are usually put together in US standard sizes 8 or 10 – which, as indicated by Ambrose and Harris (2007: 125), counterpart Euro sizes 36 and 38 and UK sizes 10 and 12 –,[130] a fact that, on the basis of my own experience, I had knowledge of.

Nonetheless, as the aim was to create an artifact in agreement with the Portuguese reality – not just the worldwide preference –, it became mandatory to confirm if the Portuguese clothing industry has the same predisposition. With this intention in mind the names and addresses of 229 manufacturers that, according to the *Portugal Têxtil* (www.portugaltextil.com) and *AICEP Portugal Global* directories,[131] produce patterns for Womenswear were compiled, as well as the twenty-eight names and addresses of the Portuguese – or based in Portugal –

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[130] Because of the many discrepancies between sizing systems and the differences between manufacturers, the US and UK standard clothing sizes mentioned above may be classified as sizes 6 and 8 and 8 and 10 respectively (http://www.onlineconversion.com/clothing_womens.htm).

[131] http://www.portugaltextil.com and http://aicep.pt, respectively.

independent designers[132] that present, or have presented, Womenswear collections at the Lisbon's fashion week, happening biannually.

A questionnaire was designed and subsequently sent to these companies/designer houses, via email and phone. The purpose of the integrated set of questions was not only to find out which base size is the most utilized but also to contextualize it according to each brand's target market and market level.[133] Correspondingly, the questions focused on:

(1) *The destined target market*, e.g. Northern Europe, Portugal, etc.

(2) *The age group and figure type of the target customer*.

(3) *The market level of the brand*, e.g. high street, casualwear, sportswear, etc.

(4) *The size in which the prototypes are developed.*

(5) *The size designation system utilized*, e.g. UK, Euro, etc.

(6) *The anthropometric measurements corresponding to the employed base size*, i.e., the bust, waist and hip girths.

(7) *The company's human resources.*

After gathering the answers to the questionnaire,[134] it was ascertained that, within the industry group, **(1)** the percentage of companies giving a response is 23%, and **(2)** the percentage of manufacturers that have failed to reply is 77% [*Figure 39*]. In relation to the group of independent designers, **(1)** the percentage of respondents is 32%, and **(2)** the percentage of those that have not replied is 68% [*Figure 39*].

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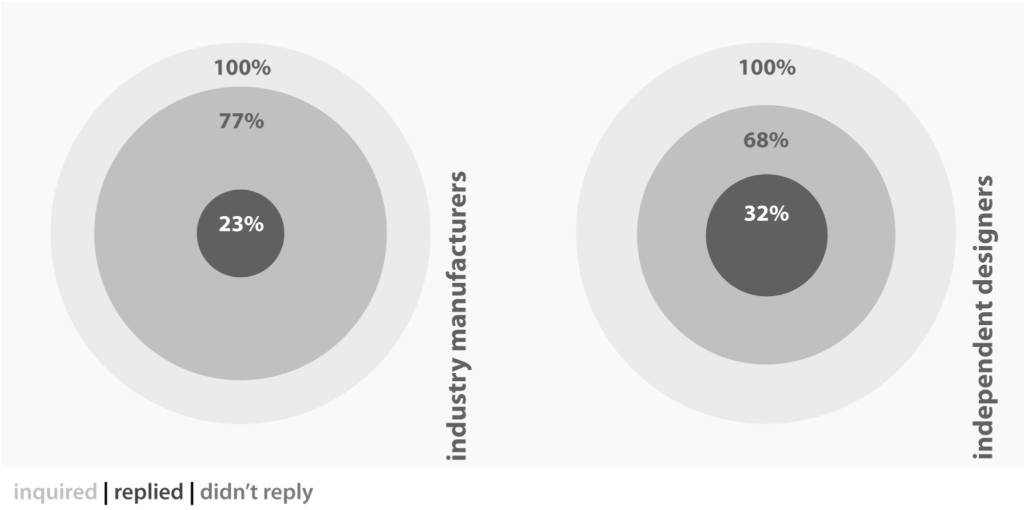
[132] Listed in http://www.modalisboa.pt.

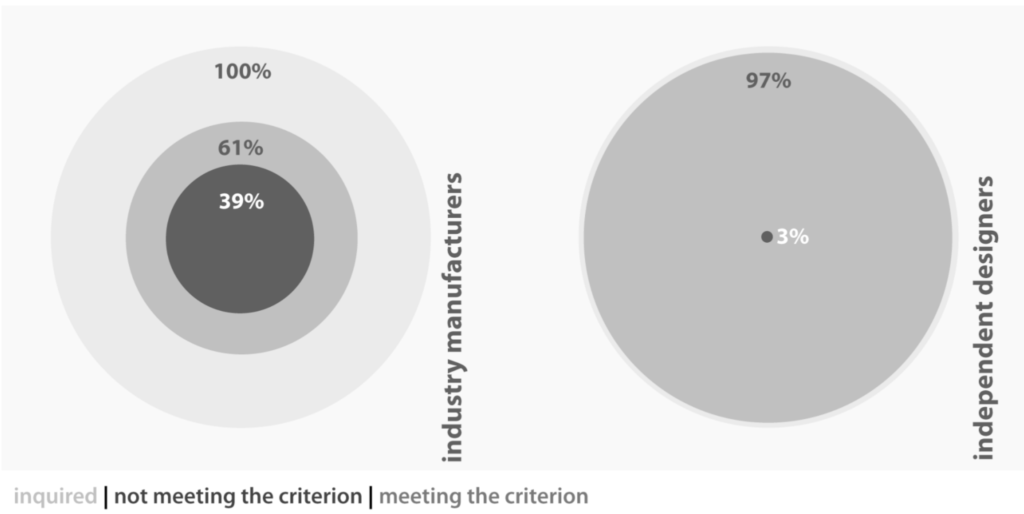
[133] See Appendix Two for the [*Base Size Questionnaire*] sent to Portuguese clothing manufacturers and designers.

[134] See Appendix Two for the [*Responses to Base Size Questionnaire*] given by the Portuguese clothing manufacturers and designers.



[*Figure 39*]
Proportion Of Respondents

It must be clarified that the first three questions were solely asked to confirm if the inquired industry companies and designers produced Womenswear patterns. As it happens, though the consulted directories listed them as meeting this criterion, the gathered information shows that, among the fifty-four respondents of the first group [*Figure 40*], **(1)** thirty-three meet the requirement (61%), but **(2)** twenty-one don't (39%) either because they lack a pattern design department or because they produce menswear or Childrenswear. Among the nine respondents of the second group [*Figure 40*], **(1)** eight designers create Womenswear (97%), and **(2)** one is, presently, only designing menswear collections (3%).



[*Figure 40*]
Respondents Producing Womenswear Patterns

The fifth question included in the questionnaire, i.e., the system in which the adopted base sizes fit in, was meant to facilitate – if needed – the proper translation of the communicated sizes into its Euro equivalent. With regard to the sixth question, the control measurements of the communicated sizes were requested so it was certain that they agreed with the anthropometric data presented in Winifred Aldrich's size chart (1997: 15), as it is the chart I utilize when designing patterns in standard sizes.[135]

If the fifth question was answered quite straightforwardly, the sixth led to a misunderstanding. While the gathered information was examined, it became clear that the manufacturers and designers have a tendency to enter not the body dimensions of the base size but the measurements of the clothing that are developed from it. Trusting John Winks when he tells that "it is unrealistic to expect all fashion garments of the same labeled size to have identical measurements – unless, of course, they are from the same manufacturer, and of an identical style" (1997: 1), this information was left out from the two tables displaying the results to the questionnaire, as it was significantly inconclusive.

Regarding the fourth question – the very reason of the questionnaire –, as shown in [*Figure 41*], the resultant information shows that, within the thirty-three industry manufacturers that have responded, **(1)** ten of them use the base size 36 (30%), **(2)** two the base size 36-38 (6%), **(3)** seventeen the base size 38 (52%), **(4)** two the base size 38-40 (6%), **(5)** one the base size 40 (3%), and **(6)** one the base size 44 (3%). Also as shown in [*Figure 41*], the size range covered by the inquired nine independent designers is much smaller, as **(1)** seven use the base size 36 (78%), **(2)** one the base size 36-38 (11%), and **(3)** one the base size 38 (11%).

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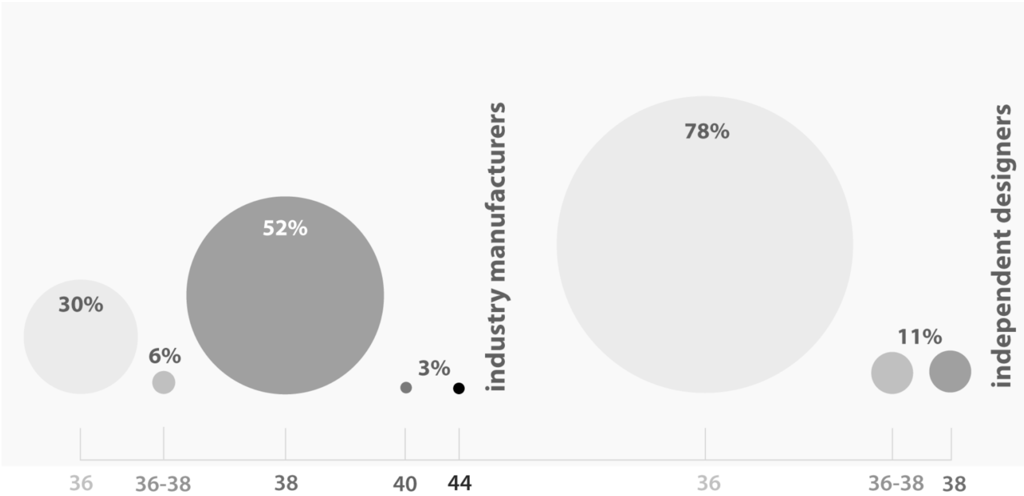
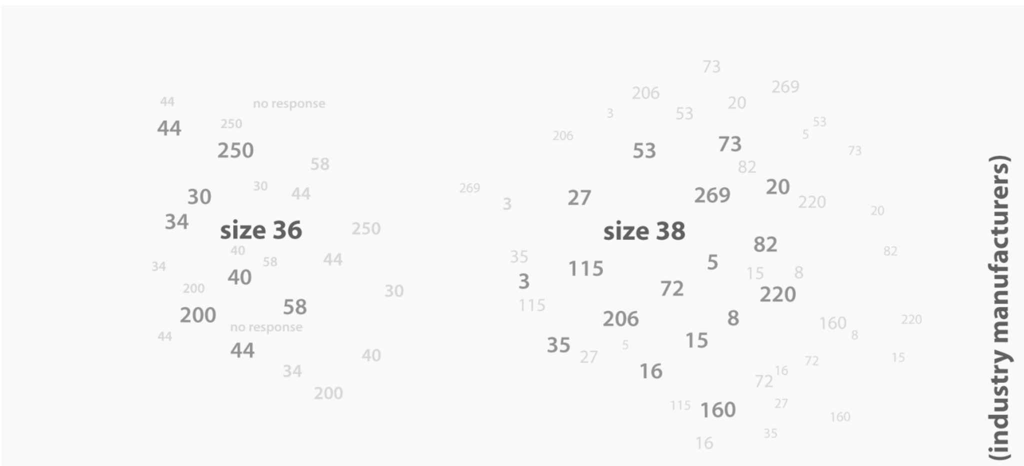
135 See the following section, [*Deciding On The Source Pattern*], pp. 139-165.



[*Figure 41*]
Distribution Of Base Sizes

The seventh question of the questionnaire was included to confirm that there is no relationship between the number of staff employed by an industry company and the base size utilized by the same manufacturer, as demonstrated in [*Figure 42*] for the most relevant sizes. As stated before the selection of a particular base size depends exclusively on the awareness of the manufacturers as to who represents best their target consumer (Armstrong 1987: 30; Ashdown 2007: 158).



[*Figure 42*]
Number Of Employees Vs. Base Size Preference

Bearing in mind the results of this questionnaire, it is safe to estimate that a considerable percentage of the Portuguese Womenswear manufacturers and designers create their patterns and sample garments in sizes Euro 36 and 38, or equivalent ones. In view of this assumption, these two sizes were the most applicable to the research, as either one reflects the Portuguese preference. Presupposing that Euro 36 and 38 sizes also reflect the Portuguese reality – as in all likelihood they do –, size 38 was chosen over size 36.

Two practical reasons support this decision. The first relates to the fact that numerous women integrate the referred subsets of the female population; thus, representing Euro sizes 36 and 38, eleven women studying or teaching at the Faculty of Architecture and three women outside the referred college – namely a videographer, a restaurateur and an architect – were conveniently chosen to become participants.[136] The second reason is connected with the fact that the size interval between sizes 36 and 38 only totals four centimeters.[137] For that reason, being not much larger than the discarded size, the selected size accommodates the dimensions of the participants that normally wear Euro size 36 more fruitfully than the reverse situation would.

Conceptually, the motivation to adopt a standard base size relates to the intrinsic aim of this doctoral research: to contribute to a new body representation paradigm in pattern design. Exactly because it is a paradigm, the idea to represent a standard body implies the – *a priori* – acknowledgment that everyone possesses the same inherent qualities with regard to the physical body, namely the way all parts are arranged and fit together or the relationship between form and function; the idea to direct attention to ordinary activities is an expression of appreciation for "the flexible hidden architecture of bone, nerve, and brain that animates [any] human frame in motion" (Tsiaras and Werth 2004: 11), thus a tribute to everyday life.

Precisely because it is a paradigm, the research focused on ordinary people and common situations to survey the deformations the body inevitably undergoes during routine movements; even though each activity performed throughout the day entails different movements – an actual circumstance that makes it difficult to present, or be presented with, "a precise list of desirable characteristics for mobile clothing design" (Watkins 1995: 246) –, the fact that everybody is expected to

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[136] As must be acknowledged only eleven women ended up participating in the study.

[137] The standard body measurements of size 38 against size 36 are **(1)** around the bust, 88cm and 84cm, **(2)** around the waist, 68cm and 64cm, and **(3)** around the hip, 93cm and 89cm.

walk, stand, sit, don and doff everyday required that a design mechanism on which the creation of generic clothing could lean was devised: the lineament of the mobile body.

Forming the basis of an alternative theory in pattern design, the proposed model incorporates the dynamic anthropometric measurements – covering "the whole continued range of movements available to us at leisure or at work" (Croney 1971: 68) – with the static body dimensions presented in size charts. Because it is a paradigm we're interested in, Euro size 38 – representing the standard body – was consistently applied throughout phase one, phase two, phase three and phase four, i.e., all along the steps that were connected with **(a)** the construction of the first garments embodying the static body of conventional pattern design, **(b)** the construction of the tangible mannequin symbolizing the mobile body, **(c)** the subsequent creation of the alternative set of two-dimensional basic patterns standing for the lineament of the mobile body, and **(d)** the evaluation of the second garments reflecting the created artifact.

[*Deciding On The Source Pattern*]

The intention to plan a set of basic patterns that translates the dynamism of the body only appeared logical if the represented subject was considered not as an entity made up of isolated segments but as an organism that is structured by interdependent parts.

In point of fact, the expression *mobile body* stands for the continuous change of the outward appearance of the body caused by its ability to generate movement. The same designation also suggests that the skill to walk, sit and climb stairs – as examples of movements performed everyday by everybody – involves the coordination of various body actions.

For instance, **(a)** squat lifting draws in the synchronized extension of the hip, knees and ankles (Knudson 2003: 125), **(b)** arm raising requires that the torso's skeletal muscles counterbalance the torques created by the shoulder and arm (Mackay 2006[2003]: 161), and **(c)** walking comprises the alternation of the legs extension and flexion combined with the swing of the arms and the forward/backward motion of the torso – so that the body's axial rotation is adjusted step after step (Mackay 2006[2003]: 156-157).

Body movement – as infinitesimal as it may be – never occurs, then, at one single area/segment. The idea of a body composed by remarkably elastic tissues, which, from top to bottom, work together to transfer energy between segments, made it clear that the effects of this interaction was more easily discernible if, at the initial stage of the lineament of the mobile body, the garments – that were given to the participants to wear in phase one – covered the whole body.[138]

For this reason, the source flat pattern used to trigger the creation of a tangible mannequin and of an alternative two-dimensional basic pattern set was shaped by joining an *easy fitting bodice block* (Aldrich 1997), a *basic sleeve pattern* (Fashion Institute of Technology, F.I.T.)[139] and a *jeans block* (Aldrich 1997) since these three slopers – along with the developed *sleeve/bodice combination* into a *kimono with gusset* (Armstrong 1987) –, affecting the trunk, arms and legs respectively, were the most suitable for the intention mentioned above: to cover the body to the greatest extent required through a one-piece garment and to assemble it with the smallest amount of seams that's feasible.

Accordingly, the left and right pieces of the merged top, sleeves and pants suit are joined at **(1)** the center front/center back seams, and its back and front pieces are joined at **(2)** the legs inseams, **(3)** the underarm/side seams and **(4)** the overarm/shoulder seams.

Though the referred slopers have different origins in terms of authorship and construction approach, the first criterion that has determined their selection relates to their availability. In effect, the drafting instructions of these specific basic patterns are presented in flat pattern design textbooks – intentionally "written for […] students who are starting practical pattern cutting as a part of a Fashion Degree" (Aldrich 1997: 4) –, as well as being taught in flat pattern design courses – and, therefore, kept in undergraduates' notebooks. In a way that is appropriate, the directions provided by the authors/professors are quite easy to

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[138] With the exception of the head, hands and feet, as these body segments require the expertise of designers specialized in headwear, handwear and footwear respectively.

[139] Taught at the Fashion Institute of Technology (F.I.T.), State University of New York, this sleeve corresponds to an updated version of the *one-piece sleeve foundation pattern* included in Curtis, Irving E., *Fundamentals Principles of Pattern Making for Misses and Women's Garments*, revised by Professor Harry Besserman, New York: FIT's Patternmaking Technology Department, 5th printing, pp. 44-45.

follow given that clear diagrams supplement the written information released in an algorithmic mode.

The second decisive factor for choosing these basic patterns – bodice, pants and sleeve – is connected with their *fit* quality, i.e., "the relationship of the garment to the body (Watkins 1995: 264) they provide. Actually, based on my professional experience – both as a pattern designer and a pattern design teacher –, the selected three basic patterns prove to have a close correlation between their shapes and the body's figure, in addition to showing to be markedly compatible among themselves.[140]

With respect to the drafting systems of the selected set, they all appear to be based on *hybrid* approaches. This is to say that, though the anthropometric data they resort to are provided in tables of standard body measurements, the included parametric equations – setting the exact coordinates of the key and auxiliary points integrating each pattern and, correspondingly, the geometric properties of the segment lines forming each pattern piece's shape – reflect a reasoning that – to accomplish the body's representation – combines **(1)** measurements taken directly on the body, which "should be used whenever [they] can be taken accurately and applied safely" (Hulme 1945b: 50) – characteristic of a *direct-measure system* –, and **(2)** dimensions derived from the body's height and/or bust measurement, which "may be used when a direct measure cannot be safely used" (Hulme 1945b: 50) – typical of a *proportional system*.[141]

However, none of the references employed to develop the source pattern – Aldrich, Armstrong and FIT's didactic material – clarify the aimed reader or student about the reasoning behind the guiding algorithms. If nowadays students, trainees and practitioners – and teachers, most probably – do not normally question how the provided parametric equations have been ascertained it's because divulgers and addressees alike do automatically accept that they are the product of years and years of a research carried out by people with sound backgrounds in tailoring and anthropometry.

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[140] As Aldrich's guidelines for "dungaree adaptations" (1997: 88-90) corroborate.

[141] On this subject, see Simoes (2005: 87-97).

Proposing an alternative explanation, Penelope Watkins, a Research Fellow in 3D Design/Technical Fashion at the London College of Fashion, writes "most block [or basic] patterns used by clothing manufacturers have been developed and adapted by numerous people over many years. This means that the rationale implementing the pattern profile, the apportionment of direct body measurements, proportional measurements and those applied for ease is often inaccessible" (2011: 247).

If the clarification of the parametric equations reached through trial and error is now lost, it could also be because pattern design has been regarded as a technical activity within the development of clothing – more exactly, "the bridge function between design and production" (Cooklin 1994: vii) –, an intermediate activity that doesn't demand from the group interested in its practice to understand the theory supporting it. Gerry Cooklin actually reinforces the view, as the senior lecturer conveys that it's irrelevant if the books pattern designers learn from are difficult or vague by saying, "for one the reader requires a calculating machine, and for another blind faith in the author" (1994: vii).

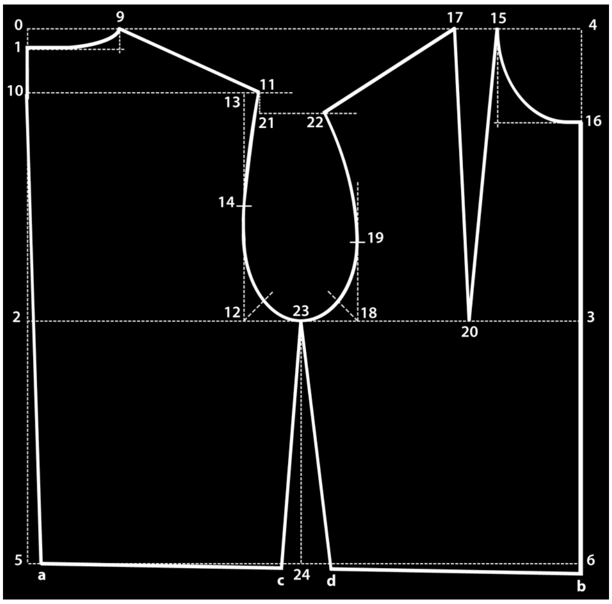
Immediately after Cooklin concludes that "how the patterns are constructed is really immaterial" (1994: vii), a statement that exhibits an inconsistency as the lecturer also declares that the construction of clothing patterns depends on four vital elements – interpretation, technique, technology and freedom – which, combined, enable pattern designers to decode the fashion drawing, accomplish the aimed result, foresee the production implications of every pattern's feature and express their individuality as professionals (Cooklin 1994: vii).

This criticism – concerning not only Cooklin's but other authors and teachers stance – is supported by questioning how can pattern designers acquire an open and creative approach to clothing construction if the mathematical problems sustaining the creation of "the most fundamental tool of pattern development" (Cooklin 1994: 4) – i.e., the basic patterns – are never clearly explained or, in the worst case, aren't even presented to them?[142]

[142] As a matter of fact Cooklin, in his textbook, only gives the solutions not the parametric equations, which makes it impossible to reproduce the drafting process if one needs to construct a pattern in a size other than the size exemplified by him – i.e., a Euro 40.

As hard as it is to comprehend these types of flaw in the way in which the pattern design's bases have been transmitted from generation to generation of practitioners, the thesis tries to unravel the directions provided by the authors/professors that disseminated the easy fitting bodice block, the basic sleeve pattern, the jeans block and the sleeve/bodice combination that were employed to develop the source pattern.

So that this exposition is simple to follow, the series of actions directed toward the configuration of the source pattern are described as they occurred. Accordingly, the body measurements pertaining to the base size determined previously – Euro size 38 – were assembled first, as Aldrich efficiently provides her readers with **(a)** a size chart of the standard static anthropometric data pertaining to the "largest percentage of the population [falling] into medium height range" (1997: 15)[143] and **(b)** one diagram comprising the front and back views of a woman's body showing the approximate locations of the corresponding measurements (1997: 14).



[*Figure 43*]
Easy Fitting Bodice Block For First Garments, diagram with key and auxiliary points

Having began by drafting the easy fitting bodice block (Aldrich 1997: 20-21, 22, 33) [*Figure 43 and Plate One*], the relevant body dimensions to this basic pattern's construction amount to eight, separated into three groups: **(1)** *girth*

143 The stature of this significant subset within the women's consumer varies between 160cm and 170cm.

measurements, **(2)** *length* measurements and **(3)** *width* measurements. To keep to Aldrich's designations, the *bust* and *neck* dimensions belong to the first group, the *armhole depth*, *nape to waist* and *shoulder* dimensions belong to the second group, and the *back*, *chest* and *dart* dimensions belong to the third group.

If some of these body dimensions are fairly easy to identify on the body, some of them don't have definite anatomical points from which they can be accurately assessed, as Hulme rightly informs (1945a, 1945b). However, after reviewing the selected literature on anatomy and kinesiology it became possible to associate all the implicated body landmarks to specific anatomical points; after reviewing literature on pattern design – particularly Hulme's (1945a; 1945b) – it also became possible to trace some of the proportional relationships that were, at one time, devised between the referred body dimensions.[144]

Correspondingly, the eight required measurements are characterized according to the locations provided by Aldrich in her "standard body measurements" diagram (1997: 14), as this author is the person responsible for the easy fitting bodice block:

> **(1.1)** The most identifiable anatomical point associated with the *bust* circumference is the nipple – or apex, as designated by pattern design and pattern grading –, a "small projection positioned slightly off center on the breast form" (Winslow 2009: 126).
> The governing measurement *par excellence*, "the ratio of height to breast girth is [in men] as 68 is to 38" (Hulme 1945a: 30).
> In [*Figure 43 and Plate One*], the key points matching this dimension are [2-3].
>
> **(1.2)** The *neck* girth comprises the seventh cervical, the trapezius point[145] and the suprasternale notch (Ashdown 2007: 176-177; Hulme 1945a: 11).

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[144] It must be adverted, though, that Hulme's formulas do not offer an unquestionable reliability, as they're surely dated. As it happens, more than a century after the publication of Hulme's books, anthropometric data have clearly changed, a situation for which many factors are accountable: in the case of the body itself, diet and exercise, and in the case of the measuring techniques, "the new developments in three-dimensional scanning for body measurements" (Ashdown 2007: 48).

[145] Though Schofield designates it *trapezius point*, the precise location of this site cannot be provided since the upper portion of the trapezius muscle "begins at the base of the skull (occipital protuberance) [...]. From there, muscular fibers descend obliquely and insert into the outer (lateral) third of the clavicle" (Winslow 2009: 130).

Because the neck girth "is a dimension for which no direct measurement can be taken satisfactorily or applied without possibility of error" (Hulme 1945b: 57), Hulme indicates that its perimeter is about forty percent of the bust circumference (1945a: 23).
In [*Figure 43 and Plate One*], the key points matching this body dimension are [1-9] and [15-16].

(2.1) The *armhole* depth is comprised between the seventh cervical anatomical point and the axilla body landmark (Ashdown 2007: 176-177; Hulme 1945a: 11).
Hulme describes the armhole depth as "the distance from the nape to *a* lateral line on the body close under the armpits" (1945b: 52),[146] adding that its measurement is "approximately one-eighth of the total height of the figure" (1945a: 86).
In [*Figure 43 and Plate One*], the key points matching this body dimension are [1-2].

(2.2) The *nape to waist* is comprised between the seventh cervical anatomical point and the plane crossing the twelfth thoracic vertebra (Hulme 1945a: 11).
According to Hulme, the nape to waist measurement is approximately the height of the body divided by four (1945a: 89).
In [*Figure 43 and Plate One*], the key points matching this dimension are [1-5].

(2.3) The *shoulder* width is comprised between the point of the trapezius muscle located at the base of the neck and the acromium (Ashdown 2007: 176-177).
In spite of being possible to identify its boundaries, Hulme says that "the difficulty of taking reliable direct measures in the shoulder section is well recognized" (1945a: 80), a circumstance that makes it safer to use a fraction of the bust circumference (1945a: 80-81).[147]

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[146] In this quotation the "a" is deliberately printed in italic so as to emphasize the imprecise location of the points of the body from which the measurement would be taken.

[147] Hulme, though, doesn't divulge the comparative relationship between the two dimensions.

In [*Figure 43 and Plate One*], the key points matching this body dimension are [9-11] and [17-22].

(3.1) Even though pattern design doesn't associate a specific anatomical point to the *back* measurement, the inferior angle of the scapula bones "are easy to locate on the surface form and can help [...] determine the correct placement of the shoulder blades" (Winslow 2009: 118).
Although Hulme declares that the "dominant dimension is from the spine to elbow: this is fixed, and the back width and sleeve length share this measurement in what proportion the designer decides" (1945b: 56), he states that the back width is arbitrarily dictated by style adding that its location equals, in the draft, one third of the armhole depth plus 2.5cm (1945b: 56).
In [*Figure 43 and Plate One*], the key points matching this body dimension are [2-12]; the location of key point [14] suggests that the back width level is situated halfway between the acromium and the axilla.

(3.2) The *chest* level is related with the site where the muscle pectoralis major attaches on the humerus. But the fact that this insertion is undetectable on the surface of the body makes pattern design unable to associate a specific anatomical point to this measurement.
Despite this difficulty Hulme conveys that half of the chest measurement may correspond to one third of half the bust circumference, measured from the center front construction line (Hulme 1945b: 55).
In [*Figure 43 and Plate One*], the key points matching this body dimension are [3-18]; the location of key point [19] suggests that the chest width level might be positioned halfway between the suprasternale and the axilla minus 2cm.

(3.3) Again, the only anatomical point associated to the *dart* is the bust point or apex (Ashdown 2007: 176).
Hulme, asserting that "the amount to be removed [in a dart] *may* be fixed as an arbitrary amount decided as the result of experience"

(1945b: 57), emphasizes that the dart width depends on how much shape the designer wants to create over the bust; however, its full amount can be established on the draft using a fraction of the armhole depth equal to one sixth plus 1.25cm or 2.5cm (Hulme 1945a: 113; Hulme 1945b: 57).[148]
In [*Figure 43 and Plate One*], the key points matching this dimension are [15-17]; the location of key point [20] corresponds to the apex.

As a rule, the construction of a basic pattern for the upper body is organized within a rectangle with sides corresponding to two chief dimensions: the total height – or the distance between the highest anatomical point, the trapezius, and the lowest, the twelfth thoracic vertebra – and one-half of the bust circumference.

In [*Figure 43 and Plate One*], the distance between [0-5] – equaling [4-6] – determines the dimension of the rectangle's vertical sides; the distance between [2-3] – mirrored in [0-4] and [5-6] – controls the dimension of the rectangle's horizontal sides.
The first vertical line forming the rectangle – placed on the left side of the work area – becomes delimited as **(a)** the segment [0-1], measuring 1.5cm, fixes the starting point of the pattern, i.e., the nape, **(b)** the segment [1-2], measuring the same as the armhole depth, locates the bottom of the armhole level as well as the apex's, **(c)** the segment [1-5], measuring the height of the upper body at *center back*, situates the waist level, and **(d)** the segment [1-10], measuring one fifth of the armhole depth measurement minus 1cm, develops into the line where point [11] is set.

Also as a rule, length measurements, positioned in vertical lines, equal the size chart dimensions exactly – with the exception of the armhole depth, to which ease is added; in contrast, girth and width measurements, placed in horizontal lines, are normally equivalent to the size chart dimensions plus ease. Due to the nature of the selected nonwoven textile – of which the one-piece garments used in phase one were made –, so that the source pattern was kept closely fitted to the body the recommended ease allowances were not combined to the following measurements:

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[148] A quotient that is, then, placed on the front shoulder line.

> In [*Figure 43 and Plate One*], **(e)** the armhole depth measurement, placed in the center back line between [1-2], **(f)** the bust measurement, placed between [2-3], **(g)** the neck measurement, placed in the back pattern piece between [0-9] and in the front pattern piece between [4-15] and [4-16], **(h)** the back measurement, placed in the back pattern piece between [2-12] and [10-13], **(i)** the chest measurement, placed in the front pattern piece between [3-18], and **(j)** the shoulder measurement, placed in the back pattern piece between [9-11] and in the front pattern piece between [17-22].

Notwithstanding the outcome of the decision mentioned above, points [14], [20], [23] were positioned at the same distance from points [12-13], [3-18], [12-18] respectively, and point [19] at the center of [3-16] minus 2cm; also as advised, segment [15-17] equals half the standard dart measurement – an amount that is justified seeing that this basic pattern is intended for the construction of easy fitting garments.

If up to now almost all the mentioned measurements relate to body dimensions, the segments [0-1] and [11-21] – both measuring 1.5cm – are almost certainly exceptions. An invariable amount throughout all sizes, this measurement appears to have been determined through practice. Recognizing that one of the functions of [0] is to assist the neck's description and the sole purpose of [21] is to support the shoulder area's delineation, it may be said that, to keep the draft within the rectangle,

> In [*Figure 43 and Plate One*], points [1] and [16], respectively representing the seventh cervical and the suprasternale, and points [9] and [15/17], representing the trapezius point – to be noted that these three points, after joined in a dart and subsequently in a seam, become a single point –, form a line that describes the base of the neck being successively set, **(a)** for the back area, below the rectangle's top horizontal line, **(b)** for the side area, exactly at the rectangle's top horizontal line, and **(c)** for the front area, again below the rectangle's top horizontal line. In the end, the faithful

> replication of the artificial boundary separating the torso and neck is achieved through a tilted and refracted curved line.
>
> Points [9] and [15/17], situated on the rectangle's top horizontal line, represent the trapezius anatomical point – thus, a single point once joined in a seam –, and points [11] and [22], positioned in different levels below the rectangle's top horizontal line, represent the acromium anatomical point – hence, for the reason stated before, one point only. Although there's an evident lack of correspondence between the angles of the segments formed by [9-11] and [15/17-22] – both portraying the artificial boundary that divides the front and back torso at the shoulder area –, it is indeed this disparity that translates a body that cannot be described in the same way as a regular three-dimensional figure.

Seemingly puzzling are the amounts that are subtracted – to agreed fractions of the segments with which they are correlated – so as to place point [19] and segment [1-10].[149] However, when it is understood that the mathematical problems provided by Aldrich (1997) translate, in a very operative way, the following vertical body measurements,[150] the problems become more easily appreciated:

> The point where the arm is definitely separated from the chest; having no actual anatomical point to identify it, point [19] – in [*Figure 43 and Plate One*] – coincides with the narrowest part of the front armhole. As indicated by Hulme, this point "is an important anatomical point: at this part the garment must fit; there must be neither too much nor too little in the garment. The normal movement of the arm is forward, so that every time the arm reaches out it comes into contact with the garment at this point. The garment should therefore fit without constriction, otherwise the movement of the arm is impeded" (1945b: 55).
> Taking into account that the easy fitting bodice block represents only the upper part of the body, it is really more reasonable to find

[149] See pp. 146 and 147. Once more, these two amounts are constant throughout all sizes.

[150] A vertical body measurement is the same as the linear distance between a horizontal plane – where the body is placed in the upright position – and an anatomical point.

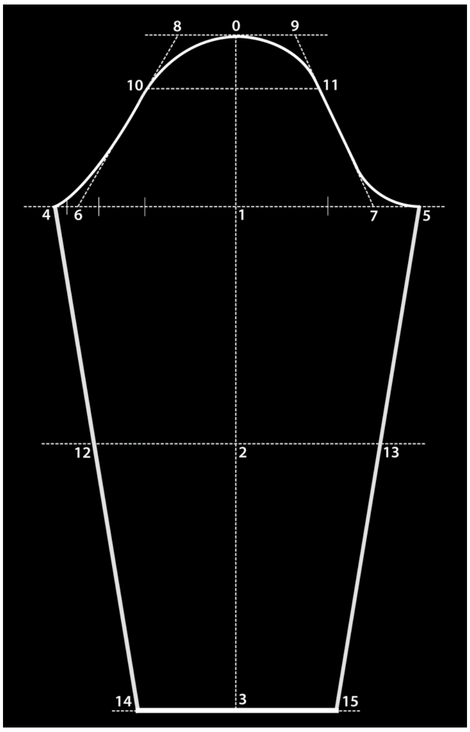
> the location of point [19] – on a line squared up from point [18] – through the equation "half the measurement 3-16 minus 2cm" (Aldrich 1997: 20) than to resort to its actual vertical measurement.
>
> The acromium is point [11] in [*Figure 43 and Plate One*]; according to M. Y. Kwong, "Hutchinson and Munden maintained that the critical area of the body concerning fit is around the shoulders. The researchers stated that if garments fit the figure perfectly between the neck and the horizontal line encircling the figure at the lowest level of the armhole, then the main difficulties would be overcome" (Fan, Yu and Hunter 2004: 199). Hulme corroborates this point of view, as a few decades before he argued that the control section of a pattern designed for the upper body is the neck to chest area (1945a: 50). All these authors' preliminary considerations are complemented by Aldrich, as she sets the acromium, in the back pattern piece, on an auxiliary line – squared across point [10] and beyond point [13] – measuring "one fifth of armhole depth minus 1cm" (1997: 20) and, in the front pattern piece, one fifth of the armhole depth minus 2.5cm.[151]
> All things considered, it is definitely more logical to apply the provided equations than to use the actual vertical measurement of the acromium.

So that the lower edge of the easy fitting bodice block doesn't end up measuring the same as the bust girth, shaping the waist requires squaring down from [23] to [24], a point located at the waist level. In the chart provided by Aldrich (1997: 15), the difference between those two body landmarks is, for standard size 38, 20cm. In view of the fact that the body is symmetrical – along a vertical plane dividing it into left and right sides –, for pragmatic reasons basic patterns only reproduce the right side of the body. Thus, by combining Aldrich's directions for semi-fitted clothing and waisted garments (1997: 22, 33), 10cm are subtracted along the waist level. Accordingly, point [a] is set 1cm to the right of point [5] and point [b] 1cm below point [6]. On segment [a-b] – the final waist level – points [c] and [d] are placed 1.5cm to the left of point [24] and 2.5cm to its right respectively.

---

[151] The second mathematical problem is deduced from the previous explanation about point [21]. See p. 148.

The construction of the easy fitting bodice block concludes by outlining the back pattern piece through: **(1)** points [1] and [9], for the neckline, **(2)** points [9] and [11], for the shoulder, **(3)** points [11], [14] and [23] – in addition to an auxiliary point set on a bisecting-line measuring from [12] approximately 2.5cm –, for the armhole, **(4)** points [23] and [c], for the side seam, **(5)** points [c] and [a], for the waistline, and **(6)** points [c], [10] and [1], for the center back line; correspondingly, the front pattern piece outline comprises: **(1.1)** points [15] and [16], for the neckline, **(2.1)** points [22] and [17], for the shoulder, **(3.1)** points [23], [19] and [22] – and also an auxiliary point set on a bisecting-line measuring from [18] about 2.25cm –, for the armhole, **(4.1)** points [d] and [23], for the side seam, **(5.1)** points [b] and [d], for the waistline, **(6.1)** points [16], [3] and [b], for the center front line, and **(7)** points [17], [20] and [15], for the bust dart.



[*Figure 44*]
Basic Sleeve Pattern For First Garments First Garments, diagram with key and auxiliary points

Moving on to the next basic pattern, the *sleeve* [*Figure 44 and Plate Two*] was constructed knowing that the easy fitting bodice block is the provider of the two body dimensions, from which all the others are derived: **(1)** the armhole circumference – i.e., [11-14-23-19-22] –, **(2)** the measurement comprised between the armhole depth level and the waist level – i.e., [23-24]. Considering that the

F.I.T.'s basic sleeve pattern was modified to some extent, **(3)** the wrist circumference – a measurement that is conventionally determined after positioning the front underarm seam in the wrist level – is found in Aldrich's standard measurements chart (1997: 15).

The reason for not having to resort to a chart of standard measurements to get the first two dimensions is easy to understand: **(1.1)** the sleeve head is joined to the bodice at the armhole circumference, a circumstance that demands that the height and span of the two curved lines are consistent with one another, **(2.1)** in a proportionate body the vertical measurement of the elbow matches that of the waist circumference; thus, the distance from the biceps level to the elbow's on the basic sleeve pattern equals the measurement of the side seam on the basic bodice pattern and **(3.1)** the distance from the elbow to the wrist equals the side seam measurement plus 2.5cm.

The following listing relates to the body landmarks and anatomical points that, describing the arm, regulate the sleeve pattern:

> **(1)** In terms of height, the limits of the sleeve head are the acromium and the axilla. In terms of width, the lowest level of the sleeve head encircles the biceps and triceps muscles.
> In [*Figure 44 and Plate Two*], the key points matching these dimensions are [0-1] and [4-5] respectively.
>
> **(2)** In terms of height, the axilla and the hulmeroulnar joint establish the limits of the space between the lowest level of the sleeve head and the elbow level. In terms of width, the elbow level surrounds the hulmeroulnar joint.
> In [*Figure 44 and Plate Two*], the key points matching these body dimensions are [1-2] and [12-13] respectively.
>
> **(3)** In terms of height, the hulmeroulnar joint and the carpal bone set the boundaries of the space between the elbow and the wrist levels. In terms of width, the carpal bone envelops the wrist level.
> In [*Figure 44 and Plate Two*], the key points matching these body dimensions are [2-3] and [14-15] respectively.

As a rule, the construction of the basic sleeve pattern is planned around an axis corresponding to one paramount dimension: the arm's total height. Although the contour of the sleeve isn't exactly symmetrical around the sleeve head area, the vertical line sets the limits of its back and front parts:

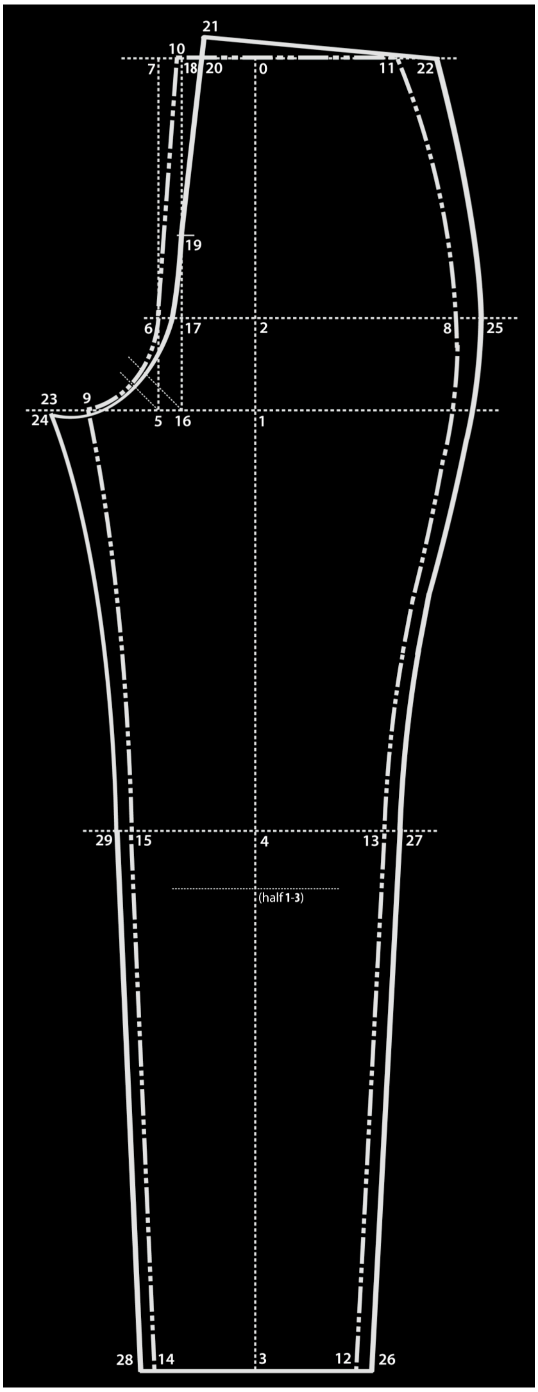
> In [*Figure 44 and Plate Two*], the distance between point [0] and point [1] is one third of armhole circumference plus 1cm.
> Points [4] and [5] are placed to the left and right of point [1] respectively. The resulting segments [1-4] and [1-5] measure respectively three quarters of armhole circumference divided by two.
> The distance between point [4] and auxiliary point [6] is the same as measurement [4-5] divided by sixteen. The distance between point [5] and auxiliary point [7] is the same as measurement [4-5] divided by eight.
> The segments [0-8] and [0-9] measure the same as [4-5] divided by eight plus [4-5] divided by thirty-two respectively.
> Auxiliary point [6] is connected to auxiliary point [8] and auxiliary point [7] is connected to auxiliary point [9].
> Measuring the same as segment [0-1], the auxiliary segment [10-11] is positioned wherever it tallies the space between auxiliary segments [6-8] and [7-9].
>
> In the end, the back part of the sleeve head is formed by points [4], [10], [0] and [1], and the front part of the sleeve head is shaped by points [5], [11], [0] and [1].

From the above description, it is clear that the method applied to the construction of the basic sleeve pattern resorts to the division of segment [4-5] into consecutive halves of the resultant halves with the aim of situating all the key and auxiliary points of the sleeve head. Although this approach seems to be inexplicable, it works; undoubtedly the outcome of trial and error, in all probability its origins goes back to a time when pattern designers, lacking schooling, "learned to think in spatial distances rather than in measurements coded into abstract units, such as inches" (Kidwell 1979: 4).

In a very intuitive way tailors folded the pattern until the back part of the sleeve head looked wide enough and the front's adequately narrower; in a very perceptive way tailors drew the bottom of the curve less concave at the back part than at the front's. In this manner, the usual movements of the upper limbs are considered seeing that "a little drapery is […] arranged at the back of the outer sleeve and a small amount is left on the under sleeve. These amounts are utilized when the arm is moved forwards or upwards, yet are not so great as to be unsightly when the arm is at rest. No such arrangement is needed at the front of scye, there being no normal movement of the arm to warrant it" (Hulme 1945a: 45).

In the adaptation of F.I.T.'s basic sleeve pattern, the underarm part of the sleeve – located below segment [4-5], commonly designated the biceps circumference level – is symmetrically organized around axis [0-3] as all the features that translate the "normal" or "functional" (Croney 1971: 14) position of the forearms – i.e., the slanting toward the front – were excluded. Thus:

> In [*Figure 44 and Plate Two*], segment [14-15], measuring the same as the agreed wrist dimension pertaining to standard size 38, is equally distributed to the left and right sides of point [3].
> Points [12] and [13] are marked on the elbow level – previously situated to the left and right sides of point [2] – exactly where this level intersects segments [4-14] and [5-15].
>
> In the end, the back part of the sleeve wrapping the underarm is formed by points [4], [1], [2], [3], [14], and [12], and the front part is shaped by points [5], [13], [15], [3], [2] and [1].



[*Figure 45*]
Jeans Block For First Garments, diagram with key and auxiliary points

Coming after in sequence, the *jeans block* (Aldrich 1997: 82-83) was constructed [*Figure 45 and Plate Three*] using six body dimensions made available by Aldrich (1997: 15).

In the same way as the upper body and arm measurements were differentiated according to orientation parameters, the jeans block body dimensions are arranged into two groups: **(1)** *circumference* measurements and **(2)** *length* measurements. Again, to keep to Aldrich's designations, the *waist*, *hip* and *jeans bottom* dimensions belong to the first group, and the *body rise*, *waist to hip* and *waist to floor* dimensions belong to the second group.

The list that follows describes the body landmarks and anatomical points that, concerning the lower trunk and legs, organize the jeans pattern:

(1.1) Visibly located between the pelvis and the thorax, the most precise anatomical reference of the *waist* level is the twelfth thoracic vertebra. Although the waist circumference is "a very variable relative dimension," its measurement equals [in men] eighty-five to ninety percent of the bust circumference (Hulme 1945a: 23).
Taking into account that women's waist is slender, an adaptation of Hulme's formula to fit the updated standard measurements – displayed in Aldrich's size chart (1997: 15) – would be around seventy-five to eighty percent of the bust girth.
In [*Figure 45 and Plate Three*], the key points matching this body dimension are [10-11] and [21-22] respectively.

(1.2) The *hip* plane is located between the anterior iliac spine and trochanterion landmarks. If Hulme informs that "the [hip circumference] measurement should be taken on the largest pelvic girth" (1945b: 51), he also says that this dimension is approximately seven percent more than the bust circumference measurement (Hulme 1945a: 23).
In [*Figure 45 and Plate Three*], the key points matching this body dimension are [6-8] and [17-25] respectively.

(1.3) The anatomical reference regarding the *jeans bottom* circumference is the ankle or *talocrural* joint, a body part "formed by the joining of the tibia and fibula of the leg segment to the talus of the foot" (Kelley 1971: 202). Even if Aldrich recommends a specific dimension to apply to the bottom level of the jeans, she

actually – and naturally, we're able to add – proposes different dimensions for other types of pants (1997: 82). Hulme, never suggesting explicit amounts, just advises to place one-quarter of the hem width in each side of the pants axis. The pants bottom measurement is, manifestly, a variable measurement as it depends exclusively on style.
In [*Figure 45 and Plate Three*], the key points matching this body dimension are [14-12] and [28-26] respectively.

(2.1) The *body rise* – or crotch depth – measurement is comprised between the level of the twelfth thoracic vertebra and the gluteal furrow landmarks. "In cases where direct measures of side and inside leg are used, the amount of body rise is readily found by deducting the inside leg measurement from the side" (Hulme 1945a: 25); however, if direct measures cannot be taken, this body dimension equals the total height divided by eight plus 5cm (Hulme 1945a: 26).
In [*Figure 45 and Plate Three*], the key points matching this body dimension are [0-1].

(2.2) The *waist to hip* measurement is assessed from the twelfth thoracic vertebra to a point between the anterior iliac spine and trochanterion landmarks. Although Aldrich indicates that, in size 38, the standard waist to hip measurement is 20.3cm (1997: 15), Hulme mentions that this dimension "has been fixed by long usage at 7 inc[hes]. [Slightly after Hulme writes that the waist to hip measurement] should, however, be regarded more properly as a fraction of the total height of the figure and, therefore, varying with the height; a little greater in the tall woman, a little less in one shorter than average" (1945b: 51).[152]
In [*Figure 45 and Plate Three*], the key points matching this body dimension are [0-2].

[152] Even if there are no doubts that women are, at the present time, taller than they were around 1940/1950, Hulme's words aren't at all erroneous; quite the opposite, they even seem to corroborate the revised measurements presented by Aldrich. Taking into account that anthropometric data has been being updated, surprisingly or not, it is known for a fact that the North-American apparel industry still uses eighteen centimeters – the equivalent to seven inches – for the hip length measurement.

(2.3) The *waist to floor* measurement is normally assessed on the side of the body, from a point at the level of the twelfth thoracic vertebra to the ankle or *talocrural* joint or floor. This dimension is unmistakably a vertical body dimension.
In [*Figure 45 and Plate Three*], the key points matching this body dimension are [0-3].

In some methods – such as Aldrich's or F.I.T.'s –, the construction of basic patterns for bifurcated garments is organized around a vertical line around which one pattern piece is designed; once this piece is completed it acts as the basis from which the other one is developed. And if, in this case, the front pattern piece is the starting part, the axis is actually an element belonging to both, as their side length is the same.

Formed by four segments, each corresponding to the actual body dimension it represents, this axis integrates: the body rise [0-1], the waist to hip [0-2], the waist to floor [0-3], and the body rise to knee [1-4].

In [*Figure 45 and Plate Three*], even though the *waist to knee* dimension is presented in Aldrich's standard body measurements chart (1997: 15), the construction of a basic pattern for pants usually sets the knee level 5cm above the line placed halfway between the crotch depth and ankle levels. This formula actually translates the proportional relationship between the vertical body measurements concerning the crotch and tibia heights.

On a par with the strategy taken on for the construction of the easy fitting bodice block, the suggested ease allowances were not added to the hip and waist measurements. Thus,

In [*Figure 45 and Plate Three*], placed in the front pattern piece **(a)** [1-5] remains one twelfth of hip measurement, **(b)** [10-11] remains a quarter of waist measurement; placed in the back pattern piece **(c)** [21-22] remains a quarter of waist measurement, and **(d)** [17-25] remains a quarter of hip measurement.

The segments or points set in the pattern that maintain the measurements indicated in the directions are:

> In [*Figure 45 and Plate Three*], located in the front pattern piece **(e)** [6-8], equaling hip measurement divide by four, **(f)** [5-9], equaling one sixteenth hip measurement, **(g)** [7-10] equaling 1.5cm, **(h)** [3-12] and [3-14], equaling jeans bottom width divided by two minus 0.5cm respectively, **(i)** [4-13] and [4-15] equaling measurement [3-12] plus 2cm respectively; positioned in the back pattern piece **(j)** [5-16] equaling measurement [1-5] divided by four, leads to points [17] on hipline and [18] on waistline, **(k)** [16-19] equaling measurement [16-18] divided by two, **(l)** [18-20] and [20-21] equaling 2cm respectively, **(m)** [9-23] equaling half measurement [5-9] minus 0.5cm, **(n)** [23-24] equaling 0.25cm, **(o)** [12-26] and [14-28], equaling 1cm respectively, **(p)** [13-27] and [15-29] equaling 1cm respectively.

Impossible to explain are the formulas imparting the locations of **(1)** points [5] and [9] positioned in the front pattern piece that are openly derived from the hip measurement, and **(2)** points [16] and [23] positioned in the back pattern piece. Though Aldrich presents them as fractions of measurements connected with the pattern, it can be deduced that they also relate to the hip measurement (1997: 82). This assumption has to do with the fact that those fractions are, in fact, equivalent to small percentages of distances that have been derived from the hip measurement.

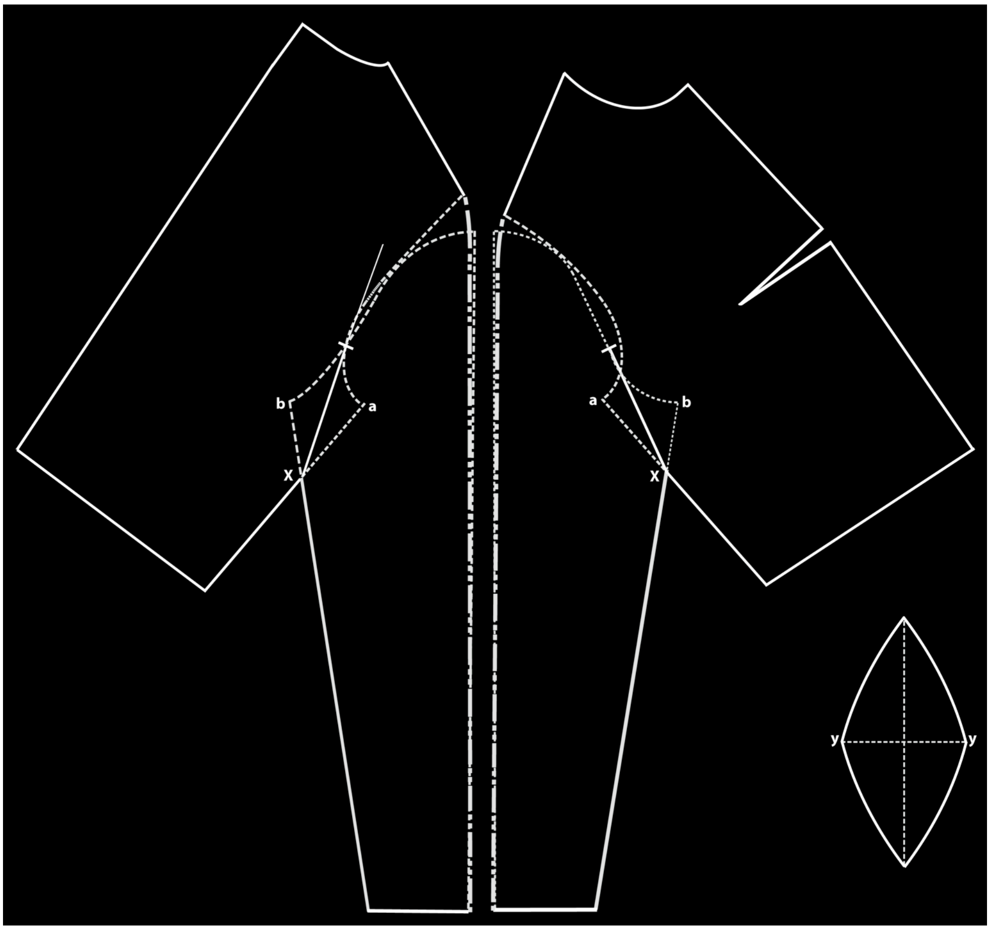
The measurements of the segments [7-10], [18-20] are [20-21] and [23-24] are apparently inexplicable, as it becomes clear that they don't relate to body dimensions as well as they're constant throughout all sizes. And if these measurements appear to have been determined through practice they certainly seem to translate the nineteenth century's inclination to design patterns out of an orthogonal construction, which is the same as to suggest that they embody a strategy that converts auxiliary vertical lines into key slanting lines following fixed algorithms.

> In [*Figure 45 and Plate Three*], the sole function of point [7] is to assist placing the jeans front crotch, a line that between points [6] and [10] becomes slightly off-center; similarly, the exclusive purpose of points [18] and [20] is to support setting the jeans back crotch, a line that between points [21] and [19] becomes visibly slanted; finally the only role of point [23] is to help situating point [24] below the body rise level.
>
> The different sizes and angles of the front and back crotch lines and waistlines portray the physical structure of a body that has, ideally, a flattened abdomen and protruded buttocks; as a result, the waist is lower at the front and higher at the back.

It follows that, in the front and back pattern pieces of the jeans block, the whole area comprised between the waist and knee levels differ in shape.

> In [*Figure 45 and Plate Three*], the discrepancy between the lengths of the front and back inseams – the back's having been shortened – provides sufficient space for the distension of the thigh's anterior group of muscles that occurs, for instances, in the sitting and crouching positions as well as throughout movements like walking up and down stairs.
>
> The divergence between the knee and ankle levels is only in size as the lines connecting them are parallel, a decision that may accommodate two factors, one of a scientific order – as the muscles integrating the posterior crural group are more salient than the muscles composing the anterior crural group – and the other of an aesthetic sort – as in many cases the outseam and inseam are exactly alike in position and size.

As to the jeans block, the outline of the front pattern piece comprises the **(1)** points [9], [6] and [10] – and also an auxiliary point set on a bisecting-line measuring from [5] about 3.25cm –, for the crotch line, **(2)** points [10] and [11], for the waistline, **(3)** points [11], [8], [13] and [12], for the outseam, **(4)** points [12] and [14], for the hemline, and **(5)** points [14], [15] and [9], for the inseam; correspondingly, the contour of the back pattern piece includes the **(1.1)** points [24], [19] and [21] – in addition to an auxiliary point set on a bisecting-line measuring from [16] approximately 4cm –, for the crotch line, **(2.1)** points [21] and [22], for the waistline, **(3.1)** points [22], [25], [27] and [26], for the outseam, **(4.1)** points [26] and [28], for the hemline, and **(5.1)** points [28], [29] and [24], for the inseam.



[*Figure 46*]
Sleeve/Bodice Combination Into A Kimono With Gusset For First Garments, diagram with auxiliary points and lines

Following the construction of the elected three basic patterns, the source flat pattern construction proceeded as the two-dimensional representation of the upper part of the trunk, arms and legs – so that a one-piece garment was formed – were merged by combining, first, the bodice and sleeve slopers into a single pattern [*Figure 46 and Plate Four*].

The reason why the Western-style kimono with gusset (Armstrong 1987: 394-397) was chosen among several designs sharing the same characteristic to be developed,[153] regards the fact that this is the only sleeve/bodice combination that provides a close fit in conjunction with "room for arm movement and lift" (Armstrong 1987: 394). After having divided the basic sleeve pattern into two parts along its axis, the overlapping area in the front and back pattern pieces of the bodice and sleeve blocks had to be determined. Accordingly,

> In [*Figure 46 and Plate Four*], in the front and back bodice pattern pieces, point [x] is placed 6.25cm beneath point [a] at the side seams respectively; in the front and back sleeve pattern pieces, point [x] is positioned 3.75cm below point [b] at the underarm seams respectively.

Each pair of points [x] is, then, superimposed and firmly fixed so that, in the function of pivot points, the sleeve rotates around them until its head touches – or extends slightly beyond – the armhole. Following this construction step,

> In [*Figure 46 and Plate Four*], the points where the sleeve head and the armhole meet, along with points [x], give the direction of the 8.75cm slit where the gusset is inserted. The diamond-shaped wedge is constructed from a 10cm horizontal line intersected at right angles by a comparatively longer vertical line. After that, four rounded lines – measuring the length of the slit – are set in points [y] of the 10cm horizontal line until they come into contact with the vertical line.

The last part of the kimono's construction involves delineating the final overarm seams, so as to connect the shoulder seams with the split axis of the sleeve.

Before the last step of the source pattern's construction is described it must be mentioned that Helen Joseph Armstrong explains none of the measurements she tells to set in the bodice and sleeve patterns or gusset, be they the distances [a-x] and [b-x], the length separating points [y] or the slit's extent. Surely these dimensions were ascertained through experience; surely they work, as – though [a-x] and [b-x] don't seem to be numerically correlated with the respecting seams, on the contrary, they appear to be inversely proportional – it can be seen that, on

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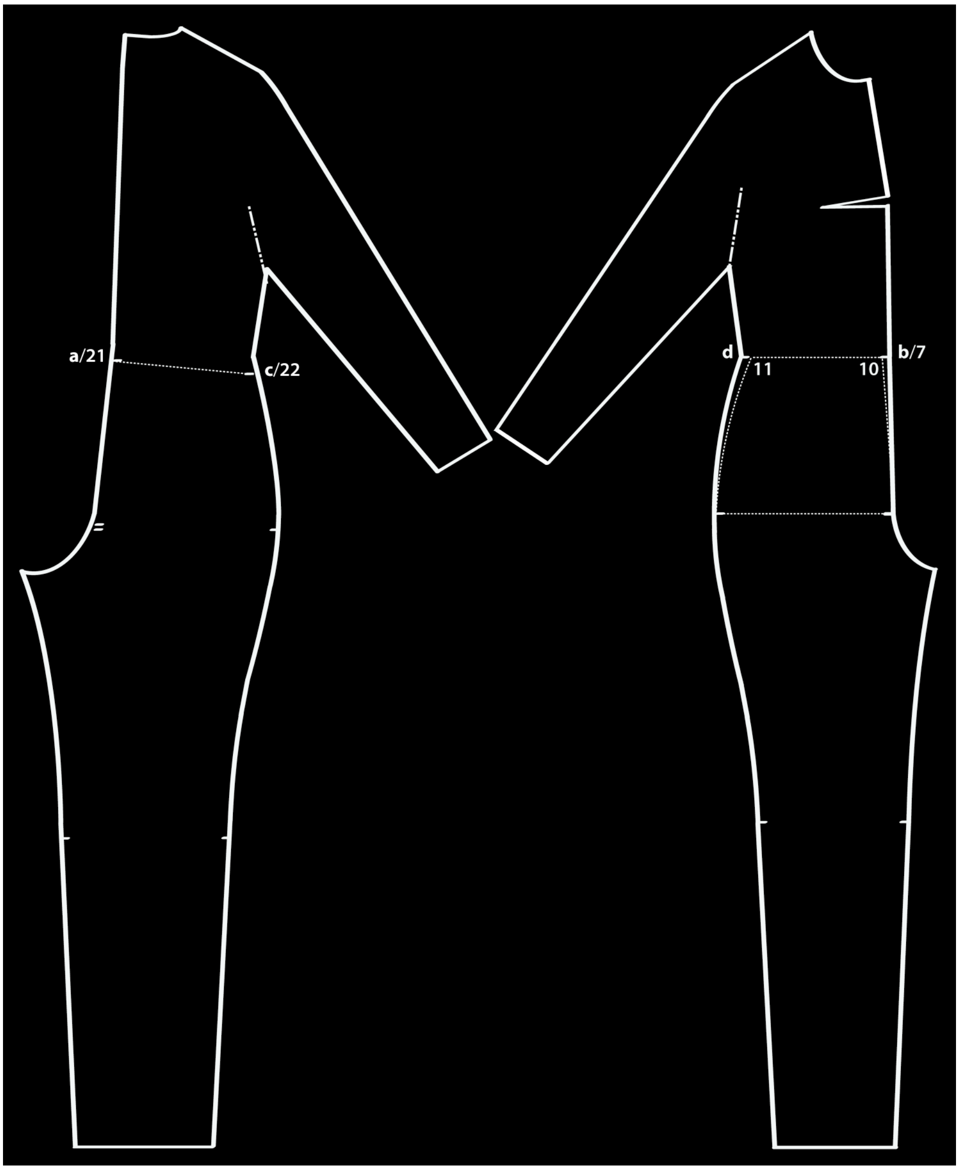
[153] Such as the basic kimono or the dolman sleeve.

account of the position of points [x], the way the bodice and sleeve patterns overlap each other causes the tip of the sleeve head to be properly aligned with the end point of the shoulder. Regarding the length of the slit, the measurement recommended by Armstrong presumably translates the intention that the seam joining gusset and kimono is imperceptible when the arms hang by the sides of the body, as beyond this measurement – i.e., 8.75cm – the two ends of the wedge would certainly be visible.



[*Figure 47*]
Source Pattern, diagram with joining lines

Lastly, the resultant pattern was merged with the jeans block [*Figure 47 and Plate Five*]. For that purpose, the kimono and jeans patterns were joined together along their respective waistlines.

The back pattern pieces' waists corresponded completely, as

> In [*Figure 47 and Plate Five*], **(1)** points [21], on the jeans' back crotch line, and [a], on the center back/waist of the bodice, came to the same location, a circumstance that also occurred with **(2)** points [22] and [c], on the jeans side seam and bodice's respectively.

However, the front pattern pieces waists didn't match end-to-end. For that reason, the front pattern piece was amended this way:

> In [*Figure 47 and Plate Five*], **(1)** point [10] on the jeans' front crotch line, was moved back to location [7] so as to align with point [b] on the center front/waist of the bodice, and **(2)** point [11] on the jeans waistline was repositioned to come into contact with point [d] on the bodice's waistline.[154]

Constructed according to the long-established paradigm of representation taken up by conventional patter design, the source pattern reproduces the body standing still [*Figure 48*].

This means that the seams that separate the left and right sides of the one-piece garment plus its font and back pieces match the lines dividing the body into equal vertical halves and portions that result from the imaginary intersection of this entity by the sagital and coronal planes employed by anatomy and anthropometry [*Figure 48*].

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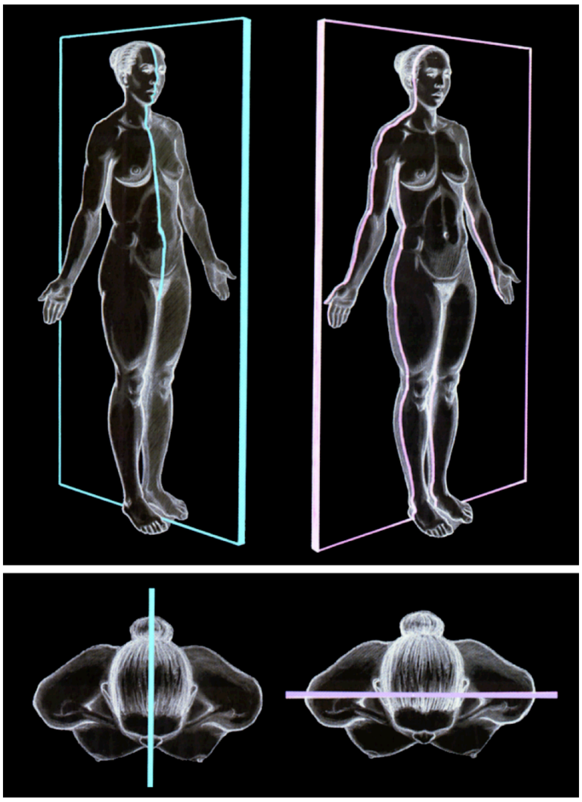
154 See [*Plate One*] and [*Plate Three*].



[*Figure 48*]
Sagital And Coronal Planes: Anterior View And Superior View, diagrams adapted from Valerie L. Winslow (2009: 29)

Summary

In Part Three several issues pertaining to the construction of The First Garments employed in phase one are covered, as they were a vital tool for the subsequent creation of the artifact developed in phase two and phase three.

Appropriately, it describes the processes of selecting **(1)** the appropriate *nonwoven textile*, i.e., a 50% Wool/50% Viscose under collar felt, so that they'd become imprinted with the amalgamation of all body positions assumed through movement, **(2)** the applicable *base size*, i.e., the Euro size 38, so that they'd fit the bulk of the female population, and **(3)** the suitable *source pattern*, i.e., a one-piece garment, so that they'd cover practically the whole body in view of the fact that motion never occurs at one single body segment.

Because they played an important part in the selection of the fabric and size, Part Three goes over the procedures of **(1a)** testing through wear several felted fabrics with different fiber contents and thicknesses, and **(2a)** surveying to the Portuguese manufacturers and independent designers producing Womenswear. Because the one-piece garment was planned in conformity to conventional pattern design, an effort was made to **(3a)** decipher the reasoning that underlies the delineation of the easy fitting bodice block, the sleeve block and the jeans block, that form its pattern.

Strongly linked to the decision to comprise the information about the key points and measurements of the *source pattern*, imparted throughout the description of the step-by-step procedure for its construction, is the need to validate the generated theory – grounded in data – within the field of pattern design by establishing links between the representation of the static body and the lineament of the mobile body.

As the thesis proposes a new body representation paradigm in pattern design, the decision to use a *base size* is strongly linked to the motivation to portray the standard body throughout the various stages of the artifact's creation – i.e., in the first garments, in the tangible mannequin and in the alternative set of basic patterns. Because it concerns a paradigm, the focus is on the structural characteristics that nearly everybody shares. Because it involves a paradigm, the focus is on the actions that nearly everybody performs everyday, no matter which their professional and leisure pursuits are: walking, sitting, standing, mounting steps, etc.

Strongly linked to the decision to choose a *nonwoven textile* is the belief that it brings the narrative to the picture, as it the one-piece garments used by eleven women who wear Euro standard size 38 become deformed as the deformations undergone by their bodies during routine movements get imprinted on them.

Part Four, thus, expounds **(1)** the way in which the first garments were employed for the process of self-modeling, **(2a)** the way in which the collected self-portraits were converted into a compound portrait, **(2b)** the way in which the compound portrait yielded an additional, central, tool, and **(3)** the way in which the alternative set of basic patterns was created on the produced tangible mannequin that stands for the mobile body.

4 The Creation Of The Artifact

Introduction

With determination pattern design has figured out a way of reproducing the body through parametric equations – the natural tendency having always been to view it as a standing, static, entity. With insight pattern design has figured out a way of planning the body by sizes – the artifice having been to view it as an anonymous, standardizable, entity. With cleverness pattern design has figured out "how to use the fabric[s'] characteristics to the design[s'] best advantage" (Baugh 2011: 25) – the first choice being to make the vertical and horizontal levels of the body coincide with the vertical and horizontal threads of fabrics.

Touched by the strength of will, awareness and intelligence of all the professionals that have come up with or furthered the theory of pattern design and hoping to match their investigative drive, the paradoxical concept underlying this discipline's approach to representation – the rigid body – began to be revised.

Following the lead of Vionnet, Newman, Korff and Throup, it was mandatory to begin by looking into its true nature, i.e., the body's deformable quality coming from within, as the aim was to translate it into a set of basic patterns. Like Vionnet and Throup,[155] designing in three-dimensions was the choice – as well as to use the generated three-dimensional patterns as the source of a two-dimensional

[155] In this particular aspect the MIT professor had to be left out since it wasn't possible to find out which pattern design technique her team employed to create the BioSuit; the former Levi's design director was also left out since – despite all the attempts to get in touch with Rikke Korff when, in 2004, I was carrying out the Master's research – the design method behind the twisted-seam jeans is unknown.

pattern. Like Throup, a tangible mannequin was developed with the aim of using it as a system for blocking patterns for the mobile body.

Knowing that the mobile body is a complex, variable, phenomenon, a methodology, divided into three phases and involving varied procedural techniques, was devised so as to solve the addressed problem. Reminding that this research was managed *through* creative practice, the devised methodology applied the principle of learning by doing.

In practical terms, it means that the understanding of the mobile body was attained as the creation of the twofold artifact – mannequin and patterns – progressed. It also means that the process of making sense of data drew from the total immersion in it.

The truth of the matter is that however lengthy the process of translating the participants' logs into diagrams was, however repetitive the process of handling the photos of the plain- and self-portraits was, however laborious the process of averaging the silhouettes of the self-portraits was, it was exactly through *doing* them that it was possible to perceive **(1)** *a reality projected on the plane* of the first garments, **(2)** the *deformation pattern* that would be incorporated into the compound portrait, and **(3)** the *implicated basic features* of the created basic patterns.

In relation to the initial analytical stage in the artifact's creation, I must admit that I'm inclined toward qualitative approaches in general. For this reason the first section of Part Four describes how the combination of **(1a)** a procedural technique akin to *theoretical sampling*, and **(1b)** the practice of *artifactualization*, led to the way the commissioned Self-Portraits ended up looking. Then again, knowing that the referred methods of data collection bear differences and similarities with the ones that were actually implemented, the divergences and convergences between the two are pointed out.

On the one hand, like theoretical sampling, the collected visual data contributed to identify and relate the building blocks of the mobile body's lineament. Yet, unlike theoretical sampling, the process of data collection wasn't circular or cumulative, as the pattern and fabric from/of which the first garments were made – as well as its type – caused the same categories to emerge in all self-portraits.

Again, like twentieth century female artists, the participants produced their self-portraits by playing a part inherently known to them all – that of living with a body – and through a practice/medium extremely familiar to them all – that of wearing clothes. But unlike the outcome of self-portraiture, the process of artifactualization resulted in visual images that are objective rather than subjective.

Then, admitting that I grasp data best through visual means, the second section of Part Four illustrates how the application of **(2a)** an approach similar to visual somatometry, and **(2b)** an experimental method developed by R. Hutchinson and D. L. Munden, led to the way the composed Compound Portrait ended up looking.

In fact, by comparing the whole silhouettes of the photographed self-portraits instead of focusing on the rounded up angle measurements for each body segment it was possible **(i)** to determine the *properties* and *dimensions* of the deformations that emerged out of movement, **(ii)** to separate into five pairs the front and lateral silhouettes of the selected self-portraits on grounds of closest similarity, and **(iii)** to find the average contours of the formed set of two by drawing bisecting lines pair after pair until one remained.

Admittedly, the final stage in the artifact's creation was indeed a process of discovery through *doing*. 'Indeed' because, **(3a)** by Designing On The Mobile Body, it was possible **(3b)** to use an idea gained through the experience. So in the third section of Part Four, it is shown, one after another, how the lineated pants, torso and sleeve basic patterns ended up looking.

Deliberately a skirt sloper was not designed nor ever regarded as one of the drawings that should make up the generated set of basic patterns. The reason is that the type of garment it portrays is abstract in the sense that it does not depict the body – mobile or static –, it just hangs from the body's waist and covers all or part of the legs.

The Self-Portraits

[*Drawing On Theoretical Sampling And Artifactualization*]

According to Martin N. Marshall, “the choice between quantitative and qualitative research methods should be determined by the research question, not by the preference of the researcher” (1996: 522). Juliet Corbin and Anselm Strauss (2008: 24) confirm that “some problems clearly suggest one form of research over another,” though they believe that “when a problem area suggests that either qualitative or quantitative methods might be used” the researcher – consciously or unconsciously[156] – frames the question to fit his/her preferred way of carrying out an inquiry.

Between these two stances I’m inclined to agree with Corbin and Strauss, that is, to think that the manner in which the problem is formulated reflects the researcher’s personality: his/her tendency to ask “more mechanistic ‘what?’ questions” or to pose “humanistic ‘why?’ and ‘how?’ questions,” as Marshall puts it (1996: 522); him/her being “drawn to the fluid, evolving, and dynamic nature of” the qualitative approach or “to the more rigid and structured format of quantitative methods,” as Corbin and Strauss write (2008: 13).

Based on the two types of disposition outlined above, the aim to *create a set of basic patterns that translates the mobile body* – or to present an interpretation of a complex, variable, phenomenon – determined that a qualitative approach was adopted. Particularly because the research progressed without having a preconceived image of how the alternative basic patterns ought to look – and, to a great extent, without a stepwise, predetermined, plan of action.

Owing to my intrinsic character, I “enjoy serendipity and discovery,” as Corbin and Strauss don’t hesitate to say qualitative researchers do (2008: 13). For that reason, pre-set hypotheses were not tested to “produce generalizable results,” as it’s proper to quantitative studies (Marshall 1996: 522), but “real people [were studied] in natural settings rather than in artificial isolation,” as it’s characteristic of qualitative approaches (Marshall 1996: 524).

Therefore, it was irrelevant to obtain, or to know, in advance

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[156] An issue yet to be ascertained, as indicated by Corbin and Strauss (2008: 24).

(1) The statistical values for selected static and dynamic body dimensions[157] [*Figure 49*] – provided in documents like the 2003 *HFDS Human Factors Design Standards* (www.hf.faa.gov), and the 1991 *DOD-HDBK-743A Military Handbook Anthropometry of U.S. Military Personnel* (www.everyspec.com).[158]

Body Landmark	**1968** 1,905 USAF Women Statistical Value (Mean)	**Difference**	**1977** 1,331 US Army Women Statistical Value (Mean)	**Difference**	**1988** 2,208 US Army Women Statistical Value (Mean)	**Difference**
Trunk						
Standing	154.43cm	4.36cm	153.84cm	7.40cm	153.02cm	—
Sitting	150.07cm		146.44cm		—	
Biceps						
Flexed	26.79cm	1.18cm	26.87cm	0.98cm	28.13cm	—
Relaxed	25.61cm		25.89cm		—	
Elbow						
Flexed	26. 89cm	—	25.98cm	—	—	—
Relaxed	—		—		23.83cm	
Forearm						
Flexed	24.98cm	1.5cm	24.63cm	1.35cm	25.37cm	—
Relaxed	23.48cm		23.28cm		—	
Interscye						
Back	35.06cm	14.33cm	37.86cm	—	35.20cm	—
Maximum	49.39cm		—		—	
Arm length						
Straight	—	—	53.80cm	—	54.72cm	5.12cm
Bent	59.21cm		—		59.84cm	
Hip						
Standing	95.27cm	4.73cm	95.52cm	2.58cm	96.69cm	—
Sitting	100.00cm		98.10cm		—	

[*Figure 49*]
Selective Static And Dynamic Body Dimensions, diagram adapted from *DOD-HDBK-743A* (www.everyspec.com)

(2) The values in degrees of the normal range of motion for individual joints [*Figure 50*] – provided in documents like *The Merck Manual* on physical therapy (www.merckmanuals.com) and 2003 *HFDS*.

[157] The measurements of the body taken in normal positions – e.g., standing – and in common and mobile working positions – e.g., seated –, respectively (www.hf.faa.gov).

[158] According to the team conducting human factors work for the US Federal Aviation Administration, the data comprised in *DOD-HDBK-743A* represents “the most comprehensive samples available” (www.hf.faa.gov).

Joint	**Motion**	**Normal Values**	Joint	**Motion**	**Normal Values**
Hip	Flexion	0°-125°	**Shoulder**	Flexion	0°-90°
	Extension	115°-0°		Extension	0°-50°
	Hyperextension	0°-15°		Abduction	0°-90°
	Abduction	0°-45°		Adduction	90°-0°
	Adduction	45°-0°		Lateral Rotation	0°-90°
	Lateral Rotation	0°-45°		Medial Rotation	0°-90°
	Medial Rotation	0°-45°			
Knee	Flexion	0°-130°	**Elbow**	Flexion	0°-160°
	Extension	120°-0°		Extension	145°-0°
				Pronation	0°-90°
				Supination	0°-90°

[*Figure 50*]
Normal ROM For Individual Joints, diagram adapted from *The Merck Manuals: Online Medical Library* (www.merckmanuals.com).

(3) The values in degrees of the standard range of motion for two joints – provided in documents like the 2003 *HFDS*.

Or even to turn to **(4)** the percentages of body surface change – reported by researchers like Kirk and Ibrahim (1966), Lotens (2007[1989]), Choi and Ashdown (2010), referred to previously.[159]

The truth is that the number of comparative body dimensions comprised in the reviewed manuals is limited. More importantly, they are the product of anthropometric surveys that were conducted using standard standing and seated postures, namely, "standing squarely with feet slightly apart" (Ashdown 2011: 278) and sitting with hips and knees at a ninety-degree angle [*Figure 51*], even when they were based on data collected via 3D body scanners (Choi and Ashdown 2010: 81).

The fact that the seated posture is used "by the automotive and airline industry, and by the military for cockpit design" (Ashdown 2011: 291) and that "most clothing is designed for the 'anthropometric' position" – as Ashdown calls the standard standing position (2011: 278) – explains why one position is normally analyzed independently from the other (Ashdown 2011: 291). Yet it doesn't explain why the position chosen for the design of clothing is ideal, illusory, in the sense that it describes a fixed, unchanging body.

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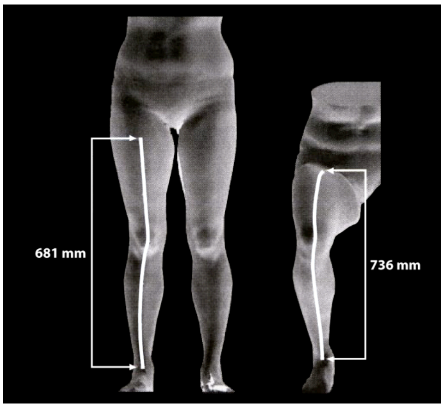
159 See Antecedents Of The Research, pp. 97-101.



[*Figure 51*]
The Conventional Standing And Seated Postures Of Anthropometric Surveys, illustration adapted from Susan P. Ashdown (2011: 292)

What really goes on with the body is the perpetual displacement of its shape: even when the body is just standing, sooner or later it shifts its weight from one leg to the other, it bends its trunk forward and backward, it moves its arms upward and downward, *etc*; even commonplace activities like walking, mounting steps, reaching for a book or a subway strap, trimming hedges and playing tennis, comprise a multitude of active positions [*Figures 52a and 52b*].

[*Figure 52a*]
Participant 10 Trimming Hedges While Wearing The One-Piece Garment, photos by Francisca Manuel

[*Figure 52b*]
Participant 14 Playing Tennis While Wearing The One-Piece Garment, photos by Filipa Valladares

The chance to reject the reviewed anthropometric data doesn't mean that the physical characteristics and capabilities of the body failed to be cared about when designing the alternative basic patterns.[160] In actual fact, the chance to embrace a qualitative approach meant that the body's dimensional changeability was taken into account combined with its shape variability. And so, data was collected through entrusting *real people* with the task of describing themselves in terms of the referred relationship.

Akin to theoretical sampling, the procedural technique used in phase one contributed to identify and relate the building blocks of the produced tangible mannequin, the basis of the mobile body's lineament. Unlike theoretical sampling – or the majority of the sampling strategies for qualitative research in social and health sciences[161] –, the procedure used in phase one neither depended on interviewing nor observation, which are "the two prevailing forms of data collection associated with qualitative inquiry," as indicated by Marie C. Hoepfl (1997).

But as Corbin and Strauss avow, "one of the virtues of qualitative research is that there are many alternative sources of data" (2008: 27). So the technique used in phase one drew on a form of self-portraiture, as visual data was searched for rather than verbal accounts of experiences.

Aside this purpose, opting for an unconventional source of data was gainful as, **(1)** without the misleading factor that interviews are liable to yield – indeed "it is not unusual for persons to say they are doing one thing but in reality they are doing something else" (Corbin and Strauss 2008: 29) –, it secured truthfulness, i.e., what really happens, **(2)** without the intrusiveness that observation can present (Corbin and Strauss 2008: 29) or the distortion factor that it can introduce (Hoepfl 1997), it captured reality, i.e., when and where it really happens. Bringing another advantage, the tailored investigative procedure used in phase one, **(3)** resulted in visual images that – unlike the outcomes of self-portraiture in the strict sense of the word – are objective rather than subjective.

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[160] Actually, upon Christina Goulding's advice, when "the researcher's mission is to build his/her own theory from the ground [...] literature in the immediate area should be avoid so as not to prejudice or influence the perceptions of the researcher" (1999: 8).

[161] Under the umbrella of purposeful sampling, the types of sampling strategies in qualitative research include: deviant case sampling, maximum variation sampling, convenience sampling and theoretical sampling, among many others (Sandelowski 1995: 181-182; Hoepfl 1997).

Despite this last point, to categorize the collected three-dimensional descriptions as self-portraits brings, unavoidably, a conflict to the fore: if indeed they are to be viewed as a subtype of self-portraiture, it presupposes, first of all, that their makers are artists. Then, to admit the study participants as artists presupposes that **(1)** they have exercised critical self-reflection (Brea 2003: 98), **(2)** their work displays a signature or the "consistency of the subject-as-author," to use José Luis Brea's expression (2003: 96), and – if it may be added – **(3)** they have intentionally selected the technical devices of image-making they used.

In view of these premises, the participants that agreed to self-model for this research cannot be regarded as artists because **(3a)** they surely didn't pick their own means of expression, and **(1a)** they clearly didn't decide who was going to be depicted, that is, they didn't determine how they wanted to be seen. All the same **(2a)** the formed three-dimensional visual renderings reflected their own identities, or at least their individual marks.

To be frank, when the participants accepted to carry out their daily activities while dressing the one-piece garments made of felt S. 11803, they didn't view themselves as agents of artistic production. But without realizing it, they went through the process of self-modeling by playing a part inherently known to them all – that of living with a body –, and through a practice/medium extremely familiar to them all – that of wearing clothes.

So, deliberately or not – a matter that, in practical terms, is beside the point–, the participants **(1)** projected a "reality" on the "plane" – to reuse Juan Antonio Ramírez choice of words –, **(2)** without controlling the traces their physical bodies left on the emerging three-dimensional garments made of a plastic, flat material, **(3)** for approximately forty hours of wear.

The process itself, resembling the approach performance art has, consisted "in stepping out of the canvas, out of two-dimensionality, in order to enter space, and to use the body as the subject of a simple and direct work," to use Esther Ferrer's own words (www.angelsbarcelona.com). Like this particular artistic medium, the process carried out by the study participants "represents a moment when time, space and presence intervene at once" (Esther Ferrer in www.angelsbarcelona.com).

Before disclosing how these three elements converged into the self-portraits – that is, **(1)** *body*, as an instrument of action, **(2)** *space*, as the multiple settings in which the body acted, and **(3)** *time*, as a force capable of acting on the body and the medium clothing it –, it must be explained how people were chosen to self-model, i.e., who was going to self-model. By writing this sentence it seems that the study participants were commissioned on the basis of their skills – which indeed they inherently possessed.

To tell the truth, people were selected on the basis of what the inquiry depended on: artifactuality and grounded theory. With respect to the first instance, choosing the right people to function as artists implicated knowing that the proposed subtype of self-modeling involved work and commitment, as they would have to modify an existing artifact into another artifact.[162] With regard to the second instance, choosing the right people to engage in self-portraiture implicated envisaging the kind of information they could yield about the studied phenomenon, as the lineament of the mobile body would be derived from the collected data – as indeed it has.

About the first condition introduced above, i.e., the participants' willingness to devote time and energy, it must be said that of the fourteen women that started to self-model only eleven managed to accomplish it. The three women that stopped producing their self-portrait stated that the difficulty of dealing with the assigned task was due to: **(a)** the prickliness and **(b)** hotness sensations instigated by the properties of the employed nonwoven textile; **(c)** the tearing of the employed nonwoven textile caused by its construction; and finally **(d)** the tightness and **(e)** strangeness sensation/feeling instigated by the design of the employed one-piece garments.[163]

With regard to the last condition presented before, i.e., the participants' eagerness

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[162] If an artwork has necessarily to be an artifact or if a natural object can be construed as an artifact – for example, a piece of driftwood untouched by an artist exhibiting it in an art gallery or museum –, is an ongoing debate among influential philosophers of art since the 1970s (Davies 1991: 120-123). By bringing up the issue of the artifactuality condition vs. artifactualization I'm not insisting on the idea that the self-portraits produced by the study participants should be regarded as, or qua, artworks; instead I'm claiming that the handled one-piece garments are artifacts in the primary sense of the concept, a meaning that implicates "[being] manufactured via the direct manipulation of a material item [an idea that] suggests in turn that the artifact must share at least some material properties with its progenitor [i.e., a natural object]" (Davies 1991: 124).

[163] To simplify the identification of the remaining eleven participants presented in [*Projecting A Reality On The Plane*] and [*In Search Of A Deformation Pattern*], the renouncing participants were labeled participant 12, participant 13 and participant 14, even though they entered the study after participant 09.

to communicate information, a seeming conflict must be raised for discussion: if, as maintained by Margarete Sandelowski (1995: 180), people "enter qualitative studies primarily by virtue of having direct and personal knowledge of some event [...] and only secondarily by virtue of demographic characteristics (e.g., age, race, sex)," it appears that any person could provide the sought data since anyone fulfills the dual prerequisite previously framed: *being a mobile, dressed, body.*

Then again, and to make use of a truer syllogism, **(1)** if in qualitative research it is concepts that are sampled (Corbin and Strauss 2008: 144), that is, events, incidents and experiences (Sandelowski 1995: 180), and **(2)** if, on the word of Susan P. Ashdown (2011: 280), culture, age, gender, physical condition and body proportions are among the most important factors that affect body movement, body positions and range of motion, it makes sense that **(3)** with regard to the phenomenon in question, the target population from whom the enormous variety of commonly held active body positions were sampled were **(3a)** women, **(3b)** aged nineteen to forty-eight,[164] **(3c)** who wear Euro standard sizes 36 and 38.

Admittedly, the age bracket catered for by Womenswear, usually sixteen to fifty, determined the age range of the participants entering the study.[165] According to B. Le Pechoux and T. K. Ghosh (2002: 3), the reason for the defined upper limit relates to the fact that women's body measurements are liable to change after the age of fifty; alluding to recent anthropometric surveys, the authors let know that, in comparison with the younger female population with the same bust size, the waist, hip and total crotch dimensions of the older consumers increase on average 2cm, 6cm and 3.5cm, respectively, and the inseam leg measurement decreases about 1cm.

On the basis of the information supplied by Ashdown in the penultimate paragraph, it is reasonable to believe that the option to impose age limits would also influence the quality of information obtained per participant: admittedly, the collected self-portraits reflect a specific reality, a reality represented by the specific movements that a body of people within the same sex, size and age categories carry out each day, a reality corresponding to the specific movements that a body of people living in a particular *milieu* carry out day after day.

[164] For the record, the renouncing participants were aged 25, 26 and 34.

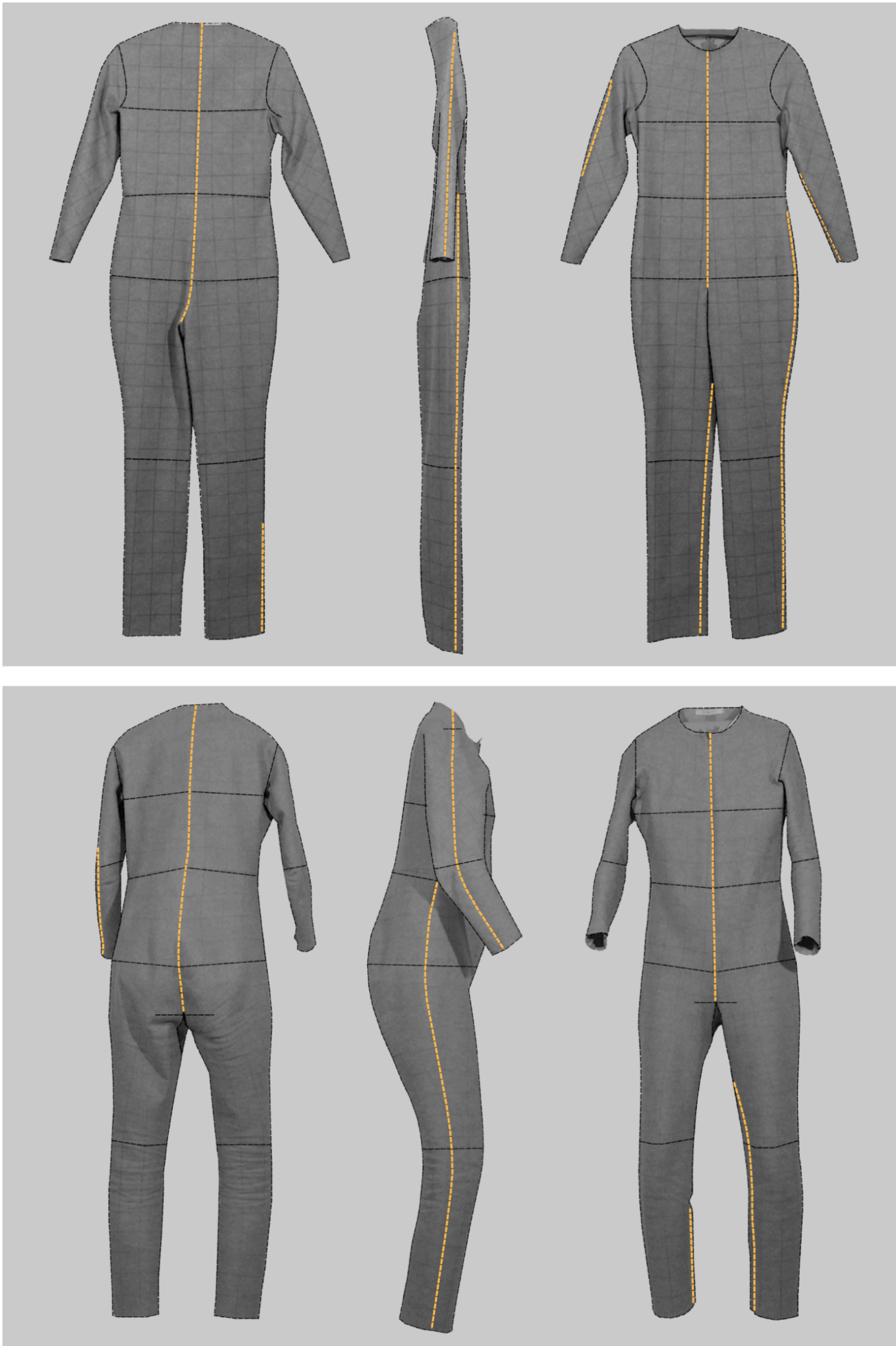
[165] And in phase four, for that matter.

The information yielded by the participants is, thus, context dependent as it reflects the interplay between them and the settings in which they act. All the same, the mundaneness and sweeping character of the studied phenomenon allowed gathering data “by sampling on the basis of convenience” (Corbin and Strauss 2008: 153). Aside the practicality of accepting whoever agreed to participate – so long as they integrated the target population –, the collected self-portraits allowed detecting the similarities and differences between them and, more importantly, identifying the deformation pattern that was subsequently incorporated into the compound portrait and tangible mannequin.

Again, the mundaneness and sweeping character of the studied phenomenon allowed the participants the possibility of leaving their tracks on the one-piece garments without my involvement. This seeming indifference to the process doesn’t mean that proper attention failed to be given to the participants; it means that their innate experience of living with a dressed body – or being a dressed body, as Joanne Entwistle prefers to phrase (2000: 6) – was regarded as ensuring they’d self-model properly.

The apparent detachment doesn’t mean either that the process of data collection failed to be given the care it required; it means that the purpose of sampling was not to check how the participants responded to the situation of wearing a fitted one-piece garment made of a plastic material like felt S. 11803. As it happens the point of sampling was to see how the amalgamation of myriad movements of a common, everyday, kind – that the participants carried out freely for approximately forty hours – ended up looking.

Therefore, the procedural technique that we’ve employed to collect data bears a difference with true theoretical sampling, as its process wasn’t exactly circular. In reality there was no need to analyze the first set of visual data to determine what needed to be sampled next. The characteristics of the first garments – a combination of garment type, garment pattern and fabric used – made it possible that the same categories emerged in all self-portraits: **(a)** the forward inclination acquired by the bodice, **(b)** the curved/angled shape acquired by the sleeves, and **(c)** the curved/angled shape acquired by the trouser legs [*Figure 53*], just to give only the main points with little detail.



[*Figure 53*]
First Garment Before And After Wear With Highlighted Seams, photos by Francisca Manuel with superimposed lines

The employed technique wasn't exactly cumulative: in reality "sampling [didn't become] more specific with time because the questions [didn't] become more specific as the researcher [sought] to saturate categories," to reverse Corbin and Strauss' definition of theoretical sampling (2008: 146). As it happens the set of directions given to every participant was identical; in practical terms the act of self-modeling had to **(1)** be carried out for the decided period of time, **(2)** include indoors and outdoors activities, and **(3)** be attached with a daily record of the performed activities and implicated movements.

Although the sampling technique didn't exactly draw on a process where "data collection and analysis go hand in hand" (Corbin and Strauss 2008: 145), it engaged two successive sampling groups to verify if the one-piece garments used in both rounds showed comparable degrees of distortion in the same parts of the body. Ideally the two groups would have integrated the same number of participants, though the first group included seven women and the second only four;[166] nonetheless the three-dimensional visual data collected from the last group confirmed that each projected reality – despite its individuality – bore a resemblance to all others.

It's true that data could have continued to be collected forever;[167] yet, after analyzing the eleven self-portraits that were produced for this research it was certain that sufficient sampling had occurred. To be sure, each category derived from data was explored in some depth, its properties and dimensions were identified; surely the separation of the collected data into categories made it possible to grasp how they matter to the overall story.

[*Projecting A Reality On The Plane*]

Resembling the approaches Ana Mendieta and Esther Ferrer, regarded as one, have to self-modeling – that is, the manner both Mendieta and Ferrer use their bodies to transcend the exclusive interest in the self –, two groups of women, one after the other, performed the movements of everyday activities so they'd get imprinted on the first garments.

Before engaging in self-modeling, the eleven study participants agreed to bond together the movements they unvaryingly execute each day under the following major categories: **(1)** walking, **(2)** running, **(3)** standing, **(4)** walking up/down

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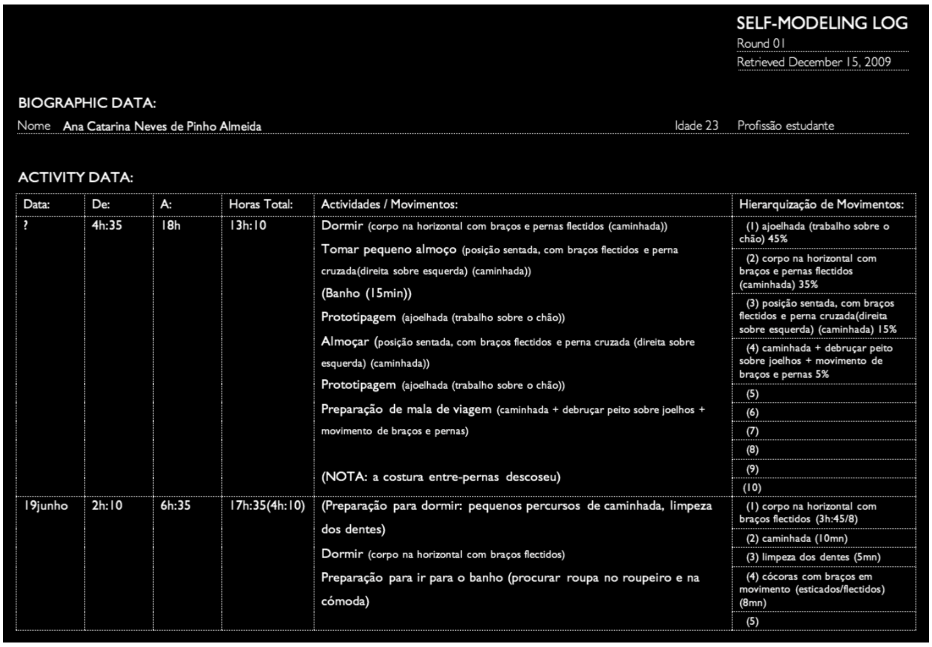
[166] In spite of everything the number of participants entering this study is close to what has been suggested, i.e., "a sample size of twelve [is] the minimum for any grounded theory study, although it is unclear how this arbitrary figure was reached. Riley (1996) states that most studies achieve saturation between 8-24 interviews depending on the topic focus" (Goulding 1999: 15).

[167] As it happens phase one alone took a whole year to accomplish, which determined that it had to be brought to an end so that the research could progress as scheduled.

stairs, **(5)** stretching trunk/limbs, **(6)** bending trunk/limbs, **(7)** sitting, and **(8)** lying down.[168] Throughout the period of self-modeling, each participant agreed to log the following information: **(a)** the dates in which the first garment was worn, **(b)** the amount of time the first garment was worn each day, **(c)** the sequence of activities done each day and their association with one or several movements, and **(d)** the ranking of the implicated movements according to their frequency [*Figure 54*].



SELF-MODELING LOG
Round 01
Retrieved December 15, 2009

BIOGRAPHIC DATA:
Nome Ana Catarina Neves de Pinho Almeida Idade 23 Profissão estudante

ACTIVITY DATA:

Data:	De:	A:	Horas Total:	Actividades / Movimentos:	Hierarquização de Movimentos:
?	4h:35	18h	13h:10	Dormir (corpo na horizontal com braços e pernas flectidos (caminhada)) Tomar pequeno almoço (posição sentada, com braços flectidos e perna cruzada(direita sobre esquerda) (caminhada)) (Banho (15min)) Prototipagem (ajoelhada (trabalho sobre o chão)) Almoçar (posição sentada, com braços flectidos e perna cruzada (direita sobre esquerda) (caminhada)) Prototipagem (ajoelhada (trabalho sobre o chão)) Preparação de mala de viagem (caminhada + debruçar peito sobre joelhos + movimento de braços e pernas) (NOTA: a costura entre-pernas descoseu)	(1) ajoelhada (trabalho sobre o chão) 45% (2) corpo na horizontal com braços e pernas flectidos (caminhada) 35% (3) posição sentada, com braços flectidos e perna cruzada(direita sobre esquerda) (caminhada) 15% (4) caminhada + debruçar peito sobre joelhos + movimento de braços e pernas 5% (5) (6) (7) (8) (9) (10)
19junho	2h:10	6h:35	17h:35(4h:10)	(Preparação para dormir: pequenos percursos de caminhada, limpeza dos dentes) Dormir (corpo na horizontal com braços flectidos) Preparação para ir para o banho (procurar roupa no roupeiro e na cómoda)	(1) corpo na horizontal com braços flectidos (3h:45/8) (2) caminhada (10mn) (3) limpeza dos dentes (5mn) (4) cócoras com braços em movimento (esticados/flectidos) (8mn) (5)

[*Figure 54*]
Self-Modeling Log, print screen

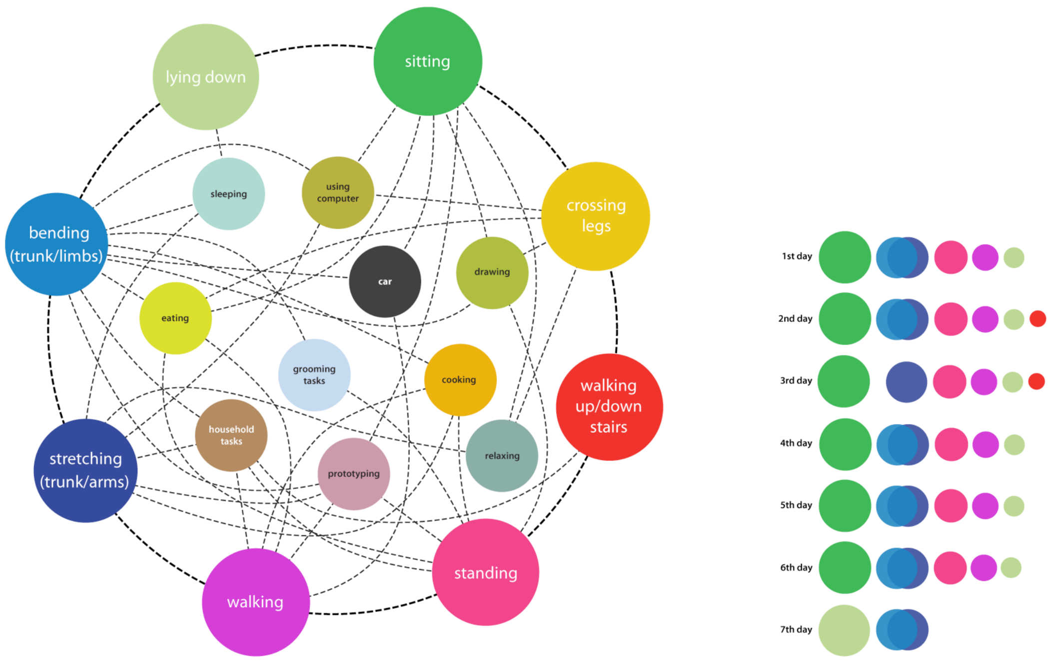
When the process of self-modeling was over and the logs were handed back, the participants' words were translated into drawings. Admitting that I am "more of a visual person" (Corbin and Strauss 2008: 107) – as the authors characterize the analytic skills of some researchers –, the representation of the written data in the form of diagrams enabled to sort out, more easily, the conveyed relationships between movements and activities. Thus,

According to participant 01, a Fashion Design student aged 22, integrating round one, **(i)** sitting, leg crossing, bending and stretching are connected with *computer use*, **(ii)** sitting, bending, stretching and walking are connected with *prototyping* –

[168] The sequence of movements was chosen to be listed arbitrarily, not according to the frequency of each.

i.e., cutting, sewing, and the like –, **(iii)** sitting, bending and standing are connected with *drawing*, **(iv)** walking, standing, stretching and bending are connected with *cooking*, **(v)** sitting, leg crossing, bending and standing are connected with *eating*, **(vi)** walking, standing, stretching, bending and walking up/down stairs are connected with *household tasks* – i.e., cleaning, washing dishes, vacuuming and the like –, **(vii)** standing and bending are connected with *grooming tasks*, **(viii)** sitting, bending and leg crossing are connected with *relaxing*, **(ix)** lying down, stretching and bending are connected with *sleeping*, **(x)** sitting, bending and stretching are connected with *commuting by car* [*Figure 55, left*].

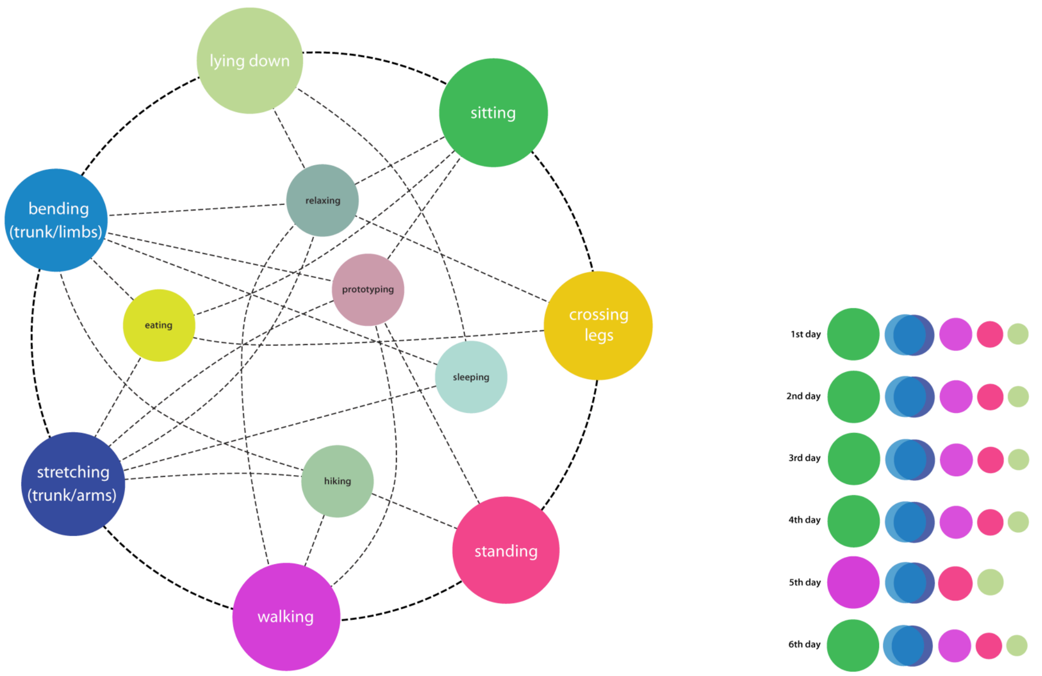
As indicated by her log, the movements that participant 01 executed most in seven days – i.e., forty-three hours –, were **(1st)** sitting, **(2nd)** stretching and bending, **(3rd)** standing, **(4th)** walking, **(5th)** lying down, and **(6th)** walking up/down stairs [*Figure 55, right*].



[*Figure 55*]
Participant 01: Overall Movements/Activities Relationship And Daily Ranking Of Movements

According to participant 02, a Fashion Design student aged 20, integrating round one, **(i)** sitting, bending, stretching, standing and walking are connected with *prototyping* – i.e., cutting, sewing, and the like –, **(ii)** walking, standing, stretching and bending are connected with *hiking*, **(iii)** sitting, leg crossing, bending and stretching are connected with *eating*, **(iv)** sitting, bending, leg crossing and lying down are connected with *relaxing*, **(v)** lying down and stretching are connected with *sleeping* [*Figure 56, left*].

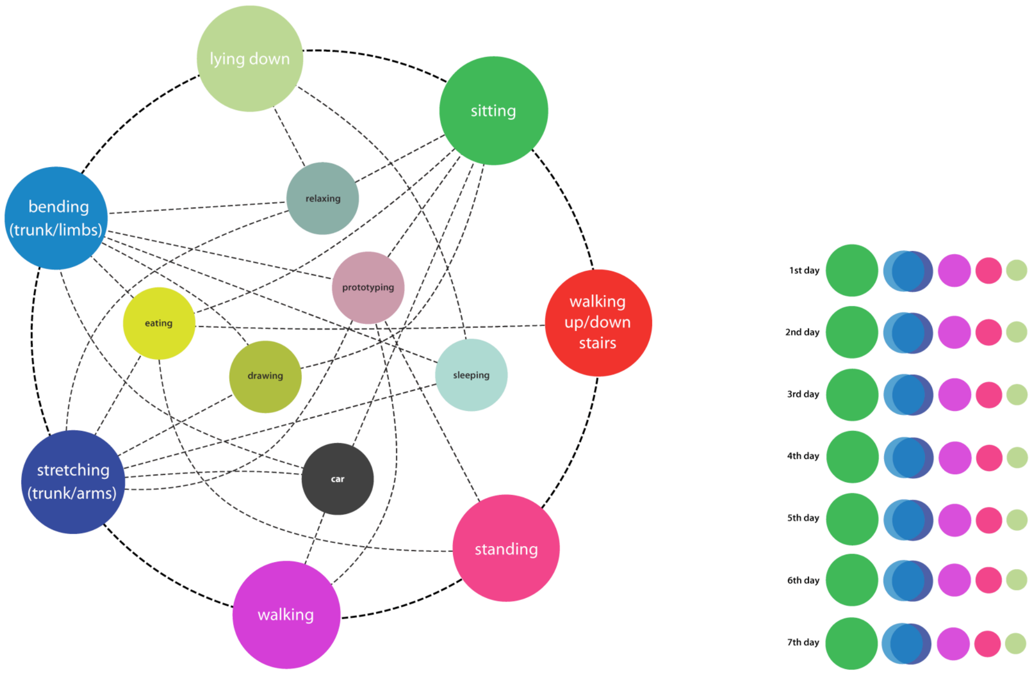
As indicated by her log, the movements that participant 02 executed most in six days – i.e., forty-eight hours –, were **(1st)** sitting, **(2nd)** stretching and bending, **(3rd)** walking, **(4th)** standing, and **(5th)** lying down [*Figure 56, right*].



[*Figure 56*]
Participant 02: Overall Movements/Activities Relationship And Daily Ranking Of Movements

According to participant 03, a Fashion Design student aged 24, integrating round one, **(i)** sitting, standing, walking, bending and stretching, are connected with *prototyping* – i.e., cutting, sewing, and the like –, **(ii)** sitting, stretching and bending are connected with *drawing*, **(iii)** sitting, walking, walking up/down stairs, bending and stretching are connected with *eating*, **(iv)** sitting, bending, stretching and lying down and are connected with *relaxing*, **(v)** lying down and stretching are connected with *sleeping*, **(vi)** sitting, bending, stretching and walking are connected with *commuting by car* [*Figure 57, left*].

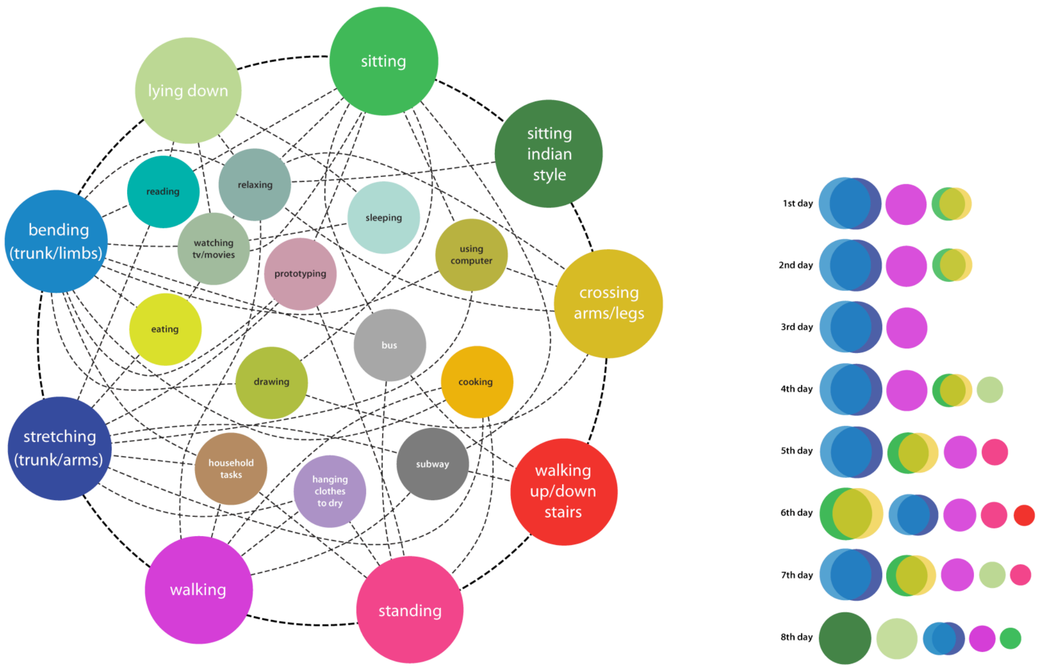
As indicated by her log, the movements that participant 03 executed most in seven days – i.e., fifty-two hours –, were **(1st)** sitting, **(2nd)** stretching and bending, **(3rd)** walking, **(4th)** standing, and **(5th)** lying down [*Figure 57, right*].



[*Figure 57*]
Participant 03: Overall Movements/Activities Relationship And Daily Ranking Of Movements

According to participant 04, a Fashion Design student aged 19, integrating round one, **(i)** sitting, leg crossing, bending and stretching are connected with *drawing*, **(ii)** sitting, leg crossing, bending and stretching are connected with *computer use*, **(iii)** sitting, standing and bending are connected with *prototyping* – i.e., cutting, sewing, and the like –, **(iv)** standing, walking, bending and stretching are connected with *cooking*, **(v)** sitting, leg crossing, bending and stretching are connected with *eating*, **(vi)** standing, walking, bending and stretching are connected with *household tasks*, **(vii)** standing, walking and stretching are connected with *hanging clothes to dry*, **(viii)** sitting, leg crossing, lying down, bending and stretching are connected with *watching TV*, **(xi)** sitting, leg crossing, lying down, bending and stretching are connected with *reading*, **(x)** walking, standing, sitting, walking up/down stairs, bending, stretching and are connected with *commuting by subway and bus*, **(xi)** lying down, sitting, leg crossing, walking, bending and stretching are connected with *relaxing*, **(xii)** lying down and bending are connected with *sleeping* [*Figure 58, left*].

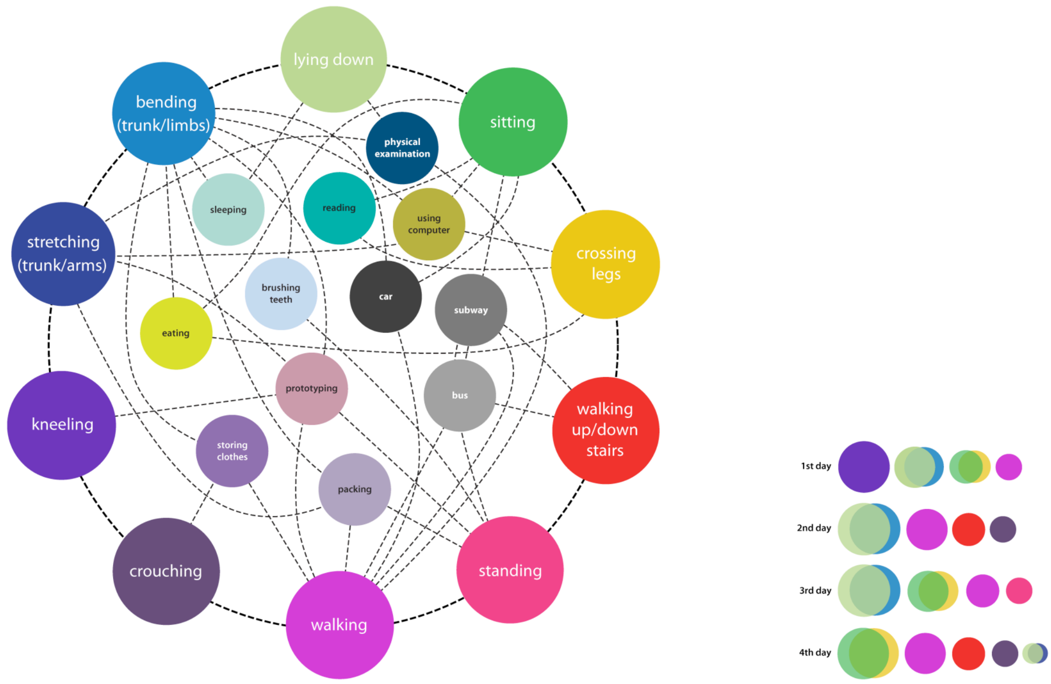
As indicated by her log, the movements that participant 04 executed most in eight days – i.e., forty hours –, were **(1st)** stretching and bending, **(2nd)** walking, **(3rd)** sitting and leg crossing, as one, **(4th)** lying down, **(5th)** standing plus sitting Indian-style, and **(6th)** walking up/down stairs [*Figure 58, right*].



[*Figure 58*]
Participant 04: Overall Movements/Activities Relationship And Daily Ranking Of Movements

According to participant 05, a Fashion Design student aged 23, integrating round one, **(i)** lying down, curling up and bending are connected with *sleeping*, **(ii)** sitting and leg crossing are connected with *eating*, **(iii)** kneeling down, bending, stretching and walking are connected with *prototyping* – i.e., cutting, sewing, and the like –, **(iv)** sitting and leg crossing are connected with *computer use*, **(v)** sitting and leg crossing are connected with *reading*, **(vi)** walking, standing, stretching and bending are connected with *packing*, **(vii)** walking, crouching and bending are connected with *storing clothes*, **(viii)** walking, standing, sitting, walking up/down stairs, bending and stretching are connected with *commuting by car, bus and subway*, **(ix)** standing and bending are connected with *brushing teeth*, **(x)** lying down, stretching and walking are connected with *physical examination* [*Figure 59, left*].

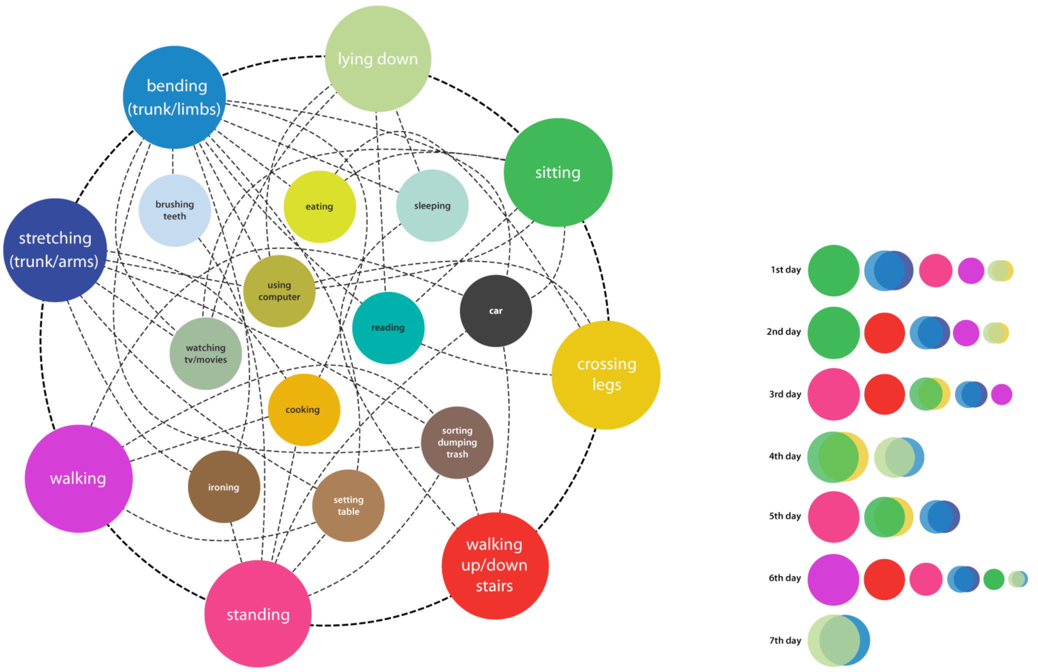
As indicated by her log, the movements that participant 05 executed most in five days – i.e., forty-three hours –, were **(1st)** lying down, curling up and bending, as one, **(2nd)** walking, **(3rd)** sitting and leg crossing, as one, **(4th)** kneeling, **(5th)** crouching, and **(6th)** standing [*Figure 59, right*].



[*Figure 59*]
Participant 05: Overall Movements/Activities Relationship And Daily Ranking Of Movements

According to participant 06, a Fashion Design student aged 23, integrating round one, **(i)** sitting, leg crossing, lying down, stretching up and bending are connected with *computer use*, **(ii)** sitting, leg crossing, bending and lying down are connected with *reading*, **(iii)** standing down, bending, stretching and walking are connected with *cooking*, **(iv)** sitting, leg crossing and bending are connected with *eating*, **(v)** standing, stretching and bending are connected with *ironing*, **(vi)** walking, standing, stretching and bending are connected with *setting the table*, **(vii)** standing, stretching, bending, walking and walking up/down stairs are connected with *sorting/dumping trash*, **(viii)** sitting, bending, stretching, walking and walking up/down stairs are connected with *commuting by car*, **(ix)** standing and bending are connected with *brushing teeth*, **(x)** sitting, bending and lying down are connected with *watching TV*, **(xi)** lying down, stretching and bending are connected with *sleeping* [*Figure 60, left*].

As indicated by her log, the movements that participant 06 executed most in seven days – i.e., forty hours –, were **(1st)** standing, **(2nd)** stretching and bending, **(3rd)** sitting and leg crossing, as one, plus walking up/down stairs, **(4th)** sitting, **(5th)** walking, **(6th)** lying down and bending, as one, and **(7th)** lying down and leg crossing, as one [*Figure 60, right*].

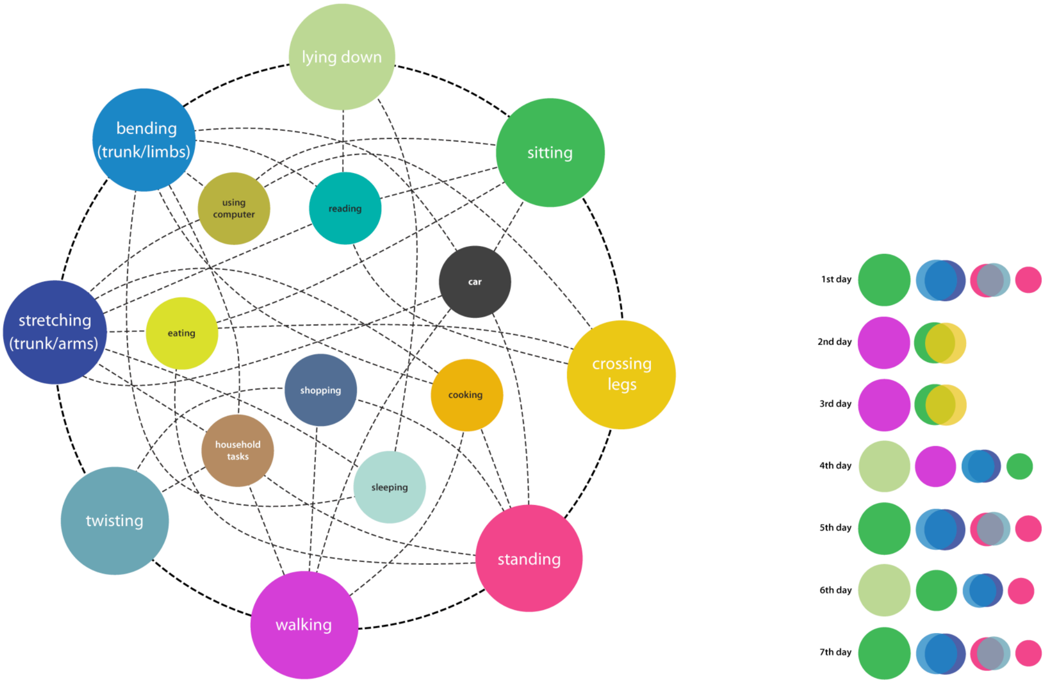


[*Figure 60*]
Participant 06: Overall Movements/Activities Relationship And Daily Ranking Of Movements

According to participant 07, a Fashion Design student aged 21, integrating round one, **(i)** sitting, leg crossing, stretching and bending are connected with *computer use*, **(ii)** sitting, leg crossing, lying down, stretching and bending are connected with *reading*, **(iii)** walking, standing and twisting are connected with *shopping*, **(iv)** sitting, stretching, bending, walking and standing are connected with *commuting by car*, **(v)** standing, walking, stretching and bending are connected with *cooking*, **(vi)** sitting, leg crossing, standing and stretching are connected with *eating*, **(vii)** standing, walking, twisting, stretching and bending are connected with *household tasks*, **(viii)** lying down, stretching and bending are connected with *sleeping* [*Figure 61, left*].

As indicated by her log, the movements that participant 07 executed most in seven days – i.e., fifty-eight hours –, were **(1st)** sitting, **(2nd)** stretching and bending,

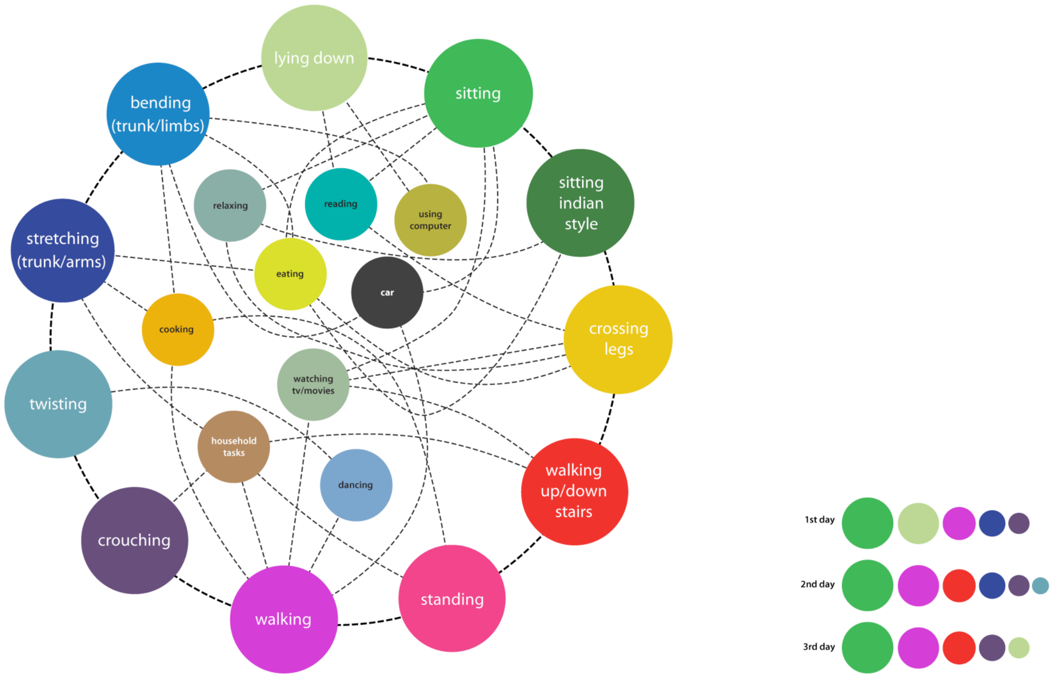
(3rd) walking, **(4th)** lying down, **(5th)** sitting and leg crossing, as one, and **(6th)** standing [*Figure 61, right*].



[*Figure 61*]
Participant 07: Overall Movements/Activities Relationship And Daily Ranking Of Movements

According to participant 08, a Fashion Design student aged 20, integrating round two, **(i)** sitting and leg crossing are connected with *relaxing*, **(ii)** sitting, sitting Indian-style and leg crossing are connected with *reading*, **(iii)** lying down is connected with *computer use*, **(iv)** sitting, leg crossing, walking and walking up/down stairs are connected with *going to a movie theater*, **(v)** standing, walking, bending and stretching are connected with *cooking*, **(vi)** standing, walking, walking up/down stairs and crouching are connected with *household tasks*, **(vii)** walking and twisting are connected with *dancing*, **(viii)** walking, standing, sitting, walking up/down stairs, bending and stretching are connected with *commuting by car* [*Figure 62, left*].

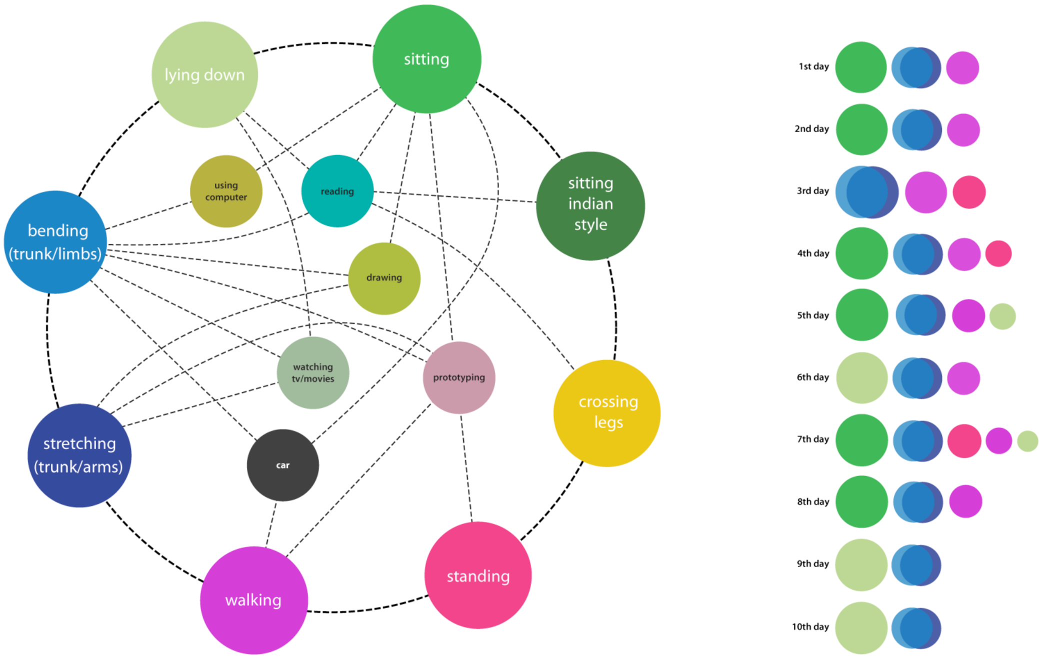
As indicated by her log, the movements that participant 08 executed most in three days – i.e., forty-two hours and thirty minutes –, were **(1st)** sitting, **(2nd)** walking, **(3rd)** walking up/down stairs, **(4th)** lying down, **(5th)** stretching plus crouching, and **(6th)** twisting [*Figure 62, right*].



[*Figure 62*]
Participant 08: Overall Movements/Activities Relationship And Daily Ranking Of Movements

According to participant 09, a Fashion Design student aged 21, integrating round two, **(i)** sitting, standing, stretching, bending and walking are connected with *prototyping* – i.e., cutting, sewing, and the like –, **(ii)** sitting, stretching and bending are connected with *drawing*, **(iii)** sitting and bending are connected with *computer use*, **(iv)** sitting, sitting Indian-style, leg crossing, lying down and bending are connected with *reading*, **(v)** lying down and bending are connected with *watching TV*, **(vi)** sitting, stretching, bending and standing are connected with *commuting by car* [*Figure 63, left*].

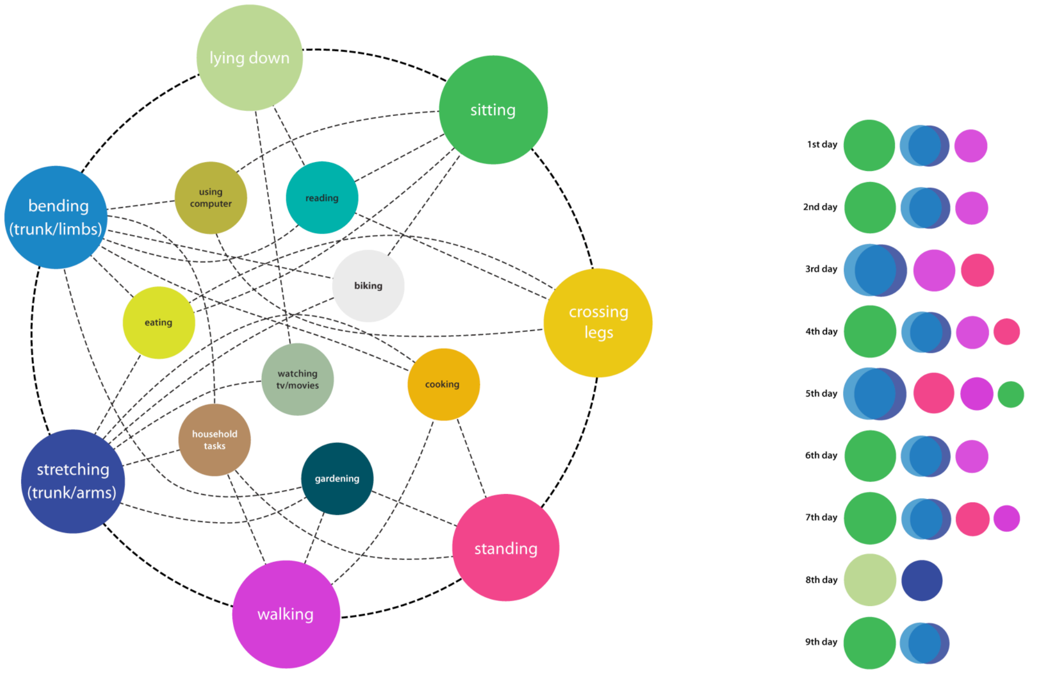
As indicated by her log, the movements that participant 09 executed most in ten days – i.e., forty hours –, were **(1st)** stretching and bending, **(2nd)** sitting, **(3rd)** walking, **(4th)** lying down, and **(5th)** standing [*Figure 63, right*].



[*Figure 63*]
Participant 09: Overall Movements/Activities Relationship And Daily Ranking Of Movements

According to participant 10, a Fashion Theory assistant professor aged 48, integrating round two, **(i)** sitting, leg crossing and bending are connected with *computer use*, **(ii)** sitting, leg crossing, bending and lying down are connected with *reading*, **(iii)** standing, walking, stretching and bending are connected with *cooking*, **(iv)** stretching, bending, walking and standing crossing are connected with *household tasks*, **(v)** sitting, leg crossing, stretching and bending are connected with *eating*, **(vi)** stretching, bending, standing and walking are connected with *gardening*, **(vii)** lying down and stretching are connected with *watching TV*, **(viii)** stretching, bending and sitting are connected with *commuting by bicycle* [*Figure 64, left*].

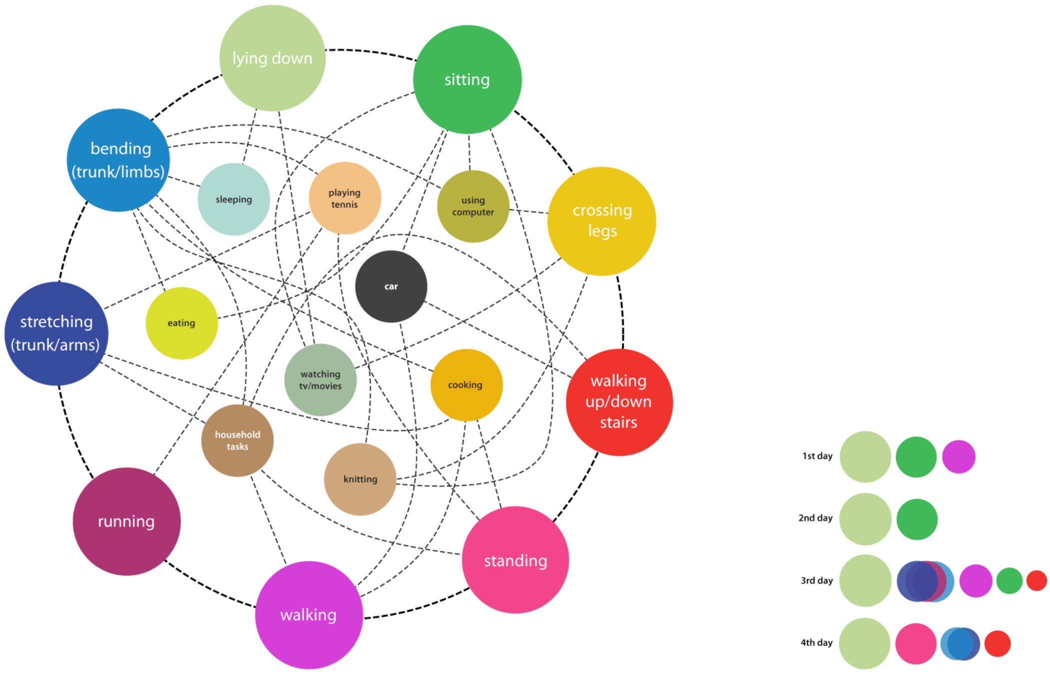
As indicated by her log, the movements that participant 10 executed most in nine days – i.e., thirty-eight hours –, were **(1st)** stretching and bending, **(2nd)** sitting, **(3rd)** walking, **(4th)** standing, and **(5th)** lying down [*Figure 64, right*].



[*Figure 64*]
Participant 10: Overall Movements/Activities Relationship And Daily Ranking Of Movements

According to participant 11, an architect aged 37, integrating round two, **(i)** sitting, leg crossing and bending are connected with *computer use*, **(ii)** standing, walking, stretching and bending are connected with *cooking*, **(iii)** walking, walking up/down stairs, standing, stretching and bending are connected with *household tasks*, **(iv)** sitting and bending are connected with *eating*, **(v)** lying down, sitting and leg crossing are connected with *watching TV*, **(vi)** running, standing, stretching and bending are connected with *playing tennis*, **(vii)** sitting, leg crossing and bending are connected with *knitting*, **(viii)** sitting, walking and walking up/down stairs are connected with *commuting by car*, **(ix)** lying down and bending are connected with *sleeping* [*Figure 65, left*].

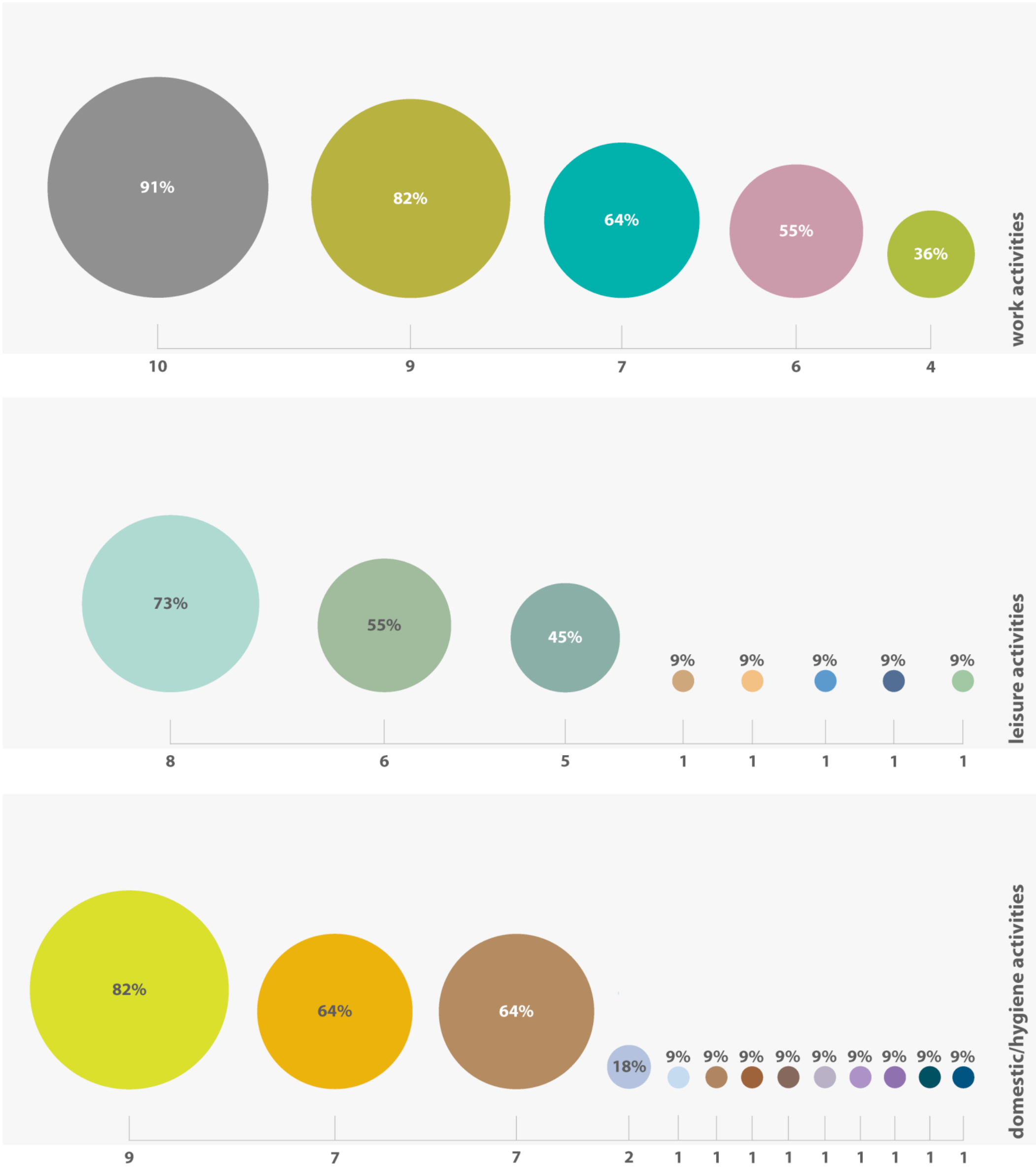
As indicated by her log, the movements that participant 11 executed most in four days – i.e., forty hours –, were **(1st)** lying down, **(2nd)** sitting, **(3rd)** walking, **(4th)** stretching, bending and running, as one, plus standing, and **(5th)** walking up/down stairs [*Figure 65, right*].



[*Figure 65*]
Participant 11: Overall Movements/Activities Relationship And Daily Ranking Of Movements

By looking at the diagrams just presented it is clear that some of the eleven participants described their routines more vividly than others. Noticeably some of them registered movements that had not been defined by them before – like leg crossing, crouching, kneeling and twisting –, possibly because they were unable to anticipate all the activities they would carry out while wearing the one-piece garments. It is also evident that some participants performed more activities than others – like knitting, gardening, shopping and hiking –, yet it is irrelevant to determine the reasons for this alleged disparity since the intention was they'd behave normally while wearing the one-piece garments.

Perhaps some participants are just more thorough when they record their daily experiences in writing than others. In fact, seven of them mentioned that they've performed household tasks – besides cooking, represented in a darker yellow –, but only **(1)** one participant specified that she ironed, set the table and sorted/dumped the trash – represented in three shades of brown respectively –, **(2)** a different one that she sorted clothes – represented in a darker shade of mauve –, and **(3)** another that she laundered/dried clothes – represented in a lighter shade of mauve – [*Figure 66, bottom strip*].

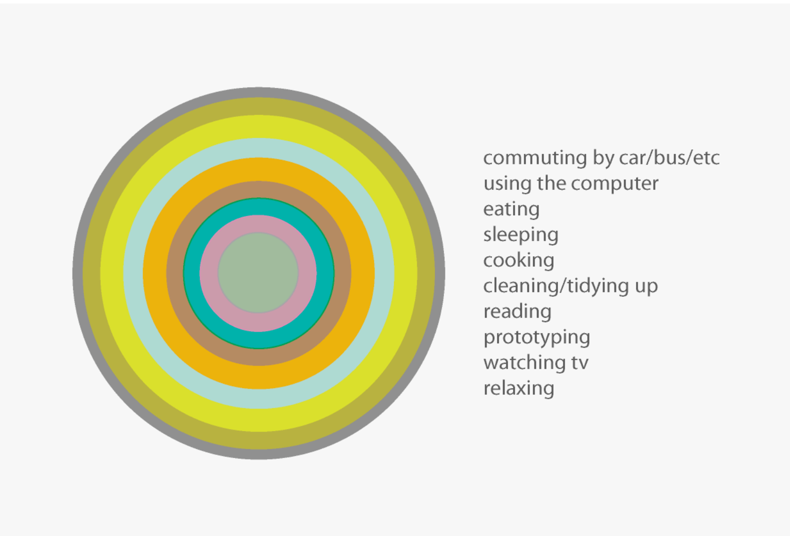


[Figure 66]
Categorization And Assessment Of Performed Activities

Gardening – represented in a greenish-blue color –, and grooming the hair – represented in the lighter blue – are other activities related to domesticity and personal hygiene that were only carried out by one participant, respectively *[Figure 66, bottom strip]*; similarly some leisure time activities were carried out only by one participant respectively, such as, shopping and dancing – represented in two shades of grayish-blue –, knitting and playing tennis– represented in a beige and flesh color –, and hiking – represented in a light veronese green – *[Figure 66, middle strip]*.

Within the two categories mentioned previously, six activities have been performed by several participants, namely, **(1)** sleeping, by eight, which amounts to 73% of them, **(2)** watching TV, by five, i.e., 55%, **(3)** relaxing by five, i.e., 45%, **(4)** eating, by nine, i.e., 82%, **(5)** cooking by seven, i.e., 64%, and **(6)** house cleaning, by seven, i.e., 64%. With reference to work activities [*Figure 66, top strip*] **(7)** nine participants, i.e., 82%, indicated using the computer, **(8)** seven, i.e., 64%, reading, **(9)** six, i.e., 55%, prototyping, **(10)** four, i.e., 36%, drawing, and **(11)** ten, i.e., 91%, driving and/or using public transportation.[169]

[*Figure 67*] represents the activities that five or more participants – i.e., equal or more than 50% of them – carried out during the process of self-modeling, sorted according to the percentages previously communicated.[170]



[*Figure 67*]
Sorting Of Foremost Activities

Surely more important to the way the fitted one-piece garments looked in the end than the performed activities – and the category they fit in – are the implicated movements. In fact, the change in shape of the first garments occurred as a direct result of the rotatory motions of joints described by the body – to say the least –, which comprise **(a)** the bending and stretching of a body segment, which

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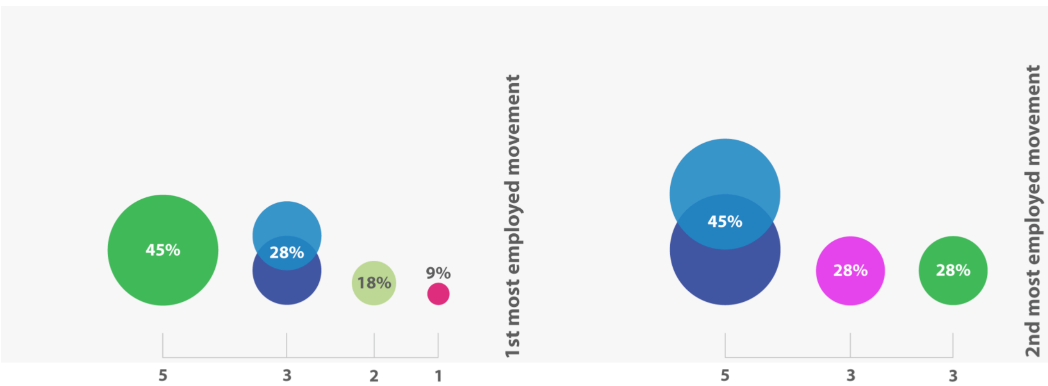
[169] Even though commuting was categorized as a work activity it could have been integrated into any other category, as clearly the participants also drive and/or use public transportation to go shopping, going out, *etc*.

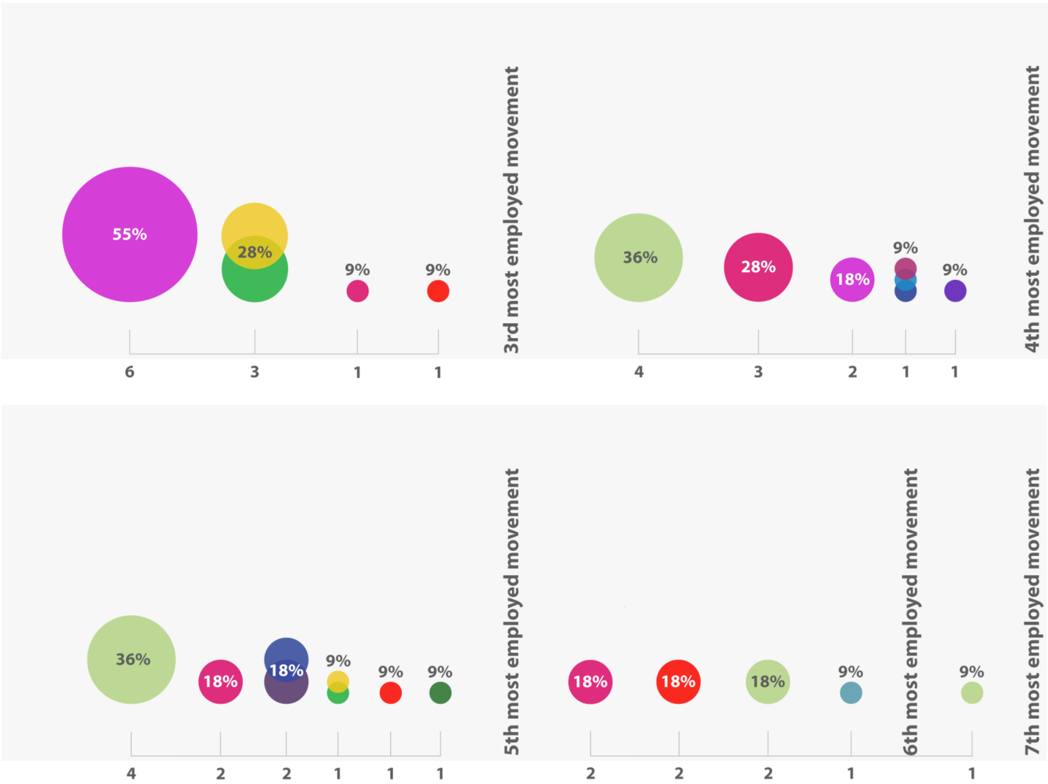
[170] In reality the circles that represent the foremost activities aren't arranged in the correct relationship of size since the intention was not to provide a quantitative account.

correspond to flexion and extension movements respectively, **(b)** "the movements of a body segment away from [and toward] the midline of the body or body part to which it is attached" (Kelley 1971: 74), or abduction and adduction movements respectively, and **(c)** the inward and outward rotations of a body segment, or pronation and supination movements respectively.

Manifestly the processes of **(i)** prototyping, an activity that, in the case of Fashion Design students, includes drawing and cutting patterns, spreading and cutting fabrics, sewing and pressing clothes, *etc*, **(ii)** using a computer, an activity that, in the case of Fashion Design students, teachers and architects, includes writing and/or drawing, reading and net surfing, or **(ii)** cooking, an activity that, whoever the person is, may include getting utensils from cupboards and ingredients from the refrigerator, peeling and chopping ingredients, stirring the contents in pots and pans, washing dishes, *etc* , – just to mention a few everyday activities – involve the combined action of many body joints and, therefore, a variety of different movements.

Therefore, to present an overarching explanatory scheme of the mobile body – i.e., to include motion as part of the deformation pattern –, it was also considered necessary to sort the movements that the participants as a whole have most employed, an assessment that was noticeably harder than arranging the performed activities in a set order. Through analyzing the eleven individual diagrams, specifically the plots placed on the right side, it was possible to add together the scaling of movements supplied by each participant [*Figure 68*].





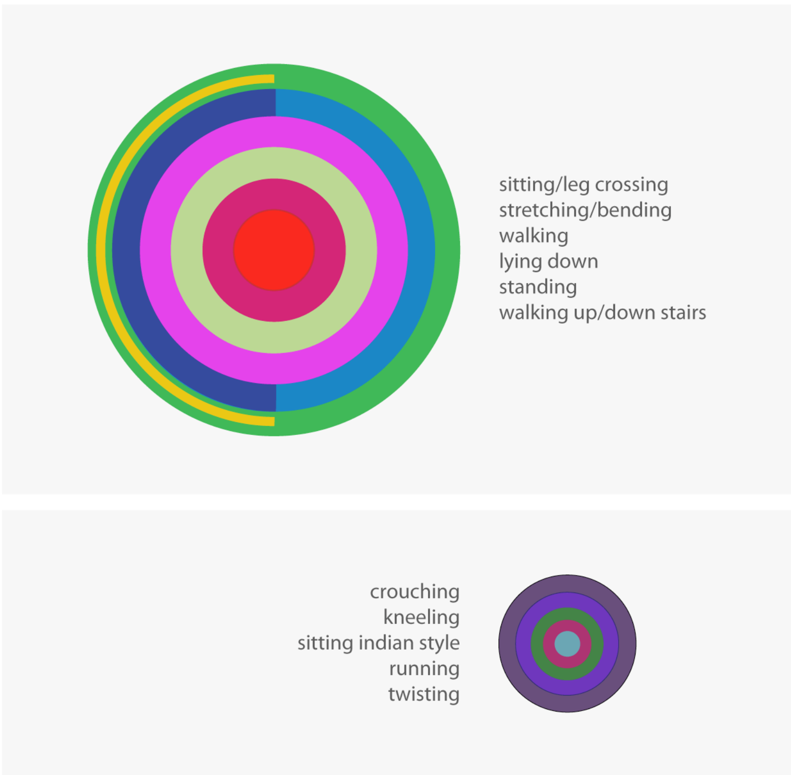
[Figure 68]
Assessment Of Employed Movements

Arranged according to their frequency, the first most employed movements were **(1.1)** sitting, adopted by five participants, i.e., 45% of them, **(1.2)** stretching and bending, by three, i.e., 28%, **(1.3)** lying down, by two, i.e., 18%, and **(1.4)** standing, by one, i.e., 9% [*Figure 68, top left*]. The second most employed movements were **(2.1)** stretching and bending, by five, i.e., 45%, **(2.2)** walking, by three, i.e., 28%, and **(2.3)** sitting, also by three, i.e., 28% [*Figure 68, top right*].

The third most employed movements were **(3.1)** walking, adopted by six participants, i.e., 55% of them, **(3.2)** sitting with one leg crossed, by three, i.e., 28%, and **(3.3)** standing, together with **(3.4)** walking up/down stairs, by one, i.e., 9%, respectively [*Figure 68, middle left*]. The fourth most employed movements were **(4.1)** lying down, adopted by four, i.e., 36%, **(4.2)** standing, by three, i.e., 28%, and **(4.3)** walking, by two, i.e., 18%, and **(4.4)** stretching/bending/running, along with **(4.5)** kneeling, by one, i.e., 9%, respectively [*Figure 68, middle right*].

The fifth most employed movements were **(5.1)** lying down, adopted by four participants, i.e., 36% of them, **(5.2)** standing, along with **(5.3)** crouching/stretching, by two, i.e., 18%, respectively, and **(5.4)** sitting with one leg crossed, plus **(5.5)** walking up/down stairs, and **(5.5)** sitting Indian-style, by one, i.e., 9%, respectively [*Figure 68, bottom left*]. Regarding the sixth and seventh ranked movements, **(6.1)** standing, along with **(6.2)** walking up/down stairs, and **(6.3)** lying down, were adopted by two participants, i.e., 18% of them, respectively, **(6.4)** twisting, by one, i.e., 18%, respectively, and **(7)** lying down with one leg crossed, by one i.e., 9%, [*Figure 68, bottom right*].

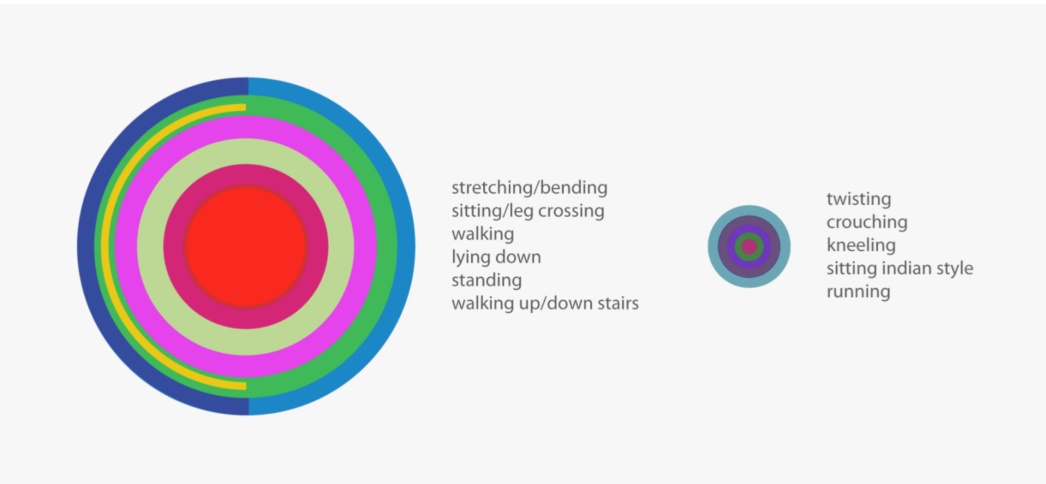
By adding together the relative percentages of movements obtained from the self-modeling logs, it was estimated that the participants, considered as a whole, **(1)** spent most of the time sitting – sometimes cross-legged –, **(2)** a substantial amount of time stretching and/or bending the trunk and limbs, **(3)** a large amount of time walking, **(4)** a reasonable amount of time lying down, **(5)** some time standing, and **(6)** a relatively small amount of time walking up/down stairs [*Figure 69, top strip*].



[*Figure 69*]
Sorting Of Foremost Movements

Although the time devoted to movements like **(i)** crouching, **(ii)** kneeling, **(iii)** sitting Indian-style, **(iv)** running, and **(v)** twisting [*Figure 69, bottom strip*] throughout the process of self-modeling was very small – not counting the fact that only one or two participants reported having employed them [*Figure 63*] –, they must be integrated into an overarching account of the mobile body, as they are not remarkable in terms of mechanical, motor, capabilities.[171]

Actually, the account would be more truthful if the circle that represents stretching and bending enfolded completely all the other movements [*Figure 70*] since these two motions are involved in every movement employed by the body day after day. Admittedly, when walking, walking up/down steps, running, *etc*, the ankles, knees, hips, elbows, *etc*, alternately flex and extend repeatedly; when sitting, standing up, crossing a leg, kneeling, crouching, *etc*, the knees, hips, trunks, shoulders, *etc*, also flex and/or extend; when lying down, the trunks, hips, knees, elbows, shoulders, ankles, *etc*, flex and extend every so often. On the other hand, twisting should be valued highly since the body definitely rotates when looking over the shoulders, *etc*.



[*Figure 70*]
Alternative Sorting Of Foremost Movements

Still, the written accounts of the participants are amply reliable, considering that the task of remembering, discriminating, naming and ranking all the movements they've employed was indeed a very strange and thorny one to perform.

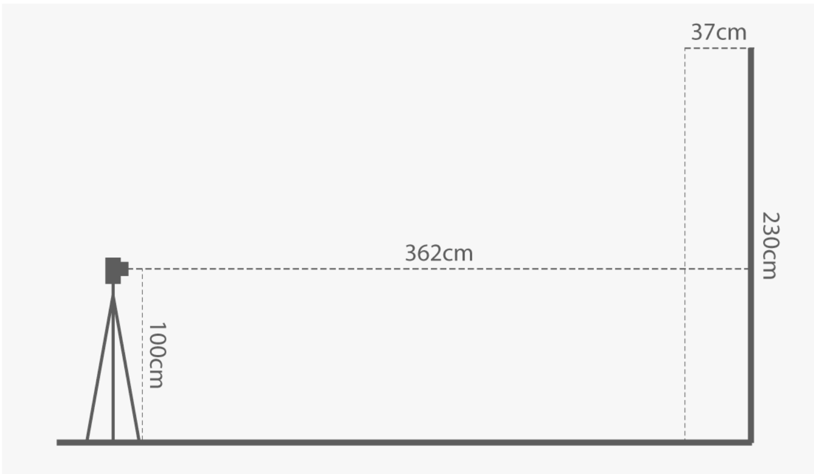
[171] Though the circles that represent the foremost movements are arranged in the order communicated by the participants, they aren't in the correct relationship of size since the intention was not to provide a quantitative account.

The Compound Portrait

[*In Search Of A Deformation Pattern*]

When the process of self-modeling was over, participants and self-portraits were photographed in a studio – the former, being images of the static body, are called plain-portraits. The set up included a digital camera, two 150w halogen projectors and a neutral backdrop [*Figure 71*].

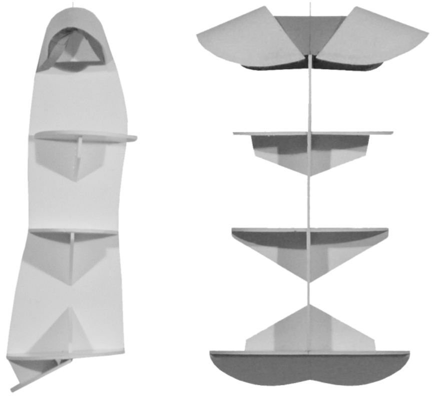
Adhesive tape was placed on the floor to indicate the precise positions of the equipment, participants and self-portraits, throughout the various photographic sessions.



[*Figure 71*]
Set Up For Photographic Capture Of The Plain- And Self-Portraits

During these sessions each participant wore beige leotards with long sleeves; having been told to stand naturally, each of them was captured from four views, i.e., back, lateral right, front, and lateral left, each photo taken at the participants' midpoint.

The self-portraits were placed on a hanger created for the purpose [*Figure 72*] – not to mold the one-piece garments into a different volumetric shape than that developed via self-modeling, but to let them drape freely – and were also photographed from the back, lateral right, front, and lateral left views.



[*Figure 72*]
Custom-Made Hanger For Self-Portraits' Capture: Lateral Right And Front Views, photos by Francisca Manuel

The objective of collecting four views was to analyze the similarities and differences between **(1)** the four silhouettes of the plain-portrait against the four silhouettes of the self-portrait respecting each participant, **(2)** the forty-four silhouettes of the plain-portraits respecting the eleven participants among themselves, and **(3)** the forty-four silhouettes of the self-portraits respecting the eleven participants among themselves. The aim was, thus, to discover if there was a relationship of cause and effect, i.e., a deformation pattern that could be used in the lineament of the mobile body.

Actually by adapting the approach of visual somatometry the intention was not "to 'transplant' silhouette curves of the [body] directly to the [...] pattern" (Gazzuolo *et al.*: 162) – as attempted by some researchers in the 1960s, 1970s and 1980s – but to transfer the contour lines of the self-portraits directly to a compound portrait, and subsequently a tangible mannequin, both standing for the mobile body.

To that purpose, the resulting eighty-eight photos were handled individually using the Adobe Illustrator graphic design software:

(a) A 5x5cm grid was superimposed over the static bodies and the deformed one-piece garments.

(b) A black line was drawn around the outside edges and on the bust, waist, hip, knee, armhole and elbow lines of the static bodies and the deformed one-piece garments.

(c) A blue line was placed on the center back, center front of the static bodies and the deformed one-piece garments as well as on the back/front boundaries of the deformed one-piece garments.

(d) An orange vertical line was drawn along the static bodies and the deformed one-piece garments from the center of the gluteal and pubic regions, and the outer end of the acromion – showing where the sagital and coronal planes would slice through the body.

(e) The angle measurements of the resulting outer shapes and front/back boundaries were measured, line segment by line segment.

Actually the obtained data is relatively accurate because the Adobe Illustrator measuring tool was used. But free from error or not, the assessment of the traced silhouette curves supported the interpretation of the mobile body by giving it consistency.

Throughout this section only the rounded up 'ideal' degrees for each body segment presented in the Plain- and Self-Portraits: Individual Data Tables,[172] respectively are imparted, as it simplifies the description of the portraits' contours and their correlation. Representing the static and mobile bodies if they were symmetrical, the 'ideal' degrees were calculated by adding or subtracting the symmetry deviation values from the average silhouette angles – both indicated in the referred tables. The idea to communicate the information of the right side of the body agrees with pattern design's tendency to represent this side, as the emergence of ready-made and mass-produced clothing required thinking of the body as a symmetrical entity.

Accordingly, the 'ideal' angle measurements of **(1)** the trunk, divided into three parts, **(2)** the arm, divided into two parts, and **(3)** the leg, divided into three or five parts – marked on the back, front and lateral views of the plain-portraits (designated PP in the tables) and the photographed self-portraits (designated SP in the tables), including the difference between them –, plus the angle measurements of **(4)** the front/back boundary – marked on the lateral views of the self-portrait –,

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[172] See Appendix Four and Appendix Five.

are presented in a condensed format for all the participants that succeeded doing their visual image.

Respecting participant 01 – a representative of Euro size 36 by virtue of measuring 86cm around the bust, 66cm around the bust waist, 92cm around the bust hip, and 158cm in height –, the 'ideal' angle measurements for the right side of her body are:

Back View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	161º	139º	- 22º
Acromium/Elbow	105º	106º	+ 1º
Elbow/Wrist	92º	96º	+ 4º
Acromium/Bust	82º	85º	+ 3º
Bust/Waist	85º	78º	- 7º
Waist/Hip	105º	101º	- 4º
Hip/Knee	96º	101º	+ 5º
(Inner and Outer Sides)	88º	92º	+ 6º
Knee/Ankle	92º	96º	+ 4º
(Inner and Outer Sides)	87º	95º	+ 8º

Front View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	24º	41º	+ 17º
Acromium/Elbow	81º	76º	- 5º
Elbow/Wrist	88º	81º	- 7º
Acromium/Bust	105º	96º	- 9º
Bust/Waist	92º	101º	+ 9º
Waist/Hip	75º	79º	+ 4º
Hip/Knee	84º	75º	- 9º
(Inner and Outer Sides)	95º	88º	- 7º
Knee/Ankle	87º	85º	- 2º
(Inner and Outer Sides)	93º	87º	- 6º

Back Outline (Length Measurements)	**PP**	**SP**	
7th Cervical/Bust	75º	76º	+ 1º
Bust/Waist	104º	83º	- 21º
Waist/Hip	70º	84º	+ 14º
Hip/Knee	97º	101º	+ 4º
Knee/Ankle	92º	86º	- 8º
Acromium/Elbow	94º	95º	+ 1º
Elbow/Wrist	101º	98º	- 3º

Front Outline (Length Measurements)	**PP**	**SP**	
Suprasternale Notch/Apex	112º	105º	- 7º
Apex/Waist	84º	86º	+ 2º
Waist/Hip	88º	89º	+ 1º
Hip/Knee	82º	88º	+ 6º
Knee/Ankle	87º	82º	- 5º

Lateral View (Depth Measurements)	**PP**	**SP**	
(Apex) Bust	176º	178º	+ 2º
Elbow	172º	183º	+ 11º
CF Waist/CB Waist	180º	181º	+ 1º
Hip	179º	179º	0º
Knee	177º	175º	- 2º

Back/Front Boundary (Length Measurements)	**SP**
Trapezius Point /Acromium	90º
Acromium/Elbow	92º
Elbow/Wrist	98º
Waist/Hip	*86º
Hip/Knee	89º
Knee/Ankle	84º

[Figure 73]
Participant 01: Condensed 'Ideal' Visual Data

The back, lateral right, front and lateral left views of the plain-portrait and self-portrait of participant 01 *[Figure 74 and Plates Six 1-8]* from which the visual data was assessed are respectively:

[*Figure 74*]
Participant 01: Plain-Portrait And Self-Portrait, photos by Francisca Manuel with superimposed diagrams by the researcher

Although participant 01 declared that she doesn't suffer from any physical condition aside from allergic rhinitis,[173] the plain-portraist – as well as the correlative Individual Data Tables – clearly show that, when standing, she tends **(i)** to place her weight on the left, causing **(ii)** the right arm to be positioned further back than the left arm, and **(iii)** the right leg/foot to be positioned further back than the left leg/foot [*Figure 74 top and Plates Six 1-4*].

The same traits became more strongly imprinted on her self-portrait, as the corresponding four views – and the correlative Individual Data Tables – plainly display [*Figure 74 bottom and Plates Six 5-8*].

Respecting participant 02 – a representative of Euro size 36 by virtue of measuring 85cm around the bust, 65cm around the waist, 91cm around the hip,

[173] Before engaging in self-modeling all the participants were required to fill a short biographical questionnaire, which included examples of disorders they might suffer from like diabetes, asthma and scoliosis. The point of having this kind of information is related to the fact that some conditions influence the way people move – and therefore the look of the self-portraits – as well as their tactile sense – and therefore the way they perceive garments during wear.

and 159cm in height –, the condensed ‘ideal’ angle measurements for the right side of her body are:

Back View (Length Measurements)	PP	SP	
Trapezius Point/Acromium	156°	148°	- 8°
Acromium/Elbow	104°	109°	+ 5°
Elbow/Wrist	88°	98°	+ 10°
Acromium/Bust	80°	85°	+ 5°
Bust/Waist	79°	76°	- 3°
Waist/Hip	107°	101°	- 6°
Hip/Knee	99°	99°	0°
(Inner and Outer Sides)	90°	89°	- 1°
Knee/Ankle	93°	88°	- 5°
(Inner and Outer Sides)	85°	89°	+ 3°

Front View (Length Measurements)	PP	SP	
Trapezius Point/Acromium	25°	35°	+ 10°
Acromium/Elbow	76°	70°	- 6°
Elbow/Wrist	91°	82°	- 9°
Acromium/Bust	98°	94°	- 4°
Bust/Waist	94°	102°	+ 8°
Waist/Hip	73°	80°	+ 7°
Hip/Knee	82°	80°	- 2°
(Inner and Outer Sides)	91°	92°	+ 1°
Knee/Ankle	87°	92°	+ 5°
(Inner and Outer Sides)	94°	88°	- 6°

Back Outline (Length Measurements)	PP	SP	
7th Cervical/Bust	92°	79°	- 13°
Bust/Waist	118°	84°	- 34°
Waist/Hip	70°	82°	+ 12°
Hip/Knee	94°	98°	+ 4°
Knee/Ankle	91°	87°	- 4°
Acromium/Elbow	102°	95°	- 7°
Elbow/Wrist	111°	112°	+ 1°

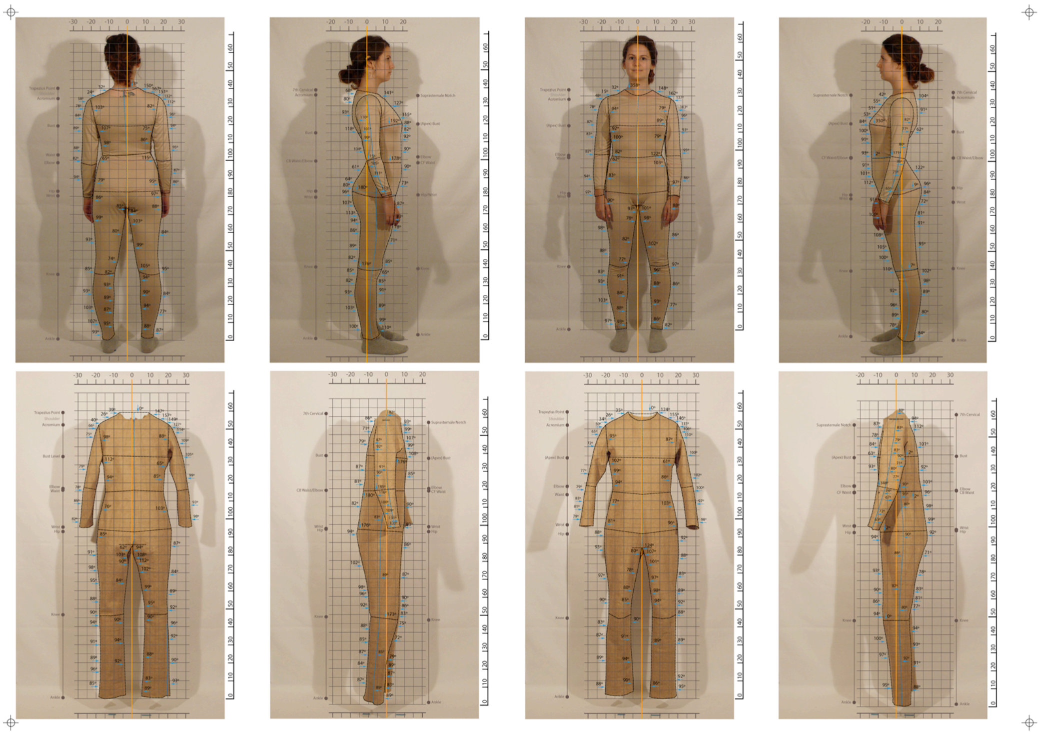
Front Outline (Length Measurements)	PP	SP	
Suprasternale Notch/Apex	129°	102°	- 27°
Apex/Waist	88°	86°	- 2°
Waist/Hip	82°	*87°	+ 5°
Hip/Knee	78°	88°	+ 10°
Knee/Ankle	89°	83°	- 5°

Lateral View (Depth Measurements)	PP	SP	
(Apex) Bust	176°	177°	+ 1°
Elbow	168°	189°	+ 21°
CF Waist/CB Waist	180°	179°	- 1°
Hip	179°	177°	- 2°
Knee	177°	177°	0°

Back/Front Boundary (Length Measurements)	SP
Trapezius Point /Acromium	87°
Acromium/Elbow	95°
Elbow/Wrist	104°
Waist/Hip	85°
Hip/Knee	92°
Knee/Ankle	88°

[Figure 75]
Participant 02: Condensed ‘Ideal’ Visual Data

The back, lateral right, front and lateral left views of the plain-portrait and self-portrait of participant 02 [*Figure 76 and Plates Seven 1-8*] from which the visual data was assessed are respectively:



[*Figure 76*]
Participant 02: Plain-Portrait And Self-Portrait, photos by Francisca Manuel with superimposed diagrams by the researcher

Having declared that she doesn't suffer from any physical condition, the plain-portraits of participant 02 – as well as the correlative Individual Data Tables – visibly show that **(i)** she has an unusual inward curving of the spine in the lower part of the back, and the **(ii)** left shoulder, **(iii)** left arm, and **(iv)** the waist's left lateral point, are lower than the counterpart segments and body landmark [*Figure 76 top and Plates Seven 1-4*].

If participant 02 has an undiagnosed lordosis is beside the point, as her self-portrait does not display any signs of this postural trait. What the four views of her self-portrait – and the correlative Individual Data Tables – display is that the right and left sides of the body got imprinted on the first garment differently, as **(v)** the right arm is farther back and more distant from the trunk than the left, and **(vi)** the right leg is positioned farther back and closer to the axis than the left [*Figure 76 bottom and Plates Seven 5-8*].

Respecting participant 03 – a representative of Euro size 38 by virtue of measuring 88cm around the bust, 70cm around the waist, 93cm around the hip, and 167cm in height –, the condensed 'ideal' angle measurements for the right side of the body are:

Back View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	149°	142°	- 5°
Acromium/Elbow	97°	105°	+ 8°
Elbow/Wrist	88°	88°	0°
Acromium/Bust	73°	80°	+ 7°
Bust/Waist	80°	79°	- 1°
Waist/Hip	102°	100°	- 2°
Hip/Knee	95°	100°	+ 5°
(Inner and Outer Sides)	86°	90°	+ 4°
Knee/Ankle	94°	90°	- 4°
(Inner and Outer Sides)	89°	88°	- 1°

Front View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	27°	37°	+ 10°
Acromium/Elbow	83°	74°	- 9°
Elbow/Wrist	90°	90°	0°
Acromium/Bust	113°	99°	- 14°
Bust/Waist	91°	99°	+ 8°
Waist/Hip	80°	80°	0°
Hip/Knee	85°	78°	- 7°
(Inner and Outer Sides)	94°	91°	- 3°
Knee/Ankle	87°	91°	+ 4°
(Inner and Outer Sides)	91°	92°	+ 1°

Back Outline (Length Measurements)	**PP**	**SP**	
7th Cervical/Bust	85°	78°	- 7°
Bust/Waist	100°	82°	- 18°
Waist/Hip	78°	80°	+ 2°
Hip/Knee	101°	106°	+ 5°
Knee/Ankle	89°	86°	- 3°
Acromium/Elbow	104°	96°	- 8°
Elbow/Wrist	112°	109°	- 3°

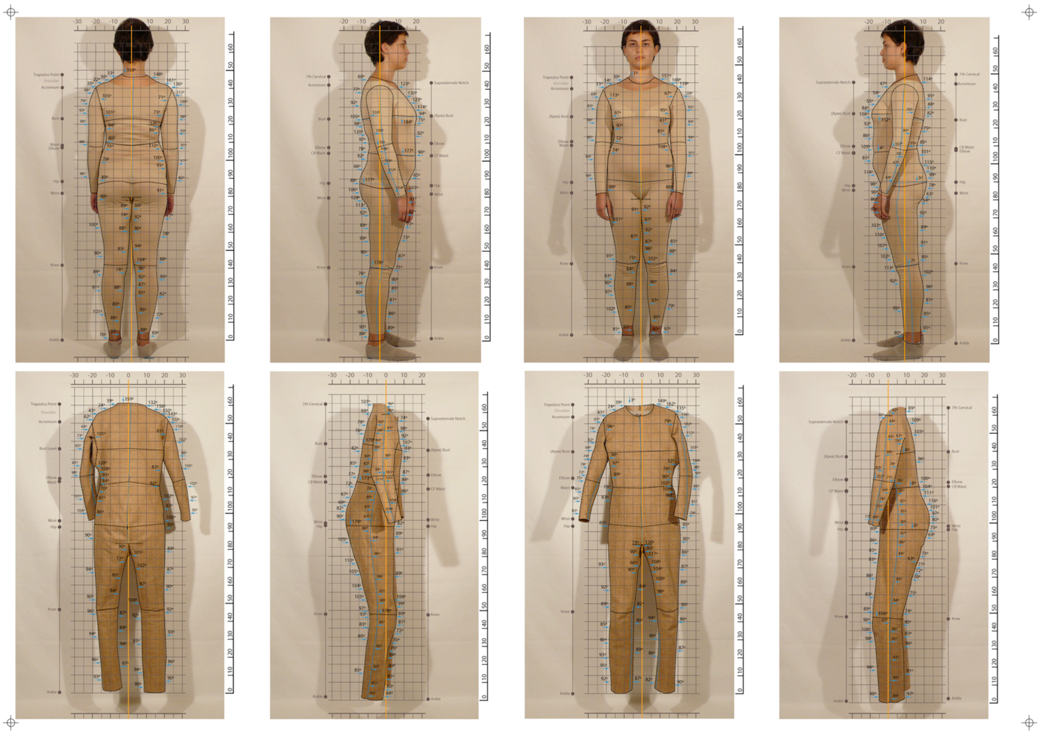
Front Outline (Length Measurements)	**PP**	**SP**	
Suprasternale Notch/Apex	119°	*93°	- 26°
Apex/Waist	85°	*87°	+ 2°
Waist/Hip	79°	*84°	+ 5°
Hip/Knee	80°	95°	+ 15°
Knee/Ankle	85°	83°	- 2°

Lateral View (Depth Measurements)	**PP**	**SP**	
(Apex) Bust	186°	172°	- 14°
Elbow	166°	189°	+ 23°
CF Waist/CB Waist	177°	174°	- 3°
Hip	177°	180°	+ 3°
Knee	176°	181°	+ 5°

Back/Front Boundary (Length Measurements)	**SP**
Trapezius Point /Acromium	106°
Acromium/Elbow	93°
Elbow/Wrist	103°
Waist/Hip	85°
Hip/Knee	95°
Knee/Ankle	87°

[Figure 77]
Participant 03: Condensed 'Ideal' Visual Data

The back, lateral right, front and lateral left views of the plain-portrait and self-portrait of participant 03 *[Figure 78 and Plates Eight 1-8]* from which the visual data was assessed are respectively:



[Figure 78]
Participant 03: Plain-Portrait And Self-Portrait, photos by Francisca Manuel with superimposed diagrams by the researcher

Having declared that she doesn't suffer from any physical condition, the plain-portraits of participant 03 – as well as the correlative Individual Data Tables – let see that **(i)** at times she leans a bit to the right, causing **(ii)** the right area between the bust and waist to appear somewhat crushed, and **(iii)** the right shoulder to slope downward *[Figure 78 top left and Plate Eight 1]*, though, even when she stands straight, **(iv)** the left forearm hangs slightly toward the front *[Figure 78 top and Plate Eight 1-4]*.

The four views of the participant 03's self-portrait – and the correlative Individual Data Tables – manifestly display that the left and right sides of the body got very differently imprinted on the one-piece garment, as the way **(v)** the axis tilts to the right, and **(vi)** the right shoulder slants down, **(vii)** the left arm curves more and hangs closer to the trunk than the right arm, and **(viii)** the left leg is more curved and further away from the axis than the right leg [*Figure 78 bottom and Plate Eight 5-8*].

Respecting participant 04 – a representative of Euro size 38 by virtue of measuring 90cm around the bust, 70cm around the waist, 92cm around the hip, and 159cm in height –, the condensed 'ideal' angle measurements for the right side of the body are:

Back View (Length Measurements)	PP	SP	
Trapezius Point/Acromium	161°	150°	- 11°
Acromium/Elbow	108°	110°	+ 2°
Elbow/Wrist	90°	93°	+ 3°
Acromium/Bust	81°	86°	+ 5°
Bust/Waist	85°	83°	- 2°
Waist/Hip	103°	100°	- 3°
Hip/Knee	96°	101°	+ 5°
(Inner and Outer Sides)	87°	90°	+ 3°
Knee/Ankle	97°	90°	- 7°
(Inner and Outer Sides)	89°	91°	+ 2°

Front View (Length Measurements)	PP	SP	
Trapezius Point/Acromium	18°	27°	+ 9°
Acromium/Elbow	72°	65°	- 7°
Elbow/Wrist	90°	85°	- 5°
Acromium/Bust	97°	96°	- 1°
Bust/Waist	93°	98°	+ 3°
Waist/Hip	80°	79°	- 1°
Hip/Knee	87°	83°	- 4°
(Inner and Outer Sides)	93°	91°	- 2°
Knee/Ankle	84°	90°	+ 6°
(Inner and Outer Sides)	89°	90°	+ 1°

Back Outline (Length Measurements)	PP	SP	
7th Cervical/Bust	78°	79°	+ 1°
Bust/Waist	*102°	85°	- 17°
Waist/Hip	72°	78°	+ 6°
Hip/Knee	97°	101°	+ 4°
Knee/Ankle	89°	85°	- 4°
Acromium/Elbow	96°	103°	+ 7°
Elbow/Wrist	107°	105°	- 2°

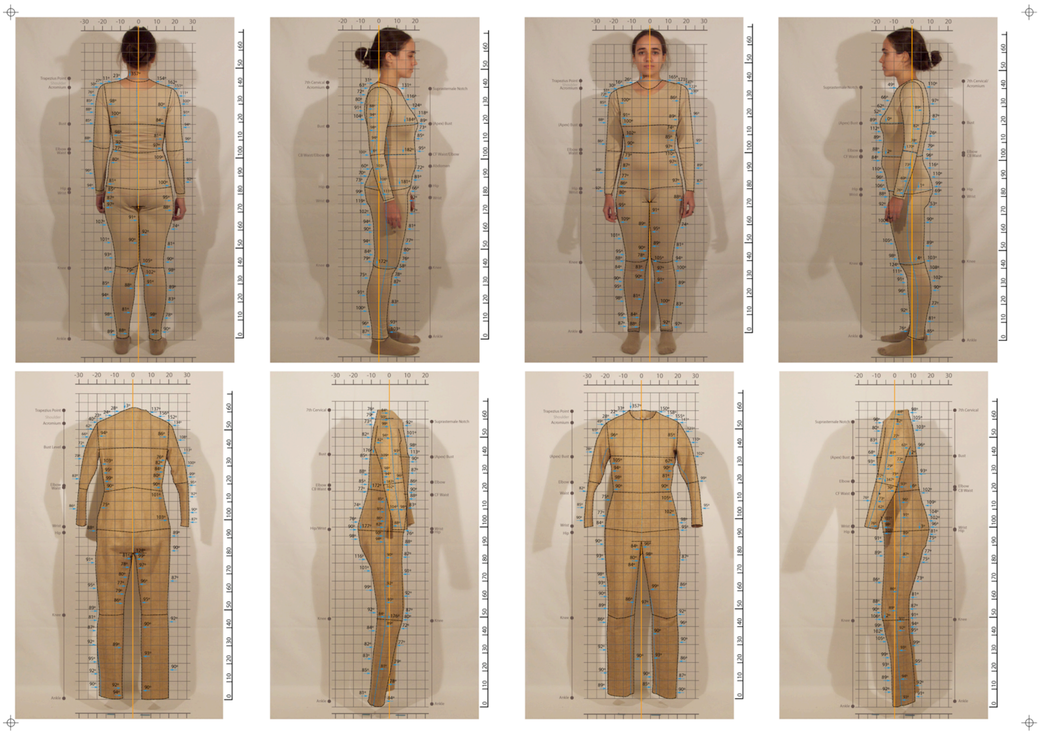
Front Outline (Length Measurements)	PP	SP	
Suprasternale Notch/Apex	119°	101°	- 18°
Apex/Waist	86°	88°	+ 2°
Waist/Hip	82°	82°	0°
Hip/Knee	80°	88°	+ 8°
Knee/Ankle	83°	81°	- 2°

Lateral View (Depth Measurements)	PP	SP	
(Apex) Bust	182°	177°	- 5°
Elbow	172°	190°	+ 12°
CF Waist/CB Waist	180°	173°	- 7°
Hip	180°	177°	- 3°
Knee	174°	177°	+ 3°

Back/Front Boundary (Length Measurements)	SP
Trapezius Point /Acromium	90°
Acromium/Elbow	98°
Elbow/Wrist	103°
Waist/Hip	87°
Hip/Knee	92°
Knee/Ankle	88°

[*Figure 79*]
Participant 04: Condensed 'Ideal' Visual Data

The back, lateral right, front and lateral left views of the plain-portrait and self-portrait of participant 04 [*Figure 80 and Plates Nine 1-8*] from which the visual data was assessed are respectively:



[*Figure 80*]
Participant 04: Plain-Portrait And Self-Portrait, photos by Francisca Manuel with superimposed diagrams by the researcher

Having declared that she doesn't suffer from any physical condition, the plain-portraits of participant 04 – as well as the correlative Individual Data Tables – clearly show that, when standing, **(i)** she places her weight on the right, causing **(ii)** the whole right shoulder to be positioned further down than the left shoulder, **(iii)** the right arm is positioned much further down than the left arm, and **(iv)** the right leg/foot to be positioned slightly further back than the left leg/foot [*Figure 80 top and Plates Nine 1-4*].

The same traits became more strongly imprinted on her self-portrait as the corresponding four views – and the correlative Individual Data Tables – plainly display [*Figure 80 bottom and Plates Nine 5-8*].

Respecting participant 05– a representative of Euro sizes 36 (top) and 38 (bottom) by virtue of measuring 85cm around the bust, 64cm around the waist, 96cm around the hip, and 163cm in height –, the condensed 'ideal' angle measurements for the right side of the body are:

Back View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	156°	145°	- 11°
Acromium/Elbow	103°	107°	+ 4°
Elbow/Wrist	90°	74°	- 16°
Acromium/Bust	80°	81°	+ 1°
Bust/Waist	84°	81°	- 3°
Waist/Hip	106°	100°	- 6°
Hip/Knee	96°	105°	+ 9°
(Inner and Outer Sides)	89°	91°	+ 2°
Knee/Ankle	93°	91°	- 2°
(Inner and Outer Sides)	88°	94°	+ 6°

Front View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	21°	32°	+ 11°
Acromium/Elbow	77°	70°	- 7°
Elbow/Wrist	87°	96°	+ 9°
Acromium/Bust	102°	97°	- 5°
Bust/Waist	94°	99°	+ 4°
Waist/Hip	76°	80°	+ 4°
Hip/Knee	97°	81°	- 16°
(Inner and Outer Sides)	94°	88°	- 6°
Knee/Ankle	86°	88°	+ 2°
(Inner and Outer Sides)	94°	88°	- 6°

Back Outline (Length Measurements)	**PP**	**SP**	
7th Cervical/Bust	78°	77°	- 1°
Bust/Waist	104°	80°	- 24°
Waist/Hip	71°	77°	+ 6°
Hip/Knee	96°	109°	+ 13°
Knee/Ankle	85°	87°	+ 2°
Acromium/Elbow	92°	99°	+ 7°
Elbow/Wrist	114°	116°	+ 2°

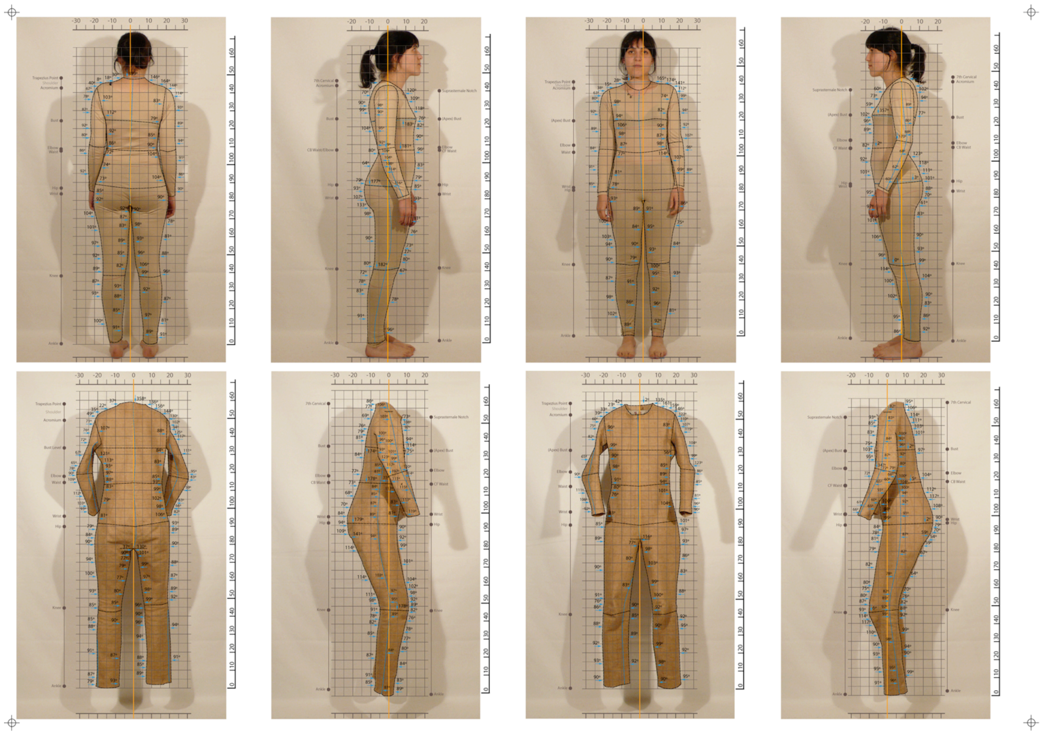
Front Outline (Length Measurements)	**PP**	**SP**	
Suprasternale Notch/Apex	116°	97°	- 19°
Apex/Waist	87°	81°	- 6°
Waist/Hip	87°	83°	- 4°
Hip/Knee	81°	97°	+ 16°
Knee/Ankle	81°	81°	0°

Lateral View (Depth Measurements)	**PP**	**SP**	
(Apex) Bust	183°	176°	- 7°
Elbow	170°	195°	+ 25
CF Waist/CB Waist	180°	177°	- 3°
Hip	177°	179°	+ 2°
Knee	181°	176°	- 5°

Back/Front Boundary (Length Measurements)	**SP**
Trapezius Point /Acromium	102°
Acromium/Elbow	99°
Elbow/Wrist	115°
Waist/Hip	85°
Hip/Knee	97°
Knee/Ankle	85°

[*Figure 81*]
Participant 05: Condensed 'Ideal' Visual Data

The back, lateral right, front and lateral left views of the plain-portrait and self-portrait of participant 05 [*Figure 82 and Plates Ten 1-8*] from which the visual data was assessed are respectively:



[*Figure 82*]
Participant 05: Plain-Portrait And Self-Portrait, photos by Francisca Manuel with superimposed diagrams by the researcher

Having declared that she doesn't suffer from any physical condition, the plain-portraits of participant 05– as well as the correlative Individual Data Tables – clearly show that, **(i)** due to the fact that she places her weight on the right, **(ii)** the right shoulder is positioned further down than the left shoulder, **(iii)** the right arm is positioned much further down than the left arm, **(iv)** the right leg is positioned further away from the axis than the left leg, **(v)** the left foot slants toward the inside, and **(vi)** the bust, waist and hip all tilt to the right [*Figure 82 top and Plates Ten 1-4*].

The four views of the participant 05's self-portrait – and the correlative Individual Data Tables – let see that **(vii)** the right arm hangs further down than the left arm, **(viii)** the right leg is positioned more toward the front than the left leg, and **(ix)** both right arm and leg are positioned closer to the trunk or axis than the counterpart segments [*Figure 82 bottom and Plates Ten 5-8*].

Respecting participant 06 – a representative of Euro sizes 36 (top) and 38 (bottom) by virtue of measuring 85cm around the bust, 66cm around the waist, 94cm around the hip, and 163cm in height –, the condensed ‘ideal’ angle measurements for the right side of the body are:

Back View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	154°	145°	- 9°
Acromium/Elbow	106°	106°	0°
Elbow/Wrist	90°	100°	+ 10°
Acromium/Bust	81°	79°	- 2°
Bust/Waist	87°	81°	- 6°
Waist/Hip	104°	100°	- 4°
Hip/Knee	95°	105°	+ 10°
(Inner and Outer Sides)	88°	89°	+ 1°
Knee/Ankle	98°	91°	- 7°
(Inner and Outer Sides)	90°	93°	+ 3°

Front View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	18°	33°	+ 15°
Acromium/Elbow	78°	72°	- 6°
Elbow/Wrist	89°	77°	- 12°
Acromium/Bust	110°	105°	- 5°
Bust/Waist	92°	100°	+ 8°
Waist/Hip	78°	79°	+ 1°
Hip/Knee	86°	80°	- 6°
(Inner and Outer Sides)	94°	91°	- 3°
Knee/Ankle	84°	91°	+ 7°
(Inner and Outer Sides)	92°	88°	- 4°

Back Outline (Length Measurements)	**PP**	**SP**	
7th Cervical/Bust	81°	82°	+ 1°
Bust/Waist	99°	82°	- 17°
Waist/Hip	79°	79°	0°
Hip/Knee	97°	103°	+ 6°
Knee/Ankle	91°	86°	- 5°
Acromium/Elbow	100°	92°	- 8°
Elbow/Wrist	110°	116°	+ 6°

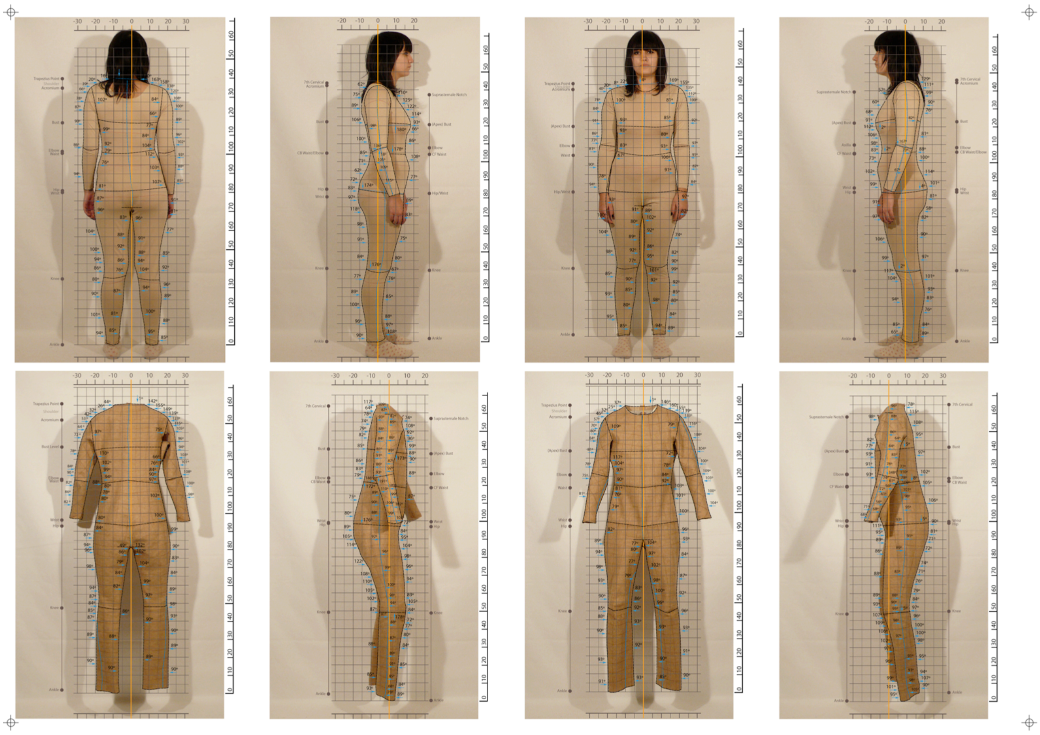
Front Outline (Length Measurements)	**PP**	**SP**	
Suprasternale Notch/Apex	112°	94°	- 18°
Apex/Waist	82°	89°	+ 7°
Waist/Hip	92°	79°	- 13°
Hip/Knee	79°	90°	+ 11°
Knee/Ankle	87°	81°	- 6°

Lateral View (Depth Measurements)	**PP**	**SP**	
(Apex) Bust	179°	174°	- 5°
Elbow	164°	192°	- 28°
CF Waist/CB Waist	178°	172°	- 6°
Hip	175°	176°	+ 1°
Knee	177°	177°	0°

Back/Front Boundary (Length Measurements)	**SP**
Trapezius Point /Acromium	91°
Acromium/Elbow	92°
Elbow/Wrist	106°
Waist/Hip	85°
Hip/Knee	94°
Knee/Ankle	85°

[Figure 83]
Participant 06: Condensed ‘Ideal’ Visual Data

The back, lateral right, front and lateral left views of the plain-portrait and self-portrait of participant 06 [*Figure 84 and Plates Eleven 1-8*] from which the visual data was assessed are respectively:



[*Figure 84*]
Participant 06: Plain-Portrait And Self-Portrait, photos by Francisca Manuel with superimposed diagrams by the researcher

Having declared that she doesn't suffer from any physical condition, it is easily noticeable in the plain-portraits of participant 06 – as well as in the correlative Individual Data Tables – that **(i)** her spinal column curves sideways doubly, causing **(ii)** her left shoulder to be straighter and higher than the right shoulder, **(iii)** the left arm to hang higher and slightly more toward the front than the right arm, and **(iv)** the right side area between the bust and waist to appear somewhat crushed [*Figure 84 top and Plates Eleven 1-4*].

The four views of her self-portrait – and the correlative Individual Data Tables – show that **(v)** the left shoulder continues to be slightly higher than the right shoulder, and **(vi)** the left arm hangs higher, further to the front and away from the trunk than the right arm, and **(vi)** the right leg projects more to the front than the left [*Figure 84 bottom and Plates Eleven 5-8*].

Respecting participant 07 – a representative of Euro size 36 by virtue of measuring 86cm around the bust, 67cm around the waist, 90cm around the hip, and 163cm in height –, the condensed ‘ideal’ angle measurements for the right side of the body are:

Back View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	155°	145°	- 10°
Acromium/Elbow	109°	107°	- 2°
Elbow/Wrist	93°	97°	+ 4°
Acromium/Bust	84°	78°	- 6°
Bust/Waist	85°	81°	- 4°
Waist/Hip	103°	102°	- 1°
Hip/Knee	102°	104°	+ 2°
(Inner and Outer Sides)	89°	89°	0°
Knee/Ankle	91°	91°	0°
(Inner and Outer Sides)	84°	92°	+ 8°

Front View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	19°	31°	+ 12°
Acromium/Elbow	79°	69°	- 10°
Elbow/Wrist	87°	82°	- 5°
Acromium/Bust	101°	93°	- 8°
Bust/Waist	94°	99°	+ 5°
Waist/Hip	76°	79°	+ 3°
Hip/Knee	81°	81°	0°
(Inner and Outer Sides)	92°	91°	- 1°
Knee/Ankle	91°	89°	- 2°
(Inner and Outer Sides)	94°	88°	- 6°

Back Outline (Length Measurements)	**PP**	**SP**	
7th Cervical/Bust	84°	75°	- 9°
Bust/Waist	104°	86°	- 18°
Waist/Hip	79°	81°	+ 2°
Hip/Knee	94°	100°	+ 6°
Knee/Ankle	92°	86°	- 6°
Acromium/Elbow	97°	96°	- 1°
Elbow/Wrist	105°	111°	+ 6°

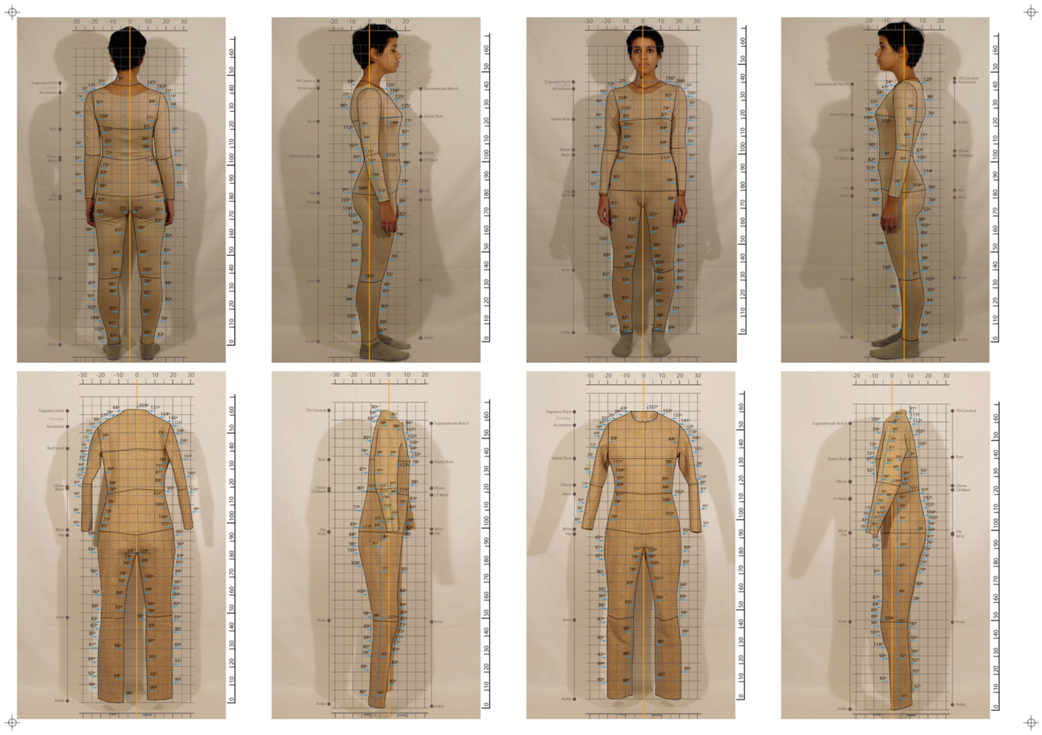
Front Outline (Length Measurements)	**PP**	**SP**	
Suprasternale Notch/Apex	119°	99°	- 20°
Apex/Waist	87°	85°	- 2°
Waist/Hip	88°	84°	- 4°
Hip/Knee	81°	89°	+ 8°
Knee/Ankle	88°	80°	- 8°

Lateral View (Depth Measurements)	**PP**	**SP**	
(Apex) Bust	188°	177°	- 11°
Elbow	171°	187°	+ 16°
CF Waist/CB Waist	176°	172°	- 4°
Hip	183°	179°	- 4°
Knee	179°	179°	0°

Back/Front Boundary (Length Measurements)	**SP**
Trapezius Point /Acromium	91°
Acromium/Elbow	95°
Elbow/Wrist	100°
Waist/Hip	86°
Hip/Knee	89°
Knee/Ankle	87°

[Figure 85]
Participant 07: Condensed ‘Ideal’ Visual Data

The back, lateral right, front and lateral left views of the plain-portrait and self-portrait of participant 07 [*Figure 86 and Plates Twelve 1-8*] from which the visual data was assessed are respectively:



[*Figure 86*]
Participant 07: Plain-Portrait And Self-Portrait, photos by Francisca Manuel with superimposed diagrams by the researcher

Having declared that she doesn't suffer from any physical condition, the plain-portraits of participant 07 – as well as the correlative Individual Data Tables – show that **(i)** she tends to lean to the right, causing **(ii)** the right shoulder to slope downward, **(iii)** the right side area between the bust and waist to appear a little crushed, and **(iv)** the right arm to hang slightly toward the back and lower than the left arm [*Figure 86 top and Plates Twelve 1-4*].

The four views of the participant 07's self-portrait – and the correlative Individual Data Tables – display that **(vi)** the right arm is less curved, hangs a lot further to the back and is lower than the left arm [*Figure 86 bottom and Plates Twelve 5-8*].

Respecting participant 08 – a representative of Euro size 36 by virtue of measuring 84cm around the bust, 65cm around the waist, 92cm around the hip, and 160cm in height –, the condensed 'ideal' angle measurements for the right side of the body are:

Back View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	158º	144º	- 14º
Acromium/Elbow	106º	109º	+ 3º
Elbow/Wrist	87º	102º	+ 15º
Acromium/Bust	90º	83º	- 7º
Bust/Waist	79º	77º	- 2º
Waist/Hip	102º	104º	+ 2º
Hip/Knee	99º	102º	+ 3º
(Inner and Outer Sides)	88º	87º	- 1º
Knee/Ankle	91º	90º	- 1º
(Inner and Outer Sides)	85º	91º	+ 6º

Front View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	22º	27º	+ 5º
Acromium/Elbow	74º	66º	- 8º
Elbow/Wrist	93º	77º	- 16º
Acromium/Bust	98º	94º	- 4º
Bust/Waist	91º	99º	+ 8º
Waist/Hip	79º	81º	+ 2º
Hip/Knee	84º	77º	- 7º
(Inner and Outer Sides)	95º	92º	- 3º
Knee/Ankle	88º	92º	+ 4º
(Inner and Outer Sides)	97º	90º	- 7º

Back Outline (Length Measurements)	**PP**	**SP**	
7th Cervical/Bust	84º	78º	- 6º
Bust/Waist	97º	81º	- 16º
Waist/Hip	81º	78º	- 3º
Hip/Knee	101º	105º	+ 4º
Knee/Ankle	90º	85º	- 5º
Acromium/Elbow	101º	90º	- 11º
Elbow/Wrist	115º	110º	- 5º

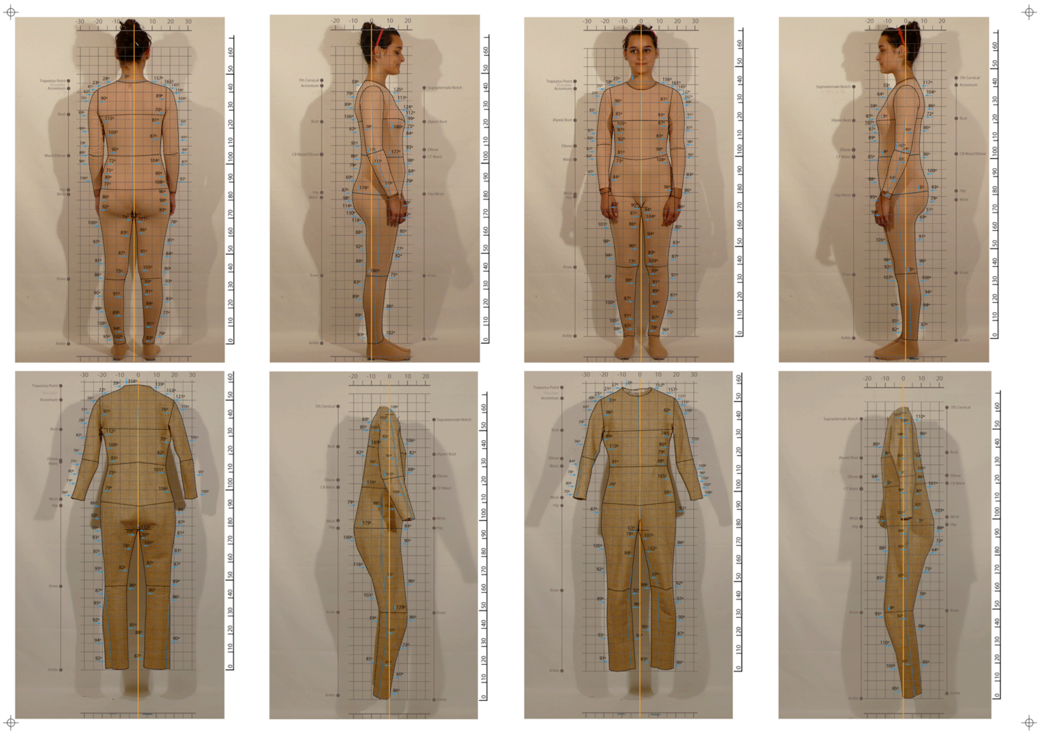
Front Outline (Length Measurements)	**PP**	**SP**	
Suprasternale Notch/Apex	115º	103º	- 12º
Apex/Waist	88º	86º	- 2º
Waist/Hip	88º	84º	- 4º
Hip/Knee	82º	90º	+ 8º
Knee/Ankle	87º	81º	- 6º

Lateral View (Depth Measurements)	**PP**	**SP**	
(Apex) Bust	179º	171º	- 8º
Elbow	165º	183º	+ 18º
CF Waist/CB Waist	177º	176º	- 1º
Hip	177º	179º	+ 2º
Knee	179º	178º	- 1º

Back/Front Boundary (Length Measurements)	**SP**
Trapezius Point /Acromium	94º
Acromium/Elbow	93º
Elbow/Wrist	95º
Waist/Hip	*88º
Hip/Knee	91º
Knee/Ankle	87º

[Figure 87]
Participant 08: Condensed 'Ideal' Visual Data

The back, lateral right, front and lateral left views of the plain-portrait and self-portrait of participant 08 [*Figure 88 and Plates Thirteen 1-8*] from which the visual data was assessed are respectively:



[*Figure 88*]
Participant 08: Plain-Portrait And Self-Portrait, photos by Francisca Manuel with superimposed diagrams by the researcher

Corroborating that she doesn't suffer from any physical condition as declared, the plain-portraits of participant 08 – and the correlative Individual Data Tables – show that **(i)** both sides of her body are identical to each other, and **(ii)** her physical posture, when standing, is straight, with the exception of **(iii)** her right arm, which hangs slightly further back than the left [*Figure 88 top and Plates Thirteen 1-4*].

The four views of her self-portrait – as well as the correlative Individual Data Tables – reveal that **(iv)** the right arm projects more to the front and is more distant from the trunk than the left arm, **(v)** the same occurrences happening with the right leg [*Figure 88 bottom and Plates Thirteen 5-8*].

Respecting participant 09 – a representative of Euro size 38 by virtue of measuring 95cm around the bust, 68cm around the waist, 96cm around the hip, and 167cm in height –, the condensed ‘ideal’ angle measurements for the right side of the body are:

Back View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	154°	147°	. 7°
Acromium/Elbow	109°	108°	- 1°
Elbow/Wrist	93°	92°	- 1°
Acromium/Bust	93°	84°	- 9°
Bust/Waist	82°	76°	- 6°
Waist/Hip	100°	100°	0°
Hip/Knee	98°	104°	+ 6°
(Inner and Outer Sides)	87°	88°	+ 1°
Knee/Ankle	94°	86°	- 8°
(Inner and Outer Sides)	87°	88°	+ 1°

Front View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	22°	32°	+ 10°
Acromium/Elbow	77°	73°	- 4°
Elbow/Wrist	87°	86°	- 1°
Acromium/Bust	97°	99°	+ 2°
Bust/Waist	93°	106°	+ 13°
Waist/Hip	81°	80°	- 1°
Hip/Knee	87°	88°	+ 1°
(Inner and Outer Sides)	95°	91°	- 4°
Knee/Ankle	85°	93°	+ 8°
(Inner and Outer Sides)	93°	79°	- 14°

Back Outline (Length Measurements)	**PP**	**SP**	
7th Cervical/Bust	76°	81°	+ 5°
Bust/Waist	99°	85°	- 14°
Waist/Hip	80°	82°	+ 2°
Hip/Knee	101°	107°	+ 6°
Knee/Ankle	89°	89°	0°
Acromium/Elbow	98°	84°	- 14°
Elbow/Wrist	111°	99°	- 12°

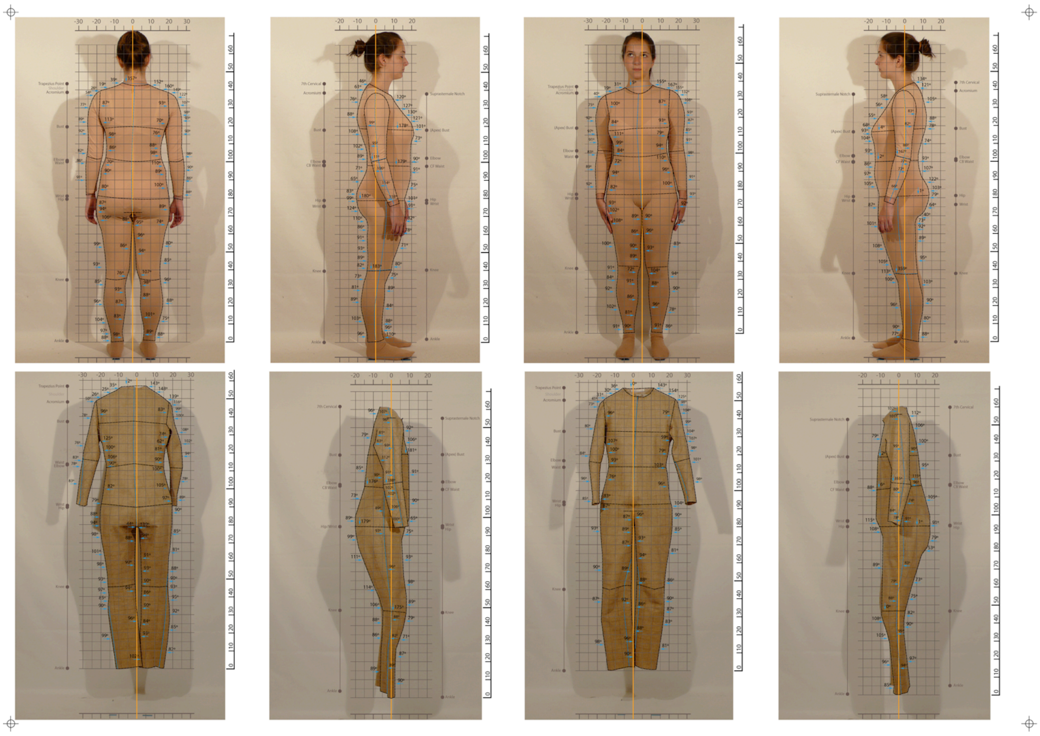
Front Outline (Length Measurements)	**PP**	**SP**	
Suprasternale Notch/Apex	121°	100°	- 21°
Apex/Waist	86°	92°	+ 6°
Waist/Hip	88°	78°	- 10°
Hip/Knee	81°	85°	+ 4°
Knee/Ankle	88°	83°	- 5°

Lateral View (Depth Measurements)	**PP**	**SP**	
(Apex) Bust	177°	180°	+ 3°
Elbow	168°	187°	+ 19°
CF Waist/CB Waist	179°	175°	- 4°
Hip	180°	179°	- 1°
Knee	182°	178°	- 4°

Back/Front Boundary (Length Measurements)	**SP**
Trapezius Point /Acromium	93°
Acromium/Elbow	91°
Elbow/Wrist	100°
Waist/Hip	89°
Hip/Knee	95°
Knee/Ankle	87°

[Figure 89]
Participant 09: Condensed ‘Ideal’ Visual Data

The back, lateral right, front and lateral left views of the plain-portrait and self-portrait of participant 09 *[Figure 90 and Plates Fourteen 1-8]* from which the visual data was assessed are respectively:



[Figure 90]
Participant 09: Plain-Portrait And Self-Portrait, photos by Francisca Manuel with superimposed diagrams by the researcher

Having declared that she doesn't suffer from any physical condition, the plain-portraits of participant 09 – as well as the correlative Individual Data Tables – clearly show that **(i)** she tends to lean toward the right, causing **(ii)** the left shoulder to get higher than the right shoulder, and **(iii)** the left arm to hang higher and more toward the front than the right arm *[Figure 90 top and Plates Fourteen 1-4]*.

Both sides of the self-portrait produced by participant 09 became very different from each other, as the self-portrait's four views – and the correlative Individual Data Tables – clearly display: **(iv)** the left arm also hangs higher more toward the front than the right arm and a lot more distant from the trunk than the right arm, **(v)** the right leg is positioned along the axis and slightly more to the front than the left, and **(vi)** the left leg overlaps the right – two traits that only surfaced on this particular self-portrait – *[Figure 90 bottom and Plates Fourteen 5-8]*.

Respecting participant 10 – a representative of Euro size 38 by virtue of measuring 88cm around the bust, 70cm around the waist, 96cm around the hip, and 165cm in height –, the condensed ‘ideal’ angle measurements for the right side of the body are:

Back View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	156°	135°	- 21°
Acromium/Elbow	108°	103°	- 5°
Elbow/Wrist	87°	88°	+ 1°
Acromium/Bust	86°	88°	+ 2°
Bust/Waist	79°	77°	- 2°
Waist/Hip	101°	100°	- 1°
Hip/Knee	98°	103°	+ 5°
(Inner and Outer Sides)	91°	91°	0°
Knee/Ankle	93°	93°	0°
(Inner and Outer Sides)	86°	90°	+ 4°

Front View (Length Measurements)	**PP**	**SP**	
Trapezius Point/Acromium	22°	37°	+ 15°
Acromium/Elbow	74°	77°	+ 3°
Elbow/Wrist	91°	87°	- 4°
Acromium/Bust	100°	110°	+ 10°
Bust/Waist	95°	103°	+ 8°
Waist/Hip	79°	81°	+ 2°
Hip/Knee	83°	80°	- 3°
(Inner and Outer Sides)	92°	90°	- 2°
Knee/Ankle	87°	80°	- 7°
(Inner and Outer Sides)	92°	91°	- 1°

Back Outline (Length Measurements)	**PP**	**SP**	
7th Cervical/Bust	81°	76°	- 5°
Bust/Waist	101°	82°	- 19°
Waist/Hip	91°	82°	- 9°
Hip/Knee	91°	102°	+ 11°
Knee/Ankle	90°	86°	- 4°
Acromium/Elbow	100°	101°	+ 1°
Elbow/Wrist	112°	110°	- 2°

Front Outline (Length Measurements)	**PP**	**SP**	
Suprasternale Notch/Apex	111°	101°	- 10°
Apex/Waist	88°	87°	- 1°
Waist/Hip	89°	88°	- 1°
Hip/Knee	77°	90°	+ 13°
Knee/Ankle	86°	83°	- 3°

Lateral View (Depth Measurements)	**PP**	**SP**	
(Apex) Bust	179°	175°	- 4°
Elbow	168°	187°	+ 19°
CF Waist/CB Waist	178°	175°	- 3°
Hip	177°	181°	+ 4°
Knee	176°	180°	+ 4°

Back/Front Boundary (Length Measurements)	**SP**
Trapezius Point /Acromium	101°
Acromium/Elbow	95°
Elbow/Wrist	103°
Waist/Hip	96°
Hip/Knee	93°
Knee/Ankle	89°

[Figure 91]
Participant 10: Condensed ‘Ideal’ Visual Data

The back, lateral right, front and lateral left views of the plain-portrait and self-portrait of participant 10 [*Figure 92 and Plates Fifteen 1-8*] from which the visual data was assessed are respectively:

[*Figure 92*]
Participant 10: Plain-Portrait And Self-Portrait, photos by Francisca Manuel with superimposed diagrams by the researcher

Having declared that she doesn't suffer from any physical condition, the plain-portraits of participant 10 – as well as the correlative Individual Data Tables – clearly show that **(i)** occasionally she leans a great deal to the left [*Figure 82 top left and Plate Fifteen 1*], though **(ii)** the whole trunk and arms, and consequently the shoulders, bust, waist and hip, appear to remain symmetrical along the tilted spinal column [*Figure 92 top left and Plate Fifteen 1*]. Aside from this predisposition, participant 10's posture is rather straight, as [*Figure 82 top and Plates Fifteen 2-4*] let see.

The four views of her self-portrait – and the correlative Individual Data Tables – let see that **(iii)** the right arm is more projected to the front than the left arm, just as **(iv)** the right leg is more projected to the front than the left leg [*Figure 92 bottom and Plates Fifteen 5-8*].

Respecting participant 11 – a representative of Euro size 38 by virtue of measuring 94cm around the bust, 72cm around the waist, 93cm around the hip, and 162cm in height –, the condensed 'ideal' angle measurements for the right side of the body are:

Back View	**PP**	**SP**	
(Length Measurements)			
Trapezius Point/Acromium	158º	146º	- 12º
Acromium/Elbow	107º	104º	- 3º
Elbow/Wrist	86º	92º	+ 6º
Acromium/Bust	91º	78º	- 13º
Bust/Waist	83º	81º	- 2º
Waist/Hip	101º	99º	- 2º
Hip/Knee	96º	105º	+ 9º
(Inner and Outer Sides)	86º	90º	+ 4º
Knee/Ankle	95º	92º	- 3º
(Inner and Outer Sides)	87º	88º	+ 1º

Front View	**PP**	**SP**	
(Length Measurements)			
Trapezius Point/Acromium	20º	34º	+ 14º
Acromium/Elbow	75º	75º	0º
Elbow/Wrist	91º	84º	- 7º
Acromium/Bust	96º	97º	+ 1º
Bust/Waist	90º	102º	+ 12º
Waist/Hip	78º	83º	+ 5º
Hip/Knee	86º	79º	- 7º
(Inner and Outer Sides)	98º	89º	- 9º
Knee/Ankle	86º	89º	+ 3º
(Inner and Outer Sides)	91º	91º	0º

Back Outline	**PP**	**SP**	
(Length Measurements)			
7th Cervical/Bust	87º	65º	- 22º
Bust/Waist	100º	77º	- 23º
Waist/Hip	80º	78º	- 2º
Hip/Knee	96º	106º	+ 10º
Knee/Ankle	89º	85º	- 4º
Acromium/Elbow	97º	93º	- 4º
Elbow/Wrist	112º	115º	+ 3º

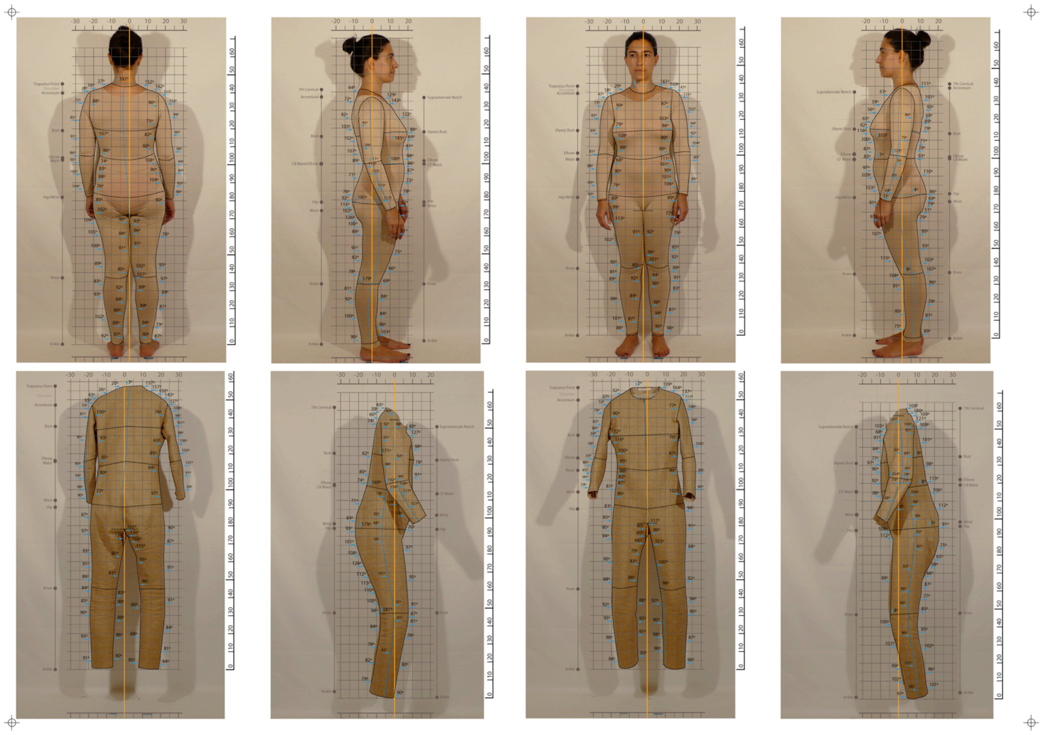
Front Outline	**PP**	**SP**	
(Length Measurements)			
Suprasternale Notch/Apex	118º	100º	- 18º
Apex/Waist	84º	86º	+ 2º
Waist/Hip	83º	82º	- 1º
Hip/Knee	78º	83º	+ 5º
Knee/Ankle	86º	82º	- 3º

Lateral View	**PP**	**SP**	
(Depth Measurements)			
(Apex) Bust	185º	171º	- 14º
Elbow	170º	189º	+ 19º
CF Waist/CB Waist	180º	171º	- 9º
Hip	178º	177º	- 1º
Knee	178º	179º	+ 1º

Back/Front Boundary	**SP**
(Length Measurements)	
Trapezius Point /Acromium	86º
Acromium/Elbow	92º
Elbow/Wrist	113º
Waist/Hip	83º
Hip/Knee	94º
Knee/Ankle	85º

[Figure 93]
Participant 11: Condensed 'Ideal' Visual Data

The back, lateral right, front and lateral left views of the plain-portrait and self-portrait of participant 11 [*Figure 94 and Plates Sixteen 1-8*] from which the visual data was assessed are respectively:



[*Figure 94*]
Participant 11: Plain-Portrait And Self-Portrait, photos by Francisca Manuel with superimposed diagrams by the researcher

Having declared that she doesn't suffer from any physical condition, the plain-portraits of participant 11 – as well as the correlative Individual Data Tables – clearly show that **(i)** occasionally she leans to the left [*Figure 94 top left and Plate Sixteen 1*], causing the **(ii)** left shoulder, **(iii)** left arm, and **(iv)** the point of the waist located in the lateral left, to get lower than the counterpart segments and body landmark [*Figure 94 top and Plates Sixteen 1-4*].

The four views of her self-portrait – and the correlative Individual Data Tables – visibly display that **(v)** it slants to the right, **(vi)** the right arm is further away from the trunk than the left arm, **(vii)** the left elbow is further back than the left elbow, and the right and left legs are bent differently, as **(viii)** the right knee is projected to the front, **(ix)** the left ankle is closer to the axis, and **(x)** the left ankle is positioned further back [*Figure 94 bottom and Plates Sixteen 5-8*].

After identifying the main characteristics of the plain-portraits and self-portraits for all the participants separately, as well as the relationship between each participant's plain-portrait and self-portrait, it was patent that

> **(a)** Only the plain- and self-portraits of participants 01 and 04 shared identical characteristics, respectively.
>
> **(b)** Only the plain- and self-portraits of participant 03 shared two characteristics among four.
>
> **(c)** Only the plain- and self-portraits of participants 05, 06, 07 and 09 shared one characteristic among six, four, three and five, respectively.
>
> **(d)** The plain- and self-portraits of participants 02, 08, 10 and 11 shared no characteristics whatsoever, respectively.

Then, the differences and similarities among the participants' plain- and self-portraits all together were considered. To that purpose the 'ideal' rounded up angle measurements for each body segment previously imparted were organized according to **(1)** range, or the lower and upper relative values, **(2)** extremes, or who held the lowest and the highest relative values, **(3)** correspondence, or who possessed identical relative values, and **(4)** average, or the arithmetic mean of the relative values – presented in the Plain-Portraits: Cross Data Tables, Self-Portraits: Cross Data Tables and Undergone Changes: Cross Data Tables.[174]

Using a gradation of seven, or eight,[175] colors to group two consecutive angle measurements – where the darker gray represents the relative values that are closer to the lower extreme, filled in blue, and the lighter gray represents the relative values closer to the upper extreme, filled in yellow –, it was easier to see the correspondences between every body segment that makes up the plain- and self-portraits.

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174 The Undergone Changes: Cross Data Tables don't include the arithmetic means of the relative values for each body segment as it's pointless to the formation of the compound portrait.

175 Only the Undergone Changes: Cross Data Tables comprise an eighth color, i.e., white, to indicate the angle measurements of the plain- and corresponding self-portraits that didn't change.

Despite having determined these parallels, the huge amount of numerical data contained by the three Cross Data Tables made it very difficult to verify if one self-portrait stood out more than the others in terms of change or if the degree to which one self-portrait differed from the plain-portrait occurred randomly.

In fact, searching for a deformation pattern using the three Cross Data Tables resembled the "Diet Problem" presented by Simon (1996[1969]: 60-61), where the quantities of foods, prices and nutritional contents are figured out via mathematics to optimize the nutritional requirements and diet cost.[176]

One thing, though, was immediately perceptible: the fact that wearing Euro sizes 36 or 38 had no effect on the way the eleven self-portraits ended up looking. For the sake of argument lets weigh the collected 'ideal' numerical data respecting the back outer shape of the self-portraits' lateral view against the correlative angle measurements of the plain-portraits:

Body Segment	Participant	Euro Size	Plain-Portrait	Self-Portrait	Undergone Change
7th Cervical/Bust	P02 P04	36 38	92º 78º	**79º**	- 13º + 1º
Bust/Waist	P06 P10	36 38	99º 101º	**82º**	- 17º - 19º
Waist/Hip	P02 P10	38 36	70º 81º	**82º**	+ 12º - 9º
Hip/Knee	P01 P10	36 38	97º 91º	**101º** **102º**	+ 4º + 11º
Knee/Ankle	P01 P03	36 38	92º 89º	**86º**	- 8º - 3º
Acromium/Elbow	P03 P07	38 36	104º 97º	**96º**	- 8º - 1º
Elbow/Wrist	P01 P09	36 38	101º 111º	**98º** **99º**	- 3º - 12º

[*Figure 95*]
Paired Participants: Matching Angle Measurements In Plain-Portraits And Self-Portraits

Given the indication that the changes occurred independently of clothing size, the eleven participants' plain- and self-portraits – were superimposed by the right ankle in the back and front contours, and by the acromium in both lateral silhouettes –, as an alternative approach to detect the relationships between them [*Figures 96 and 97 and Plates Seventeen 1-8*].

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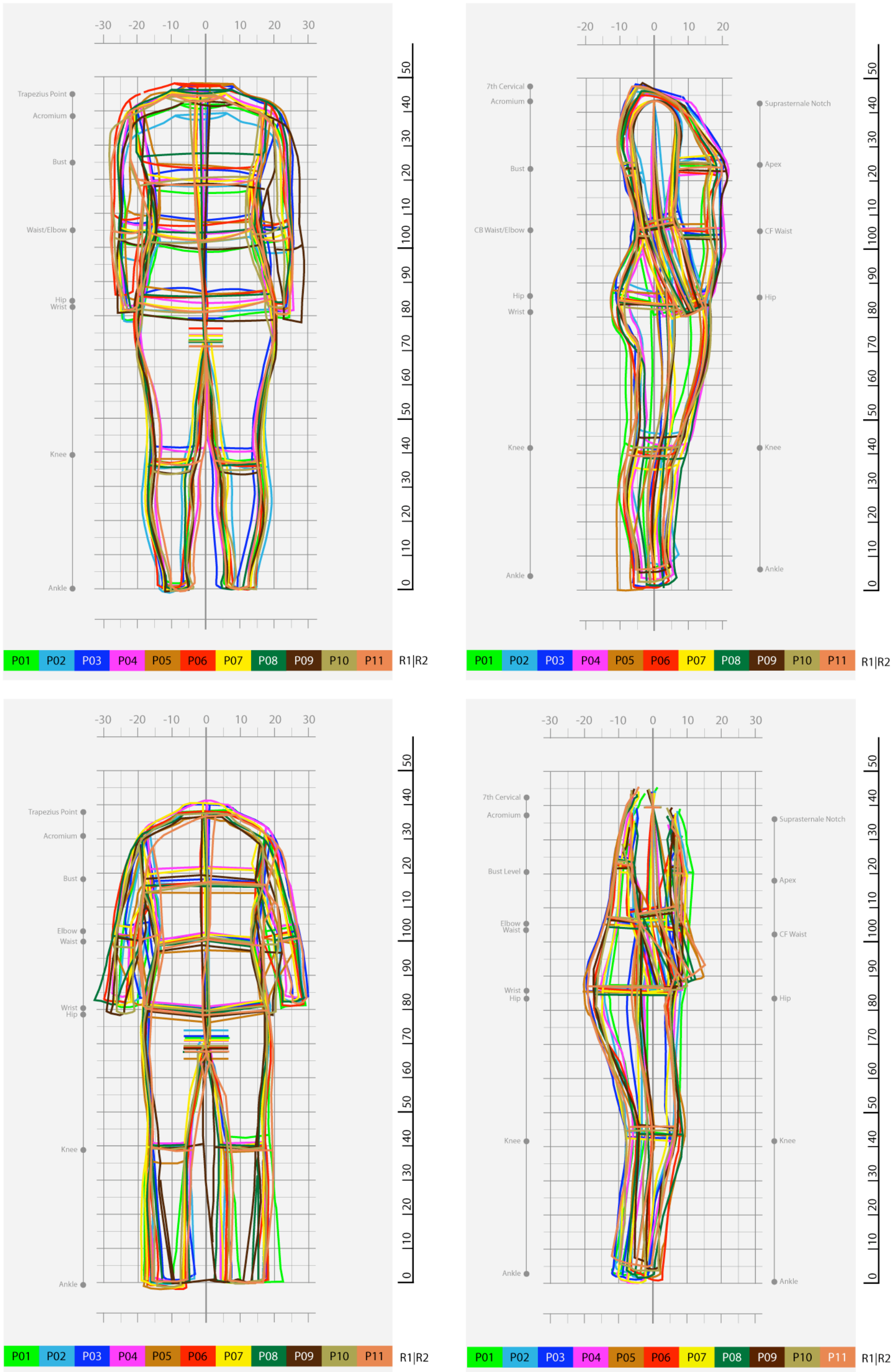
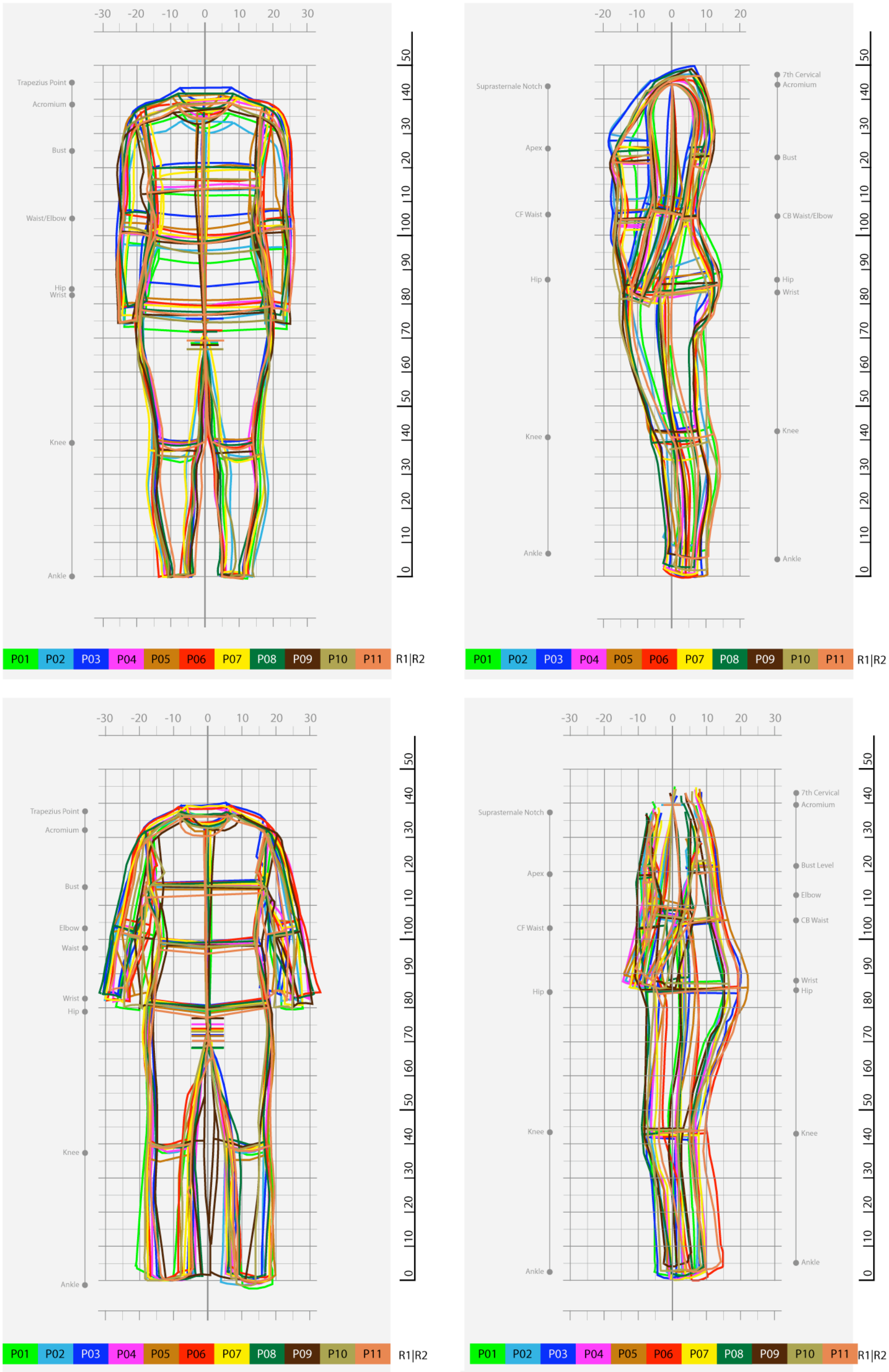
176 See [*Figure 1*], p. 37.

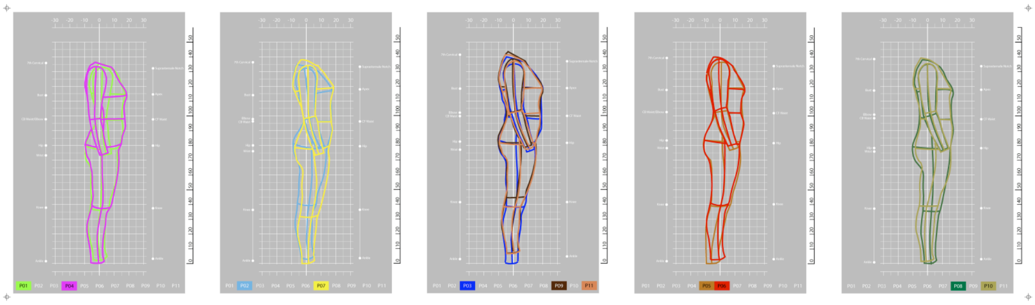


[Figure 96]
Plain-Portraits And Self-Portraits: Superimposed Back And Lateral Right Contours Of The Eleven Participants



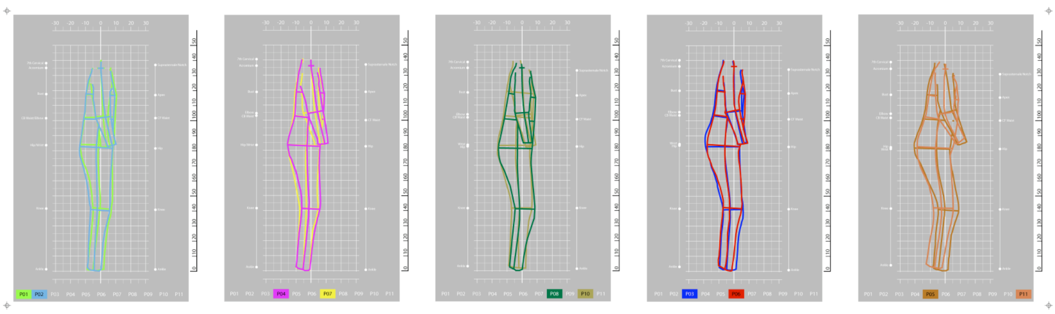
[Figure 97]
Plain-Portraits And Self-Portraits: Superimposed Front And Lateral Left Contours Of The Eleven Participants

In fact, comparing the whole silhouettes instead of focusing on numerical data enabled to keep an overall perspective of the studied phenomenon. Regarding the plain-portraits, a reasonable similarity – in terms of physical posture – was found between **(i)** participants 01 and 04, who wear Euro sizes 36 and 38 respectively, **(ii)** participants 02 and 07, who wear Euro size 36 respectively, **(iii)** participants 03, 09 and 11, all of whom wear Euro size 38, **(iv)** participants 05 and 06, who wear Euro sizes 36/38 respectively, and **(v)** participants 08 and 10, who wear Euro sizes 36 and 38 respectively [*Figure 98 and Plate Eighteen*].



[*Figure 98*]
Lateral Right Views Of Paired Plain-Portraits

With reference to the self-portraits, a significant similarity – in terms of emerged categories – was found between **(i)** participants 01 and 02, who wear Euro sizes 36 and 38 respectively, **(ii)** participants 04 and 07, who wear sizes 38 and 36 respectively, **(iii)** participants 08 and 10, who wear sizes 36 and 38, respectively, **(iv)** participants 03 and 06, who wear sizes 38 and 36/38 respectively, and **(v)** participants 05 and 11, who wear Euro sizes 36/38 and 38 respectively [*Figure 99 and Plate Nineteen*].



[*Figure 99*]
Lateral Right Views Of Paired Self-Portraits

Interestingly, only participants 08 and 10 continued to have a relationship of similarity from the plain-portraits to the self-portraits, even though **(1)** with reference to the static body, their bust, waist and hip linear measurements, not counting their respective height, are distinct from one another, and **(2)** with reference to the mobile body, the 'ideal' angle measurements of the lateral right contours are fairly distinct from one another, as only four are identical in value.[177]

To keep, or not keep, having a complementary relationship throughout the plain- and self-portraits indicates, therefore, that the deformations acquired by the one-piece garments result – to a certain extent – from the physical postures of the participants and – to a great extent – from the participants' way of executing movements.

This specificity, having to do with range of motion or ROM, i.e., "the extent to which a joint goes through all of its normal spectrum of movement" (backandneck.about.com), is really what identifies each participant in terms of artistic production, it is really what stands for their signatures as agents of artifactuality.

Corroborating this assertion is the fact that, even though [*Figures 55-65*] show that many participants carried out identical actions – an occurrence that, in and by itself, is not surprising since the research is focused on motions of a common everyday kind –, [*Figures 98-99 and Plates Nineteen-Twenty*] show that the plain- and self-portraits are paired not because of absolute likeness but of closest resemblance.

So much so that, although participant 09 has performed the same activities and movements as other participants have – in particular those that are/were also Fashion Design students –, the lower part of her self-portrait deviates a great deal from the shape developed by the other ten, namely, the space between the legs, from top to bottom, which in her case is nonexistent.

This fact alone determined that her self-portrait should be removed from the group integrating the compound portrait.

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[177] See Appendix Four and Appendix Five for the Plain-Portraits: Cross Data Tables and Self-Portraits: Cross Data Tables.

[*Developing A Tangible Mannequin*]

The search for a deformation pattern involved organizing the *categories* that surfaced on the self-portraits into *properties* and *dimensions*.

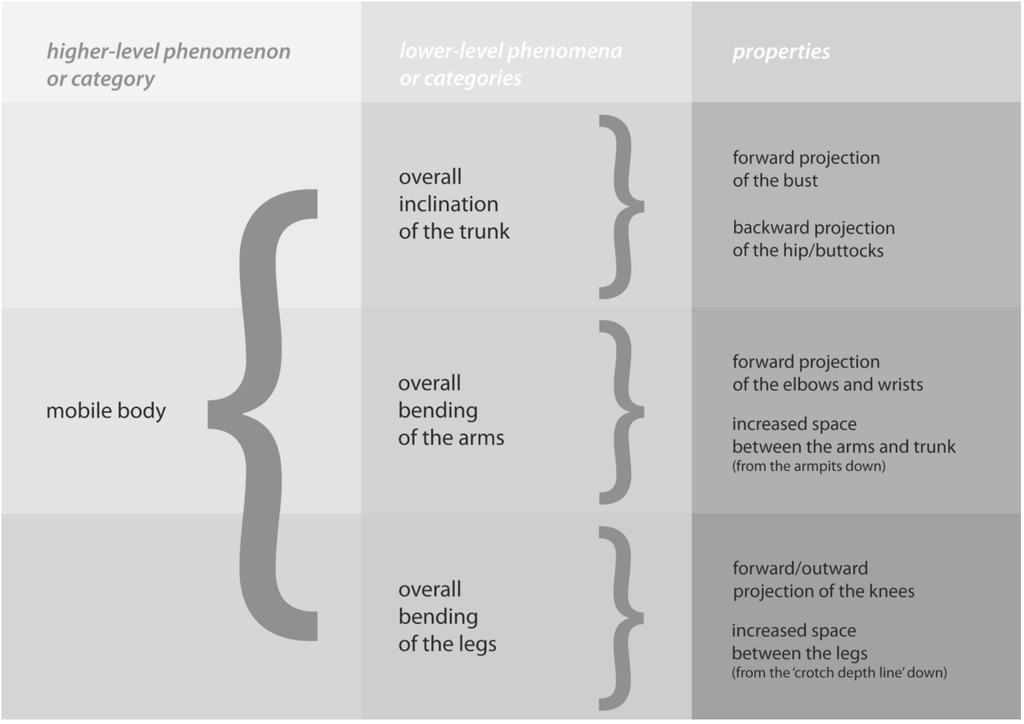
From the perspective of qualitative research, Corbin and Strauss give the precise meanings of the three words previously written in italics: accordingly **(a)** categories are "higher-level concepts under which analysts group lower-level concepts according to shared properties," **(b)** properties are the "characteristics that define and describe concepts," and **(c)** dimensions are the "variations within properties that give specificity and range to concepts" (2008: 159).

Due to the nature of the developed research – or the field in which the research was developed – the word *phenomenon* was used instead of the word *concept*, as it stands for the deformations of the body that occur through movement and are easily recognized by any onlooker.

> *The mobile body is, thus, the higher-level phenomenon from which all other phenomena emanate.*

Owing to the essence of the studied matter, Corbin and Strauss' first definition was rephrased to convey the idea that the no less important lower-level phenomena, or categories, are fundamentally the self-expression of the higher-level phenomenon, or category; in that capacity, being as easily identifiable by anyone, they didn't require "searching for the right word or two that best describe conceptually what the researcher believes is indicated by the data" (Corbin and Strauss 2008: 160).

The necessity of putting what Corbin and Strauss refer to as "conceptual labels on data" (2008: 160), has to do with the need to communicate the visual data through words as well as to reduce it to its essential properties. With regard to the mobile body, the process of coding is illustrated like so [*Figure 100*]:



[*Figure 100*]
Coded Visual Data

Regarding the dimensions of the listed properties, the degree to which the deformations manifested on the one-piece garments – arranged in [*Figure 99 and Plate Twenty*] from the lowest to the highest, i.e., from participants 01 and 02 to participants 05 and 11 – endows the mobile body with depth.

Arising as a consequence of action,[178] the variations within the forward projection of the bust, the backward projection of the hip/buttocks, the forward projection of the elbows and wrists, the increased space between the arms and the trunk, the forward and outward projection of the knees and the increased space between the legs, are reflections of a reality that affects everyone.

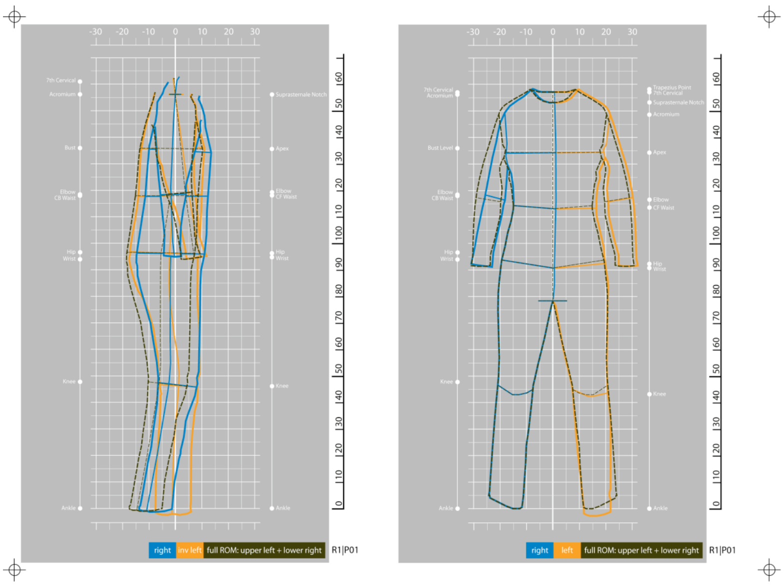
Indeed people are normally either right or left handed; people tend to cross either the right or the left leg over the other, to place their weight either on the right or left side of the body, among other instances. But, generally, the fact that people have these kinds of predispositions doesn't mean that they have limited range of motion in one or more joints. As it happens none of the participants mentioned having flexibility issues yet all the produced self-portraits are asymmetrical.

[178] Understood as the combination of time, space and energy.

The coexistence of these two situations permits to assume that the participants are capable of using either the right or the left of their bodies with equal skill – or that both sides are provided with the same spectrum of movement. Thus it was decided that the self-portraits integrating the compound portrait be redrawn to reproduce only the results of movement in its full potential.

After analyzing the front and lateral views of every self-portrait **(a)** the side of their upper and lower parts that had been subjected to greater ROM – therefore strain, the result of which being greater degrees of distortion – were selected, and **(b)** mirrored around center front – which implied straightening them.[179]

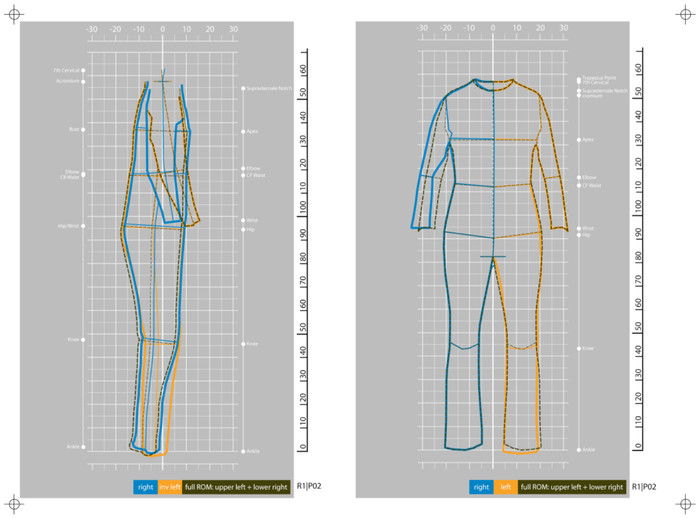
Graphically, the performed two actions are as follows: **(1)** the right sides of the original front and lateral views are represented in a blue continuous line, **(2)** the left sides of the original front and lateral views – inverted in the second instance to be placed under the right side – are represented in a yellow continuous line, and **(3)** the redrawn front and lateral views are represented in a dark olive green dashed line. Accordingly, the redrawn ten self-portraits ended up looking like:



[Figure 101]
Participant 01: Original And Redrawn Contours, Boundaries And Key Lines Of Self-Portrait

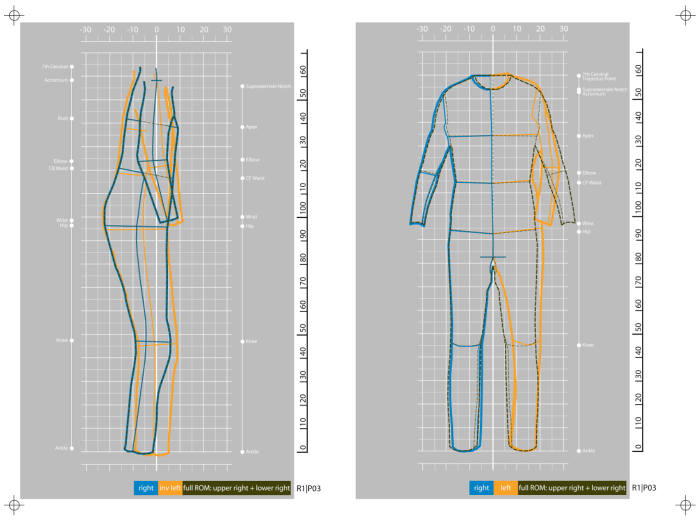
[179] Having been a very time consuming process, only the front and lateral silhouettes were redrawn because it was clear that, from them, the whole virtual three-dimensional compound portrait could be derived. Since the self-portraits became symmetrical, the redesigned lateral contours represent the right of the self-portraits.

Respecting participant 01 [*Figure 101 and Plate Twenty*], the upper left and lower right sides of her self-portrait make up the redrawn front and lateral views, as the right trouser leg and the left sleeve yielded more in response to localized movement strain.



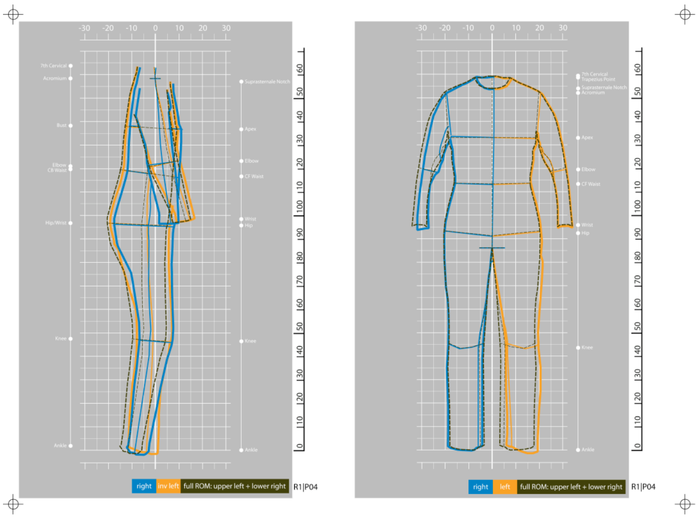
[*Figure 102*]
Participant 02: Original And Redrawn Contours, Boundaries And Key Lines Of Self-Portrait

Respecting participant 02 [*Figure 102 and Plate Twenty-One*], the upper left and lower right sides of her self-portrait make up the redrawn front and lateral views, as the right trouser leg and the left sleeve yielded more in response to localized movement strain.



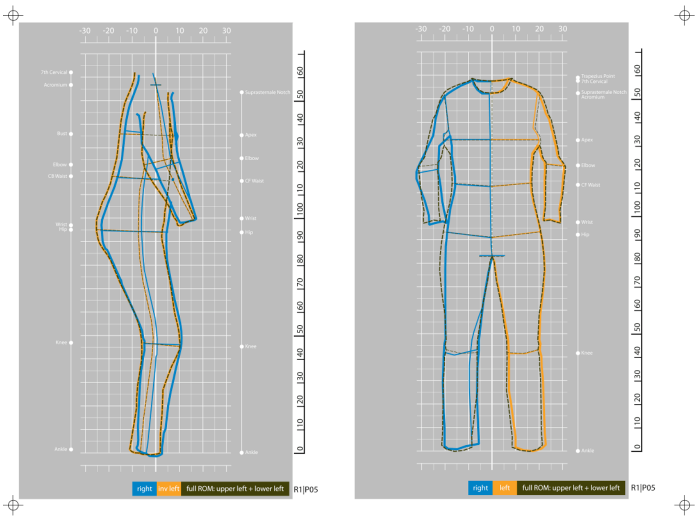
[*Figure 103*]
Participant 03: Original And Redrawn Contours, Boundaries And Key Lines Of Self-Portrait

Respecting participant 03 [*Figure 103 and Plate Twenty-Two*], the right side of her self-portrait makes up the redrawn front and lateral views – upper and lower parts simultaneously –, as the right trouser leg and sleeve yielded more in response to localized movement strain.



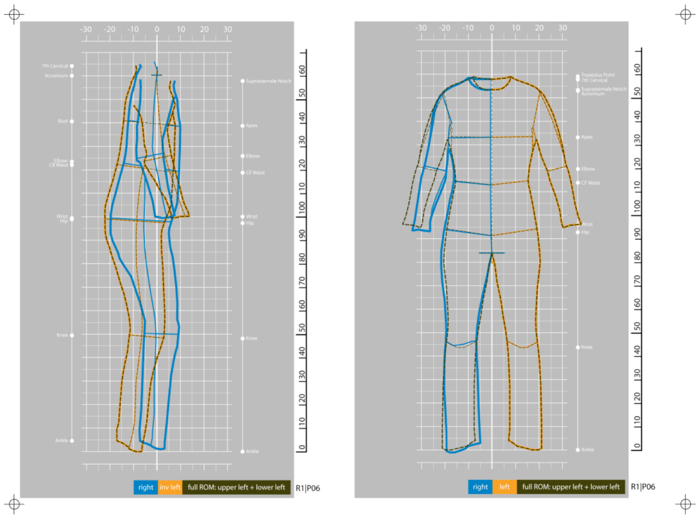
[*Figure 104*]
Participant 04: Original And Redrawn Contours, Boundaries And Key Lines Of Self-Portrait

Respecting participant 04 [*Figure 104 and Plate Twenty-Three*], the upper left and lower right sides of her self-portrait make up the redrawn front and lateral views, as the right trouser leg and the left sleeve yielded more in response to localized movement strain.



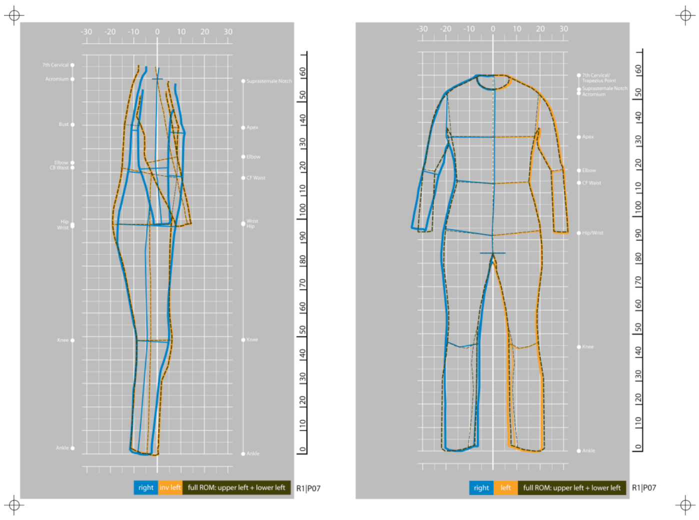
[*Figure 105*]
Participant 05: Original And Redrawn Contours, Boundaries And Key Lines Of Self-Portrait

Respecting participant 05 [*Figure 105 and Plate Twenty-Four*], the left side of her self-portrait makes up the redrawn front and lateral views – upper and lower parts simultaneously –, as the entire left side of the one-piece garment yielded more in response to localized movement strain.



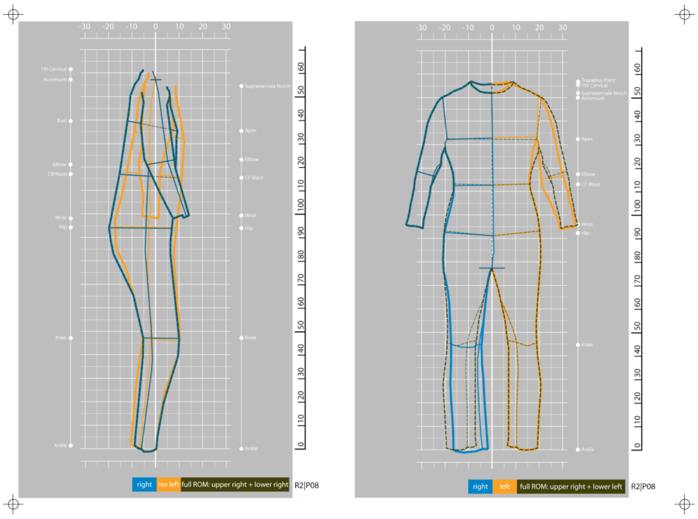
[*Figure 106*]
Participant 06: Original And Redrawn Contours, Boundaries And Key Lines Of Self-Portrait

Respecting participant 06 [*Figure 106 and Plate Twenty-Five*], the left side of her self-portrait makes up the redrawn front and lateral views – upper and lower parts simultaneously –, as the entire left side of the one-piece garment yielded more in response to localized movement strain.



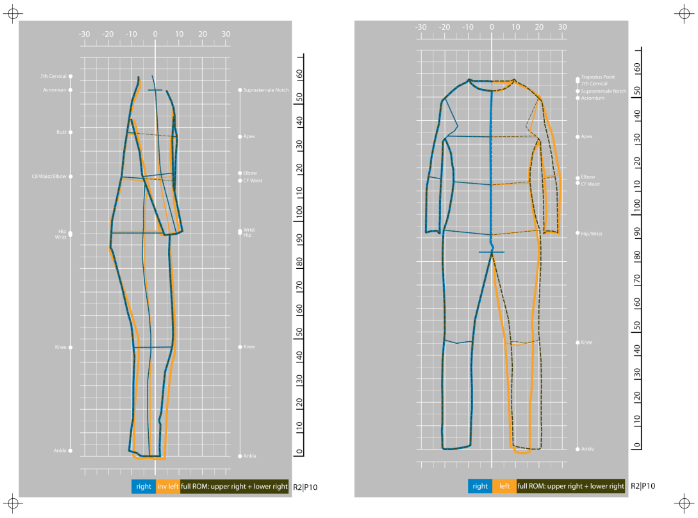
[*Figure 107*]
Participant 07: Original And Redrawn Contours, Boundaries And Key Lines Of Self-Portrait

Respecting participant 07 [*Figure 107 and Plate Twenty-Six*], the left side of her self-portrait makes up the redrawn front and lateral views – upper and lower parts simultaneously –, as the left trouser leg and sleeve yielded more in response to localized movement strain.



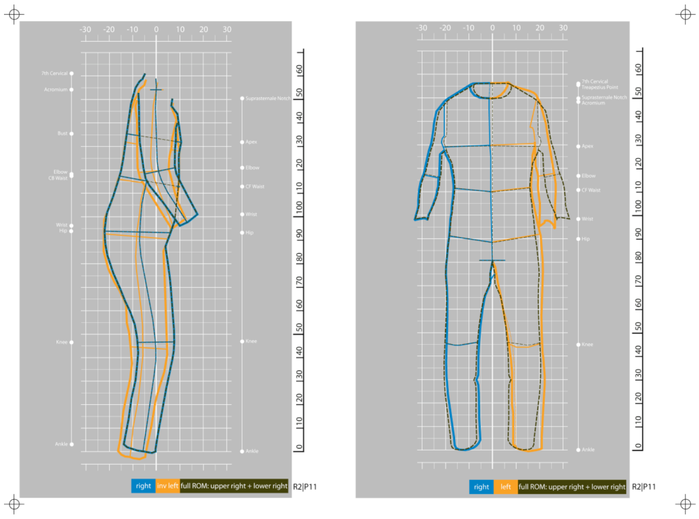
[*Figure 108*]
Participant 08: Original And Redrawn Contours, Boundaries And Key Lines Of Self-Portrait

Respecting participant 08 [*Figure 108 and Plate Twenty-Seven*], the right side of her self-portrait makes up the redrawn front and lateral views – upper and lower parts simultaneously –, as the right trouser leg and sleeve yielded more in response to localized movement strain.



[*Figure 109*]
Participant 10: Original And Redrawn Contours, Boundaries And Key Lines Of Self-Portrait

Respecting participant 10 [*Figure 109 and Plate Twenty-Eight*], the upper and lower right side of her self-portrait make up the redrawn front and lateral views, as the right trouser leg and sleeve yielded slightly more in response to localized movement strain.



[*Figure 110*]
Participant 11: Original And Redrawn Contours, Boundaries And Key Lines Of Self-Portrait

Respecting participant 11 [*Figure 110 and Plate Twenty-Nine*], the upper and lower right side of her self-portrait make up the redrawn front and lateral views, as the right trouser leg and sleeve yielded more in response to localized movement strain.

When the process of redrawing the ten self-portraits was completed,[180] the process of converting the resulting silhouettes into a compound portrait began. Continuing to be a two-dimensional approach, this particular stage toward the visual representation of the mobile body drew on an experimental method developed by R. Hutchinson and D. L. Munden in the late 1970s.

Having realized that the proportions of the dress forms on which the construction of basic patterns depended on were "inaccurately shaped, especially in the shoulder area" (Hutchinson and Munden 1978: 119), the researchers aimed to improve the fit of women's garments.

Although the reviewed technique was intended for the construction of block patterns, the one aspect that makes it worthy of note – or important to this doctoral

[180] See the Self-Portraits: Individual Data Tables for the actual angle measurements.

research – is connected with the fact that Hutchinson and Munden derived an average basic pattern from eight women whose body measurements conformed to a standard size 12, the UK counterpart of Euro size 38. Accordingly the researchers

> **(a)** Applied a molding material[181] to each subject's back shoulder to waist, front shoulder to waist, back waist to hip and front waist to hip sections – on which had been marked the corresponding key points.
>
> **(b)** Converted the three-dimensional molded patterns into two-dimensional patterns by cutting them along the waist, sides and vertical princess-style lines – to match the placement of garments seams.
>
> **(c)** Found "the average skin fitting pattern of the eight subjects" (Hutchinson and Munden 1978: 128) by drawing bisecting lines pair after pair until one pattern remained.

Using the same technique to obtain the patterns of two dress forms – also size 12 –, the researchers measured the shoulder angles and neck widths of the three patterns, i.e., the dress forms' and the final average pattern; the differences between the three sets of data corroborated that "the shoulder seam [of a garment cut to fit either stand] would not lie along the shoulder line of the wearer" (Hutchinson and Munden 1978: 128).

Although it was not possible to find out if the findings of the authors' research has had an impact on the theory of pattern design and/or on the devices utilized by the mass production trade, the fact that later researchers have referred to their work[182] reinforce the idea that Hutchinson and Munden's sampling strategy has been positively looked upon by their peers and that a sample size of eight is suitable for deriving average body shapes.

Since all the produced self-portraits were considered as true descriptions of the mobile body – even with or because of the dimensional range of the identified properties –, the averaging procedure employed by Hutchinson and Munden to

---

[181] Namely, polyethylene foam sheeting, 3mm thick.

[182] Namely, B. K. Hinds and J. McCartney, in 1990, as well as Chin-Man Chen, in 2010 and 2011 (www.springerlink.com and (http://trj.sagepub.com).

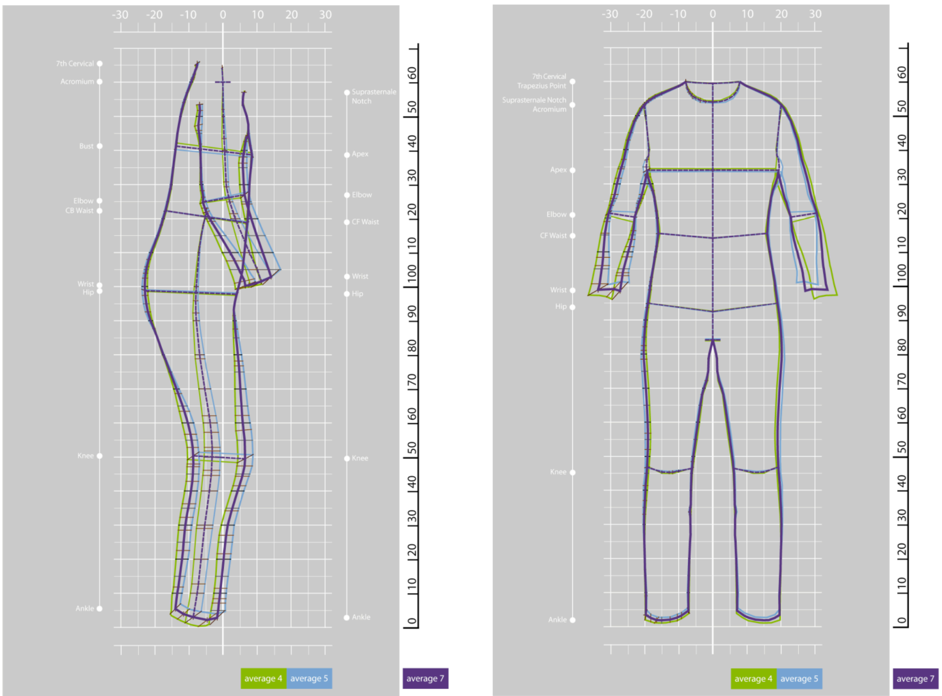
create a compound portrait of the mobile body was adopted instead of taking the actual sample median.

Using again Adobe Illustrator, the derivation of the two-dimensional version of the compound portrait from the silhouettes with full ROM was treated in a series of five steps. Step One involved separating into five pairs the redrawn front and lateral silhouettes on grounds of closest similarity, as the changes made to the contours brought about different relationships – in fact only three of the five pairs with uneven ROM presented earlier maintained a considerable connection [*Figure 111*].

[*Figure 111*]
Five Steps Toward The Compound Portrait

Step Two involved finding, one by one, the average contours of the formed pairs – designated averages 1, 2, 3, 4 and 5 [*Figure 111*] – by calculating the average distance between the points within and drawing a bisecting line through them

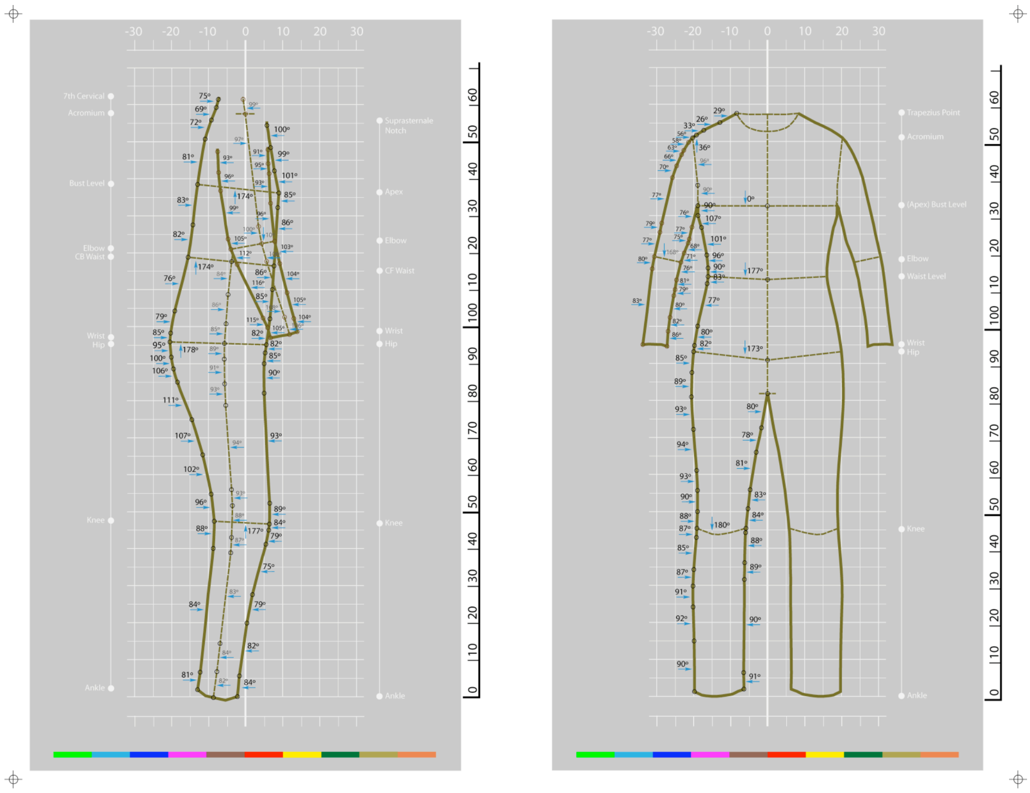
[Plates Thirty and Thirty-One]. Step Three and Step Four involved, once again, separating into pairs the five front and lateral average silhouettes obtained before as well as finding the respective average contours – designated averages 6, 7, 8 and 9 *[Figure 111]* – by drawing a bisecting line between them *[Figure 112 and Plates Thirty-Two and Thirty-Three]*.



[Figure 112]
Bisecting Line Between Average Silhouettes 4 and 5

Step Five, the culmination of this very process, involved finding the average front and lateral contours – designated average 10 *[Figure 111]* – of the average silhouettes 8 and 9 by calculating the average distance between the points within and drawing a bisecting line through them *[Figure 111 and Plates Thirty and Thirty-One]*.

After obtaining the average silhouette that stands for the compound portrait of the mobile body, the angle measurements for each body segment within its front and lateral outer shapes *[Figure 113 and Plate Thirty-Four]* were taken. Functioning primarily as control measurements for the design of the digital tangible mannequin, the recorded numerical data serve also as an analytic tool for comparison making: inescapably the concept of static body and the phenomenon of mobile body were compared with each other in terms of their properties, i.e., the variations within their front and lateral outer shapes and, when applied, the back/front boundaries inside them.



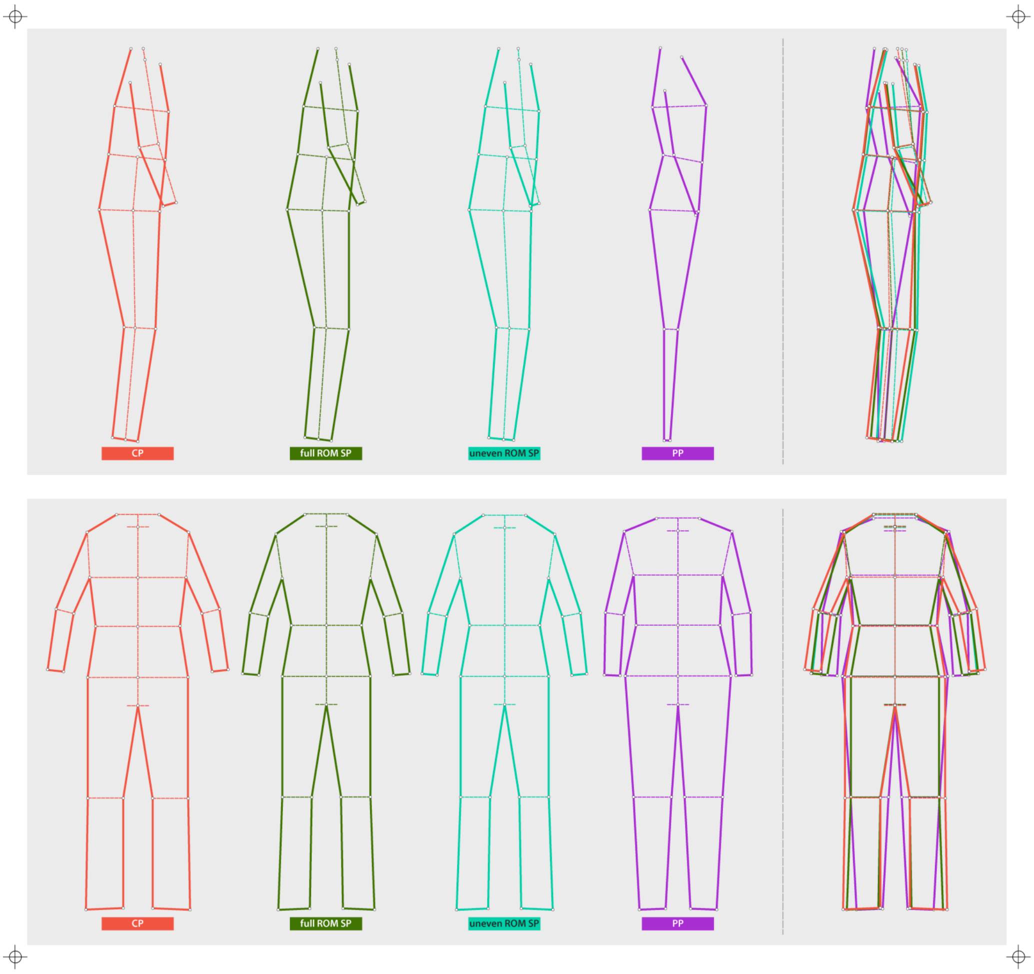
[*Figure 113*]
The Two-Dimensional Version Of The Compound-Portrait, front and lateral contours and respective angle measurements

By putting side by side the condensed angle measurements of the compound portrait, of the averaged self-portrait with full ROM, of the averaged self-portrait with uneven ROM and of the averaged plain-portrait – presented in the Cross Average Portraits Data Tables – and by converting them into rectilinear silhouettes [*Figure 114 and Plate Thirty-Five*] it's clear that

(1) The averaged plain-portrait is definitely straighter than the compound portrait and both averaged self-portraits even though its back curves in a lot more at the waist – a feature that's almost undetectable in any other of the compared portraits.

(2) The compound portrait bends more profoundly than any of the averaged self-portraits – except for the elbow/wrist segment, which slants more in the averaged self-portrait with full ROM even if the angle of the forearm's back/front boundary is identical in both portraits.

(3) The averaged self-portrait with full ROM and the averaged self-portrait with uneven ROM are very similar – except for the elbow/wrist segment and this segment's back/front boundary, which slant more in the former.



[*Figure 114*]
Rectilinear Portraits, front and lateral views laid separately and superimposed

To go into greater detail, it's visible that

(1a) The inclination of the trapezius point/acromium segment in the averaged plain-portrait is less profound than the shoulder angles in any other of the compared portraits.

(1b) The inclinations of the body circumferences within the averaged plain-portrait are distinct from the counterpart angles within the other three portraits, particularly the bust line's, which is straighter, and the waist's, which slopes down more profoundly.

(1c) The angle of the acromium/elbow segment in the averaged plain-portrait and in the compound portrait – being greater than in both averaged self-portraits – is identical.

(2a) The inclination of the 7th cervical/bust segment and the overall bending of the legs in the compound portrait are greater than in the two averaged self-portraits.

(2b) The inclinations of the apex/waist and waist/hip segments in the compound portrait and in the averaged self-portrait with full ROM are identical as well as being greater than the averaged self-portrait with uneven ROM's.

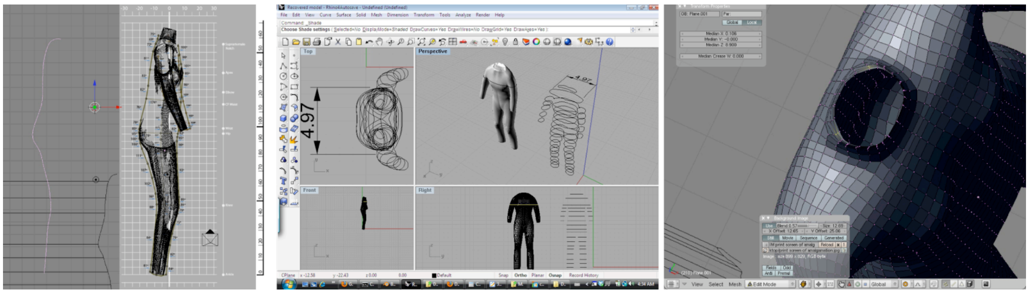
(2c) The space between the arms and the trunk – from the armpits down – as well as the space between both legs – from the crotch down – in the compound portrait is greater than in the two averaged self-portraits.

The comparative analysis made to the four rectilinear portraits corroborates that Hutchinson and Munden's approach is appropriate, as the borrowed method of obtaining an average body shape, attained step by step, brought about a verisimilar result.

In fact, apart from the enumerated differences existing between the compound portrait and the averaged plain-portrait, the front silhouette of the former is related to the latter's in terms of overall width, a property's dimension that isn't maintained in the rectilinear self-portraits. This detail alone shows that the five-step process ensured that the silhouette curves of the body – static or mobile – were kept throughout the derivation of the compound portrait.

The subsequent translation of the mobile body's flat representation into the digital three-dimensional mannequin was attained through Blender, a 3D graphics application. The modeling process started with the creation of a polygon mesh; using the front and lateral silhouettes as guidelines, the mesh was progressively refined by displacing vertices with standard editing tools and the Proportional Edit modifier [*Figure 115, left and right*].

Every so often the digital model was exported to Wavefront Object – i.e., .OBJ file format – and then imported to Rhinoceros 3D CAD design software [*Figure 115, center*] to check if the bust, waist, hip, wrist and ankle girth dimensions conformed to the standard body measurements for Euro size 38 – namely, 88cm, 68cm, 93cm, 16cm and 24cm, respectively – presented in Aldrich's size chart (1997: 15).



[*Figure 115*]
Designing The Tangible Mannequin, print screens

Ultimately the digital fabrication of the tangible mannequin was made using a CNC milling machine. The prototype was made of high density Styrofoam, as it is a lightweight rigid cellular plastic material that costs relatively little in comparison with other materials in the same category – e.g., flexible polyurethane foam or glass-reinforced polyester.

Designing On The Mobile Body

[*The Implicated Basic Features*]

Besides the aim of giving a physical form to the mobile body, the purpose of creating a tangible mannequin had to do with the decision to design the alternative set of basic patterns using the qualitative, three-dimensional, cutting approach instead of the quantitative, two-dimensional, method.[183]

Methodologically the two- and three-dimensional techniques are diametrically opposed: to begin with, flat pattern design involves applying the slashing/spreading and pivoting/transferring methods to manipulate basic

[183] With the exception of the basic sleeve pattern, as explained in p. 257.

patterns whereas draping involves manipulating fabric directly on the body or on a tangible mannequin.

Owing to the distinct ways of solving problems, in the first instance the result of the pattern drawn on paper “only reveals itself after it has been executed in cloth” whereas in the second instance “the result [of the pattern molded on fabric] is immediately visible, at any moment” (Duburg and Van der Tol 2008: 9).

Choosing draping over flat pattern design made it easier to see what the alternative basic patterns should look “in relationship to the figure” (Amaden-Crawford 1996: 1) as they were being generated. Developing design and pattern simultaneously made it easier to identify “where possible corrections [were] needed and what the cloth itself ‘want[ed]’” (Duburg and Van der Tol 2008: 9) while the patterns were being draped.

Even though the three-dimensional technique is not bound to mathematical calculations, the shape of the body – or of its surrogate – and the textile to be used keep the design process within limits (Duburg and Van der Tol 2008: 9). About the first restriction, the Belgian fashion designer Tim van Steenbergen emphasizes that “clothing should be wearable. The design should not dominate, but always serve the person wearing it” (as quoted in Duburg and Van der Tol 2008: 23); therefore, minding the body on which the pattern is molded – its dimensions and proportions – as well as the potential wearer’s – inherently deformable – is of great relevance.

Regarding the second restriction, the American author Connie Amaden-Crawford (1996: 12) calls attention to the fact that “the fabric selected for a garment greatly influences the finished look;” thus, minding the weight of the muslin with which the pattern is draped helps simulating the draping quality of the textile with which the garment will be produced (Amaden-Crawford 1996: 4; Duburg and Van der Tol 2008: 31).

Involving physics, the draping quality of a textile manifests itself in the way it reacts to the force of gravity: structural fabrics have the ability “to stay in place, rather than collapse when released” while fluid fabrics flow over the body, following its figure (Baugh 2011: 52, 133). Gail Baugh adds that the first type of fabrics provide shape by themselves, the second type do not support themselves (2011: 52, 133).

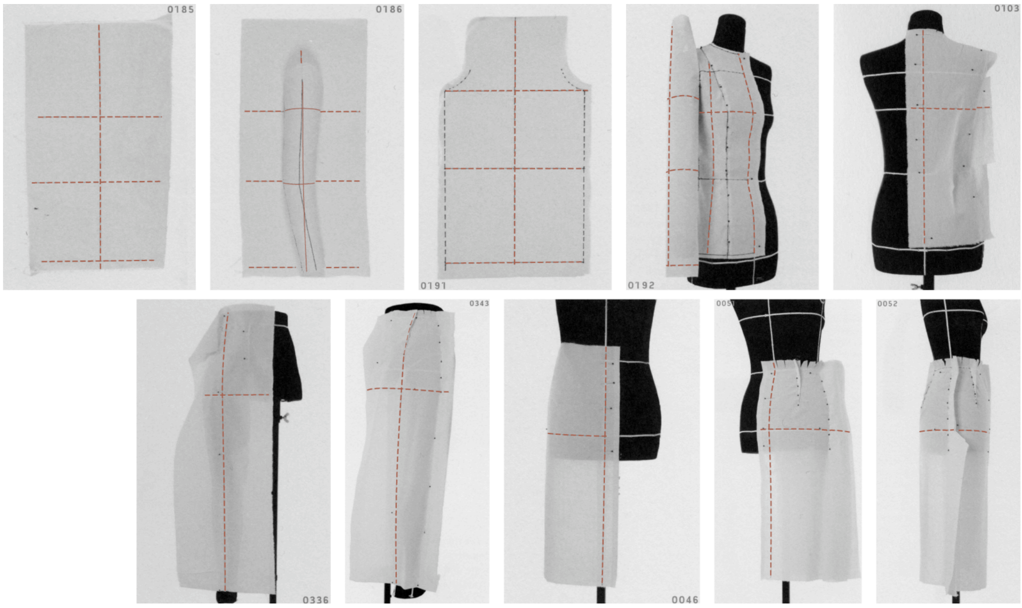
"To subvert the relentless force of gravity" – as the physicists and mathematicians E. Cerda, L. Mahadevan and J. M. (2004: 1806) characterize the work of a draper –, a designer decides which is the most suitable grain direction of the fabric for the planned design. On this very subject, Baugh (2011: 25) writes,

> *Designers use the straight grain for strength and to keep the fabric close to the body [...] The direction of cross-grain wovens will provide a little 'give' or slight expansion of the fabric, which can accommodate normal body expansions such as sitting or breathing [...] Bias is a very creative grain because it can cause a fabric to become stretchable as well as flexible or drapery.*

Easily identifiable **(1)** the straight or length grain, coinciding with the warp threads, is parallel to the material's selvage, **(2)** the cross grain, coinciding with the weft yarns, runs perpendicular to the lengthwise grain, and **(3)** the true bias is at a precise 45° angle from the straight and cross grains of the fabric.

With regard to basic patterns, the intended outcome is that they "hang straight up and down and be parallel to the floor," as pointed out by Amaden-Crawford (1996: 17).[184] For that reason drapers align **(a)** the straight grain of the fabric on the center of the mannequin's torso, for bodices and skirts, and arms and legs, for sleeves and pants, as well as **(b)** the crosswise grain on the bust level, for bodices, biceps level, for sleeves, and hip level for skirts and pants [*Figure 116*]. By doing so, drapers ensure that the correct balance between the garments' front and back is maintained (Amaden-Crawford 1996: 17).

[184] No matter if they're created by draping or by flat pattern design.



[*Figure 116*]
Alignment Of Fabric Grains On A Mannequin's Torso, Arm And Leg, photos of basic sleeve, torso, pants and skirt being draped (Duburg and Van der Tol 2008: 44-45, 64-65, 92-93, 138-139)

Usually tangible mannequins are supplied with seams and tapes that signal "the different axes that are necessary for garment construction by draping" (Wargnier 2009: 31). Suitably, the following key body landmarks with black cotton ribbon [*Figure 117, bottom*] were marked on the produced Styrofoam tangible mannequin [*Figure 117, top*]:

> **(1)** The lines that divide the body horizontally – referred to as the *bust*, *waist*, *hip*, *neck*, *elbow*, and *knee* levels.
>
> **(2)** The lines that separate the right and left of the body –otherwise known as *center front* and *center back*.
>
> **(3)** The lines that demarcate the front and back of the body – also known as *side seams*, *inseam*, *shoulder seams*, and *upper arm* and *underarm seams*.

Although the drawing of the compound-portrait was used as an aid to lining up the boundary lines on the tangible mannequin,[185] their positioning had to change slightly so that they suited the three-dimensionality of the mannequin better.

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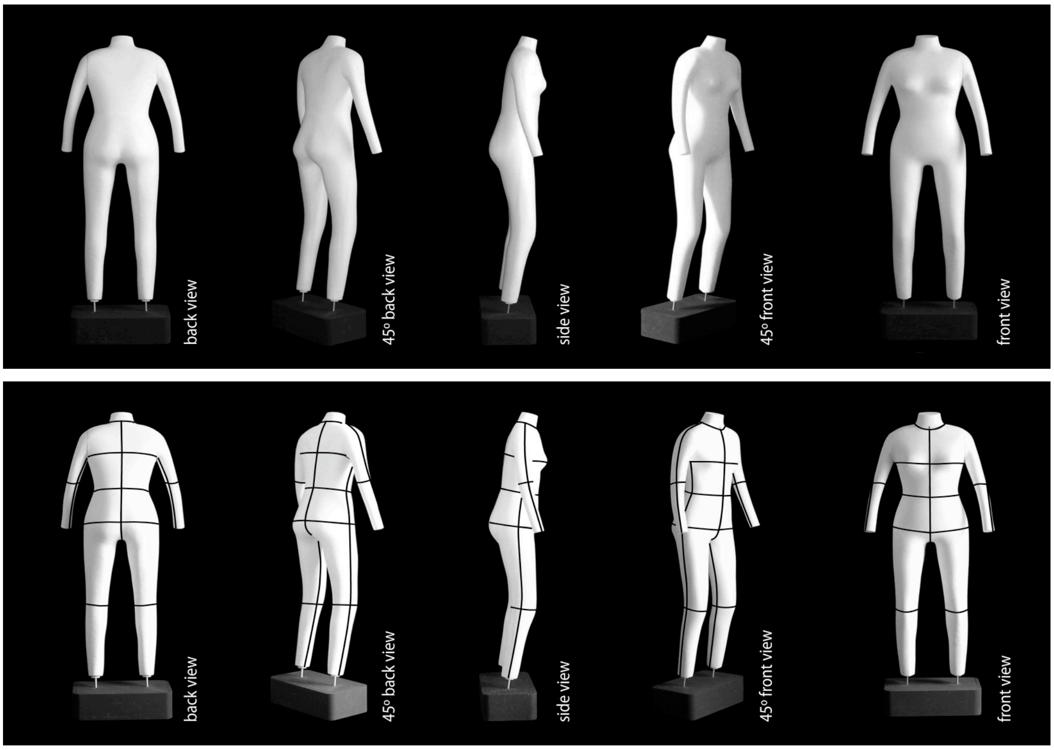
185 See [*Figure 113*], p. 241.



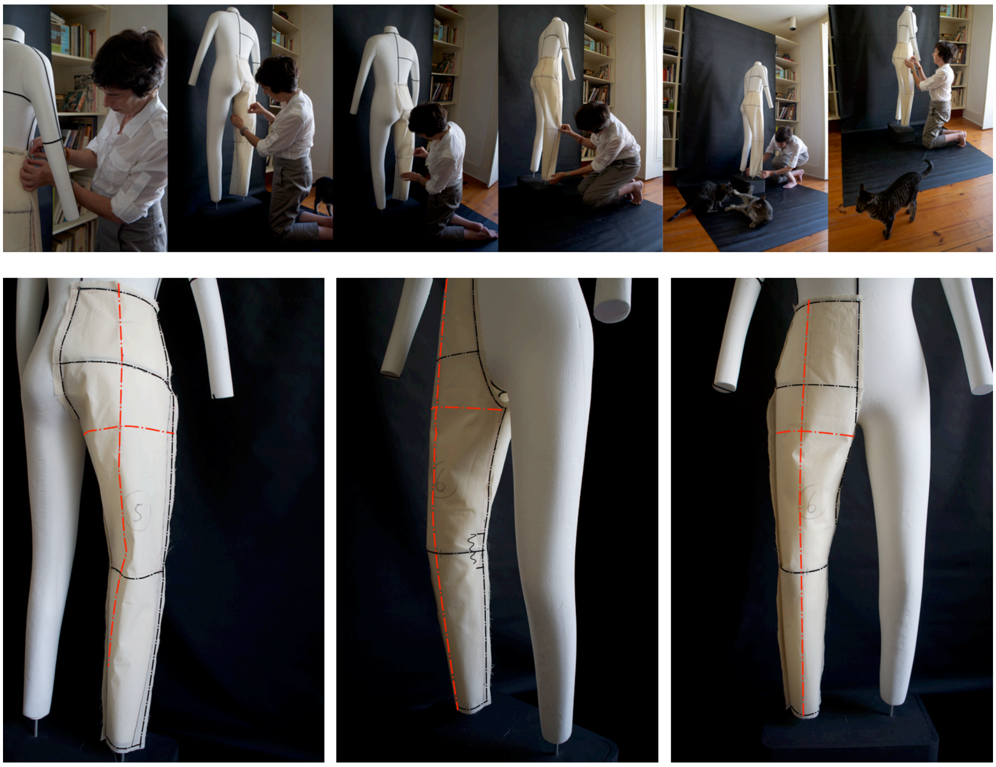
[*Figure 117*]
The Tangible Mannequin Without And With Tape On Key Body Landmarks

Following Amaden-Crawford's advice, the basic patterns began to be made keeping in mind that "sufficient time [had to be] allowed to drape, fit, readjust, and refit before [the] finished set of patterns [was] prepared" (1996: 27). Two reasons justify the author's recommendation, namely **(a)** the fact that American clothing manufacturers usually drape basic patterns instead of drafting them, and **(b)** the importance of this type of patterns for the development of clothing.

The process of draping on the alternative mannequin was analogous for the basic pants and torso, from preparing the muslin to shaping the pattern pieces:

(1) Only the right leg of the pants and the right of the torso were draped since the tangible mannequin is symmetrical [*Figures 118 and 119*].

(2) Four rectangular pieces of muslin were cut exceeding in about five centimeters the length and width of the mannequin's top and bottom, back and front, sections, respectively.



[Figure 118]

Draping The Basic Pants On The Alternative Tangible Mannequin, photos of back and front pattern pieces by Luísa Barreto with highlighted seams, grains and lines

[Figure 119]

Draping The Basic Torso On The Alternative Tangible Mannequin, photos of back and front pattern pieces by Luísa Barreto with highlighted seams, grains and lines

(3a) Grain lines were marked on the muslin panels to function as vertical guidelines.

(3b) Cross grain lines were marked on the muslin panels to serve as horizontal guidelines.

(4a) The vertical guidelines were pinned to the middles of the leg, for the pants [*Figure 118, bottom*], and to the centers of the upper body, for the torso [*Figure 119, bottom*] – first the back section, then the front.

(4b) The horizontal guidelines were pinned to the crotch depth line on the leg [*Figure 118, bottom*], and to the bust level on the upper body [*Figure 119, bottom*] – first the back section, then the front.

(5) Working on the back and front sections separately, the leg and upper body's outside edges were marked on the muslin panels [*Figures 118 and 119, bottom*].

(6) The excess fabric that fell between the side seams and centers – and/or inseams – of the pants and torso's back and front pattern pieces became darts so that the pattern pieces followed the curves of the mannequin, respectively.

(7) The back and front pattern pieces of the pants and torso were pinned together to check their fit on the tangible mannequin in relation to *line*, *balance*, and *set* [*Figures 118 and 119, bottom*].[186]

(8a) The fabric pattern pieces of the pants and torso were trued up onto paper.

(8b) The joining lines of the pants [*Figure 120 and Plate Thirty-Six*] and torso [*Figure 121 and Plate Thirty-Seven*] were superimposed to check that they matched in length and/or flowed as one.

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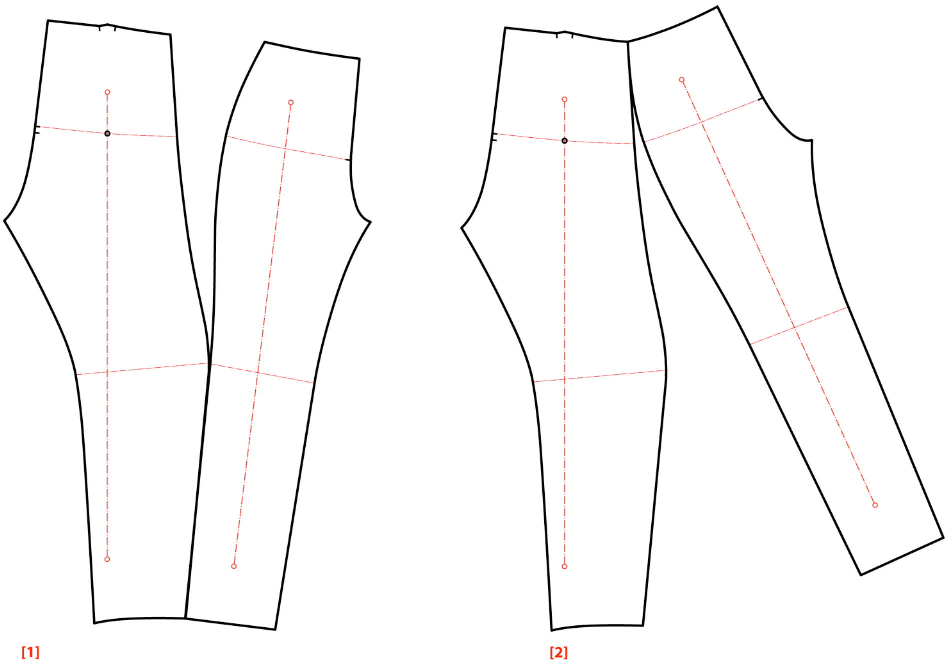
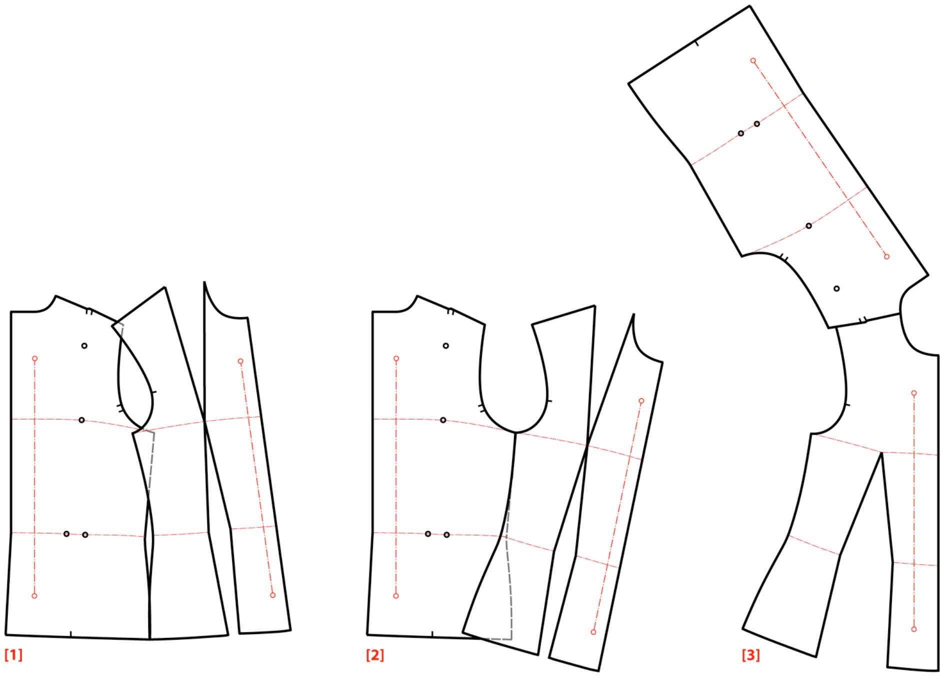
186 See Antecedents Of The Research, p. 68.



[*Figure 120*]
Truing Up The Draped Basic Pants

To be precise the side seam lines of the draped basic pants were joined from top to bottom to check whether or not the ankle level [*Figure 120, left*] and the waistline [*Figure 120, right*] had to be readjusted.



[*Figure 121*]
Truing Up The Draped Basic Torso

Regarding the draped basic torso, the side seam lines and shoulder seam lines were joined from top to bottom to check whether or not the hip level [*Figure 121, left*], the armholes [*Figure 121, center*] and the neckline [*Figure 121, right*] had to be rearranged.

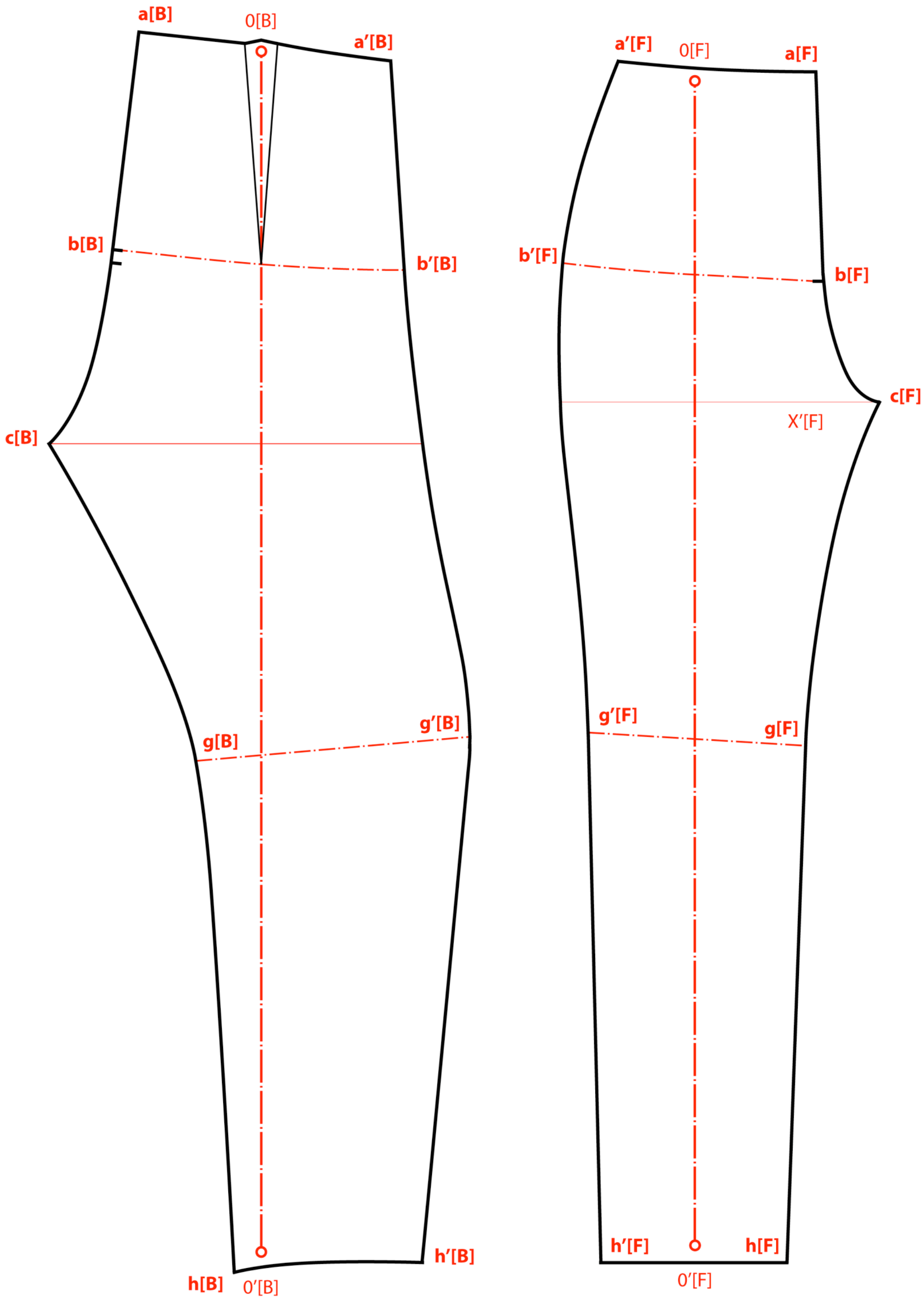
To be frank, draping the basic pants on the alternative mannequin was somewhat difficult. The series of considerably convex and concave surfaces of the legs, forming different angles, make it trickier to mold a textile – however pliable it is – into them than into the straight legs of conventional dress forms [*Figure 122*]. The solution to this problem is to supply some ease to the fabric pattern, particularly to the back piece from the 'crotch depth line' to the calf and to the front piece around the knee area.

[*Figure 122*]
Conventional 'Neck To Ankle' Forms, photos from www.kickstarter.com

After the draped pattern were removed from the mannequin it was manifest that the overall form of the pants resembles the outlines of the *Levi's Engineered Jeans* pattern[187] seeing that from the hip level down, both the side seam and inseam lines of the back pattern piece arch to the right – or far away from the middle, the side seam line, and close to the middle, the inseam line, to the extent that that it almost meets the grainline of the pattern – while the matching lines in the front pattern

[187] See [*Figure 33*] in Antecedents Of The Research, p. 110.

piece are aligned more vertically and equidistantly relative to/from the middle [*Figure 123 and Plate Thirty-Eight*].



[*Figure 123*]
The Draped Basic Pants Pattern, the back and front pattern pieces

In the graphic representation of the basic pants pattern [*Figure 123 and Plate Thirty-Eight*] it's also easy to see that the crotch depth line isn't at the same level in both pattern pieces – being much lower at the back pattern piece than at the front – and that the ankle line curves downward in the back pattern piece while the front's is perfectly horizontal.

Ultimately the main points of the draped pants' back pattern piece [*Figure 123 and Plate Thirty-Eight, left*], introduced clockwise, are listed next:

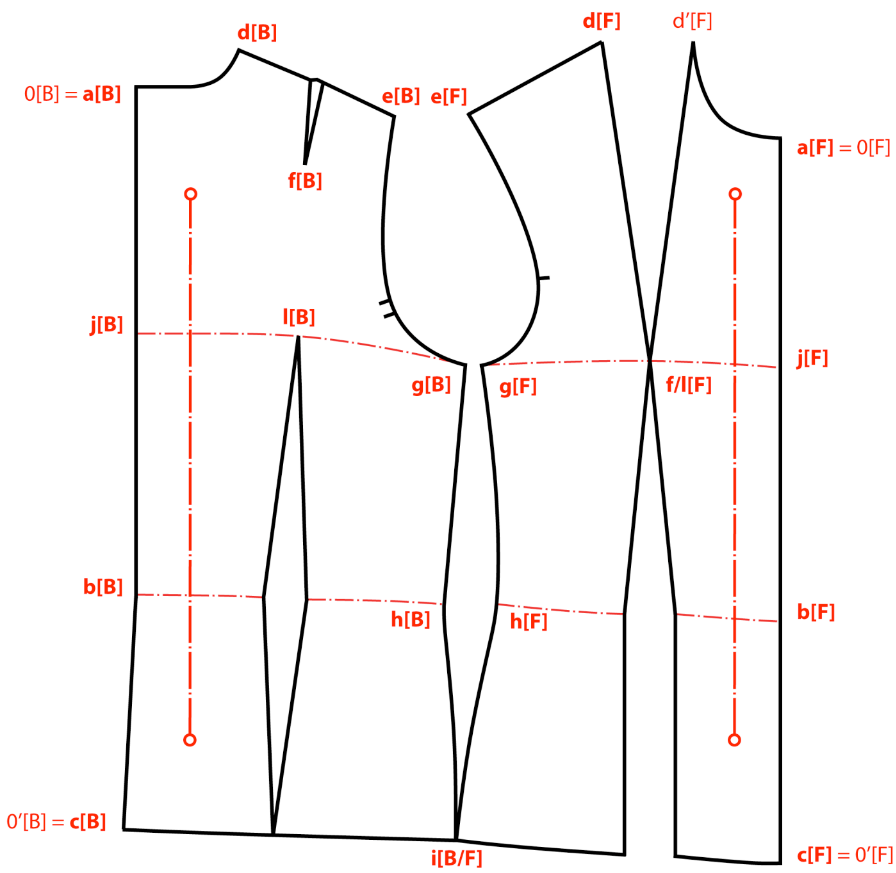
> **(1)** [0[B]-0'[B]] is the axis from which the back pattern piece develops, which matches the straight grain of the fabric.
>
> **(2)** The bottom point of the dart that shapes the waistline [a[B]-a'[B]] is positioned on the hip level [b[B]-b'[B]]; the center of the dart lies on top of the axis.
>
> **(3)** The side seam line comprises points [a'[B]-b'[B]- g'[B]- h'[B]].
>
> **(4)** The knee level is positioned on segment [g'[B]-g[B]].
>
> **(5)** The ankle level is positioned on segment [h'[B]-h[B]].
>
> **(6)** The inseam line comprises points [c[B]-g[B]-h[B]].
>
> **(7)** The crotch line comprises points [a[B]-b[B]-c[B]].

Also introduced clockwise, the main points of the draped pants' front pattern piece [*Figure 123 and Plate Thirty-Eight, right*] are listed below:

> **(1)** [0[F]-0'[F]] is the axis from which the front pattern piece develops, which matches the straight grain of the fabric.
>
> **(2)** No dart is required to shape the waistline [a[F]-a'[F]].
>
> **(3)** The hip level is positioned on segment [b[F]-b'[F]].
>
> **(4)** The crotch line comprises points [a[F]-b[F]-c[F].
>
> **(5)** The inseam line comprises points [c[F]-g[F]-h[F]].
>
> **(6)** The knee level positioned on segment [g[F]-g'[F]].
>
> **(7)** The ankle level is positioned on segment [h[F]-h'[F]].
>
> **(8)** The side seam line comprises points [a'[F]-b'[F]-g'[F]-h'[F]].

Draping the basic torso on the alternative tangible mannequin was much simpler than to design the basic pants, as its series of convex and concave surfaces and the different angles they formed – manifested through the projection of the bust toward the front and of the hip and buttocks toward the back – don't make it necessary for a draper to devise a special approach.

Despite the fact that the draping process was unproblematic – and that the alternative basic torso looked similar to a conventional basic torso when it was still on the created mannequin –, after removing the draped pattern pieces from the mannequin it was noticeable that its graphic, two-dimensional, representation appears to be somewhat off-center – as the center back line seems to tilt toward the right, probably because it slants toward the left from the waistline to the hip level [*Figure 124 and Plate Thirty-Nine*].



[*Figure 124*]
The Draped Basic Torso Pattern, the back and front pattern pieces

In the two-dimensional representation of the three-dimensional basic torso pattern it's also easily seen that the hip level drops unevenly, particularly from the side seam line to center front, and that the center of the back double-ended dart isn't parallel to the center back's longest part – located above the waistline – nor to the grainline of the pattern. In addition, the back and front armholes don't meet at the bust level, which, together with all the features described previously, reinforce the idea that the mobile body's torso is a bit skewed [*Figure 124 and Plate Thirty-Nine*].

Ultimately the main points of the draped torso's back pattern piece [*Figure 124 and Plate Thirty-Nine, left*], introduced clockwise, are listed below:

(1) [0[B]-0'[B]] is the axis from which the back pattern piece develops, which matches the straight grain of the fabric from point [a[B]] to point [b[B]].

(2) Center back comprises points [a[B]-j[B]-b[B]-c[B]].

(3) The neckline is contained by points [a[B]] and [d[B]].

(4) The shoulder line is contained by points [d[B]] and [e[B]].

(5) The center of the shoulder dart begins at the middle point of the shoulder line and slopes inward 1cm to point [f[B]].

(6) The armhole comprises points [e[F]-g[F]].

(7) The bust level is positioned on segment [j[B]-l[B]-g[B]].

(8) The side seam comprises points [g[B]-h[B]-i[B]].

(9) The waistline is positioned from points [b[B]] to [h[B]].

(10) The hip level is positioned on segment [c[B]-i[B]].

(11) The top point of the double-ended dart passing through the waist is [l[B]] and the bottom point is positioned on the hip level [c[B]-i[B]].

Also introduced clockwise, the main points of the draped torso's front pattern piece [*Figure 124 and Plate Thirty-Nine, right*] are listed as follows:

(1) [0[F]-0'[F]] is the axis from which the front pattern piece develops, which matches the straight grain of the fabric from point [a[F]] to point [c[F]].

(2) Center front comprises points [a[F]-j[F]-b[F]-c[F]].

(3) The bust level is positioned on segment [j[F]-f/l[F]-g[F]].

(4) The waistline is positioned on points [b[F]] and [h[F]].

(5) The hip level comprises points [c[F]] and [i[F]].

(6) The side seam line comprises points [g[F]-h[F]-[i[F]].

(7) The armhole comprises points [e[F]-[g[F]].

(8) The shoulder line is contained by points [e[F]-[d[F]/[d'[F]].

(9) The bust dart comprises points [d[F]-[d'[F]-[f[F]], the latter is positioned on the apex.

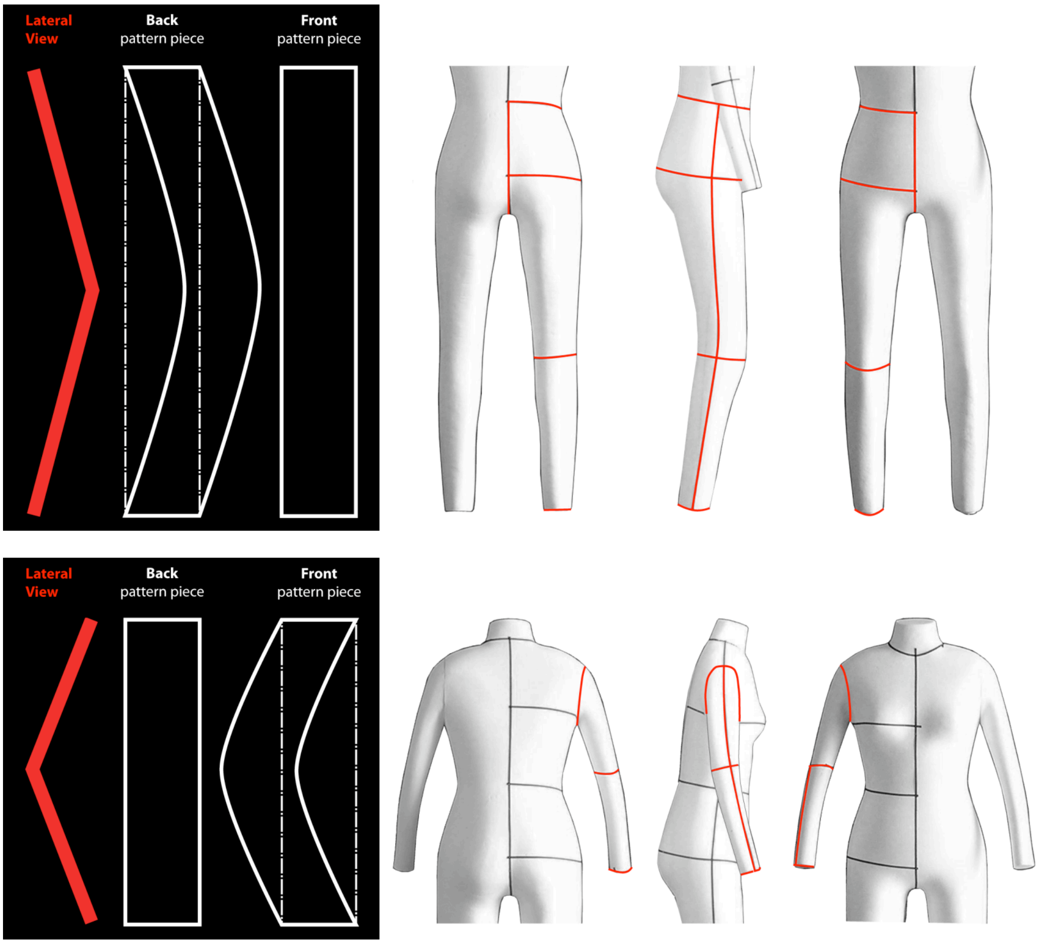
(10) The top point of the double-ended dart passing through the waist is [l[F]], also positioned on the apex; the bottom dart legs are parallel to one another, to center front and to the pattern piece grainline.

(11) The neckline is contained by points [a[F]]-[d[F]/[d'[F]].

The basic, set-in, sleeve pattern was developed in two-dimensions because it "can be drafted with a great deal more accuracy than by draping," as stated by Amaden-Crawford (1996: 78). The word 'accuracy' employed by the author stands for the ability of the pattern designer to reproduce the size and the position assumed by an arm, which in this particular situation was problematic as the arms of the produced tangible mannequin lost some accuracy during the modeling process – namely the way the convex and concave surfaces alternate in actual arms and form different angles.

In spite of the method used, after it was drafted on paper, the two-piece sleeve was fitted into the created basic torso to check **(a)** the relationship of the sleeve cap and the armhole, as well as **(b)** the relationship of the whole sleeve and the arm of the created tangible mannequin.

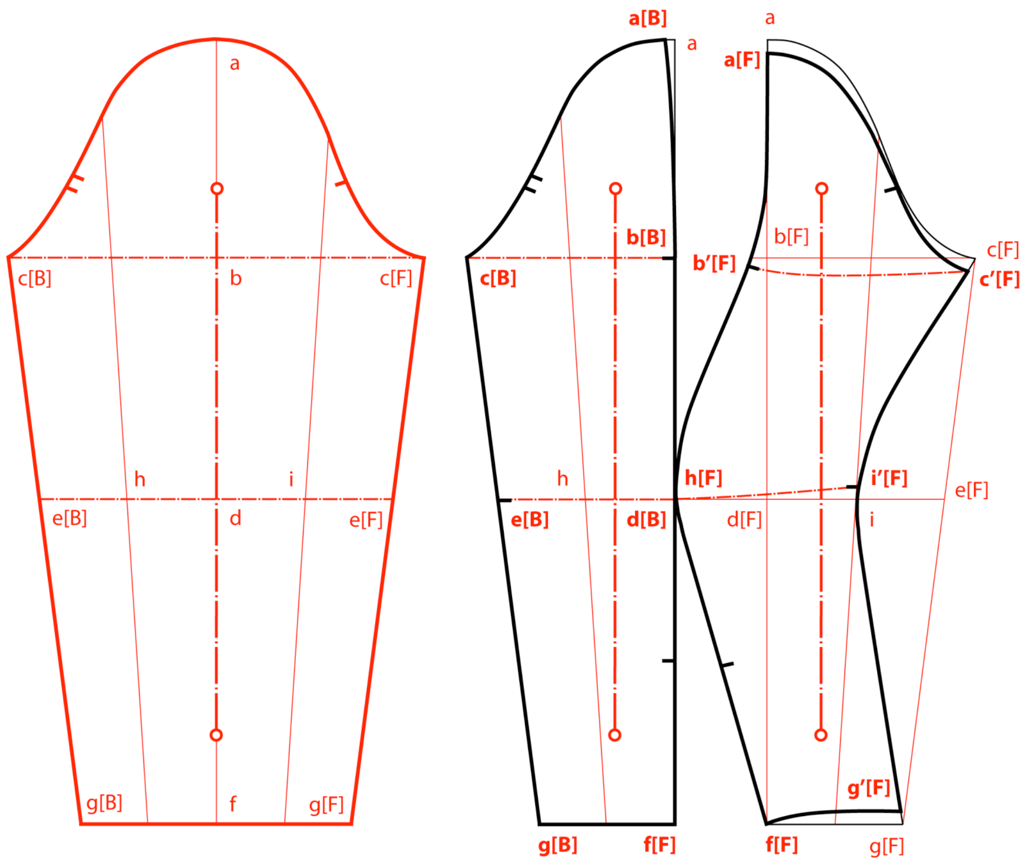
Designing a sleeve pattern for the mobile body involved taking into account **(1)** the overall bending of the arms, **(2)** the forward projection of the elbows and wrists, and **(3)** the increased space between the arms and trunk from the armpits down [*Figure 125, bottom*]. Recalling that the legs of the mobile body assumed the inverse posture [*Figure 125, top*], a possible way of creating the alternative basic sleeve pattern was to draw it as a reverse image of the pants [*Figure 125, left*].



[*Figure 125*]
Idea For The Mobile Body's Basic Sleeve Pattern, schematic back and front pattern pieces of the pants and sleeve

In practical terms, this idea implied, first of all, to split the pattern of a one-piece sleeve – drafted according to the conventional layout [*Figure 126 and Plate Forty-One, left*] – into two pieces, divided into two sections respectively – [h] and [i] in [*Figure 126 and Plate Forty-One*] being the dividing lines.

Lastly, it implied to redraw the outlines of the back and front pattern pieces according to the devised strategy [*Figure 126 and Plate Forty-One, right*].



[*Figure 126*]
The Basic Sleeve Pattern Drafted After The Mobile Body, conversion of the one-piece sleeve into the two-piece sleeve

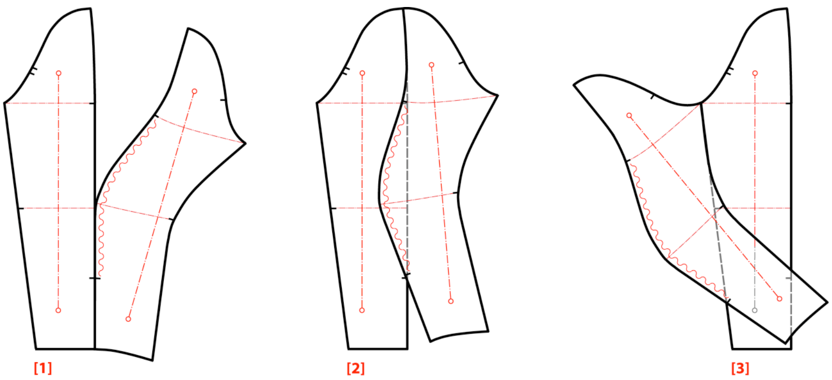
(1) In the same way as the side seam and inseam lines of the pants' front pattern piece stayed virtually vertical and relatively equidistant from the dividing line, the back pattern piece of the sleeve remained unchanged except for the sleeve cap – as point [a] was moved to the left to remove ease.

(2) In the same way as the side seam and inseam lines of the pants' back pattern piece arched a great deal to the right, the original elbow level of the sleeve's front pattern piece – segment [e[F]-d[F]] – was placed on top the dividing lines [h-i]; accordingly the shoulder seam line and the under seam line arched to the left.

(3) In the front pattern piece, the points [a] and [c[F]] on the sleeve cap and armhole depth line were dropped to create a gap between the whole sleeve and the bodice.

(4) In the process of truing up the back and front pattern pieces, the front pattern piece's elbow and wrist levels were raised where they intersected the under seam line so the latter matched the back pattern piece's under seam line in relation to its length *[Figure 127 and Plate Forty-One]*.

(5) The amount by which the front pattern piece's shoulder seam line exceeds its counterpart in the back pattern piece is maintained to be eased in from the armhole depth line to a notch marked 12.5cm above the wrist level *[Figure 127 and Plate Forty]*.



[Figure 127]
Truing Up The Drafted Basic Sleeve

As a result the main points of the drafted two-piece sleeve *[Figure 126 and Plate Forty-One, right]*, introduced clockwise, are,

For the back piece:

(1) The center of the sleeve [a[B]-b[B]-d[B]-f[B]] aligns with the shoulder line.

(2) The armhole depth line is contained by points [b[B]-c[B]] and aligns with the bust level.

(3) The elbow level is contained by points [b[B]-h-e[B]] and aligns with the waistline.

(4) The wrist level is positioned on points [f[B]] and [g[B]].

(5) The under seam line is contained by points [c[B]-e[B]-g[B]].

(6) The sleeve cap is contained by points [a[B]-c[B]].

(7) The segment [b[B]-[f[B]] is parallel to the straight grain of the fabric.

For the front piece:

(1) The center of the sleeve [a[F]-b'[F]-h[F]-f[F]] aligns with the shoulder line.

(2) The sleeve cap is contained by points [a[F]-c'[F]].

(3) The under seam line is contained by points [c'[F]-I'[F]-g'[F]].

(4) The armhole depth line is contained by points [b'[F]-c'[F]] and aligns with the bust line.

(5) The elbow level is contained by points [i'[F]-h[F]] and aligns with the waistline.

(6) The wrist level is positioned on points [f[F]] and [g[F]].

(7) The segment [a[F]-b[F]-d[F]-f[F]] is parallel to the straight grain of the fabric.

Summary

Divided into three sections, Part Four describes the process of creating the artifact, a twofold object made up of a tangible mannequin and a set of basic patterns, both reflecting the mobile body.

Admitting right from the start that I'm more appealed to "the fluid, evolving, and dynamic nature" of qualitative work than "to the more rigid and structured format of quantitative methods" (Corbin and Strauss 2008: 13), the first section of Part Four discusses **(1)** why the research question determined that qualitative approach be adopted, **(1a)** why data collection drew on a sampling strategy resembling *theoretical sampling,* and **(1b)** why it relied on the practice of *artifactualization* to collect data.

The Self-Portraits that eleven women – aged 19 to 48 and representatives of Euro standard sizes 36 and 38 – voluntarily produced for this research are, then, analyzed as it had to be found out what the particular *projected reality on the* *plane* was made up of, i.e., **(i)** what activities and associated movements were carried out throughout the process of self-modeling, and **(ii)** what was their rate of recurrence throughout the process of self-modeling.

The second section of Part Four identifies **(1)** the categories that form the *deformation pattern*, as they consistently emerged on the first garments: **(1a)** the forward inclination acquired by the bodice, **(1b)** the curved/angled shape acquired by the sleeves, and **(1c)** the curved/angled shape acquired by the trouser legs.

Then, by adapting R. Hutchinson and D. L. Munden's experimental method, **(2)** the contour lines of the selected self-portraits – marked on photos capturing each from four orthogonal views – into to a *compound portrait* were merged, and used **(3)** to *develop a tangible mannequin* that, standing for the *mobile body*, was used as a tool *on which* the presented basic patterns were *designed*.

Finally, the third section of Part Four describes, one after another, the pants, torso and sleeve blocks that form the generated alternative set of basic patterns, hinting how the respective back and front pieces deviate from their conventional counterparts.

The aim to present an overarching theoretical explanatory scheme about the studied problem requires that the validity of the produced artifact, or its value, be verified. Thus, Part Five, Form Follows Action looks at how the resulting patterns bring about the illusion of the portrayed entity **(1)** from the perspective of *visual representation*; then, **(2)** from the *perspective of the dressed body*, it looks at how the second garments – made from the resulting patterns – were perceived by a group of six women aged 19 to 41, who wear Euro standard sizes 36 and 38, while they performed varied indoors and outdoors generic activities.

5 Form Follows Action

Introduction

Presumably every practicing architect and designer born in the second half of the 20th century is familiar with Louis Sullivan's dictum *form follows function*,[188] particularly because it became known as the "shorthand summary of the ambitions of the modernist architects and designers" (Michl 1995). Presumably even those who grew up when postmodernism was rising were taught to value an aesthetic of minimal form and to disdain capricious choices or unnecessary detail.

Perhaps, then, the adaptation of the well-known formula into the less alliterative principle *form follows action* is a legacy of the modernist movement. In fact, in the same way as modernists adopted Sullivan's dictum as a design precept (Michl 1995), the replacing phrase intends to express an alternative way of thinking in pattern design. But unlike the manifestations of the modernists' principles, the replacing phrase doesn't intend to suggest that pattern design should seek simplicity in form.

The truth of the matter is that patterns, basic and clothing, were always meant to portray only the essential. All the same, the full implication of the *form follows action* principle is patent in the shapes of the created patterns, as they give a visible form to the ever-varying deformable body.

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[188] See footnote 88 in Antecedents Of The Research, p. 83.

By substituting the word function with the term action in one of Jan Michl's (b. 1946) sentences it may questioned – like the professor of history and theory of design does about the modernist formula – if the phrasing *form follows action* also "hides a remarkable claim, namely that [action] is something that precedes form, that it exists independently of form, that it is there before form emerges" (1995).

The starting point of Michl's discussion is that architects and designers are makers of things – unlike scientists, who are observers of things. In that quality, architects and designers subscribe a notion of function that equals the notion of purpose. The *intended* functioning of an artifact – or its anticipated purpose and performance – is, thus, what architects and designers aim to interpret visually: "they [...] start from forms at hand and see how any of them could be used, whether unchanged or redesigned, to solve the particular task" (Michl 1995).

Before returning to the question submitted in the penultimate paragraph, one of the arguments behind Sullivan's dictum (Sullivan 1896) is presented,

> *All things in nature have a shape, that is to say, a form, an outward semblance, that tells us what they are, that distinguishes them from ourselves and from each other. Unfailingly in nature these shapes express the inner life, the native quality, of the animal, tree, bird, fish, that they present to us; they are so characteristic, so recognizable, that we say, simply, it is 'natural' it should be so.*

Seen in this light it looks like 'action' precedes 'form' since the outward appearance of the body indisputably expresses its inner movement. As communicated in Part Four, the process of solving the particular task of representing the mobile body when no forms were at hand[189] was based on the hypothesis that "it is of the very essence of every problem that it contains and suggests its own solution" (Sullivan 1896).

Not that Sullivan regarded his *form follows function* dictum as a working hypothesis. On the contrary, he viewed it as "a summary of a metaphysical belief

[189] Actually until the end of action **(1c)** – phase three of the artifact's creation – how the alternative basic patterns ought to look and how they would end up looking was not known.

applied to design" (Michl 2009: 283). Suggesting that anything in the world, natural and manmade, is the result of a transcending intelligence, the dictum implied that architects and designers should renounce their aesthetic views as well as the clients' demands and "become a medium through which the pre-ordained solutions would find their true expression" (Michl 2009: 276).

This idea, however demeaning it sounds, was actually fascinating to the modernists architects and designers: viewing it as a *carte blanche*, it confirmed their higher status and artistic autonomy not counting that it authorized them to "go forward with [their] designs whether people like it or not" (Michl 2009: 276). But although it is appealing to back the modernists view about the market's mechanism of supply and demand interfering with the creative act – and that I believe that the mobile body is in the formal solutions communicated in this dissertation –, the idea that the generated basic patterns are only valid if they meet the actual functioning of the body, i.e., its *action*, is supported.

For that reason the phrase Form Follows Action takes in Part Five a descriptive sense. Divided into two sections, the first concerns The Internal Validity Of Form, as it is about the act of establishing the truthfulness of the formal solutions *within the territory of visual representation*. In this ambit the generated basic patterns are described by focusing on the developed illusions of the mobile body; to illustrate this point **(1)** the alternative patterns were placed against their conventional counterparts, as well as **(2)** their prototypes – assembled in muslin – against the conventional prototypes – also assembled in muslin.

Then, The External Validity Of Form, the second section of Part Five, imparts *the perspective of the dressed body* on the generated basic patterns. Wearing alternately the two sets of prototypes made from the mobile body and static body slopers, six women – aged 19 to 41 and representing Euro standard sizes 36 and 38 – execute generic actions through a path that was designed to include both outdoor and indoor settings.

Surprisingly, even though it was hoped that the basic patterns generated after the mobile body were appraised higher than the conventional ones in terms of action comfort, it was never expected that they'd also be favored in terms of form.

The Internal Validity Of Form

[*A Description Within The Territory Of Visual Representation*]

In the article "The tall office building artistically considered," the American architect Louis Sullivan (1896) used repeatedly the phrase *form ever follows function*. Abridged by the American architect Dankmar Adler (1844-1900) a few months later (Michl 1995),[190] the three-word alliterative formula became the "*the* gist of the modernist philosophy of design" (Michl 2009: 279).

By adding a "comprehensive formula" to the catchy dictum, Sullivan proposed a definition of form – or shape, outward expression, design "or whatever we may choose" as synonym (Sullivan 1896) – that is inseparable from "the inner life, the native quality" of every single thing, be it organic or inorganic, physical or metaphysical. The essential point of his argument was that, if all things in nature are recognizably different from one another, the design of tall office buildings should not follow "any theory, symbol, or fancied logic" advocating any of the many trinities in art and nature as a guide, be it

> *[…] The classical column, consisting of base, shaft and capital […] the day subdividing into morning, noon, and night; the limbs, the thorax, and the head, constituting the body [or] the suitable flower with its bunch of leaves at the earth, its long graceful stem, carrying the gorgeous single flower* (Sullivan 1896).

Sullivan's (1896) closing argument was that, freed from the mystical, historicist, naturalistic, constraints, the design of tall office buildings would find its proper place in architecture; what's more, by recognizing that any form – e.g., oak-tree, knife, engine, church, skyscraper – expresses its purpose or function – i.e., oak, knife, engine, church, skyscraper – and by keeping to design solutions where form and function are in accord with each other, architecture "would certainly become a living form of speech, a natural form of utterance" (Sullivan 1896), it would certainly repossess a language all its own.[191]

Unknowingly Sullivan gave the cue enabling modernist architects and designers to

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[190] Sullivan's senior partner.

[191] For Sullivan (1896), "the Greek temple, the Gothic cathedral, the medieval fortress" are examples of architectural types with a visual identity of their own.

claim their status and artistic autonomy, to develop myriad expressions, every one truly breaking with the past, every one grounded in an aesthetic of minimal form and a loathe of inconsistent, superfluous, detail.

Also unknowingly Sullivan and the subsequent supporters of the formula *form follows function* instigated a dispute. Rejecting the precept as a sort of fallacy, the American architect and design thinker Christopher Alexander (b. 1936) upheld the idea that "what we refer to as design problems are really failures of earlier design solutions to perform satisfactorily" (as quoted in Michl 2009: 284-285).

Implicit in Alexander's assertion is the view that designers start always from past forms to derive new, provisional, ones. So therefore the phrase should be *form follows form*, as claimed by the Polish architect Matthew Nowicki (1910-1950) (Michl 2009: 284).

Actually this alternative to the modernists' formula sounds rather realistic, as learned through Bohm that even creative and original acts of insight are associated with images already available in the mind at some point along the problem-solving or experimental thinking process (2006[1996]: 55).[192] Nowicki's down-to-earth claim is also implied in Corbin and Strauss' viewpoint as the authors defend that "our backgrounds and past experiences provide the mental capacity to respond to and receive the messages contained in data" (2008: 33).

To be honest, the process of designing the basic patterns on the developed tangible mannequin followed the "ten golden rules for draping" spelled out by Duburg and Van der Tol (2008: 41).[193] It could be inferred, then, that the resulting forms were just new versions of the past formal solutions, as they've been produced in accordance with the standard procedure.

Likewise, or because of that, it could be inferred that the replacement of the modernists' slogan with the *form follows action* phrase is also a fallacy. Furthermore, if it departs from Sullivan's idea that "the life and the form [are] absolutely one and inseparable" (1896), the replacing phrase sounds more like a

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[192] See Conceptual Framework, pp. 25-26.

[193] See The Creation Of The Artifact, pp. 248-252.

pleonasm than a design attitude: the words *form* and *action* mean the same for the reason that the body expresses itself through movement.

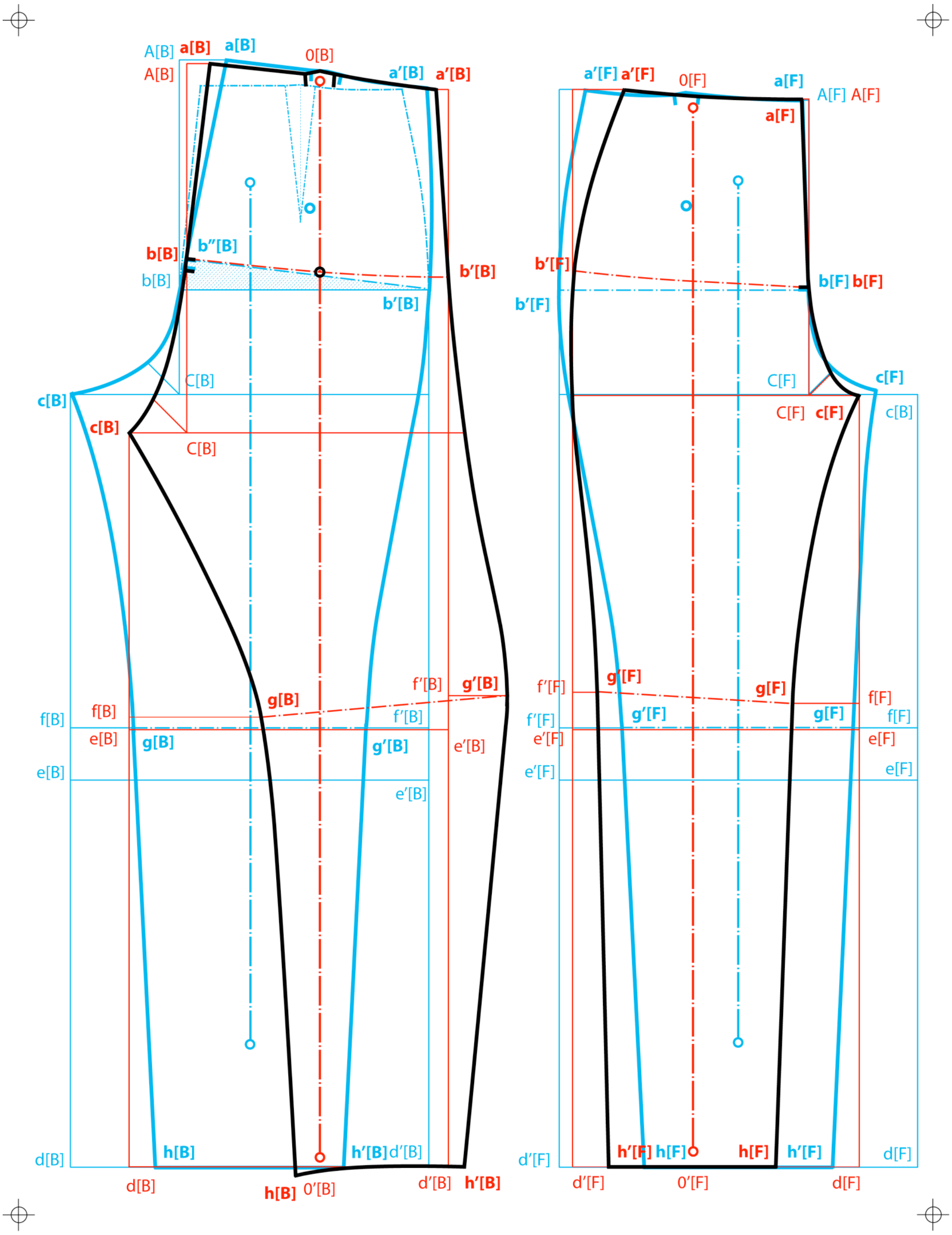
For the sake of argument let's look at the created basic patterns from Nowicki's point of view. So they are placed next to, and over, the corresponding conventional slopers, as it facilitates seeing how much their shapes differ from one another and ultimately how valid is the devised approach toward the representation of the body.

To consider the mobile body basic patterns from the angle of *form follows form* is actually practical because "people are constantly thinking comparatively," as said by Corbin and Strauss (2008: 74). Intrinsic as it is to our nature, comparison making is, thus, a valuable analytic tool for describing an object and comprehending its worth, in this case the created set of basic patterns.

Accordingly the pants, torso and sleeve slopers are presented one after another, that is, in the order in which they were designed. To facilitate the act of examining the three pairs of basic patterns – each pair comprising the conventional pattern and its alternative counterpart – their diagrams include **(1)** all the construction lines from which **(2)** all the key and auxiliary points were derived – or would be only if the alternative pants and torso slopers were formed using the two-dimensional pattern design technique –, plus **(3)** their grain lines.

Furthermore the three pairs of diagrams are superimposed as follows: **(i)** keeping the grain lines of the pants parallel to each other, the crotch lines of one pattern are placed over the crotch lines of the other by overlapping the respective key points in the hip levels, **(ii)** keeping the grain lines of the torsos parallel to each other, the center lines of one pattern are placed over the center lines of the other by overlapping the respective key points in the bust levels, and **(iii)** keeping the grain lines of the sleeves parallel to each other, the center lines of one pattern are placed over the center lines of the other – i.e., the upper seams – by overlapping the respective key points in the armhole depth lines and elbow and wrist levels.

Regarding the generated basic pants pattern, the superimposition of the corresponding layouts of the mobile body's block – diagrammed in black and red – and of the static body's sloper – diagrammed in blue – clearly shows that **(a)** the two back pieces are substantially different from the hip levels down, and **(b)** the two front pieces, though similar in form, are reasonably different on all sides except for the crotch lines and the waist levels [*Figure 128 and Plate Forty-Two*].



[*Figure 128*]
Superimposed Alternative And Conventional Basic Pants Patterns

If at first glance the two back pieces seem alike from the hip levels up, their likeness is merely attributable to the 3cm wedge that was opened at the crotch line of the static body sloper [*Figure 128 and Plate Forty-Two*], an artifice used by conventional pattern design to add ease into “easy fitting pants, particularly [into] dungarees” (Aldrich 1997[1976]: 78), which is no longer needed for the lineament of the mobile body. Had this not been done the outline of the static body back piece would include the broken line made up of smaller segments diagrammed above the hip line [*Figure 128 and Plate Forty-Two*], a circumstance that would determine that the two back pieces be different in all respects.

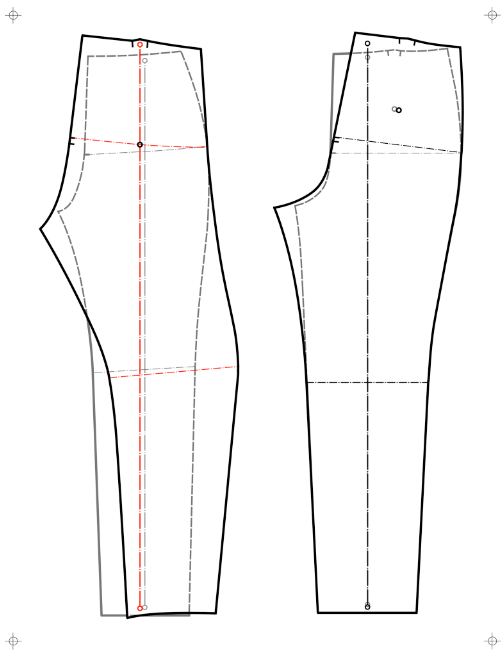
Settled this particular aspect, the following table describes the mobile body basic pattern and the altered static body sloper. All key and auxiliary points of each layout are indicated in terms of horizontal and vertical distances relative to a given point of reference within the respective pattern piece:

Back Pattern Pieces				**Front Pattern Pieces**			
Point	Point of Reference	**MB Pattern**	**SB Pattern**	**Point**	Point of Reference	**MB Pattern**	**SB Pattern**
[a[B]]	[A[B]]	2cm 0cm	4.5cm 0cm	**[a[F]]**	[A[F]]	-0.7cm 0cm	-0.5cm 0cm
[a’[B]]	[a[B]]	21.7cm -2.5cm	19cm -2.7cm	**[a’[F]]**	[a[F]]	-17cm 1cm	-21cm 1cm
[b[B]]	[C[B]]	16cm 0cm	0cm 10cm	**[b[F]]**	[C[F]]	0cm 10cm	0cm 10cm
[b’’[B]]	[b[B]]	—	0.6cm 3cm				
[b’[B]]	[b[B]]	25cm -2cm	23cm -3cm	**[b’[F]]**	[b[F]]	-22.5cm 1.5cm	-24cm 0cm
[c[B]]	[C[B]]	-5.5cm 0cm	-10cm 0cm	**[c[F]]**	[C[F]]	0cm 5cm	—
					[C[B]]	—	-4cm 0.3cm
[d[B]]	[c[B]]	0cm -70cm	0cm -74cm	**[d[F]]**	[c[B]]	0cm -74cm	0cm -74cm
[d’[B]]	[d[B]]	30cm 0cm	34cm 0cm	**[d’[F]]**	[d[F]]	-27.5cm 0cm	-34cm 0cm
[e[B]]	[c[B]]	0cm -28cm	0cm -37cm	**[e[F]]**	[c[B]]	0cm -32cm	0cm -37cm
[e’[B]]	[e[B]]	30cm 0cm	34cm 0cm	**[e’[F]]**	[e[F]]	-27.5cm 0cm	-34cm 0cm
[f[B]]	[e[B]]	0cm 1.2cm	0cm 5cm	**[f[F]]**	[e[F]]	0cm 2.5cm	0cm 5cm
[f’[B]]	[e’[B]]	0cm 3cm	0cm 5cm	**[f’[F]]**	[e’[F]]	0cm 3.5cm	0cm 5cm
[g[B]]	[f[B]]	12cm 0cm	6cm 0cm	**[g[F]]**	[f[F]]	-6cm 0cm	-6cm 0cm

	Back Pattern Pieces				Front Pattern Pieces		
Point	Point of Reference	**MB Pattern**	**SB Pattern**	**Point**	Point of Reference	**MB Pattern**	**SB Pattern**
[g'[B]]	[f'[B]]	6cm 0cm	-6cm 0cm	**[g'[F]]**	[f'[F]]	0cm 2cm	6cm 0cm
[h[B]]	[d[B]]	4cm -0.8cm	8cm 0cm	**[h[F]]**	[d[F]]	0cm -8cm	-8cm 0cm
[h'[B]]	[d'[B]]	1.2cm 0cm	-8cm 0cm	**[h'[F]]**	[d'[F]]	0cm 3cm	8cm 0cm

The darts comprised by the two pants slopers to shape the waist are **(1)** in the back piece of the mobile body pattern 3cm wide and 19cm long; and in the static body pattern **(2a)** 3cm wide and 14cm long in the back piece, and **(2b)** 2.5cm wide and 11cm long in the front.

As implied before, the most remarkable difference between the outlines of the two basic patterns is the position of all the points situated below the hip level relative to their grain lines – represented by broken lines made up of larger/thicker segments in [*Figure 128 and Plate Forty-Two*].



[*Figure 129*]
Superimposed Alternative And Conventional Pattern Pieces Making Up The Right Leg

In fact, while in conventional pants patterns, basic and clothing, the placement of segments [g[B]-h[B]], [g'[B]-h'[B]], [g[F]-h[F]] and [g'[F]-h'[F]] is invariably the same on both sides of the back and front pattern pieces' grain lines [*Figure 129, right*], the corresponding segments in the generated mobile body pattern aren't symmetrical to each other nor the grain lines correspond to the back and front pattern pieces central dividing lines – as the back piece conspicuously shows and the front more subtly [*Figure 129, left*].

Particularly noticeable is also the curvature of the crotch line in the mobile body back pattern piece: very different from the curvature in the static body, it looks longer because point [c[B]] is positioned lower and closer to [C[B]], a point that signals the crotch level [*Figure 128 and Plate Forty-Two*]. The knee level in the mobile body pattern is also worth commenting on because, unlike the corresponding level in the static body pattern, it is not positioned horizontally.

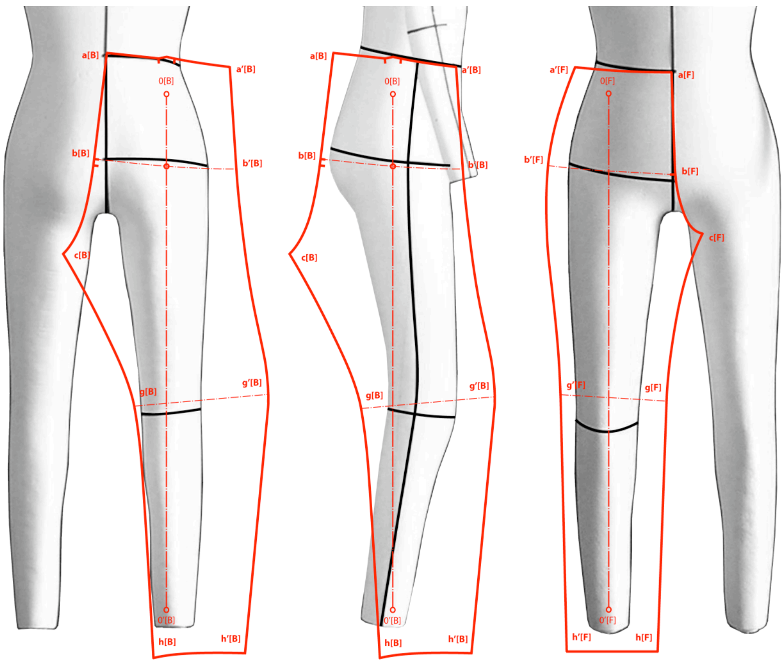
To fully appraise the mobile body pattern, the coordinates of all key and auxiliary points making up its layout are designated relative to a given point of reference in the static body pattern:

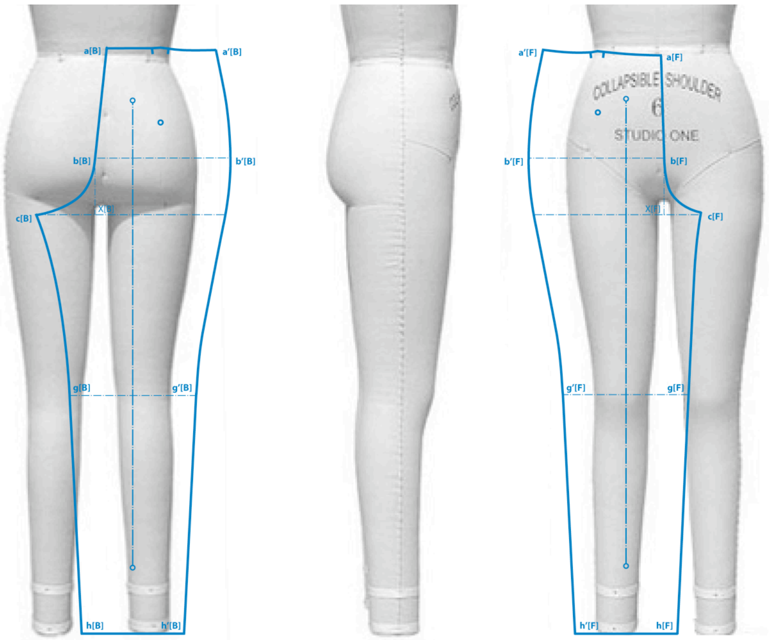
Back Pattern Pieces			Front Pattern Pieces		
MB Pattern	**SB Pattern**	**X and Y Distances**	**MB Pattern**	**SB Pattern**	**X and Y Distances**
[a[B]]	[a[B]]	**1.5cm** **-0.4cm**	**[a[F]]**	[a[F]]	**0cm** **0cm**
[a'[B]]	[a'[B]]	**1cm** **0cm**	**[a'[F]]**	[a'[F]]	**4cm** **0cm**
[b[B]]	[b''[B]]	**0cm** **0cm**	**[b[F]]**	[b[F]]	**0cm** **0.3cm**
[b'[B]]	[b'[B]]	**2cm** **1.2cm**	**[b'[F]]**	[b'[F]]	**1.2cm** **2cm**
[C[B]]	[C[B]]	**0.7cm** **-3.5cm**	**[C[F]]**	[C[F]]	**0cm** **0cm**
[c[B]]	[c[B]]	**5.5cm** **-3.5cm**	**[c[F]]**	[c[F]]	**1.5cm** **0.5cm**
[d[B]]	[d[B]]	**5.5cm** **0cm**	**[d[F]]**	[d[F]]	**5.5cm** **0cm**
[d'[B]]	[d'[B]]	**2cm** **0cm**	**[d'[F]]**	[d'[F]]	**1.2cm** **0cm**
[e[B]]	[e[B]]	**5.5cm** **5cm**	**[e[F]]**	[e[F]]	**-5.5cm** **5cm**
[e'[B]]	[e'[B]]	**2cm** **5cm**	**[e'[F]]**	[e'[F]]	**1.2cm** **5cm**
[f[B]]	[f[B]]	**1.5cm** **1cm**	**[f[F]]**	[f[F]]	**-5.5cm** **2cm**
[f'[B]]	[f'[B]]	**2cm** **3cm**	**[f'[F]]**	[f'[F]]	**3.5cm** **1.2cm**

Back Pattern Pieces			Front Pattern Pieces		
MB Pattern	**SB Pattern**	**X and Y Distances**	**MB Pattern**	**SB Pattern**	**X and Y Distances**
[g[B]]	[g[B]]	12cm 1cm	**[g[F]]**	[g[F]]	-6cm 2.4cm
[g'[B]]	[g'[B]]	7.5cm 3cm	**[g'[F]]**	[g'[F]]	-2.5cm 1.2cm
[h[B]]	[h[B]]	13cm -0.8cm	**[h[F]]**	[h[F]]	5.5cm 0cm
[h'[B]]	[h'[B]]	11.5cm 0cm	**[h'[F]]**	[h'[F]]	3.5cm 0cm

Given all these coordinates, it's clear that the draped pants pattern doesn't conform to the conventional layout of basic pants. But however important it is to describe the generated legs sloper quantitatively it is imperative to look at it in terms of its relationship with the tangible mannequin representing the mobile body, i.e., to consider if its form follows the action of the body.

Keeping to the analytic strategy used so far, the conventional pants sloper is also considered in terms of its relationship with the paradigmatic body adopted by pattern design. Suitably the respective diagrams of the back and front pattern pieces are placed over photos of mannequins, one set overlaying the produced tangible mannequin, the other overlaying a standard dress form [*Figure 130*].



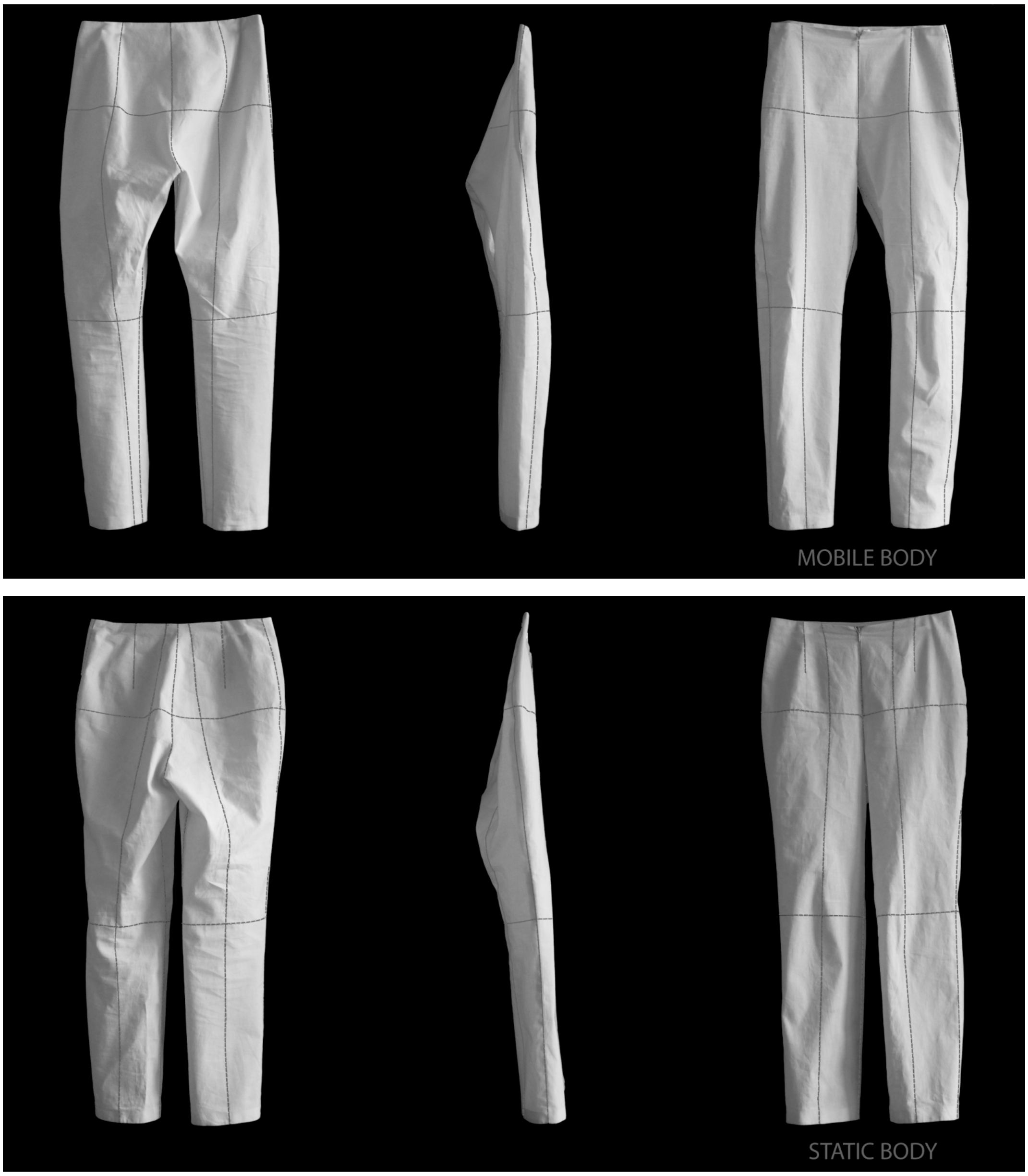


[*Figure 130*]
Relationship Between Diagrams And Mannequins I, alternative and conventional basic pants patterns

At this point it must be stressed that even patterns that are generated after the mobile body are orthographic projections, and it's on grounds of this fact and the fact that the enclosed photos of the tangible mannequin correspond to orthogonal views that a comparison can be made: **(1)** the back pattern piece of the alternative pants reminds us, at least, of the leg on the mannequin's side view while the front pattern piece portrays rather well the front view of the leg [*Figure 130, top*], and **(2)** the back pattern piece of the conventional pants reminds us of the back view of the mannequin's leg while the front pattern piece portrays rather well the front view of the leg [*Figure 130, bottom*].

Based on the images in [*Figure 130*], it's evident that the two basic patterns are truthful since each one corresponds to the body it portrays, static or mobile. Nevertheless, the alternative form for the pants yields an enhanced illusion of the body we experience day after day, i.e., a body that's indivisible from action.

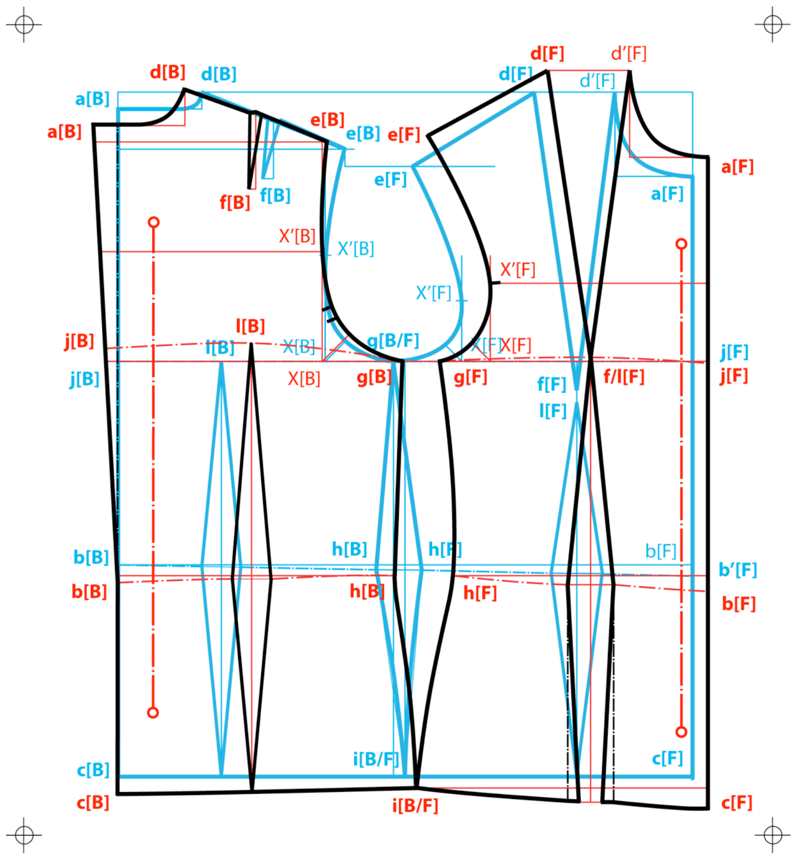
Turned into a prototype made of muslin the illusion becomes more convincing, especially when compared with the pants made from the conventional sloper [*Figure 131*].



[*Figure 131*]
Muslin Prototypes Of Basic Pants, adapted from photos by Luísa Barreto

Even on a hanger with clips that hold the front and the back waist of the pants together, even without a body filling the empty space inside, **(1)** the form retained by the alternative pants appears to be moving about, as **(1a)** the buttocks protrude considerably, **(1b)** the legs bend a little at the knees, and **(1c)** separate from each other [*Figure 131, top*]; in contrast, **(2)** the shape taken by the conventional pants seems to be flatter, as **(2a)** the buttocks droop to a certain extent, **(2b)** the whole legs stand straighter, and **(2c)** closer to each other [*Figure 131, bottom*].

With regard to the generated basic pattern of the torso, the superimposition of the layouts of the mobile body's block – diagrammed in black and red – and of the static body's sloper – diagrammed in blue – shows that **(1)** the two back pieces seem reasonably similar in form owing to **(1a)** their center back sections below the waist level, **(1b)** the centers, or inside fold lines, of their double-ended darts, **(1c)** their shoulder lines, and **(1d)** side seam lines, being either parallel or almost parallel; likewise **(2)** the two front pieces are comparable in shape, although they differ in length and width [*Figure 132 and Plate Forty-Three*].



[*Figure 132*]
Superimposed Alternative And Conventional Basic Torso Patterns

Before describing the generated basic torso pattern in comparison with the conventional torso it must be clarified that the sloper presented in [*Figure 132 and Plate Forty-Three*] is an adaptation of the pattern introduced in [*Figure 124*].[194]

194 See Creation Of The Artifact, p. 255, and [*Plate Forty*].

Though the draped basic torso pattern reproduced exactly the form, or more accurately, the posture of the tangible mannequin, the decision to rotate the torso's back piece so that the upper section of center back be on bias – thus causing the lower part to become perfectly vertical – took into account the constant expansion of the thoracic and shoulder areas in response to arm movement and the necessity that clothes perform in conformity.

Therefore the table below applies to the adjusted mobile body sloper and the static body basic pattern put side by side. The approximate XY coordinates of all key and auxiliary points in each layout are specified relative to a given point of reference, or segment, within the respective pattern piece:

	Back Pattern Pieces				**Front Pattern Pieces**		
Point	Point of Reference	**MB Pattern**	**SB Pattern**	**Point**	Point of Reference	**MB Pattern**	**SB Pattern**
[a[B]]	[b[B]]	-2cm 39cm	0cm 39cm	**[a[F]]**	[b[F]]	0cm 37cm	0cm 33cm
[b[B]]	[b[B]]	0cm 0cm	0cm 0cm	**[b[F]]**	[b[F]]	0cm 0cm	0cm 0cm
				[b'[F]]	[b[F]]	—	0cm -1cm
[c[B]]	[b[B]]	0cm -18cm	0cm -18cm	**[c[F]]**	[b[F]]	0cm -18.5cm	—
				[c[F]]	[b'[F]]	—	0cm -17.5cm
[d[B]]	[a[B]]	8cm 3cm	7cm 1.5cm	**[d[F]]**	[d'[F]]	-7cm 0cm	-7cm 0cm
				[d'[F]]	[a[F]]	-7cm 7.5cm	-6.5cm 7cm
[e[B]]	[a[B]]	20cm -1.4cm	19cm -3.5cm	**[e[F]]**	[d[F]]	-10cm -5.5cm	-10cm -6cm
[f[B]]	[d[B]]-[e[B]] / 2	-0.7cm -6.5cm	-1cm -5cm	**[X[F]]**	[e[F]]	5.4cm -19cm	4cm -16.7cm
[X[B]]	[e[B]]	-0.3cm -19cm	-1.7cm -18cm	**[f[F]]**	[X[F]]	8.5cm 0cm	10cm -2.5cm
[g[B]]	[X[B]]	7cm 0cm	5.8cm 0cm	**[g[F]]**	[X[B]]	4.5cm 0cm	-5.8cm 0cm
[h[B]]	[b[B]]	23.5cm 0.6cm	22cm 0.5cm	**[h[F]]**	[b[F]]	-22cm 1.3cm	-23cm -0.5cm
[i[B]]	[c[B]]	25.5cm 0.5cm	24.5cm 0cm	**[i[F]]**	[c[F]]	-25cm 2cm	-24.5cm 0cm
[j[B]]	[g[B]]	-25cm 1cm	-23.4cm 0cm	**[j[F]]**	[g[F]]	0cm 13cm	25.5cm 0cm
[l[B]]	[j[B]]	12cm 0.4cm	8.5cm 0cm	**[l[F]]**	[j[F]]	0cm 0cm	0cm -1cm
[X'[B]]	[X[B]]	0cm 9cm	0cm 9cm	**[X'[F]]**	[X[F]]	0cm 7cm	0cm 5cm

Regarding the width and length of all the darts in the two patterns at issue, they are as follows:

	Back Pattern Pieces			Front Pattern Pieces	
	MB Pattern	**SB Pattern**		**MB Pattern**	**SB Pattern**
Shoulder Dart	1cm wide 6.5cm long	1cm wide 5cm long	**Bust Dart**	7cm wide 25cm long	7cm wide 25.5cm long
Double-Ended Dart	3cm wide 38cm long	3cm wide 35cm long	**Double-Ended Dart**	4cm wide [at waist] 38cm long 2cm wide [at hip]	4.5cm wide 32cm long

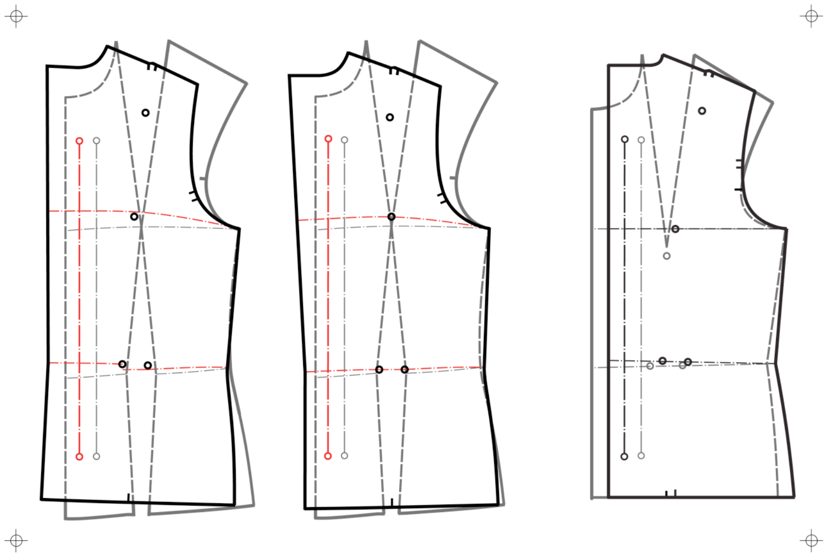
Though it is evident that the layouts of the two patterns are different, the approximate coordinates of all key and auxiliary points of the mobile body pattern are now designated relative to a given point of reference in the static body pattern:

Back Pattern Pieces			Front Pattern Pieces		
MB Pattern	**SB Pattern**	**X and Y Distances**	**MB Pattern**	**SB Pattern**	**X and Y Distances**
[a[B]]	[a[B]]	-2cm -1.5cm	**[a[F]]**	[a[F]]	1.3cm 1.7cm
[b[B]]	[c[B]]	0cm -2.5cm	**[b[F]]**	[b’[F]]	1.3cm -1.3cm
[c[B]]	[c[B]]	0cm -1.5cm	**[c[F]]**	[c[F]]	1.3cm -3cm
			[d[F]]	[d[F]]	1cm 2cm
[d[B]]	[d[B]]	-1.5cm 0.2cm	**[d’[F]]**	[d’[F]]	1.3cm 2cm
[e[B]]	[e[B]]	-1.5cm 0.5cm	**[e[F]]**	[e[F]]	1.4cm 2.5cm
[f[B]]	[f[B]]	-1cm -1cm	**[f[F]]**	[f[F]]	1.2cm 3cm
[g[B]]	[g[B]]	0.7cm 0cm	**[g[F]]**	[g[F]]	4cm 0cm
[h[B]]	[h[B]]	1.5cm -0.5cm	**[h[F]]**	[h[F]]	2.5cm -0.4cm
[i[B]]	[i[B]]	1cm -1cm	**[i[F]]**	[i[F]]	1cm -1cm
[j[B]]	[j[B]]	-1cm -1cm	**[j[F]]**	[j[F]]	1.3cm -0.2cm
			[l[F]]	[l[F]]	1.2cm 4cm
[X[B]]	[X[B]]	-0.3cm 0cm	**[X[F]]**	[X[F]]	2.4cm 0cm
[X’[B]]	[X’[B]]	-0.3cm 0.3cm	**[X’[F]]**	[X’[F]]	2.4cm 1.5cm

Apart from the workable quantitative characterization, the conventional and the atypical torso patterns can also be compared in qualitative terms. Probably the most striking feature that distinguishes the two layouts relates to their boundaries.

To be exact, within the logic of conventional pattern design, we are taught to plan the back and front pattern pieces within a 'rectangle' – **(a)** whose vertical sides represent center back and center front, **(b)** whose lower horizontal side stands for the hip level, **(c)** whose upper horizontal side determines the positioning of the back and front trapezius points, and **(d)** whose vertical middle line fixes the positioning of the back and front armpit points together –, however it is noticeable that the outline of the mobile body pattern isn't delimited so orderly [*Figure 132 and Plate Forty-Three*].

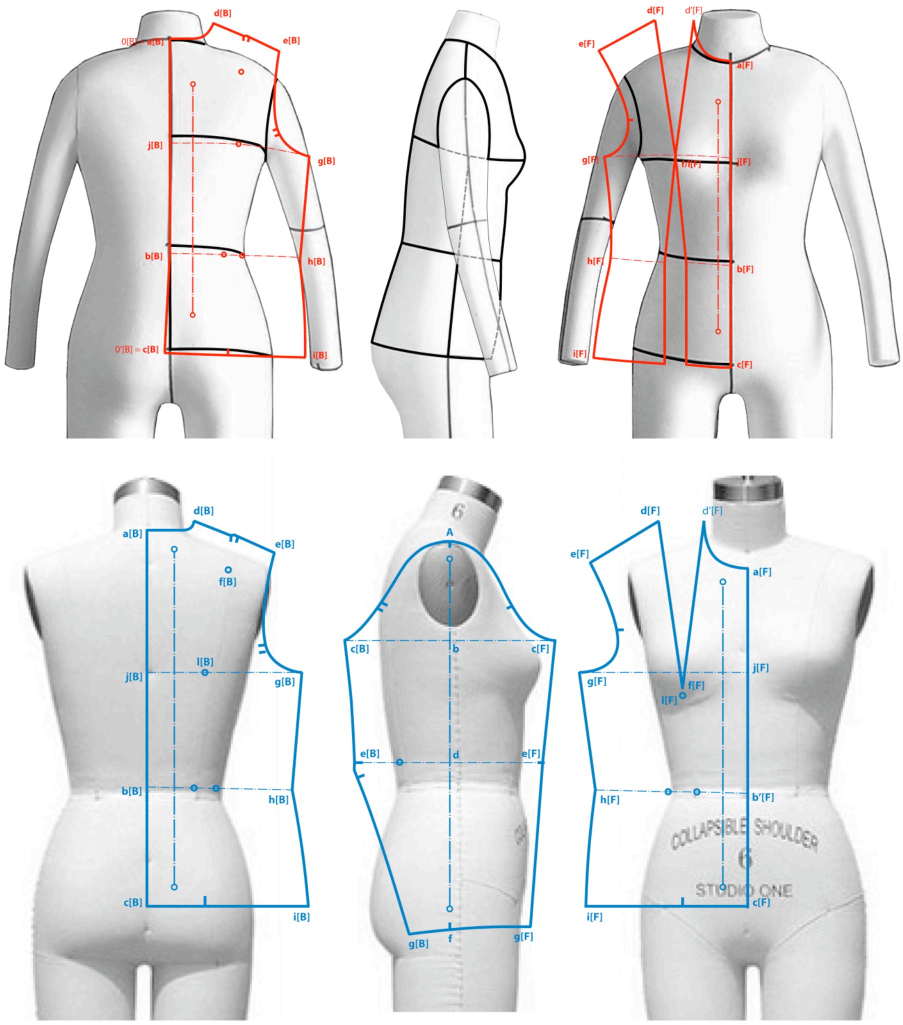
In fact, neither one of the presented mobile body torso patterns [*Figure 132 and Plate Forty-Three, Figure 124 and Plate Thirty-Nine*] has their center backs and hip levels perfectly vertical and horizontal; neither one has their back and front trapezius points in the same horizontal line; neither one has their back and front armpit points in the same vertical middle line.



[*Figure 133*]
Superimposed Alternative And Conventional Pattern Pieces Making Up The Torso's Right Side

As a result of an apparently disordered construction, when the mirrored front and the back pattern pieces of the alternative sloper are joined at the side seam – as they're set on the right side of the body – they still look askew, whether they belong to the adjusted pattern [*Figure 133, center*] or to the initial one [*Figure 133, left*]. As a result of an orderly construction, the mirrored front and the back pattern pieces of the conventional block, joined at the side seam, remain looking quite aligned [*Figure 133, right*].

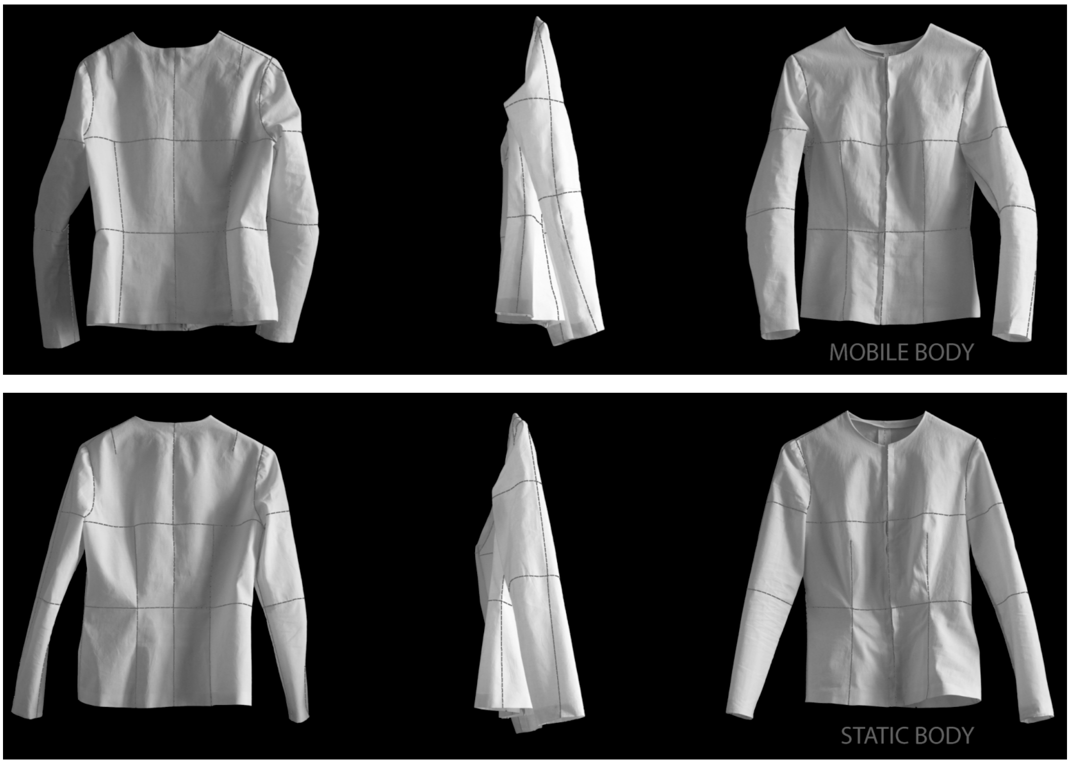
Contributing to the appraisal of the conventional and the draped basic patterns in terms of their relationship with the static and mobile bodies, the respective diagrams of the back and front pattern pieces are placed over photos of a standard dress form and of the produced tangible mannequin [*Figure 134*].



[*Figure 134*]
Relationship Between Diagrams And Mannequins 2, alternative and conventional basic torso patterns plus conventional basic sleeve pattern

As long as one is able to see a body within any of these patterns, it can be said that, aligned or askew, both bring forth the illusion of the body each one portrays with the same intensity. On the one hand, the conventional sloper suggests a body in the upright position; on the other hand, the alternative basic pattern suggests a standing body as it's leaning forward – a position or action that's possibly easier to discern in [*Figure 133, left*].

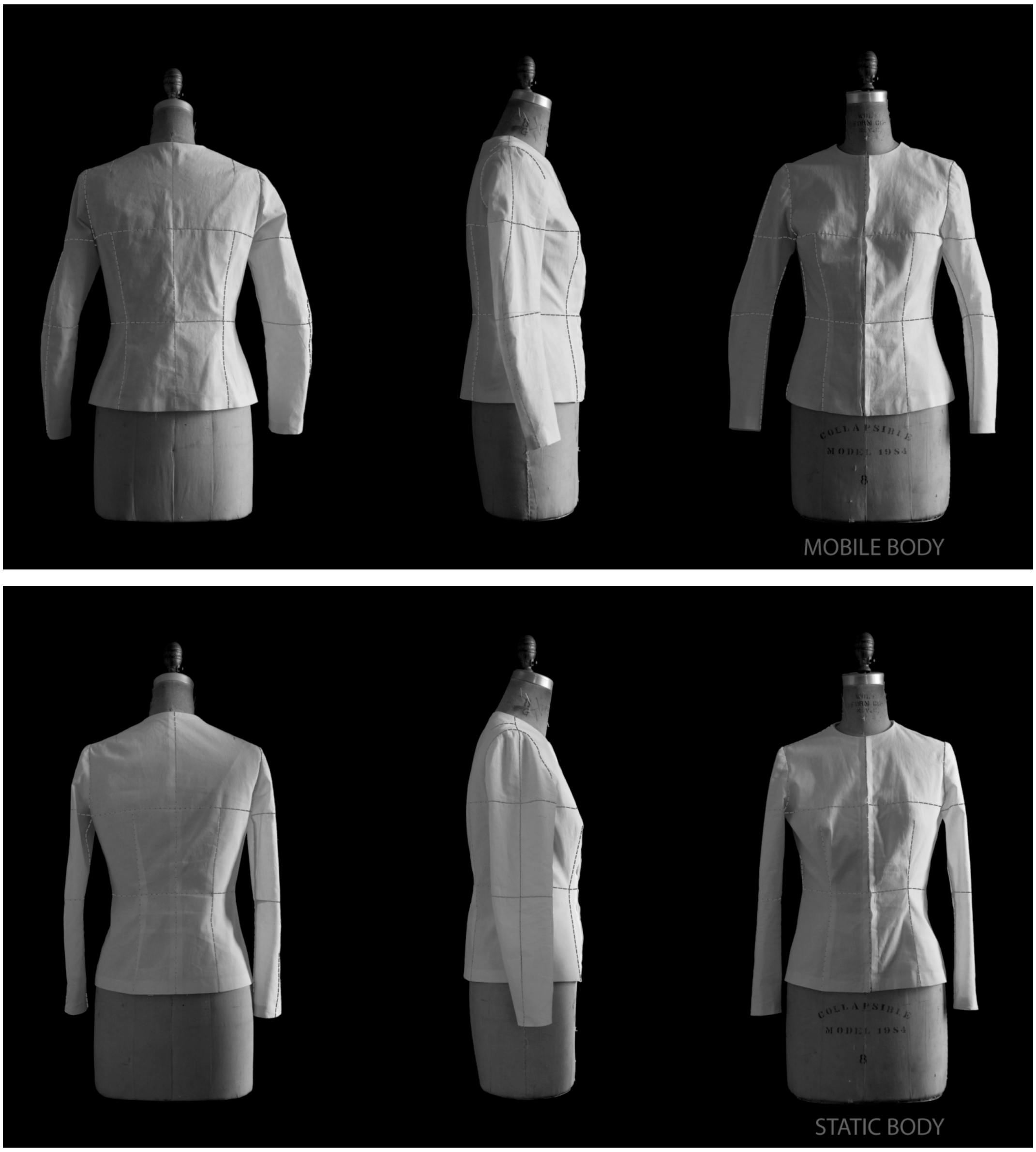
The truth of the matter is that the inclination of the trunk represented in the tangible mannequin – having resulted from the amalgamation of all body positions assumed by ten women –, isn't as extreme as the curvature of the arms and legs of the used device. Nonetheless, the alternative basic pattern under consideration incorporates more ease at the shoulders than its conventional counterpart; it incorporates a double-angled center back; it incorporates a curved hip level that drops at the front. It's the combination of the enumerated features contained by the alternative basic pattern that yields the illusion of the mobile body, however slight it appears to be or however its degree is comparable with the illusion yielded by the conventional pattern.



[*Figure 135*]
Muslin Prototypes Of Basic Torsos On Hanger, adapted from photos by Luísa Barreto

By looking at the muslin prototypes of the two basic patterns it is noticed that, even on a hanger [*Figure 135*] or put on a conventional dress form [*Figure 136*], the way the surface of the torsos drape is different.

On a hanger [*Figure 135*], the alternative top looks more contoured than the conventional one, an effect that's consistent in the back and front components. On a conventional dress form [*Figure 136*], the conventional top looks more fitted than the alternative one, an acquired effect that's also consistent all around its surface.



[*Figure 136*]
Muslin Prototypes Of Basic Torsos On Conventional Dress Form, adapted from photos by Luísa Barreto

Though the alternative top keeps its contoured appearance on a conventional dress form [*Figure 136*], it also incorporates more room for body movement: in fact **(1)** its whole back, **(2)** including the neckline, and **(3)** its sides, all hang away from the mannequin.

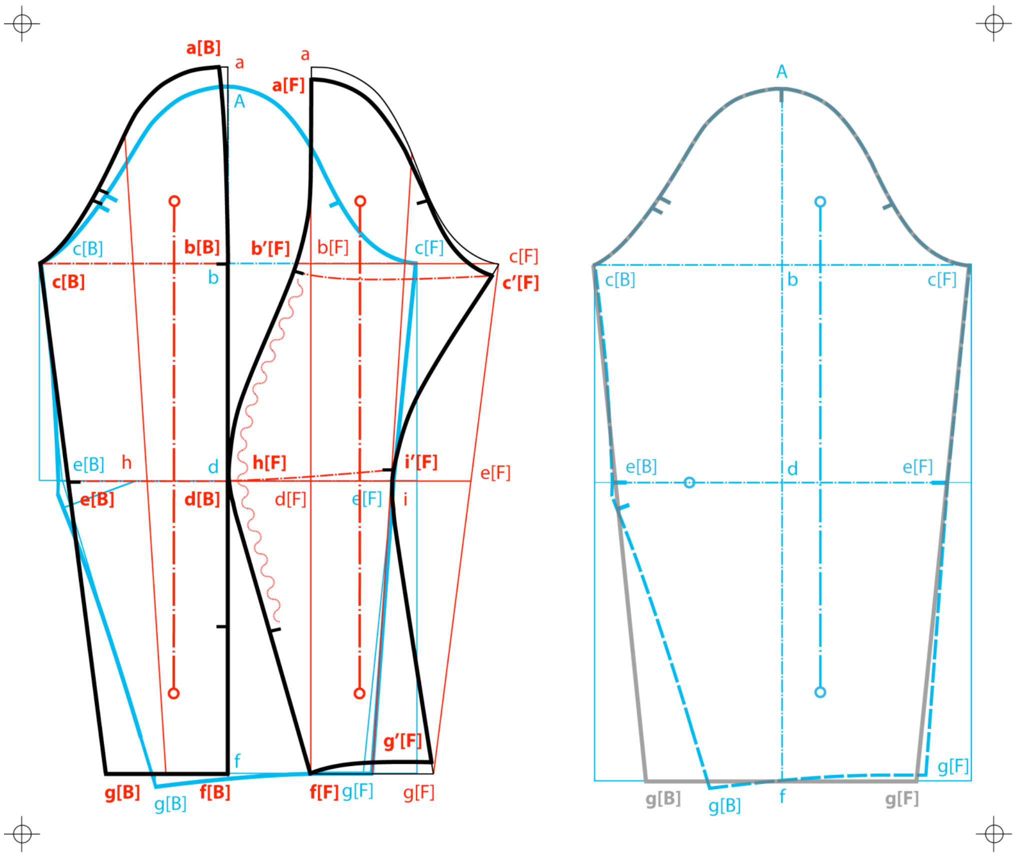
But what really stands out in all the photos above is the way the sleeves, conventional and alternative, drape differently.

As explained in Part Four, the layout of the mobile body sleeve derived from the shape of the draped basic pants, i.e., the way its various elements are arranged into a coherent whole. Summing up the rationale behind the alternative pants, it is fair to say that, together, the contours of the back and front pattern pieces, being nothing like each other in appearance, reproduce a body in action.

It could be said that linking the idea of a sleeve with the image of the alternative pants is an instance of the mobile body's lineament where Bohm's model manifests itself. Or it could be alleged that the act of drafting the alternative sleeve from the drawing of the draped pants is *the* instance of the mobile body's lineament where Nowicki's phrase *form follows form* applies the most.

In fact, the superimposition of the layouts of the mobile body's basic sleeve pattern – diagrammed in black and red – and of the static body's sloper – diagrammed in blue – openly shows [*Figure 137, left, and Plate Forty-Four*] that

> **(1)** The two back pieces are reasonably similar in form – particularly if compared with the back part of a conventional straight one-piece sleeve block [*Figure 137, right*], as this type of sleeve is more likely to be designed than a close fitting one-piece one.
>
> **(2)** The two front pieces are different on all sides except for the sleeve head.



[*Figure 137*]
Superimposed Alternative And Conventional Basic Sleeve Patterns Plus Superimposed Conventional Basic Sleeve Patterns, Fitted And Straight

Derived one from the other, the following table describes, separately, the layouts of the two sleeve patterns presented in [*Figure 137, left*]. But before presenting the respective table it must be pointed out that the construction of the alternative basic sleeve pattern incorporates two extra oblique guidelines – namely, [h] and [i], which divide the back and front pattern pieces into two lengthwise 'halves' respectively – for the reason that they were both essential for the conversion of a one-piece sleeve into a two-piece sleeve.

Taking point [A] as the starting point of the generated and conventional patterns' construction, the approximate XY coordinates of all key and auxiliary point integrating each one are designated in relation to a given point of reference within the respective pattern piece:

Back Pattern Piece [or Side]				Front Pattern Piece [or Side]			
Point	Point of Reference	**MB Pattern**	**SB Pattern**	**Point**	Point of Reference	**MB Pattern**	**SB Pattern**
[a]	[A]	0cm 1.7cm	—	**[a]**	[A]	7cm 1.7cm	—
[a[B]]	[a]	-0.7cm 0cm	—	**[a[F]]**	[a]	0cm -1cm	—
[b[B]] *[b]	[A]	0cm -15cm	*0cm -15cm	**[b[F]] *[b]**	[A]	7cm -15cm	0cm -15cm
				[b′[F]]	[b[F]]	-1.3cm -0.8cm	—
[c[B]]	[b[B]] *[b]	-16cm 0cm	*-16cm 0cm	**[c[F]]**	[b[F]] *[b]	16cm 0cm	*16cm 0cm
				[c′[F]]	[c[F]]	-0.6cm -1cm	—
[d[B]] *[d]	[b[B]] *[b]	0cm -18.5cm	*0cm -18.5cm	**[d[F]] *[d]**	[b[F]] *[b]	0cm -18.5cm	*0cm -18.5cm
[e[B]]	[b[B]] *[b]	-13.5cm 0cm	*-14.5cm 0cm	**[e[F]]**	[b[F]] *[b]	13.5cm 0cm	*14cm 0cm
[f[B]] *[f]	[d[B]] *[d]	0cm -25cm	*0cm -25.4cm	**[f[F]] *[f]**	[d[F]] *[d]	0cm -25cm	*0cm -25.4cm
[g[B]]	[f[B]] *[f]	-10.4cm 0cm	*-6cm -0.6cm	**[g[F]]**	[f[F]] *[f]	10.4cm 00cm	*12.3cm 0.6cm
				[g′[F]]	[g[F]]	0cm 1cm	—
				[h[F]]	[d[F]]	-7cm 0cm	—
				[i′[F]]	[e[F]]	-6.6cm 1cm	—

Next, the approximate coordinates of all key and auxiliary points are now designated relative to a given point of reference in the static body pattern, i.e., the conventional close fitting one-piece sleeve sloper:

Back Pattern Piece [or Side]			Front Pattern Piece [or Side]		
MB Pattern	**SB Pattern**	**X and Y Distances**	**MB Pattern**	**SB Pattern**	**X and Y Distances**
[a[B]]	[A]	**-0.7cm 1.7cm**	**[a[F]]**	[A]	**7cm 0.6cm**
[b[B]]	[b]	**0cm 0cm**	**[b′[F]]**	[b]	**5.6cm -0.8cm**
[c[B]]	[c[B]]	**0cm 0cm**	**[c′[F]]**	[c[F]]	**6.3cm -1cm**
[d[B]]	[d]	**0cm 0cm**			
[e[B]]	[e[B]]	**0.8cm 0cm**			

Back Pattern Piece [or Side]			Front Pattern Piece [or Side]		
MB Pattern	**SB Pattern**	**X and Y Distances**	**MB Pattern**	**SB Pattern**	**X and Y Distances**
[f[B]]	[f]	0cm -0.6cm	**[f[F]]**	[f]	7cm 0.6cm
[g[B]]	[g[B]]	-4.3cm 1cm	**[g[F]]**	[g[F]]	5cm 1cm
			[h[F]]	[d]	0cm 0cm
			[i'[F]]	[e[F]]	0cm 1cm

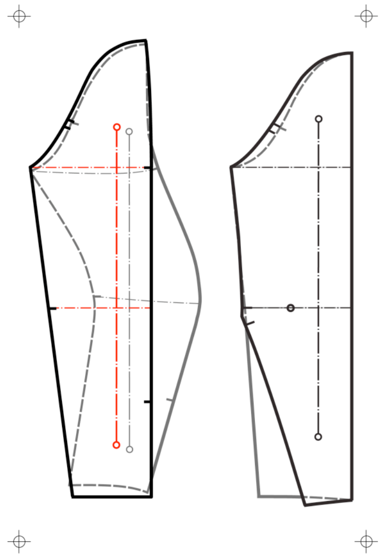
Apart the acknowledgement of the differences and similarities possessed by the alternative and the conventional basic sleeve patterns communicated quantitatively, the two layouts are recognizably different in qualitative terms.

The most conspicuous feature relates to the outlines of the sleeve slopers. In fact, conventional pattern design teaches us **(1)** to draw the back and front lines of the sleeves' under seam symmetrically from the armpit to the wrist levels [*Figure 137, right*], **(2)** to cut the back section of the sleeve from the elbow to the wrist levels, and **(3)** to pivot this section forward to make a dart at the elbow level.

By following these steps, we get a close fitting one-piece sleeve whose outline **(ii)** looks curved all around – even though it's made up of straight lines from the armpit level down –, an impression produced by **(i)** the back outline slanting toward the front.

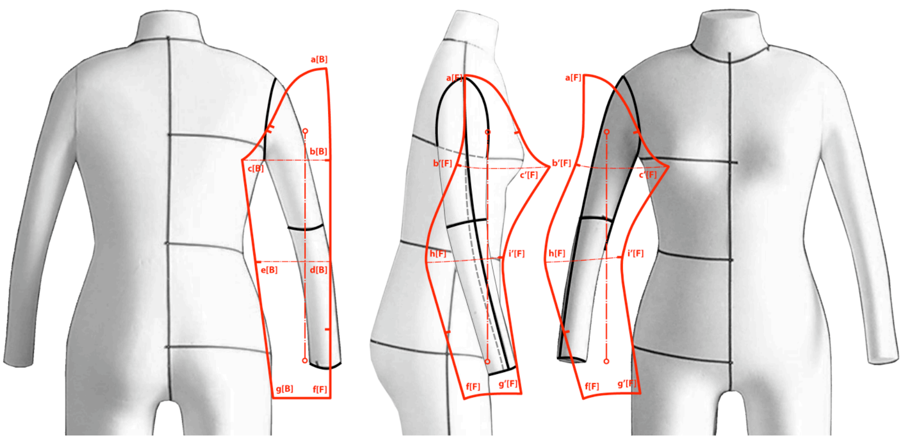
As it happens, the layout of the mobile body pattern reverses the logic of conventional pattern design: **(1a)** the outline of the front pattern piece is all made up of curved lines, that **(1b)** bending toward the back, **(1b)** appear to have been dragged by the elbow level; conversely **(2)** the outline of the back pattern piece is made up of entirely straight lines from the armpit level down [*Figure 137, left, and Plate Forty-Four*].

Owing to this seemingly illogical construction, the mirrored front and the back pattern pieces of the alternative sloper, joined at the upper seam lines, give the impression of being completely unrelated, particularly from the armpit level down [*Figure 138, left*]. In contrast, owing to the prescribed paradigmatic construction the mirrored front and the back pattern pieces of the conventional block, folded at the axis, appear quite related [*Figure 138, right*].



[*Figure 138*]
Superimposed Alternative And Conventional Pattern Pieces Making Up The Right Arm

However deviant one is comparatively to the other, it's critical to check how each relates with the body. The two diagrams of the alternative basic pattern and the single diagram of the conventional sloper are, thus, placed over the produced tangible mannequin's photos, the former [*Figure 139*] and over the standard mannequin's photos, the latter [*Figure 134*].[195]



[*Figure 139*]
Relationship Between Diagram And Mannequin 3, alternative basic sleeve pattern

[195] See p. 280.

To tell the truth it's hard to see how realistically or not the conventional sleeve pattern reproduces the arm, a difficulty that's attributable to the fact that conventional dress forms don't usually come with a detachable upper limb or arm cap.[196] Nevertheless [*Figure 134*] clearly shows that the axis of the one-piece sleeve is aligned with the side seam in the mannequin, i.e., the line of stitching that represents the imaginary line separating the front and the back of the torso.

With regard to the alternative two-piece basic sleeve pattern [*Figure 139*], it must be acknowledged that the back pattern piece doesn't bring forth the aimed illusion, as its form doesn't bear a resemblance to the posterior part of the tangible mannequin's arm. It also must be acknowledged that this circumstance is puzzling since the front pattern piece of the alternative pants – from which the idea for its outline derived – portrays rather well the front view of the legs of the mannequin [*Figure 130*].[197] In any case the front pattern piece of the alternative sleeve suggests the position assumed by the mannequin's arms [*Figure 139*] – even if exaggerated – in the same way as the back pattern piece of the alternative pants suggests the profile of the mannequin's legs [*Figure 130*].

All things considered, the generated basic sleeve pattern "faithfully reproduces the part of the body to be clothed" (Hulme 1945b: 23) – as it is supposed to, according to the quoted author – when the two fabric pieces are sewn together and to the armhole of the muslin top [*Figures 135* and *136*].[198] In comparison with the conventional one-piece sleeve, which yields the illusion of the arms much better when the prototype is on a dress form, the alternative sleeve always suggests that the arm is there, inside it, not rigidly put but caught in the act of moving.

The External Validity Of Form

[*A Description From The Perspective Of The Dressed Body*]

It can be drawn from the previous comparative analysis that the generated basic patterns set is an embodiment of the *form follows action* principle, as it was lineated from, or on, the mobile body.

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[196] Actually they are an additional cost (www.wolfform.com/femaleforms.html).

[197] See p. 273.

[198] See pp. 281-282.

However the internal validity of the formal solutions corresponds only in part to the desired outcome of five years of research. ‘In part’ because the body is the *raison d’être* for their making, so their confirmation depends ultimately on the body itself.

For the findings to be complete, or to establish that the interpretation of the mobile body is valid, wear trials were implemented, as this is “one of the most widely used methods to observe subjects immediate responses in clothing under different [...] conditions and activities” (Li and Wong 2006: 286).

Explicit in the authors’ characterization of wear trials is the idea that the part played by the observer is decisive; implicit in Li and Wong’s definition is that the role given to the subjects is rather active since they’re required to verbalize and/or write down their perception of clothing during wear.

Actually the implementation of wear trials is common practice in the ready-to-wear trade. Before a garment goes into production expert fit models

> *[...] Try on each piece to show the designer and the technical designer (that’s the pattern maker for anyone who does not speak fashion-world jargon) how it moves on a real person, instead of a mannequin standing frozen in one place. Can the model comfortably hug a friend in the sample without the shoulders pulling? Can he or she raise an arm to hail a taxi without ripping an armhole? Do the buttons need to be moved so the garment lies flat on the body? Does the fabric give or have an itchy feel?* (Flanagan 2011).

Truly “the spirits who move behind the scenes of the fashion industry,” as publicized by journalist Jenna Flanagan from the WNYC (2011),[199] fit models work closely with the pattern design team to make sure that clothes aren’t ill fitted.

In a way the six women who took part in this research’s wear trials are comparable to fashion fit models. Not that the generated patterns underwent adjustments after their prototypes were tried, but because they answered all the questions about the performance of the prototypes.

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[199] A pair of public radio stations located in New York City known for their nationally-syndicated news and culture programming.

Comparable to fashion fit models the participants represent either Euro size 38 or Euro size 36 since their measurements are within 1.2cm to 2.5cm larger or smaller than the proportions befitting those standard sizes.[200] Considering that "fit modeling is one of the few areas in the modeling world that allow for a long career" (Flanagan 2011), the six women are also comparable to fashion fit models as they're 19 to 41 years old; however the main reason for including an apparently extensive age range relates to the aim of matching, as much as possible, the age range of the participants who produced their self-portraits.[201]

Like fashion fit models the participants executed a variety of generic actions but unlike fashion fit models the six women considered the wearing experience with the prototypes made from the alternative basic patterns against the wearing experience with the prototypes made from the conventional slopers, as it facilitated recognizing, one by one, the positive features and the negative aspects of the mobile body blocks. Unlike fashion fit models they wore each set of trial clothes for approximately twenty minutes one day and again in a different day.

To minimize potential bias, the first sets of prototypes were discarded and the new ones were tested in reverse order. On the one hand, to supply unused prototypes each time a participant entered a wear trial assured that the clothes were not deformed as a result of previous wear and body movement; on the other hand, the idea to have the participants try out first the type of clothes that were tested last the day before assumed that their judgments would be made not on the basis of order or sequence but on grounds of the sensory responses elicited by the prototypes.

Also to minimize potential bias, all the prototypes were made of muslin and were topstitched similarly [*Figure 140*]. Aside the idea of not wanting to influence the participants' judgments to the findings' best advantage – or let their personal aesthetical preferences influence their judgments –, the idea to make all the prototypes of muslin had to do with this fabric's properties and function.

For one thing, muslin "is the artistic medium used to initially interpret apparel designs" because it's a 100% cotton fabric "with an even surface texture" easy "to cut

[200] The reason for including those two sizes equals the explanation presented in Preliminary Steps Toward The Artifact's Creation, p. 138.

[201] See Creation Of The Artifact, p. 177.

and sew" (Baugh 2011: 81); being "a neutral fabric" (Baugh 2011: 81) it is used "so that the modeling can be done on the basis of the pattern's effect" (Duburg and Van der Tol 2008: 15). For another, muslin "is generally somewhat stiff" (Baugh 2011: 81), a property that made it all the more possible for the participants to perceive the effect of the alternative and conventional forms – caused by the alignment of the seams – on the body in action.

[*Figure 140*]
Participants With Mobile Body And Static Body Prototypes On, photos by Diana Água-Mel

Although the alternative and conventional prototypes bear some differences constructionwise – e.g., the conventional sleeve does not have a seam dividing the back and front parts while the alternative sleeve does, the top point of the double-ended dart in the front of the conventional torso is positioned 3.5cm below the bust level while the same point in the alternative torso is placed on the bust level, *etc* – all the prototypes' seams or looking like seams, when nonexistent, were topstitched for the following reasons: **(1)** to strengthen the seams, **(2)** to make the two types of trial clothes look similar, **(3)** to embellish the otherwise plain garments, and **(4)** to make easier seeing how the seams flowed on actual bodies [*Figure 140*].

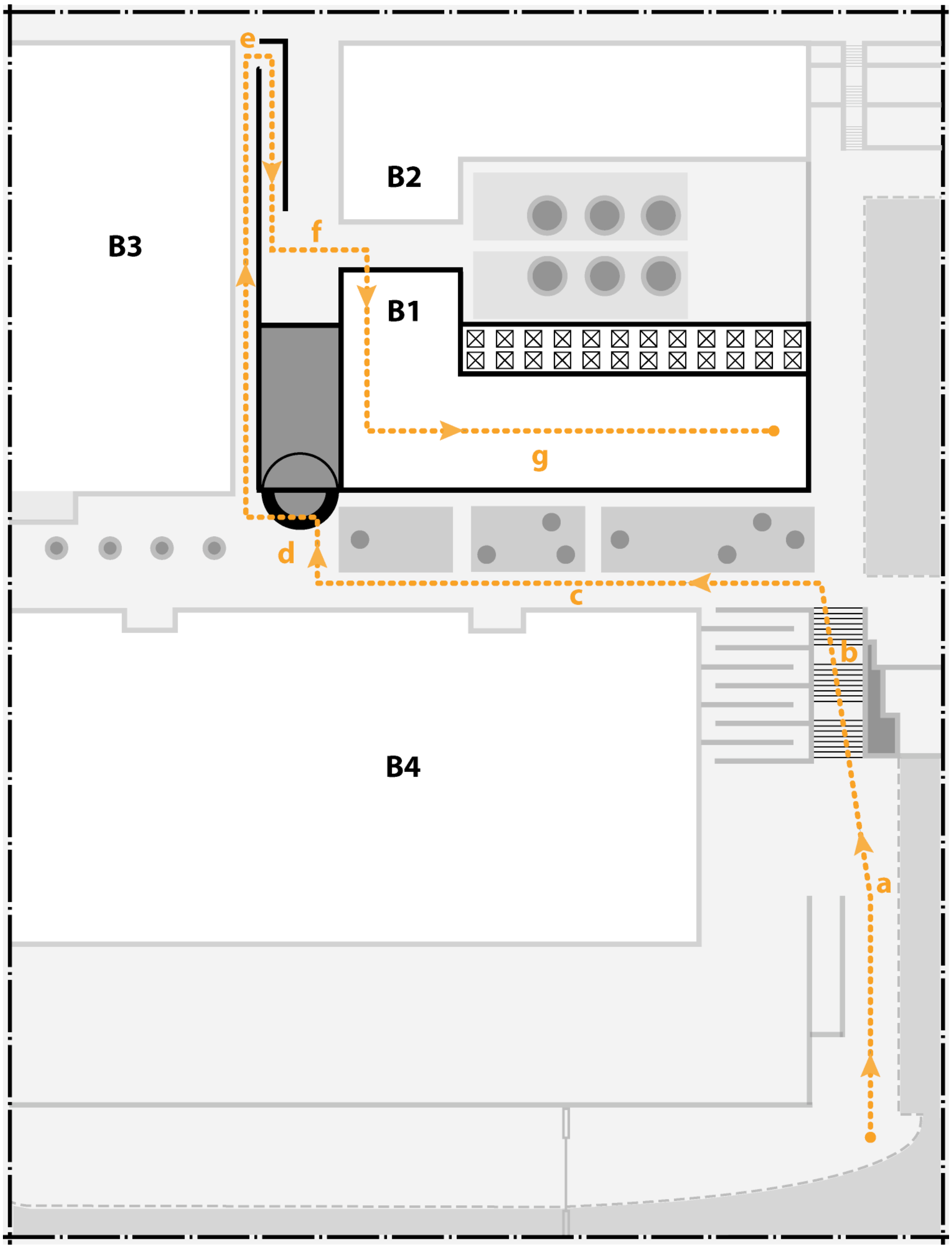
Dimensionwise, though the alternative and conventional patterns have been created/drafted to fit Euro standard size 38, several linear measurements of the respective key levels differ to some extent except for the bust level in both torsos and the hip level in both pants:

		Mobile Body	**Static Body**	
Pattern	**Key Level**	Linear Measurements	Linear Measurements	**Difference**
Torso	Bust	97cm	97cm	—
	Waist	72cm	73cm	1cm
	Hip	99cm	98cm	1cm
Pants	Waist	72cm	70cm	2cm
	Hip	95cm	95cm	—
	Knee	41.5cm	44cm	2.5cm
	Ankle	32.5cm	36.5cm	4cm
Sleeve	Biceps	33cm	32cm	1cm
	Elbow	27cm	28cm	1cm
	Wrist	20.5cm	19.5cm	1cm

Other than those it's noticeable that the corresponding dimensions in the two types of patterns don't follow logic, as they're either larger in the alternative slopers – namely, **(a)** the hip level in the torso, **(b)** the hip level in the pants and **(c)** the biceps and wrist levels in the sleeve – or in the conventional blocks – namely, **(a)** the waist level in the torso, **(b)** the knee and ankle levels in the pants, and **(c)** the elbow level in the sleeve. In relation to the corresponding measurements themselves, they don't follow logic either, as the difference between them fluctuates from 1cm – a negligible amount differencing the torsos' waist and hip levels – to 4cm – the amount differencing the pants' ankle levels.

Excluding the fact that the conventional pants are wider from the knee level down – from 2.5cm to 4cm –, the disparity between the linear measurements found in the two types of patterns does not answer for their somewhat dissimilar appearances on the body [*Figures 140, 143, 144 and 145*], much less the different appraisals reached through wear.

To minimize inevitable variables, the series of wear trials were conducted in two controlled environments, both sited in the Faculty of Architecture. Together they formed a 300m route that comprised the outdoors areas designated **a**, **b**, **c**, **d**, **e** and **f**, plus the indoor space designated **g**, all identified in [*Figure 141*].[202]

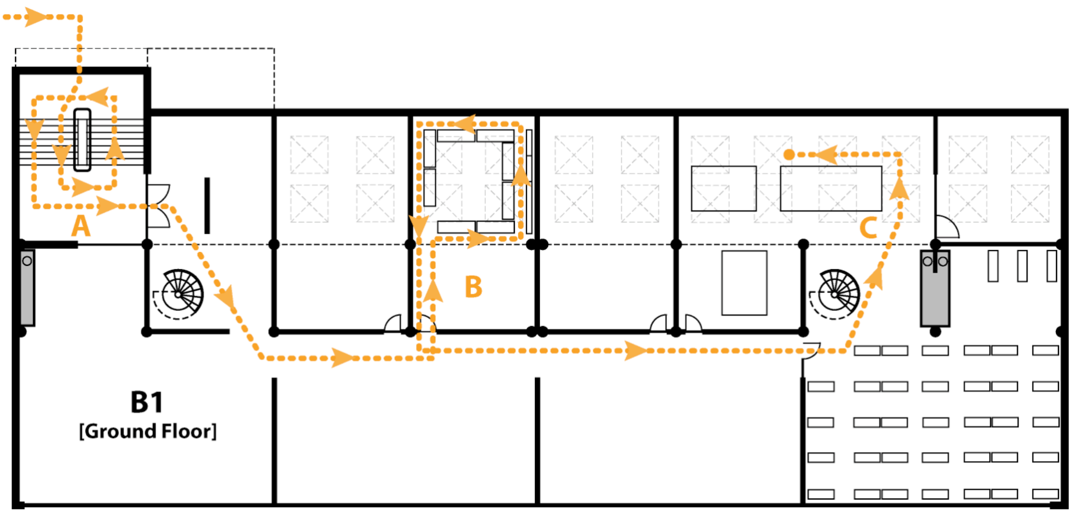


[*Figure 141*]
The Whole Wear Trial's Route, diagram adapted from architectural plan of FA|TUL (www.fa.utl.pt/images/PDF)

[202] The incorporation of two environments in the wear trials had to do with the way each influences gait motion. See Preliminary Steps Toward The Artifact's Creation, pp. 124-125.

Following the predetermined protocol for the outdoors, the six women **(1a)** walked along a 40m horizontal walkway, **(2)** walked up three flights of 9x8x8 steps, **(1b)** walked along a 52m horizontal walkway, **(3)** sat – normally and cross-legged – on a concrete bench 0.42m tall, and **(1c)** walked along a 68m access ramp plus **(1d)** a 11m horizontal walkway; as agreed by the all participants **(4)** they could also stand anywhere along the route [*Figures 142, 143 and 144*].

Within the building that accommodates the Fashion Design classrooms – previously identified as **g** in [*Figure 142*] and as **B1** in [*Figure 142*] –, the wear trials progressed along the spaces designated **A**, **B** and **C** in [*Figure 142*].



[*Figure 142*]
The Indoor Wear Trial's Route, diagram adapted from the architectural plan displayed at FA|TUL

Here the six women executed the same actions: they **(1)** walked, **(2)** went down 8x8x8 steps, **(3)** sat – while using a computer or flipping the pages of a portfolio –, and **(4)** stood – while drawing part of or cutting a pattern –; furthermore they assumed four of the seven extreme positions reported by Lotens:[203] **(i)** they raised one arm – while reaching a book on a high shelf –, **(ii)** they bent down the whole upper body – while picking up a scrap from the floor, **(iii)** they crouched, and **(iv)** they crossed the arms and hands around the shoulders [*Figures 143, 144 and 145*].

[203] See [*Figure 25*] in Antecedents Of The Research, p. 97.

[*Figure 143*]
First Group Of Women During The Wear Trials, photos of 1st and 2nd rounds by Luísa Barreto

[*Figure 144*]
Second Group Of Women During The Wear Trials, photos of 1st and 2nd rounds by Luísa Barreto

[*Figure 145*]
Third Group Of Women During The Wear Trials, photos of 1st round by Luísa Barreto

For no other reason than to lessen the time-consuming aspect of the implemented wear trials, the six women were divided into three groups, as seen in [*Figures 143, 144 and 145*]. To ensure that all the participants and I knew what they experienced, before each group set off on their first trial the actions to be carried out as well as the body locations to focus on were agreed on.

Based on past experience of wearing close fitting clothes, nine body locations where clothing pressure may be sensed as uncomfortable were identified: **(1)** waist, **(2)** hip, **(3)** thighs, **(4)** knees, **(5)** crotch, **(6)** across chest, **(7)** across back, **(8)** upper arms, and **(9)** elbows.

On the one hand, by asking the six women to pinpoint the body locations where they felt more pressure while carrying out the various actions, they were implicitly answering about the performance properties of the prototypes, namely their ability to follow movement. On the other hand, by asking them to decide upon the set of trial clothes with which was easier to carry out the various actions, they were implicitly answering about the ability of the prototypes made from the generated patterns **(a)** to accommodate surface change throughout ROM, **(b)** to stretch together with the skin throughout ROM, and **(c)** to exert little pressure on muscle tissues throughout ROM.

Apart the fact that garments made of wovens "may be close fitting and comfortable in one body position [but] become poorly fitting if the wearer moves or bends his arms, legs or trunk," as Denton (1972: 14) remarked forty years ago – demanding therefore that the six women adopted various body positions throughout the implemented wear trials –, the aspects of space, time and energy deserve attention because, together, they truly affect the overall perception of comfort. Separately these factors are defined as **(1)** the area of physical contact, **(3)** the duration of the mechanical stimulus, and **(2)** the sensitivity of a particular body site (Cholewiak and Collins 1991: 46).

Comfort *per se* is generally defined as freedom from pain, a neutral sensation that in the context of clothing appraisal is the "physiologically and psychologically unaware[ness] of the clothing we are wearing" (Smith 1993: 18). Additionally the author explains that "everyone has his or her own discomfort threshold relating to the individual's pain threshold. Each person also has certain views on what is and is not an acceptable type of discomfort sensation" (Smith 1993: 19).

In this sense asking only six women for their subjective feedback about the prototypes made from the generated patterns could be viewed as insufficient to satisfy the foreseen outcomes. However, since the participants used comparative analysis – a process that involved four rounds in total –, each one was able **(a)** to distinguish the sensations that were temporarily aroused by the prototypes as they triggered the local deformation of body tissues, as well as **(b)** to provide consistent responses about their individual wearing experiences.

What's more, the responses each one gave proved to be shared by everyone even though the time each participant took to execute the same actions throughout the wear trial's route wasn't almost certainly equal – seeing that they were asked to perform them as normally as they could – and the degrees of sensitiveness of each participant are unknown.[204]

In fact, the following tables show that in most cases the participants, independently of their age, considered the mobile body prototypes to be more comfortable than the static body trial clothes.

Regarding the first question, which aimed at knowing *with which set of prototypes was it **easier** for the participants to perform the outdoors actions*, the answers were as follows:

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[204] Actually only the areas of physical contact between body and clothing were equal for all the participants seeing that both sets of prototypes covered their whole upper bodies, arms and legs.

		Mobile Body						Static Body					
		Participant | Age						Participant | Age					
Action	**Location**	**41**	**19**	**27**	**22**	**21**	**21**	**41**	**19**	**27**	**22**	**21**	**21**
Walk along plane path	[a; c; f]	P1	P2		P4	P5	P6			P3			
Go up set of steps	[b]	P1	P2	P3		P5	P6				P4		
Sitting cross-legged	[d]	P1				P5	P6		P2	P3	P4		
Sitting normally	[d]	P1	P2			P5	P6			P3	P4		
Standing	[d]	P1	P2	P3	P4	P5	P6						
Resting against one leg	[d]	P1	P2	P3			P6					P5	
Go up ramp	[e]	P1		P3	P4	P5	P6						

Regarding the second question, which aimed at knowing *in which body sites did the participants feel **more** pressure while performing the outdoors actions*, the answers were as follows:

	Mobile Body						Static Body					
	Participant | Age						Participant | Age					
Body Site	**41**	**19**	**27**	**22**	**21**	**21**	**41**	**19**	**27**	**22**	**21**	**21**
Waist			P3		P5		P1	P2				P6
Hip			P3	P4			P1	P2				
Thighs									P3			P6
Knees							P1	P2	P3		P5	
Crotch			P3				P1	P2				P6
Across chest							P1	P2			P5	P6
Across back							P1	P2	P3		P5	P6
Upper arms							P1	P2	P3		P5	P6
Elbows							P1	P2	P3		P5	P6

Regarding the third question, which aimed at knowing *with which set of prototypes was it **easier** for the participants to perform the indoor actions*, the answers were as follows:

		Mobile Body						Static Body					
		Participant | Age						Participant | Age					
Action	**Location**	**41**	**19**	**27**	**22**	**21**	**21**	**41**	**19**	**27**	**22**	**21**	**21**
Walking	[A; B; C]	P1	P2	P3	P4	P5	P6						
Go down set of steps	[A]	P1	P2		P4	P5	P6			P3			
Sitting	[B; C]	P1	P2	P3	P4	P5	P6						
Standing	[B; C]	P1	P2	P3	P4	P5	P6						

Regarding the fourth question, which aimed at knowing *in which body sites did the participants feel **more** pressure while performing the indoor actions*, the answers were as follows:

	Mobile Body						Static Body					
	Participant | Age						Participant | Age					
Body Site	**41**	**19**	**27**	**22**	**21**	**21**	**41**	**19**	**27**	**22**	**21**	**21**
Waist			P3		P5							P6
Hip			P3									
Thighs			P3									
Knees							P1					
Crotch			P3									P6
Across chest								P2		P4	P5	P6
Across back							P1		P3	P4	P5	
Upper arms							P1		P3	P4	P5	P6
Elbows							P1		P3	P4	P5	P6

Regarding the fifth question, which aimed at knowing *with which set of prototypes was it* ***easier*** *for the participants to perform the selected 'extreme' positions*, the answers were as follows:

	Mobile Body						Static Body					
	Participant | Age						Participant | Age					
Extreme Position	**41**	**19**	**27**	**22**	**21**	**21**	**41**	**19**	**27**	**22**	**21**	**21**
Arm raising	P1	P2	P3	P4	P5	P6						
'Hug oneself'	P1	P2	P3	P4	P5	P6						
Lean down	P1	P2	P3	P4	P5	P6						
Crouching				P4		P6		P2	P3		P5	

After having gone through the series of wear trials, the six women described their experiences with the mobile body and static body prototypes more thoroughly – hereafter written MB and SB. For example, participant 1, aged 41, pointed out that the SB pants made movement at the hip and knee areas more difficult, a hindrance she attributed to the waist and crotch levels being lower than the mobile body pants' counterpart levels – indeed a 'misperception' considering the respective patterns [*Figure 128*].[205]

Participant 4, aged 22, expressed that the MB pants felt much more comfortable than the SB's even though they are tighter; she also preferred the way the MB pants looked on her, mentioning that they seemed to have been custom-made; she added that the only time the MB pants were somewhat uncomfortable was when she lifted her leg to lace her shoes.

[205] See p. 269.

Participant 6, aged 21, emphasized that the looser legs of the SB pants didn't make them more comfortable than the MB pants, on the contrary; curiously with the SB pants on she felt the constant need to lift them up at the waist – again a 'misperception' considering the linear measurements of both pants.[206]

Participant 3, aged 27, said that the SB pants seemed to fit her body better when she stood straight, although they exerted more pressure at the thighs and knee areas when she walked than the MB pants; about the MB pants, she mentioned that they became tight around the thighs and knees when she sat down – in fact the knee circumferences are the main difference between the MB pants and the SB, in terms of dimensions.[207]

Participant 5, aged 21, and participant 2, aged 19, didn't elaborate much on the their experience with the pants on, though the former stated that the MB pants felt and fitted better throughout movement than the SB pants and the latter declared that the MB prototypes, both pants and sleeved top, are more pleasing in appearance and also in fit than the SB clothes – more emphatically she mentioned that the SB pants made her buttocks 'disappear.'

With reference to the sleeved tops – or jackets, as the participants referred to them –, participant 1 commented that the SB set exposes the abdomen and lower back areas and got tight around the armhole when she moved the arms. Participant 3 stressed that the MB sleeved top was undoubtedly more comfortable, as it eased all movements; about the SB jacket, she told that it exerted too much pressure around the upper arms, elbows and across the back during movement.

Participant 5 and participant 6 have the same opinion as participant 3 about the MB sleeved torso, but the latter advances that its curved sleeves allow more arm movement than the SB's; about the SB jacket, she also said that it restrained movement on the waistline, bust circumference and armholes when the arms were raised high.

Participant 4 stated that she didn't notice a difference between the two jackets in terms of their contribution to ease of movement, adding that in fact she experienced

[206] See table in p. 292.

[207] See table in p. 292.

the same difficulties with either one in the course of some actions, such as raising an arm. She concluded, though, saying that she preferred the way the MB sleeved top looked on her.

As a final point, participants 2, 5 and 6 insisted that the comfort provided by the MB prototypes was felt as soon as they were donned, i.e., they were more comfortable even in the standing position – an attribute the three women predicted as remaining throughout movement.

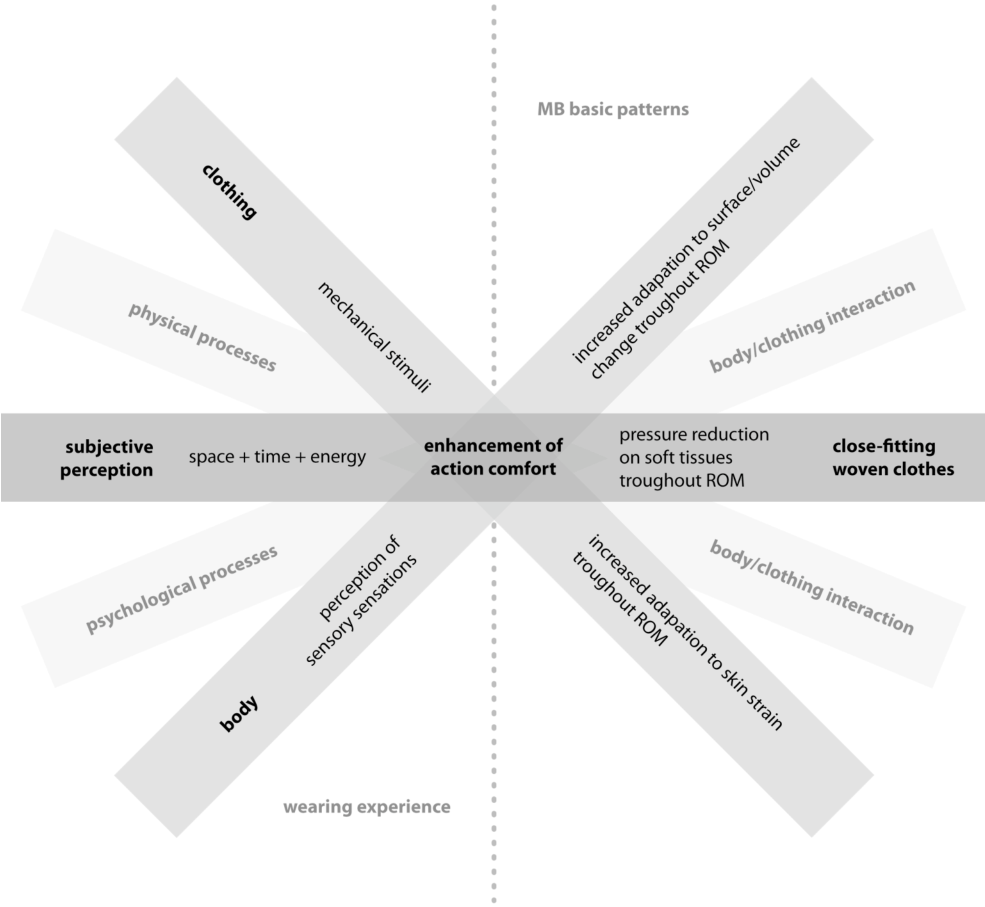
This particular inference isn't at all too impetuous, as Denton corroborates: "when we first put on a garment we may or may not be aware of the feel or warmth of the fabric but we certainly realize if the garment is too tight or too loose, that is, if it fits badly" (1972: 12).

On the other hand, when we put on a garment for the first time we assess it "subconsciously and simultaneously" (Smith 1993: 18) on grounds of aesthetics and comfort. The combination of these two aspects, which play a significant part in purchase decisions, is based on past experiences as well as on current trends (Smith 1993). Ultimately, the way we see a garment looking and feeling on us, i.e., its overall perception, is not an absolute appraisal, but a contextual one.

In effect, the subjective perception of comfort concerning the mechanical aspect of fit involves the interaction of a series of processes, such as the physical and psychological. Within the physical, the sensory organs **(a)** receive the pressure and tactile stimuli from clothing, **(b)** convert them into nerve impulses, which are then **(c)** transmitted to the brain; within the psychological, once the sensory sensations reach the brain, **(d)** they're evaluated and weighed "against past experiences and present desires to form an overall assessment of comfort status" (Li and Wong 2006: 4).

In any case, based on the information collected via the implemented wear trials, the prototypes made from the generated basic patterns are 76% easier to move about with in outdoors actions against the 19% scored by the SB prototypes, 96% against 4% in indoors actions, and 83% against 13% in extreme positions.

All in all, the results obtained via the implemented wear trials confirm the truthfulness of the created artifact: derived from, or on, the three-dimensional compound portrait of the mobile body, the two-dimensional drawings were appraised by the actual body as enhancing action comfort in general, accommodating volume change and decreasing pressure on body tissues in particular [*Figure 146*].



[*Figure 146*]
The Subjective Perception Of Action Comfort Regarding The Mobile Body Basic Patterns

Summary

Departing from the Form Follows Action phrase – and adaptation of Louis Sullivan's *form follows function* formula later adopted by the modernist architects and designers –, Part Five looks at the found two-dimensional formal solutions with the intention of determining their truthfulness.

Actually the advanced phrase holds two – somewhat metaphysical – meanings, as one attempts to convey the cause, the other the effect: **(a)** on the one hand, the generated basic patterns denote a solution contained by the problem, as their shapes express the intrinsic nature of the body, **(b)** on the other hand, the generated basic patterns turn into clothing that have the ability to follow the movement of the body.

For that reason, Part Five is divided into two sections. The first, concerning The Internal Validity Of Form, explores the two-dimensional artifact *within the territory of visual representation*. Employing a comparative analysis, **(1)** the generated depictions of the mobile body are described against the corresponding drawings of the static body, and **(2)** the alternative and conventional diagrams of the body are described against the corresponding three-dimensional representations of the body, namely the produced tangible mannequin and a standard dress form.

The second section, concerning The External Validity Of Form, imparts *the perspective of the dressed body* about the generated basic patterns. Employing a series of wear trials, the performance of the resulting prototypes was appraised by six women aged 19 to 41, who wear Euro standard sizes 38 and 36. To facilitate the women's task, the set of mobile body prototypes was assessed against the corresponding set of static body prototypes, all made of muslin and topstitched similarly.

Ultimately a convergence of point of views ensuing from the internal and external perspectives is seen: the application of the *form follows action* principle, or the interpretation of the mobile body put forward, is truthful, as the forms of the alternative pants, torso and sleeve **(1)** yield the illusion of the body experienced day after day, i.e., a body that's indivisible from its action, and **(2)** meet the actual functioning of the body, i.e., its everyday action.

6 Conclusions

[*The Overall Picture*]

The assumption that pattern design can do with a new way of considering the body and its representation is the driving force behind the research reported in this thesis.

The purpose of carrying out a research through creative practice presupposes that the created artifact – made of two parts, one the building block of the other, one the three-dimensional representation of the mobile body and the other its two-dimensional form – embodies the answer to the research question or problem.

Probably because of an earlier training in painting, the aim to place the created twofold artifact within the field of art over and above the field of design presupposes that the research seeks to raise an issue rather than to provide a fixed answer. By problematising the portrayal of the mobile body in pattern design the thesis seeks to broaden the audience for which the outcomes of the research would also be significant.

Although the deep-rooted paradigm of representation in pattern design is being more and more viewed as paradoxical, this entrenched paradigm is also recognized as having contributed to the knowledge about the body. Actually, the everlasting aim to represent the body factually has caused pattern designers to convert the convex and concave surfaces of the body into various flat shapes – more or less analogical, depending on the period in history –; the everlasting aim to interpret reality has caused pattern designers to work on a geometrical representation grounded in the analysis of the comparative proportions between different body parts.

Even considering that the deep-rooted paradoxical paradigm may be the product of our embodied reasoning and of the limitations of technical representation, the fact that pattern design has consistently opted to depict the static, standing, body has given assurance to its practitioners in addition to having awarded status to the profession. So much so that in the nineteenth century pattern design was claimed as an art and science (Simões 2005).

All the same, the distinctive portrayals of the body produced by pattern designers have rarely been the focus of museum and art gallery exhibitions. This seeming disinterest in patterns by the artworld may be explained by the entrenched notion that this type of drawings isn't created with the aim to afford a pleasurable aesthetic experience to people outside the garment industry.

To be frank, to recognize the body in the patterns is tricky for almost anyone since the represented subject has been designed like a jigsaw puzzle, each part being diagrammed separately. But once the subject in the patterns is identified, illusion emerges and with it the rewarding feeling of having been able to fit together the partial drawings that make up the picture.

Through the disclosing of the whole picture comes the perception of the patterns' beauty, i.e., the certitude of having grasped their meaning, a meaning that's conveyed by the orderliness, coherence and harmony of their parts and by the produced correspondence between sketch and body.

Admittedly connoisseurs and amateurs share the tacit knowledge that patterns turn ultimately into clothing but most probably only connoisseurs know that clothing patterns derive from basic patterns. Most probably also, only connoisseurs know that both types of patterns represent the body, the difference being that basic patterns must reproduce it exactly.

For that reason alone it is proposed that the faithful two-dimensional, colorless, minimalist, drawings of the body done by pattern designers, i.e., the basic patterns, be regarded *qua* artwork rather than a starting point or a valuable tool for the development of clothing. For that reason alone it is defended that the paradox in pattern design has to be solely resolved within the territory of visual representation rather than finding the solution, or solutions, with the help of mathematics and anthropometry – two fields that have been lending a hand for over a century.

Despite the fact that the research problem reported in this thesis involved working in pattern design – as the answer comprises a set of basic patterns meant for women's nonspecific clothing made from non-stretch woven textiles –, the outcome of the research falls within the ambit of visual representation. Underlying the addressed research problem – i.e., the reproduction of a body that is not rigid but deformable, a body that is never static but always moving, on the created patterns – is the question of how do clothes made from the created alternative basic patterns move with the body.

Implicitly, thus, the research is framed by body/product physical interaction concerns, for the positions assumed by the body throughout motion are among the factors that cause clothing pressure to increase to such degrees as those leading to the perception of discomfort.

However enthralling the results would be, at the start of this venture the difficulty was to figure out how to go beyond the paradigm of representation one is usually trained in, that is, how could the kind of logic that sustains the theory of conventional pattern design be surpassed. Certain that the static posture had to be replaced not by the position most assumed day after day but by the amalgamation of all body positions executed every day, the difficulty was to discern how this event, how this perpetual displacement of contour, would became visible.

While "the principal feature of [research trough design] is not the employment of a particular method" (Biggs 2002: 2), the devised methodology for this research became as significant as the created artifact itself. Integrating varied procedural techniques borrowed – or adapted – from the social sciences, fine arts and clothing engineering, the series of implemented actions directed toward the creation of the artifact applied the principle of learning by doing.

As it happens the understanding of the mobile body was attained as the making of the alternative tangible mannequin and basic patterns progressed. Spread throughout three phases, the search favored a qualitative approach that drew on **(1a)** the practice of self-portraiture – as it is called in the thesis – combined with a sampling strategy resembling theoretical sampling, **(2a)** an approach similar to visual somatometry combined with an experimental method of averaging body shapes, followed by **(3a)** the two- and three-dimensional techniques of pattern design.

In practical terms, the methods used for data collection and interpretation enabled to perceive **(1b)** the amalgamation of all the body positions that the commissioned eleven self-portraits disclosed, **(2b)** the deformation pattern of the reality projected on the plane that was incorporated into the compound portrait as well as into the alternative tangible mannequin standing for the mobile body, and **(3b)** the implicated basic features of the generated basic pants, torso and sleeve patterns.

However the research aspired to capture reality, it could only aspire to capture part of it. Therefore it was essential to decide who would play best the role of any other, or who – going along the strategy of the clothing industry – was going to act on behalf of the body. Conceptually, the motivation to focus on **(1a)** ordinary women, **(2a)** who wear standard clothing sizes, and on **(3a)** the ordinary activities they perform everyday, **(4a)** while dressed in nonspecific clothing, related to the intrinsic aim of this doctoral research: to contribute for a new body representation paradigm in pattern design.

Exactly because the research aims to contribute for an alternative explanatory model of a complex, variable phenomenon, the motivation to represent a standard body, to choose Euro size 38, to focus on ordinary activities and to generate a set of basic patterns for nonspecific clothing departed from the following principles and/or notions, respectively: **(1b)** presumably everyone possesses the same inherent qualities regarding the physical body, namely the way the head, trunk and limbs are arranged and fit together, **(2b)** it is agreed that it befits the bulk of the female population aged sixteen to fifty, **(3b)** everybody is expected to walk, stand, sit, don and doff, day after day, and **(4b)** the design of nonspecific garments – i.e., produced for no particular purpose – ought to enhance the performance of the wearer.

About the devised methodology, it must be added that if it was through doing that the mobile body took shape it was also through trial and error that the answer was found. Not having a preconceived idea of how data should be handled, **(i)** the 5cm grids that were printed on the one-piece garments before they were handed to the participants, and **(ii)** the angle measurements of all the segment lines forming the outlines and front/back boundaries of the plain- and self-portraits that were taken, were eliminated as they proved to be of little or no consequence for the understanding of the phenomenon at issue.

Instead the self-portraits' silhouettes, alone, were the means of **(a)** determining the properties and dimensions of the deformations that emerged out of movement – to put it simply, the forward inclination of the torso, the curved/angled shape of the arms, and curved/angled shape of the legs –, **(b)** redrawing the asymmetric silhouettes so they reproduced only the result of movement in its full potential, **(c)** separating into five pairs the front and lateral silhouettes of the selected self-portraits on grounds of closest similarity, and **(d)** finding the average contours of the coordinated sets by drawing bisecting lines pair after pair until one remained.

To understand the significance of the body – or the interest in it – in the context of the developed research it must be stated, right from the start, that it is the body that describes itself. Representing evidence of this condition, the work of Madeleine Vionnet, Aitor Throup, Rikke Korff and Dava Newman and the *oeuvre* of Esther Ferrer and Ana Mendieta corroborate also the precept advanced by Louis Sullivan that form follows function, i.e., that every problem contains and suggests its own solution.

In fact all the tissues, soft and rigid, that make up the body illustrate this principle: their individual designs are directly linked to their individual functions, as described in the thesis. Together they produce movement, an incessant occurrence that is conspicuously displayed on the surface of the body.

Like the skin, skeletal muscles and bones, the structure of the drawings produced by pattern designers must reflect their inherent function: they ultimately develop into garments that are in direct contact with the body while the body is in motion. Thus the forms of the patterns must reflect the myriad shapes adopted by the body in innumerable sequences.

Having understood the primary characteristic of patterns, the designers and researchers mentioned above have created or are creating nonspecific and functional clothing that include the movement of the body in the act of moving; having understood the ultimate effect of the forces within the body that produce movement, the artists referred to previously use or have used their own bodies to call attention to the transitory and poignant aspect of life that binds us all as one.

Following the lead of the designers, researchers and artists alluded to earlier, the logic behind the creation of the twofold artifact reported in this thesis was based on reciprocity, as its formalization was done by the body and for the body. Shaped from the inside out, no parametric equations were utilized or worked out to derive the alternative tangible mannequin and basic patterns.

Correspondingly the design of the twofold artifact did not follow the deficient construct of body representation in conventional pattern design, a circumstance that also corroborates Sullivan's well-known formula – or its adaptation into the less alliterative phrase *form follows action* advanced in the thesis.

The result of a pragmatic approach – i.e., three-dimensional pattern design, a technique more commonly known as draping –, the patterns molded in fabric yield the illusion of the body in the act of moving. From the perspective of visual representation, the formal solutions not only validate the submitted interpretation of the mobile body but also the developed interpretative methods.

In spite of that the proposal that basic patterns be regarded *qua* works of art implicates that this status is to be conferred by an audience and that the created slopers must provide a rewarding aesthetic experience. On the other hand, if the submitted formal solutions are merely regarded *qua* basic patterns, this status must also – or ultimately – be conferred by the body itself.

Given that the body is the *raison d'être* of pattern design and that aesthetic responses are intimately linked to artifacts themselves, in phase four, six women experienced prototypes made from the basic patterns designed on the alternative tangible mannequin against prototypes made from conventional slopers.

The implemented wear trials, being the concluding part of the artifact's validation, confirmed that the created artifact embodies the answer to the research problem: the lineament of the mobile body, as viewed in the created basic patterns, **(i)** achieves coherence and compatibility between pattern pieces, **(ii)** as their 'distorted' contours and grain line orientations, **(iii)** enhance fit and action comfort.

All in all, the idea of the mobile body shows potential as long as designers and manufacturers are prepared to embrace a paradigm shift. Vionnet, Throup and Korff – on behalf of *Levi Strauss* – have led the way within the territory of the fashion industry, but the truth is that to consider the body's mobility as the source of the design process is still not common practice.

For my part, the submitted interpretation of the mobile body needs further attention: however the created tangible mannequin proves that it is a valuable *a priori* tool for pattern design, it could be perfected by increasing considerably the number and kinds of sampling units. A further aspect – rather mandatory, it should be added – that needs consideration is to check how promising the generated basic patterns are for developing other pattern shapes by slashing and spreading their surfaces, by pivoting and transferring the darts in them, which are the characteristic methods of flat pattern design.

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