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**Towards the creation of an annotation system
and a digital archive platform
for contemporary dance**

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Resumo

Esta tese explora diferentes problemas e ideias para a documentação e disseminação da dança contemporânea. A questão basilar é compreender como a dança pode ser materializada, de modo a que se possa preservar a sua história, e como este material pode ser disponibilizado para que as pessoas possam inteirar-se da cultura da dança. Este trabalho tem como objectivo descrever os diferentes aspectos da elaboração de um sistema de anotação para análise da dança contemporânea e do movimento, assim como criar a base para a publicação web da dança contemporânea e da sua documentação. Foi desenvolvido através de uma aproximação multidisciplinar e combina teorias e métodos de várias áreas do conhecimento, como a Dança, o Estudos do Gesto e a Informática.

Para realizar estas tarefas, a tese estuda a decomposição de uma peça de dança para analisar o movimento humano e os seus diferentes aspectos. Explora diversos modos de arquivar e publicar a Dança e a sua documentação relacionada na web, concluindo com a criação de uma plataforma de arquivo digital online para coreógrafos.

Palavras-chave: dança contemporânea, documentação, sistema de anotação, arquivo digital, plataforma online

Abstract

This thesis explores different issues and ideas for documenting and disseminating contemporary dance. The main question behind it is how dance can be materialized, in order to preserve its history, and how this material can be easily accessed in order for people to be acquainted with dance culture. This work aims at describing the different aspects of the elaboration of an annotation system for analyzing contemporary dance and movement, as well as creating the basis for web publishing of contemporary dance and its documentation. This study was developed with a multidisciplinary approach and combines theories and methods from various areas such as Dance, Gesture Studies and Computer Science.

To accomplish these tasks, the thesis studies the decomposition of a dance piece in order to analyze human movement and its aspects, and explores possible ways of archiving and publishing dance and its documentation on the web, concluding with the creation of a digital archive platform for choreographers.

Keywords: contemporary dance, documentation, annotation system, digital archive, online platform

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Table of Contents

Resumo	iii
Abstract	v
Acknowledgements	vii
List of Figures	xi
List of Tables	xiii
Chapter 1: Introduction	1
1.1 Objectives	1
1.2 The TKB Academic Project	2
1.3 Structure of the Thesis	2
Chapter 2: Context	4
2.1 Dance Documentation and Preservation	4
2.1.1 A Brief History	4
2.1.2 Documenting Dance	7
2.1.3 Access to the Dance Material	10
2.2 Digital Archive Platform	11
Chapter 3: Theoretical Background	13
3.1 Structure of Dance	13
3.2 Movement Analysis and Notation in Dance	16
3.2.1 Laban Movement Analysis (LMA) and Notation	16
3.2.2 Benesh Movement Notation	21
3.2.3 The Eshkol-Wachman Movement Notation	23
3.3 Movement Notation in Sports	25
3.4 Movement Description in Computer Science	27
3.5 Gesture Analysis and Annotation	29
3.6 Dance Archives and Interactive Collections	33
3.6.1 Dance Archives	34
3.6.2 Technology and Tools of Online Archives	37
Chapter 4: Determining Analysis Criteria	40
4.1 Issues related to Documentation and Web Publishing of Dance	40
4.2 Defining a Framework for Dance Analysis and Distribution	41
4.2.1 Elaboration of an Annotation System	42
4.2.2 The Creation of a Dance Video Archive	46
Chapter 5: Towards the creation of a Dance Annotation System	48

5.1 Annotation Tool.....	48
5.2 Segmentation of a Dance Piece.....	49
5.3 Movement Analysis and Annotation.....	50
5.2.1 Phrasing.....	51
5.2.2 Representation of the Body.....	52
5.2.3 Bodily Expressivity.....	53
Chapter 6: Towards the Creation of a Digital Archive Platform	59
6.1 Technology Used	59
6.1.1 HTML5 <video>.....	59
6.2 Structuring the Data	61
6.3 Workflow of the Web Site	63
6.4 Upload Phase	64
6.5 Relationship Structure Definition	65
6.5.1 Creation of the Relationship Structure.....	65
6.5.2 Submission of the Relationship Structure.....	69
6.6 Displaying the Videos and the Documentation.....	70
6.6.1 Building a new XML file.....	70
6.6.2 Metadata Page Display.....	71
6.6.3 Video and Annotations Display	72
Chapter 7. Conclusions and Future Work.....	75
7.1 Conclusions.....	75
7.2 Future Work.....	76

List of Figures

Figure 2.1: Pina Bausch in ‘Café Müller’	7
Figure 2.2: A Labanotation score from George Balanchine's <i>Symphonie Concertante</i>	10
Figure 3.1: The division of the body in Labanotation	19
Figure 3.2: Symbols for describing the movement in Labanotation.....	20
Figure 3.3: The length of a symbol demonstrates the timing of the movement.....	21
Figure 3.4: A: Representation of the body in BMN. B: Example of Benesh notation for an Arabesque. Left arm extended front and right leg to the back	22
Figure 3.5: A: Stick figure representation of the body in EWMN. B: The System of Reference (SoR). C: The curves formed on the surface of the sphere, by the movement of the forearm, will be circles or parts of circles.....	23
Figure 3.6: A: A manuscript page: Each segment of the body has its own space. B: A manuscript page with notations.....	24
Figure 3.7: A: The fundamental starting position. B: Relative angle of the knee joint.....	25
Figure 3.8: Movement element list from the International Federation of Gymnastics.....	26
Figure 3.9: The three shaping zones.....	28
Figure 3.10: A gesture unit and its phases.....	31
Figure 3.11: Gestures that inform about the Sender’s mind.....	31
Figure 3.12: An example of cue annotation in <i>One Flat Thing, Reproduced</i> project.....	36
Figure 4.1: Movement phrase contains a jump.....	43
Figure 5.1: Elan interface with the tiers created for Rui Horta’s piece <i>SetUp</i>	48
Figure 5.2: The hierarchical structure of the first analysis step.....	49
Figure 5.3: An example of annotation while segmenting a dance piece	49
Figure 5.4: A moves towards B completing a phrase. B is moving away, responding to A’s phrase.....	51
Figure 5.5: The representation of the body.....	52
Figure 5.6: Description of static bodily expressivity within a movement phrase	56
Figure 5.7: Movement analysis for each dancer	56
Figure 6.1: The annotation structure.....	61
Figure 6.2: The form where the choreographer can upload his videos.....	63
Figure 6.3: Definition of the relation structure by the user.....	65
Figure 6.4: The flowchart of the function <i>createRelation</i>	66
Figure 6.5: The relation structure	67
Figure 6.6: The user can browse the metadata of the video.....	70

Figure 6.7: Main page where the user can watch the video linearly or
interactively.....71

List of Tables

Table 3.1: Basic terms of motion.....	26
Table 3.2: Emotions in relation with body movement.....	28
Table 5.1: Elements for describing dynamic and static bodily expressivity.....	53
Table 5.2: The dynamics that were used to describe a movement.....	54
Table 6.1: HTML5 video support into main browsers.....	60

Chapter 1: Introduction

Dance is an inalienable part of human culture. It does not exist as an object. Like language, it can only be experienced when it is being produced. Therefore, it is part of the immaterial patrimony of a community, and as such, its past, present and future are worth being documented.

In fact, dance has been characterized as ephemeral, since each movement, once danced, belongs to the past, without leaving behind records, evidence, material that can prove its existence. Therefore, the field of dance history has always struggled to establish itself.

Nowadays, there is an increasing effort for preserving immaterial patrimony, such as traditions, knowledge, languages and artistic expressions, religious celebrations and rites.

The material left behind by a dance performance consists of programs, written articles, photographs, sketches and notations. Progressively, with the development of new technologies, records have expanded beyond text and image to include audiovisual recordings, such as videos of performances or rehearsals, and interviews of both creators and participants. Subsequently, at the present, dance is leaving behind more records than ever, a fact that permits communities to start making dance history. In fact, in the recent years, dance has experienced a growing interest for video recording and documentation as well as movement analysis.

1.1 Objectives

Contemporary dance is part of the most recent dance history. Artists that perform contemporary dance explore new principles and techniques and research philosophies of movement that are outside the realm of classical dance technique. Thus, unlike ballet, contemporary dance has not developed a kind of controlled technique or vocabulary that can be passed on future generations.

One of the objectives of this thesis is the description of the creation of a reliable vocabulary, which can be used for describing dance and movement within dance pieces. The composition of a dance piece and the movements that form the dance will be expressed in words, building in this fashion, an annotation system. In order to analyze movement, it was necessary to study body movements beyond dance, considering the perspectives of different research areas, such as Sports and Gesture Studies. Therefore, the thesis will explain, on the one side, how systems that annotate dance evolved differently throughout the years, and, on the other side, how movement is described depending on the perspective of each research area.

The final objective of the thesis is the dissemination of contemporary dance and its documentation through the creation of a dynamic online video archive. The first requirement for accessing dance and its history is for the material to be gathered together to one place, where people can easily find what they are looking for. Obviously, nowadays this place can be virtual so that any user can access it and reach the information. In this thesis, we will create an online digital platform with the purpose of hosting dance videos and their related documentation, all parts of the creation of an artistic work.

Thus, the objective of this thesis is to combine multidisciplinary backgrounds from Art, Linguistics and Computer Science in order to motivate people to appreciate dance, to introduce them to choreography and finally contribute in the field of dance history. For this purpose, this thesis will explore the choreographic composition and the movement structure within a dance piece for the formation of an annotation system and will study the possible ways of distributing the created dance documentation online.

1.2 The TKB Academic Project

This thesis was funded and developed within the scope of the FCT¹ academic project: PTDC/EAT-AVP/098220/2008 - *TKB - A Transmedia Knowledge Base for contemporary dance*, and some aspects of the methodology used in the thesis were defined by a working team.

The project's main targets are: 'to extend the scope and application of the "documentation" concept to contemporary dance in different ways; to develop a strong link between the recent dance-research community and the well-established communities in cognitive linguistics and computer science, by taking a closer look at the cognitive process of "choreographic thinking" and therefore contribute to the domains of multimodal corpora , terminological ontologies, cognition and verbal-nonverbal relations' (*TKB - A Transmedia Knowledge Base for contemporary dance* 2009). A description of the TKB project can be seen in (Fernandes and Costa 2010) and (Fernandes and Jürgens 2010).

1.3 Structure of the Thesis

Chapter 2 presents a brief history of ballet and modern dance in order to get to the foundation of contemporary dance. Furthermore, it describes how dance is documented and preserved since its earlier times and how this documentation serves different research purposes. Finally, it introduces the notion of a dance online digital platform.

¹ FCT: Fundação para a Ciência e a Tecnologia

Chapter 3 gives an overview of different approaches for dance documentation and analysis and various efforts that have been accomplished for securing and distributing dance heritage. It explores how movement is structured and analyzed within different research areas, such as Dance, Sports, Computer Science and Gesture Studies. It concludes with the presentation of various dance archives and the technological tools they use.

In Chapter 4 some issues concerning dance documentation and dissemination will be analyzed. Here, will also be presented the decisions made before the implementation of the system and the analysis principles incorporated from the theoretical background.

Chapter 5 focuses on the tools and methodology used for the formation of an annotation system for documenting dance and movement.

Chapter 6 presents the online video archive platform. It describes the implementation, provides an overview of the main features and offers a walk-through with screenshots of the web pages.

Chapter 7 summarizes the contribution of this thesis and suggests tasks to be performed in the future.

Chapter 2: Context

*Dance is the only art of which we
ourselves are the stuff of which it is made.*

Ted Shawn

2.1 Dance Documentation and Preservation

Dance is a form of art created by movement of the body, which is usually rhythmic and accompanied with music. It is used as a form of expression in social interaction and spiritual or performance settings. Dance is also a form of nonverbal communication between humans. Although very important to human life, dance, unlike other arts like painting or sculpture, is difficult to preserve as a result of its changeable nature. The fact that very little documentation is available does not permit to say when dance first became part of the human culture. In the next sections, some important moments in the history of dance will be pointed out, as well as issues related to dance documentation and preservation.

2.1.1 A Brief History

As said before, dance is an indispensable part of human's social and cultural life. Throughout history, it has accompanied social and religious events, ceremonies, rituals, celebrations and entertainment. In this thesis, we are interested in tracing back the roots of contemporary dance, which are found in techniques and philosophies of contemporary ballet and modern dance.

There are six important moments to be mentioned in the history of ballet: pre-classical dance history (15th-16th century), court ballet and baroque dance history (16th-17th century), ballet of action (18th century), romantic ballet history (end of 18th-19th century), classical, academic and/or imperial ballet history (second half of 19th century) and contemporary ballet history (20th century - present time) (Naranjo Rico 2010). Here, we will briefly refer to the Romantic and Classical era in order to make an introduction to contemporary ballet.

During the Romantic era, ballet performances started to be seen as expression of the soul and focused on the emotions, fantasy and spiritual worlds. In this era some popular ballets premiered; an instance is "Giselle" (1841): choreographed by Jean Coralli and Jules Perrot, and scripted by Théophile Gautier and Vernoy de Saint Georges.

The Classical ballet era is identified by the influence of the French ballet dancer and choreographer Marius Petipa (1818-1910). Petipa, in 1888, started working with P.I. Tchaikovsky, as a composer, and created some of the most popular dancing pieces in ballet history, like “Swan lake” (1895), “The Nutcracker” (1892) and “The Sleeping beauty” (1890) (Naranjo Rico 2010).

After the Classical period follows the modern ballet era, which lasts until the present time. Nowadays, in contemporary ballet, dancers and choreographers mix their choreographic legacy with modern and contemporary art values, creating a greater range of movements that may not adhere to the strict ballet technique. One of the first pioneers of contemporary ballet is George Balanchine (1904–1983). He worked with the modern dance choreographer Martha Graham expanding, in this fashion, his technique to modern influence.

There have been continuing attempts from dancers and choreographers to break the mold of classical ballet in the early 20th century. To sum up, we could say that ballet is a form of theatrical dance that uses firm movements and poses characterized by elegance and grace. Ballet movements follow specific rules and technique regarding the positions of the arms, feet, and body, and serve grace and geometry. They are precise and delicately choreographed focusing on the lightness of the dancers. Concerning the structure, ballet pieces are usually composed by acts and follow a linear narrative.

This strictness of ballet movement didn't keep up with the explosion of new thinking and exploration in the early 20th century and impelled many choreographers like Isadora Duncan and Martha Graham to come to rupture with the ballet foundations and the social conventions.

Subsequently, ballet and its rigid techniques were succeeded by modern dance, which allowed a broader range and fluidity of movement. Modern dance era brings the liberation of body and its expression, the creation of renowned schools and masters, and the refusal or ignorance of ballet and its aesthetic paradigms. Some of the known figures of the modern dance era are Isadora Duncan (1877-1927), Martha Graham (1894-1991), Rudolf Laban (1879–1958), Doris Humphrey (1895-1958) and Ted Shawn (1891-1972).

Ted Shawn together with his wife founded, in 1915, the Denishawn School of Dancing and Related Arts, where, between others, Martha Graham and Doris Humphrey refined their technique. Ted Shawn also ran the Jacob's Pillow Dance center which is known for the oldest internationally acclaimed summer dance festival in the United States².

² See chapter 3.6 for the Jacob's Pillow Dance Interactive

Martha Graham was one of the first to establish modern dance as a new movement. Martha Graham's dancer, Betty MacDonald, states, 'Martha wanted to say something in terms of movement [...]. She wanted to move the body differently. And she certainly did. Already Martha's technique was beginning to explore contraction and release' (Betty MacDonald in Tracy 1997:3-5).

Rudolf Laban (1879-1958) was one of the most important figures who produced the ideological and conceptual basis of modern dance. Laban is known as a choreographer, dancer, teacher and researcher and he invented Labanotation, which is a notational system for analyzing and writing movement³.

Contemporary dance is considered to be the evolution of dance after the 1950s. It aims towards simplicity, the beauty of the body and the movement. Contemporary techniques use some of the modern and classical techniques, mainly for the dancers training and they also use a selective choreographic vocabulary on stage. However, contemporary dance, unlike ballet, is not associated with a characteristic technique. It is an expression used in a popular way to gather a big variety of different choreographic practices, which can be sometimes contradictory in their aesthetical proposals. In our opinion, this derives from the fact that dance has a social and political role as much as an aesthetical role.

Contemporary dance continues to increase and change every day with the foundation of new companies and the establishment of new dramaturgical and compositional perspectives. Some of the known contemporary choreographers and dancers are Merce Cunningham (1919-2009, United States), Yvonne Rainer (1934, United States), Sasha Waltz (1963, Germany), Siobhan Davies (1950, England), Pina Bausch (1940-2009, Germany), William Forsythe (1949, United States) and Rui Horta (1957, Portugal). Many of the above choreographers or their companies are performing at the present.

Merce Cunningham was Martha Graham's student for several years until he started an independent career as a choreographer accompanied by the music of John Cage (1912-1992, United States). Cunningham was considered one of the greatest creative forces in American dance since he 'aimed for modernism that was not anti-ballet (as was so much of modern dance at that point), but somehow beyond ballet' (Bremser and Sanders 2011:106). In addition, Cunningham was one of the first choreographers to create dances in a computer environment with body motion using a program called 'Life Forms', now known as 'Danceforms'⁴(Bremser and Sanders 2011:108).

³ See chapter 3.2 for Laban's theory and Labanotation

⁴ Merce Cunningham Company – DanceForms (*Merce Cunningham Company – DanceForms* 2009)

Pina Bausch was a leading influence in the development of the Tanztheater style⁵ of dance. The contemporary dancers at the time were interested above all in movement. ‘Pina Bausch, however, has expressly determined that she is less interested in how people move as in what moves them’ (Daly 2002:8).



Figure 2.1: Pina Bausch in ‘Café Müller’ (Itzkoff 2009).

2.1.2 Documenting Dance

Concerning the interest of studying dance and its history we could argue that dance history, serves different needs and uses. On the one hand, it can help dancers and choreographers to acquire knowledge on the Dance field, to gain a critical perspective on choreographic conventions, to see how movement is formed within different cultures and in conclusion to clarify their own choreographic visions. On the other hand, dance history serves the various purposes of historians, ethnographers, anthropologists, preservationists and theorists.

However, dance multidimensionality is an obstacle regarding its documentation. The difficulty of recording dance, since its early time, results to the lack of material that can narrate the history of dance. ‘This shortage of recorded dance gives the impression that dance itself does not have a history’ (Johnson and Snyder 1999). In fact, the tools, such as video technologies, that can fully document a three-dimensional form have not been available until the 20th century.

⁵ The German term Tanztheater first appears in the 1920s to identify a particular style of expressionist dance. One of the main supporters was Laban. Tanztheater appears again with Pina Bausch in 1973 (Daly 2002:7).

Furthermore, another obstacle in dance documentation is the fact that dance faced hostile and prejudicial attitudes before the twentieth century. The taboo subjects that dance was dealing with, like the human body, the human physicality and sexuality offered sufficient reasons for the religious conservative society to regard dance with suspicion, and as something profane. This continuous antagonistic attitude prevented the preservation of dance documentation in many parts of the world, mainly within American borders (Johnson and Snyder 1999).

One of the first efforts for documenting dance is remarked in Europe, in the 15th century, when the concept of notating dance appeared, and in this age belonged to the court culture of the higher classes (Fügedi 2003). Several notation systems were later developed as will be discussed below.

Dance notation is the symbolic representation of dance, just as the musical score serves music. The most important periods of dance notation are the 18th and 20th century. In the 18th century the Feuillet-Beauchamp system (Guest 1989:13-21) was in use for about 150 years. Thanks to Feuillet-Beauchamp notation it is possible today to study the steps and dances that form the basis of the classical ballet. However, this system focused more in the steps and lacked a clear indication of rhythm (Guest 2005:2).

In the 20th century the symbolic system of the Hungarian Rudolf Laban (1879-1958) known as Labanotation⁶ or Kinematography Laban was spread all over the world. Laban created a tool for recording movement, but took the system far more beyond verbal description. The system does not record only the steps of the dance but also focuses in the rhythm, the paths in the space, the flow of energy, the movement motivation as well as the dynamics and qualities of the movement, achieving like that a better understanding of movement.

In general, notation systems were developed with the purpose to record specific movement patterns, dances, exercises and choreography. They aim to record ‘the spatial three dimensionality, the time and dynamic values of dance. All these factors must be determined for the whole body and for all the independently moveable body parts. An important part of the system is also the indication of relations to objects, partners, groups, and other imaginative shapes such as the circular paths, etc. With a musical comparison the notation of one person's movement resembles rather a score of an orchestra than a single instrument’ (Fügedi 2003).

Dance notation, and especially Labanotation, was not broadly accepted until the foundation of Dance Notation Bureau⁷ (1940) (Lu 2009) in New York City. In fact, Dance Notation Bureau

⁶ Labanotation and other notational systems are discussed in detail in chapter 3.2

⁷ The activity of Dance Notation Bureau is further discussed in Chapter 3.6.

played an important role in the acceptance of dance notation by choreographers like George Balanchine and Doris Humphrey, who later became supporters of Labanotation.

Dance notation changed legal and academic attitudes toward dance, but it wasn't until the later development of the moving image that it managed to affect the experience of dance documentation (Johnson and Snyder 1999). The entrance of video in the process of dance documentation sparked the discussion of whether video can replace notation for movement recording. In fact, neither can replace the other, but they can complement each other. 'Video records an individual performance; notation records the work itself, not the performance of it'(Guest 2005:6).

Many dance experts regarded dance notation with reservations and consider the idea of dance documentation as a luxury. Nonetheless, as said before, dance documentation can serve different purposes. In the short term, documentation can serve as a tool for audience-building, publicity, grant applications as well as a working tool for the dancer and the choreographer during the creation process of choreography. Sarah Warsop, Siobhan Davis' dancer, said: 'Transferring the information into a different medium allows you to see or 'resee' what you've done. To be able to stand outside the movement and look at rhythm, structure, and shape (shape as a moveable thing, and a static thing), could allow you to go back into the movement with new information' (Sarah Warsop cited in Delahunta and Zuniga Shaw 2006).

In long term, dance notation permits the preservation of choreography for future reconstruction. A fully detailed and accurate movement notation of choreography gives the possibility of next generations to revive the dance exactly as it was originally danced. An instance of restaging a dance directly from a notation score is Balanchine's *Symphony in C*. In 1958 the High School for the Performing and Visual Arts in New York City staged the piece from the Labanotation score (Fig. 2.2). This was the first of many staging from scores in both ballet and modern dance (Lu 2009).

Furthermore, dance notation serves the purposes of ethnologists, historians and anthropologists to examine dance within the social events and the cultural history of a given community. A strong advantage of dance notation is that it moved beyond preserving dance, making possible the study of movement in depth and helping to expose the real dance history and dance tradition.

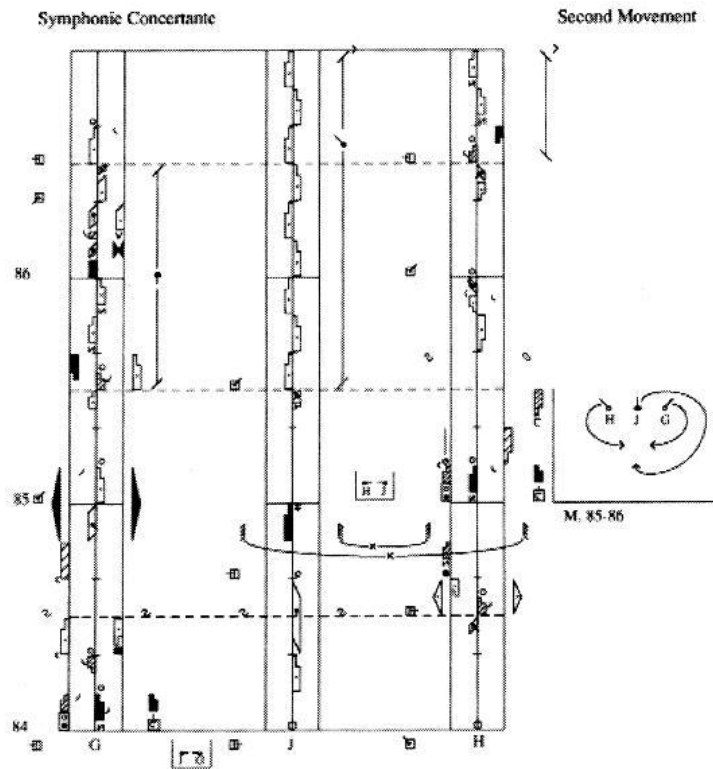


Figure 2.2: A Labanotation score from George Balanchine's *Symphonie Concertante* (1947; originally performed in 1945 by students of School of American Ballet). Notation by Ann Hutchinson Guest, assisted by Els Grelinger (1948)⁸.

Nowadays, many dance companies and institutions continue to notate dance using Labanotation or other notation systems. However, the perspective of looking at dance has changed from the Laban era until today. This is reflected to the concerns and needs of today's choreographers in documenting dance. In fact, many choreographers, like William Forsythe, Wayne McGregor and Rui Horta, collaborate with cognitive scientists and researchers from various research areas, in order to shed light to their choreographic process. They are interested in showing how the creation process is developed from the inside, motivating the public to get familiar with choreography. From the point of view of cognitive scientists the study of dance movement can serve to obtain knowledge about human complex mental processes.

2.1.3 Access to the Dance Material

The dance community as well as people interested in dance need to have access to dance information for various reasons, like research purposes, for getting acquainted with

⁸ Source: The Dance Heritage Coalition Publications (*Dance Heritage Coalition* 1998)

choreography or just for entertainment. The term access means that the material is available to the user and a user can easily find and reach the information.

Over the past decades, the broader and more reliable access to the dance resources has changed the population's perspective towards dance and has increased public support for funding research projects in the area of Dance (Johnson and Snyder 1999). From personal experience, though, we could argue that dance users cannot easily find the information they need.

After the 1950s, there has been a great effort from institutions, libraries, and organizations to collect dance materials by cataloging them and making them available to the public. Additionally, many choreographers started seeking ways of preserving their work and getting interested in sharing their creative process.

Nowadays, there are several places where someone can access dance material, such as the New York Library, which has one of the largest collection in the United States devoted exclusively to the discipline of dance (Johnson and Snyder 1999). However, the user has to visit the repository in order to have access to the information. This fact started to change with the creation of digital online archives where users from everywhere can access the information they need, as will be discussed in the next chapter.

2.2 Digital Archive Platform

Archive is a storage location that maintains a collection of historical records for permanent or long-term preservation. Many choreographers consider their archive to be all the things that are related to their creation throughout their artistic life. This may include both primary and secondary source material in two- or three- dimensional formats. For a professional archivist, though, not all of this material would fulfill the qualifications to be placed in an archive.

Information about dance is more often found in materials like choreographic notes, anthropological field notes, moving image material, audio recordings, photographs, programs and other ephemeral publications. Archival projects related to dance are an effort to collect these material and documentation associated with the works of a choreographer to a single collection. For this purpose, the collaborative teams proceed to a digitization of the materials, if needed, in order to store them and eventually place them online to a collection. In this way many data that otherwise would remain unavailable can be catalogued and placed online accessible to users.

Digital preservation, the process of managing information in digital form over time in order to guarantee its accessibility, consists of a set of procedures designed to ensure the availability of

the data records to the users. Consequently, a reliable digital repository is assigned with the mission to maintain archived digital resources and the related metadata so as to provide long-term access. In fact, the repository has to be designed accordingly to universally accepted conventions and standards in order to confirm the simplicity of managing and accessing it.

The documentation of the resources with metadata results to a better filtering and searching of the archived material. Metadata are text fields, built-in media files or additional text files, like XML files, for recording information for the material. In fact, metadata is the digital equivalent of a library classification system and ensure a seamless and accurate online search by any user.

A computing platform might simply provide a framework and a set of tools which enable authenticated users to integrate and publish their work on a website.

In this thesis, a digital archive platform is considered to be a computing platform which provides the interface that permits the authorized user/choreographer to place the digital material and its metadata, which constitute his artistic work, online to an archive. The platform provides also the framework of how the material should be managed and catalogued in order to be included in the archive.

Chapter 3: Theoretical Background

As before mentioned, dance is a form of art that refer to movement. Hence, for someone to create an analytical framework for dance it is essential to study movement and its expressivity. In fact, movement analysis is studied in different research areas and within different contexts. Consequently, in this thesis we assumed to be very important to include in our study the different perspectives on movement analysis that derive from various research areas.

This chapter makes a short journey among theoretical notions and concepts based on dance theory and notation that have been used as theoretical background in this thesis. Chapter 3.1 describes the different approaches and analysis of the structure of contemporary dance. Chapters 3.2-3.5 explore different methods of movement analysis and notation in various research areas: Dance, Sports, Computer Science, and Gesture Studies. Finally, chapter 3.6 presents dance archives, which aim on preserving and disseminating dance and its documentation, and allow access to information for both research and entertainment.

3.1 Structure of Dance

In this section the process of deconstructing a dance piece for further annotation and interpretation will be discussed. Various researches embark on dance studies in order to shed a light onto the structural skeleton of choreography. A formal approach to choreography includes the analysis of the trinity of Space, Time and Dynamics of dance movement as well as the observation of the factors of music, costume, lighting, and props from the point of view of the above three elements.

A composition of a new dance derives from a stimulus, ‘something that rouses the mind, or spirits, or incites activity.’ (Smith-Autard 1976:20). For the choreographer a stimulus can be a piece of music, an image or a painting, a specific physical movement or a state-of-mind. The choreographer explores the idea inspired by this stimulus and starts developing and forming a general shape for his creation. The creation of a dance depends both on composition and on design. The design contains the harmonization of the diverse components, which form a dance, so that the result is aesthetically enjoyable. Additionally, the choreographer chooses a dramatic structure or movement dramaturgy to organize a piece and present it to the audience.

After the conceptualization and the initial structure of a dance, the element ‘dancer` starts contributing into the choreographic process. The degree of freedom a choreographer gives to his dancers for improvising around a theme, a motif, or a movement phrase depends on the

choreographer. For example as (Foster 1986) refers regarding to the choreographic approach of the American choreographer Merce Cunningham, 'Cunningham's dancers bring their own passion and their own interpretation of the dance to each performance. Cunningham does not direct their motivation for the movement or even their technical mastery of it. He represents the sequences, directions, and timing; the dancers refine the phrasing, comprehend the value of each movement and the logic of the sequence, accomplish the movement within a precise amount of time, and attend to the movement's expressivity.' (Foster 1986:38).

A dance composition is a creative process resulting to an artistic work. The way this artistic work will later be analyzed depends on the individual, who could be a dance historian, a researcher, a dance educator, a critic, a viewer as well as the dance maker himself.

Janet Adshead (Lansdale 1988, cited in Jackson 1994), a dance researcher, asserts the need of a dance-based theory that will lead to a better understanding of how dances are structured and how their diverse elements are put together in order to convey particular moods and meanings. According to Adshead, a systematic analysis of a dance firstly implies isolating and describing the physical actions appearing in a work, and then searching for patterns that will reveal the ways in which the choreographer has structured the movement through the use of repetition, variation, or motif development (Jackson 1994). She supports that a researcher, through this kind of dance analysis, can distinguish in a dance work discrete movement phrases, which can be categorized as phrases containing points of climax, or transition phrases and so on.

Subsequently, Adshead has incorporated the idea of discrete movement phrases in her dance analysis approach. The concept of a 'phrase' derives from music composition and appears in the context of dance in the early 20th century. A phrase can be seen as a movement unit that is consisted by consecutive movement sequences. The concept of phrasing and composing movement units in time prove to be very important in the process of looking, notating and understanding dance.

Dance analysis focuses on how a phrase is interpreted by a choreographer, its meaning and how is received by the viewer. However, there are different opinions concerning the definition of a movement phrase, as will be discussed in the next paragraphs.

According to the choreographer Doris Humphrey, the organization of movement in Time, Space, Weight and Flow⁹ is known as 'the theory of the phrase'. Doris Humphrey states that a good dance consists by clear phrases that have a beginning and an end (Humphrey and Pollack 1991, cited by DeLahunta and Barnard 2005:253-266). Humphrey classifies phrases into three

⁹ The concept of Time, Space, Weight and Flow comes from the Laban Movement Analysis and will be discussed in the chapter 3.2.1.

categories according to the position of the climax in the phrase; if the climax is found at the beginning, near the end, or near the middle of the phrase (Humphrey and Pollack 1991, cited by Maletic 2005:57).

However, many choreographers don't agree with Humphrey's 'theory of phrase'. With the transition from the modern dance era of Humphrey to the post modern dance period, different perspectives of choreographers appeared regarding the meaning of a phrase (DeLahunta and Barnard 2005). In fact, other opinions about the structure of movement phrase came to contradict Humphrey's 'theory of phrase'. Yvonne Rainer, an American dancer, choreographer and filmmaker, considers as phrase the sequence of consecutive movements or a metaphor for longer duration, and refers to 'phrasing' as the way energy is distributed in the execution of a movement or a sequence of movements (Maletic 2005:57). In contrast also with Humphrey's phrase concept is the use of repetition in the pieces of the German choreographer Pina Bausch. Nevertheless, movement phrases exist in every dance piece even if a choreographer doesn't embody the concept of phrase. In an interview choreographer Meg Stuart argues: 'I can't say I don't use phrases, I mean I think it's a bit inevitable' (Burrows 1999, cited by DeLahunta and Barnard 2005).

The Choreography and Cognition project (*Choreography and Cognition* 2005), initiated by the choreographer Wayne McGregor, realized a study on the concept of phrasing in cooperation with Wayne's McGregor company (DeLahunta and Barnard 2005). In brief, the dancers were asked to perform a range of improvisation tasks, after they have divided them into units, and then they were called to justify their decision making in phrasing the movements. The result of the experiment shows that a dance phrase can have different meanings and can be classified differently from choreographers, dancers, analysts or viewers. According to the study, dancers grouped the movements into units depending on the change of movement dynamics, or the change of energy, or the change of direction, or a pause¹⁰.

A close study of the phrasing in dance is fundamental in dance analysis. In fact, a good collaboration of the analyst with the choreographer can result to a good interpretation and understanding of a dance. Nonetheless, the choreographer's point of view is only one source to be used in the dance analysis. Most important of all, according to Adshead, is the study of the dance itself, which can result to findings that may or may not agree with the stated intentions of the creator of the dance (Lansdale 1988, cited by Jackson 1994).

As referred above, movement phrases are a very important structural factor in a dance piece and they should be considered by the dance analyst. The study of a movement phrase contains the

¹⁰ The (DeLahunta and Barnard 2005) study will be further discussed in Chapters 3.6.1 and 4.2.1.

description and analysis of dynamics of the movements that compose a phrase. The study of movement's dynamics, description and notation will be discussed in the next chapters.

3.2 Movement Analysis and Notation in Dance

3.2.1 Laban Movement Analysis (LMA) and Notation

As said before, Rudolf Laban (1879-1958), who is considered the most important movement theorist of the 1900s, was an Austro-Hungarian dancer, teacher, choreographer, philosopher, theorist and writer. Laban was above all interested in the natural movements performed by humans in everyday life. He observed how human beings move in relation to nature, at the workplace, during religious rituals or, at play. These observations motivated him to record movement on paper and analyze it.

Laban was one of the first choreographers who wrote about contemporary dance from the dancer's point of view, developing a carefully selected terminology. With his work he contributed to improve the status of dance so that it could be recognized as a kind of Arts. As Maletic states, "it appears that Laban's initial writing was, on the one hand, to restore the validity of the dance experience itself, and on the other, to develop a descriptive vocabulary for the phenomenon of movement for the purpose of mastering its techne". (Maletic 1987 p. 51).

However, Laban's studies were not restricted only to dance but reached areas beyond the world of the professional dancer.

Laban focused on the importance of the links between the physical and the mental as well as of the relation between the performer and the perceiver. Laban's theoretical framework contains four major parts (Maletic 1987):

1. Laban Movement Analysis (LMA) consists of an objective general classification and a description of movements. LMA is also the basis for Laban's notation system known as Kinetography Laban or Labanotation;
2. Space Harmony or Choreutics is a theory investigating spatial structure and relationships between movement and dance;
3. Eukinetics and Effort is a theory dealing with the dynamic structure and the rhythm of movement and dance; and
4. Harmony of Movement is the concept reflecting the idea of affinities between the movement's energy or Effort and its spatial unfolding. This concept was the starting point for Laban's Effort-Shape concept, which will be described in the next section.

3.2.1.1 Body, Effort, Shape, Space

Laban's theories are based on four main concepts: body, effort, shape and space. As Barbara Adrian (Adrian 2002) refers, "the Body is the container of our breath connection, alignment, flexibility, strength, stamina, and balance. Effort contains our impulses to move based on our attitudes towards the Effort factors: Time, Weight, Space and Flow. Shape contains how these attitudes are articulated through the Body. Space is the container for our environment, which includes architecture, objects and people, not to mention our universe"(Adrian 2002:74). The above mentioned elements will be discussed more closely in the next paragraphs.

A. Effort:

In the early 1940s, Laban was hired to study movement of factory workers in order to help industry find the most economical movement for workers in terms of their own bodies and their factory output (Ward N., Penfield K., and S 2008). He realized that certain monotonous movements could result in muscle dysfunction, unless they were balanced with opposite muscle movements to provide recuperation. He called these actions, Efforts.

During the observation of these actions he classified Efforts into four elements: Space, Weight, Time and Flow, which can be expressed by the two opposite polarities:

Weight = strong/light

Space = direct/indirect

Time = urgent/sustained

Flow = bound/free

The above four elements will be described in the following paragraphs according to (Adrian 2002:75-82).

First, Flow is responsible for the continuousness of the movement. For instance, a Free Flow movement is difficult to stop suddenly, though a Bounded Flow movement can be easily interrupted.

Second, Direct Space Effort refers to a concrete definition of space, whereas Indirect Space Effort represents a more vague relationship with the environment. For example, if someone points to an object in order to orient other's attention in the direction of that object, then he would be using Direct Space Effort.

Third, Time Effort is how movement is formed considering the time factor. For example, how movement is performed if someone has to accomplish the same task within five minutes or within one hour. In the first case, would probably have an urgent relationship with Time, doing everything in rush; in the second case, the process would be more relaxed (sustained Time).

Nevertheless, Time factor does not refer to the real duration in time. It refers to someone's attitude towards Time (Urgent or Sustained).

Finally, the factor Weight results from the observation that people usually move upward with Lightness and downwards with Strength.

The Effort elements usually appear in combination with each other, as Adrian states, "naturally, because we are complex creatures, most of our physical actions are a combination of Elements that are overlapping and sequencing with each other. But the question LMA asks, 'What in this action is more salient? Is it the Time, Weight, Space or Flow? Or is it a combination of some or all of them in equal proportions? If not in equal proportions, which Factors are secondary or tertiary?'" (Adrian 2002:74-75).

B. Body

The Body Element describes which parts of the body are connected with each other, which of those are moving, which are influenced by others and in general, statements about body organization. The Body Element was further extended by Irmgard Bartenieff, student of Laban, who also founded the Laban/Bartenieff Institute for movement studies. The representation of the Body in Labanotation is further discussed in the next section.

C. Shape

Laban Shape refers to the way the body changes configuration while interacting with the environment (Space). Firstly, this element can describe static body shapes, such as Ball-like, Pin-like, Wall-like, or Screw-like (Adrian 2002:77-78). For example, someone who is shy and closed to himself usually have a more Ball-like Shape of body, which expresses this closeness from the out world.

Additionally to the static body shapes, Shape Element is characterized by more features. Here we will refer only to Modes of Change Shape sub-category, which gives richer information about how the body is related to the environment. Modes of Change Shape consist of Shape Flow, Directional movement and Shaping or Carving. Shape Flow stands for the relationship of the body to itself, defining actions like Lengthen or Shorten, Narrow or Widen, Hollow or Bulge. Directional movement represents the relationship between the Body and the Space through Spoke-like (pointing) or Arc-like (swinging a golf club) movements. The intention of these movements is to create a linkage between the Body and people or objects in his surrounding space. For this purpose, the Body is oriented upward or downward, to the side, or backward or forward. Finally, "Shaping or Carving describes how the Body adapts to the environment by moving between an inner-outer orientation to itself and the Space."(Adrian

2002 p. 78). Shaping or Carving requires the movement of the torso, so the Body can rise or sink, enclose or spread, retreat or advance.

D. Space

Space theory, also referred above as Space Harmony or Choreutics, is a key subject in Laban Movement Analysis (LMA). Due to the complexity and the theoretical depth of this part, Space Factor is considered to be much greater than the other parts of the system. For Laban, spatial direction is the most significant element of bodily movement.

Laban presented the concept of Kinesphere or Personal Sphere, which is the sphere of movement surrounding the body. Laban distinguished the Kinesphere from infinite space. He speaks about Spatial Intention, which includes the parts of the space that the mover is identifying or using. The notation of the spatial direction of the moving parts of the body will be explained in the following section.

Summing up, Laban conceives Effort as the inner impulse, from which movement originates (Laban 1950 cited in Maletic 1987:100) . The expression of this impulse forms the Shape, and the Space is the environment where the Body performs in.

3.2.1.2 Labanotation

Labanotation, as mentioned above, is the notational language that Laban developed for recording movement on paper and analyze it. This system provides the terminology, so that every kind of movement, from the simplest to the most complex, can be accurately described. Labanotation became very popular for writing dance and dancing movements. The system was not restricted only to dance studies, but was also used in other research areas like anthropology and physiotherapy. Moreover, computer software based on Labanotation, the LabanWriter, was developed, permitting dance to be copied, edited and stored on a computer.

Laban created a complex system based on codified symbols for illustrating the elements of space, time, energy, and the parts of the body. Labanotation is composed by a vertical staff, where the movements are notated, like music scores. As Guest points out, “Labanotation serves the art of dance, as music scores serve the art of music”(Guest 2005:5).

The vertical staff represents the body divided to its right and left parts. This division is very convenient because the observer can always have a clear picture of what is happening on the right or left part of the body. Therefore, the staff is composed by vertical columns, each one representing one part of the body. Figure 3.1 illustrates the division of Laban’s Body.

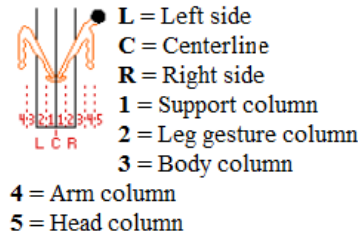


Figure 3.1: The division of the body in Labanotation (Griesbeck 1996).

Column 1 is the center line, which divides the body into its left and right halves. It represents the support column and serves for recording the placement of the weight of the body. The absence of notation in this column means the absence of weight placement, which is translated into a jump (Griesbeck 1996).

Column 2 & 4 are used for recording gestures. The term ‘gesture’ here is used for movements that do not carry weight (Guest 2005:19). If the right arm for example is raised front, a direction symbol will be included in the fourth right column. Here, the absence of notation means the absence of movement.

Column 3 is used to represent the body. Movements of the whole torso as a unit, the chest, pelvis, shoulder girdle are written in the right or left third column.

Column 5 is used to represent the head.

As mentioned above, the existence of movement in a part of the body is translated into symbols in the corresponding column. First, an annotator can use symbols to indicate the direction of the movement and its vertical dimension. Figure 3.2 represents those symbols.

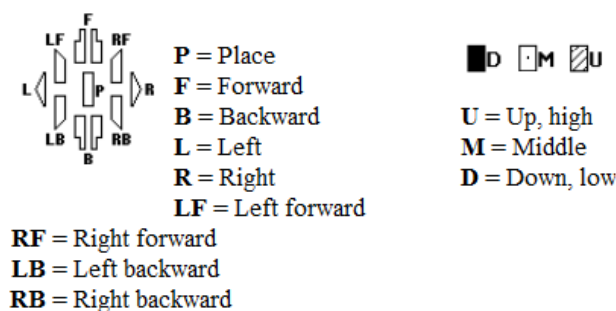


Figure 3.2: Symbols for describing the movement in Labanotation (Griesbeck 1996).

So if, for example, a dancer raises his right arm up, right to the height of the shoulders then at the right fourth column of the staff this symbol will be notated. The symbol illustrates the

direction of the movement and the point in the middle indicates that the arm was raised to the height of the shoulders.

Labanotation has no specific symbols for the time a movement takes. Instead, the duration of a movement is illustrated by the length of the above presented symbols, as can be seen in Figure 3.3.

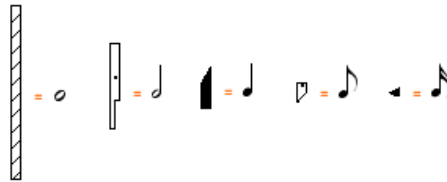


Figure 3.3: The length of a symbol demonstrates the timing of the movement (*Dance Notation Bureau* 2011).

In this section the fundamentals of Labanotation were presented accordingly to (Guest 2005), where the interested reader can also find an extensive description.

Although Laban is world-renowned for his contribution in dance notation, his concepts, though initially developed for dance, are applicable to all forms of movements, such as sports, gymnastics, physiotherapy, and movement of animals. His notation language, Labanotation, is not connected to a specific style of dance, but can also be applied to the annotation of varied dance styles, in contrast, for instance, to Benesh Notation which is based on English classical ballet (Guest 1989). Benesh Notation will be described in the next section.

3.2.2 Benesh Movement Notation

Rudolf Benesh, an accountant who was also a gifted artist and musician, created a visual system for recording dance. He was inspired by the interest of his wife, a member of the Royal Ballet in England, on writing down dance sequences. The Benesh notation system, though initially based on ballet, was further developed to be applied to other type of movements. The system was published in 1956, and became so successful that was adopted not only by the Royal Ballet, but also by other ballet dance companies all over the world.

Benesh Movement Notation (BMN) system is a stick figure visual system (Guest 1989:48-49). It was based on the idea of stick figures depicting the various positions of the arms and the legs. This contrasted with Laban's belief that this kind of representation is practical only at a simple level. A BMN score resembles a music score, similarly to Labanotation, though BMN uses a five line horizontal staff and not vertical. The five line staff offered various advantages: it

divided up the body in a way for guiding the eye, intersecting the body at its major division, and facilitating integration with music. The intersection of the body in BMN is illustrated in figure 3.4. The top line is the height of the top of the head. The second line down is the height of the shoulders. The third line is at waist level, the fourth at knee level, and the bottom line represents the floor.

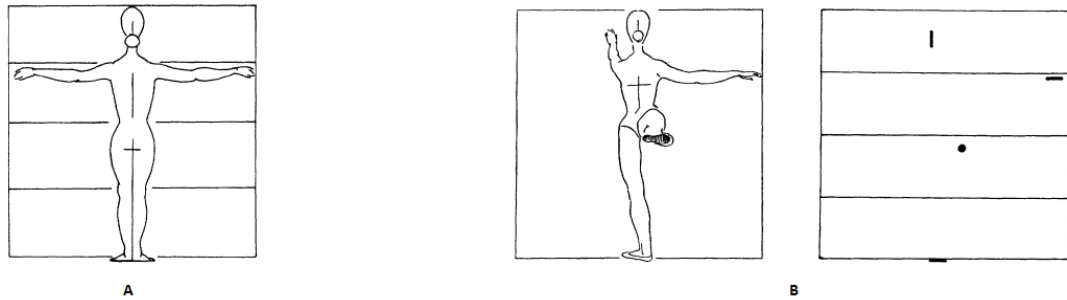


Figure 3.4: **A:** Representation of the body in BMN. **B:** Example of Benesh notation for an Arabesque. Left arm extended front and right leg to the back (Hall 1967).

For notating the position of the arms and feet, relative to the body, the below signs are used in BMN:

In front	Level	Behind
	—	●

Furthermore, in combination with the above signs, other signs are used for depicting the position of bent elbows and knees, (Guest 1989:49-50):

In front	Level	Behind
⊥	+	×

An example of BMN is illustrated in figure 3.4.B.

In the final analysis, Benesh tried to create a system that would provide speed, economy and simplicity without losing accuracy. The system does neither classify nor embody any theory of movement, but rather is considered to be an objective recording tool, neutral towards classifications and theories.

3.2.3 The Eshkol-Wachman Movement Notation

Eshkol-Wachman movement notation (EWMN) is a mathematical system for recording movement. It was invented and published in Israel in 1958 by Prof. Noa Eshkol and her student, Prof. Avraham Wachman. EWMN was initially developed for recording and writing dance, but just as the notation systems described above, was intended to notate every kind of movement even animal behavior. As (Guest 1989) states, “EWMN serves mostly the interests of those concerned with the reduction of movement to mathematical terms”(Guest 1989:117).

EWMN system is an abstract symbol system, similarly to Laban’s system. The representation of the body is similar to a stick figure image (Fig. 3.5.A) and is considered as a series of connected limbs moving in space. A limb, in EW, is considered to be any part of the body, which lies between two adjacent joints or a joint and a free extremity. Each limb is reduced to its longitudinal axis, an imaginary straight line of unchanging length. Every joint of the body, as can be seen in Figure 3.5.A, can be the center of a coordinate system with axes of the same length as the corresponding limb.

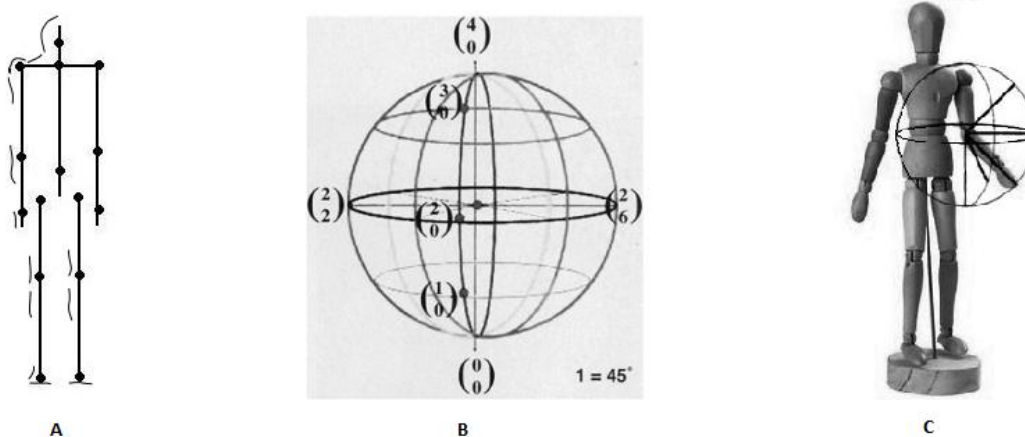


Figure 3.5: **A:** Stick figure representation of the body in EWMN. **B:** The System of Reference (SoR) (Teitelbaum 2004). **C:** The curves formed on the surface of the sphere, by the movement of the forearm, will be circles or parts of circles.

For example, let’s consider the possible movements of the forearm. In this coordinate system the elbow-arm joint will be the center of the system -fixed point- with axes of the same length as the length of the forearm. Obviously, all the possible movements of the forearm will always be enclosed by a sphere with a radius in the length of the forearm. Furthermore, the free end of the limb (in this case the wrist) will always form a curve path on the surface of the sphere. This curves will be either a full circle, or part of a circle. The above example is illustrated in figure 3.5.C.

The above discussed sphere is known as the System of Reference (SoR) of EWMN. The orientation of the SoR is such that its central axis is perpendicular to the ground (Fig. 3.5.B). The starting direction for all measurements is defined as 0. All the other directions are defined in relation to the starting direction.

The notation of EW is written in a horizontally ruled page, illustrated in Figure 3.6. Horizontal lines contain each body part, whereas vertical lines indicate units of time. EW notation page is very flexible, since it allows the notator to divide the body into as many parts as necessary to define the movement to be notated.

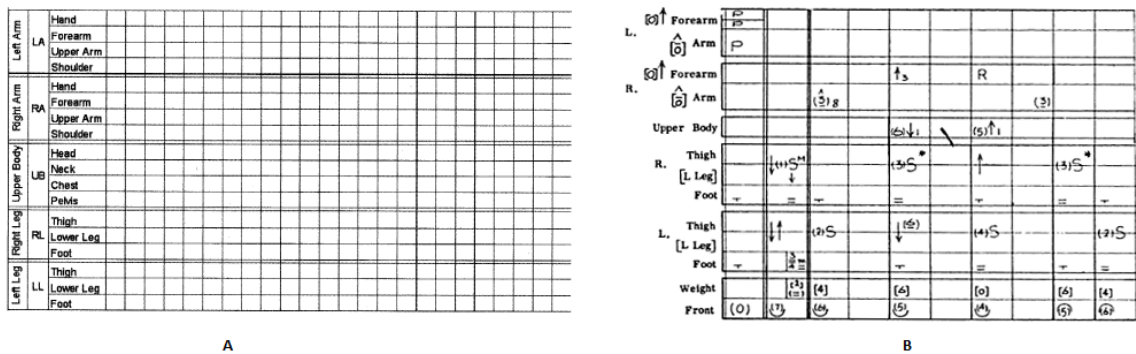


Figure 3.6: **A:** A manuscript page: Each segment of the body has its own space. **B:** A manuscript page with notations (Guest 1989).

In brief, Eshkol-Wachmann system is based on mathematical logic, a fact that guarantees the high accuracy of the system. This mathematical viewpoint assigns more complexity to the system especially for dancers, since the terminology is not based on dance terms. However, the system is used in the medical area, for instance for the early detection of autism or Asperger's syndrome (Teitelbaum 2004).

The three most popular dance notation systems were presented in this chapter. In fact, throughout the years, individual dance companies have created other dance notation systems serving their needs and requirements.

3.3 Movement Notation in Sports

In the previous section different systems of movement analysis and notation, performed in dance studies, were presented. This section contains a brief introduction to movement analysis and notation in sports studies, especially in gymnastics.

If we compare now dance movements with sports movements we could say that in dance, a sequence of movements usually serves the purpose of a narrative that is presented to the audience. Therefore, in this case the study of dance movements follows the interest in knowing how dancer's movements serve the narrative and the expression of intentions and emotions within the narrative.

In the case of gymnastics, which is a competitive sport, movements are developed from physical exercise and designed to demonstrate one's strength, balance, flexibility, and body control. Sports focus on movement efficiency from the anatomical standpoint. As Hamill and Knutzen state, in biomechanical analysis a thorough understanding of various aspects of human movement may facilitate better teaching, successful coaching, more observant therapy, knowledgeable exercise prescription, or new research ideas (Hamill and Knutzen 2009:4). Thus, movement observation and description aims on the optimal body positions and actions for efficient, effective motion. Observers and notators of the activities have different approaches to the study of movement; for example, a coach or a judge are interested in the final outcome of a split leap, while a therapist may be interested in identifying where during the movement the athlete is placing the stress.

Accordingly to (Hamill and Knutzen 2009:13-15), the representation of the body in biomechanics is illustrated in Figure 3.7.A. The body consists of rigid segments connected in the joints. The head, neck, and trunk are segments composing the main part of the body. When a movement of a segment takes place it is described as it occurs at the corresponding joint. For example, the arm movement will be described in relation with the shoulder joint activity, the forearm movement with the elbow joint and so on. Figure 3.7.A represents the fundamental starting position of human body, which usually applies as a reference position for describing movement.

A reference system, absolute or relative, is required for the accurate observation and description of movement. A reference system consists in a starting position, called the zero position, in relation to which the movements of all the body parts are described. As discussed above, the movement is described relatively to the joint activity. Hence, an accurate description should include the relative angle between two adjacent segments. Figure 3.7.B illustrates the calculation of the joint angle in a relative reference system.

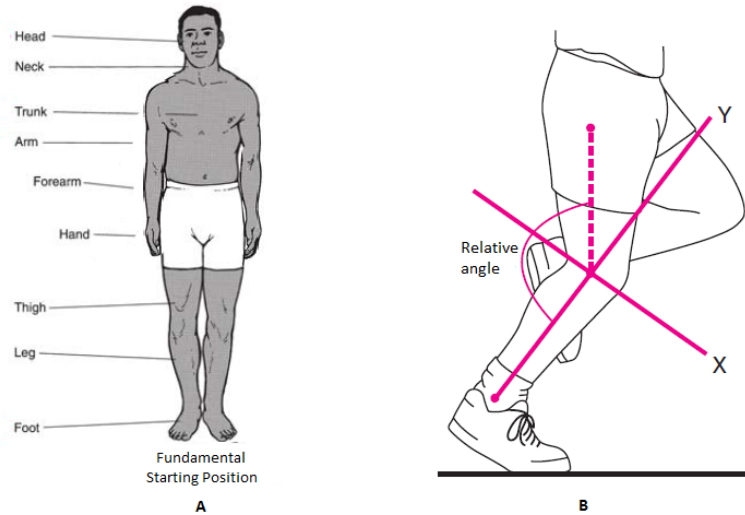


Figure 3.7: **A:** The fundamental starting position. **B:** Relative angle of the knee joint (Hamill and Knutzen 2009:13-15).

An important factor in movement description in sports is the path of the motion. There are two types of motion: linear and angular. Linear motion is the movement that forms a straight or curved path, in which all points on a body part travel the same distance in the same time interval. Angular motion is the movement around a point (rotation) in a way that different points on the same body segment do not cover the same distance in the same time interval. The linear or angular motion study focuses on the calculation of movement speed, direction and path.

In table 3.1, the basic terms of motion are presented (Hamill and Knutzen 2009:16-19):

Flexion: is the bending movement which decreases the angle between two body segments	Extension: is the straightening movement which increases the angle between two segments
Abduction: is the movement away from the midline of the body or the segment	Adduction: is the return movement of the segment back toward the midline of the body
Internal rotation: is the rotation of a segment towards the midline	External rotation: is the rotation of a segment away from the midline

Table 3.1: Basic terms of motion

Obviously, beyond the basic terms every sport has a specific terminology. Here, it will be briefly discussed the instance of artistic gymnastics, since it is a kind of sports very similar to dance. The main interest in gymnastics lies in the description of the pure movement. In fact, movements performed by athletes are controlled and very specific. For their evaluation is usually used a notation system for artistic gymnastics. The notation code, created by the

International Federation of Gymnastics, uses lines and curves, which depict some formal properties of the movement. An example is presented in Figure 3.8.

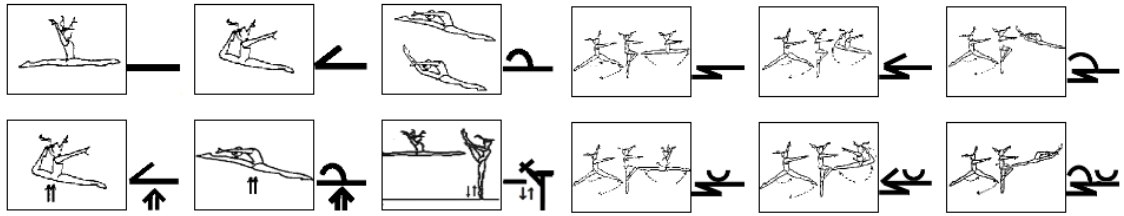


Figure 3.8: Movement element list from the International Federation of Gymnastics (*Code of Points - Women's Artistic Gymnastics 2009*).

Summing up, sports biomechanics is a quantitative study in which movement observation aims the understanding and improvement of athletic performance through mathematical modeling and measurements. Body and segments' movements are accurately described by the reference to the relative or absolute angle at the corresponding joint. The notation of the movement, mostly used by judges, uses symbols which simply depict a representative form of the formal movement.

3.4 Movement Description in Computer Science

During the last decades, the research in the area of human-computer interaction and movement recognition and classification has intensively grown. Movement recognition studies aim to create systems able to interpret human movements through algorithms (Kopp and Wachsmuth 2010). Several researchers from different disciplinary areas, such as Visual Arts, Architecture and Medical Sciences, recur to this area of computer science to create artistic forms of visualization of information (Buchan et al. 2007), to develop movement recognition systems, which are used to promote computer assisted help to disabled people (Miesenberger 2010), (Sales Dias 2009:245-54)), and to develop movement based interaction interfaces, computer agents (Sales Dias 2009:193-98), computer animation (Neff et al. 2008) and so on.

Each disciplinary area follows different models and has distinct approaches to understand and represent the moving body. In this section it will be briefly described how computational systems use movement description for extracting information about the intentions and emotions of movers.

Laban's theories have been frequently used in movement based interaction design where movements of the human body are a direct input to technology (Camurri et al. 1999), (Loke, Larssen, and Robertson 2005), (Sales Dias 2009:151-62). Other systems use Laban's Elements for simulating human movement in a realistic way as part of computer animation (Chi et al. 2000). Laban's theory is also used in systems that recognize gestures and movement qualities from dance movement (Camurri, Lagerlöf, and Volpe 2003).

All these systems aim to gain some knowledge on human movements regarding their relation to emotions and state-of-mind. This provides the data to define patterns of movements which normally correspond to the display of certain intentions or emotions. For instance, (Coulson 2004) did a study on the role of body posture in the expression and communication of emotion. For this study computer-generated mannequin figures representing various body postures were created. The representation of the body was based on a biomechanical understanding of the moving body. In order to optimize the system in regard to its flexibility, the body was divided in 1) the upper body consisting of the head/neck, chest, abdomen, two shoulders/upper arms and two forearms, and 2) lower body consisting of two thighs, two shins and two feet and the joints connecting them. For the description of the body postures six joint rotations were used; head bend, chest bend, abdomen twist, shoulder adduct/abduct, shoulder swing, and elbow bend. In this study, the movement of the mass center of the body is also considered important for understanding the emotional state.

In order to combine body postures with emotional state for modeling believable story characters, (Wen-Poh, Binh, and Wardhani 2007), divided the kinesphere¹¹ of the human body into three shaping zones: horizontally, vertically, and sagittally oriented. The way a body can move around its center, according to this study, is illustrated in Figure 3.9. As illustrated in the figure, the left side represents a closed body shape, whereas the right side represents an open body shape. The body is divided into four main parts: head, trunk, upper limbs, and lower limbs. Table 3.2 illustrates the relation between emotions, the kinesphere posture principles, and the four main body parts considered in this study.

¹¹ The meaning of kinesphere is previously explained in Laban's theories, and is considered to be the space surrounding a body (see chapter 3.2.1).

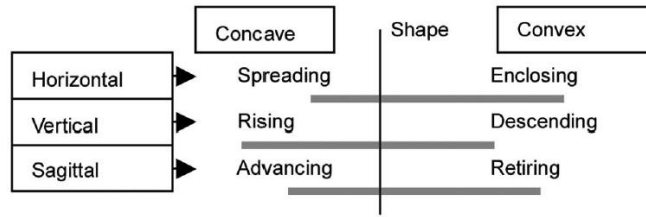


Figure 3.9: The three shaping zones (Wen-Poh, Binh, and Wardhani 2007).

Emotion	Positive Emotions	Negative Emotions	Kinesphere Zone
Head	Face up	Chin down	Vertical
Upper Limbs	Elbows open or Armpits exposed	Arms crossed	Horizontal
	Hands placed Behind the head	Hands clenched in lower position	Vertical
Trunk	Leans backward	Leans forward	Sagittal
	Back straight	Back lowered	Vertical
Lower Limbs	Jump or trot	Draggy or saggy	Vertical

Table 3.2: Emotions in relation with body movement (Wen-Poh, Binh, and Wardhani 2007).

In conclusion, with the development of computers, new solutions were conceived for modeling complex mental processes. Thus, computational systems use different approaches to movement analysis and annotation in order to extract results contributing to the knowledge of the functioning of inner human intentions and emotions.

3.5 Gesture Analysis and Annotation

In above sections, the word 'gesture' was used from a dance theory point of view. For instance, Laban considers as 'gesture' every movement which doesn't carry weight (Guest 2005:19). In this section the concept of 'gesture' will be discussed from the Gesture Studies (GS) perspective, as well as their typology and annotation schemes. For a better understanding of this research area, firstly a brief history will be presented about the origin of the studies of the upper limbs' movements, called gestures, which seemed to be more directly linked to language than the other body movements.

Since the middle of the 1970s, Gesture Studies were established as an independent discipline in the areas of Anthropology, Linguistics and Psychology. However, the interest on gestural activity has been traced long before.

The first systematic study on gestures was done in the antiquity by Marcus Fabius Quintilianus and was related to gestures used in rhetorical discourse (Kendon 2004:17-19).

In the nineteenth century, Andrea de Jorio (Jorio and Kendon 2000) studied gestures from an ethnographic perspective, describing their different forms and functions within the Neapolitan community. In the meantime, William Wundt (Wundt 1973, cited by Kendon 2004:57-60), one of the founding figures of modern Psychology, made a comprehensive study and presented a classification scheme for gestures.

Although, in the nineteenth century, gestures were studied mostly in the areas of psychology and ethnography, they weren't restricted to these research areas. Later, with the establishment of Gesture Studies as an independent research area, an emergent interest arose in the contribution of gestures to cognitive processes. This was due to the 'cognitive turn' of Psychology and Linguistics.

The numerous studies on gestures throughout the last decades offered different classification schemes and typologies. As Kendon states, gestures have been classified according to many different criteria. Some classify them as voluntary or involuntary; or according to their literal or metaphorical meaning; some as 'objective', referring to something in the external world or 'subjective', communicating the gesturer's state-of-mind, etc (Kendon 2004:84).

The first systematic research and typology considering different forms and functions of gestures was made in 1941 by David Efron (Efron 1972). Efron realized a study on the spatio-temporal and "linguistic" aspects of the gestural behavior of eastern Jews and southern Italians in New York City. Efron's spatio-temporal analysis of gesture focuses on: a) the size of the radius of the movement, b) the form of the movement (elliptical, angular or straight), c) the level of movement (sideways/transverse, towards/away), d) the body parts involved in the gesticulation and e) the tempo of the gesture (abrupt/flowing transition) (Efron 1972).

Ekman/Friesen studies were based on Efron's study and focus on the information conveyed by non-verbal behavior and specifically on the kind of information that derives from facial and body behavior (Kendon 2004:94-98).

All the above mentioned researchers proposed gesture typologies which gave account for different types of co-speech gestures, as the conventionalized gestures and the affect display

gestures. These classifications were used as a basis for future gesture typologies from researchers like McNeill.

McNeill is the first researcher who methodically studied the relation between gesture and mental content. His gesture typology considers five gesture types: iconic, deictic, metaphoric, beats, cohesive (McNeill 1992). Iconic and metaphoric gestures refer to how the image that the gesture displays is used by the speaker. Deictic gestures are pointing movements and beats are simple biphasic movements that do not present a discernible meaning (McNeill 1992:80). McNeill defines as cohesive the gesture that serve to 'tie together thematically related but temporally separated parts of the discourse' (McNeill 1992:16).

McNeill's classification of bodily movement is based on what is known as Kendon's continuum (McNeill 1992:37), where gestures are aligned according to their degree of conventionalization:

– Gesticulation - "Language-like" gestures - Pantomime - Emblem - Sign Language –

Kendon's continuum reflects his observation that, on the one hand, gestures can serve as graphical or pantomimic representations when used simultaneously with speech and on the other hand, when speech is absent, gesture, since it has structural properties similar to speech, can serve as words (Kendon 2004:104). Subsequently, at one end of the continuum gesture is used to accompany speech, whereas at the other end gesture is used independently from speech.

In his research Kendon writes about the way gestural activity is coordinated with speech and divides gestural action in units, *gesture units* and *gesture phrases*. Gesture unit is a sequence of contiguous gestures that begin from the rest position and conclude to the rest position, completing an excursion (unit). A gesture unit contains three phases: *preparation*, *stroke* and *recovery*. Stroke is the phase that the movement reaches its apex. 'It is the phase of the excursion in which the movement's dynamics of 'effort' and 'shape'¹² are manifested with greatest clarity' (Kendon 2004:112). The preparation is the phase that precedes the stroke and recovery the phase that follows the stroke. The preparation and stroke phases constitute a *gesture phase*. Every gesture phase contains only one stroke and its preparation phase, if it exists. Consequently, a gesture unit may contain one or more gesture phases. Figure 3.10 illustrates a gesture unit.

¹² The concepts 'effort' and 'shape' are previously discussed in Laban Movement Analysis (chapter 3.2.1)

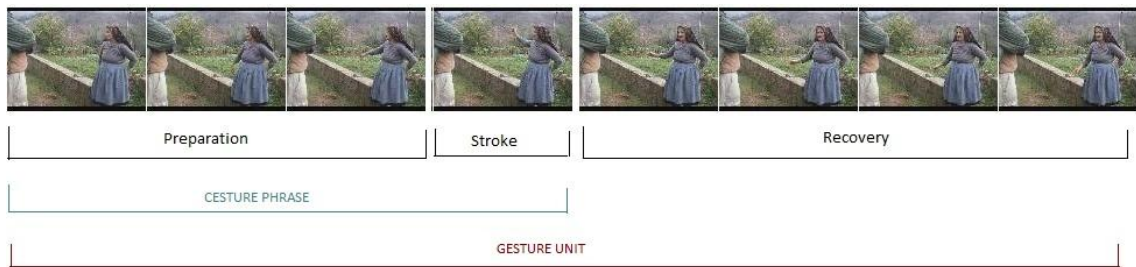


Figure 3.10: A gesture unit and its phases (Rodrigues 2010)

In her classification scheme (Poggi 2002:158-68) refers to communicative gestures that inform about the Sender's mind. In other words, gestures may convey information about the Sender's beliefs, goals and emotions. Figure 3.11 presents some examples of gestures that are usually connected with the Sender's beliefs, goals or emotions.

BELIEFS	Degree of certainty	<i>Palm open hand</i> = this is evident <i>Forearms down with empty hands</i> = I am uncertain
	Meta-cognitive Information	<i>Index on nose</i> = I am concentrating <i>Snap fingers</i> = I'm trying to remember
GOALS	Performative	<i>Raised index finger</i> = attention
	Sentence plan	<i>Hand up</i> = this is the topic <i>Hand down</i> = this is the comment
	Discourse plan	<i>Count on fingers</i> = n.1... n.2... <i>Bent index and middle fingers</i> = I don't really mean that <i>Rotating fist with curved thumb and index</i> = there is a link
	Conversation plan	<i>Hand raised</i> = I want to speak
EMOTIONS		<i>Fists raised</i> = I am exulting <i>Pulling hair</i> = I am in despair

Figure 3.11: Gestures that inform about the Sender's mind (Poggi 2002)

Gesture studies are not restricted to the study of gesture, as the movement of hands and arms, but also focus on the movement and the configuration of the trunk, head, gaze and facial expressions, known as non-verbal modalities (Rodrigues 2005).

Posture, as well as movement, can also convey a great deal of information. According to (Argyle 1988) posture can display information about the degree of involvement of the mover as well as the status relative to other participants, or the degree of liking for other speakers. Posture defines a period of interaction longer than a gesture and shorter than a spatial position. Together

with facial expressions, postures are the best way to communicate emotions and state-of-mind (Argyle 1988, cited by Wen-Poh, Binh, and Wardhani 2007).

To sum up, the study of gesture contributes to many research areas from Psycholinguistics and Cognitive Linguistics to discourse analysis, to the neuroscience of motor action and language, and even to applied areas such as Computer Software and Human-Computer Interaction, as referred in above chapter. Consequently, the methodology used for gesture annotation depends on the focus or interest of each researcher. Researchers, who annotate gestures from an ethnographic perspective focus on culture-specific gestures, regarding their form, amplitude, and codification, which can be used as replacement for words and can have a very different significance in different cultural contexts, like (Kendon 2004), (Rodrigues 2008). Others annotate gestures in correlation to speech and to its properties ((McNeill 1992), (Rodrigues 2007)), and among them many follow the cognitive perspective in the study of gesture. In addition, there are researchers that study bodily action in complex cognitive processes in dance and theater as well as the relation between language and thought, such as (Hanna 1987) and (Stam and Ishino 2011).

The empirical study of bodily action in every day social life usually requires video recordings annotated with movement descriptions. There is no universal system for the annotation of gestures. Researchers on gesture studies use software tools that permit them to annotate bodily movement from video and audio resources. Two of the most known annotation software for gestures are Anvil (Kipp 2008) and Elan (Sloetjes and Wittenburg 2008). These tools provide the researcher the option of parsing a film frame by frame and annotate the configuration of the gestures. Some examples of gesture annotation can be seen in (Kendon 2004) and (Rodrigues 2007).

3.6 Dance Archives and Interactive Collections

In the above chapters, we discussed about various ways of analyzing dance structure and movement. As said before, in this thesis we are interested not only in the research of analyzing dance but also how a dance piece as well as the written texts, thoughts, notations and analysis that originate from the piece can be best preserved and disseminated.

3.6.1 Dance Archives

As mentioned before, in the last 50 years, there have been a lot of efforts from several libraries, institutions and organizations for developing and maintain dance collections. This tendency is discussed in the following paragraphs.

The Dance Notation bureau (DNB) (*Dance Notation Bureau* 2011) was founded in 1940 by Ann Hutchinson Guest, Helen Priest Rogers, Eve Gentry and Janey Price in New York. Its mission is to document, preserve, study and promote dance and movement using the Labanotation system for notating dance pieces. Initially, the DNB's goals were identified as: '1) to act as a clearinghouse, research, and work center; 2) to standardize the Laban notation; 3) to teach dance notation; 4) to issue diplomas to those qualified to teach and to notate; 5) to record dances and ballets; 6) to form a library of dance works; 7) to perpetuate dance through the use of notation' (Lu 2009). After the DNB's initiative the dance world started accepting the notation. Consequently, dance companies like George Balanchine's and Doris Humphrey's collaborated with the DNB and their dances were notated with Laban's system and preserved in its library. Nowadays, the DNB maintains one of the biggest collections of dance and movement notation. The interested researchers can find notated dance archives, or documentation about dance and notation in the DNB's library¹³.

Laban's legacy is also promoted by the Laban Institute, a leading center for training dancers, and funding dance and movement research. The Laban collection maintains personal notes, scores, drawings, slides and books as well as recorded interviews of people worked with Laban (Fowler 2010). The archival collection is available for researchers and students in the library of Laban's Institute (*Trinity Laban Conservatoire Of Music and Dance* 2011).

The Dance Heritage Coalition (DHC) was founded in 1992 in order to contribute to the preservation and documentation of dance in America (Johnson and Snyder 1999:19-20). The founders of DHC recommended the establishment of an alliance of the nation's major dance collection in order to establish national standards and policies in the fields of dance preservation, documentation, and access. Between the DHC members are the Dance Notation Bureau, New York Public Library for the Performing Arts, Dance Division, and the Library of Congress.

The Library of Congress holds materials for documenting dance as well as an archival collection. In 1999, the Library of Congress embarked on a documentation and preservation project of Martha Graham's dances. The Library of Congress has also digitized collections of early dance manuals and made them available online creating the American Ballroom web site

¹³ The catalog of notated theatrical dances is available on DNB's web site: <http://dancenotation.org/catalog/>.

(*An American Ballroom Companion-Dance Instruction Manuals* 2005). The site provides videos of contemporary reenactment of the dance as well as documentation related to the dance.

As previously referred, another member of the Dance Heritage Coalition is the New York Public Library (NYPL) for the Performing Arts. The Jerome Robbins Dance Division of The New York Public Library (*Jerome Robbins Dance Division* 2011) was founded in 1944 as a separate division of the NYPL and is the largest archive in the world devoted to the documentation of dance. In NYPL's library a user can read an Elizabethan court dance, observe a Rudolf Nureyev's arabesque, browse to Merce Cunningham's collection, or compare the modern dance styles of Isadora Duncan, Martha Graham, and Doris Humphrey.

In fact, in all the above archival collections, except the American Ballroom web site, the access to the user is restricted. Although many of these libraries provide online catalogs where the user can browse the material, not many of those collections that have been digitized are available in an online archive. Thus, the interested researcher or potential user has to visit the repository to access the dance material. However, recently an interest has arose by various organizations and choreographers for creating dance collections to be available online and provide interactive environments where a user can browse among dance videos and images, full-text documents and generally multimedia, related to a dance piece.

In 2007 the Siobhan Davies RePlay (*Siobhan Davies Replay* 2009) project began to collect and archive material and documentation that is related with the English choreographer Siobhan Davies. It is the first online dance archive in the UK and contains thousands of fully searchable digital records including moving image, still image, audio and text. Sarah Whatley's¹⁴ team in collaboration with the choreographer followed a digitization process and placed the material online accessible for all users (Whatley 2008). The metadata of the artifacts are based upon a framework using the Duplin Core Standard (*Dublin Core Metadata Initiative* 2011) and facilitate the online searching of the archive. Thus, any user can explore the collection by the title of work, the name of the dancer, the date and so on. The online archive includes filmed records and photographic collection of choreographies, in performance and in the studio, notations, dance flyers and also biographies of the dancers and the choreographer.

A project for preserving the Greek dance tradition was established in 2006. The Greek Dance Pandect (*Pandect* 2006) is an online archival collection that includes documentation related to Greek traditional dances. Pandect's collection includes videos, pictures, songs, music related to Greek dance as well as documentation about the traditional costumes, the music instruments,

¹⁴ Sarah Whatley's personal page: <http://www.coventry.ac.uk/cu/d/163/a/409>

lyrics, history, and objects related to the dance. The collection can be searched by the title of the dance, the name of the population, or the region the dance was performed.

Furthermore, the Jacob's Pillow Dance center, where Denishawn Company was founded, keeps an essential archive from the Dance Festivals. The online collection Jacob's Pillow Dance Interactive (*Jacob's Pillow Dance Interactive* 2011) offers selected clips from an extensive video collection accompanied with contextual information about the artists who performed at the Pillow from the 1930s to the present day. The collection is searchable by the name of the artist, the genre of the dance as well as the year of the dance.

An important online catalogue was created by the Archive of Performance of Greek and Roman Drama, University of Oxford (APGRD). The APGRD maintains an online database (*APGRD Database* 2010) that holds records for productions of Greek and Roman drama which have been performed on stage, screen, and radio from the Renaissance to the modern day throughout the world. Although the database doesn't maintain video or images related to the pieces, it provides a significant documentation on the productions, about the theater company, the hosting theater and so on, and can serve as a useful map for interested researchers.

In 2005 the Forsythe Foundation in collaboration with the Ohio State University Dance Department and Advanced Computing Center for the Arts and Design developed an interactive media project focusing on *One Flat Thing, Reproduced* (OFTR), a piece of the choreographer William Forsythe. This project differentiates from the above mentioned since it is not about documenting and notating dance for recreation or for historical purposes but for motivating the user to study the different components of the dance. The cross-disciplinary project involves researchers from architecture, designing, engineering, dance, philosophy and psychology, who approached the piece and its elements within dance and without. The aim of the project shows from Forsythe's statement 'I'm trying to develop a dance notation [...] to show how a piece develops from the inside, how it functions, how it's put together. To demystify the process and elucidate the principles of choreography' (William Forsythe in Delahunta and Zuniga Shaw 2006). The project's collection is available online (*Synchronous Objects* 2005), where a user can interact with the interface through three levels of organization: movement material, cueing and alignments.

Movement material is fixed movement sequences, the themes, which compose the dance. The themes are repeated and combined during the dance with a factor of improvisation from the dancers. The movement sequences are organized by a cueing system that acts as an internal clock (Ahlqvist et al. 2010). The term alignments, defined by the Forsythe Company, are short instances of synchronization between dancers. Every time the dancers perform the dance produce a unique sequence since they control the flow of the dance by observing each other and

improvise on the given movement material, cues and alignments (Fig. 3.12). The collection also includes software tools that permit the user to interact and experiment with the concepts of the choreographic structure of *One Flat Thing, Reproduced* like alignment and cueing.

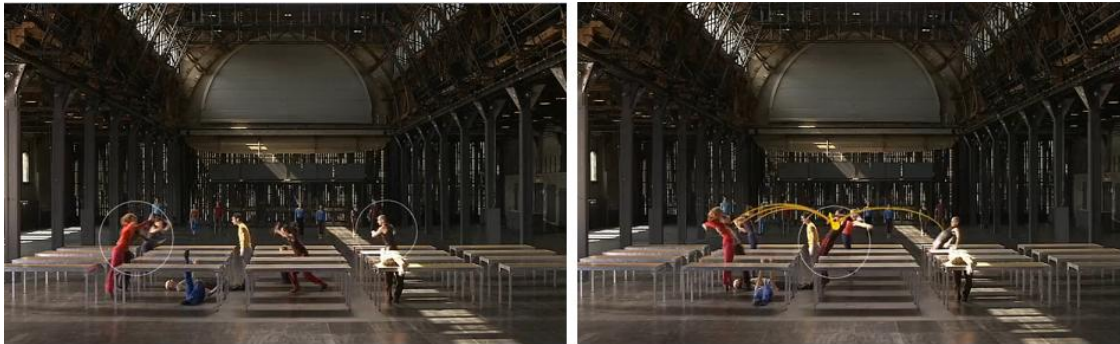


Figure 3.12: An example of cue annotation in *One Flat Thing, Reproduced* project (*Synchronous Objects* 2005).

In chapter 3.1, we referred to the study of the phrasing concept of the Choreography and Cognition project. In the scope of this project, and more specific of the experiment on phrase composing, an online interactive tool¹⁵ was created and provided to the users online giving them the chance to contribute to this experiment. The tool integrates different clips where dancers of the Wayne McGregor Company perform short movement sequences. The user, while seeing the clips, can divide the sequences into units, by his own experience and point of view, and indicate with available buttons the starting and ending points of these units. Eventually he can submit the result and take part in the experiment.

3.6.2 Technology and Tools of Online Archives

As said before, ultimately, in the dance society, there is an increasing need for storing various types of digital content, such as text, image, movies and other data types, into digital archive systems. Some key technologies for these archives are long-term preserving storage, database management systems, information retrieval, and web services. Digital archives contain objects, documented with metadata based upon a framework created by the archiving team or else a framework using a known standard (such as the Dublin Core of the Dublin Core Metadata Initiative). The main purpose of metadata, which may be included in the page's header or in a separate file (for example using the XML format), is to facilitate the online search of the archive.

¹⁵ The online interactive tool of Choreography and Cognition project: <http://www.choreocog.net/online.html>

The online search functionality of a digital archive works with queries to its database; the server receives a request from a web page and the system retrieves information, such as images, text, and metadata, from one or several databases. Subsequently, the system will dynamically create a web page adjusted to the user's demands.

The video archive in Siobhan Davies Replay is catalogued by dance work. Every dance work includes videos of the performance and rehearsals related to this work. Every video is documented with appropriate metadata, based upon a framework using the Duplin Core Standard. In fact, writing about the project, Sarah Whatley said that the aim of the team was to develop a comprehensive and representative standard for the metadata, which simultaneously would allow for the generalities and particularities of each dance object (Whatley, Allender, and Varney 2008).

In this way, the archive is fully searchable, since the user can query the database by any of the types of metadata. The page is implemented with web technologies and the videos are displayed with the Flash Player plug-in.

The Greek Dance Pandect's video archive is searchable only by the metadata of the video that refer to the region and the population of each dance. The videos of the archive are displayed with the Flash Player plug-in.

The Synchronous Objects for *One Flat Thing, Reproduced* web site was fully created with the Adobe Flash technology. As referred above, the user can search the page by the objects, which are screen-based visualizations (video, digital artwork, animation, and interactive graphics) that reveal the organization of the choreography. The web page provides also interactive tools that work on the Java Platform.

There are two ways of searching the Archive of Performance of Greek and Roman Drama, University of Oxford (APGRD) Database; one which enables the user to type data into the search boxes and the other with drop-down lists in most of the search boxes which enable the user to scroll through the whole index in the search box. The data entry system for the APGRD Database was created using MS Access and a prototype web interface was built for searching and reporting in ASP.

To sum up, the last decades dance preservation has become an important focus at several institutions and libraries like the New York public library. Moreover, individual dance companies and organizations begin archival projects in order to maintain a collection of the dance pieces. Nowadays, there is an increasing interest on online dance archival collections where a user can fully browse among the material in order to be acquainted with the work of a choreographer such as the Siobhan Davies RePlay, or to dive deeper into the choreographic

process like the William Forsythe One Flat Thing, Reproduced project. The digital archives use metadata frameworks to document the objects from the collection in order to improve the online searching of any user.

Chapter 4: Determining Analysis Criteria

4.1 Issues related to Documentation and Web Publishing of Dance

As it has been already said, dance is the least documented of all arts. The recognized immaterial nature of dance, the difficulty of documenting it, and the negative attitude towards dance contributed to the fact that very little effort has been made to document dance since its early time.

In fact, the difficulty of preserving and disseminating dance doesn't lie only in its documentation but also in the possibility of accessing it. As mentioned before, there are many reasons to access dance documentation, for instance, for reconstruction of dances, teaching, for people to get acquainted with Dance culture, for historical reasons, and so on. However, it is a common occurrence that dance users cannot easily find the information they need (Johnson and Snyder 1999).

Researchers, like Laban, caused a shift in this tendency. They were concerned with notating dance and its movement and, this interest resulted in the development of a methodical technique for documenting dance. Additionally to this new way of working with dance, arose the possibility of recording dance movements first in analog and later in digital video, which reinforced the development and acceptance of dance notation.

Therefore, with the objective of preserving dance documentation and analysis and providing the possibility of future reconstruction of choreographies and dance forms, dance notation systems began being developed. As said before, dance notation systems use symbols for representing the movement and classifying it in movement phrases. Nonetheless, notational language increases the complexity of the systems and potential users have first to study and learn the system language before using it. Consequently, notational systems have a degree of difficulty for the users to understand and learn.

On the subject of where dance notation applies, we have already pointed out how notation systems are useful firstly for the dancer and choreographer to study or reconstruct the movement, and then for historians, ethnologists, and other researchers that focus on dance. As (Delahunta and Zuniga Shaw 2006) state, 'anthropologists, ethnographers, preservationists and librarians of culture all consider the dance's recording or document, as flawed as it may be, is the vehicle for furthering aims and goals of the institutional domain whether they are research in higher education, public understanding or promotion of heritage'(Delahunta and Zuniga Shaw

2006). In fact, this need of dance documentation is reflected in the increasing interest in recording and documenting dance during the last decades.

Within the effort of preserving dance, many institutions, organizations and dance companies are interested in documenting and archiving dance pieces and eventually, permit access to this material. In fact, many choreographers, like William Forsythe¹⁶, are willing to document and share their creative process, ‘perhaps sensing and looking to interact with this increasing external interest or seeking to understand themselves better, a self-demystification of one’s own practice in order to sustain continuous innovation’(Delahunta and Zuniga Shaw 2006).

Nowadays, this increasing interest for preserving dance has focused on disseminating dance through the World Wide Web, where the access is a lot easier and users from all over the world can find the information they need. As mentioned in the above chapter, some projects have been carried out with the cooperation of the choreographer, like the Siobhan Davies RePlay, for creating a dance archive. The William Forsythe’s *One Flat Thing, Reproduced* project creates an interactive archive including annotation and analysis made by the choreographer as well as the analysts.

It is rare, though, to find an interactive dance archive which includes the plays of various choreographers and their documentation, where a user can explore the work of an individual as well as compare the different dance styles of various choreographers.

4.2 Defining a Framework for Dance Analysis and Distribution

As mentioned earlier, within the objectives of this thesis is to present the creation of a flexible prototype annotation system for dance/theater performances, which choreographers and their working teams can use for analyzing and documenting dance pieces. The final objective is to create a digital platform, where choreographers can place this documentation online in a web archive, available for all users. As (Fernandes and Bermúdez 2010) state, “the aim is to organize and structure a specific choreographic process in order to make its transmission more efficient—both for the choreographer and for the dancer/interpreter—and essentially to allow the creation of a collective memory.”

The first phase of the work includes the formation of a framework for dance analysis with object of study a dance piece of the Portuguese choreographer Rui Horta. The second phase of the work is the implementation of a video archive, which will contain selected videos of a

¹⁶ See chapter 3.6.

performance with the correspondent documentation and analysis and will be available online for potential users.

In the followings sections a brief introduction of the work of the team will be presented, as well as the criteria of the theoretical background that were used in this thesis.

4.2.1 Elaboration of an Annotation System

As mentioned before, this thesis is a part of the TKB¹⁷ project, a Transmedia Knowledge-Base for contemporary dance (*TKB - A Transmedia Knowledge Base for contemporary dance* 2009) with project coordinator Doutora Carla Fernandes¹⁸. With the objectives of creating an annotation system Carla Fernandes had already done the recordings during the creation and rehearsal phases as well as the performances of the dance piece *SetUp* by the Portuguese choreographer Rui Horta (Fernandes and Costa 2010). Additionally, from discussions of Carla Fernandes with Rui Horta, the intentions of the choreographer during the creative process of the pieces, as well as the way he structures his choreographies were known to the team. Consequently, the choreographic notes as well as the videos, which would be the objects of study, were available to the team.

As a result of the above mentioned, it was already known that the choreographer divided the choreographies into *Sections* and *Scenes*, and that was a starting point for decomposing the dance piece. Further, within the structure defined by the choreographer the team documented the dance piece through two different viewpoints of analysis: the approach to the composition without the movement, and the approach within movement.

During the first phase of analysis, the team observed the interdisciplinary contribution in the creation of the choreographic work. In other words, the team effectuated the deconstruction of the piece into sections and scenes and then, inside these parts, the observation of elements which reinforce the dance, like music, costumes, lighting and others.

The second part of the analysis contains the observation of the dance movement. For the movement analysis the knowledge of different research areas like Dance, Sports and Gesture Studies was incorporated. During the movement analysis the movement sequences of the dancers were divided into smaller units, the phrases, so that within these units one may look closer to the movement, describe it regarding different criteria and parameters.

¹⁷ We have to mention here that the formation of the dance annotation system was the result of a team work. The members of the team are Doutora Carla Fernandes (project coordinator), Doutora Isabel Galhano Rodrigues, David dos Santos and Paraskevi Dimakopoulou.

¹⁸ The personal page of Carla Fernandes: <http://www.clunl.edu.pt/en/?id=1167&mid=196>

One of the first decisions the team had to take was related to the vocabulary to be used for the annotation. The above mentioned systems of Laban, Benesh and Eshkol-Wachman use symbols for the depiction of movement and some of them stick figures for the representation of the body, fact that turns the systems more accurate. However, notational language assigns more complexity to the systems and turns it more time consuming for users to understand and learn. Since the final objective of the work is the annotations created during the analysis to be available online for users, the team decided to simplify the system using natural language. Hence, the vocabulary for the annotations uses terminology universally accepted and understood. In this manner, the system manages to combine the accuracy of movement description with enough simplicity for users to read and learn.

As said before, the notational systems, such as Labanotation, provide evidence of the quality of movement as well as the steps, shape or pattern of the movement. Thus, the priority of the traditional dance documentation is the reconstruction of a dance. The proposed annotation system is not an effort to create documentation which could be used for the reconstruction of a dance piece. It is an effort of showing the cross-disciplinary contribution in choreography and how the various disciplines can serve the choreographic thinking and the movement dramaturgy, as well as how movement and postures are the tools that will lead to a better understanding of the intensions, moods, emotions and thoughts of the dancers as well as the choreographer.

Traditional notation systems aim to analyze mainly dance and dance movements. For example, Benesh notation system is most popular for notating ballet movements. Although the suggested annotation system is being developed on the bases of dance, it can also be applied to any dance/theater performance. The fact that dance performances were used for this purpose is not random, since dance offers a great variety of body movements and emotion displays, which on their turn are very important for the development of the system. In addition, within parts of the dance piece that contain speech movement was studied in relation to it, including, in this manner, the case of movement in theatrical speech.

In chapter 3.1, we analyzed the concept of phrasing and discussed its importance in dance analysis. There, we referred to the study of (DeLahunta and Barnard 2005) with the collaboration of the choreographer Wayne McGregor. In the exercise carried out by the dancers of the company, there were different opinions of how someone identifies a phrase. According to the above study and to different opinions of choreographers and dance analysts on the 'phrase concept', which were discussed in Chapter 3.1, we can argue that there is not an established methodology for categorizing movement phrases. Thus, the team had to decide a clear framework, which would be the basis for organizing movement into phrases. For this reason, the

team considered different perspectives on identifying movement phrases, which will be discussed in the following paragraphs.

To begin with, the team considered the views of Wayne McGregor's dancers in the above experiment. Kham Halsackda (Dancer Random Dance) stated that a clear way to segment movement was a change in level or direction, because it was such a definite change. He adds that during the exercise he started looking at the intention of where the movement is coming from (Kham Halsackda in DeLahunta and Barnard 2005). Claire Cunningham (Dancer Random Dance) argues that a segmentation of movement sequences happens when a task is clear in a phrase. She adds that in sequences that a task is not obvious, segmentation can happen by a change of energy or dynamics or by a pause (Claire Cunningham in DeLahunta and Barnard 2005). Consequently, Wayne McGregor's dancers classified phrases mainly depending on the tasks enclosed in a movement sequence or on a change in the dynamics that makes clear that a phrase is finished and a new one begins. In the following paragraphs we will discuss the concept of a movement phrase within other research areas.

(Bishko and Beane 2010) study movement within phrases in order to create believable animation. They aim to show the interplay between biomechanics and intent and refer to a 'movement phrase that tells a story' (Bishko and Beane 2010). The phrasing process depends on their assumption that movement is organized in clear phrases, which communicate the intent of the action. They argue that intent results to bodily actions and is expressed through them, while body mechanics enable the realization of intent. According to (Bishko and Beane 2010), there are five stages within movement phrase: 1.Preparation (intent) 2.Initiation (anticipation) 3.Exertion/Main Action 4.Follow Through/Recuperation and 5. Transition, as illustrated in Figure 4.1.

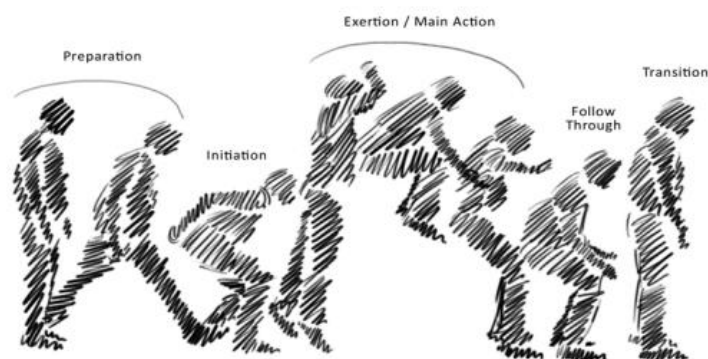


Figure 4.1: Movement phrase contains a jump(Bishko and Beane 2010)

From the perspective of Gesture Studies, as already discussed in Chapter 3.5, Kendon classifies gestures into a hierarchical structure (Kendon 2004:112). The main unit is the *gesture unit*, composed from *gesture phrases* that can be divided in different gesture phases, preparation, stroke and recovery¹⁹. This schema is created concerning the movement of the upper limbs.

(Rodrigues 2005), while analyzing units and categories of nonverbal communication, considers the movements of the trunk, head, gaze, upper limbs and facial expressions. She extends the concept of gesture phrase into *movement phrase* in order to include the above modalities in the analysis. The criteria (Rodrigues 2005) used to define units are amplitude and trajectory shape as well as immobility time, contrasting with the movement phase. She distinguishes between dynamic movement units, identified by the change of direction of the movement, and static movement units, which correspond to the immobility time, namely the period of time during which a part of the body maintains the same configuration (Rodrigues 2005).

Considering the above theories that deal with the concept of movement phrase, the team realized that the intention behind a movement is an essential kick starting parameter of a motion, which prepares the body to move and patterns the movement phrase that follows. Consequently, the team decided to identify movement phrases by the intension that commands the bodily action. In other words, the mover moves in order to satisfy his intention completing like that a cognitive unit. In fact, the team observed that when a movement phrase is finished the beginning of a new one is frequently marked by a different path of the movement of one of the modalities, or by the end of the immobility time of a modality, as was defined in (Rodrigues 2005).

The representation of the body in the presented system is based on a biomechanical understanding of the moving body. (Hamill and Knutzen 2009) state, ‘a reference system is necessary for accurate observation and description of any type of motion. The use of joint movements relative to the fundamental or anatomical starting position is an example of a simple reference system’(Hamill and Knutzen 2009:19). The zero position in our system is the fundamental position²⁰, in relation to which the movements of all the body parts can be described. The body is treated as a system of rigid parts connected at the joints and the movement is described by the relative angle of the correspondent joint.

Concerning the description of the movement, the team constructed a framework where the movements of different body parts as well as the position or configuration they assume, are described. In fact, there are two parameters in the movement description; the description of the movement of various body parts and the description of their configuration, which can result to a

¹⁹ See figure 3.10 for an illustration of a gesture unit.

²⁰ The fundamental position can be seen in Figure 3.7.

certain posture. The team decided to use the terms *dynamic or static bodily expressivity*, as used in (Maurizio Mancini, Bjoern Hartmann, and Pelachaud), in order to define the above two description parameters.

Within the description of the dynamic bodily expressivity, the dynamics of the movement were defined. For this purpose a framework was formed with a vocabulary of dynamics. Part of this vocabulary was based on some of Laban's concepts of Effort, (Laban and Ullmann 1980:78-79, cited in Maletic 2005), for defining the dynamics during the performance of a movement. Here we refer to dynamics as the intensity, weight and energy aspects of movement. The suggested vocabulary includes two of the four elements of Effort: weight and flow, for describing the lightness of the movement as well as the continuousness of the movement.

The traditional notational systems usually provide information about the placement of the weight of the body and some, like Laban's, describe the shape of the body during the movement. Here, the team decided to consider the static bodily expressivity, which includes the configuration of the different body parts that maintain the same configuration within a phrase. For the description of the body parts configuration, elements like palm shape, finger shape, gaze and palm orientation were added in the vocabulary.

We mentioned above that the annotations were created within a specific vocabulary, which was formed by the team during the analysis. This, in combination with the fact that each description follows a specific outline raises the possibility of a future use of the information into a consistent database that can be manipulated in the frame of various domains like archival and retrieval projects. As (Fernandes and Costa 2010) state, "creating new words, terms or expressions (in other words, producing neology) in order to designate the observed realities is not only important for a possible communication between members of the community, but also for the organization and structuring of a Digital Archive. Terms can then be used as means of indexing, accessing and restoring information".

In this section we discussed the theoretical basis of the suggested annotation system. The various elements of this system will be described in detail in Chapter 5.

4.2.2 The Creation of a Dance Video Archive

The second stage of this thesis consists of the creation of a digital platform, where authenticated users/choreographers will be able to upload and archive videos of their artistic work online, which later will be available for everyone to browse and explore in the web page.

The already presented online archives, like the Siobhan Davies Replay, are created with the purpose to publish the artistic work of a specific choreographer. The archival teams worked in collaboration with the choreographers in order to expose the selected artifacts and to give the user the possibility of interacting with them in various ways. In this way a user can get familiar with choreography and with the choreographic process of a specific artist.

The proposed archival platform is initially created based upon the artistic works of the Portuguese choreographer Rui Horta. The videos of Rui Horta's pieces that have already been annotated with the above presented annotation system are placed on the online archive. However, the purpose of the digital platform is not limited only to one choreographer. The digital platform is built to give the future possibility for different choreographers to document their work and place it on the online archive creating like this their personal archive. In this way, the users will later have the possibility not only to be acquainted with the work of an individual but also to compare the different choreographic styles of various choreographers.

In order for a choreographer to upload the videos to the platform, he has to document the video with required metadata. For this metadata we chose a framework similar to the one used for the Siobhan Davies dance archive. Thus, every authorized user, while uploading his work to the platform, has to create the appropriate metadata according to this framework.

Obviously, the annotations of the video created with the above presented annotation system can also be considered as a type of metadata. The text/annotations that document the video improve the filtering and searching of the videos. As (Pfeiffer 2010) states, 'because search technology is very advanced when it comes to text, but very poor when it comes to audio or video content, alternative text provides the only reliable means of indexing audio-visual content for high quality search'(Pfeiffer 2010:247).

The already mentioned online archives²¹, are displaying the videos to the web pages with the Adobe Flash player plug-in. Thus, the potential users of the archives will forcibly have to install the Adobe Flash in their browser in order to watch the videos. In this thesis, the video archive is implemented with the HTML5 technology²². HTML5 is the fifth revision of the HTML standard featuring many new syntactical features. One of them is the 'video' element, whose functionality is built into the browser.

A detailed description of the digital video archive platform and its features is discussed in the Chapter 6.

²¹ See chapter 3.6

²² For a detail description of the HTML5 technology see Chapter 6.1.1.

Chapter 5: Towards the creation of a Dance Annotation System

In this chapter, we will discuss the methodology that the team followed in order to accomplish the formation of the annotation system. First, we introduce the tools the team used to develop the annotation system and then we describe the analysis steps.

5.1 Annotation Tool

The tool that was used for the creation of the annotations was Elan-Language Archiving Technology (*Language Archiving Technology* 2008) by the institute: Max Planck for Psycholinguistics, Nijmegen, The Netherlands. ‘ELAN is a tool for the manual creation of annotations to audio and/or video files. In its most elementary form an annotation is a piece of text referring to a segment of the media. In the case of audio or video a segment is usually identified by a begin time and an end time, both referring to a point in the media’s timeline’ (Sloetjes and Wittenburg 2008).

Elan provides the interface for creating tiers, which is a kind of layers, where the user can insert annotations. Annotations on a tier are characterized by begin and end time, identifying a segment of media. In a transcription each tier is associated with a “Linguistic Type” and in this way tiers that share the same linguistic type can be grouped together. Elan tool creates an XML file that contains the link to the media that is annotated as well as the relationships among the tiers, the tiers and their linguistic types, and the annotations and their time slots.

The team selected this wide known tool due to its flexibility in creating and grouping annotations and to its user friendly interface. In addition, the XML file can be easily parsed in order to be used in web applications.

An instance of Elan interface is illustrated in Figure 5.1, containing the tiers created for the first piece of Rui Horta, *SetUp*.

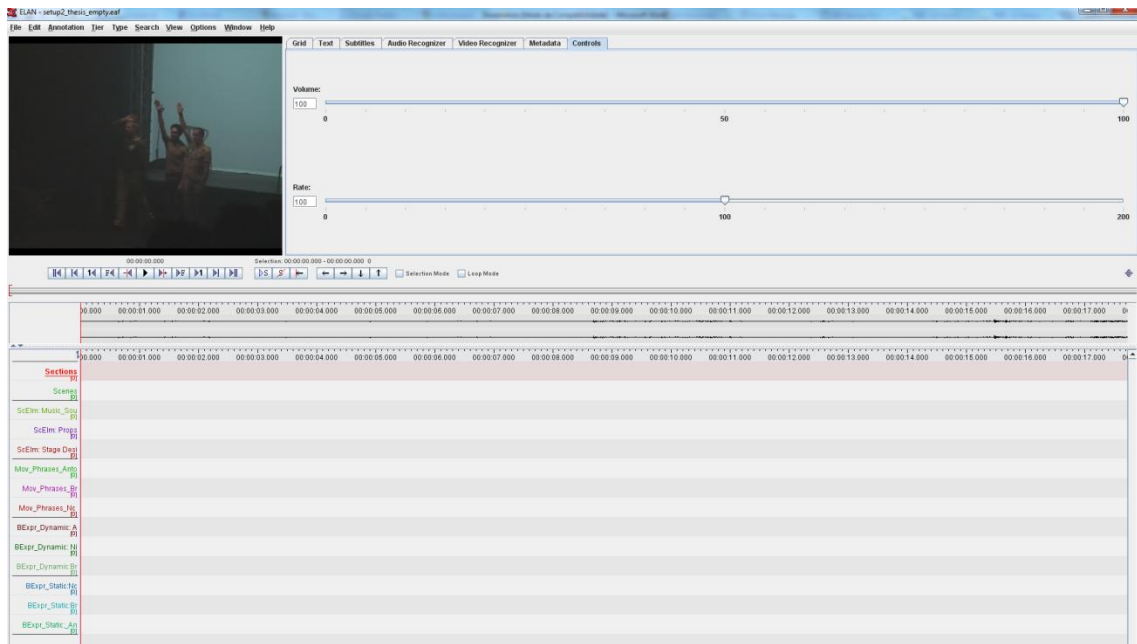


Figure 5.1: Elan interface with the tiers created for Rui Horta’s piece SetUp.

5.2 Segmentation of a Dance Piece

As already mentioned, a formal approach to choreography contains the analysis of the trinity of Space, Time and Dynamics of dance movement and through the prism of the above three elements the observation of the factors of music, costume, lighting, props and content. The first approach of the analysis didn’t include the actual dance but the peripheral components that encircle a dance composition, like the architecture design of the space, the music and sounds, the props the dancers use, the lighting, the costumes, the multimedia design and so on²³.

Initially, the team segmented the piece according to the choreographer’s Sections and Scenes. The analysis follows a hierarchical structure starting from dividing the piece into sections, next into smaller units, the scenes, and then inside these units the design components of the piece were annotated. In fact, it was observed that the beginning or the end of a scene is marked by the change of lights, the change of props, the change of the stage design, a pause in the music and so on. Figure 5.2 illustrates the annotation scheme of the first step of the analysis and Figure 5.3 illustrates an instance of the above explained annotation in the Elan annotation tool.

²³ The elements used for segmenting the dance piece were chosen by the team with collaborators: Carla Fernandes, Isabel Galhano Rodrigues, David Santos, and Paraskevi Dimakopoulou.

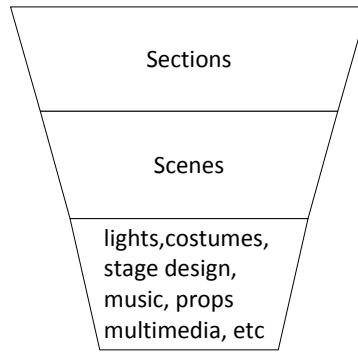


Figure 5.2: The hierarchical structure of the first analysis step

Nr	Annotation	Begin Time	End Time	Duration
1	Back to intimacy	00:00:00.330	00:03:05.245	00:03:04.9
2	10.The spectator's perspective II	00:03:05.245	00:03:52.080	00:00:46.8
3	11. Bruno's solo	00:03:52.080	00:04:57.150	00:01:05.0
4	12a. Shit Talk	00:04:57.150	00:09:33.660	00:04:36.5
5	12b. Microphone	00:09:33.660	00:16:54.170	00:07:20.5
6	13. Silent Duet	00:16:54.170	00:19:23.730	00:02:29.5
7	14. Thank you for coming	00:19:23.734	00:20:35.240	00:01:11.5
8	15. Percussion	00:20:35.240	00:22:46.654	00:02:11.4

Figure 5.3: An example of annotation while segmenting a dance piece.

Summing up, this first stage can be seen as an observation of the choreographic thinking through the study of different cross-disciplinary aspects involved in the creation of choreography, such as: stage architecture, lights, music, costumes, and other relevant elements.

5.3 Movement Analysis and Annotation

As mentioned before, the characteristics inherent in moving may provide useful information about a person's intentions, abilities, emotions, state-of-mind, and psychological and physical propensities. This second analysis phase focuses on compose a framework first for dividing the

movement sequences into units, the phrases, and then describing the features of movement within the phrases.

5.2.1 Phrasing

Phrasal structure in dance plays an important role in communicating meanings. Phrasing helps choreographers structure their dance pieces and dancers structure their movements. Movement phrase also plays an important role for teachers, critics and theoreticians who are engaged with the work of watching and analyzing dances.

In the above chapter, we concluded that there is not a traditional way for determine the structure of a phrase in dance. Hence, the phrasing method varies from dance to dance and from choreographer to choreographer and it is an individual decision of how a dance is composed, or from the dance analysts point of view decomposed, into movement phrases.

As referred above, the team decided to identify movement phrases depending on the intension that motivate a mover to perform a movement. Thus, each dancer's phrase contains a sequence of movement that can communicate the performer's intent.

We can explain the above idea by analyzing a basic walk in the context of a movement phrase. Assuming that a performer A is walking towards a performer B, we could argue that his clear task/intension is to approximate or to communicate with B. Obviously, the phrase is finished when performer A gets to its destination and stops. Then, B may also perform a phrase, which may contain the intension of accepting A, or the intension of rejecting A by moving away. The above instance is illustrated in Figure 5.4.

The method the team followed for annotating phrases was composed by two parts; by the participants of the interaction and by the intension included in the movement phrase. An instance of a phrase annotation for a dancer would be: "Interaction with B - proximity", or "Interaction with A-rejecting A". An example of the above annotation is illustrated in Figure 5.4.

In the annotation system a tier for each dancer was created for the annotation of the movement phrases (Fig. 5.7). As discussed above, a movement phrase usually is accompanied by a change of state. Thus, in many cases movement phrases were marked by the change of direction of the movement of different body parts, or the change of dynamics or a pause. Within each phrase bodily expressivity was described, as we will discuss in following chapter.

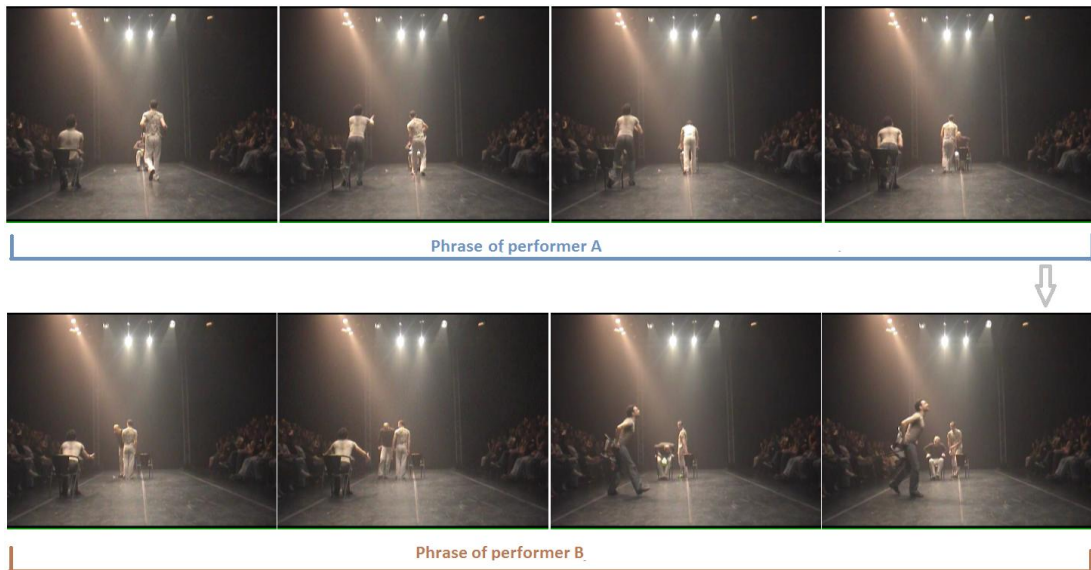


Figure 5.4: A moves towards B completing a phrase. B is moving away, responding to A's phrase.

5.2.2 Representation of the Body

The body representation in the system follows a biomechanical approach and the movement of the body parts is described in relation to the fundamental position²⁴. The body is treated as a system of interconnecting rigid segments, forming the major joints. The movements of the body segments are described by the relative angles of the joints connecting them.

The body parts the team decided to include for the representation of the body are the head, torso, arms, hands and legs.

The head, neck and torso are segments composing the main part of the body. Without taking into account the fingers and the toes we considered the following major joints of the human skeleton with different degrees of freedom: ankles, knees, elbows and chest, which are monoaxial, wrists, which are biaxial, and shoulders, hips, and the head/neck and abdomen `joint` are triaxial.

For describing movements that are performed by body parts that form monoaxial joints the team decided that the reference to the relative angle of the joints was sufficient for an accurate description. The triaxial joints were described not only by the relative angle of the joints but also by the orientation of the movement, which can be front, back, and side.

The chest and abdomen are treated together referred to as torso. The movement of the torso includes its inclination, which can be forward, backward or to the side, as well as its orientation,

²⁴ The fundamental position can be seen in Figure 3.7.

which can be to the left or right side. The joint of the wrists are not described since the palm orientation is sufficient for the description of the hands' movement and shape.

The angles and body parts' orientation that were included in our annotation are presented in Figure 5.5.

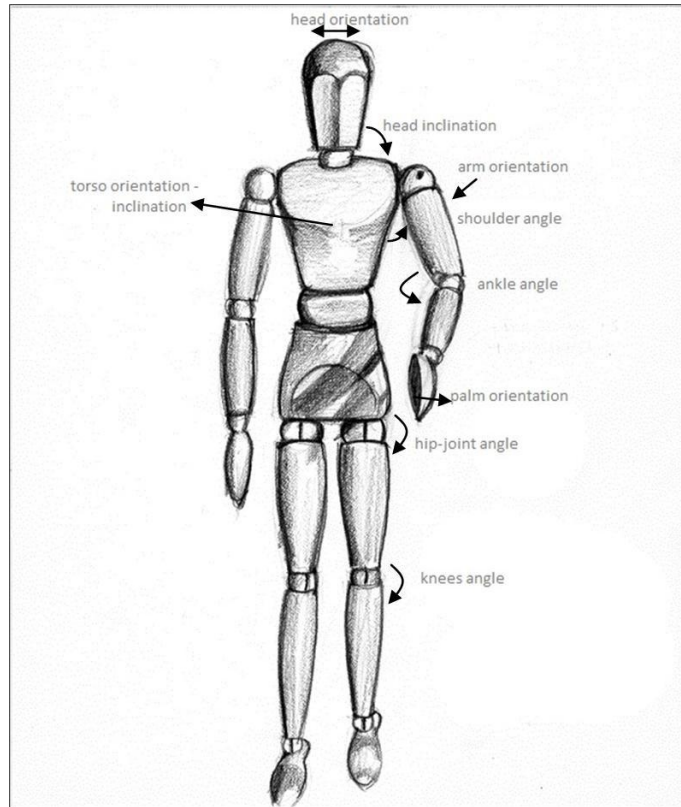


Figure 5.5: The representation of the body.

5.2.3 Bodily Expressivity

Bodily Expressivity is the element that gives dance its articulation. The term bodily expressivity is used here for describing the dynamics of the movement and the configuration of the body while performing a movement. These elements give the movement its expressivity. In fact, when the dynamic dimensions of a movement are changed the entire feeling tone of the movement is altered. A single movement such as the lifting of an arm can be changed dynamically when it is varied from fast to slow, from fluid to fragmented, from moving upward a small distance to extending it to its fullest reach. Walking, performed relaxed and with small steps won't give the same information as a fast walking performed with energy.

For the description of bodily expressivity, movements were observed closely within each movement phrase, and were annotated using a standard vocabulary of various dynamics and their qualitative values, which was created by the team.

As already mentioned, the vocabulary was defined in team work during the annotation of the dance videos and includes terms for describing movements, its dynamics as well as static configurations. For describing a movement simple language was used like, walking, jumping, rolling, swinging, and so on. The different body parts that were included in the analysis and the movements they can perform are illustrated in Table 5.1.

<i>Body Parts</i>	<i>Orientation</i>	<i>Inclination</i>	<i>Type of movement</i>	<i>Angles</i>	<i>Additional Information</i>
Head	up, side, down, back	left, right	head-nod, head-shake, circular		Facial expression: Eyebrows (normal, raised), Mouth (light-wide smile, opened-closed relaxed, opened extended-pressed lips), Eyes(open, closed, pressed)
Torso	left, right	front, side, back			
Arms	up, front, side, back		crossing arms, rotating arms, raising arms, extending arms, etc	shoulder elbow	
Hands			vibrating, twisting, snapping fingers, etc		Hand Shape: extended, curled, hooked, ok-sign, hand-purse, bent, cross- fingers, etc.
Palm	up, down, vertical, oblique, to front, to body				
Legs	up, front, side, back			hip-joint knees	

Table 5.1: Elements for describing dynamic and static bodily expressivity²⁵.

²⁵ The vocabulary of movements and its dynamics was created by the team during the first TKB lab in the residence “O espaço do Tempo”: http://www.oespacodotempo.pt/en/prog.php?idpan=pro_det&recid=566

Furthermore, the dynamics of the movements were also considered. Its description was based in 9 features, referred in Table 5.2.

speed: fast/medium/slow	information about the speed of the movement
type: single/repeated	if a movement is performed once or is repeated
intensity: low/high	refers to the physical strength - energy put into a movement
tension: tense/loose	refers to the contraction or loosening of the muscles
tempo: accelerando/rallentando	if a movement accelerates or decreases
flow: fluid/staccato/fragmented	if a movement is continuous, formed by short movements separated by a pause, or just discontinuous
weight: light/heavy	the effort put into a movement in relation to gravity
path: straight/circular/zig-zag/s-curved	the path formed between the starting and ending point of the movement
direction: up/down/forward/backwards/right/left/diagonal	the direction of the movement

Table 5.2: The dynamics that were used to describe a movement ²⁵.

Every movement can be described with a combination of the above dynamics. First, some basic characteristic of the movement are chosen to describe it, like the speed, the type and the direction.

The direction of movement firstly was described only in relation to the mover. During the annotation we observed that the direction of the movement plays important role for the interaction schemes that are formed among the performers. In other words, the direction of a movement that an actor performs in relation to other participants can convey information about the kind of interaction among them and the intension or thoughts of the mover. For instance, in the case that a mover A walks towards a mover B, the movement direction of A is influenced by the position of B. Consequently, it was important the movement description of an actor that is interacting with other actors to be expressed by two elements, one that describes it in relation to him and one in relation to the participants in the interaction. An instance of a movement

description would be like: 'running; direction: forward, towards B', which shows the intension of the actor A to move closer to B.

The same logic was followed in the case of the path. The type of the path was described in relation to the space and then in relation to the receiver if it exists one. For instance, the annotation: 'walking, carrying his chair; speed: medium; path: circular, around B', defines the type of the path and also conveys information about the interaction between the two performers.

For the description of the features of a movement the team observed the various levels of intensity during the time interval it is performed and within the distance it travels in space. Hence, it was essential to include in our analysis the elements of intensity, tense, flow and weight. The elements of flow and weight proceed from Laban's concept of Effort (Laban and Ullmann 1980:78-79, cited in Maletic 2005). The element of intensity describes the degree of energy or force put in a movement and the element of tension describes the contraction or relaxation of the muscles that perform the movement.

The element tempo derives from music terminology and it is the pace of a given piece. The team used the term tempo to describe the change in the pace of a movement within a phrase. Tempo here can take two values: *accelerando*, which characterizes a movement that is speeding up, and *rallentando*, which characterize a movement that is gradually slowing down.

In brief, the above nine elements were chosen for describing the characteristic features of a performed movement. A combination of these elements can give a clear and accurate description of a movement and can reveal thoughts and moods which have motivated the mover. For instance, in the example of Figure 5.4 the dynamics carried in the walking of A can reveal thoughts or emotions of the performer, while approaching performer B.

Concerning the static bodily expressivity, the team described the configuration or position of the different modalities, in case some parts of the body maintain the same configuration (immobility time (Rodrigues 2005)) within a phrase. In addition, facial expressions were described whenever visible.

An instance of static bodily expressivity description can be seen in Figure 5.6. The selected frame belongs in the interval of the movement phrase: 'Interaction with Anton - agreement'. As illustrated in the figure the description of the configuration of the body parts reveals the elements that convey the intension (agreement) of the mover.

In this chapter the methodology of the prototype annotation system was discussed in detailed. The analysis progressed in two stages, the performance design and the movement analysis. The methodology is user-oriented focusing on the accuracy and simplicity of the system for the user to learn and understand. With the system every movement of a dance or theater performance can be precisely described. Both stages follow a hierarchical structure organizing the annotations in order to be further analyzed and defining a structure of how the analysis will be placed online at the archive. This subject will be discussed in the following chapter.

Chapter 6: Towards the Creation of a Digital Archive Platform

In the above chapter, we discussed the methodology for forming an annotation system for documenting dance videos. The documentation was created with the final purpose of being placed online available for users who are interested in being introduced to dance, movement and choreography. In the current chapter, we study a method for displaying the videos in combination with the annotations in the online archive. The study examines technological as well as structural concerns for creating the digital platform for the video archive.

6.1 Technology Used

For building the web pages, we obviously used web technologies. As said before, the Elan tool was used to create the annotations. The Elan tool produces XML files, which include the annotations themselves and their metadata. Hence, several technologies for treating the XML files were used. In brief, the following bullets present the web technologies used in the project:

- HTML5, the new version of the HTML standard, for building the pages
- XML, for transporting and storing data and metadata
- JavaScript, which runs on the client side and permits the manipulation of web pages and browsers
- Ajax (Asynchronous JavaScript Technology and XML), for reading and sending data to and from the server through JavaScript requests. It provides associated server and client-side functions
- PHP, which runs on the web server for server-side web development
- CSS3, for manipulating the style and look of the web pages

The above technologies are used in order to orchestrate media types (sound, video, changing text, etc.) creating this way dynamic web pages.

6.1.1 HTML5 <video>

HTML5 is a recently developed technology and at the current time is still under development (*HTML5 differences from HTML4* 2011). HTML5 launched many new syntactic features, like

the <video>, <audio> and <canvas> elements. In this thesis the HTML5 <video> element is used for displaying the videos on the page.

HTML5 defines a standard way to embed video in a web page, using the <video> element. Before the introduction of the <video> element, the videos were included in the HTML web pages through <object> and <embed> elements, which required browser's plug-ins to be previously installed on the user's machine. Nowadays, the major plug-in, providing rich Internet applications, is Adobe Flash Player.

In 2007, the first trial implementation of the <video> element was published and since March 2010 Microsoft Internet Explorer includes support for the <video> element. From then on all the newer versions of the Internet browsers support the HTML5 video element (Pfeiffer 2010:1).

Above all, HTML5 video can be used directly into supporting browsers, without the requirement of plug-ins, enabling, in this fashion, publishers to distribute high-quality video seamlessly and considerably faster. Moreover, it integrates easily with the HTML content and can be manipulated with JavaScript and CSS. This facilitates the Web developers' tasks, when building video player interfaces, to be more consistent to the rest of the website. At the present time, two of the most popular video-sharing websites, YouTube (*YouTube* 2010) and Vimeo (*Vimeo* 2010), have started experimenting with HTML5 video.

However, as (Pfeiffer 2010) argues, 'an early and ongoing debate around the HTML5 media elements is that of a baseline encoding format, also called a 'baseline codec'. A baseline codec is a video and audio encoding format that is supported and implemented by all browser vendors and thus a web developer can rely on it to work in all browsers' (Pfeiffer 2010:2). The baseline codec is not referring only to the codec data of the video, which is the compressed video itself, but it refers also to the container format, which can be consider as a ZIP file that contains multiple kinds of files within. At the present time, a combination of containers and codecs that works in all HTML5 browsers does not exist. That was our main concern in using the HTML5 video element instead of the Adobe Flash plug-in.

The solution found to this problem requires the developers to publish the videos in more than one format in order to be watchable across all browsers. Table 6.1 has a summary of the current browser implementation status.

Browser	Release	Formats
Internet Explorer	9.0 (March 2011)	MP4 H.264/AAC
Mozilla Firefox	5.0.1 (July 2011)	Ogg Theora, WebM
Google Chrome	12.0.742.112 (June 2011)	Ogg Theora, MP4 H.264/AAC, WebM
Safari	5.0.5 (April 2011)	MP4 H.264/AAC
Opera	11.50 (June 2011)	Ogg Theora, WebM

Table 6.1: HTML5 video support into main browsers

6.2 Structuring the Data

Before starting building the video archive the team assumed to be very important to filter the information in order to avoid displaying the information in an incomprehensive way for the user. For this purpose, the team had to define the metadata framework and the relationships structure between the annotations in order to classify and display them.

The video's metadata structure is critical for archiving the videos and for searching and filtering the information. Thus, for each video rudimentary metadata, such as the title, performers and duration were created. For structuring the metadata the team followed a simplified framework similar to the one created by the archival team of Siobhan Davies RePlay. In this way, while the users upload their videos they also have to fill metadata fields in order to archive the videos.

The relationships structure among the created annotations is also essential. As mentioned in the previous chapter, while analyzing the dance piece the annotations created from the annotation system were organized in a structure and can be linked in various ways. Thus, it was decided that it is necessary to define how the annotations are linked and also give the opportunity for future users to do likewise.

Displaying the videos documented with the appropriate annotations motivates the users to look closely to the dance movements and allows them to have a critical opinion on the significance and the relations between the annotations. The structure of relationships of the annotations is illustrated in Figure 6.1.

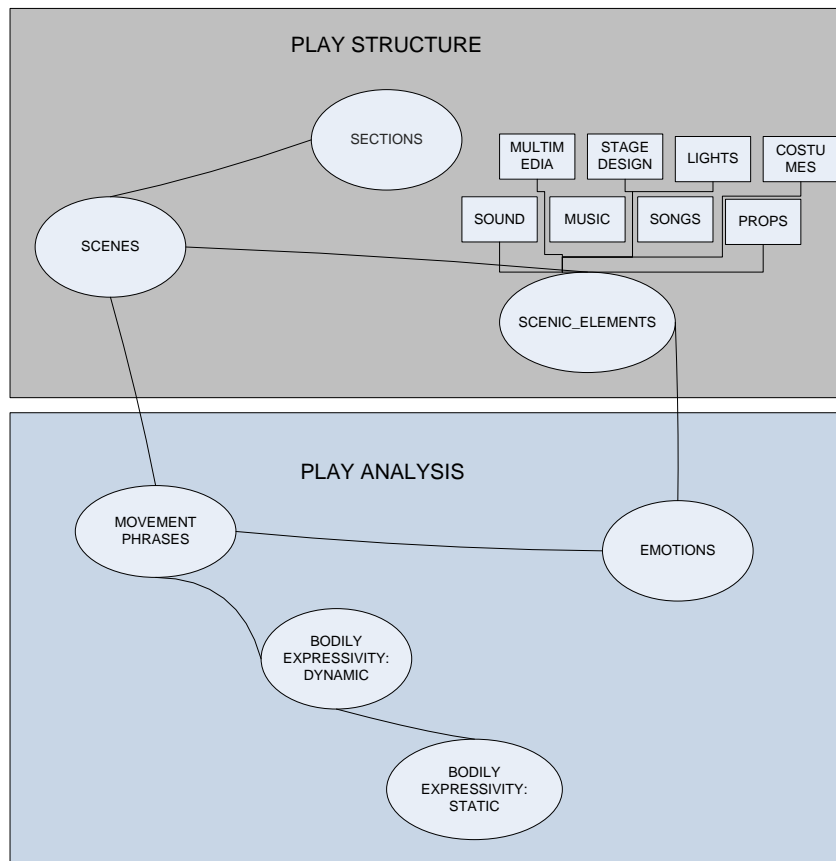


Figure 6.1: The annotation structure.

As illustrated in Figure 6.1, the way annotations were created as well as the topics they enclose allows them to be connected in various ways. However, in order to display them online, the connections' organization had to be simplified in order to facilitate the user's observation, thus preventing him to be flooded with annotation's data. Hence, the connections that were selected to be shown online are the following:

- Scenes & Scenic Elements
- Movement Phrases & Bodily Expressivity Dynamic & Static
- Emotions²⁶ & Bodily Expressivity Dynamic & Static

In this fashion, a user can observe how the scenic elements are changing within a scene, how the movement dynamics and the body configuration are formed within a movement phrase, and how the movement dynamics can reveal information on the emotions of the performer.

On the whole, the annotations as well as the selected relationships can improve searching, filtering and processing the information from the videos. While forming the annotation

²⁶ The annotation of the emotions is not explained in this thesis. However, the description of the dancer's emotions was also part of the team work so we will just display them in the online video archive.

structure, we realized that the user/choreographer who wishes to upload the analysis of his work should be able to define the connection among the annotations. In this mode, the system will be able to structure and display the annotations as the choreographer chooses to. For this reason we decided to implement a web page where the authenticated user can classify the annotations by defining the relationships among them, as we will discuss in chapter 6.5.

6.3 Workflow of the Web Site

The video archive consists of a back end interface where the authenticated user has the possibility of archiving his videos, and a front-end interface where all users can browse the videos and the annotations as well. The user that uploads the videos to the platform, can provide additional information to the system as well as the related analysis. The steps a user must follow for archiving his videos in the platform so that they can be later watchable by everyone are summarized below:

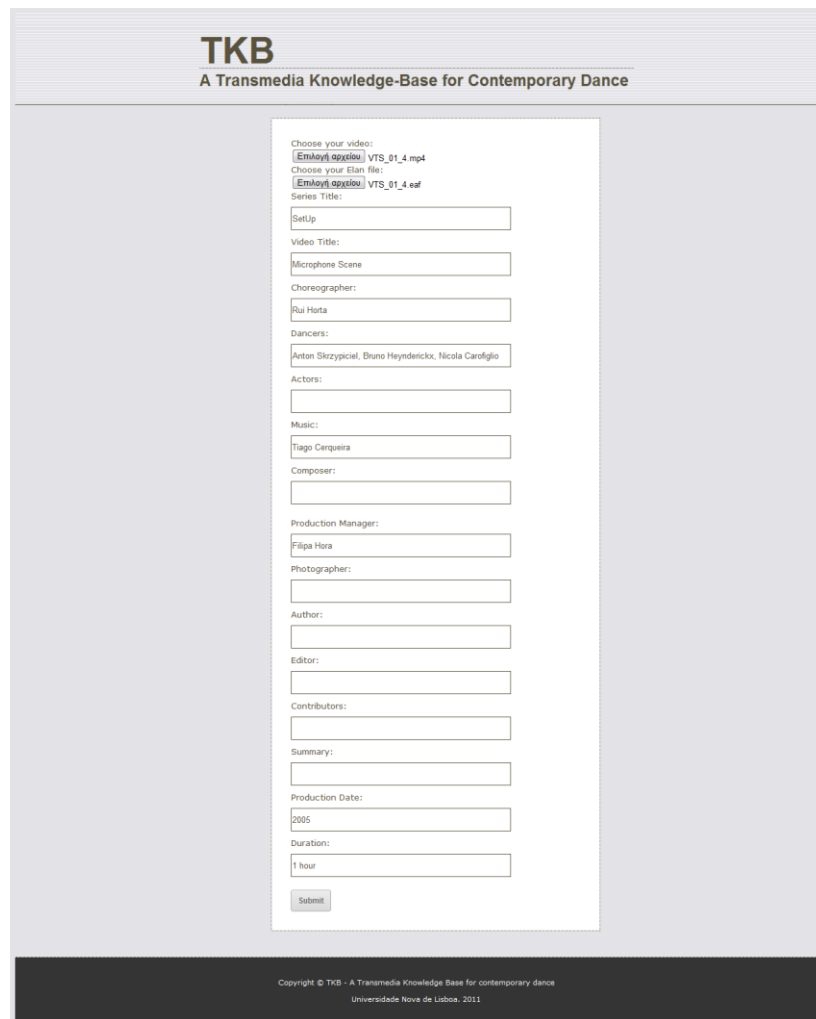
1. The authenticated user is directed to a page for uploading the video, the file with the analysis of the play created in Elan, we will refer to it as Elan-XML, and the required metadata for archiving the video
2. This step is performed only if the user uploads an Elan-XML file; if the Elan-XML file does not exist then this step is skipped. After submitting the form, the user is redirected to a page where the titles of each annotation, as read from the Elan-XML file, are displayed so that the user can associate the annotations in a structure of relationships. When the user completes the definition of the relationships the upload process is concluded.
3. The user is redirected to the actual online video archive, which contains the videos with the related documentation. Here a user can watch the selected video and browse over the metadata and the analysis. In this web page the menu is dynamically created from the above defined annotation structure. The annotations are displayed in synchronization with the video, accordingly to the annotation relationships the user defined in step 2. A user can choose to watch a video linearly, while the related annotations will scroll up as the video is playing, or to watch the video interactively by clicking on the annotation he wishes to see.

In the next chapters the steps presented above as well as the technology behind them are discussed in detail.

6.4 Upload Phase

To begin with, the upload page can be accessed only by an authenticated user. The user is expected to be an artist/choreographer, who wants to archive his artistic work, or a collaborative team that works with the choreographer.

The first page contains an HTML form where the user can upload the video, the Elan file with the annotations and finally fill in the metadata fields. Some basic metadata are required for archiving the videos, such as the title of the work and of the selected video, the choreographer and so on. The upload page is illustrated in Figure 6.2.



The screenshot shows a web form titled "TKB A Transmedia Knowledge-Base for Contemporary Dance". The form is centered on a light gray background. It contains several input fields for metadata, each with a label and a text box. The fields are: "Choose your video:" (with a dropdown menu showing "Embley_oxysiou | VTS_01_4.mp4"), "Choose your Elan file:" (with a dropdown menu showing "Embley_oxysiou | VTS_01_4.eaf"), "Series Title:" (with a text box containing "SetUp"), "Video Title:" (with a text box containing "Microphone Scene"), "Choreographer:" (with a text box containing "Rui Horta"), "Dancers:" (with a text box containing "Anton Szczypciel, Bruno Heydenickx, Nicola Carolgio"), "Actors:" (with an empty text box), "Music:" (with a text box containing "Tiago Cerqueira"), "Composer:" (with an empty text box), "Production Manager:" (with a text box containing "Filipa Hora"), "Photographer:" (with an empty text box), "Author:" (with an empty text box), "Editor:" (with an empty text box), "Contributors:" (with an empty text box), "Summary:" (with an empty text box), "Production Date:" (with a text box containing "2005"), and "Duration:" (with a text box containing "1 hour"). A "Submit" button is located at the bottom of the form. At the bottom of the page, there is a small copyright notice: "Copyright © TKB - A Transmedia Knowledge Base for contemporary dance Universidade Nova de Lisboa, 2011".

Figure 6.2: The form where the choreographer can upload his videos

At the present time, the user can upload the videos only using the .mp4 codec since the system only handles this type of videos. In the future, this will be improved and the system will deal with more formats.

While the user submits the form, the video file and its related Elan-XML file are uploaded to the server through PHP. The PHP code will then rename the files by extending their name with a timestamp using the build-in function *time()*. This function extends the name of the file with a numeric value in seconds, creating a unique name for each file a user is uploading. In this fashion, unique records are created and it is guaranteed that no uploaded file will conflict with an existing one.

Moreover, the PHP will receive the values of the metadata fields the user imported. A new XML file will be created to include the metadata, and then it will be saved to the server also containing a timestamp in its name. The root element of the metadata XML file holds an attribute, which contains the path to the video in the server.

As said before, the Elan annotation file is an XML file that includes the created annotations and their metadata. The file contains a reference to an online XSD schema, following the W3C standard; therefore it is well formed and has an online validation. The Elan-XML file also contains a reference to the related video. Since the name of the video is extended with a timestamp, the PHP changes the value of the element that holds the path to the video to the current value. In this way, all the three files, video, Elan-XML, and metadata-XML are interconnected via the path to the video on the server.

To sum up, the HTML form, where the user uploads the required files and information, calls the *uploader.php* file, which is responsible for renaming the uploaded files with a timestamp and store them to the server.

6.5 Relationship Structure Definition

As said before, this step is executed only if the user includes an Elan-XML file to the above form. In this case, the user is redirected to a page where he can define the connections among the annotations included in the Elan-XML file, likewise the creation of the annotation structure for the play of the choreographer Rui Horta discussed in Chapter 6.2.

6.5.1 Creation of the Relationship Structure

As discussed above, the relationships that a user can create as well as the layers of annotations included in each relationship should be limited in order to avoid confusing the user with a plethora of annotation data. Hence, we decided to define a limit of relationships and annotations' layers enclosed in them for simplifying the user's understanding and observation.

Particularly, the user can create up to four annotation's relationships, which in turn can contain up to three layers of annotation.

The page where the user defines the annotation structure, *tierselection.php*, contains two HTML forms. The first form includes two main <divs>, which in turn perform two tasks that are triggered with the form button.

The first <div> holds a list of checkboxes, which values are the titles of the annotation layers contained in the Elan-XML file. This list is dynamically created by Ajax, which calls the *loadXMLDoc* function. The function receives as a parameter the path to the Elan-XML file on the server. This function handles the following tasks:

- loads and reads the Elan-XML file
- searches for the attribute that holds the name of each annotation layer and keeps the values in variables
- writes in the HTML creating the checkbox list dynamically

The second <div> of the form contains the submit buttons in the shape of arrows as well as a text field (Fig. 6.3), where the user can type a name for the relation he is creating. Since the user can build up to four relationships, there are four submitting buttons and text fields, one for each relationship. The user can choose up to three checkboxes and then presses the corresponding button in order to create an annotation relationship. These fields are illustrated in Figure 6.3.

TKB

A Transmedia Knowledge-Base for Contemporary Dance

<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Sections <input checked="" type="checkbox"/> Scenes <input type="checkbox"/> BExpress_dynamic_An <input type="checkbox"/> BExpress_dynamic_Nc <input type="checkbox"/> BExpress_dynamic_Br <input type="checkbox"/> ScElm: Music_Sound_Song_Multimedia <input type="checkbox"/> ScElm: Props <input type="checkbox"/> ScElm: Stage_Design_Lights <input type="checkbox"/> BExpress_static_Nc <input type="checkbox"/> BExpress_static_Br <input type="checkbox"/> BExpress_static_An <input type="checkbox"/> Emotions_Nc <input type="checkbox"/> Emotions_Br <input type="checkbox"/> Emotions_An <input type="checkbox"/> Mov_Phrases_An <input type="checkbox"/> Mov_Phrases_Br <input type="checkbox"/> Mov_Phrases_Nc 	<div style="border: 1px solid #ccc; padding: 5px; display: inline-block; margin-bottom: 10px;">Sections and Scenes</div> <input type="button" value="➔"/> <input type="text"/> <input type="button" value="➔"/> <input type="text"/> <input type="button" value="➔"/> <input type="text"/> <input type="button" value="➔"/>	<div style="border: 1px solid #ccc; width: 100%; height: 40px; margin-bottom: 10px;"></div> <div style="border: 1px solid #ccc; width: 100%; height: 40px; margin-bottom: 10px;"></div> <div style="border: 1px solid #ccc; width: 100%; height: 40px; margin-bottom: 10px;"></div> <div style="border: 1px solid #ccc; width: 100%; height: 40px;"></div>
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Copyright © TKB - A Transmedia Knowledge Base for contemporary dance
 Universidade Nova de Lisboa, 2011

Figure 6.3: Definition of the relation structure by the user

The above described form is assigned with an *action* attribute, which calls the same page, namely the *tierselection.php* page. In other words, whilst clicking on one of the arrows the user is redirected to the same page to continue with the creation of the other relationships. When completing the annotation structure, the user should then press the submit button in order to be directed to the next page, but this will be discussed further below.

When the user presses one of the buttons to submit a newly created relationship, the PHP calls the *createRelation* function with an index as a parameter. This index will be “1” when the first button is pressed, “2” when the second button is pressed and so on. The tasks of the *createRelation* function are illustrated in the flowchart of the Figure 6.4:

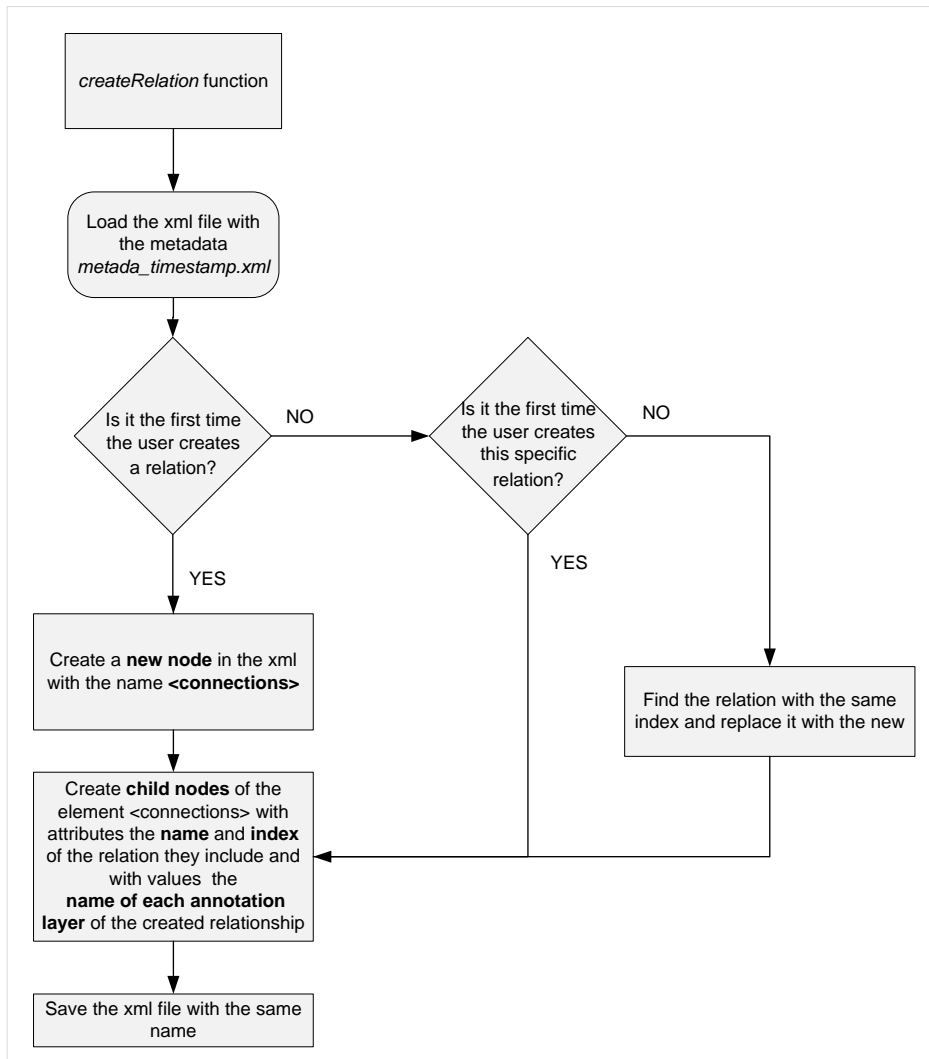


Figure 6.4: The flowchart of the function *createRelation*

As depicted in the above figure, the *createRelation* function adds nodes in the XML file that holds the metadata of the video in order to include in this file information about the created relationships, such as the index, the video name and the names of the annotation layers constituting the relationship.

At the end of each process, the metadata file, which now contains also information about the annotation relationships created by the user, is stored on the server. This file will be later used from the web page that displays the video in synchronization with the annotations.

6.5.2 Submission of the Relationship Structure

The second form of this page contains four read-only text areas. The form is not utilized for importing text, but for receiving relationship data from the user and sending it over to the next web page.

When the user clicks a button to create a relationship, the names of the chosen checkboxes, namely the titles of the annotation layers, are written in the above text areas, so that the user can see the relations he created. If the user decides to change a created relation, the data displayed in the text area will also change. In this fashion, the user can check the data before submitting the relation structure. An instance of this web page is illustrated in Figure 6.5.

The screenshot displays the TKB (Transmedia Knowledge-Base for Contemporary Dance) interface. At the top, the title 'TKB' is prominently displayed, followed by the subtitle 'A Transmedia Knowledge-Base for Contemporary Dance'. The main content area is divided into three vertical sections. On the left, there is a list of checkboxes corresponding to various annotation layers, including 'Sections', 'Scenes', 'BExpress_dynamic_An', 'BExpress_dynamic_Nc', 'BExpress_dynamic_Br', 'ScElm: Music_Sound_Song_Multimedia', 'ScElm: Props', 'ScElm: Stage Design_Lights', 'BExpress_static_Nc', 'BExpress_static_Br', 'BExpress_static_An', 'Emotions_Nc', 'Emotions_Br', 'Emotions_An', 'Mov_Phrases_An', 'Mov_Phrases_Br', and 'Mov_Phrases_Nc'. The middle section contains four buttons with right-pointing arrows: 'Sections and Scenes', 'Design', 'Movement Analysis', and 'Emotions'. On the right, there are four read-only text areas, each containing a list of the selected annotation layer names. The first text area contains 'Sections' and 'Scenes'. The second contains 'ScElm: Music_Sound_Song_Multimedia' and 'ScElm: Props'. The third contains 'Mov_Phrases_An', 'BExpress_dynamic_An', and 'BExpress_static_Nc'. The fourth contains 'BExpress_dynamic_An', 'BExpress_static_Nc', and 'Emotions_Nc'. A 'Submit' button is located at the bottom right of the form area. At the bottom of the page, a footer contains the copyright information: 'Copyright © TKB - A Transmedia Knowledge Base for contemporary dance Universidade Nova de Lisboa, 2011'.

Figure 6.5: The relation structure

The above described form has an *action* attribute, which calls the page that displays the video with the related information. Moreover, the path to the Elan-XML file as well as to the metadata file is sent through PHP to the next page. This way the next web page can access the information included in these XML files.

To sum up, this page gives the user the opportunity to classify the annotation layers of the analysis, thus defining how he wishes the annotations to be displayed while the video is playing. Furthermore, the user has the opportunity to give a name to the relations he created.

6.6 Displaying the Videos and the Documentation

As said before, in the above step the user completed the upload phase and now is directed to the page where the uploaded video and the related information are displayed. This page can be viewed by all users, authenticated or not, and we will refer to it as the *mainpage*.

6.6.1 Building a new XML file

This process is responsible to structure the annotations according to the relations the user created in the above step, into an XML file. The *mainpage* will display the video and a transcript box, which contains blocks of text that each time will include the annotations of a specific relationship that matches a specific segment of the video. To accomplish that, it is necessary to combine the information about the relation structure with the information from the annotations.

In fact, the data related to the relation structure is contained in the *metadata.xml* file and the data related to the annotations is contained in the Elan-XML file. To achieve a merge of these two XML files, we created a new XML file that contains information from both files.

Moreover, until now the Elan-XML file contains the annotations classified by the annotation layer. This classification does not serve the purpose of displaying the annotations in synchronization with the video. As discussed before, every annotation is identified by a start and end time. Consequently, while converging the annotations from different annotation layers that constitute a relation, firstly, a sorting is performed by the starting time of the annotation (*TIME_REF1*). In this way, the system can access the annotations arranged in a time order for displaying them in synchronization with the video.

Moreover, the merged annotations are contained in a node that is characterized by the index and the name of the corresponding relation. This data is extracted by the *metadata.xml* file.

In brief, the PHP on the main page performs the following tasks:

- opens the *metadata.xml* file
- parses the file and extracts the <connections> node

- opens the Elan-XML file
- parses the file and extracts the <header> and <time order> nodes
- creates a new XML file and copies the nodes <header> and <time order>
- reads the name of the annotation layers that constitute a relation and extracts the corresponding annotations' values from the Elan-XML
- sorts the annotations by time order
- writes the annotations in the new XML file
- performs the above steps for all the created relations
- saves the new XML file

By the end of this process, the nodes of the final XML file will contain the annotations included in a relation grouped together and ordered by the starting time.

6.6.2 Metadata Page Display

The main page contains the <div> that holds the selected video, the <div> with the buttons that permit the user to browse among different documentation of the video and hidden <divs> that are displayed when the corresponding button is clicked.

The menu of the page permits the user to browse the metadata of the video and the different layers of annotations as well. For displaying the metadata of the video, the *metadata.xml* file is loaded and parsed and the elements that are not null are displayed on the page, as illustrated in Figure 6.6.

The menu is created dynamically by the PHP, and the number of buttons depends on the number of relations that the user created in the previous step. Moreover, the name of the button is the name the user imported to define the relation. If for example, according to chapter 6.2, a user chooses the annotation layers 'Scenes' and 'Scenic Elements' to create the first relationship, and names the relation 'Design', then one of the menu options will be named 'Design' and will display the video with the annotations included in 'Scenes' and 'Scenic elements' compounded.

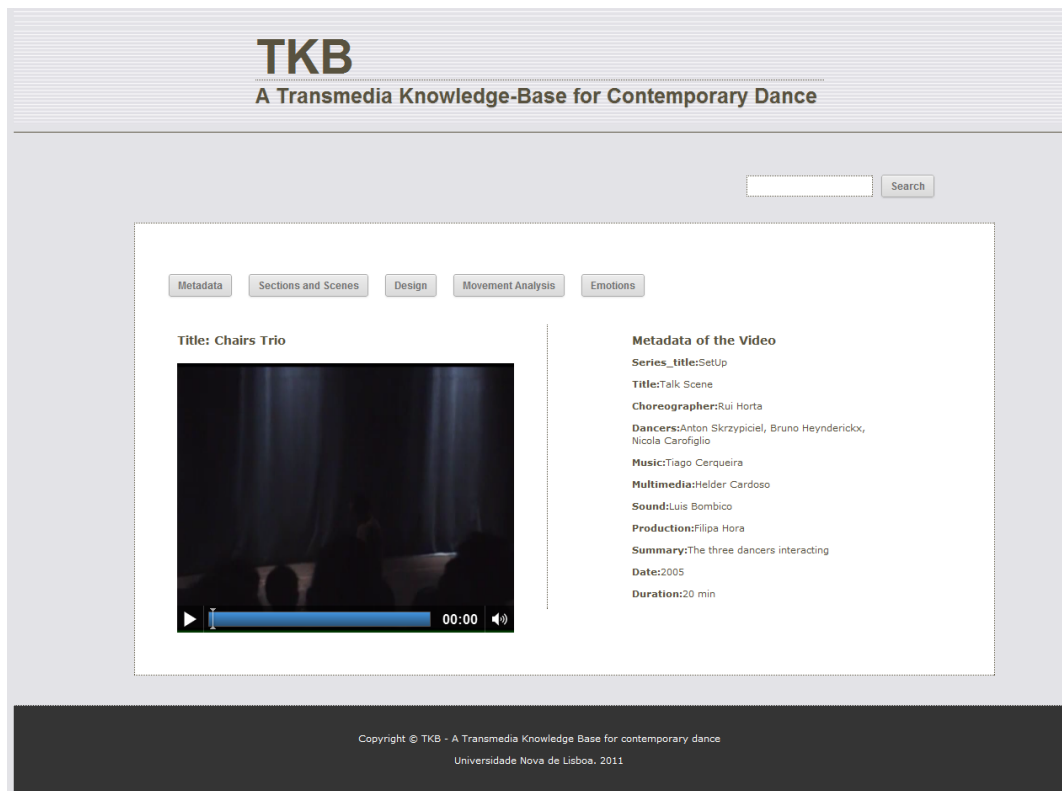


Figure 6.6: The user can browse the metadata of the video

The visibility of the hidden <divs> is managed with the CSS and the JavaScript. Thus, every button is registered with a JavaScript *onclick* event and when this event is true it triggers the CSS to change to *on* the visibility of the <div>.

6.6.3 Video and Annotations Display

With the purpose of displaying the annotations, the final XML file is loaded and read and the linked annotations are brought together in a single block of text in order to be shown in the interactive transcript box. For this purpose, the PHP code creates the *displayAnnotation* function with parameter the index of the relation.

The *displayAnnotation* function is responsible for holding the annotations, which belong to the same relation and are included in the same time slot. Obviously, only annotations from different annotation layers can overlap through time. In this way, the function displays the appropriate information in the HTML code creating cues that contain the annotation's values and have attributes, which hold the start and end time of the block.

Now, the transcript box contains time-synchronized blocks such that a click on a specific text cue will navigate the video to the specific time offset. The JavaScript handles the following functions:

- each cue is assigned with an *onclick* event, such that it is possible to use them to navigate around the video
- a *mouseover* event is assigned to the transcription box, so that the video is paused as soon as a user moves the mouse on into the box for navigation
- an *ontimeupdate* event is registered on the video, which checks the scrolling position of the text and scrolls it up if necessary so that the current block of text is in the upper position of the transcription box

Consequently, a user can see a video in a linear way, where the annotations are scrolling up while the video is playing, or in an interactive way, where the user clicks on the block of annotations so as to navigate around the video. The above can be seen in Figure 6.7.

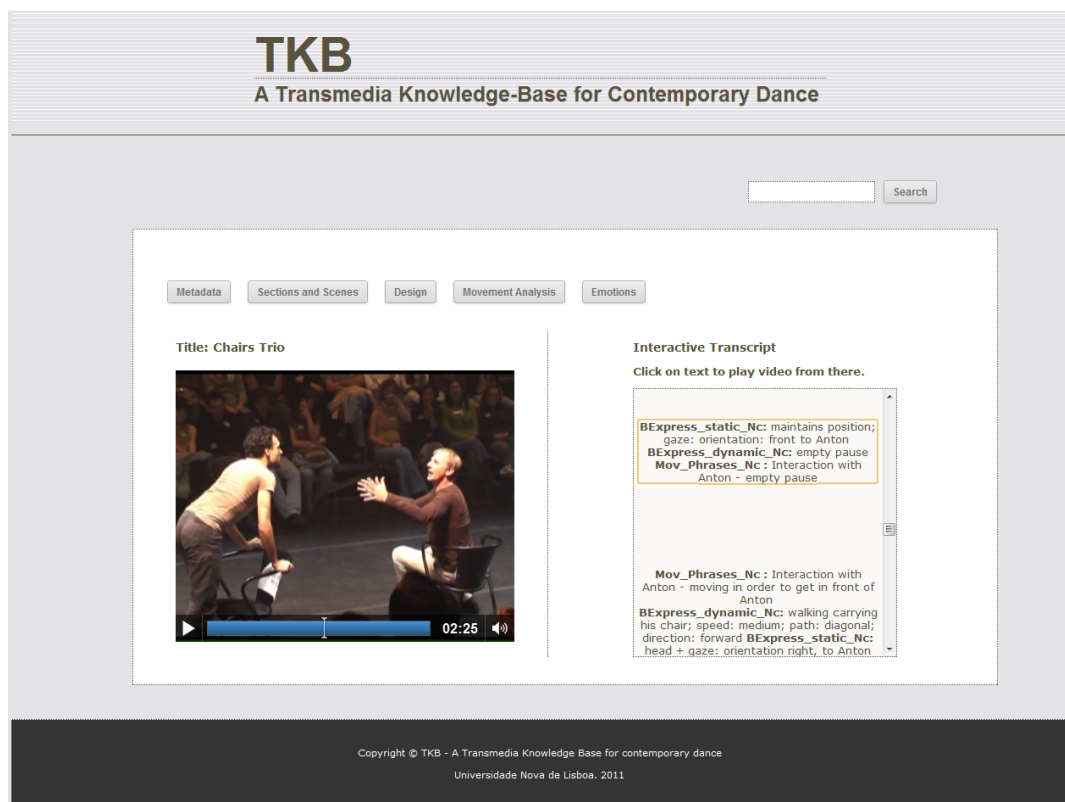


Figure 6.7: Main page where the user can watch the video linearly or interactively.

Summing up, this chapter presented the steps that a user should follow in order to import a dance video, the related dance analysis and the metadata of the video in the online archive platform. Following these steps, a video is eventually displayed in the final web page and the user can browse the metadata and the related annotations.

Chapter 7. Conclusions and Future Work

In this thesis, we explored the aspects of dance and movement analysis with the objective of elaborating a proposal for documenting dance pieces and distributing them to the World Wide Web. We have taken as starting point contemporary dance as an area of knowledge based in and dealing with human movement. In the first part of the thesis, the way movement is studied and annotated in various research areas as well as the way dance and its documentation is disseminated were explored. In the second part, we make use of these explorations to study the requirements of both dance and theater annotation system, and the necessities for constructing a digital platform to host dance/theater documentation structured with the help of the above referred system.

7.1 Conclusions

The research presented in this thesis shows that it is both a challenge to place dance in word oriented documents and to find ways to archive and distribute them. In this thesis, the approach of combining methods from different research areas has proven to be very beneficial. The holistic attitude towards movement analysis made it possible to build a framework that includes many aspects of movement.

The object of study, Rui Horta's piece *SetUp*, includes also parts containing speech and gave us the opportunity to describe movement when accompanying speech. In this fashion, the annotation system can be extended in the annotation of theatrical pieces.

For the formation of the annotation system, one dance piece was used. Although the specific dance piece provided a big repertoire of movements, it is essential that more pieces should be annotated in order to provide a more reliable system. However, the system is flexible enough to change or to be extended with more annotation layers.

On the subject of the system language, on the one hand natural language makes the system more intuitive and easy to use and understand. On the other hand the use of natural language can push the annotation into not being so precise. However, the vocabulary created by the team provides the user with an accurate framework for the annotations. In addition, natural language contributes to the easiest distribution of dance documentation.

The video archive platform for choreographers was based on the annotations created with the use of the annotation system. Being a part of the creation process of the annotation system helped us understand the various steps needed in producing an online video archive for choreographers to communicate the work. Looking back, it turned out that being aware of the issues during the documenting process of a dance piece is a necessity for creating an online archive.

The digital archive is implemented in a way to give the choreographer the possibility to archive his videos online from a choreographic work and also provide the documentation. In addition, the platform gives the opportunity for the individual to filter information by linking annotations with related content, namely the relationship structure. In this way, the potential user of the archive can browse the videos and the documentation structured by the choreographer. The interface of the archive provides visualization with interactivity, where the user can choose the part of related annotations to see.

The platform is built in HTML5, which is built-in into browsers, so there is no need for the user to install plug-ins in order to view the videos. In addition, the video is smoothly integrated in the HTML code making it easier for the developer to attach time synchronized text related to the video and assign interactivity.

In fact the annotations related with the video provide trustworthy means of indexing the video content since search technology is very advanced when it comes to text, but very poor when it comes to video content. In this way, it is easier for the users to filter and search the information they need in the video.

On the other hand, HTML5 is still under development and not all browsers support the same video codecs and containers. This fact results in the necessity of the video to be encoded more than once. At the present time, the platform supports the .mp4 format of video.

7.2 Future Work

The team started the creation of the annotation system based on one dance piece with the intention of annotating more dance pieces in order to broaden the annotation layers and to create a system that is prepared to describe various kinds of contemporary dance and movements. Thus, in the future more dance piece will be annotated.

The main page of the video archive will contain a search module that will give the opportunity to the users to search the information with key words. In addition, we will extend the system for the users to be able to upload videos in more formats other than .mp4.

The video archive platform is part of a bigger archive that will host the artistic works of different choreographers. Thus, in the future the video archive platform will be integrated in the complete archive.

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