Master's thesis

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«Are You jumping or bouncing?»

NTNU
Norwegian University of
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Faculty of Humanities
Department of Music, Dance studiess

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A case-study of jumping and bouncing in classical ballet using the Motiongram computer program.

Master's thesis in Dance

Trondheim, Spring 2012

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Nordic Master's in Dance (NoMAds)
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Preface

”Are You jumping or bouncing” my ballet teacher William Buys asked me. I was slamming my body all over the dancefloor, cavorting wildly, doing weird things not in the vocabulary of classical ballet and in general not paying much attention to my teacher. The words ”Could you please jump or bounce!” rang out from William and my brain started to ponder – what is jumping and bouncing? – then I started to pay a little bit more attention to what William was saying.

What is the difference between jumping and bouncing in classical ballet?
During the course «Dance Analysis 3003» at NTNU in the autumn of 2009, a lecture and demonstration of the computer program Motiongram was given by Alexander Refsum Jensenius. This computer programs ability to provide numeric and visual data of video clips for later analysis provided a starting point of a first attempt at examining differences between jumping and bouncing in classical ballet. The format of this first attempt was a short essay using video clips from several styles of classical ballet as source material.

This master thesis expands vastly on this initial essay by using a new set of source material solely from the Bournonville style of classical ballet and developing a much more stringent method for analysing the difference between jumping and bouncing in classical ballet. Most of this work was accomplished during the spring of 2011 with extra material being added during the spring of 2012.

On a personal note, I would like to thank my supervisor Gediminas Karoblis for sage advice and constructive input throughout the work on this master thesis. I would also like to thank Knud Arne Jürgensen for clarifying certain aspects of Bournonville style to me. I am also greatly indebted to all teachers and faculty staff that I have met during my academic studies in the NoMAds program, and finally a very special «Thank You» and «high five» goes to all my fellow NoMAds dance students for making these years a very happy time of my life.

This master thesis is dedicated to all my dance teachers, none named, all remembered.

Trondheim, May 2012 per.erik@walslag.no

Prologue

This master thesis is about tasks and tools and how they connect.

Accessing Websters online dictionary and thesaurus yields a number of definitions of tool such as “a handheld device that aids in accomplishing a task” to “an element of a computer program that activates and controls a particular function”. Likewise, task is described as deriving from the latin term *tasca* and is “something hard or unpleasant that has to be done”. (www, Webster dictionary) Clearly, there are many other descriptions of these terms and no singular definition is more accurate than any other.

A task can be simple and concrete such as connecting 2 pieces of timber by using a screw and a screwdriver, or it could be complex and conceptual such as translating streams of movement into a structured movement system. Connecting the appropriate tool to a specific task is clearly significant, using a screwdriver as a tool in order to construct a choreographic score would yield no result.

So how does good tools come into being? What defines a good tool? A screwdriver can be bought readymade in any hardware store and as long as it fits the head of the screw and the hand of the wielder can be said to be a good tool. Conceptual tools to be used when dealing with structured movement systems also exist, such as Labanotation, but when it comes to computer tools that can accomplish such tasks, the shelves of the computer stores are quite empty, there are no “Dummies guide to computer aided structured movement systems construction” to be bought, in fact the academic dancefield may have to start making such computer tools pretty much from scratch. That there is a focus on structured movement systems in the academic dancefield and an interest in using computer tools is quite clear, so how do we proceed in order to make good computer tools to aid us in developing structured movement systems?

A method for accomplishing this vast and complex task could be to first select an existing computer tool that may not be readymade for the full task, perhaps even a new tool that is not totally appropriate or even wrong, and then to construct a small sub-task that the tool may actually solve. However, it is not the solving of this sub-task that is important, but the knowledge and insights learned throughout the process of exploration. This is the purpose of this master thesis in dance studies.

Having thus initiated this master thesis, it is necessary to say some words about the author trying to accomplish this exploration and the academic dancefield in which it is to be situated.

My grandfather was a carpenter who constructed his own personalized versions of his tools by making his own handles so his screwdrivers could fit his rather big hands. My father was a photographer who designed his own special lenses for his cameras. Throughout my career as a computer programmer I have consistently made my own computer tools, even building my own computers, so I am a tool builder and user by heritage. My dancing background stems from classical ballet and contemporary dance where I use my body as my tool. Since my programmer's brain resides within my dancing body, I see no distinction between computers and dance but instead a symbiosis of both as a form of embodied knowledge. Thus the author and the exploration connects well and since the aim is to produce information of value to the academic dancefield, the publication of this exploration as a master thesis in dance studies seems appropriate.

However, others might see dance and computing as separate academic fields, even making the distinction quite big by situating one within the humanities and the other within the natural sciences. For them this master thesis might perhaps be termed a master thesis with interdisciplinary qualities. Briefly stated, this should present no problem as the intent of "The Faculty of the Humanities at NTNU is both a faculty within the tradition of human sciences and a faculty that is a humanistic force within the main profile of technology and natural sciences specific for NTNU" as stated in the strategy statement of the Faculty of the Humanities website. (www, HF strategy) This positions the dancefield at NTNU as a wide interdisciplinary academic dancefield and aligns the start point of this master thesis with the stated intent of the Faculty of the Humanities at NTNU. The resulting trajectory of this master thesis within this interdisciplinary dancefield will be reflected upon in a separate chapter named *Positioning the thesis* towards the close of this thesis.

At this point it is also necessary to describe the sources that where used to find relevant academic source upon which to base this master thesis and how they also affected its title. The following is a brief description of these sources:

Books privately owned by the author or accessed through the faculty library at NTNU and RFF library.

All books, compendiums, authors own notes and other types of handouts from the 3 main modules and previous individual courses which constitutes the No-MA-ds program where assessed in order to find academic material relevant to this thesis.

The JSTOR repository was accessed using a number of keywords in order to search for relevant publications outside the pensa of the various course-modules of the No-MA-ds program. A number of these publications where then downloaded with the aid of my supervisor Gediminas Karoblis. (www, jstor repository)

The excellent dvd published by ICTM containing proceedings throughout 1988-2008 from the study group on ethnochoreology was accessed, first by using keywords in a free-text search, secondly by individually accessing a vast number of these publications in order to search for appropriate academic source material.

Having participated in 1 IPEDAK and 2 IPEDAM seminars, the academic papers, handouts and authors notes was also accessed.

A number of webpages containing dictionary, etymological or similar types of information was also accessed,

When formulating the title of this master thesis, a choice had to be made of whether to focus on *similarity*, *difference* or *characteristics* of jumping and bouncing. When accessing the academic source material described above, it became clear that most of these papers focused on the term *difference* when presenting comparative studies. This was also the case at the 2011 IPEDAM seminar where a number of teachers where canvassed regarding their opinion in this matter. This resulted in a focus on describing *differences* between jumping and bouncing in this master thesis.

Part I – Dance background

I.1 Dance style

After the 1996 symposium of the Ethnochoreology Study Group, Adrienne Kaeppler and Ann Hutchinson Guest disagreed completely on what constitutes a dance style.

Many uses of the term style were discussed, but no consensus was reached. After reading a report of this symposium, Ann Hutchinson Guest noted that this lack of consensus was 'rubbish'. To her and other Labanotators, apparently one needs only to 'observe and record the gross differences as well as the fine differences in a variety of movement types' to arrive at style. In other words to her style is 'etic' and can be derived from observation, .. I emphasise that style is 'emic'. (Kaeppler, 2001, footnote 2 page 49)

This indicates that concepts surrounding definitions of dance styles is an interesting concept to explore further. In 1979 the centenary of the Danish choreographer August Bournonville's death his legacy was celebrated in Copenhagen with the publication of “The Bournonville School – the daily classes”, a three volume publication by Kirsten Ralov with one volume of Labanotation by Ann Hutchinson Guest. 2 years later Guest also published her paper ”The Bournonville style” where she stated:

It may seem impertinent for a non-Dane, a non-Bournonville dancer, to write in detail about what appears to constitute the Bournonville style, yet this writer has on hand a tool through which the fact can be recorded, comparisons made, and specific points illustrated. I refer, of course to the tool of Labanonation, through which fine stylistic details can be captured. (Guest, 1981, page 113)

Here Guest places an emphasis on Labanotation as a the tool that can be used to define dance style. So what will using other tools such as computer programs bring to the concepts of defining dance styles? The importance of acquiring skills in using computer tools was recently underlined at the latest Ipedam seminar in Trondheim during the spring of 2011, where a plenary session was held in order to canvas opinions on how to proceed. A case-study linking a computing tool to an exploration of suitable movements using appropriate source material in an attempt to gain new insight into a particular dance style could be a way to move forward.

Using Guest's argument that dance styles can in fact be defined as a starting point, how do Guest define dance style in her paper?

Guest states that style can be "used in several senses" and then proceeds to list arrangement of steps, placement of limbs, manner of movement, variations in timing and several other factors. Guest also states that the following "main features immediately strike one as being different about a Bournonville class or ballet: use of the body, space, timing and dynamics" (Guest, 1981, page 114-115) before presenting 54 fragments along with minor variations as examples of Bournonville style.

Kaeppler in the introduction to her paper also connects the concept of time and space to the concept of style. (Kaeppler, 2001, page 15) Based on this it can be argued that concepts of style may change over time, and that defining a particular style as done by Guest using the tool of Labanotation may also fix this specific definition of style in time and space. This leads to the idea that the process of defining a particular style may engage prior definitions in a diachronic perspective.

The word diachronic is based on the Greek words *dia,* or through, and *khronos,* or time, and the term diachronic perspective is commonly held to be the study of the development of a phenomenon through time.

June Layson in her chapter "Historical perspectives in the study of dance", from "Dance history" co-authored with Janet Adshead-Lonsdale, describes several types of studies of dance through time. This according to Layson can be a systematic continuous study or a period based study. Layson states that a "systematic study which attempts to cover … a sizeable portion of the whole, such as several centuries" can be used to examine broad features. Layson also states that in "a period based study … eras can be chosen which are highlights in the history of dance and offers opportunities for in-depth enquiry" (Adshead-Lansdale, 1983, page 6) This leads to the tantalizing question of whether both types of diachronic perspectives can be used.

The Bournonville legacy has been celebrated on at least 2 major occasions, the 50 and 100 anniversaries of his death in 1928 and 1979 respectively. Other major events are the publications and papers of Knud Jürgensen's from the 1980 onwards. There also exists a large number of video and photographic material from period performances and later reconstructions which offer additional perspectives on the Bournonville style of ballet. This style is often described as a living tradition, having been passed down from teacher to dancer from the time of August Bournonville.

The living tradition of the Bournonville legacy can be seen as a systematic development over time while the other source material can be seen both as a systematic and period development over time, resulting in several diachronic perspectives being present.

A way forward would then be to use several types of source material in order to gain several types of diachronic perspectives. Crucial to this approach would be finding steps that are both appropriate denominators of Bournonville style and at the same time be suitable for study by an appropriate computer tool.

I.2 Jump and Bounce

In her paper "When the landscape becomes flesh: an investigation into Body Boundaries with special reference to Tiwi Dance and Western Classical Ballet" Swiss anthropologist Andrée Grau compares aspects of Tiwi dance and western classical ballet. (Grau, 2005) Focusing on notions of verticality, Grau argues that "Ballet, for instance, is often discussed in terms of its Apollonian verticality because its technique is seen to resist gravity and the dancer's limbs are centred and aligned in such a way as to allow maximum stability and ease of movements, which flows from the body's vertical axis" (Grau, 2005, page 3)

Based on Grau's focus on *verticality* in classical ballet, it can be argued that one important aspect of classical ballet is *recognized vertical movement*.

So how is this vertical movement described? The International Encyclopedia of Dance (abbreviated IED) describes aerial work in classical ballet in the following way "The search for weightlessness – the desire to appear to be escaping from gravity – is the single characteristic that most strongly differentiates the development of ballet technique and ballet aesthetics in the nineteenth century and in much of the twentieth century"(Glasstone in IED volume 1, 2004, page 340) At first glance this may seem to be a somewhat grand and sweeping description, but it does alert us to the possibility that certain types of steps may carry wider implications than the mere movements themselves.

Glasstone in IED states that "The particular phrasing of a series of jumps can give the impression of the dancer hovering for the moment in mid air, at the peak of each jump, before landing softly in demi-plie just in time to soar upward again (this is the quality known as ballon, the hallmark of good elevation)". (Glasstone in IED volume 1, 2004, page 340)

The online etymology dictionary's entry for bounce states that the word bounce can be traced back to the 13 century, in 1510 the description "to bounce like a ball" is in use, in 1520 "a leap, a rebound" appears. (www, online etymology dictionary)

The balletic term bounce, from the french term ballon*,* has often been attributed to the French dancer Claude Ballon (1671-1744) but Regine Astier in IED states that "there is no evidence for this story that the term ballon was taken from his name". (Astier in IED volume 1, 2004, page 355)

Carlos Blasis in his *Traite Elementaire* from 1820 urged dancers to “be as light as possible .. I would like to see You bound with a suppleness and agility which gives me the impression You are barely touching the ground and may at any moment take flight”. (Blasis quoted in Hammond in IED volume 1, 2004, page 344) Do note the use of the verb *bound* by Magri to describe a certain quality of movement into the air. The online etymology dictionary's entry for bounce states that the word bounce is probably influenced by the word bound.

The subtext in a photo of male dancers in Astier's article doing aerial work from The Royal Danish Ballet states that they “... demonstrate extraordinary ballon that is the trademark of the Bournonville style”. Astier's article directly connects the balletic term ballon with the Bournonville style of classical ballet. (Astier in IED volume 1, 2004, page 354)

A further connection is present in Hans Beck's use of the word *balon* when describing exercise 51 as “Balon (sic) pas (af mig)” in his 1893 description of the Bournonville classes. (Jürgensen, 1992, page 75)

So it can be argued that the use of the word *hallmark* in the previous statements along with the various connections of the concept of *ballon* or *bounce* to the Bournonville style suggests a possible path towards using jumping and bouncing steps from the Bournonville repertoire as the basis for exploration by appropriate computer tools.

Part II – Technical background

II.1 Aspects of visual perception of dance:

In his paper "Film versus notation for dance: basic perceptual and epistemological differences" notator and scholar William Reynolds focuses on both film and notation as methods " … of producing permanent, manipulatable, public records of dance movement". Reynolds further narrows his scope to "films carefully made for documentary purposes .. artistic dance film is not included", regarding notation he is primarily concerned " … with those systems which, parallel to film, are capable of approaching complete movement information". Reynolds then focuses on films ability to show " … only one instant at a time" arguing that this makes " … the use of film perceptually and epistemologically equivalent to visual perception of the original dance event" finally arguing that " … if we look at the complete notation for the same dances we immediately discover the most striking effect of notation – we are free of time". This according to Reynolds " … allows us to process information as complex visual patterns, rather than as linear, temporal sequences of isolated bits". (Reynolds, 1990, page 1-4)

Further on in his paper Reynolds states that " … film converts a three dimensional event into a two dimensional image" and that " … once a two dimensional image is made, information is lost forever". (Reynolds, 1990, page 8)

It could be argued that since the focus of this thesis is to examine movement along the vertical axis only, Reynolds focus on loss of information when reducing a three dimensional event into 2 dimensions is not critical. It could further be argued that by translating the video into motiongram images and numbers, some of the benefits attributed to a notated score are present, the missing component being the presence of the notator and his or hers influence when selecting what to notate.

This also implies that the body is transformed from a human body into a reduced numeric body, no longer present in 3 dimensions + time, but only present in 2 dimensions and frozen in time. No longer at the centre of the universe, but situated in a virtual cartesian space. If movements where then observed only in the horizontal and vertical plane, new odontologies of movements could be developed that might engage other older taxonomies, such as body positions described in French ballet terms, in various diachronic perspectives.

II.2 Motiongrams

In his Ph.d. thesis “Action – sound” Alexander Refsum Jensenius explored various uses of movement visualisations such as timelapse photographs, chronophotography, point light displays, video mangas, keyframe trees, storyboards, keyframe displays, motion history images, videograms and motiongrams (Jensenius, 2007, chapter 8) The use of motiongrams in academic circles in Norway is on the rise, partly due to Jensenius interest and publication, and will no doubt increase even further with the resent formation of a National network for interdisciplinary movement studies as initiated by the fourMs-group at the University of Oslo. (www, National network)

Central to his work in “Action – sound” are visualisations based on the concept of motiongrams. Jensenius states that he was inspired by waveform and spectrogram display and wanted to display long sequences of movement containing visual information on quantity as well as other types of distributions in time and space. Jensenius describes the process of creating a motiongram in the following way:

“The process is based on reducing the matrix of a motion image to a 1 pixel wide or tall matrix which is plotted over time. More specifically, a matrix of size MxN is reduced to 1xN and Mx1 matrices by calculating the mean value for the column and row respectively. Thus for each frame of a video file, a 1xN or Mx1 matrix is calculated. Drawing these 1 pixel wide (or tall) stripes next to each other over time, results in either horizontal or vertical displays of the "collapsed" motion images. These running displays are motiongrams that make it possible to see both the location and level of movement of a video sequence over time.” (Jensenius, 2007, page 186-187)

Each vector in the 1xN and Mx1 matrix is then averaged to find a position in the horizontal and vertical plane. These positions are then used to calculate velocities, accelleration, Quantity of motion and other numeric values. The entire process of creating motiongrams are decribed graphically on the next page.

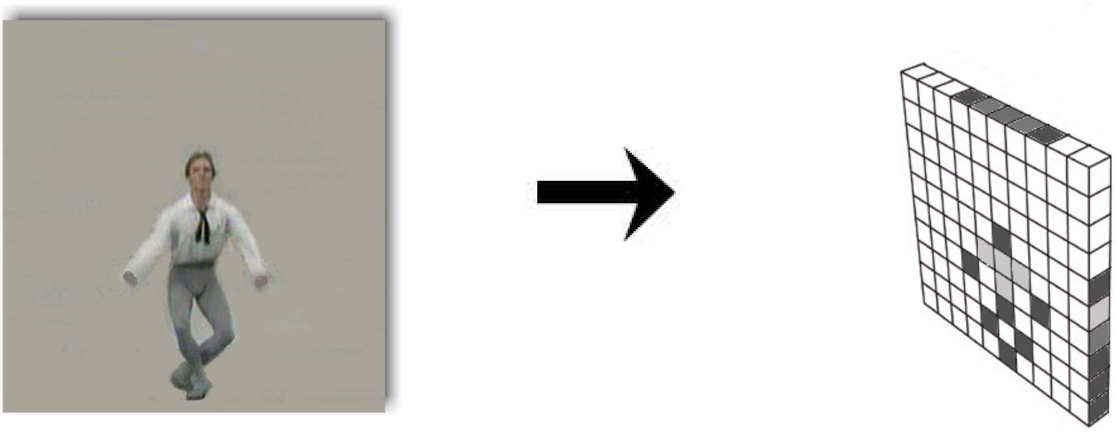

Fig 1: Using one image to create a single-frame motiongram
(Contains image from video “fifty enchainements” © Knud Arne Jürgensen and Vivi Flindt)

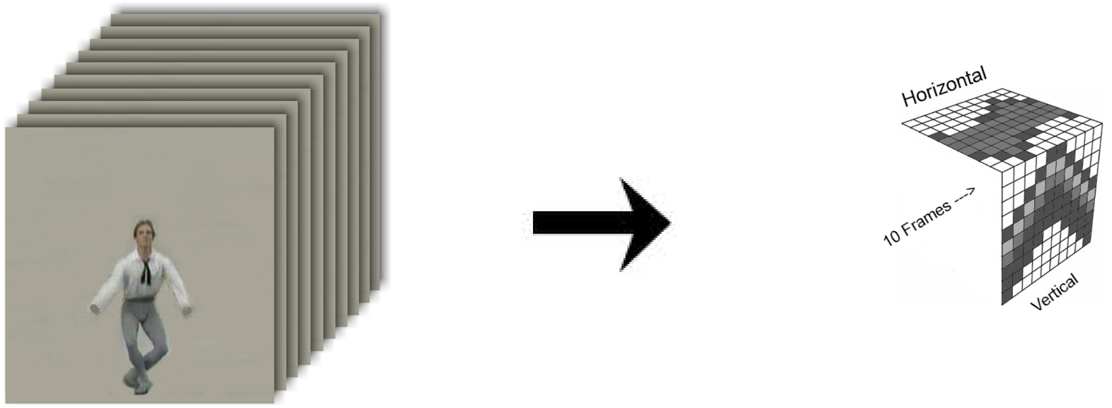

Fig 2: Using a video to create a multi-frame motiongram
(Contains image from video “fifty enchainements” © Knud Arne Jürgensen and Vivi Flindt)

The horizontal motiongrams from a 2min 32sec video is shown below, the dancer performs batteries, pirouettes, tour l'airs while moving from side to side in the room. Do note that the images has been stretched for easy viewing:

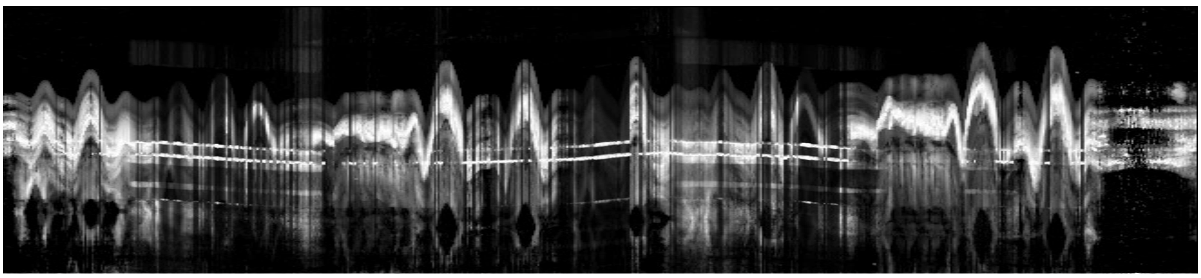

Fig 3: Sample horizontal motiongram

Jensenius further expands on the process of creating motiongrams by describing how the selected video is adjusted by cropping the image and adjusting the brightness and contrast. These adjustments are done in order to get the best input signal of the foreground, containing the dancer, against the background. (Jensenius, 2007, page 187) Jensenius accomplished these and other tasks by writing modules in an open source programming environment called Jamoma, (Jensenius, 2007, page 141)

The motiongram computer program consists of 2 windows, the first is used to open the appropriate file and folder, perform the process and output a text file containing numbers along with two images containing motiongrams of the x- and y-axis. This is a screendump showing the first window in use:

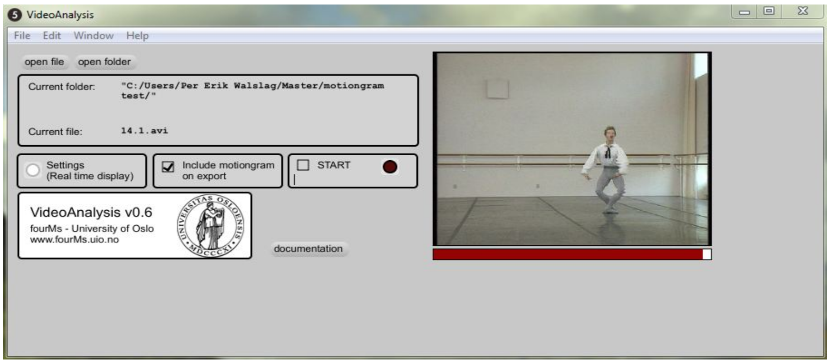

Fig 4: Motiongram program first windows

(contains image from video “fifty enchainements” © Knud Arne Jürgensen and Vivi Flindt)

The second window of the motiongram program is used to adjust settings of contrast, length of median filter, perform cropping and finally previewing the resulting motiongrams images of the quantity of motion, x-axis and y-axis. This is a screendump of the second window in use:

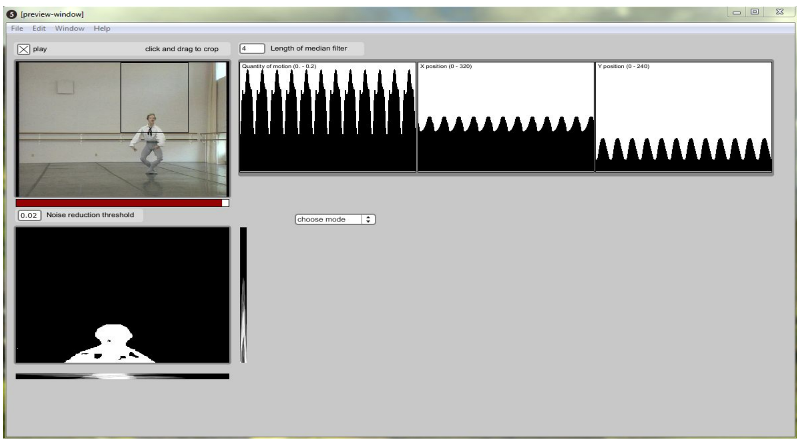

Fig 5: Motiongram program second window

(contains image from video “fifty enchainements” © Knud Arne Jürgensen and Vivi Flindt)

II.3 The physics of jumping and bouncing:

Kenneth Laws is a professor of physics and has used his knowledge of physics to examine ballet in his book ”The physics of dance”. (Laws, 1984) In his book he placed 2 dancers of various size and weight on pressure pads to record data while on the ground and also used this data to give us some insight into aerial work. The physics of jumping is described as ”In order to jump of the ground vertically, we need to exert a force downward against the floor greater than our weight, for long enough to achieve the vertical upward velocity desired. Although small vertical velocities may be achieved with the feet alone, most jumps require an acceleration from bent legs – a plie position” (Laws, 1984, page 32) He then focuses on the height of the jump presenting the following formula to calculate the height:

$$H = d * (R-1)$$

Where ”H” is the height achieved, ”d” is the vertical distance over which the force is exerted and ”R” is the ratio between the vertical force exerted against the floor and the length of time or vertical distance through which that force is exerted. ”If a plie lowers the centre of gravity one foot, then a vertical force of double one’s weight will allow for a jump in which the centre of gravity rises one foot above the equilibrium value”. (Laws, 1984, page 32) In his book Laws does not examine the differences between jumping and bouncing, but in Appendix A he expands on the subject of the physics of jumping by focusing on the duration of the jump.

Do note the precise use of the term ”centre of gravity” not ”centre of body”. No forces acts on a body once it is airborne but the location of the centre of gravity within the body can change by changing the configuration of the body in the air. An example of this is the raising of the legs at the top of a grand jete resulting in an upward change to the centre of gravity at the same time as the body starts to descend. This gives the appearance of the dancer floating in the air defying gravity for a split moment at the top of the leap. (Laws, 1984, page 35)

Laws also focused on how elasticity and friction between the sole of the dancers foot and the dancefloor could influence the way an aerial step was performed. (Laws, 1984, pages 39-43)

Another way of achieving the same result can be done by pulling the legs up underneath the body while in the air. This fashion of jumping is attributed to the Italian dance master Gennaro Magri and is described as ritirate and was in use by the Italian school well into the twentieth century. (Glasstone in IED volume 1,2004, page 341)

A study done by Paula A. Dozzi focused on the effect of heel contact in ballet allegros (Dozzi, 1989) In this study she examined balloon and bouncing properties when the heel was not in full contact with the floor during landing and takeoff, focusing on the possibilities of sustaining injuries to the shin or front part of the leg. In her study she concluded that firm heel contact was not necessary in order to achieve the same height as jumps with firm heel contact. (Dozzi, 1989, page 90)

What happens in the leg during bouncing? A full anatomical description is somewhat beyond the scope of this master thesis, but some insight can be gleaned from the way bouncing has been described to the author in a Bournonville class by teacher William Buys. The anatomical basis for bouncing in such a setting was described as a spastic reaction in the calf muscle resulting from a sharp pressure being brought to appear on a nerve centre in the heel in close proximity to the end point of the achilles tendon. A prerequisite for such a spastic reaction to happen was the contraction of the muscles of the heel towards the arch of the foot, the teacher did not say ”point your toes” but ”raise your heel” when doing floorwork during class.

At first glance this suggests that bouncing, which uses very little or no plie, breaks the laws of physics when achieving comparable height to jumping, but this can be explained by bouncing transferring the force from the downward movement of the previous jump into an upward movement when coming into contact with the floor instead of dampening the downward movement and coming to a complete halt as in a full plie while jumping. It also suggests that although very light heel contact may be present while bouncing, this does not represent a problem in achieving the desired height. The anatomical explanation given during a Bournonville class further suggests that the transfer of force during contact with the floor during bouncing is very quick with a lot of acceleration or change of velocity taking place.

This suggests that impulse, or changes in momentum over time as expressed in the impulse-momentum theory, and how it is transferred from either the downward movement of the preceding step or from other types of steps, has significance when performing bouncing.

Part III - Exploration

III.1 Hypothesis

As previously outlined, Andrew in IED describes Bournonville's balletic style as "linked, phrased and nuanced". Glasstone in IED uses the words "phrasing of a series of jumps" in describing ballon. Blasis focuses on "impressions … (of) taking flight" as a result of bounding. Laws presents information on the physics of dance and Reynolds on the visual aspects of dance.

Based on this, it could be argued that differences in how impulses are transferred from one step to another and how they might be observed could form the following hypothesis:

"The difference between jumping and bouncing in classical ballet is based on if and how the impulse from a previous step is transferred, and how the resulting movement is interpreted".

It could further be argued that by selecting appropriate source material, the motiongram computer programs ability to output both numeric information and visual motiongram images could be used to explore this hypothesis.

III.2 Selecting source material

The motiongram computer program can accept live input and pre-recorded video material. If live input of steps where chosen as source material, these steps could be arranged to maximize the differences between jumps and bounces. The video recording process could also be maximized by using high definition video camera filming at high speeds. Specific body parts could also be selecting for close-up recording. The video recording process could also be repeated or adjusted if needed.

If pre-recorded material where used, the above benefits would be lost, but this could be offset by possibly using a highly skilled professional dancer performing the steps. It could also engage the source material in a diachronic perspective if the video source material was accompanied by an academic text establishing the combined source material as belonging to the Bournonville ballet style.

Based on this, a video containing aerial work along with an accompanying academic text clearly establishing the performed steps as belonging to the Bournonville style of classical ballet, and meeting Reynolds crtieria of "films carefully made for documentary purposes", (Reynolds, 1990, page 1) and be visually suitable for analysis by the technical restrictions of the Motiongram computer program, was felt to be the best starting point for testing the hypothesis. Knud Arne Jürgensen and Vivi Flindt's reconstruction of fifty Bournonville enchainements as both a video and book publication is just such an example so it was selected as the source from which to draw examples of jumping and bouncing in classical ballet. In his critique of this video Byron Suber states that "the dancers, Rose Gad and Johan Kobborg, embody the historic style of the Royal Danish Ballet and brilliantly execute the pure expression of Danish technique still taught at the Royal Danish Ballet Academy". (Suber, 1996, page 134)

This seminal work takes the form of a book outlining fifty enchainements reconstructed from archival sources and the Bournonville living heritage as passed down through the daily classes. Accompanying this book is a video of these fifty enchainements being performed by Rose Gad and Johan Kobborg of The Royal Danish Ballet. (Jürgensen, 1992, front cover notes) The video was first published as a VHS tape in 1992 and then as a DVD disc in 2005, the latter being used as the source of this study.

In the introduction to the video and on the back cover, it is stated that the enchainements presented is based on Hans Beck's notation of Bournonville classes from 1893, Hans Beck being the successor of Bournonville as ballet master in Copenhagen. The accompanying music is based on original catalogues of scores made in the 1860's by Ferdinand Hoppe. Emphasis is placed on linking these enchainements to ballet classes by August Vestris, Bournonville's teacher in Paris, with the intent of presenting "documentary evidence of the form and characteristics ... a representation of a typical ballet class by August Bournonville as practised a century ago". (Jürgensen, 1992, Video introduction and back cover notes)

Jürgensen also used the knowledge from the Bournonville style as a living tradition by collaborating with the renown dancer Vivi Flindt from the Royal Danish Ballet. The living tradition can be seen as an accumulation of changes over time, so it engages the original written notation by Hans Beck from 1893 in a different diachronic perspective. By using Jürgensen's video material as the source of this case study, it can be argued that these diachronic perspective do not end with Jürgensen's publication in 1992, but becomes part of an ongoing academic living tradition of diachronic perspective extending into the future.

So how does the source material engage in a diachronic perspective? The video source material is said to represent a typical ballet class as performed over a century ago, so what changes to Bournonville style as compared to a more contemporary Bournonville style is present in the video material? A full and detailed list is outside the scope of this master thesis but Erik Aschengreen in his paper "Bournonville style and tradition" alerts us to the fact that spotting in pirouettes was not performed at the time the video is said to represent. Spotting "is keeping the head fixed in direction while the remainder of the body turns, then rotating the head quickly around to face the original direction again" (Laws, 1984,page 49) Aschengreen states that spotting was introduced into the Bournonville style either by the Danish dancers Hans Brenna around 1930 or by the anglo-russian pedagogue Vera Volkova after she started to teach in 1951. (Aschengreen, 1986, page 50) The female dancer in the source video clearly does not spot when performing pirouettes, while the male dancer do in fact spot somewhat when performing both pirouettes and tour l'airs. This indicates that the video reconstruction can be seen as a a negotiation between plural diachronic perspectives.

III.3 Primary and secondary source

At this point it is appropriate to bring in the terms primary and secondary sources and how they relate to the selected source material. Lena Hammergren in her paper “Many sources, many voices” published in the anthology “Rethinking dance history” when describing first and secondary source states that the “former category generally includes material that is 'close' in time to the object of study and may be considered 'raw material' … the latter includes sources produced 'further away' in time” (Hammergren in Carter, 2004, pages 20-21)

Hammergren then states that “instead of trying to distinguish between sources … we should look at them as parts of discourses” (Hammergren in Carter, 2004, pages 22) The written source material used by Jürgensen and Flindt could be termed primary source material but so could the resulting video when used by the author for this master thesis. The resulting master thesis could also become the source material for future academic studies. This seems to negates the usual distinction between primary and secondary source material when applying source criticism, and supports Lena Hammergren's claims as stated above.

Lena Hammergren's focus on discourse also raises the fundamental question of weather academic and non-academic source material also engages in a similar type of discourse, thereby negating the concept of peer review as a dividing barrier.

III.4 Selecting excerpts

As the video has a total length in excess of 37 minutes containing 50 enchainements with an even larger number of male and female variations using a large number of balletic steps, making an analysis of the entire video is impractical, so a number of criteria for selecting a smaller subset of steps to be analysed had to be made. These criteria where drawn up and final selections where done in 2 stages, in the first stage a broad set of criteria for selecting video clips of jumping and bouncing steps and their division into jumping and bouncing steps where done as described below.

Jumping and bouncing steps can be done by both male and female dancers, it is commonly held that the male syllabus contain a larger amount of aerial work. The female dancer has a skirt reaching well beneath the knees which flares when moving, this flaring movement could influence the interpretation of the Motiongram computer program as the program does not make any distinction between the body and its clothing. However, the male dancer is wearing tights, a shirt with very little flaring or extraneous movement. Based on this, steps exclusively performed by the male dancer was selected as a criteria for studying jumping and bouncing.

As has been previously described, altering the configuration of the body when airborne can result in a change to the centre of gravity within the body relative to the body itself. (Laws, 1984, page 35) The computer program Motiongram, as used in this study, only detects changes of the body relative to the background, not changes to the centre of gravity within the body. This could result in the possibility of making errors when interpreting the resulting information. Based on this, balletic steps starting from and landing on both feet with the legs being held in a straight line beneath the trunk of the body would best represent changes of gravity as expressed by changes of the body relative to the background while jumping.

Formulating the criteria for dividing steps to be analysed into 2 groups labelled jumping and bouncing to test the hypothesis could be done in several ways. If the accompanying text in “Bournonville Ballet Technique” had described the performance of the selected steps as either “jumped” or “bounced”, the division of steps to be analysed could be based on these descriptions. Alas, no such descriptions are to be found, neither in Jürgensen's written reconstructions nor in the source material contained in the book.

As “we cannot ask questions to a film” (Reynolds, 1990, page 11) Knud Jürgensen was contacted directly via his webpage and kindly offered the following distinction between jumping and bouncing:

"Bounce" (hop) er hvis man står på f.eks. v ben, (med højre fod surlecoudepied) og så laver gentagne temps levé på samme ben - ligesom at spille bold - dvs. bounce- or rebounce. "Jump" (spring) er hvis man spriger fra et eller begge ben og lander enten på det andet ben eller på begge ben igen men så ikke hopper (bounce) op igen.

(Jürgensen, 2011, private correspondence)

Based on this, the following criteria for selecting steps for analysis where made:

•Aerial steps performed by the male dancer
•Performed several times in succession without other intermediate steps
•Performed starting from 2 feet and landing on 2 feet
•Legs extended in a straight line beneath the trunk
•Steps preceded by another step with a transfer of impulse - labelled bouncing steps
•Steps performed with no prior impulse from a preceding step - labelled jumping steps

By using these criteria, the tour l'air performed by the male dancer in entrechat 14 and 28 could be termed jumping. The entrechat six performed by the male dancer in entrechat 47 and 50 could be termed bounce, and the following video segments from “fifty enchainements” where then selected for further study. The time signature is in the format minute:second:frame number.

Enchainement no	Start on dvd
14	12:54:00
28	22:37:00
47	33:31:00
50	35:39:00
47	36:30:15

Fig 6: Enchainements originally selected for analysis

Jensenius allows for a certain amount of interactive adjustment of some parameters of the selected clip in his computer program Motiongram, such as changing the contrast and cropping the picture. Jensenius has described how he writes new modules in Jamoma for inclusion into the Motiongram program, this approach was discarded in this master thesis as it would mean a vast amount of work for the author to learn the appropriate computer language, program new modules, debug them and finally test them in order to ensure that they functioned as intended. At this point the Pinnacle studio video editing program version 14 was selected as a pre-processing tool as it allows a larger amount of parameters to be interactively adjusted. The results from preprocessing the selected clips in Pinnacle studio could then be used as input to the computer program Motiongram.

After selecting the enchainements described in table 1, their suitability for video analysis by the computer program Motiongram was examined, resulting in the exclusion of enchainement 50 and the second performance of enchainement 47 based on the following criteria:

During the filming of enchainement 50, the video camera is panning and zooming while the male dancer is performing the steps intended for study. This would necessitate dynamic cropping the dancer to compensate for the relative change in height within the selected video excerpt. As neither the computer programs Motiongram nor Pinnacle Studio allows for dynamic adjustment of cropping, enchainement 50 was discarded from further study.

Sections of Enchainement 47 is present twice in the video, the second time in slow motion during the final title section towards the end of the video. This presented an opportunity for studying the chosen steps not only in the usual format of 25 frames per second, but in a format where the steps might have been recorded at a higher speed than 25 frames per second in order to achieve the slow motion effect, resulting in the visual and numeric information of the steps being present in a larger number of frames which might result in a larger data set as the starting point of the Motiongram computer program. A drawback of the second version of enchainement 50 is its reduction in size as the steps are shown in a picture-in-picture format, the vertical amount of pixels of the steps having been reduced, resulting in a reduction in the range of the numeric data representing the steps.

Upon close examination of the video clip in Pinnacle studio, it was discovered that the slow motion effect had been achieved not by recording the steps at a higher frame rate than 25 frames, but by inserting every other frame twice in the following manner:

Original video footage framecount: (1,2,3,4,5,6,7,8,9,10,11,12 etc)
Slow motion footage framecount: (1,2,2,3,4,4,5,6,6,7,8,8,9,10,10,11,12,12, etc)

This changes the dynamics of the steps in such a manner that this slow motion version of enchainement 47 was discarded from further study.

This resulted in the elimination of all but enchainements 14, 28 and 47 from further study. Among the aerial steps performed in enchainements 14 and 28 are tour l'airs and in enchainement 47 entrechat six. A further reduction in steps to be analysed within each enchainement was done in the following manner:

The tour l'airs in enchainement 14 are performed as two alternating tours done twice for a total of 4 tours. A pirouette precedes these alternating tours and the male dancer clearly uses his arms to retain impulse in the horizontal plane leading up to the first tour in each combination, then stops with legs fully stretched between the tours and performs the second tour in each combination with no prior impulse. Based on this, tours 2 and 4 being the second tour of each alternating tour combination was selected for further study and labelled jumps.

The tour l'airs in enchainement 28 are performed as three alternating tours done four times for a total of 12 tours. An assemble en avant precedes these alternating tours and this clearly adds vertical impulse to the first tour performed in each alternating tour combination, but the male dancer clearly stops all movement between both the second and third tour. The male dancers moves slightly backwards during the second and fourth performance of these four alternating tours. Based on this, tours 2,3,8 and 9 being the second and third tours of the first and third performance of these alternating tours was selected for further study and labelled jumps.

The entrechat six in enchainement 47 are performed as two entrechat six done twice for a total of 4 entrechat six. A small assemble precedes the first entrechat six in each combination clearly adding vertical impulse to the first assemble. This impulse is also retained between the first and the second entrechat six in each combination. Based on this, all 4 entrechat six where selected for further study and labelled bounces.

The next table shows the video clips containing the selected steps from the enchainements with matching start and stop times along with their movement quality. The start of each clip is at the deepest point in the demi plie preceding the aerial step, the end of each clip is at the deepest point in the demi plie after the aerial step. The selection of steps within each enchainement are numbered 14.1 14.2 - 28.1 28.2 28.3 28.4 - 47.1 47.2 47.3 47.4 for ease of identification.

Enchainement no section no	Start on dvd	End on dvd	Jump or bounce
14.1	13:09:03	13:10:04	Jump
14.2	13:21:01	13:21:23	Jump
28.1	22:49:20	22:50:17	Jump
28.2	22:51:02	22:52:01	Jump
28.3	23:07:22	23:08:18	Jump
28.4	23:09:07	23:10:07	Jump
47.1	33:39:17	33:40:13	Bounce
47.2	33:40:13	33:41:09	Bounce
47.3	33:53:12	33:54:08	Bounce
47.4	33:54:08	33:55:03	Bounce

Fig 7: Sections from the dvd selected for analysis.

When importing the "fifty enchainement" dvd into Pinnacle studio, it was found to contain 40 scenes of material. The 3 scenes containing the 3 enchainements where extracted and the time signatures adjusted as shown in the next table:

Enchainement no section no	Start in scene	End in scene	Jump or bounce
14.1	02:36:15	02:37:12	Jump
14.2	02:48:09	02:49:06	Jump
28.1	02:49:09	02:50:06	Jump
28.2	02:50:16	02:51:15	Jump
28.3	03:07:10	03:08:07	Jump
28.4	03:08:21	03:09:21	jump
47.1	00:08:20	00:09:16	Bounce
47.2	00:09:16	00:10:12	Bounce
47.3	00:22:15	00:23:11	Bounce
47.4	00:23:11	00:24:06	Bounce

Fig 8: Sections within each scene selected for analysis

The enchainments in Jürgensen's video and book are numbered from 1 to 50 and are based on notation by Hans Beck from 1893. (Jürgensen, 1992, page 7) Hans Beck used his own numbering system and in Hans Beck's numbering system, the male variation found in enchainement 14 is named “Beck no 19” and the selected steps are termed “tour en l'air”, (Jürgensen, 1992, page 33-34) the male variation found in enchainement 28 is named “Beck no 75” and the selected steps are termed “tour en l'air”, (Jürgensen, 1992, page 48) while the male variation found in enchainement 47 is named “Beck no 105” and the steps selected are termed “entrechat six”. (Jürgensen, 1992, page 67-68)

Directly comparing jumping and bouncing steps should preferable be done with the same type of step. However, the tour en l'airs in enchainements 14 (Beck 19) and 28 (Beck 75) not only contains movement in the vertical plane but rotational movement in the horizontal plane as well. As the motiongram computer program separates vertical and horizontal movements into 2 different motiongrams, it could be argued that this does not negate the use of these steps as the basis for study. It can in fact lead to new odontologies of dance not based on the human body but how such a body is represented in various data formats.

III.5 Analysis

It is assumed that the flooring in the dance studio where the video was filmed has the same amount of friction and elasticity throughout the area used to perform the various steps. It is assumed that the male dancer uses the same set of shoes throughout the enchainements and that the friction and elasticity of this footwear does not change in any significant way. It is assumed that the male dancer has warmed up prior to performing the enchainements, and although he shows some signs of tiredness after a few of the enchainements, it is assumed that this does not alter the elastic properties of the various muscles and ligaments in his legs significantly throughout the enchainements. Based on Laws focus on how elasticity and friction of dancing floors and the legs can influence aerial work, (Laws, 1984, page 39-43) it is assumed that these properties are the same throughout the enchainements.

It is assumed that the camera was placed in one spot throughout the filming of the selected enchainements. The male dancer is not moving towards or away from the camera when performing the selected steps, so no relative change to the male dancers height in the video occurs within each video clip. It is further assumed that the height of the camera from the floor was not altered between the selected enchainements.

The selected video clips where extracted from the dvd with the aid of Pinnacle studio 14 and exported as AVI files with the resolution 768x576 pixels. No adjustment of contrast where done to the selected video clips as the default noise reduction values of 0.02 and median filter value of 4 was found to produce very clean images.

The male dancer was cropped from the upper horisontal bar to the top of the frame. This cropping was retained without change through video clips 14.1 to 47.2 with a very slight adjustment of vertical adjustment done in video clips 47.3 and 47.4. This adjustment is not believed to be critical in comparing the numbers output from the motiongram program.

The output from the motiongram program for each section of the enchainements consists of a text file containing numbers and two images showing horizontal and vertical motiongrams. The image showing horizontal movement was discarded from further study as the aim of this master thesis is to study vertical movement. An example of the vertical motiongram is shown on the nest page. Do note that the image has been stretched sideways and reduced in height for better viewing.

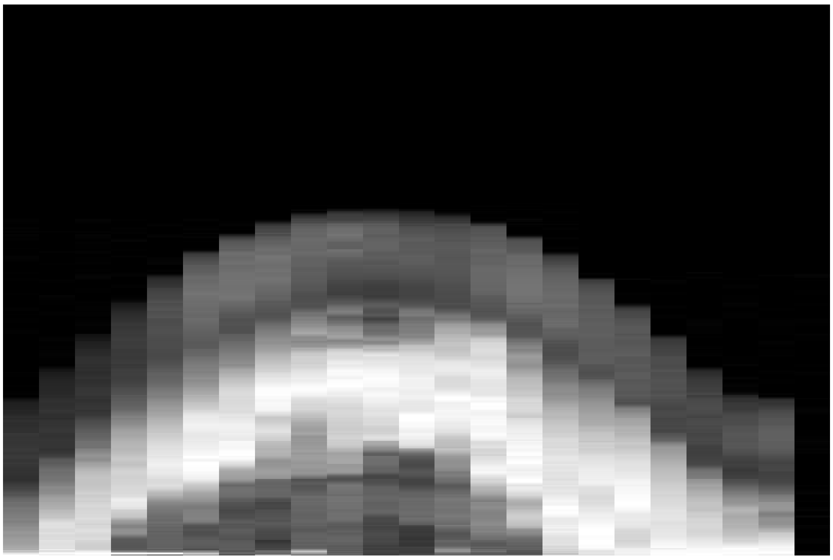

Fig 9: Motiongram image showing enchainement 14, section 1, jump

When examining numeric output from computer programs, it is important to evaluate if a large accumulation of computational errors occurs and that the number of decimals is neither too small or too large.

When performing a long series of iterative calculations, the accumulation of computational errors might eventually start to influence the results to such a degree that the result would not contain correct information. This can be observed when performing integral calculus by using computer programs. The motiongram program averages one horizontal row of pixels, each containing several numbers of colour information in the ARGB format (alpha channel, red, green, blue) in order to obtain one number in the range 0-255 representing each colour.(Jensenius, 2007,page150) The number of iterative calculations is quite small so it is believed that accumulation of computational errors does not influence the final result.

The number of decimals output by the motiongram program is 4. The original video footage is 576 pixels in height, so a change of one pixel is 0.001736. It is believed that using the first 2 decimals output by the motiongram program is appropriate.

The numeric information was first plotted as a graph with the x-axis representing number of frames and the y-axis showing the vertical position of the male dancer. A second graph was then made showing the velocity of the male dancer along the y-axis. The sample graphs are all based on Enchainement 14 section 1 being a jump. The male dancer is airborne between frames 6-17 reaching the highest elevation in frame 11. One sample graph of each type is shown next:

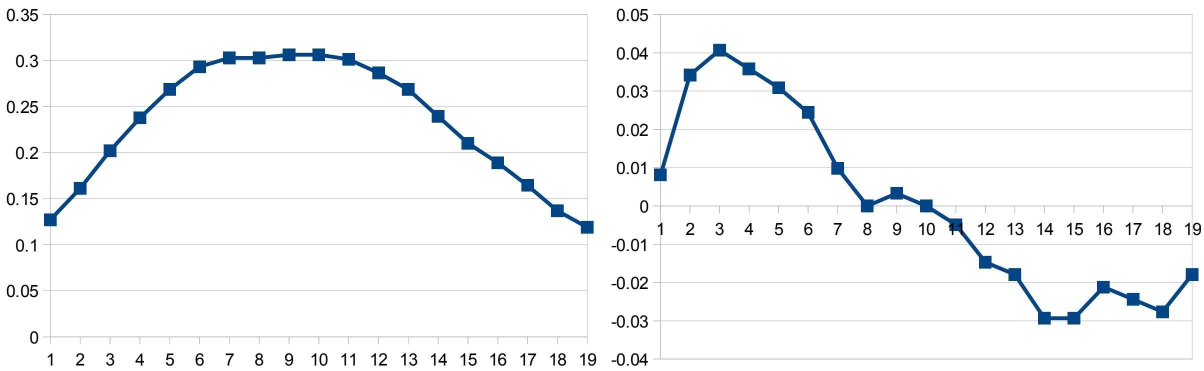

Fig 10: Vertical position and velocity of tour from enchainement 14, section 1, jump

When examining the resulting graphs, it was found that the deviations in velocity was so large that using the original video clips as input did not produce an acceptable result. At this point it was also believed that information from acceleration, or changes in velocity over time, could contain the information needed. However, the motiongram program does not output acceleration directly along separate x- and y-axis, only as one combined series of numbers and a direction.

The video clips where then subjected to preprocessing in order to obtain the best possible data for input to the motiongram program. This preprocessing was done in three steps; first each frame of all the selected video material was extracted for a total of 236 individual images. Secondly the male dancers top of head was determined manually in each individual image, the area below was then coloured white and the area above was coloured black. Thirdly all the manually adjusted images where reassembled into individual videoclips in the same order as they where extracted, yielding a parallel set of videoclips which could then be input to the motiongram computer program. Sample frames of original video footage and the manually adjusted images are shown on the next page.

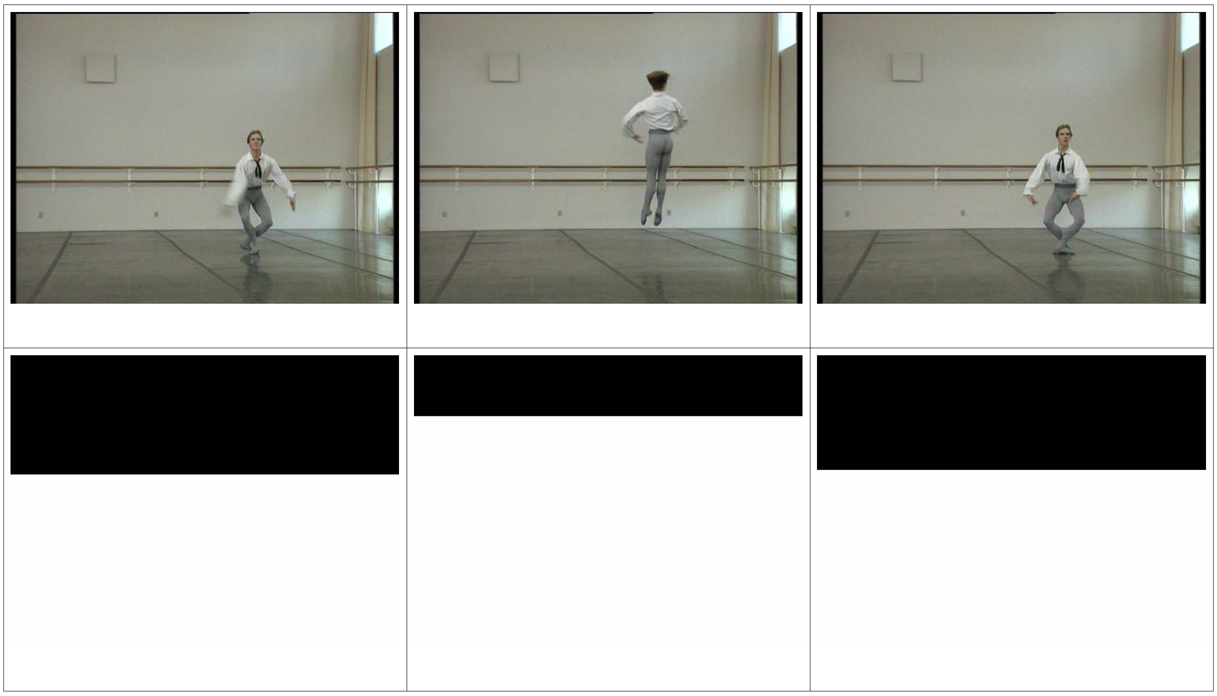

Fig 11: Original and adjusted images of frames 1,11 and 23

(Contains images from video “fifty enchainements” © Knud Arne Jürgensen and Vivi Flindt)

These new videoclips where then input to the motiongram program. The median value was adjusted to be only 1 in this new series of computations in order to remove any smoothing of the results. Do note changes in scaling of the axis and the nearly linear change in velocity. These new results are shown next:

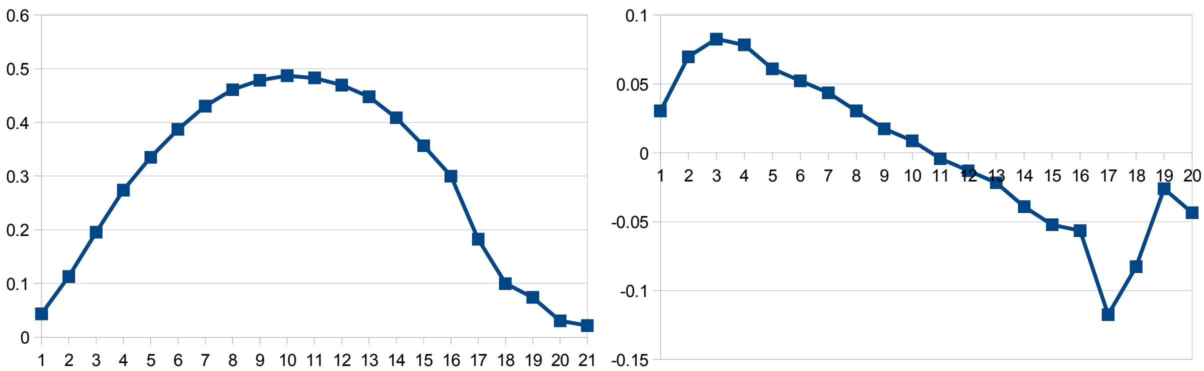

Fig 12: New vertical position and velocity of tour from enchainement 14, section 1, jump

A comparison of the above graphs clearly show that preprocessing the videoclips not only results in an improvement in the results obtained, but also indicated that acceleration, or changes in velocity over time, was not the determining factor due to the values being in the third decimal. Instead it was found that graphs containing absolute velocity could be more useful as shown on the next page.

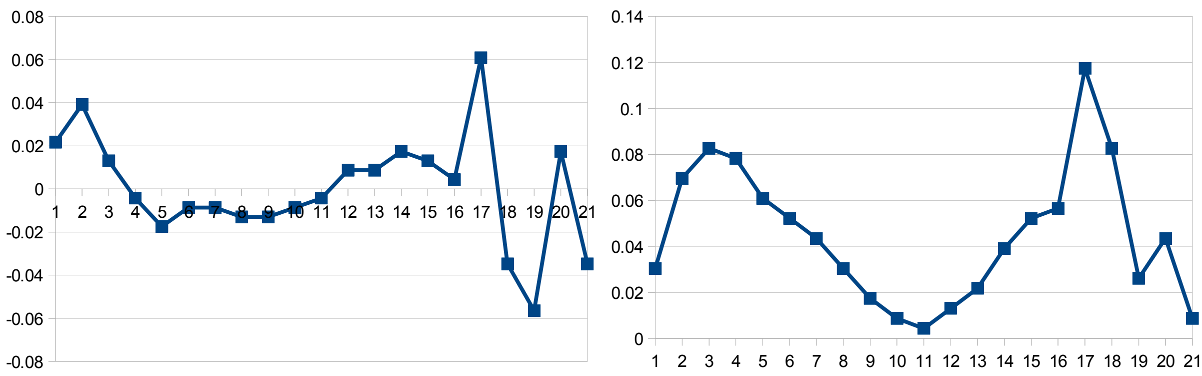

Fig 13: Acceleration and absolute velocity from tour in enchainement 14, section 1, jump

At this point a curious anomaly surfaced within the numeric material of one of the jumps when performing a tour, and traces of the same anomaly was also found in the rest of the numeric material from other jumps. According to the numeric data, the male dancer appeared to reach the apex of the jump, start to descend then sharply rise ever so slightly again before continuing the descent. This seems to break the laws of physics unless it could be explained in a satisfactory manner. At first it was believed that an error had been made when manually extracting and reassembling the images, but repeating this process using one of the videoclips yielded the same result. By examining the original videoclip under high magnification in a step by step manner a more plausible explanation was found; when performing the tour the male dancer presents the back of his head towards the camera at the apex of the jump. As the male dancer starts to descend, his hair at the top and back of his head is still rising and snaps upwards while the male dancer descends towards the floor. As this anomaly does not occur at the exact apex of the jump, it should not affect the interpretation of the numeric information.

However, by reflecting on the process undertaken to present a plausible explanation of this anomaly, it becomes clear that an increase in resolution may not increase the information available for analysis, in fact a decrease in resolution may be beneficial in that it removes minute movement events that may otherwise result in the presence of a lot of fussy information in need of minute examination in order to explain the phenomena they represent.

At this point all the numeric information and resulting graphs was scrutinizes in order to establish a way forward towards presenting the information in such a way that an analysis could be performed.

A graph showing all velocities for all the 10 jumps and bounces would present too much visual information to be of any use, but the numeric table with this information can be found in the appendix along with 10 graphs showing the velocity of all the 10 jumps and bounces. A sample output of all numeric information from enchainement 14, section 1 is also provided.

To overcome the problem of presenting excessive visual information, the velocity at the highest elevation along with 3 values on either side, for a total of 7 values, was extracted from all the 10 jumps and bounces. These extracted values could then be plotted as 3 graphs, one for each enchainement.

At this point a decision had to be made on whether to perform smoothing of the data or not. Smoothing is usually done in order to transform data points into curves. Two types of smoothings where considered, cubic spline and b-spline. Cubic spline is a curve that passed through each data point. B-spline is a curve that do not pass through each data point, but is commonly used when the curve changes direction several times. The shape of both curves can be influenced by adjusting a number of parameters such as number of data points used to calculate one point in the graph.

Based on this it was decided that smoothing the data points would unduly change the visual appearance of the graphs and could lead to false interpretations. Examples of both types of smoothing curves along with an non-smoothed graph are presented in the next figure.

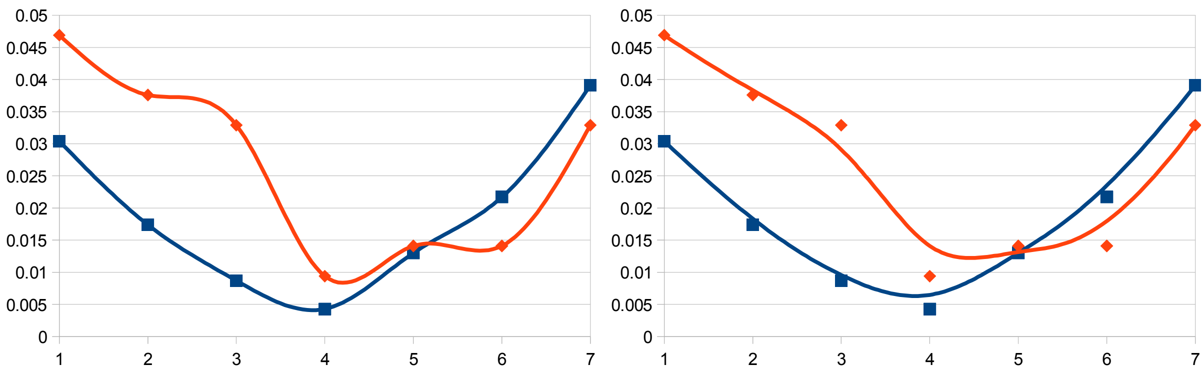

Fig 14: Cubic spline and b-spline velocities from tours in enchainement 14, section 1 and 2

The next 3 graphs contain non-smoothed velocities from all 3 enchainements.

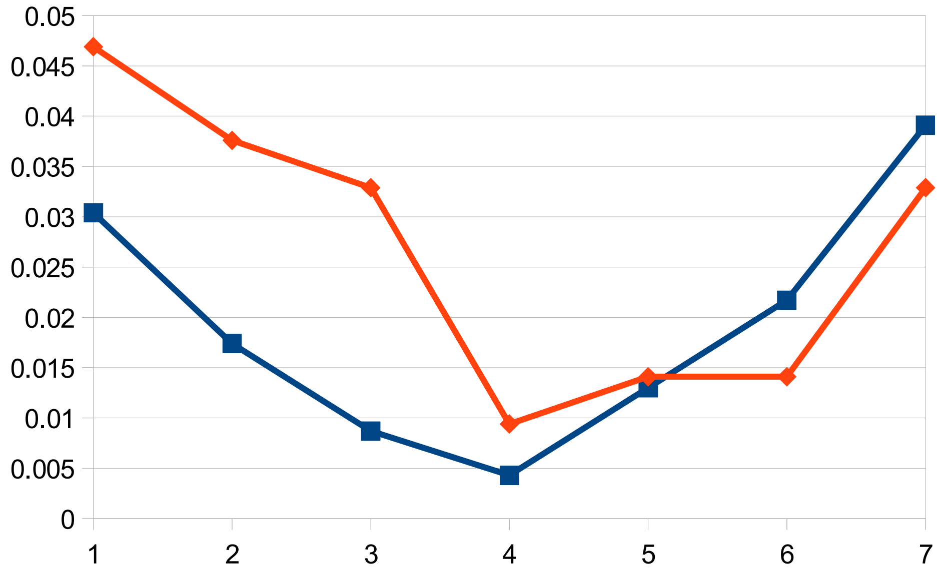

Fig 15: Non-smoothed velocities from tours in enchainement 14, section 1 and 2, jumps

The above graph indicates that the second jump has the highest vertical velocity as the male dancer rises upwards, but that the velocities near the apex of the jump and afterwards are quite similar, the difference being in the third decimal.

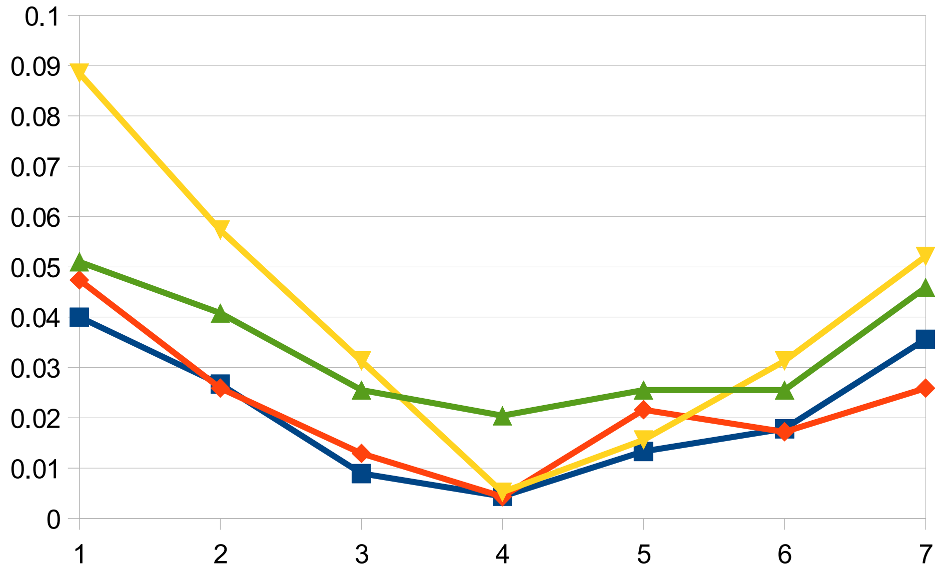

Fig 16: Velocities from tours in enchainement 28, sections 1-4, jumps

The above graph indicates that the third tour has the highest vertical velocity as the male dancer rises upwards, and that the fourth tour has a slightly lower velocity at the apex of the jump. Otherwise, the velocities are exactly the same at the apex of the jump and quite similar throughout most of the jump, the differences being in the second decimal.

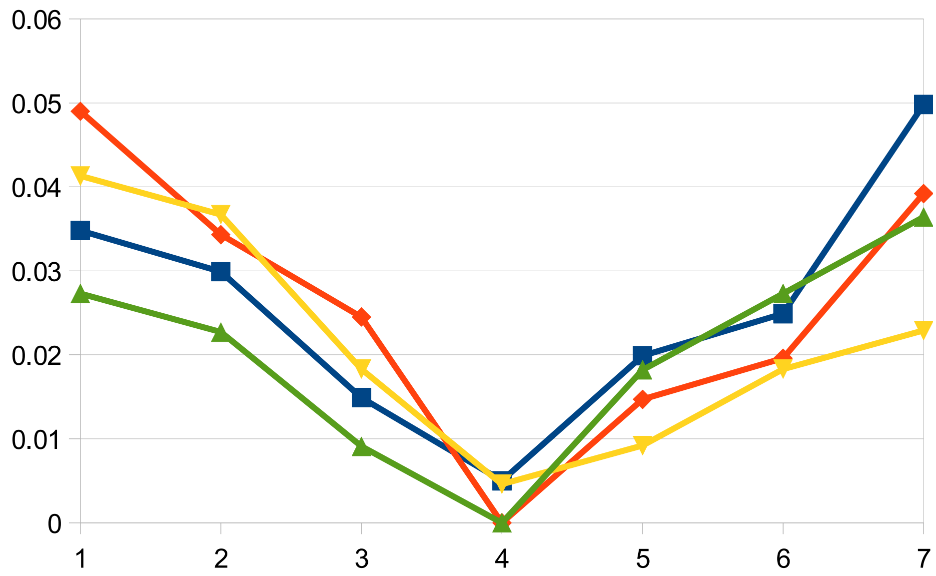

Fig 17: Velocities from entr. six in enchainement 47, sections 1-4, bounces

The above graph indicates that the second bounce has the highest initial velocity followed by the third, first and fourth bounce. The velocities are very similar at the apex of the bounces and quite similar throughout most of the bounces, the differences being in the second decimal.

At this point it became clear that directly comparing all of the information within each enchainement was not going to result in any clear and conclusive overall picture, indicating that in order to reach a satisfactory result new ways of comparing and assessing the informations contained within the graphs had to be made. It also became clear that there was a chance of obtaining a negative result, that no significant difference could be found in the airborne section between a jump and a bounce by using the motiongram computer program and that other factors such as bias and belief might be held accountable.

Reappraising the above 3 graphs along with all the other graphs indicate that the largest difference in velocities could be found by directly comparing the jump with the highest initial velocity and the bounce with the highest initial velocities, this being the third tour in enchainement 28 and the second entrechat six in enchainement 47. A new graph containing only these 2 values was made as shown on the next page.

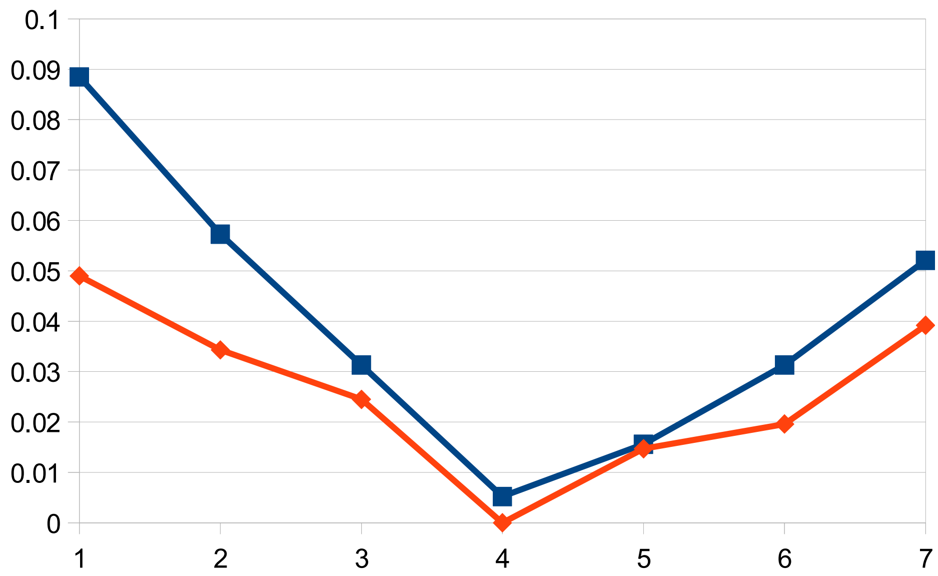

Fig 18: Highest velocities from jump and bounce

The above graph indicates that among the 2 aerial steps with the highest initial velocities, the jumped tour has the highest initial velocity compared to the bounced entrechat six, but that the velocities near the apex and afterwards are quite similar, the difference being in the second decimal.

The information present in the above graphs indicate that the impulse from pushing off the ground when jumping, is different from the impulse when rebounding from a previous bounce. However, the result when approaching the apex of the aerial step is quite similar, and that this can be explained by the impulse-momentum theory, which states that different amount of forces applied over different amounts of times may yield the same momentum.

In the end; when examining the aerial part of jumps and bounces, not much difference is found between a single jump and a single bounce, but difference is clearly present when examining how a series of jumps or a series of bounces progresses as regards the maximum elevation obtained.

To conclude; the above result supports the hypothesis that "*The difference between jumping and bouncing in classical ballet is based on if and how the impulse from a previous step is transferred, and how the resulting movement is interpreted*".

Positioning the thesis

This chapter aims at positioning the contents of this master thesis by tracing its trajectory within the wide interdisciplinary academic dancefield.

When reflecting upon the exploration that forms the foundation of this master thesis, one single decision and its consequences stands out as having a major influence on the resulting trajectory; the decision to use existing video recordings of ballet steps instead of live input of ballet steps performed in a movement lab.

This prime decision was based on a clear wish to engage with existing video material containing balletic steps of a high quality, that this video material should be of a historic nature so it could be engaged using various diachronic perspectives and finally that it was accompanied by an academic text that could also be engaged on multiple levels. This ultimately resulted in using the dvd containing Knud Jürgensen's reconstruction of a Bournonville ballet class and accompanying academic text in book form as source material upon which to base this master thesis.

The downside to this prime decision could be that the selected video material would not be the most optimal from a purely technical point of view, the person performing the steps could not be directly engaged in any interviews nor be made to comment upon the result, a cycle of performance – evaluation – performance etc could not be established in order to obtain optimal results, no stylistic different ways of performing the balletic steps could not be explored nor could explorations of performing the steps *the wrong way* be accomplished, the latter being an intriguing and innovative approach that would directly engage with Paula Dozzi's paper on heel contact in ballet allegros published in ”Dance technology, current applications and future trends”. (Dozzi, 1989)

On the next page there is a comparative summary in table form of the major points of these 2 trajectories.

Outlined below are the major points in the resulting trajectory of this master thesis along with an alternate trajectory, both clearly showing divergent tracks and ultimately pointing this master thesis towards the heartland of the interdisciplinary dancefield:

Trajectory of the master thesis	Alternate trajectory
A focus on balletic steps in the exploration	Non-balletic steps explored
Using “Fifty Enchainements” dvd as video source material	Performing ballet steps in a movement lab
Accompanying academic text by Knud Jürgensen	No academic text directly accompanying the live performance
Engaging with academic texts from the curriculum of the No-MA-ds program	Engaging with academic texts from outside the NO-MA-ds program from the fields of Movement studies, Computer science etc
Supervisor Gediminas Karoblis from Dance studies	External supervisor from the field of Movement studies or Computer science etc
Result published within the No-MA-ds program	Result published ouside the No-MA-ds program in the fields of Movement studies, Computer science etc

FIG 19: Master thesis Trajectories.

The above direct comparison of different trajectories clearly positions the contents of this master thesis in a far better way than merely writing a large section containing numerous academic reference from the dancefield, counting the number of pages containing academic references from the dancefield, perceived quality of said references, focusing on the use of computer programs, graphic presentations of the results or any other more arbitrary or loose descriptions.

In the end, the positioning of this document is based on 3 simple facts:

- I am enrolled in the No-MA-ds program
- This document is a master thesis
- The title

Reflections

This chapter re-engages with academic texts, presents some reflections on the process, results obtained, insights gained and also extends the trajectory of this master thesis towards a possible new future of computer enhanced structured movement systems.

In their joint paper "Writing a dance: epistemology for dance research" Egil Bakka and Gediminas Karoblis engages in a dialogue on methodological issues, among them the use of film which is seen as problematic by many influential American anthropologists of dance. (Bakka, 2010, Page 167) It could be argued that using a computer program such as Motiongram as a tool using pre-recorded film footage places said computer program in the same methodological category as film when engaging in the above dialogue. It should be noted that Bakka and Karoblis limits their discussion to the disciplines of ethnochoreology and anthropology, but as the tools of Labanotation and films are also used in other disciplines, it could be argued that their discussion impacts other disciplines as well and that the views expressed could be brought to bear on this master thesis. (Bakka, 2010, Page 170)

When describing the emergence of new tools such as motion-capture and virtual representations of dance, Bakka and Karoblis employs the term *artistic tools.* (Bakka, 2010, Page 172) No explanation is provided for the use of the word *artistic*, so it is not known if this is used to indicate that the user of these emerging tools is an *artist* as opposed to a more lowly *craftsman*, or that this is used to indicate a set of skills outside the academic sphere, but it does indicate that emerging tools may be different in some way from already existing tools, that they might perhaps be *outsider* tools instead of *insider* tools. In this light film and the use of computer programs might be considered *artistic* and *outsider* tools while Labanotation and existing structured movement systems might be considered *insider* tools.

Karoblis suggests that "the most important aspect of hard science is that interpretations compete on the basis of the same data". (Bakka, 2010, Page 186) When outlining the intentions of the UNESCO convention for safeguarding intangible cultural heritage, it is stated that "The convention creates a demand for methodologies handling movement and movement analysis for the purposes of documentation and transmission". It is also stated that "the analysis of of such recordings need renewal and development". (Bakka, 2010, Page 187) This to me clearly indicates a need for the academic dancefield to embrace emerging tools such as computer programs thereby making these tools *insider* tools.

So what is the effect of employing an emerging artistic tool such as the Motiongram computer program ? Below is a summary of both negative and positive aspects as well as some thoughts on the process itself a experienced during the exploration within this master thesis:

The Motiongram computer program may be seen as a tool that is preceded by other tools such as pressure plates or sensors directly attached to the soles of the dancer. It's uniqueness lies in it's ability to clearly separate horizontal an vertical movement, and output the results as both numeric information in tabular form and a visual motiongram. When using such a program, designing the workflow or process in which raw data in transformed info salient information becomes important. Crucial to this process is the ability to assess if the information at a certain step is of high quality. This clearly adds both complexity and stringency to the process so this step by step approach of calculation – assessment of information may be reminiscent of a screw being used to connect 2 pieces of wood with the help of a screwdriver. Based on this, could the use of computer programs in dance analysis be the equivalent to using a stringent screwdriver?

The sourcecode of the Motiongram was not scrutinised in order to determine if the program worked as stated in Jensenius Ph.D. Instead a series of artificial data sets was constructed in order to test if the results where as expected. During this testing phase no problems where encountered. It is possible to interactively crop parts of an image for analysis, but unfortunately it is not possible to select this cropping by inputting x- and y-coordinates, making it a bit hard to maintain the same cropping over a prolonged use of the program. This was overcome by using the bars in the image behind the dancer as a guideline when cropping the image. The process of manually extricating, rotoscoping and reassembling of images could not be performed within the Motiongram program. If a large amount of such rotoscoping becomes necessary in the future, a more automated process should be considered. It should be stressed that the Motiongram program saw extensive use over a considerable amount of time in order to gain fingertip expertise in it's use, and that a high level of computer knowledge is necessary when engaging in such a process.

Reynolds has earlier stated that “we cannot ask questions to a film” (Reynolds, 1990, page 11) but by using a computer program such as Motiongram this can indeed be accomplished.

The optimal way of evaluating the results obtained would be to consult directly with either Johan Kobborg, Vivi Flindt or Knud Jürgensen, but this would be a major undertaking involving possibly travelling to Copenhagen in order to conduct interviews and explore the results in a dance studio, so this was not undertaken for practical reasons. At first glance this supports Kaeppler's argument as attributed by Bakka and Karoblis that her technique based on participatory observation is correct and that “video recordings are not a main resource”. (Bakka,2010, Page 171) However, it could be argued that the above statement is based on the premise that the person doing the analysis is an outsider to the field and possess little or no emic knowledge of the movement material under scrutiny. As this master thesis focuses on the difference between basic steps and not complete dances, it could be argued that an analyst with good emic knowledge of ballet technique in general and some practice in the Bournonville style in particular could engage the movement material directly by performing it and then reflect upon the experience, and that the insights gained would be the equivalent to insights gained based on participatory observation. I have been dancing classical ballet over a period of 30 years and also studied Bournonville style under Willkiam Buys so possess good emic knowledge of classical ballet and the Bournonville style. It should be noted that my dancing expertise is not equivalent to Johan Kobborg, nor is my specific knowledge of Bournonville style as comprehensive as either Vivi Flindt nor Knud Jürgensen, but I believe that my emic knowledge of classical ballet and Bournonville style is sufficient to comment on the results obtained. So it was time to put the steps into my body and dance once more

When performing a prolonged series of jumps, the body starts to tire quite fast when attempting to perform each jump to maximum elevation, so clearly the first few jumps are higher than the latter ones. In the enchainment used to study the jumps, the male dancer has to perform 12 tours, this adds considerable strain on the dancer. Furthermore, the full stop in demiplie between each tour also adds to the strain experienced, so my body heartily agrees that the first jump in a series is the highest one.

When performing bounces, initially there seems to be much less difference throughout a series of bounces performed from first position. When adding beats to the bounces and performing them from fifth position more strain is experienced by the dancer. When adding a step with a more horizontal trajectory after the last bounce, my body clearly strives to take the last bounce to maximum height in order to maximize the impulse transferred to the next step, so at this point my body agrees that the last bounce is the highest one.

At this point it was clear that my body agreed with the concept that the dynamics of individual steps is not only based on the one step, but also on the dynamics of the preceding and trailing step, that impulse and momentum along with the dancers intent when maximizing elevation or horizontal movement also affects the dynamics and characterization of a single step within a series of steps.

This to me indicates that structured movement systems focusing on using only movement information contained within a single step to describe said step may be lacking, and that information spanning several steps may be needed to describe a singular step. It is also apparent from the video source material that there can be a certain amount of movement between steps that affect the dynamics properties of a singular step in such a sequence, so there is a need to describe such minor movement events also. Throughout the exploration a strategy of reducing the amount of information in order to analyse the dynamics of steps was successfully employed, thereby negating the assumption that an increase in information about a singular step is to way to go when attempting to describe the dynamics of singular steps. This leads to the idea of using a meta-step to describe a singular step within a new type of structured movement system.

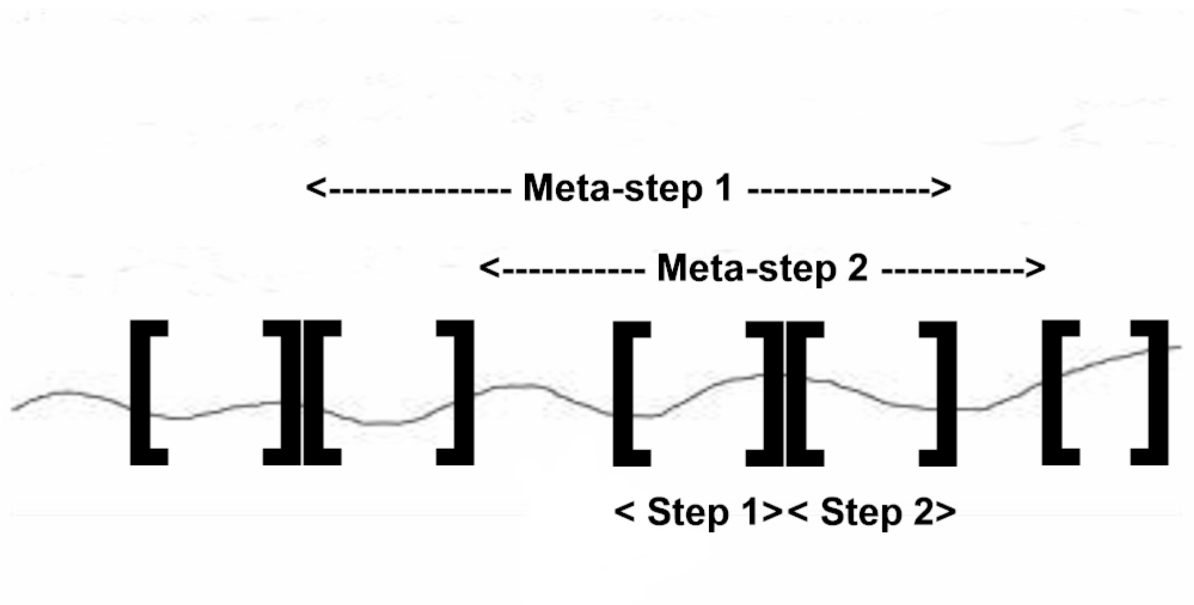

FIG 20: Step and Meta-step

In the above figure a singular step is described using a meta-step consisting of the preceding and trailing steps along with other minor movement events. As several of the information elements within a meta-step are reused when describing the next singular step, the above meta-step is a structure that overlaps the preceding and trailing meta-steps.

It should be noted that classical ballet already employs the concept of *compound* or *composite* steps to describe a combination of certain steps such as a *sissonne doublee decote*, which is a combination of a *sissonne* from 2 feet to 1 foot jumping sideways linked with an *assemble*, so the meta concept is already present in some ballet terminology (Ryman, 2007, page 75). However, the use of the meta-concept in classical ballet terminology could merely be seen as a way of abbreviating often used combinations of some basic steps. It's use does not contain within it descriptions of different dynamic qualities, such as the difference of performing the above *sissonne doublee decote* step to a ¾ or 4/4 beat where the gesturing leg is extended a la seconde and held briefly on the second count while the supporting leg is performing a *fondue* before the concluding *assemble* when performing the combination to a 4/4 beat. This type of dynamic difference is something usually learned in the classroom, an observer with little or no emic knowledge of classical ballet might even consider the pause on the second count to be an indication that this is not a *composite* step but 2 separate steps and not employ the correct meta-concept when describing the dance.

The above example signifies that there is a major difference from the way meta-concepts are presently employed in classical ballet terminology and how a new form of structured movement system can be constructed using overlapping meta-steps as the core feature. This could lead to shifting the focus away from SMS – *Structured Movement Systems* towards MSMS – *Multiple Structured Movement Systems*.

It is quite apparent that using existing tools such as hand-drawn Labanotation, existing computer notation programs or textual descriptions to record dance in such a system is not the optimal route forward. It is customary when writing a master thesis to include some ideas on how the results can be extended by briefly outlining a trajectory towards the future. What follows is a more elaborate roadmap that attempts to extend and combine Labanotation stored as information in a computer file with other types of Multiple Structured Movement Structures. To include such an elaborate roadmap in a master thesis might be considered unusual, but as I possess 40 years of expertise as a professional in the Information Technology field along with 30 years of experience dancing classical ballet, I believe that the following roadmap might be of interest to future researchers.

When writing computer programs, it often necessary to start by defining the information file format. This is especially important when files such as HTML web pages must be shared between many computer programs running under various operating systems, so defining and standardizing the information file format is the first task. So how to proceed when there is no standardized information file format available such as HTML for storing Multiple Structured Movement Systems?

An elegant approach is by using XML - Extensible Markup Language. (www, XML) A full and technical description of XML is totally beyond this master thesis, so what follows is a brief description focusing on the basic concepts used by XML and how they could be applied when storing Multiple Structured Movement information.

A Markup Language is a way of storing information in a format that can be understood by both computers and humans. An example is HTML – HyperText Markup Language – used to store web pages. This can be seen by opening any web page in a browser such as Internet Explorer 8, then selecting *page* and *edit with notepad* or the equivalent commands of other browsers in order to view the information. An example HTML file could look like this:

```
<!DOCTYPE html>
<html>
        <body bgcolor=”#FFFFFF” text=”#000000”>
                <h1>My First Heading</h1>
                <p>My first paragraph.</p>
        </body>
</html>
```

This simple example writes *My first heading* followed by *My first paragraph* as black text on a white background.

Notice that the information in the above example is stored using a previously defined grammar or syntax, and that the keywords and associated values are also predefined. XML extends on this by employing a previously defined grammar but allows the construction of new keywords and values. An example of a simple dance notated in XML can be found on the next page:

```
<dance>
	<beat>
		<step>forward</step>
		<level>middle</level>
		<foot>right</foot>
	</beat>
	<beat>
		<step>forward</step>
		<level>middle</level>
		<foot>left</foot>
	</beat>
</dance>
```

The above dance consists of a step forward on the right foot at middle level followed by another step on the left foot also at middle level.

So how does a computer program know what to do with the new keywords and their value? The concept of *dictionary* is employed, a dictionary detailing the keywords, values and what to to with them is constructed for each new computer program. So when a computer program needs to read a file containing information in the XML format, it also needs the correct dictionary. This dictionary need only be constructed once for each computer program and can then be reused again and again as new dances are described. The ultimate beauty of this approach is that a simple computer program such as notepad, wordpad or any equivalent computer program under any operation system can be used to construct and edit the initial dictionary and structured movement information. Only much later will there be a need to write new computer programs and then only if existing computer programs cannot perform the necessary tasks.

Initially, the first dictionary might just contain the description of one single step and the XML file would contain a dance using only this one step, this could then be tested using a linedrawing computer program in order to make a simple Labanotation of the dance. New steps could then be added to the dictionary and by also adding the new steps to the dance in the XML file, the dance could be tested again. After having described a larger number of steps in the dictionary more elaborate dances could then be described, and a completely new dictionary could be made which would make a stick figure dance in a 3D program.

At this point meta-steps containing information of variance, velocity or other types of dynamic information could be included in the XML file of the dance. If no entries of this information is found in a dictionary used by the linedrawing computer program, the linedrawing program would not do anything with this information. If entries where made in the dictionary associated with the 3D computer program, the 3D stick figure would perhaps dance a better dance, and other programs could also use this information in various ways. Using this approach it would be possible to include both Structured Movement Systems and Multiple Structured Movement Systems in one XML file.

This opens the intriguing possibility of retaining all information from a Labanotation score while extending the same score using a Multiply Structured Movement System. This results in a lossless transition between an existing system for describing dance and new systems, something to be highly desired.

At the close of this reflective chapter 2 aspects become clear after engaging in the joint paper by and Bakka and Karoblis; First that changes to such structuring systems can be seen as a series of transitions which is subject to negotiation and mediation on many levels. Secondly the presence of humans when employing different structuring systems.

When transitioning from one method of describing dance to another, there is usually several positive and negative factors that determine if such a transition is seen as a mere change, a devolution or an evolution. It could be argued that an optimal evolutionary transition takes place when the new system retains all information of the previous system while extending it with new features. As video is just a number of still images projected in such a way as to give the appearance of movement, the transition from photography to video to record dance could be said to be a lossless transition and therefore an evolution. The transition from a Structured Movement System towards a Multiply Structured Movement System implemented using the XML format as tool while retaining all information contained within the previous structured system could also be seen as evolutionary and desirable.

When writing the steps of a dance on a piece of paper it has to be done by a human notator, the dance does not write itself. Likewise, a drawing of a dance requires the presence of a human to draw it. The same applies when taking a photograph or recording film, a photographer must be present and what is recorded is affected by the human presence. When using computer programs these programs are also made by humans, no Artificial Intelligence program has ever given birth another Artificial Intelligence program, so a computer program always represent an etic view which needs to be combined with an emic human viewpoint when describing the dance.

The joint paper by Bakka and Karoblis formed the starting point of this reflective paper. It could have been tempting to engage in a more elaborate discussion with the philosophical and epistemological arguments presented in their paper, but instead of copying and pasting ideas and concepts from a variety of sources in order to present some sort of minor insight, I wanted to present something more unique based on my own knowledge of computer science and classical ballet. However, at the close of this reflective chapter it seems appropriate to quote the final argument of Bakka and Karoblis that “there is a need in dance research to work systematically with empirical material and to strive for a transparency about how singular events bring us to generalizations”. (Bakka, 2010, Page 187)

Double reflections

Fig 21: Foyer old Royal Danish Theatre

(Photo: Ingrid Skanke Høsøien)

In the upstairs foyer at the old Royal Danish Theatre in Copenhagen, 2 large mirrors facing each other allows a person to view double reflections of his own illuminated heads tapering off into infinity as shown in the above photograph. This visual metaphor reflects well on the relationship between me, my master thesis and previous writings.

Most of my writing skills have been developed through writing computer programs over several decades. On reflection, I find that I have approached the creative process of writing this master thesis in much the same manner, developing a bottom-up writing strategy, rewriting and reworking the thesis in an iterative way.

Computer programming employs rich environments for expressing complex structures and presenting these structures with a striking visual cadence as can be seen by viewing source code on a webpage, which is visually very unlike other types of writing where lines of text may present complex thoughts and ideas in a more streaming format.

My preferred personal writing style is not such a streaming style so this master thesis may at times contain complex written structures reflecting complex struggles with complex issues. This is not done in order to obfuscate the human reader, but may perhaps be a result of me embracing complexity while writing for the machines?

This master thesis is the result of work carried out during 2 extended periods separated by nearly a year. When re-engaging with the previous version, the concept of reflexivity was used used in order to write the framing chapters *Prologue*, *Positioning the thesis*, *Reflections* and expanding on this *Double reflections*.

It is customary when writing a master thesis to end with the conclusion and then perhaps some final remarks, but the hiatus of nearly 1 year presented a unique opportunity to expand on the initial trajectory of this thesis by discussing the results obtained, include new insights and outline a more elaborate roadmap towards the future.

A number of close friends where canvassed prior to selecting the topic of this thesis in order to build on their academic experiences. They mostly said that they wished they had been more daring and bold in selecting their topics and in the writing of their thesis, to present more of their own ideas in the text, so their reflections influenced me throughout the work on this master thesis.

Another influence came from one of the first lectures at the very first seminar in Dance Analysis by Margarita Vikander who outlined the differences between a thesis written in the *hard* sciences and *soft* humanities, between a thesis rich in archival material and another one based on doing fieldwork. Different persons should perhaps approach the selection of topic and the writing of their thesis based on their personalities, and the resulting thesis could be interpreted differently by different persons based on their personalities.

I am not an archive person and I am much to urbanized to enjoy sitting around campfires in remote lands. I am an avid reader of science fiction, so very early on I decided that my master thesis should not be about deconstructing the past nor to adhere to what Barth calls “the trompe l' æil principle whereby the detail is intended to create a sense of reality” as attributed by Munslow. (Munslow, 1997, page 64) Instead I intended my master thesis to be a forward looking construction in order to present possible *Dangerous Visions* of *Brave new Worlds* to paraphrase the titles of 2 seminal works by Harlan Ellison and Aldous Huxley.

Having started this master thesis with my ballet teacher William Buys trying to make me do steps correctly, it is only fitting that he should have the last word and the last laugh presenting an alternative way of determining the difference between jumping and bouncing in classical ballet in the final chapter.

Alternate ending

What is the difference between jumping and bouncing in classical ballet? When dissatisfied with our efforts during boys classes on Friday evenings, our ballet teacher William Buys would put a smile on his face, walk slowly over to his training bag, stick his head into it and usually scream or sob with frustration. Getting the point, we would then try our best to dance better and William would then exhort us "to eat more fish as this would enhance our brain functions".

So, based on this, a possible imaginary outcome could be that I might decide to either jump or bounce, and William might then pop his head out of his training bag with a big smile on his face.

«You didn't see if I was jumping or bouncing!», I might say.

"Ah, but I heard what You where doing», he might answer.

Laughing.

Then we would all head for the local pub of course.

Appendix

Graphs showing the velocities of the 10 jumps and bounces:

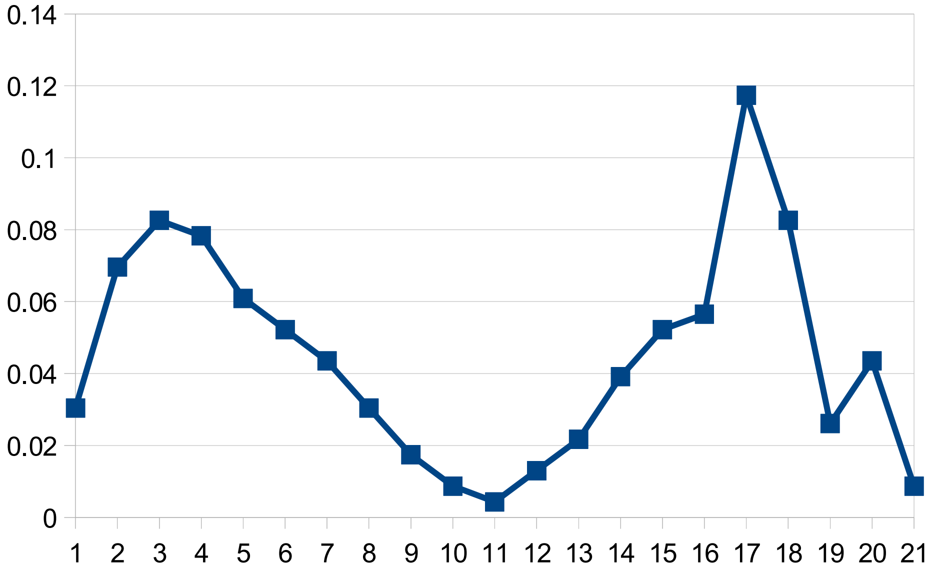

Fig 22: Enchainement 14, section 1, jump

Dancer is airborne in frame 6-17

Sequence: … tour left, **tour right** … tour right, tour left ...

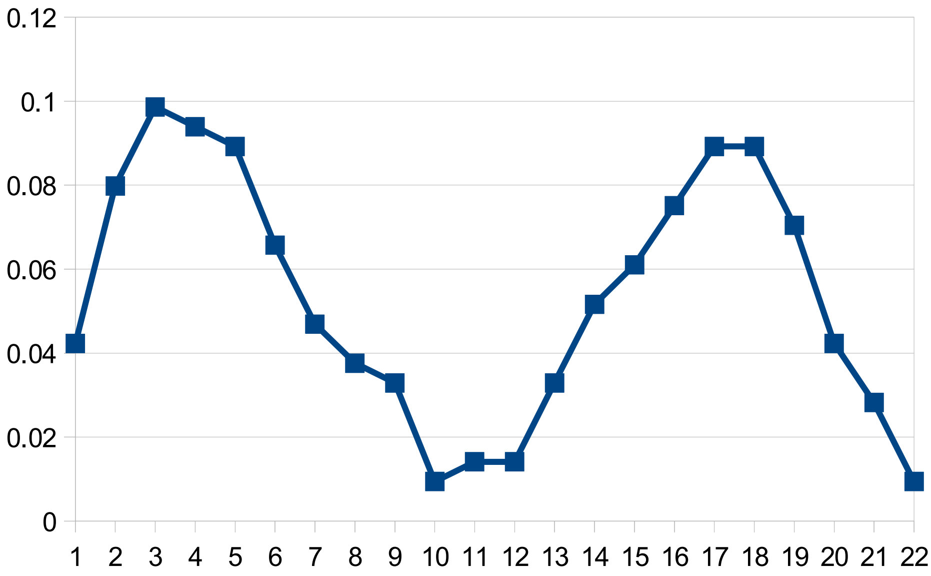

Fig 23: Enchainement 14, section 2, jump

Dancer is airborne in frame 6-17

Sequence: … tour left, tour right … tour right, **tour left** ...

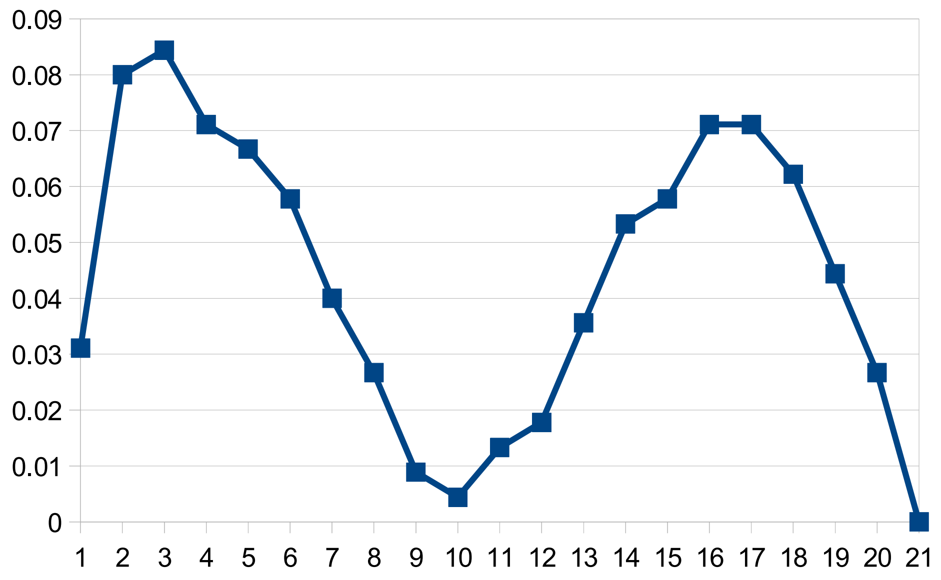

Fig 24: Enchainement 28, section 1, jump

Dancer is airborne in frame 5-17

Sequence: ... tour left, **tour right**, tour left ...

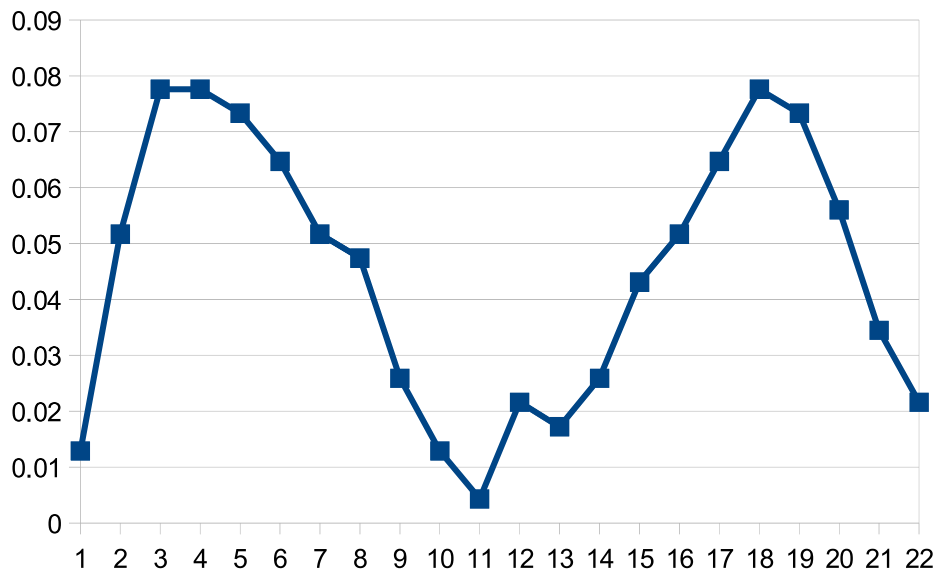

Fig 25: Enchainement 28, section 2, jump

Dancer is airborne in frame 5-18

Sequence: ... tour left, tour right, **tour left** ...

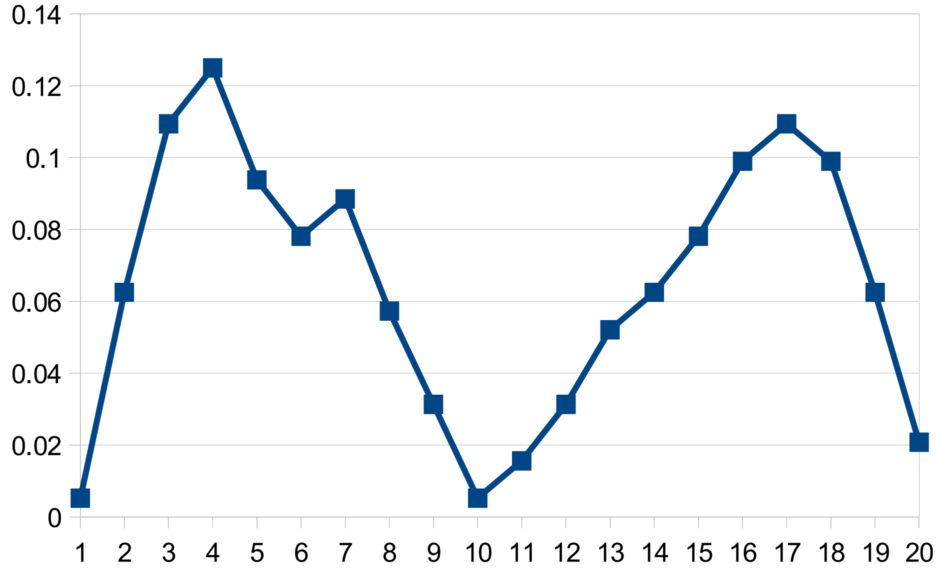

Fig 26: Enchainement 28, section 3, jump

Dancer is airborne in frame 6-18

Sequence: ... tour left, **tour right**, tour left ...

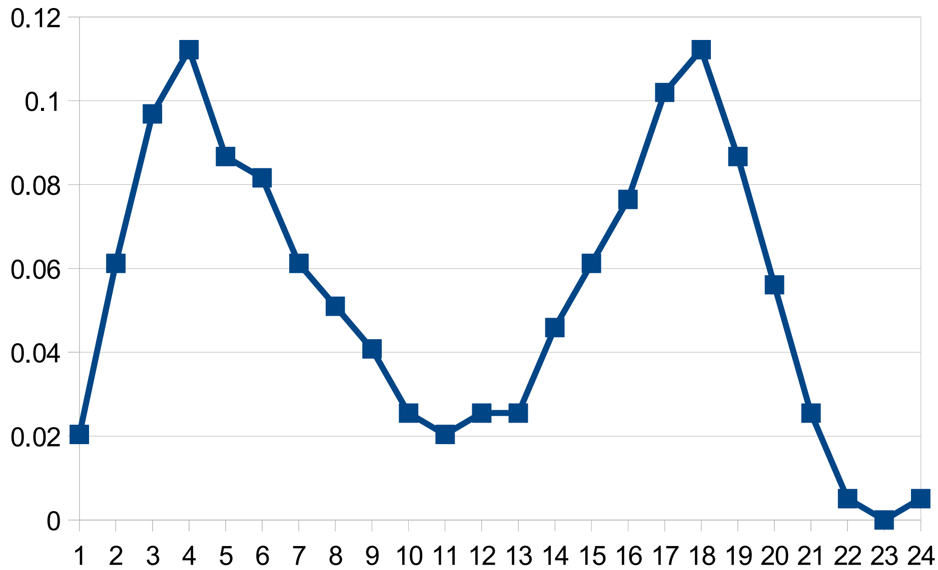

Fig 27: Enchainement 28, section 4, jump

Dancer is airborne in frame 6-18

Sequence: ... tour left, tour right, **tour left** ...

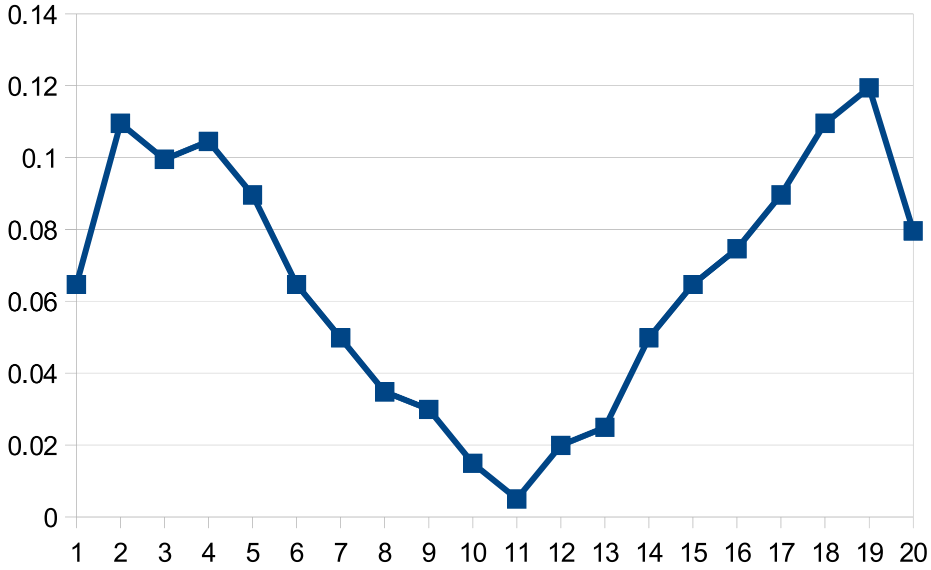

Fig 28: Enchainement 47, section 1, bounce

Dancer is airborne in frame 5-18

Sequence: ... assemble, **entrechat six**, entrechat six ...

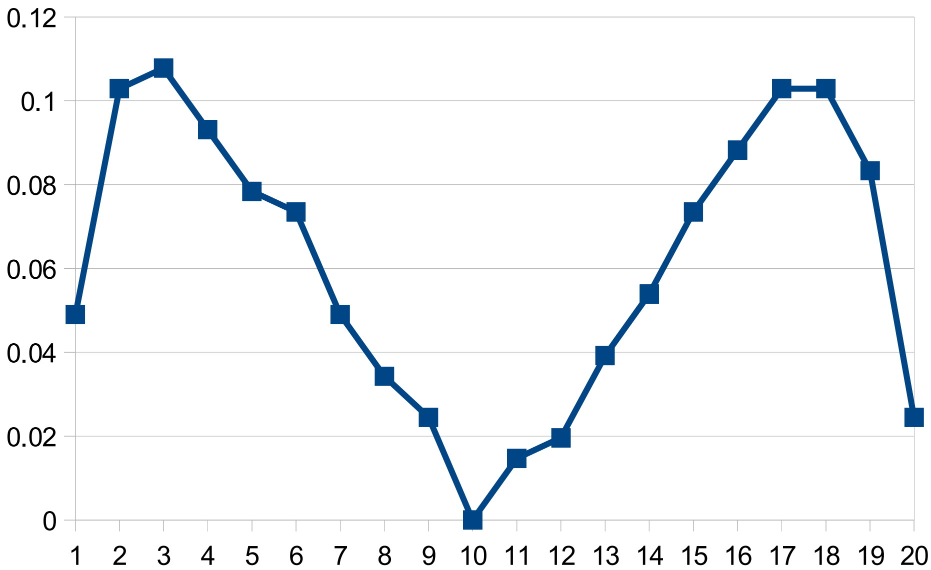

Fig 29: Enchainement 47, section 2, bounce

Dancer is airborne in frame 5-17

Sequence: ... assemble, entrechat six, **entrechat six** ...

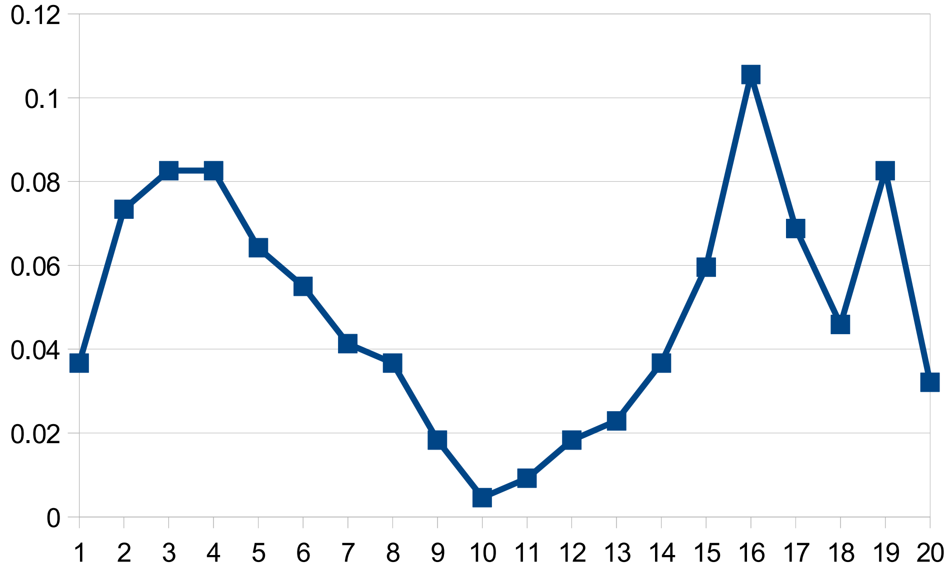

Fig 30: Enchainement 47, section 3, bounce

Dancer is airborne in frame 5-18

Sequence: ... assemble, **entrechat six**, entrechat six ...

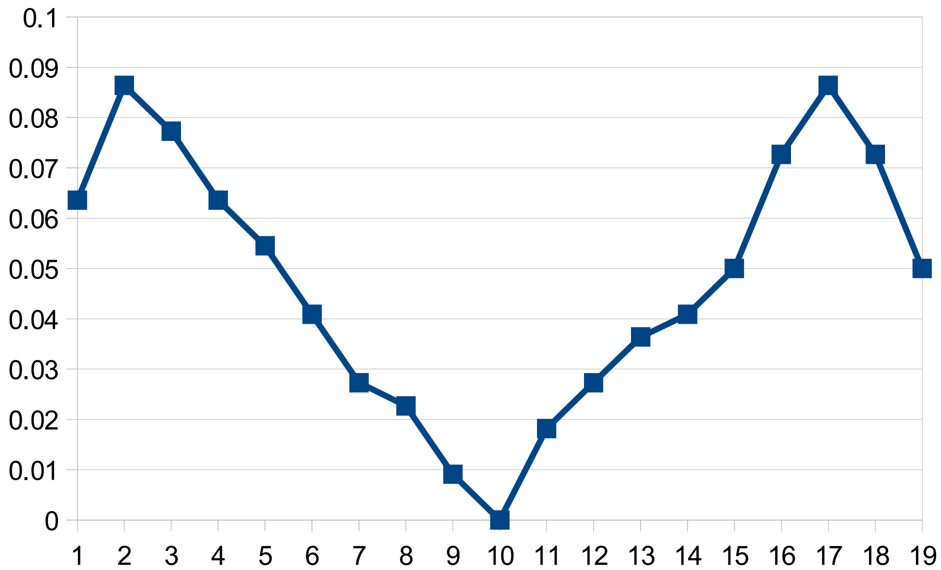

Fig 31: Enchainement 47, section 4, bounce

Dancer is airborne in frame 5-17

Sequence: ... assemble, entrechat six, **entrechat six** ...

Ench 14.1	Ench 14.2	Ench 28.1	Ench 28.2	Ench 28.3	Ench 28.4	Ench 47.1	Ench 47.2	Ench 47.3	Ench 47.4
0.0304	0.0423	0.0311	0.0129	0.0052	0.0204	0.0647	0.049	0.0367	0.0636
0.0696	0.0798	0.08	0.0517	0.0625	0.0612	0.1095	0.1029	0.0734	0.0864
0.0826	0.0986	0.0844	0.0776	0.1094	0.0969	0.0995	0.1078	0.0826	0.0773
0.0783	0.0939	0.0711	0.0776	0.125	0.1122	0.1045	0.0931	0.0826	0.0636
0.0609	0.0892	0.0667	0.0733	0.0938	0.0867	0.0896	0.0784	0.0642	0.0545
0.0522	0.0657	0.0578	0.0647	0.0781	0.0816	0.0647	0.0735	0.055	0.0409
0.0435	0.0469	0.04	0.0517	0.0885	0.0612	0.0498	0.049	0.0413	0.0273
0.0304	0.0376	0.0267	0.0474	0.0573	0.051	0.0348	0.0343	0.0367	0.0227
0.0174	0.0329	0.0089	0.0259	0.0313	0.0408	0.0299	0.0245	0.0183	0.0091
0.0087	0.0094	0.0044	0.0129	0.0052	0.0255	0.0149	0	0.0046	0
0.0043	0.0141	0.0133	0.0043	0.0156	0.0204	0.005	0.0147	0.0092	0.0182
0.013	0.0141	0.0178	0.0216	0.0313	0.0255	0.0199	0.0196	0.0183	0.0273
0.0217	0.0329	0.0356	0.0172	0.0521	0.0255	0.0249	0.0392	0.0229	0.0364
0.0391	0.0516	0.0533	0.0259	0.0625	0.0459	0.0498	0.0539	0.0367	0.0409
0.0522	0.061	0.0578	0.0431	0.0781	0.0612	0.0647	0.0735	0.0596	0.05
0.0565	0.0751	0.0711	0.0517	0.099	0.0765	0.0746	0.0882	0.1055	0.0727
0.1174	0.0892	0.0711	0.0647	0.1094	0.102	0.0896	0.1029	0.0688	0.0864
0.0826	0.0892	0.0622	0.0776	0.099	0.1122	0.1095	0.1029	0.0459	0.0727
0.0261	0.0704	0.0444	0.0733	0.0625	0.0867	0.1194	0.0833	0.0826	0.05
0.0435	0.0423	0.0267	0.056	0.0208	0.0561	0.0796	0.0245	0.0321	
0.0087	0.0282	0	0.0345		0.0255				
	0.0094		0.0216		0.0051				
					0				
					0.0051				

Fig 32: Aggregated velocities.

time	Xposition	Yposition	Xvelocity	Yvelocity	absolute_velocity	direction	change_in_absolute_velocity	change_in_direction	QoM
24	0.4968	0.0435	0	0.0304	0.0304	1.5708	0.0217	3.1416	0.0826
48	0.4968	0.113	0	0.0696	0.0696	1.5708	0.0391	0	0.1043
72	0.4968	0.1957	0	0.0826	0.0826	1.5708	0.013	0	0.113
96	0.4968	0.2739	0	0.0783	0.0783	1.5708	-0.0043	0	0.0957
120	0.4968	0.3348	0	0.0609	0.0609	1.5708	-0.0174	0	0.0783
144	0.4968	0.387	0	0.0522	0.0522	1.5708	-0.0087	0	0.0783
168	0.4968	0.4304	0	0.0435	0.0435	1.5708	-0.0087	0	0.0652
192	0.4968	0.4609	0	0.0304	0.0304	1.5708	-0.013	0	0.0478
216	0.4968	0.4783	0	0.0174	0.0174	1.5708	-0.013	0	0.0391
240	0.4968	0.487	0	0.0087	0.0087	1.5708	-0.0087	0	0.0304
264	0.4968	0.4826	0	-0.0043	0.0043	-1.5708	-0.0043	-3.1416	0.0435
288	0.4968	0.4696	0	-0.013	0.013	-1.5708	0.0087	0	0.0348
312	0.4968	0.4478	0	-0.0217	0.0217	-1.5708	0.0087	0	0.0565
336	0.4968	0.4087	0	-0.0391	0.0391	-1.5708	0.0174	0	0.0739
360	0.4968	0.3565	0	-0.0522	0.0522	-1.5708	0.013	0	0.0826
384	0.4968	0.3	0	-0.0565	0.0565	-1.5708	0.0043	0	0.087
408	0.4968	0.1826	0	-0.1174	0.1174	-1.5708	0.0609	0	0.1957
432	0.4968	0.1	0	-0.0826	0.0826	-1.5708	-0.0348	0	0.0304
456	0.4968	0.0739	0	-0.0261	0.0261	-1.5708	-0.0565	0	0.087
480	0.4968	0.0304	0	-0.0435	0.0435	-1.5708	0.0174	0	0.0478
504	0.4968	0.0217	0	-0.0087	0.0087	-1.5708	-0.0348	0	0.0304

Fig 33: Sample numeric output of enchainement 14, section 1, filtered data

Xposition_raw	Yposition_raw	Xvelocity_raw	Yvelocity_raw	absolute_velocity_raw	direction_raw	change_in_absolute_velocity_raw	change_in_direction_raw	QoM_raw
0.4968	0.0435	0	0.0304	0.0304	1.5708	0.0217	3.1416	0.0826
0.4968	0.113	0	0.0696	0.0696	1.5708	0.0391	0	0.1043
0.4968	0.1957	0	0.0826	0.0826	1.5708	0.013	0	0.113
0.4968	0.2739	0	0.0783	0.0783	1.5708	-0.0043	0	0.0957
0.4968	0.3348	0	0.0609	0.0609	1.5708	-0.0174	0	0.0783
0.4968	0.387	0	0.0522	0.0522	1.5708	-0.0087	0	0.0783
0.4968	0.4304	0	0.0435	0.0435	1.5708	-0.0087	0	0.0652
0.4968	0.4609	0	0.0304	0.0304	1.5708	-0.013	0	0.0478
0.4968	0.4783	0	0.0174	0.0174	1.5708	-0.013	0	0.0391
0.4968	0.487	0	0.0087	0.0087	1.5708	-0.0087	0	0.0304
0.4968	0.4826	0	-0.0043	0.0043	-1.5708	-0.0043	-3.1416	0.0435
0.4968	0.4696	0	-0.013	0.013	-1.5708	0.0087	0	0.0348
0.4968	0.4478	0	-0.0217	0.0217	-1.5708	0.0087	0	0.0565
0.4968	0.4087	0	-0.0391	0.0391	-1.5708	0.0174	0	0.0739
0.4968	0.3565	0	-0.0522	0.0522	-1.5708	0.013	0	0.0826
0.4968	0.3	0	-0.0565	0.0565	-1.5708	0.0043	0	0.087
0.4968	0.1826	0	-0.1174	0.1174	-1.5708	0.0609	0	0.1957
0.4968	0.1	0	-0.0826	0.0826	-1.5708	-0.0348	0	0.0304
0.4968	0.0739	0	-0.0261	0.0261	-1.5708	-0.0565	0	0.087
0.4968	0.0304	0	-0.0435	0.0435	-1.5708	0.0174	0	0.0478
0.4968	0.0217	0	-0.0087	0.0087	-1.5708	-0.0348	0	0.0304

Fig 34: Sample numeric output of enchainement 14, section 1, raw data

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http://en.wikipedia.org/wiki/XML

Computer programs:

Motiongram videoanalysis, version 0.5 published 10.08.2009

Authors A. R. Jensenius and K. Nymoen

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Sammendrag på Norsk

Bakgrunnen for denne masteroppgaven er den stadig økende interessen i bruk av dataprogrammer innen danseforskning. Masteroppgaven er utformet som en utforskning av hopp og sprett trinn fra videoen «fifty enchainements» ved å ta i bruk dataprogrammet motiongram. Formålet med denne utforskningen var å fastslå om motiongram-programmet kunne brukes til å fastslå forskjellen på trinn med hopp og sprett da disse er karakteristiske for Bournonville ballettstilen.

I prologen beskrives forfatter og det akademiske dansefeltet som tverrfaglige.

del I startet med forskjellige oppfatninger om dansestil kan sees i et diakronisk perspektiv og hvordan dette kan være til hjelp ved utvelgelse av videomateriale. Deretter fulgte en beskrivelse av hopp og sprett trinn innen klassisk ballet generelt og Bournonville ballettstil spesielt.

Del II inneholder teknisk bakgrunnsinformasjon. Først beskrives endel visuell aspekter som er viktige når dans omformes til videomateriale. Så fulgte en gjennomgang av dataprogrammet motiongram og et overblikk over prosessen med å framstille motiongram bilder. Tilslutt en beskrivelse av fysikken rundt hopp og sprett.

Del III starter med hypotesen og fortsetter med utvelgelsen av kildemateriale, primære og sekundære kilder, for så å beskrive prosessen med å velge utdrag fra kildematerialet. Etterpå følger selve analysen ved hjelp av motiogram programmet.

Den siste delen posisjonerer masteroppgaven, den inneholder refleksjoner om selve prosessen og tanker om hvordan resultatet kan brukes videre sammen med vedlegg, referanser, lister av dataprogram og illustrasjoner, dette sammendraget på Norsk etterfulgt av et sammendrag på Engelsk.

Utforskningen viste at motiongram programmet kan brukes til å fastslå små forskjeller mellom hopp og sprett, men for å klare dette må videomaterialet optimaliseres på forhånd. Utforskningen viste også at en trinnvis validering av mellomresultater er nødvendig for å oppnå gode resultater, noe som indikerer at motiongram programmet kan kalles et verktøy for å tilføre stringens til prosesser.

Summary

The background for this master thesis is the increase in interest for using computer programs as new tools in dance science. This took the form of an exploration of jumping and bouncing steps from the video “fifty enchainements” with the aid of the computer program motiongram. The aim of this exploration was to determine if the motiongram computer program could be used to determine differences between jumping and bouncing steps, these being characteristic markers of the Bournonville style of ballet.

In the prologue the author is situated in the interdisciplinary dancefield.

In part I a difference of how to determine dance styles was used to focus on Diachronic perspective in order to aid in the selection of source material. Then followed descriptions of movement characteristics of jumping and bouncing steps in classical ballet in general and Bournonville ballet in particular.

Part II contains technical background information. Fist aspect of visual perception of dance when translating dance into video material was touched upon. Then followed a description of the computer program motiongram and an outline of how motiongrams images are created. finally a brief description of the physics of jumping and bouncing was described

Part III starts with the hypothesis, then proceeds to the selection of source material, touching briefly upon primary and secondary sources, before describing the process of choosing excerpts from the source material. Then followed an analysis of the selected source material using the motiongram computer program ending with the conclusion.

The final parts positions the thesis, contains reflections on the process and some thoughts on extending the results with a roadmap along with appendix, references, list of computer programs and illustrations, a summary in Norwegian and this summary.

The exploration showed that the motiongram computer program could be used to determine small differences in the dynamics of jumping and bouncing, but this depended on pre-processing the original video source material. The exploration also showed that a step by step validation of the intermediate results where necessary in order to obtain good results, indicating that the motiongram program can be considered a tool for adding stringency.