PROCEDURAL ANIMATION: TOWARDS STUDIO SOLUTIONS for BELIEVABILITY

by

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Abstract

This thesis sets out to investigate the understanding of the relationship between key-frame movement performances and procedural animation. It is geared towards building a theory of practice that would help develop a succinct method for generating believable character animation using procedural animation. This research places an emphasis on a practical aproach to the theory of animation and movement, and investigates the historical development of character animation and the notion of believability. It uses Laban Movement Analysis as a method in the application of procedural animation. The study seeks to address the following objectives: (1) To examine what areas of procedural animation may enhance the believability of a key-framed movement performance; (2) To identify the areas of procedural animation that are or could be used within professional studio practice; (3) To examine the potential of procedural animation to help develop convincing and life-like character movements; (4) To identify where and how a key-framed character movement can be enhanced procedurally; (5) To carry out empirical studies in order to analyse the effects and possible benefits of procedural enhancements on a key-framed movement.

The techniques used for data collection include a literature review, observation, content analysis, a survey, discussions with practitioners and semi-structured interviews; the study also incorporates the author's experience in practice The information gathered was analysed quantitatively and qualitatively.

Procedural animation is an uncharted practice within the field of animation; as such, its effects and its relationship to the notions, phenomena, theories and understandings of character animation appear to have been little investigated. The discussions conducted with practitioners in the course of the study confirm that in the current context, where procedural animation is an unguided practice, they are driven to time-consuming implementation procedures, which also prevent undergraduate and postgraduate students to study and research in to this powerful tool. The recommendations and suggested approaches that follow aim to develop an understanding of the complex relation between the practice of procedural animation and believable character movement performances, to help fill this gap.

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Chapter 1: Introduction

1.0 Introduction

This research investigates the relationship between procedural animation and believable key-frame movement performances. It suggests a systematic approach to the implementation process of procedural animation, and examines the effects of this implementation on key-framed movement performances where believability of the animated character is central. This practice-led research uses Laban Movement Analysis as a method for categorising movement types. It applies contemporary procedural animation technologies to develop an understanding of a practice that would help guide practitioners towards an effective method of persuading an audience of a character's believability through the use of procedural animation.

This first chapter is divided into six sections. The first section introduces the issue under investigation. The second section outlines the scope and creative context of the research. The third section discusses the research agenda, stating the aim, objectives and questions that will be addressed in the course of thesis, and is followed by the relevance and implications of the research in the fourth section. The fifth section describes the research methodology and techniques used, and the final section presents the overall structure of the thesis.

1.1 Background and Statement of the Research Problem

The main purpose of this research is to investigate and explore the relationship between key-frame performances and procedural animation by focusing on the practitioners' methods for developing believable character animation, and their understanding of the notion of believability. As such, it is concerned with establishing the factors that contribute to the believability of the character within the context of animating character performances. This will be done by reviewing the development over time of the notions, theories and practices pertaining to performance and believability in character animation, and then by breaking the notion of believability down into its constituent factors. It is hoped this might contribute to bettering the practice of producing believable character animation. Whereas most research on the practice of procedural animation to date was confined to the field of computer sciences and engineering, this study approaches the use of procedural animation exclusively from the perspective of character animation.

In the practice of character animation, the fundamental success of the animated performance rests on the ability of the animator to create an engaging performance, which engenders empathy among the audience. Walt Disney suggested that a character animation should demonstrate a strong enough performance to make the audience respond emotionally to the animation (Thomas & Johnston, 1995). Animation practitioners and critics in the field refer to this empathic response as the believability of the character (Thomas & Johnston, 1995; Crafton, 2013).

Procedural animation is a contemporary, rapidly growing and currently progressing technology. With its processor-based calculation system, procedural animation provides practitioners with benefits that cannot be overlooked. Ed Hooks and Richard Williams highlight the importance of guidelines for common studio practice such as the *12 Principles of Animation* developed by Disney Company Animators in 1936 and its beneficial outcomes for the development and management of a professional studio project (Hooks, 2011; Williams, 2009). Currently, procedural animation (PA) lacks the benefits of having an equivalent set of guidelines (Appendices O & P). As such,, practitioners are driven to adopt methods such as produce-and-test or trial and error. This means the planning and implementation of PA and its toolsets require a considerable investment of time and resources from the professional studio.

1.2 Scope of the Research

The field of study falls under the scope of animation theory and practice. Paul Ward (Ward, 2006 pp. 244-245) suggests that the field of animation is a highly interdisciplinary field interacting with multiple contexts and theoretical approaches, and states that it is through a “working participation, alliance and recognition between diversely situated people that the particular character of animation will emerge”. Animation indeed combines a wide range of discourses including film, fine art, philosophy, technology, aesthetics and individual expressions. As stated by Ward, “it takes and recontextualizes those discourses, but also it, in turn, is taken and recontextualized” (Ward, 2006). While this research investigates the relationship between key-frame performance and procedural animation, reflecting a practice-based, technical approach, it also explores the history and evolution of character within animation and how the audience responds to the performance delivered by the character. This reflects a more critical approach, drawing on theory relating to art history, movement and performance, and audience-oriented studies to inform practice. In the process, this research uses Laban Movement Analysis (LMA) to contribute towards cultivating a theory of practice for using procedural animation, the specific aim here being to enhance character believability.

The importance of believability stems, in part, from the centrality of character to the animated performance. Donald Crafton (Crafton, 2013) views the animated character as an actor and a vessel for the animator to communicate the emotions they want to express, by composing performances which form or add to the story. A character breathes life into the animation and plays a role that cannot be overlooked, which is why contemporary studios put significant effort into expanding the body of knowledge within the practice of character animation. With this in mind, I chose to focus on the character element within animation.

Professionals in the field (Thomas & Johnston, 1995; Hooks, 2011; Williams, 2009) suggest that believable characters play an important role in engaging the audience and communicating the story explicitly. Therefore, developing believable character animation is and has been a major concern in commercial narrative animation production, short and feature animation production and the field of interactive computer games. Walt Disney and Early Disney company animators undertook the most significant development in this area in 1936. highlighting the importance of a character being life-like and convincing, or ‘believable’, they composed a set of guidelines for the utilization of key-frame animation that have since become common studio practice (Thomas & Johnston, 1995). These guidelines were developed between 1934 and 1936 and are known as the “12 Principles of Animation”. These principles and the notion of believability will be reviewed in detail in the following chapters. However, as argued by Donald Crafton (Crafton, 2013), the audience’s expectations and criteria regarding the believability of characters evolve rapidly, driving contemporary professional studio practitioners to find and adopt new ways of expanding their body of knowledge. The adoption of procedural animation is one of the fruits of this expansion.

This study brings together aspects of the theory and practice of animation and aspects of movement theory, and uses this combination to address the application of procedural animation and a concern with exploring the relationship of procedural animation and key-frame movement performances in the face of the increasing complexity of professional animation projects. The main objective is to investigate the aspects of the relation between key-frame performances and procedural enhancements and to explore the ways which procedural animation can contribute towards a succinct method of developing believable character animation. At the same time professional studios could devote more resources to establishing guidelines for better practice in this area.

Although the field of games and animation involves themselves with physics-based simulations, they are more commonly used by computer sciences and engineering as a method of predetermining or simulating events such as testing the threshold of an earthquake-prone building on a digital environment. This study does not use the usual methods for physics-based simulations (PBS); instead, the currently recognized methods used by animation and game practitioners such as cloth, muscle and hair PBS's were investigated and empirically tested. An investigation of the use of procedural animation within keyed character performances was thus established; four movement performances were designed according to the movement types Laban Movement Analysis explore the results of procedural enhancements. These movement performances were categorized using Laban Movement Analysis so that the experiment results could be addressed by practitioners in future projects.

In order to cultivate a theory of practice which could inform practitioners using procedural animation and better understand its relationship to key-framed movement performance, this study investigates the advantages of using procedural animation and its contributions to developing a believable key-frame character performance. The research stresses the need to characterize theories, phenomena, notions and practices of animation based on the utilization of procedural animation within character animation, and seeks to expand the boundary of knowledge specific to character animation practice.

1.3 Research Agenda

1.3.1 Research Aim

The aim of this research is to develop an understanding for implementing procedural animation, and form this understanding to cultivate a theory of practice that would guide practitioners towards a more succinct method of persuading an audience of a character's believability by utilizing procedural animation.

1.3.2 Research Question

(1) What is the current understanding of the application of procedural animation for character believability?

(2) How can procedural animation affect the overall outcome of a key-framed movement performance within the context of character animation?

1.3.3 Research Objectives

(1) To examine what areas of procedural animation that may enhance the believability of a key-framed movement performance.

(2) To identify the areas of procedural animation that are and could be used within professional studio practice.

(3) To examine the potential of procedural animation to help develop convincing and life-like character movements.

(4) To identify where and how a key-framed character movement can be enhanced procedurally.

(5) To carry out empirical studies in order to analyse the effects and possible benefits of procedural enhancements on a key-framed movement.

1.4 Relevance of the Research

Procedural animation is a new field in the context of animation; until the early 2000s, it was only given due attention in computer sciences, programming and engineering. Procedural animation is a computer processor-based condition and rule-calculating form of animation that could provide the field of character animation with fruitful results by animating complicated details.

The design and implementation procedures for physics-base simulations (PBS) are rather more complex compared to standard character- and key-frame animations. As such, a high resource is required to include procedural animation in to an animation project. This may rise as an issue for low budget game and animation studios and a risky investment for high budget ones. Unfortunately, this also means there is little cohesive practice and no guidelines for a common studio practice for procedural animation, which may help practitioners to understand the relevance of procedural animation to the character movement performances.

The exercise of procedural animation is complex and involves challenging issues. With this in mind, this research will focus on one aspect of the issue only, character movement performance. This research will investigate theories and practices, which may contribute towards revealing the relationship between a movement performance and procedural animation. It will also undertake several empirical studies aiming to contribute to the body of knowledge on animation theory and practice, character animation and procedural animation.

This research aims to study the theory and practice of animation. It utilizes the methods, techniques and skills used by practitioners to create believable character animations and combines them with movement theory to make a synthesis which could help guide the application process for procedural animation, providing the initial steps towards a set guidelines for common studio practice. This will contribute towards better planning for the implementation process of procedural animation within character movement performances.

1.5 Research Methods and Data Collecting Techniques

This study adopts the action research approach and a combination of qualitative and quantitative methods for analysis. The four main research phases were as follows: literature review, empirical study, sample survey and semi-structured interviews.

1) Literature review

A review of existing literature was conducted to establish the theoretical framework of the research. Three aspects were reviewed: character animation, movement performance and procedural animation. The literature review discusses and evaluates the existing theories, notions and phenomena relating to these three key concepts.

2) Experimental studies

Following the literature review, a series of experimental studies were undertaken to test and demonstrate the effects of procedural enhancements. The experiments were custom designed, specifically tailored to the purpose and aim of the study. They were undertaken in two stages:

i. Initial stage:

This stage had two main purposes: first, to explore the potential of procedural animation for producing life-like and convincing character movement performances; second, to study and analyse the currently recognized approach to using procedural animation within character animation.

ii. Second stage:

This stage included two phases. The first phase was a pilot experiment aiming to determine a suitable form and use of procedural enhancements; the second phase was designing the movement performances to be tested. In this phase Laban Movement Analysis and Laban's effort theory was utilized as a method of categorising types of movements, which covers an extensive amount of movement a human body can perform. This was done to test the effects and relationship of procedural animation with key-frame performances in different movement situations and investigate how procedural enhancements affect the overall believability of the performance.

Four animation groups were developed to demonstrate Laban's eight basic actions, and all videos included three different levels of procedural enhancements. These enhancements were kept confidential from the sample group to avoid influencing their judgements in any way.

3) Sample survey

In this stage, information pertaining to the experimental study outcomes was collected using a SurveyMonkey online survey questionnaire. This survey aimed to evaluate the experimental study results and collect data relevant to the research questions. The respondents were selected randomly from the global email lists of Anglia Ruskin University, Nottingham Trent University Researchers and Teaching Staff, the Animation Postgraduate Research Group United Kingdom (Animation PGR) and companies working in partnership with Creative Front. A total of 300 questionnaires were sent out.

The aims of the questionnaire were:

i. To explore how procedural enhancements affect the key-framed movement performance.

Information relevant to this issue was collected by asking the respondents to define the different versions of the procedural enhancements using vocabulary specific to the field of animation. The terms and notions were explained in detail within the survey questionnaire.

ii. To help establish the factors which cause the key-framed movement performance to be affected by procedural enhancements.

This information was collected by asking the respondents to specify the parts of the character and animation that most affected their choices in the previous question.

iii. To help devise a set of guiding principles which might help the practitioner in the planning and design phase of the procedural animation by revealing how and why procedural animation is perceived the way it is perceived within this study.

4) Semi-structured interviews

Semi-structured interviews were conducted with nine professionals to additionally discuss and evaluate the data collected following the experimental study that was undertaken to solve their problems. The interviews further discussed the theories supporting this research and the contribution of the research outcomes to their practices. The semi-structured interviews gave more depth to the outcomes of the research by discussions stated with open ended questions allowing the professionals to give their free opinions and even suggestions on the results gained from the research.

These four stages generated qualitative and quantitative data for analysis. The data from the survey questionnaire was coded, processed and analysed using SurveyMonkey. It was important to see whether the respond rate of the same group was enough to validate the results of the survey outcomes therefore a validity and reliability test was conducted due to respond rates. The validity and reliability tests were conducted using the Sample Size Calculator online software. The interview data, on the other hand, was individually and comparatively qualitatively analysed using Atlas. ti interview data analysis software to create themes and categories. The date gathered from the interviews had to be organised so that specific themes could be created. Since it is a complex process to draw out and compare data from the transcript interviews academic software to help organise this process was chose so that this research could eliminate any mistakes in this stage.

1.6 Structure of the Thesis

This thesis is composed of seven chapters where the first chapter is the introduction to the research paper. The second and third chapters examine literature and practices within subject of character movement performance, the notion of believability and procedural animation within character animation, then applies critical focus to the subject of this research and the fourth chapter describes the methodology. The fifth, and sixth chapters include experiments undertaken and their findings. The final chapter presents the conclusion and produce recommendations and guidelines. The following paragraphs will give detailed information about the contents of the chapters.

The second chapter includes the literature review, which provides and introductory background to the theory and practice of animation. It applies a critical focus to the theory of animation, the origins of movement performance, practices, phenomena and notions relating to character and procedural animation. The characteristics of character animation practice and its design methods are examined in relation to animation theory. The second chapter also examines the common studio practices predominantly used within the field and their application stages. The review outlines the common needs of professional studios regarding character animation. Chapter Three includes a review of other research related to the subject of procedural animation and animated character believability; and further expands on the current lack of research on the specific topic of utilizing procedural animation for believability of movement performances and narrative benefits.

Chapters four, five and six describe the research scope, aim, objectives, experimental studies and the data collection and analysis of the research. Chapter four outlines the study's scope, purpose, objectives, and underlying hypothesis, and states the methods and approaches used to collect and analyse data. Chapter five discusses the experimental stages of the research and the techniques and theories used to conduct them, revealing the full design and application of the theory to the design. Chapter Six describes the data gathering and analysis phase of the research and outlines the qualitative and quantitative methods used to obtain information from the survey questionnaire and interviews.

The final chapter of the thesis is the seventh chapter, which presents the conclusion of the thesis. Chapter seven includes the main findings of the research and addresses the research questions by suggesting an approach to improving the character animation practice. Recommendations and suggestions regarding the practice of procedural animation including its relation with movement performance and its effects on the believability of movement performance are then made. Finally, the research bibliography and appendices follow the seventh chapter.

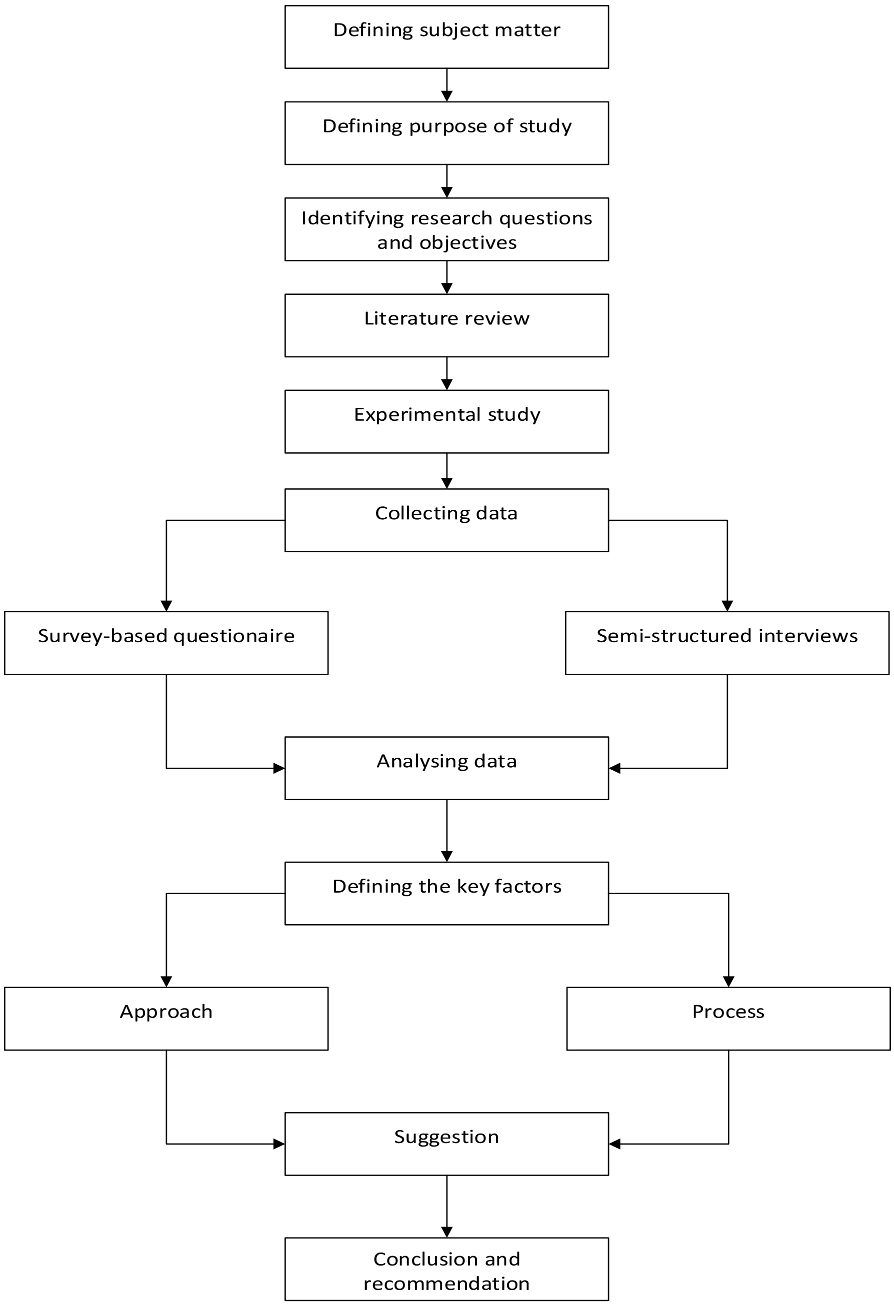

Diagram 1.1. : Structure of the thesis

Chapter 2: Animation and the Evolution of Believability within Animation

2.0 Introduction

This chapter introduces definitions and discussion of key concepts in the vocabulary of animation that are used in this thesis. In addition, believability in animation is analysed through an examination of the evolution of character in animation. The analysis aims to identify factors in the design of animated character which affect its believability. The thesis examines movement within character performance, and so this chapter also analyses movement in character animation and its origin and development during the Experimental Era of animation (1900-1927).

Next we examine the analysis of believability and realism within animation studies. The origin and development of both these concepts within animation are examined through current research in the field. This thesis aims to examine enhancement of believability within character animation, and so professional studio practice and related research are reviewed.

Finally, we introduce performance in animated characters, analysing it in detail to investigate the effect of movement in performance on the enhancement of animated character believability.

Thus this chapter is in three sections. An investigation of broad issues and contexts. A review of relevant areas of animation that have been studied academically, or in the context of professional studio practice, or both. Finally issues that are key to the research question, the notion of believability and animated characters movement performance.

2.1 Definition of Key Concepts

The key concepts are character animation, believability, performance of and in character animation, procedural animation and key-frame animation.

2.1.1 Animation

The Oxford Dictionary (2013) defines animation as “the state of being full of life or vigour; liveliness” and also as a technique for photographing successive drawings or images to create the illusion of movement when shown as a sequence. Webster’s Dictionary (2013) defines animation as “a motion picture made by photographing successive positions of inanimate objects (such as puppets or mechanical parts)”; also an animated cartoon as “a motion picture made from a series of drawings simulating motion by means of progressive change”. Webster’s Dictionary also refers to one of Walt Disney’s definitions, in which he suggests that “animation is the process of creating the illusion of life” (Thomas & Johnston, 1995).

There are numerous definitions for the word “animation”, and arguably one of the most comprehensive ones is from Wells:

> To animate, and related words, animation, animated and animator all derive from the latin verb ‘animare’, which means ‘to give life to’ , and within the context of the animated film, this largely means the artificial creation of the illusion of movement in inanimate lines and forms. A working definition therefore, of animation in practice, is that is a film made by hand, frame-by-frame, providing and illusion of movement which has not been directly recorded the conventional photographic sense. (Wells, 1998, p. 10; see also Nelmes, 2011).

2.1.2 Character Animation

The word ‘Character ’ is derived from the Greek word ‘Kharakter’. Kwan (2004, p. 8) suggests that the term stands for a symbolic image such as a cartoon, caricature, mascot, comic strip character, etc. An ‘animation character’ is an illusion of a living entity and a primary element of animation which can develop a communication link between the observer (audience) and the animator through performance. ‘Character animation’ is a specialized field of animation, which involves generating the illusion of a performance or acting. However, Hooks (2011) and Thomas & Johnston (1995) suggest that both the performance and the character originate from the animator, therefore the animator is the real performer.

2.1.3 Believability in Animation

The Oxford Dictionary (2013) suggests that ‘believable’ is the state of being able to be believed. The term believability within animation (Thomas & Johnston, 1995, pp. 71-92) refers to the capacity of character animation to convince the audience and engender an emphatic response. Research shows that the term originated among animation professionals and animation studios during the late 1980s and early 1990s (Paik & Iwerks, 2007; Thomas & Johnston, 1995; Wells, 1998; Williams, 2009).

2.1.4 Key-Frame Animation

Key-Frame animation is an animation technique wherein animators draw every frame of the animation. With key-frame, the object or form is considered to have an initial appearance, shape or position. These features will progressively change over time to a different form of appearance, shape or position. Key framing simply controls the transition and transformation of these qualities in the animated form (Thomas & Johnston, 1995; Williams, 2009, 2012).

There are two types of key-frame animation: 1) Straight Ahead, where the animator draws every frame from the first pose to the last pose without defining any key poses, and 2) Pose to Pose, where the animator first defines a set of key poses (storytelling poses) and only then fills the gaps between these poses with in-between key frames (Thomas & Johnston, 1995). This research works towards improve the believability of animated movement performance by utilising procedural animation therefore it requires a base key-framed believable movement performance to work on and to study the application of procedural animation and its affects of keyed performances. The key-frame technique will be investigated in detail in the following sections of this research (Williams, 2009, 2012).

2.1.5 Procedural Animation

Procedural animation uses sets of rules to animate forms, instead of creating them by hand using the key-frame technique. Procedural animation is calculated digitally according to a set of rules and conditions. Before calculating values and setting up rules for the animation, the animator has to design, initiate or create sets of initial conditions then run the system for the processor to simulate or animate the form according to the set rules and conditions. These rules and conditions can be real life physics rules such as gravity, force, air density or behavioural rules such as those applying to certain materials; for example, silk or metal (DeLoura, 2008).

The very first procedural animation applied within the field of 3D animation was the fluid dynamics developed by Pixar for the short animated movie Knick Knack (1989) (Paik & Iwerks, 2007). Pixar utilised procedural animation to animate the snowflakes and the water bubbles in the glass dome (see Fig. 2.1).

Figure 2.1: Knick Knack (1989) (retrieved from Pixar, 2013)

2.1.6 Laban Movement Analysis (LMA)

Laban Movement Analysis (LMA) is a multidisciplinary method used for studying all varieties of human movement (Newlove & Dalby, 2003). LMA offers a substantial model for the understanding, description, visual and textual interpretation, and documenting of movement that includes contributions from a wide range of disciplines including kinesiology, anatomy and labanotation (Laban, 2011; Newlove & Dalby, 2003). LMA will provide a theoretical framework for the sections of this research that focus on movement in keyed performance, and the studies suggested by Laban will be considered during the design phase of the experimental stage. A summary of Laban’s work is provided here, and the applications of LMA to this study will be developed in Chapter Five.

Laban studied human body movement and movement on stage. In 1950, he published a study in which he synthesised and described his research findings and their outcome, which was LMA. After his death, Lisa Ullmann studied LMA and enlarged its scope by incorporating a wider range of studies from different fields (Laban & Ullmann, 2011).

LMA studies describe a series of regular polyhedral shapes, linking motion to geometrical shapes in order to analyse and synthesise human body movement (Newlove & Dalby, 2003). Laban referred to these shapes as ‘the five crystals’, and visualised the body stepping inside regular polyhedral shapes and moving within and around their spaces. Laban’s five crystals are the cube, the tetrahedron, the dodecahedron, the icosahedron and the octahedron. Additionally, Laban defined the movement of the left side and the right side of the body separately (Newlove & Dalby, 2003, pp. 27-61).

LMA considered movement by breaking it down into various aspects such as body, effort, shape and space. He analysed the constituents of movements and suggested methods and approaches for creating, drawing or designing various types of motion. This research uses LMA as a method to design groups of movement performances to help animation practitioners use the outcomes as a point of reference against which to compare and contrast their own work, and gain a broader vision of how procedural animation could affect a key-framed movement performance.

a) Body

The LMA ‘Body’ category was developed by Laban and his student Irmgard Bartenieff. It analyses human body motion and suggests a set of structural characteristics for its movements. Under this category, Laban and Bartenieff studied the general organisation of the human body; in particular, how its different parts connect and influence each other in motion (Laban & Ullmann, 1960; Lamb & Watson, 1987).

b) Effort

The ‘Effort’ category studies the characteristics of how a movement is performed, relating this to the inner intention of the human (Laban & Lawrence, 1947). Laban often described this category as ‘dynamics’ and highlighted the different ways in which the body organizes distinct actions such as reaching for a door or punching a door (Newlove & Dalby, 2003). Laban breaks down body movement under four sub-categories: space, weight, time and flow, and suggests two opposite polarities (eg. light/ heavy; slow/fast) for all four of these categories (Laban & Lawrence, 1947; Newlove & Dalby, 2003).

Laban emphasized that space, weight and time together constitute the action drive, in other words the effort behind the motion of the human body. Laban also assigned names to different movement combinations: Float, Glide, Punch, Slash, Dab, Wring, Press and Flick (see Fig. 3). Laban visualised these different movement combinations as a cube and often referred to this cube as the 'dynamosphere', based on his view of effort as 'dynamics'. The last category within Effort is Flow, which studies the continuity of motion; Laban suggested that almost every motion and action has a flow (Newlove & Dalby, 2003).

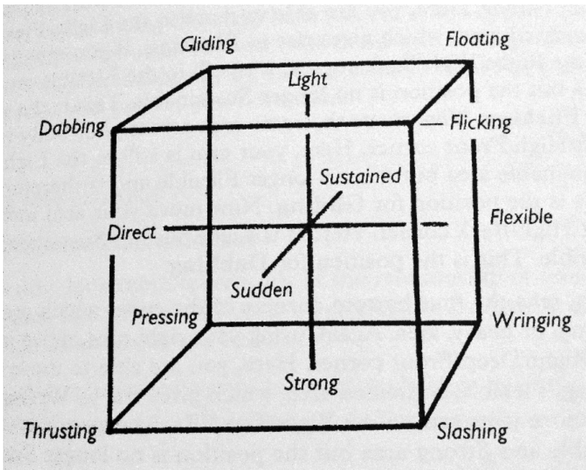

Figure 2.2: Laban's Dimensional Cross within the Cube (Dynamosphere) (Newlove & Dalby, 2003, p. 141).

c) Shape

The 'Shape' category studies the way in which the human body changes shape during and between poses. In Laban's practice, the body creates the structure of the relative connectivity of the body, while effort generates the motion for the body. This category specifically seeks to understand how the shape of the body deforms to achieve meaningful movements and deformations (Newlove & Dalby, 2003).

Shape includes four main subcategories: 'Shape Forms' studies the static shapes the human body takes; 'Shape Changes' studies the way human bodies interact and their relationship to the environment; 'Shape Qualities' examines active changes in the human body shape, such as rising or spreading, and 'Shape Flow' primarily observes the way torso movements support movement in the the rest of the body. The subcategories of Laban's

Shape concept were further developed and studied by Warren Lamb (Newlove & Dalby, 2003).

d) Space

The ‘Space’ category discusses the human body’s spatial and environmental connections when it moves. Laban stated that when the human body is in motion, the pattern it follows can be voluntary and conscious or adaptive to its environment and the space available. Laban suggested using the kinesphere to analyse and group movement types, and argued that when the human body moves it follows both a pattern and a rhythm (Newlove & Dalby, 2003).

Laban’s crystals can be considered as spaces during human body motion. The Space category studies movement by using geometrical systems to analyse the harmonic motions of the human body in performative actions. Laban suggested using kinespheres and choreographic patterns to identify the attention and intention of the human body during motion in space (Newlove & Dalby, 2003).

This research aims to help contribute towards a guide for implementing procedural animation in to keyed performances, therefore it focuses on improving the believability of the animated character to measure the affects of the procedural enhancements and seeks to investigate ways of approaching the improvement process by dividing it into two groups: movement and storytelling. LMA will provide a theoretical framework for the following sections of the research and the studies suggested by Laban will be considered during the design phase of the experimental stage.

2.1.7 Other Related Concepts

The following concepts relate to the field of animation, and help highlight the importance and scope of the concept of believability within animation. These concepts are storytelling, acting and movement; this section will also review the secondary concepts that are related to or incorporated within these three main areas.

(i) Storytelling (Narrative) within Animation

‘Narrative’ means “a spoken or written account of connected events; a story”; it is related to the verb ‘narrate’, which means to “give a spoken or written account of” (*Oxford Dictionaries*, 2013b). Narratology is the theory and study of narrative; it also studies the way in which narrative structure affects audience perception (Fludernik, 2009; Herman, 2010); as such, it was a relevant area to consider in the preparations for the experimental study.

Prince (2003, p. 58) defines narratology as “The recounting of one or more real or fictitious events communicated by one, two, or several (more or less overt) narrators to one, two or several (more or less overt) narratees.” This definition was extended by Chatman (1980), when he described narrative as conjunction of discourse and story and broadened the notion of discourse to cover multiple medias. Chatman also referred to narratology as the presentation of a story.

Asa Berger (1996) suggests that narratology expands to everyday life. His book defines a narrative as a story about things that have happened to a character or characters and describes a series of narrative structures. Berger breaks down the types of story structure in to two sections. One is the linear story structure; Berger suggests that many stories are linear and follow a straight pattern (see Fig. 2.3). He also notes that a story may not always follow a linear pattern and can move in circles, a structure he names ‘La Ronde’ (The Circle) (see Fig. 2.4). For Berger, a circular flow delivers a better understanding to the audience (1996, pp. 4-6). In order to help the audience to focus on the movement performance, complex narrative structures were eliminated from the experimental study stage, simplifying its animations.

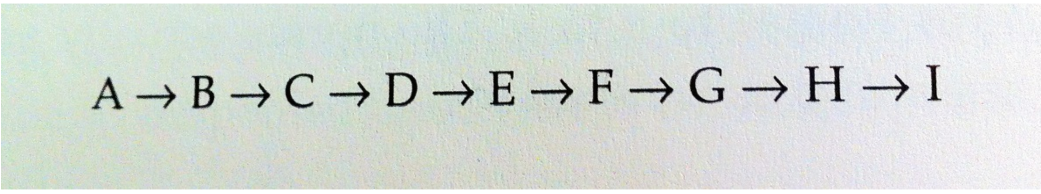

Figure 2.3: Berger’s Linear Story Structure (Asa Berger, 1996, pp. 4-6).

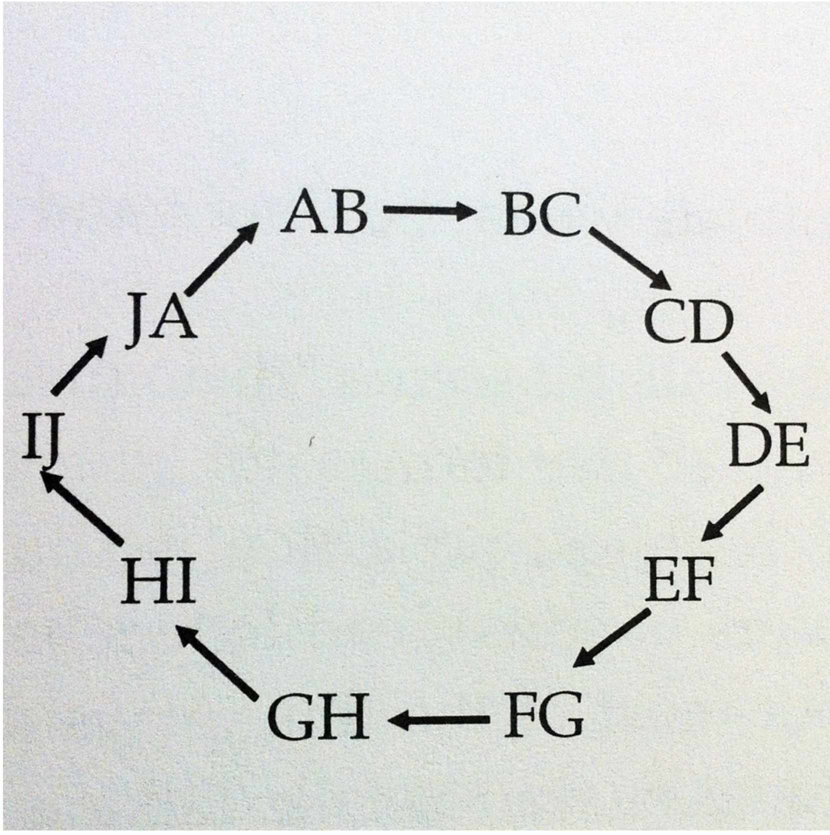

Figure 2.4: Berger 's Circular Story Structure (La Ronde) (Asa Berger, 1996, pp. 4-6).

In his research, Polkinghorne (1988) shows that the human brain perceives relationships in a sophisticated narrative structure, and his research findings are highlighted and further discussed by Fludernik (2009), who identifies that the structure of narrative flows between the storyteller and the audience who receives the story. Although Fludernik focuses on textual narratology, she associates narrators with ballerinas in her diagrams which shows them expressing thoughts and emotions and delivering the story through movement performance. Fludernik's research shows that movement performance plays a significant role in the construction of the narrative and its delivery. This research will further discuss the separation between the narrative acting performance and one of its constituents, movement performance, in the following chapters.

Berger (1996, pp. 147-160) refers to 'the willing suspension of disbelief' to explain the narrative's emotional effects on the audience. He suggests that the audience identify with the characters in narratives where the willing suspension of disbelief occurs, which highlights the role of the character in the delivery of the fiction and its success in convincing the viewer. How the the 'willing suspension of disbelief' operates with regards to character in animation will be further reviewed in the following chapters.

Thomas & Johnston (1995) and Williams (2009) suggest that storytelling plays a major role in engendering empathy among audience members within the field of animation. They both highlight the fact that Walt Disney and Disney studio professionals suggested that the absence of a story or a badly structured story may negatively affect believability within the animation.

Research shows that narrative content and structure play a role in screen-based media and therefore in animation. Research also shows that the character plays a role in telling or delivering the story to the audience; for this reason, the concept of narrative structure will be considered and its constituents will be investigated only within the scope of character animation, in the following sections of this research.

(ii) Suspension of Disbelief

'Suspension of disbelief' is an expression coined by poet and aesthetic philosopher Samuel Taylor Coleridge in a journal he published in 1917. Coleridge (2004) suggests that if a writer could embed "human interest and a semblance of truth" into a fantastic tale or a fiction this may drive the reader to suspend judgment regarding the implausibility of the narrative. A review of character animation history shows that during the 1900s the concept expanded beyond literature to include the field of animation. Welkos (1993) suggests that the factors underlying the suspension of disbelief can be used to help enhance the audience's acceptance of the narrative by leading them to partially ignore the limitations of a medium. Ferri (2007) suggests that if a written work of fiction such as a tale includes elements of human interest or has a semblance of truth, this tale causes the audience or the reader to suspend judgment on the implausibility of the story.

Successfully causing the audience to suspend their disbelief when faced with an animated character is a consistent issue within the field of animation, and one which this study seeks to address through its experimentations with procedural animation.

(iii) Audience Reception Theory and Active Audience Theory

Hall's Audience Reception, a theory that emerged during the 1800s, looks at the way an audience observes by using qualitative methods of research (Hall, 1980). Hall suggests the terms 'encoding' and 'decoding' to describe a specific type of message reception process, within a communication model where media messages are actively received and understood by the audience (Hall, 1980).

Audience theory studies the audience’s role and response in a rhetoric situation such as a speech or an act of fictional storytelling; it is an concept that thrives within literary theory and cultural studies (Abercrombie, 1998; Berger, 1995; Gauntlett, 2007; Ruddock, 2000; Stevenson, 2002). Audience theory is widely concerned with the media, media studies, culture and theatre. The theory also describes the ways in which a speaker or a writer address their audience, where real audiences and fictional audiences are considered.

A considerable number of studies and theories within media studies address the audience’s role in decoding messages. During the 1980s, the Centre for Contemporary Cultural Studies (CCCS) put forward the ‘New Audience Theory’ also known as the ‘Active Audience Theory’ (Birmingham, 2013). Active Audience Theory (AAT) is a marxist and sub-culturally (co-culturally) driven theory that comes under Audience Theory, embedding and adopting new media in the process (Huimin, 2011).[1] AAT describes the multiple forms of audience reception, and suggests that an audience can receive information actively as much as they receive it passively (Chandler, 2011). McQuail (1979, pp. 271-284) suggests that an audience receives and decodes messages from sources such as television, and the decoding can happen in various ways. Meaning can be passively received and decoded, when the audience is guided both through the story and the understanding of the message; or it can be delivered actively, though a covert message which doesn't refer to the viewer directly but instead refers to the audience’s life experience or previous knowledge gained about certain subjects.

Applied to the context of this research, Active Audience Theory suggests that the believability of animated narratives and characters depends not only on the animators’ output, but also on the audience’s reception and the way in which they decode what they see. As such, although Active Audience Theory is not central to this research, it will nonetheless be called upon when interpreting the survey results and the answers obtained from the interviewees in later sections of the thesis.

(iv) The Uncanny Valley

The Uncanny Valley Theory is a hypothesis that has been developed within fields where human aesthetics are involved, such as animation and robotics. The hypothesis was put

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[1] ‘Subculture’ refers to a group of people who differentiate themselves from the culture they originally belong to and groups themselves under the original culture (Nanda, 2003).

forward by robotics professor Masahiro Mori in 1970, who suggested that when humanoid replicas (robots or digital characters) have the appearance of human beings and move

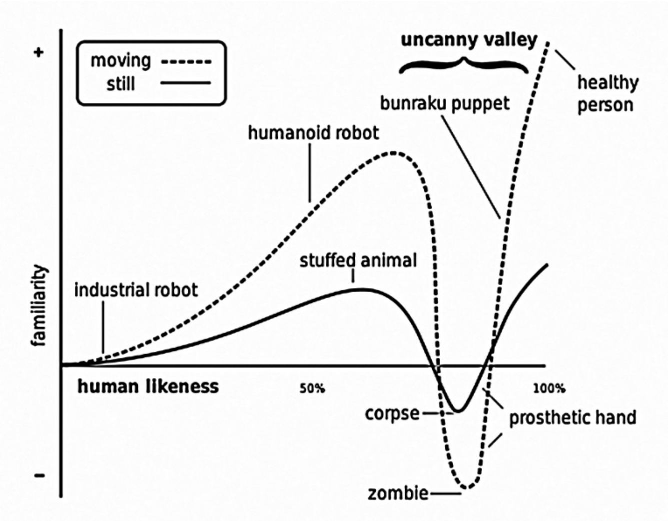

Figure 2.5: Professor Masahiro Mori's Uncanny Valley chart (Mori, 1970, p. 33)

almost, but not perfectly, like them, a sense of unease is generated among the human audience (Mori, 1970). Mori's study focused on still and moving human replicas and human-like figures on all scales and in a range of shapes (see Figure 2.5).

The Uncanny Valley hypothesis is considered important among animation professionals across the board. In an interview about *The Incredibles* (2004), Director Brad Bird states: "The character design was difficult. … CGI looks plastic without detail, but beyond a certain point with stylized deformed people, it starts to look creepy" ("Inside The Incredibles", 2005). Here, Bird highlights the disruption in the audience's experience; his description of the issue, and in particular his use of the word 'creepy', make this is a typical instance of the Uncanny Valley effect.

According to Thomas & Johnston (1995), early Disney Studio animators working at Disney Studios during the 1934–1936 period studied the line between imitating the real and generating believable characters. Walt Disney suggested that the unnecessary use of realism may in fact result in disrupting the believability of an animated character, which may affect the animated piece overall and ultimately disrupt the viewer's experience (Thomas & Johnston, 1995). Mori's Uncanny Valley hypothesis echoes Disney's observations, since both believe that replicating the movement and appearance of human features may cause revulsion among the audience.

Professor Masahiro Mori's Uncanny Valley hypothesis was rejected by David Hanson in 2003. A robotics professional, Hanson suggested that Mori's theory was 'pseudoscientific' and argued that robot designers should not be conceptually limited by a theory without scientific proof (Ferber, 2003). However, Hanson kept the scope of the discussion within the field of robot sciences only, while Mori's hypothesis extends to a wider range of fields including computer games and animation. The validity of the hypothesis is still considerably debated. In one of the most recent pieces of research on the matter, Kaba (2013) argues that the basis and relevance of the hypothesis is questionable, given that it adopts more then one field of study and scientific field, making it hard to arrive at a conclusion. However, in practice, contemporary animation, game and visual effects studios acknowledge the term and have generally adopted it to describe an effect they recognise. Likewise, this thesis does not debate the existence of the Uncanny Valley effect but acknowledges its existence and takes it into account in its design of the experimental stages.

The Uncanny Valley phenomenon was an important issue to take into consideration in the course of this research; since its effects have a disruptive effect on believability, they were to be avoided during the experimental study stages of the research. This was especially important in light of the fact that Procedural animation is a physics-based simulation designed to produce realistic movement.

2.2 Believability in Animation

This section sets out to study the notion of believability in animation. It will then focus on examining the specific issue of believability within character animation and its relationship to the movement performance of animated characters.

Paul Wells, in his journal article and his keynote to Animated Dialogues (Wells, 2007) discusses the theory-practice-history triangle of animation studies. He describes animation as "an art, a stance, a record of psychological and emotional memory, a technique, a concept" (Wells, 2007). Wells, discussing the theory and practice of animation study and describes historians as the describers of the animation and theorists as its 'interrogators' (Wells, 2007). He draws a link between theory, practice and history, stating: "No theory without practice; no practice without theory; no progress without history" (Wells, 2007). In line with Wells's approach, this section reviews and analyses the history of animation to in order to extract relevant information pertaining to the development of its techniques, teachings, toolset and notions. The assumption is that examining how the notion of character, character performance, and the believability of characters have evolved over time across various forms of animation will feed into a broader understanding of how to achieve believability in character movement performance using procedural animation. As such, the latter is viewed not as a separate technology bolted onto more traditional forms of animation, but as part of an evolving continuum.

This section aims to:

• Examine the most significant milestones that have been laid down by the professionals of the field and the drive behind them.

• Examine the development of movement (motion) in the 'Experimental Era' of animation (1900-1927) (Cavalier, 2011).

• Examine the notion of realism and believability within the field of character animation.

2.2.1 Origins and Development of Animation

The notion of animation and visual storytelling began with the attempt to visualize observations of daily life and natural events which occur around humans. Research highlights that there was evidence of an understanding of the techniques for creating sequential animatable images as early as five thousand years ago (Majlesi, 2012). The goblet discovered in the excavations of the burnt city of Shahr-e Sukhteh features static images of a goat jumping. Every image shows the goat in a different pose and position and when the goblet is spun around, it acts like an animation (see Fig. 2.6). Wells (1998, p. 11) also suggests that the development of animation extends back to 70 BC. Wells mentions evidence of a mechanism which can project hand-drawn images onto a screen, referred to in the poem 'De Rerum Natura' written by the Roman poet Titus Lucretius Carus in the 1st century BC. Evidence suggests that the first attempts at animation were made to replicate movement and to document natural events. The most striking part of the discovery cited above is that the artist who drew the images of the goat demonstrated an understanding of time and space by scaling the event onto multiple frames. Research shows that the first attempts at animation included characters to communicate a certain event or to entertain an audience by utilising devices. It appears that the animation of the goat was design according to its real life movement, in other words it was imitating natural movement of the creature, which reflects that the artist was behind getting a convincing poses of the creature during action.

Figure 2.6 : Painted Goblet found in the burnt city of Shahr-e Sukhteh (Majlesi, 2012).

In the early 15th century inventor and engineer Giovanni Fontana created a device that could project the illustrated images of a demon that Giovanni himself had designed (Sparavigna, 2013). The device is also known as the “Magic Lantern” (see Fig. 2.7) and the earliest known magic lantern dates back to c.1650 (Pfragner, 1974; Sparavigna, 2013). Inventors used the device for entertainment; images of supernatural creatures were reflected onto walls to make an audience think they were witnessing a paranormal event (Sparavigna, 2013).

At this point the review of historical data shows that an interest to moving image was imerging and utilising technology to create the illusion of movement. The initial aim of generating illustration to move them appears to be replicating movement that occur around those inventors during their daily life. In order to move their paintings and images inventors referred to technology and science, which allowed them to discover the limits of human perceptions and human eye.

“There will be a time when people will gaze at paintings and ask why the objects remain rigid and stiff. They will demand action. And to meet this demand the artists of that time will look at motion pictures for help and the artist, working hand in hand with science, will evolve a new school of art that will revolutionise the entire field.”

(O'Sullivan, 1990, p. 26)

Figure 2.7 : Magic Lantern (Retrieved from De Roo, 2014)

In 1824 British physician Peter Mark Roget presented a paper about ‘Persistence of Vision’ to the British Royal Society (Herbert, 2002). Although the phenomenon was briefly mentioned by the Roman Poet Lucretius in his poem ‘De Rerum Natura’ some sources also suggest that the Persistence of Vision theory originated in 1912 under the name of “The myth of persistence of vision” by Wertheimer (1912). Some sources claim that Persistence of Vision is considered to be a myth, describing a phenomenon which suggests an afterimage persists for one twenty-fifth of a second within the retina of the eye (Anderson & Anderson, 1993). However, Norman McClaren suggested that the recognition of movement is achieved between the frames (Wells, 1998, p.12), which supports the validity of the Persistence of Vision theory.

It is worth noting in passing that there is also a bibliographical debate regarding the origin of the theory. According to Anderson & Anderson (1993) and Anderson & Fisher (1978), Roget’s paper was in fact entitled “Explanation of an optical deception in the appearance of the spokes of a wheel when seen through vertical apertures”. These articles suggest that the title of this paper has been incorrectly referenced, following an error in citations by the film historians Terry Ramsaye and Arthur Knight.

Wells (1998, pp. 11-12) stresses the importance of the discovery and argues that it should be referred to as “Persistence of Vision Theory”. He also suggests that the theory determined why humans can perceive movement; as such, he believes Persistence of Vision is of the utmost importance when applied to film-watching in general.

During the Victorian era a popular device named the “Thaumatrope” (see Fig. 2.8.) made use of the persistence of vision phenomenon, also known as the Phi Phenomenon, to create the illusion of movement (Exeter, 2002; Herbert, 2000). The thaumatrope is a circular shaped card which has a different images on each side and it is attached to a pair of strings. When spun rapidly, the images on each side appear to blend, creating an illusion of movement. In 1824 British Physician John A. Paris presented a version of the thaumatrope to the Royal College of Physicians and demonstrated the Persistence of Vision phenomenon (Herbert, 2000). Like its ancestors, the thaumatrope used simple sequences of images, such as appearing and disappearing objects, animals and human characters.

Figure 2.8 : Thaumatrope (Herbert, 2013).

In 1829 Belgian physicist Joseph Plateau completed his doctoral thesis about colour and the retinal reception of colour. As an extension of his research findings, he developed a device called a “Phenakistoscope” in 1931 (Herbert, 2000) (see Fig. 2.9). The device was a circular shaped disc and had evenly spaced holes on it. The disc was designed to stand in front of a mirror. The viewer had to look through one of the holes on the disc and spin it to watch the reflection of the images blend in to each other and form a moving image. The phenakistoscope included animations such as a couple dancing or a clown juggling. Corporation (1857, p. 697) suggests that the device was in fact invented by Dr Roger and enhanced by Plateau and Dr Faraday in Brussels, while Herbert (2000) suggests that Australian inventor Simon von Stampfer also invented a phenakistoscope at the same time as Plateau in 1831. Arguably, the phenakistoscope was the first device to generate moving image and it has a rather higher number of frames when compared to its ancestors (Exeter, 2002). As such, the phenakistoscope can be considered a significant first step in the history of key-frame animation and character animation. The high number of frames and detailed human figures on the drawings shows that the inventors attempted to design a more convincing level of illustration. At this instance this can be seen as an urge for believable animated movement performances.

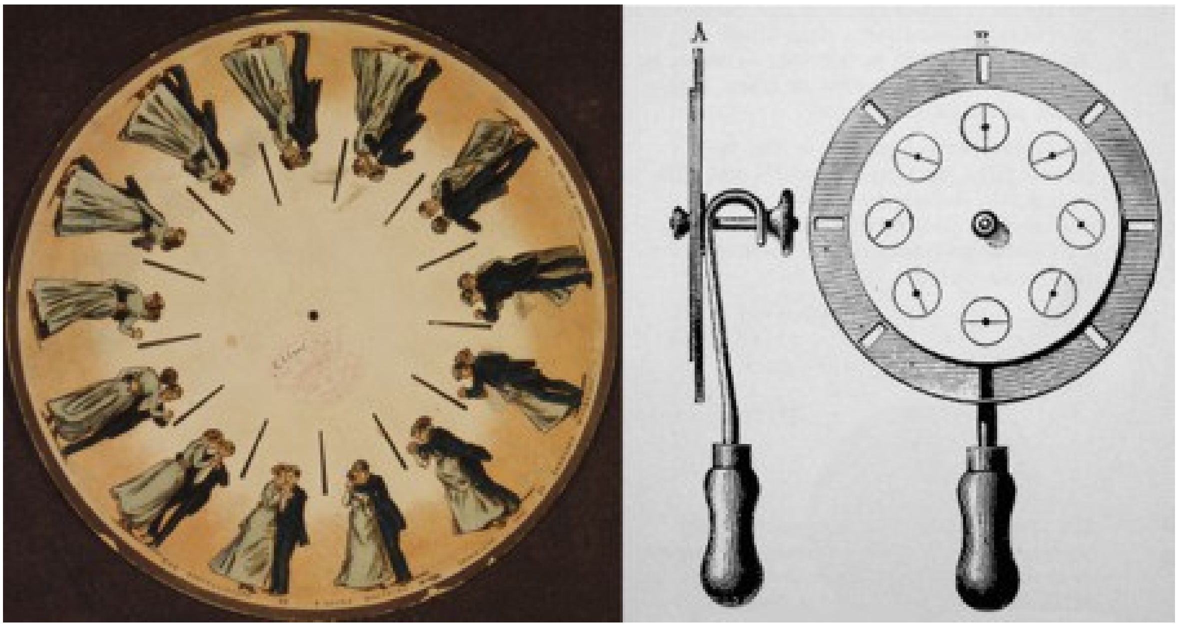

Figure 2.9: Phenakistoscope (Herbert, 2013).

In 1834 British mathematician William George Horner suggested a device with a similar design to that of the phenakistoscope (Exeter., 2002). The device worked according to a similar principle but instead this time the device was a cylindrical shape that held the drawn image frames in the interior section of the cylinder and had slots outside of the cylinder. Horner named it “Daedalum”, a word which was inspired from the Greek myth of Daedalus (Hayes & Wileman, 2005; Herbert, 2000). The device was designed to be placed vertically like a wheel, and when the viewer looked through it and spun the wheel the same visual effect as that of the phenakistoscope occurred. The device became famous and was referred to as “the wheel of the devil” (Hayes & Wileman, 2005). It was released and developed in America and named “Zoetrope” by the American inventor William F.

Lincoln (Hayes & Wileman, 2005). The device contained similar movement illustrations and sequential images to those of the phenakistoscope but with a higher frame number (see Fig. 2.10). Needham & Ronan (1978, p. 123) also argue that the first zoetrope may have been developed by the Chinese inventor Ting Huan (丁緩) in 180 AD. Huan designed a device that was similar to the modern zoetrope except for the fact that he used a translucent paper and set the device around a lamp, assuming the rising air currents would rotate the device. It has been suggested, however, that this was an incomplete device bearing very little evidence of any illusion of moving image when compared to the modern zoetrope (Herbert, 2000).

Figure 2.10: Zoetrope (Herbert, 2013).

A review of the historical progress of moving images shows that in the early stages of experimentations with the moving image, discoveries were used and devices made to create the illusion of magic. If early discoveries, rooted in science, sought to understand the relationship between the eye, the brain and the perception of image, a review of history shows that starting from the early 1820s, the devices produced for creating the illusion of movement were also used to communicate stories. This they did through movement performance, using characters.

In 1868 British printer John Barnes Linnett published the first flip book under the name of "Kineograph" (Cavalier, 2011; Furniss, 2008; Herbert, 2000) (see Fig. 2.11). Compared to the animation devices that came before them, flip books used longer sequences of images. The viewer has to bend the book backwards and release the pages rapidly one after the another to start the animated sequence. The flip book uses the same principles as the zoetrope and the phenakistoscope and can be viewed as straightforward key-frame animation. Doctorow (1976, p. 95) mentions that flip books also contained erotic drawings and were used for pornography, showing the performance of sexual acts. The kineograph demonstrated a storytelling ability through the use of the illusion of movement.

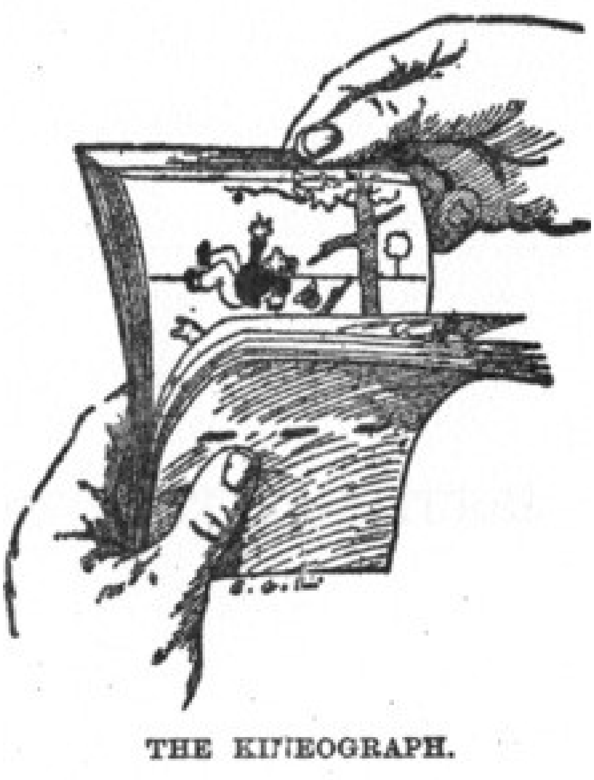

Figure 2.11: Kineograph (Flip Book) (Linnett, 1868)

Early animation continued to evolve through research into and development of motion replication in the late nineteenth century, when British photographer Eadweard Muybridge started collecting photos of animals and humans. Muybridge was interested in motion and how humans and animals performed certain everyday actions, such as running or walking, or even acrobatic movements such as artistic gymnastic performances. Muybridge shot every frame of action from a 90 degree angle from the front, back and side. When viewed sequentially, these shots formed a detailed photographic reference of a certain action in motion (see Fig.2.12). Director Michel Gondry later took inspiration from Muybridge's multi-camera system and used this in his music videos to digitally enhance the simulation of variable-speed frames within a film. This effect is called ‘Bullet Time’. In *Matrix* (Wachowski & Wachowski, 1999) visual effects designer John Gaeta used the effect to enhance his action sequences (Cavalier, 2011).

Muybridge’s discoveries and research are a significant milestone within the evolution of animation and still have a bearing on today’s professional studio practice. His animation schematics clearly indicate every detail within a character’s movement (animal, human, etc.) by defining all the key and in-between poses of the motion. Muybridge’s research represents a significant contribution to the field of animation and, of particular relevance in the context of this research, to movement performance.

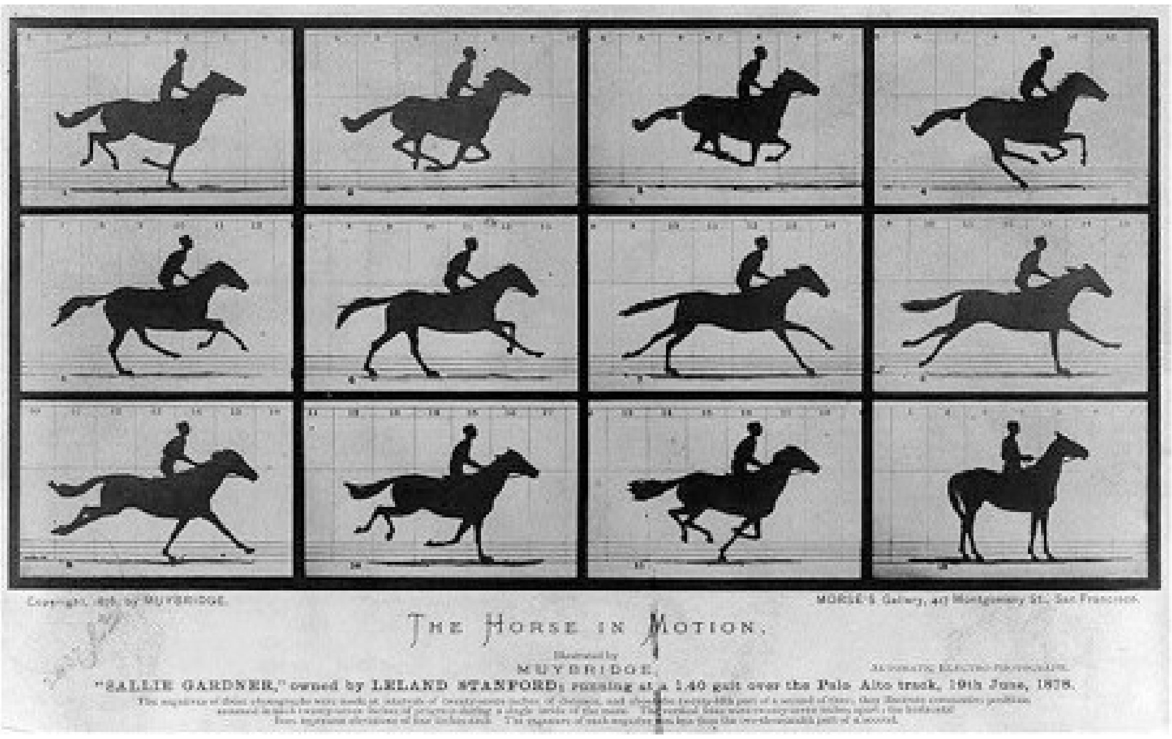

Figure 2.12: Eadweard Muybridge’s The Horse in Motion (Muybridge, 1878)

Eadweard Muybridge’s work and the technique he developed are widely used in professional animation and game studios in the 21st century. Known as live referencing, Muybridge’s approach was adopted by early Disney animators and arguably inspired the work of Max and Dave Fleischer, known as rotoscoping. Rotoscoping will be covered in the following sections of this chapter. Live referencing is a professional approach to presenting the movement performance of a character in a readable way, and was therefore used in the design of the research experiments elaborated for this study.

Eadweard Muybridge’s enthusiasm for capturing the movement of characters shows his interest in movement performance, and his study inspired other professionals to produce more convincing character animation and scenes.

In 1889 American inventor Thomas Edison invented the kinetoscope, a projector that can project a fifty-foot film strip in thirteen seconds (Congress, 2013). The device is considered to be an early attempt at motion picture (Phillips, 1997). The first design of the kinetoscope allowed only one viewer at a time to watch the short film through a peephole, which was placed on top of the device and included several sheets of sequential images Edison produced himself (Phillips, 1997). Like Muybridge, Edison was interested in capturing certain movement performances such as a man sneezing or walking (Phillips, 1997). Later, in 1895, Edison produced *The Butterfly Dance*, a short film featuring Annabella Whitford Moore (Phillips, 1997). The sequence shows Moore dancing with a long dress; as she dances, the cloth material morphs in to several different shapes following Moore’s dance figures. *The Butterfly Dance* quickly became a standard in motion picture and artistic still imagery with its creative use of cloth in a motion performance (see Fig. 15) (Phillips, 1997). Arguably the cloth deformations and the shapes generated by the flow of the cloth as Moore danced was the main point of interest of the film and the reason for its success. This highlights the importance of movement performance associated with a featured character.

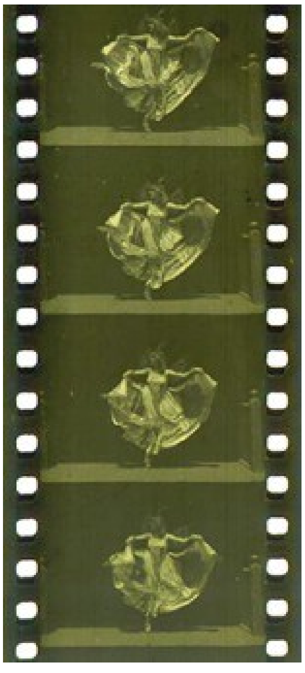

Figure 2.13: *The Butterfly Dance* featuring Annabella Whitford Moore, developed by Thomas Edison (Edison, 1895).

In 1895 French film-makers Louis and Auguste Lumière invented the *cinématographe*, a device capable of projecting films onto a screen (see Fig. 2.14). Cavalier (2011, p. 42) states that French film-maker and illusionist Georges Méliès saw the Lumière brothers' *cinématographe* near his theatre; he admired the device and immediately started setting up his own moving picture show. However, Méliès had to have his own custom made device made because the Lumière brothers were unwilling to sell the device to a rival film-maker. In 1896, when his camera jammed during a photo shoot, Georges Méliès discovered that he could make drawings and images appear and disappear by manipulating the speed of his camera; today this technique is known as the 'stop-trick' (Cavalier, 2011, p. 42; Wells, 1998, p. 13; 2002, p. 114). The discovery of stop-trick is considered to have introduced special effects to the cinema.

Figure 2.14: Louis and Auguste Lumière's Cinématographe. (Lumière & Lumière, 1895)

Wells (1998, p. 13) suggests that as a lightning cartoonist Georges Méliès pioneered many other special effects or 'trick effects' alongside the stop-trick, such as stop-motion photography and the split-screen effect, all of which he used to entertain the audience with magic tricks.. The first work Méliès published was *Le livre magique* (*The Magic Book*, 1900), in which a magician presents a human-sized book that contains mystical hand-drawn characters on every page; the magician then brings these characters to life by pulling them out of the pages of the book (Méliès, 1900). In 1902 he released *Le voyage dans la lune* (*A Trip to the Moon*), where he characterized the moon and blended a human face into it (see Fig 2.15).

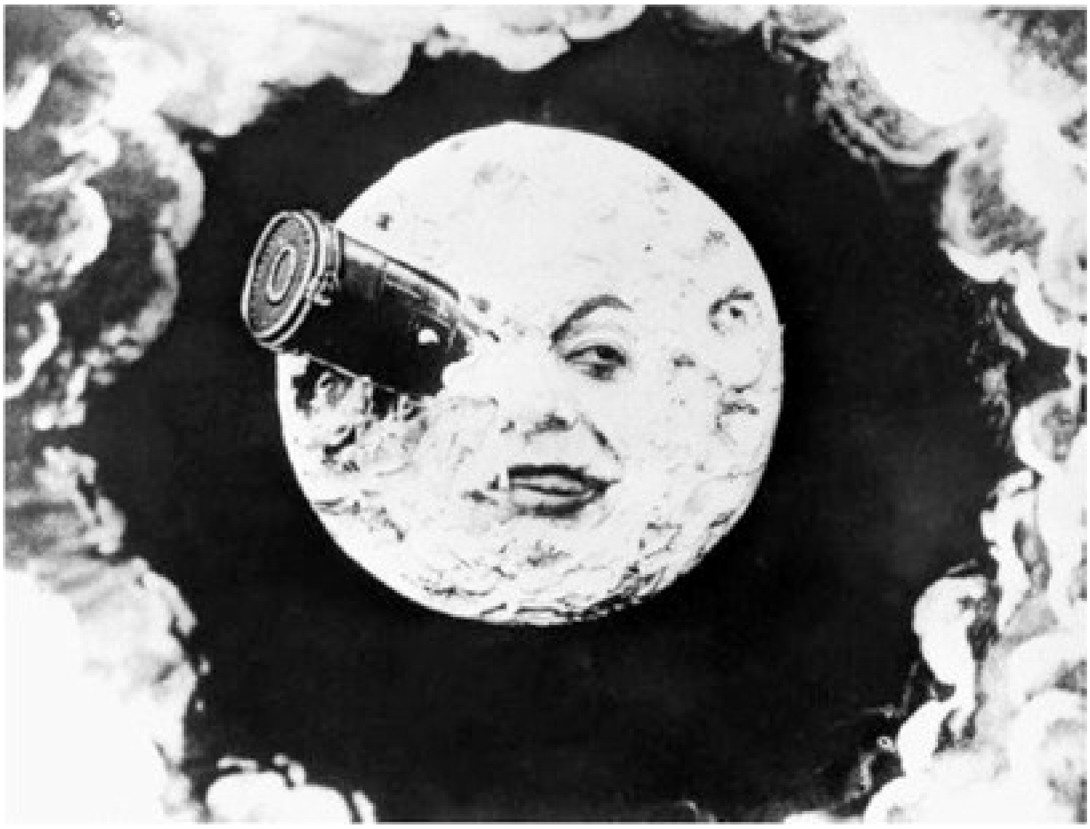

Figure 2.15: Georges Méliès's *Le voyage dans la lune* (*A Trip to the Moon*) (Cavalier, 2011, p. 43).

Cavalier (2011) and Wells (1998) suggest that the discovery of stop-trick marked the beginning of the experimentation era within film animation. Indeed, stop-trick offered many new possibilities for animators. In 1900, when American film producer J. Stuart Blackton made the *The Enchanted Drawing*, he used the stop-trick to incorporate himself in the film smoking a cigar, drinking wine and drawing a cartoon character. By revealing the character one drawing at a time, frame by frame, Blackton brings it to life, or rather creates the illusion of life. The use of animation was shifting at this stage in the history and Blacktons's use of stop-trick reflected this change. Although he was initially more focused on presenting magic tricks, he chose to incorporate the use of stop-trick to animate cartoon characters and bring them in to life as a part of his act.

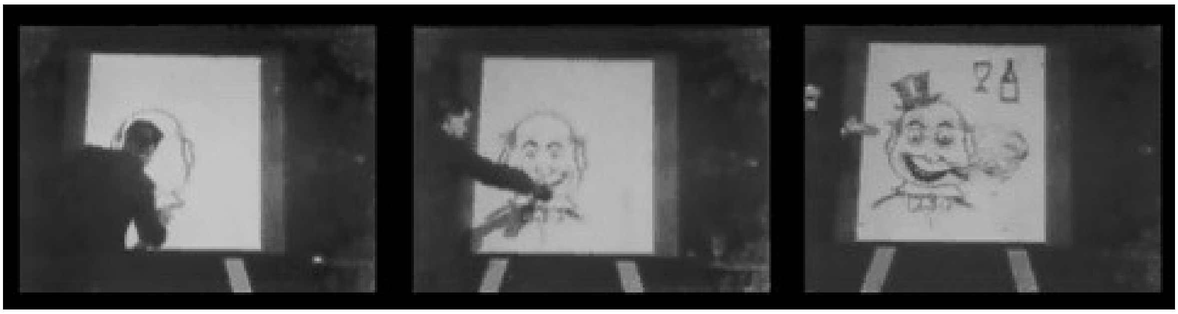

Figure 2.16: J. Stuart Blackton's *The Enchanted Drawing* (James Stuart Blackton et al., 1900).

During the experimental era of animation, film animation professionals took an interest in characterizing objects and generating unique fiction characters (Cavalier, 2011; Thomas & Johnston, 1981; Wells, 1998, 2002). In 1899, British film-maker Arthur Melbourne-Cooper published his animated stop-motion movie *Matches: An Appeal* (see Fig. 2.17) for the Bryant May match company, in which the public were asked to donate money for the British troops fighting in the Boer War in South Africa (Cavalier, 2011, p. 46). Cavalier (2011) states that many critics consider this to be the first true animated movie.

Matches: An Appeal (Arthur Melbourne-Cooper, 1899) features small characters made of matches; Cooper shot the movie frame by frame as the characters wrote a message on a blackboard. Similar successful stop motion attempts were undertaken during this time, such as Spanish photographer and film-maker Segundo de Chomón's *El hotel eléctrico* (*The Electric Hotel*, 1905) (see Fig. 2.18), in which he used the stop-trick to animate the furniture, making the hotel appear alive (Cavalier, 2011; Chomón, 1905). Arthur Melbourne Cooper made further attempts at character animation with short movies including *Dreams of Toyland* (1908) (see Fig. 2.19) in which a young boy dreams of his toys coming to life. These works are examples of early attempts at anthropomorphism applied to fictional characters; however, is unclear whether these film-makers consciously and deliberately sought to create the illusion of mood and individual identity or whether the effect was the natural, unselfconscious outcome of a creative approach to animation and magic tricks.

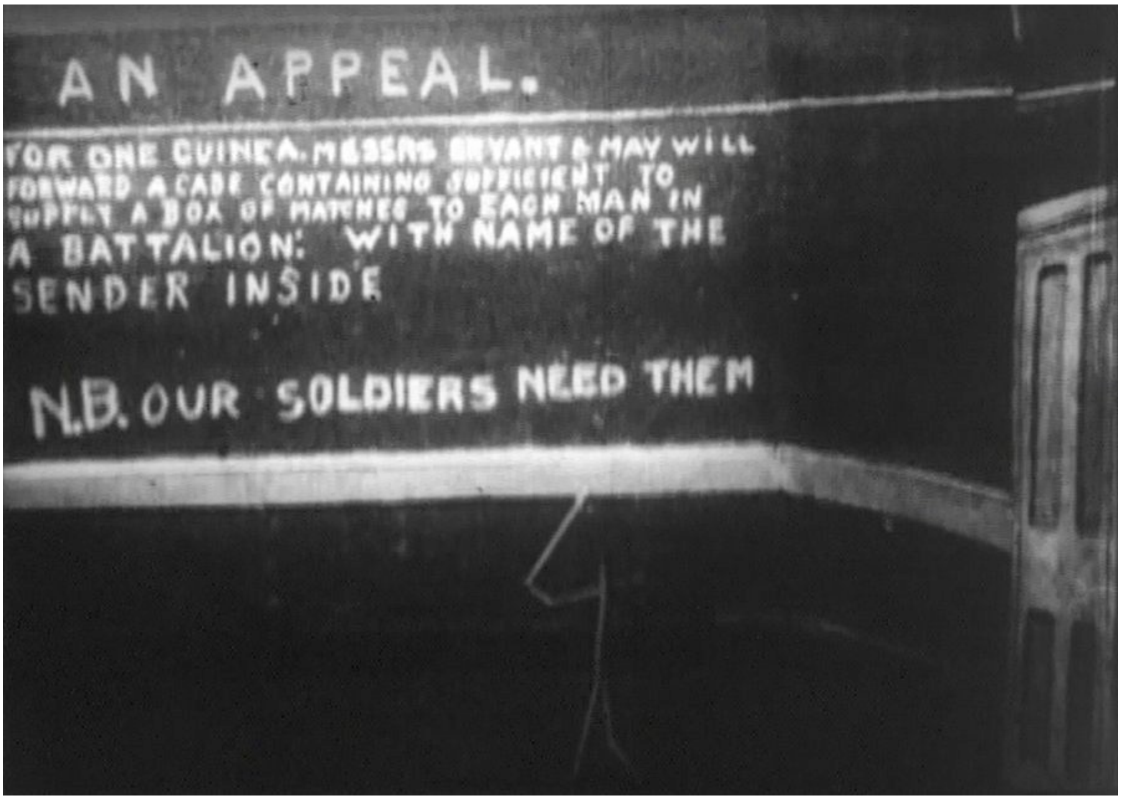

Figure 2.17: Arthur Melbourne-Cooper's *Matches: An Appeal* (1899, retrieved from Emmett, 2011).

Figure 2.18: Segundo de Chomón's *El hotel eléctrico* (*The Electric Hotel*, 1905; retrieved from Cavalier, 2011, p. 48).

Figure 2.19: Arthur Melbourne Cooper's *Dreams of Toyland* (1908; retrieved from Emmett, 2011).

Between the late 1800s and 1900 there was a significant level of interest in creating the illusion of objects coming to life and animation was adopting the notion of a magic trick; although in the early 1900s there were attempts to generate characters, these were mainly characterized objects. In 1906 J. Stuard Blackton made *The Humorous Phases of Funny Faces* (see Fig. 2.20), where he used stop-trick to create visual effects key-frame animate a series of facial expressions as well as a clown performing tricks and a gentleman juggling his umbrella (J. Stuart Blackton, 1906).

Between 1900 and 1906, animation was merely as a prop; the performance was the centre of attention and animation was used to perform trickery. 1906 was the first instance of a migration of the personality of the entertainer from the person presenting the animation to the character within the animation. From that point on, animation characters started to become invested with a personality and used as channel to communicate stories.

Figure 2.20: J. Stuart Blackton's *The Humorous Phases of Funny Faces* (retrieved from Cavalier, 2011, p. 49).

In 1908 French caricaturist Émile Cohl made his animated short *Fantasmagorie* (see Fig. 2.21). Some sources suggest that this was the first known animated cartoon in history (Cavalier, 2011). Cohl animated series of sequences where various types of characters and objects morphed in and out of other objects and shapes. Fantasmagorie was a fantastic short tale involving several characters (Cohl, 1908). Wells (1998, p. 15) describes Cohl's style as "incoherent cinema" where the film is composed of a free flow of seemingly unrelated images.

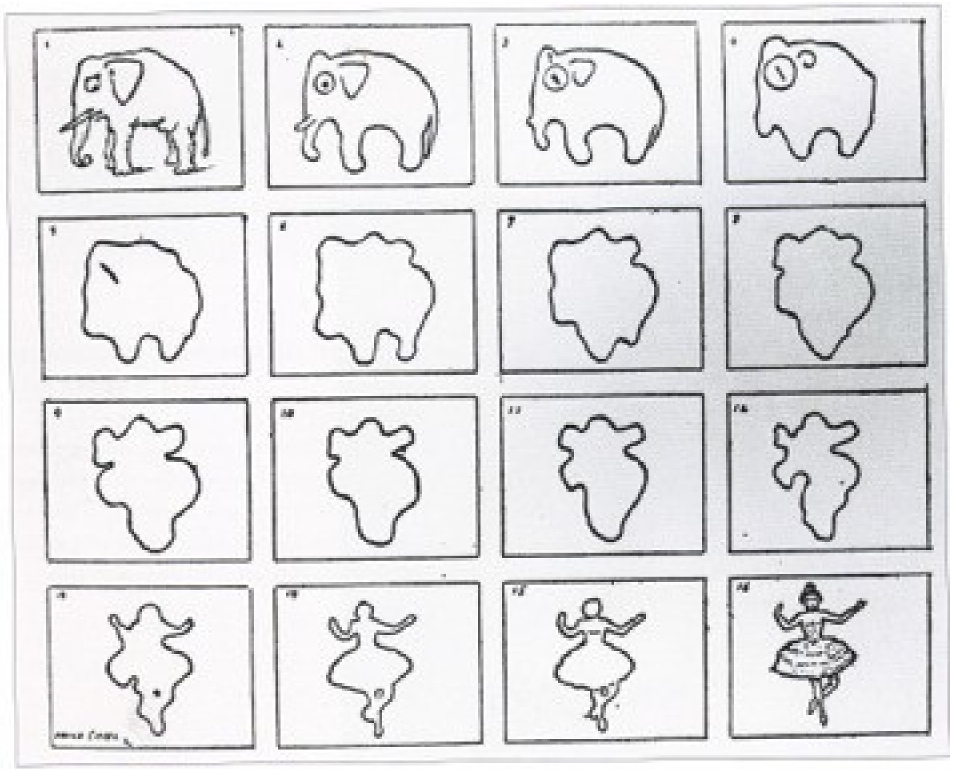

Figure 2.21: Émile Cohl's *Fantasmagorie* (retrieved from Cavalier, 2011, p. 50).

Many critics suggest that this "incoherent cinema" is a kinetic construction which is completely determined by the animator's choice of images, where the choice can be an outcome of his emotional and physiological state (Crafton, 2013, 1993; Thomas & Johnston, 1995; Wells, 1998). The same critics also suggest that the animations used in "incoherent cinema" were not similar to examples of early animation; the latter came across as magic-tricks or jokes and didn't reflect a narrative, whereas incoherent cinema attempted to communicate inner states, seek to acting on the emotions of its audience through movement.

Both "incoherent cinema" and stop-trick became commercially viable and popular during the early 1900s, a period that saw a shift in the nature and role of animation. Crafton (1993) and Wells (1998) suggest that J. Stuart Blackton had a significant influence in this conceptual shift. Blackton's *The Haunted Hotel* (1907) (see Fig. 2.22) depicted a series of supernatural events; for Crafton (1993) and Wells (1998), it was an exemplary piece which was very successful at convincing the audience. Animation was free from its bounds of being a tool for magic tricks and now was an art form seeking to recount events. Animators were no longer concerned simply with entertaining audiences but started to become concerned with convincing them also.

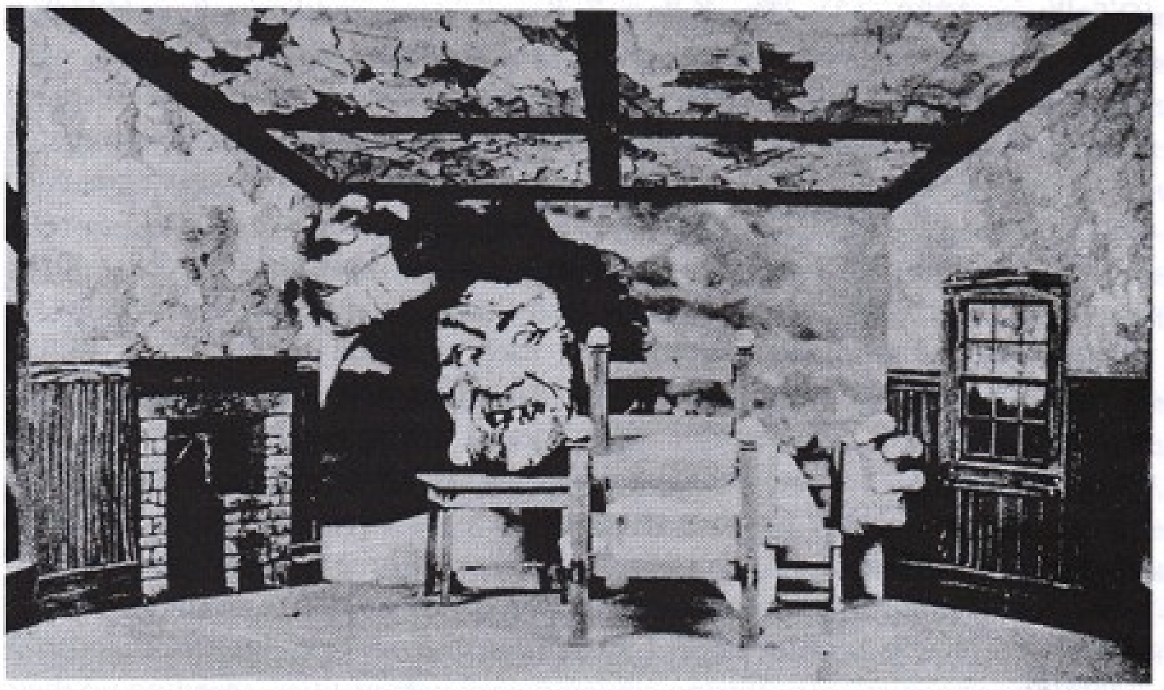

Figure 2.22: J. Stuart Blackton's *The Haunted Hotel* (retrieved from Wells (1998, p. 14)).

Cavalier (2011) notes that 1910 to 1914 was a period of experimentation with abstract animation. Futurist painter Arnaldo Ginna and screenwriter Bruno Corra, who were brothers and members of the Italian Futurist Movement, attempted to create a link between the harmony of colours and the harmony of music using what they called a "light organ". Ginna and Corra's technique was further developed by Norman McLaren and Len Lye a quarter of a century later (Cavalier, 2011, p. 54). French painter Léopold Survage attempted to animate his abstract painting that he called *Colored Rhythm* in 1912. Survage intended to cross from still image to moving image. His idea was to create a form of abstract animation, which he would name *The Glistening Bridge*; however, the attempt was unsuccessful, since he failed to convince the Gaumont Company in France to film his work (Cavalier, 2011, p. 54).

Harvey Deneroff states that animation was a marginalized art form and that cinema establishments ignored it for a long time (Pilling, 1997, p. vii). Although Deneroff doesn't state a specific year, he appears to be referring to pre-Disney animation and and the late nineteenth century This may have been a direct result of the lack of interest in the medium, or a side effect of it being an emerging field. Today, however, animation today enjoys a considerable amount of influence in screen-based media. This appears to be a direct result of the path animation as a medium has taken. Through the review of history till this instance it appears that the medium started to focus on producing entertaining piece of arts rather then just demonstrating technical capacities. The core concern of convincing moving image started to emerge where both the appearance and the movement was aimed to be appealing and engaging.

A review of the existing literature on early animation shows that it was used as a device to entertain audiences, creating the illusion of magic. Until the early 1900s, animation was either a secondary element supporting human performers or the by-product of devices created by inventors to demonstrate scientific experiments involving the perceptions of the human eye and brain (Cavalier, 2011). The invention of devices such as the Magic Lantern, the thaumatrope, the phenakistoscope, the zoetrope and flip books shows that movement performance alone was an entertainment during the early ages of animation and played a major role as a constituent in the creation of the notion of character animation.

From 1906 onwards, the appearance of animated fiction characters with personalities changed the course of animation and storytelling in animation. These characters eventually became the central feature of the animated sequences, replacing the magicians (the animators). Fictive characters, which performed and demonstrated anthropomorphic embodiments, started to form the notion of character and character performance within animation (Cavalier, 2011).

As stated at the outset of this chapter, the process of reviewing the development of the notion of animation seeks both to clarify the role and notion of character as a constituent element of animation and help bring into focus the subfield of movement performance in character animation. The previous section of this chapter (2.2.1) examined the evolution of animation and the development of character within animation. It gave an overview of artwork and technical inventions that contributed to the development of the field of animation. An emphasis was placed on the fact that these contributions and discoveries were movement-oriented, and were designed to produce the illusion of movement in order to communicate short stories. The next section (2.2.2) sets out to review movement performance within character animation, studying its technical and artistic development and the evolution of its theory and understanding.

2.2.2 Development of Character Animation and Movement in the Experimental Era

In 1910 Russian stop-motion animator Ladislas Starevich started to feature insects as characters in his works; he would remove the legs from the embalmed bodies of beetles and stick them back onto the insects using wax, so that he could later place them in various poses and animate them (Cavalier, 2011; Crafton, 1993). In one of his first works, *Prekrasnaya Lyukanida* (*The Beautiful Lyukanida*, 1912) Starevich's insects appeared wearing clothes and standing upright like human figures, narrating many pieces in the fashion of a fairy tale (Starevich, 1912). Cavalier (2011, p. 58) noted the success of the film and states that it attracted the attention of a significant number of audiences around the world. Cavalier also points out that when the movie was reviewed in the London press, it was reported that the beetles were alive and they had been trained by a Russian scientist.

After his success, Starevich further developed his character design and came up with many other ideas to animate short narratives, including *Fétiche* (*The Mascot*, 1934) (see Fig. 2.23) where he narrated the story of a dog that attempts to get back home and experiences frighting events on its way. Starevich designed and animated a number of skeletal and gothic, fantastic characters to create the illusion of nightmarish situations (Starevich, 1934). Ladislas Starevich used the characters as actors and attempted to compose narratively driven animated pieces and short animations. This is a significant milestone within the history of animation and character animation in particular, since Starevich's characters were invested with individual personalities and background stories.

Figure 2.23: Ladislas Starevich's *Fétiche* (*The Mascot*, 1934) (see Cavalier, 2011, p. 59).

According to a number of sources (Cavalier, 2011; Crafton, 1993, 2013; Thomas & Johnston, 1995; Wells, 1998) American Cartoonist Zenas Winsor McCay's *Gertie the Dinosaur* (1914) (see Fig. 2.24) was the first true cartoon character ever made. McCay's biggest contribution to film/ animation can be assessed under two headings: one is his contribution to realism[2] in character animation, and the other is his role in investing a cartoon character with the appearance of personality (Cavalier, 2011; Crafton, 1993, 2013; Wells, 1998).

Indeed, in the course of the film Gertie appears to responding and communicating. McCay incorporated himself into the film by drawing and animating a replica of his appearance and creating the illusion of an interaction with Gertie, in a scene where he stands on Gertie's head and Gertie lifts McCay up (McCay et al., 1914). Wells (1998) suggested that this illusion of interaction was an early example of discourse between animation and live-action film. In the animated short, McCay appears as an animated version of himself and both Gertie and the cartoon version of McCay are enhanced with significant levels of detail. McCay had his neighbour, John A. Fitzsimmons, animating the frames Mc Cay had drawn of Gertie by tracing them onto rice paper. In total, the animated sequence was composed of ten thousand drawings transferred onto rice paper. Then all the drawings were mounted on cardboard; this way, McCay was able to flip the drawings to check his work (Cavalier, 2011; Crafton, 1993).

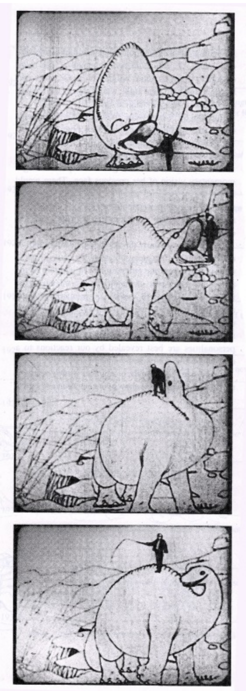

Figure 2.24: Zenas Winsor McCay's *Gertie the Dinosaur* (retrieved from Thomas & Johnston, 1995, p. 22).

[2] Realism of animated character: stands for the state of the digital character being lifelike and/or having similar qualities to its real-life equivalent (Wells, 1998).

Between 1914 and 1915, newspaper cartoonist Earl Hurd developed a method of animating cartoons by producing the background images on paper while transferring the characters on to a cel (a celluloid sheet) or multiple levels of cels overlaying each other and keeping all the steady (unmoving) parts of the drawings on a separate layer (Cavalier, 2011). Hurd's method of producing animation is called the 'Cel Technique' and became a standard way of animating characters – and indeed whole films – until the 1990s, when it was superseded by Computer Generated Imagery (CGI) (Cavalier, 2011).

Unlike its alternative, cut-out animation[3], the cel technique requires animators to draw every frame of the character's animation onto translucent papers and colour them. After this initial step the drawings are traced over the cel. The drawing phase is done on a light box so the animator can see how the characters were posed in the previous frame. Research shows that the development and use of the cel technique played a major role in reflecting more convincing and even realistic characters due to its freedom in terms of designing and detailing form (Cavalier, 2011; Crafton, 1993; Thomas & Johnston, 1995). The development of the cel technique led companies like Disney and their artists to develop sophisticated and convincing character performances. Cel technique also played a role in leading the early Disney animators (1934-1936) to develop a common studio guide for key-frame animating characters.

Wells (1998) suggests that Gertie was a playful and gleeful character; he also adds that McCay saw Gertie as a female character with her own mind, and points out that Gertie's attitude suggests the attribution of anthropomorphic qualities. McCay's work informed that of many professional studios including Disney Studios and raised many questions, including the role of characters and their behaviours. This later led to the discussion of acting for animation characters and the realism of animated characters (Cavalier, 2011; Crafton, 1993; Thomas & Johnston, 1995). Literature shows that at this juncture the character became a fundamental constituent of the animated narrative. The introduction of characters with personalities led to discussions about the production of convincing characters.

[3] Cut-out animation is an animation technique where animators cut out the drawn characters, objects or backgrounds from flat materials, such as a paper or a fabric, and then give them the illusion of movement by using the stop-motion animation technique (Cavalier, 2011, p. 89).

Cavalier (2011) and Crafton (1993) highlight the effort McCay put into breathing life into his animated characters, and Crafton emphasizes McCay's interest in moving cartoons as he made several animated pieces like *Little Nemo* (1911) (see Fig. 2.25). However McCay's use of motion in *Little Nemo* was criticised in the media, who reported at the time that McCay's use of exaggerated movement performance and deformations in the animated characters were taken to such high levels that it disrupted the viewers engagement with the characters and the story. This disturbance has been highlighted as a factor which causes the believability of the character to break down. Unnatural movement and over-exaggeration is therefore highlighted as an issue which may undermine the pleasure an audience might otherwise derive from the animated piece.

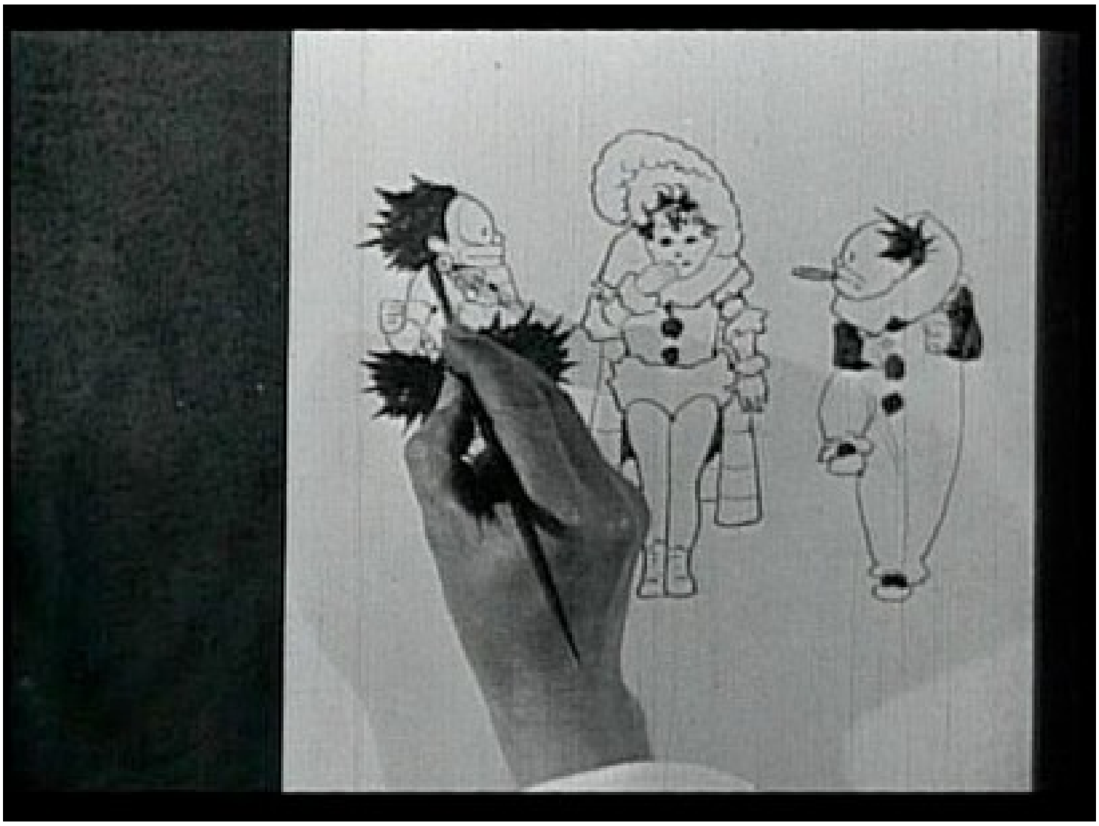

Figure 2.25: Zenas Winsor McCay's *Little Nemo* (*Watch Me Move* series,1911) (retrieved from McCay, 1911).

In 1915, American cartoonist Max Fleischer combined science and animation to achieve more realistic movements for cartoon characters (Cavalier, 2011; M. Fleischer, 1917). The Fleischer brothers designed a device that could reflect recorded film on the back of a light box, where the animator could draw over the frames of the recording (M. Fleischer, 1917). This technique is called 'rotoscoping' (see Fig. 2.26) and it was designed to generate realistic motion (Cavalier, 2011; M. Fleischer, 1917).

In their first work Max’s brother Dave posed as a clown named Koko (Cavalier, 2011; Crafton, 1993). After filming the entire performance, Fleischer traced over the image and animated Koko the Clown. In the short animated piece, Fleischer’s hand can be seen drawing the images; as Koko grows out of the ink he interacts with the animator’s hand and the real world (live footage) around him (Cavalier, 2011; Crafton, 1993; M. Fleischer & Counihan, 1919). The Fleischer brothers published the short under the name *Out of the Inkwell* (see Fig. 2.27).

M. FLEISCHER.

METHOD OF PRODUCING MOVING

PICTURE CARTOONS.

APPLICATION

FILED DEC. 6, 1915.

1,242,674.

*Flg_1_*Patentd Oct. 9, 1917.

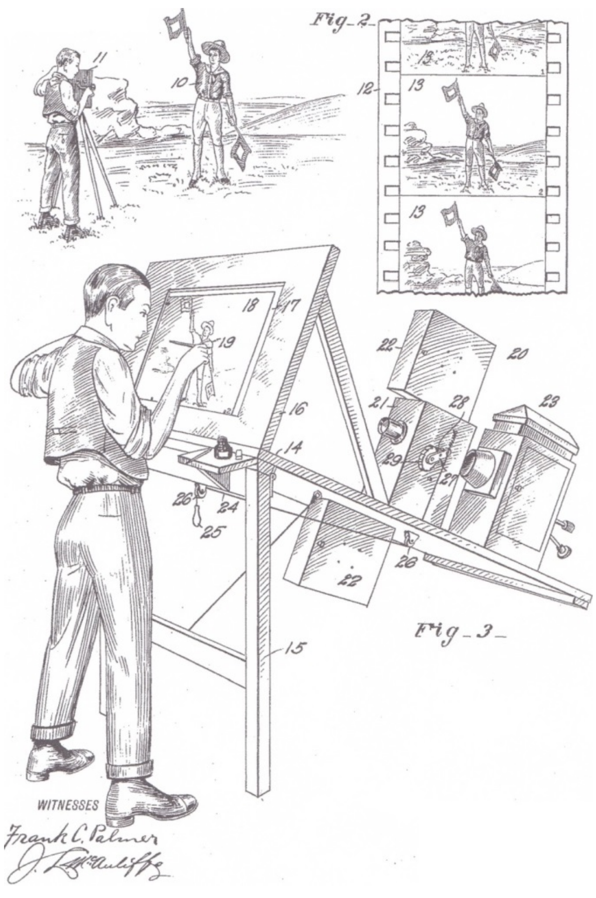

Figure 2.26: Max Fleischer's Rotoscope (retrieved from M. Fleischer, 1917).

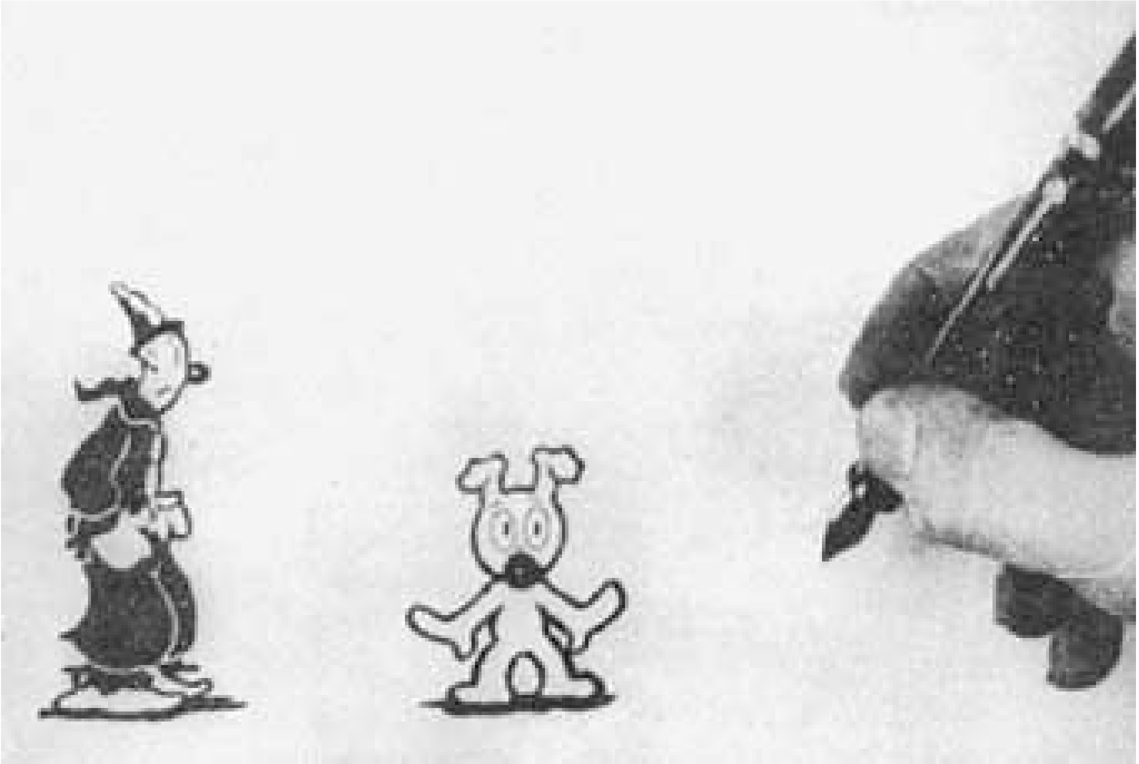

Figure 2.27: Fleischer Brothers *Out of the Inkwell* & *Koko the Clown* (retrieved from Fleischer & Fleischer, 1915).

Winsor McCay's and the Fleischer brothers' use of motion brought a new discussion to the field of animation and studio practice, which was about the representation of movement and the debate on generating appealing and convincing character movement. In 1916, French Canadian animator Raoul Barré teamed up with American Cartoonist Charles R. Bowers to animate the Mutt and Jeff newspaper comic strip series (see Fig. 2.28). Mutt and Jeff was originally created by American cartoonist Bud Fisher (Cavalier, 2011). Wells (1998) suggests that the relationship between Mutt and Jeff demonstrates a comical logic that enjoys physical comedy. Barré and Bowers used textual explanations and signals such as directional arrows to deliver the story and share the thoughts of the characters, since there was no understanding at the time of animation character performance. Signals were usually used to direct the viewers to the focus of the scene, and the character and written messages were used to deliver the concept of the scene and indeed the whole narrative. Winsor McCay also used intertitles to communicate the different structural phases of the narrative rather than body language.

Figure 2.28: Mutt and Jeff newspaper comic strip (retrieved from Fisher, Barré, & Bowers, 1916).

In 1926 German animator Lotte Reiniger made *Die Abenteuer des Prinzen Achmed* (*The Adventures of Prince Achmed*), in which she combined Middle Eastern and Asian fairy tales (Cavalier, 2011). Reiniger designed several characters and backgrounds for her narrative piece. She used the cut-out animation technique to animate the characters and even the geometrical shapes, environmental detail and effects such as smoke and steam (Cavalier, 2011; Reiniger & Copyright Collection (Library of Congress), 1926). Cut-out animation and the multiplane camera are two of the most distinct technical developments during the experimental era of film/animation. As mentioned briefly in chapter 2.2.2, cut-out animation is a technique whereby artists compose objects, characters or environments by cutting them out of materials such as paper, cloth or plastic; these materials are then put together to generate an animatable character or environment (Lutz, 1998). A multiplane camera is a motion picture camera which allows layers to be photographed onto a single plane. Cavalier (2011, p. 89) suggests that the camera allowed multiple artworks to move past the lens at different speeds and distances; various parts of some images were left transparent to give the illusion of depth. Wells (1998) suggests that artists made use of technological improvements and developments to create more realistic animations. A review of these technologies shows that they allowed artists to design scenes and characters with a greater freedom and choice. Not only did this have an effect on the artistic expression of the animation; it also reflected a greater urge for creating appealing animation.

According to Clements & McCarthy (2006), Japanese political caricaturist Ōten Shimokawa was working for Tokyo Puck magazine when the Tenketsu film studios asked him to create an animated piece for the company in 1917; the resulting movie was *Imokawa Mukuzo Genkanban no Maki* (*The Story of the Concierge Mukuzo Imokawa*, 1917). In the process of creating the film, Shimokawa studied and developed a series of techniques and guides for key-frame animating characters; unfortunately, however, all the records of his study and the produced movie were destroyed or lost over the years, and most of his work is undocumented. Ōten Shimokawa was the first animator to make an attempt at creating a series of rules to generate appealing movements and performance for character animation. His endeavour to develop a guide for animating characters is reflective of the need and importance of guidelines for best practice towards achieving convincing character animation. (This is a need that was later filled by the Disney Studios, and that can be translated today to the gap in terms of best practice for character animation where procedural animation is concerned (Cavalier, 2011; Clements & McCarthy, 2006)).

In 1919 the Pat Sullivan Studios created the cartoon character Felix the Cat (see Fig. 2.29). Felix was created and animated by the American animator Otto James Messmer. Felix was a cartoon character with a unique personality and sense of humour which distinguished him from the other cartoon characters of that time. Cavalier (2011) suggests that with its high budget and quality of work, *Felix the Cat* was an exception among animations during that period. Wells (1998, p. 21) suggests that Felix and similar cartoons are examples of an experimental tradition in graphics and fine arts and have come to represent the notion of the avant-garde in animation. Felix reflected a modernist approach to animation, and its creators created a future for the character by applying the latest available technology to the animation (Wells, 1998). Crafton (1993, p. 301) describes Felix as a quintessential cartoon character and highlights the importance of creating appealing animations with individual personality and mood. This is not only generated by the voice and physical appearance of characters, but their behaviour in the face of events and the way they move as well. The personality of a character is one of the factors that make a viewer decide whether they sympathise with a particular character or not. It is therfore important to produce and reflect an individual personality through the characters, in order for the audience to engage with them. This research only focuses on the movement performance of the character and leaves emotional reactions and behaviour out of its scope. Its approach is based on the conviction that one of the most important factors for the generation of a believable base key performance is to create an expressive key-frame movement performance, that does not only copy real-life footage but reflects an individual mood and motive.

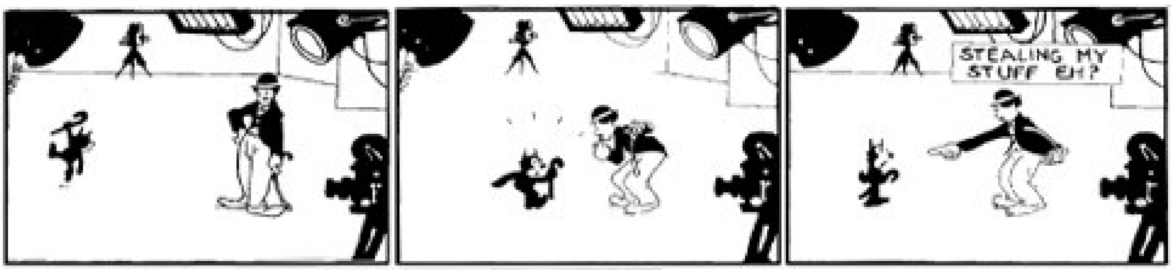

Figure 2.29: Felix the Cat in Hollywood (retrieved from Felix the Cat Productions, 2013).

According to Felix the Cat Productions, Felix the Cat was featured in a total of two hundred and fifty newspapers in numerous languages around the world. Cavalier (2011) and Wells (1998) suggest that Felix was the first cartoon character to become internationally recognised. Felix had a personal point of view on political and daily issues which was unreservedly and publicly expressed; this generated a unique personality which then expanded the understanding of realism in the animated cartoon character (Wells, 1998).

British newspaper and magazine cartoonist George Ernest Studdy animated Bonzo the Dog in 1924 (Cavalier, 2011). Like its competitor Felix the Cat, Bonzo featured a characteristic and individual personality (Studdy, 1924). For Cavalier,

> Bonzo the Dog became a kind of European answer to the success of Felix the Cat, supported by extensive merchandising exploitation of now familiar avenues such as songs, books, posters, toys, etc. (2011, p. 85)

One of the biggest steps in character animation and research into character animation was taken by Walt Disney (Cavalier, 2011; Crafton, 2013; Paik & Iwerks, 2007; Thomas & Johnston, 1995; Wells, 1998). In 1920, American cartoonists Walt Disney and Ub Iwerks set up a company called ‘Iwerks Disney Commercial Artists’, with the intention of creating newspaper ads; however, financial problems forced Disney to close the company shortly after a difficult start; Disney temporarily had to go to and work for the Kansas City Film Ad Company. Disney and Iwerks then moved to Kansas City, where they worked for the Kansas City Film Ad Company (Cavalier, 2011). After reading *Animated Cartoons; How They are Made,Their Origin and Development* (1920) by Edwin George Lutz, Disney developed an interest in Cel Animation (Gabler, 2006, p. 56).

Walt Disney made several animated shorts and sold them to Frank Newman, who was the owner of the Kansas City Theatre. Newman screened these cartoons under the name *Newman's Laugh-O-grams* (Cavalier, 2011; Thomas & Johnston, 1995) (see Fig. 2.31). Disney's company also created several other cartoons including *Cinderella* and *Puss in Boots* (1922). Disney also created a series called *Alice in Cartoonland* (1923) (see Fig. 2.30), in which he combined live-action character Alice with a cartoon environment and characters.

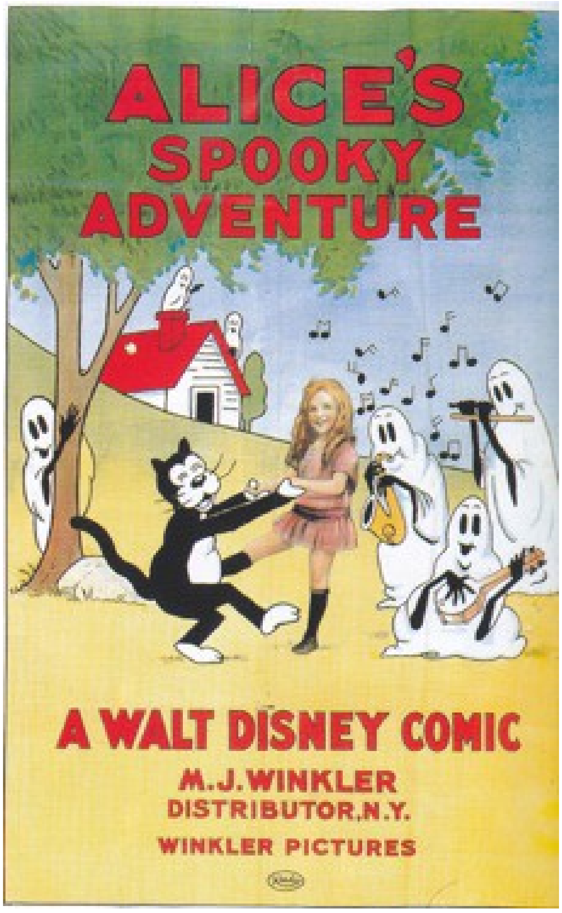

Figure 2.30: Disney's *Alice Comedies* (see Thomas & Johnston, 1995, p. 28).

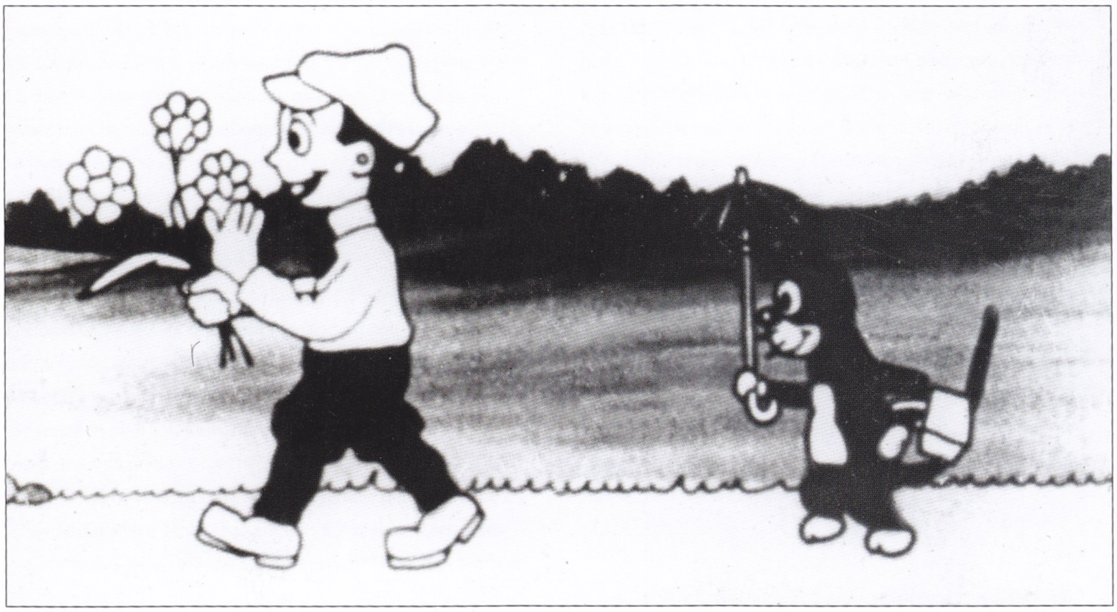

Figure 2.31: Disney and Iwerk's Laugh-O-grams (retrieved from Cavalier, 2011, p. 76).

Although some sources argue that the Laugh-O-grams and the *Alice Comedies* series were heavily influenced by Felix the Cat and the Fleischer Brothers' animations, it has been suggested that their characters demonstrate a significant level of storytelling as well as being invested with the illusion of personality (Cavalier, 2011; Crafton, 2013; Thomas & Johnston, 1995; Wells, 1998).

Alice in Cartoonland (1923) shows an urge for creating worlds and blending animation and live-action. Walt Disney experimented with cartoon animation and started to utilise it in different screen-based media such as live-action film. This was perhaps due to Disney's drive to make his cartoons more convincing and acceptable through the interaction between a real actress and the fiction world of his animated characters. However, Disney always sought to tell stories with cartoon characters. He believed that the cartoon medium should also create personalities and tell stories, engage audiences and engender empathy. Of animation, Disney said:

> At first the cartoon medium was just a novelty, but it never really began to hit until we had more than tricks... until we developed personalities. We had to go beyond getting a laugh. They may roll in the aisles, but that doesn't mean you have a great picture. You have to have pathos in the thing. (Thomas & Johnston, 1995, p. 29)

Walt Disney believed that by creating the illusion of personality, unique motive and mood, one could convey the illusion of life in an animated character (Thomas & Johnston, 1995; Williams, 2009).

The experimental era of animation involved both research and development in animation tools and techniques, character animation, storytelling and performance in animation, alongside abstract animation and technological improvements within the field (Cavalier, 2011, pp. 1-80). Several examples of abstract animation were created during this period. French artist and film-maker Fernand Léger's *Ballet Mécanique* (*The Mechanical Ballet*, 1924) included live action characters and animals alongside abstract figures and shapes. Léger was a Dadaist[4] and Cavalier (2011) highlights the demonstrated strong futuristic influence of Dada in Léger's work. Léger makes use of mechanical movement, since he included futuristic machinery in motion and geometric abstract shapes, alongside several close-up shots of live-action models and animals.

Viking Eggeling, another Dadaist and a Swedish abstract animator, made *Symphonie Diagonale* (*Diagonal Symphony*, 1924). After moving to Germany, Eggeling started experimenting with abstract animation, funded by German film studio UFA (Cavalier, 2011). Eggeling designed various symbols and custom shapes for *Symphonie Diagonale*. These custom-made symbols and shapes appeared piece by piece, eventually composing a final shape. Eggeling used various motion techniques, including the illusion of drawing . Cavalier (2011, p. 84) suggests that "Eggeling believed that the art should encompass, political, ethical and scientific ideologies, and the abstract work was the purest and freest way to try to demonstrate these beliefs." Eggeling's and Léger 's work can be viewed as early examples of how movement can communicate human thoughts and emotions and shows a drive for engaging audiences through animation.

The explicit interaction of animation with its audience reached a high point in 1924, when Max and Dave Fleischer created *Song Car-Tunes*. In this animated series, they screened moving lyrics for the audience to sing along to with the aid of a bouncing ball to guide the audience through the song. Evidently, *Song Car-Tunes* endeavoured to engage with the audience and opted for a rather distinctive way to entertain the viewers. The Fleischer brothers also used Koko the Clown in this series of shorts as a hosting character. This was the first time a cartoon character was used to host a show and engage with the audience,

[4] Dadaism: Oxford Dictionaries suggests that Dadaism is "an early 20th-century movement in art, literature, music, and film, repudiating and mocking artistic and social conventions and emphasizing the illogical and absurd." (Dictionaries, 2013a).

encouraging them to collaborate with the animated entertainment show. The purpose of the animated show was completely concerned with the viewers' world, instead of creating an individual world to tell a fiction story. This was rather different then what Disney tried with *Alice Comedies* but the urge to engage the audience is clear in both attempts.

Animation was becoming a form of entertainment the core concern of which was to engage with the audience and engender empathy by telling stories through performance and acting. This core concern hasn't fundamentally changed; throughout the history of the medium, it is clear that the notions, theories and phenomena within the field emerged out of the audiences' reception and perception of animation and animated character. This is one of the reasons why this research focuses on the delicate process of achieving believable movement performances and attempts to make it easier for the practitioner.

From this instance it can be seen that the artists were more concerned with engaging the audience and they have used several methods along the way including utilising characters with personalities and different stories for the audience to join in to the entertainment the animation is delivering. It is the evolution within the industry towards audience engagement that led artists like Winsor McCay and Otto Messmer to develop animation characters displaying complex personalities and moods. The appearance of character in animation and McCay's approach to presenting cartoon characters opened a new dimension for film-makers and animators. Otto Messmer's *Felix the Cat* had developed a further understanding and opened a debate on the realism of animated characters; the subject of convincing character design then led to the acting performance of animation characters (Crafton, 2011; 2013). The understanding of realism was taken further in the golden age of animation (1928-1957) by the early Disney Studio animators and Walt Disney himself (Cavalier, 2011). Between 1934 and 1936, Disney Burbank studio animators invested their focus in animating more convincing characters and coined the term "believability" (Thomas & Johnston, 1995).

The appearance of the animation characters led animation as a medium to evolve into a more diverse field. Characters such as Gertie the Dinosaur and Felix the Cat, examples of characters invested with personality, led artists to look for further ways of demonstrating personalities through character performances. This research focuses on the movement performance of the character and studies the application of procedural animation on character movement performances. Reviewing and understanding the constituents of a convincing character through their evolution and into the present has substantial importance for this investigation, which seeks to examine how the new technology that is procedural animation can best be applied in order to achieve optimal levels of believability in character performance.

The next section (2.2.3) will review the notion of believability and realism within character animation, and examine Disney's influence on the field of animation. Since representation of the personality of a character is closely related to movement, section 2.2.3 will also review the link between movement, realism and believability within the context of character animation.

2.2.3 Realism and Believability in Character Animation

Cavalier, (2011) and Wells (1998) suggest that Winsor McCay's *Gertie the Dinosaur* (1914) inspired a new approach to character animation, by introducing a movements that were more lifelike and convincing. McCay's discovery led to a broader sense of the possibilities in terms of movement and visual representation of characters, or as Wells (1998, pp.15-16) suggests, 'a new understanding of monster animation in cinema'. With Gertie, McCay created the illusion of skin deformations, wrinkles around the joint areas on the limbs and a lifelike anatomy. Building on McCay's work, Walt Disney and the early Disney Company later played a considerable role in developing character animation itself.

In 1934, Disney Animation Studios developed a guide for character animation and feature-length film/animation. The outcome of this development was a series of teachings and principles in the form of set of common guidelines for studio practice. However these teachings were kept within the studio and weren't revealed until the first publication of the book The *Illusion of Life* in 1981 (Thomas & Johnston, 1995). These techniques and teachings were designed to achieve convincing movement and storytelling performances from animated characters (Thomas & Johnston, 1995). The impact of the Disney Company's development of these tools and approaches was significant. Paul Wells writes:

> The animated film had reached maturity, but in doing so had established Disney as synonymous with 'animation'. This has led to animation being understood in a limited way. Disney perfected a certain language for the cartoon and the full-length feature which took it's model from live-action film-making. This overshadowed other types of innovation and styles of animation which have extended possibilities of the form and embedded other kinds of film to be made. Consequently, and ironically Disney's dominance of the medium places the issue of 'realism' at the centre of any discussion of animation. (Wells, 1998, p. 24)

Wells (1998) states that Disney helped film/animation to reach its maturity and develop its own understanding and teachings. Crafton writes: “I have determined that it is not possible to write or converse about classic animation without acknowledging Disney’s influence and contributions” (Crafton, 2013, p. xiv). However, Wells also stresses that in the process the animation industry became rather orthodox; by adopting the teachings of Disney, it placed limits on its own evolution. By adopting live-action features the animated characters were bound by conditions that blocked the creativity of other possible forms and approaches to the design and animation of characters (Wells, 1998).

During the 1930s, Disney Studio’s animators and Disney himself focused on acting and performance to develop believable characters; they took inspiration from Konstantin Sergeievich Stanislavski and his teachings and techniques, which are also known as ‘Stanislavski's system’ for acting. The early Disney Studio Animators studied Stanislavski's system to understand how to effectively communicate through movement in order to help create clear and readable animated performances (Crafton, 2013; Thomas & Johnston, 1995).

Crafton also suggests that the understanding of realism and performance that Disney brought to the field of character animation significantly affected the feature film/animation; he also emphasizes the way in which Disney changed the approach to the notion of believability within animated films. He cites *Dumbo* (1941) as an example. Crafton analyses how Disney animators explained the reasoning behind Dumbo’s ability to fly, and stresses that the character believably performs this action despite being an elephant. Crafton further suggests that the viewer’s acceptation of Dumbo’s ability to is supported by a small number of conceptually realistic elements, for example the aerodynamics of Dumbo’s large ears (Crafton, 2013). Although aerodynamics are not explicitly mentioned, the concept is nonetheless demonstrated implicitly. The logic behind how Dumbo flies is articulated in such a way that it appears both scientific and imaginative. Indeed, if the shape and size of Dumbo’s large ears appear to provide a reason for his ability to fly, there also appears to be an element of magic making the feat possible.

The ambiguous nature of the underlying explanation leaves the judgment to the viewer, giving the latter freedom of choice. As Crafton (2013) suggests, it is up to the observer to make a decision, and believing in magic is one option. Generally speaking, however, after Disney Studio’s efforts to alter the presentation of fantastic and illogical events within narrative animation, more logical narratives became prevalent, displacing the earlier trick shots and gags. The conceptual logic behind Dumbo's ability to fly, which relies on the viewer's implicit understanding of real-world physics, is what allows the viewer to suspend their disbelief. While on a rational level, the viewer knows that it is impossible for an elephant to fly, the hint at realistic physics combined with a movement performance that appreas to comply to the rules of these real-world physics is thus sufficient to make the occurrence believable within the animation.

Crafton (2013) suggests that work done by the Disney studio animators and their contributions changed the understanding of acting for cartoon characters, movement performance and audience reception of the animated form, helping them to evolve. Disney's notion of 'realism' in animated characters has been adopted by professional studio practices and this has caused the field of animation to re-shape itself in accordance with Disney's teachings (Williams, 2012, Vol.1). Disney's influence extends beyond Western and European animation. Japanese cartoonist Osamu Tezuka studied the studio's techniques and teachings alongside Disney animated films such as *Bambi* (1942) and simplified them to blend them with Japan's traditional comic style, thus developing 'Anime' (Japanese Animation) (Katayama, 2007; Patten, 2004). It appears clear that Disney's studio guidance delivered a core key-frame knowledge covering universal basics that practitioners like Tezuka have incorporated and applied to create different genres and styles of animation. This again shows the importance and the need for guidance material for the new and emerging animation toolsets.

Current literature suggests that even today, animation practitioners, professionals and academics still consider the outcome of Disney Animation Studios' research and its contributions as relevant. Paul Wells has suggested that Disney's influence brought an orthodox style of animation making in to the field (Wells, 1998). Although the Studios focused extensively on creating believable characters and personalities, their principles and teachings shows that Disney depended heavily on movement and communication through movement to achieve his goal of engendering empathy and communicating emotion, which shows the importance of the factor of movement within animation (Thomas & Johnston, 1995). Over time, the art of animation became more and more diverse thanks to Disney's contributions and practitioners started to seek more ways of enhancing their animations. Digital technology such as computer generated imagery (CGI) was one of the new routes for practitioners to imbue their practice and utilise animation in different ways. Foster states that 'the more the arts develop the more they depend on each other for definition.'

(see in Hooks, 2011, p. 6). The use of technology allowed animators and artists to not only replicate real-life conditions but to generate fantastic images that are convincing enough to easily blend into live action footage.

In 1925 Harry O. Hoyt directed *The Lost World*, a science fiction movie about the American plateau mountain, where it is believed dinosaurs are still alive (Hoyt et al., 1991). In the story, explorers have to bring a large dinosaur back to London. American stop-motion animator Willis Harold O’Brien created and stop-motion animated the dinosaur and blended it into the live action film (Cavalier, 2011; Hoyt et al., 1991). O’Brien’s dinosaur had a realistic skin texture and bone and muscle structure, and the creature was lit cinematically (Hoyt et al., 1991). O'Brien’s use of character creation in Hoyt’s movie *The Lost World* (1925) demonstrates a strong understanding of anatomy and live-referencing.

It is important, here, to highlight the difference between believable and convincing animation. Willis Harold O’Brien’s dinosaurs were made to blend into a live action movie where there were real-life environments and characters. In this case the artist attempts to match the real-life footage when generating a visual effect. This is done to preserve the audience’s experience and deliver a seamless experience. If this fails and if there is significant visual and movement-based difference between the effect and the live footage, they will not match and a contrast will appear between them which may result in disrupting the audience’s experience. However if the visual effects or CGI are designed as as though they were a part of the live-footage this will convince the audience within the scope and style of the story. These effects and animations do not particularly need to engender any sort of emotions among audience; they just have to match the live-footage and help provide a seamless experience for the viewer. In the case of believable animation, the character and its story have to engender empathy. However there are no simple pathways to achieving this; the notion of believability breaks downs into groups of elements and does not follow a linear path. It is therefore the crucial to achieve both convincing movement and well-constructed acting and narrative to deliver a believable performance.

In 1963, stop-motion animator Ray Harryhausen made an animated battle sequence for the movie *Jason and the Argonauts* (1963). Harryhausen modelled humanoid skeletal characters and animated them using the stop-motion animation technique; the characters were modelled as small figures then scaled to human size during the post-production stage (Chaffey, 1963). The texturing and skeletal structure of the characters were highly realistic, almost matching those of real humans. According to Bruce Eder (2013) the animated sequence’s success broadened the animation professionals’ understanding of the use of realistic characters, as well as the cinemagoers’ expectations. In this instance, the use of real-life referencing and the mimicking of real-life elements reached a new level, and animation characters with realistic physical features were used to support the fiction narrative and help achieve a convincing film and story.

During the 1970s computer technologies were increasingly used within the field of animation and film. American computer scientist Edwin Catmull designed an animated version of his left hand by using a computer which was then used in the film *Futureworld* (1976). Edwin Catmull aimed to create a computer animated movie and contributed to the development of Computer Generated Imagery (CGI). He worked on the creation of several important tools including the first renderer, ‘RenderMan’ (Paik & Iwerks, 2007). RenderMan was an application programming interface (API)[5] which was designed to render three-dimensional (3D) forms with a photorealistic visual appearance (Paik & Iwerks, 2007). [6]

Edwin Catmull’s RenderMan and his technologies were used to generate the Stained Glass Knight, the first three-dimensional, fully computer generated animation character to appear in a feature film (*Young Sherlock Holmes*, 1985) (Glintenkamp, 2011, p. 22). The character appears to have human proportions, but its body is composed of glass material (see Fig. 2.32). The Industrial Light and Magic (ILM) company crew designed the character with a photo-realistic texture and lighting, to match it with the live-action movie that it is embedded in.

[5] Application Programming Interface (API): arranges the interaction between the software components of a computer.
[6] Photorealistic: originates from photorealism, which is a form of representational art based directly on photographs, rather than the observation of nature (Morgan, 2007).

Figure 2.32: 3D Stained Glass Knight in *Young Sherlock Holmes* (1985) (retrieved from Glintenkamp, 2011, p. 22).

Visually realistic characters provided artists with a different form with which to convince the audience. The Stained Glass Knight was one of the early examples of a CGI character blended into real-life footage and applied the understanding of realistic light and shading, surface, texture, material and movement to convince the audience and help provide a seamless transition between the computer graphics and the real-life footage.

Advancing computer science allowed artists to present fantasy elements with a photo-realistic appearance, which led the field to a broader understanding of the use of visual realism within character creation. Glintenkamp (2011) notes the realism of the dinosaurs in *Jurassic Park* (1993), stating:

> For the first time, digital technology is used to create living, breathing characters with skin, muscle, texture, and specific behavioral disposition. The project marks a major advance in digitally simulating living organisms. (Glintenkamp, 2011, p. 26)

On one level, it would appear that the visual realism of a character is directly related to the character's surface appearance and aesthetic features. However, the features listed above, which include muscle structure and behaviour alongside other qualities, suggest that there may be a wider range of reasons behind the realism of the dinosaurs in *Jurassic Park*. As the dinosaurs move in the film it is very clear that the animation team made a distinct effort to generate the illusion of a bone and muscle structure underlying the realistic skin. In addition, the dinosaurs appear to think and have motive, since the narrative has them making decisions or acting together according to what we perceive as animal logic to reach a certain goal. The combination of these qualities with the realistic appearance may be the reason why the creatures are convincing characters: they move and act in the way an audience would generally imagine real dinosaurs might act (Duncan, 1997; Spielberg et al., 1993). There is a clear difference between Gertie the dinosaur and the Dinosaurs in *Jurassic Park*. Gertie, like Felix the Cat, displays anthropomorphic qualities in her behaviours and reactions, whereas *Jurassic Park* depicts dinosaurs in a more scientific manner: they illustrate how we imagine them to have behaved before they became extinct. (Duncan, 1997).

Developments within the field of visual effects reflect a diverse use of character within film. When compared to the anthropomorphic qualities of Gertie the Dinosaur and other similar characterizations of animals, the dinosaurs of *Jurassic Park* instead display a combination of realistic animal behaviour and logic presented and communicated through the monsters within the film. This expands the understanding and perspective of character and creature animation by presenting fiction within the rules and conditions of real life. In other words, the process of creation involves presenting the fictional creatures as though they were real and trying to maintain the illusion of the real. In the process, artists implement elements from real life such as the behaviour of the muscle and body mechanics of the creature. These are aspects that were applied in the experimental stages of this research; first, however, it was important to understand how these realistic elements affect the believability of an animated character.

Eisenberg (2011) highlighted the characters created for the movie *Rise of the Planet of the Apes* (2011), stating that the computer generated (CG) chimpanzees featured in the film were very realistic – so much so that even primatologists did not immediately realize that they were digital. Reviewing the effects and CGI used in the film, Dr. Frans de Waal, a professor of primate behaviour at Emory University in Atlanta and director of the Living Links Center at the Yerkes National Primate Research Center in Emory, concluded: “We have the illusion we are looking at chimpanzees, They are remarkably convincing.” (see Eisenberg, 2011).

Dr. de Waal chose the word ‘convincing’ to describe his experience of watching the animated chimpanzees in *Rise of the Planet of the Apes*. The film’s chimpanzees were designed by the company Weta Digital. Weta decreased the black colour and increased the white colour within the chimpanzees eyes, to make their expressions more readable. The skin texture and aesthetic qualities of the chimpanzees appear to be very similar to those of their real-life equivalents; so do most of their movements. But Dr. Waal's choice of words when he described the chimpanzees in the movie should be stressed. Rather than describing the chimpanzees as 'realistic', Dr. Waal chose to describe them as 'convincing'. This may indicate not just that the aesthetic features were lifelike but that the performance and behaviour of the characters (chimpanzees) were too. It is the overall result of both qualities of the animated character that leaves an impression causing the viewer to judge the animated piece as convincing. It appears that a part of the acceptance is driven from the expectations of the audience; as long as the character moves and behaves as the audience expect the character to, they will be perceived as convincing.

A convincing character, then, appears to have realistic aesthetic qualities combined with a personality. The expression 'convincing character' was discussed by Williams (2009, 2012), who suggested that a character should be given a sufficient amount of realism, demonstrate an individual personality and appear to think. Williams highlighted the importance of keeping the balance between realism and exaggeration within character animation, suggesting that this is the key to achieving a believable character. Evidently, the notion of a realistic character leads to a discussion centred on achieving convincing characters and character performance; this is where Disney's believability notion comes into its own. In 1934, Walt Disney said the following about generating convincing characters: "I definitely feel that we cannot do the fantastic things based on the real, unless we first know the real." (Thomas & Johnston, 1995, p. 71)

According to the studio practice guidelines developed by the Disney Company, the understanding of realism in animated characters and the reception of those characters extends beyond just copying the human body's appearance and its movement as they are in real life (Thomas & Johnston, 1995). The Disney Animation Studio actively engaged in reflexion on how the animator makes a character appear to think, thereby demonstrating an urge to achieve convincing characters for their animations. With this motivation in mind, Walt Disney hired artist Don Graham from 1932 to 1940 to improve the drawing skills of the staff (Thomas & Johnston, 1995). At first the tutorials were limited to life drawing, but after a short while they became sessions allowing Disney to experiment with the animation to generate more convincing characters. During this experimental period, the animators and Don Graham took inspiration from actors and used real-life footage as a reference.

Graham and the Disney Studio animators studied hip movements and weighting, giving the illusion of mass to the character (Thomas & Johnston, 1995). [7]

Once Disney animators begun to use live-action footage as a reference in order to obtain better results from their work, however, they soon discovered that the overuse of realism takes the appeal away from the character, affecting the outcome of the animated pieces. Of the amount of live referencing used in cartoon animation, Walt Disney said: “This is a very important thing. There are so many people starting in on this, and they might go hay-wire if they don’t know how to use this live action in animating” (1934-1936). Nearly a century later, Disney’s remarks are still valid. In 2012, Richard Williams wrote: “You just want enough realism to make it convincing, but you don't want so much that people end up asking you - why didn't you take a photo instead...” (Williams, 2012, Vol 1.)

The discussion pertaining to the use of realism in animation extends beyond the style of the animation. Strikingly, critics suggest that the less realistically stylised animations are more appealing and have a better chance of engaging the audience in the long run. It is important, for this research, to understand the outcomes of realistic effects since procedural enhancements this research focuses on are delivering realistic animations; however, with an urge to improve believability.

According to the research undertaken by Butler & Joschko (2007), ‘ultra-realistic’ animated forms may result in having a negative effect on the audience. [8] Butler & Joschko based their analysis on a case study of two animated films: *The Final Fantasy: Spirits Within* (2001) and *The Incredibles* (2004). Throughout the analysis, the box office cost and receipts of both animations are highlighted (see Table. 2.1). Butler & Joschko (2007) also suggest that the drive for mimicking real life also limits the imagination of the artists and the creativity behind the animated film. However, Butler & Joschko (2007) appear to stress only the aesthetic aspect (appearance) of the characters, leaving the effect of movement performance in relation to the Uncanny Valley effect out of the scope of their research. Although the effect is more distinct when the form (character) moves, it is very hard to estimate the effect of ‘ultra-realistic’ procedural animations on the character animation’s outcome, without a specific experiment.

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[7] Mass: in Physics, the quantity of matter which a body contains, as measured by its acceleration under a given force or by the force exerted on it by a gravitational field (Dictionaries, 2013).
[8] Ultra-Realistic: Ultra-realistic in this context means the animated character both appearing and moving (performing) in a remarkably similar or exactly like its real life counterpart. This idea is closely related to “photorealism” defined in chapter 2.2.3 (Glintenkamp, 2011; Wells, 1998).

Film	Cost (est.)	US Box Office	Int’l Box Office (est.)	Total Box Office (est.)	New Profits (est.)
Final Fantasy	$137,000,000	$32,131,830	$53,000,000	$85,131,830	-$51,868,170
The Incredibles	$92,000,000	$261,437,578	$274,900,000	$536,337,578	$444,337,057

Table 2.1: Cost and Box Office Receipts for *Final Fantasy* and *The Incredibles* (retrieved from Butler. & Joschko, 2007).

Disney animators discovered that there is a difference between ‘realistic’ and ‘convincing’; they also suggested that there could be a common studio practice guide to control the degree of blending of the two notions, so that the aim for the estimated outcome in terms of the animation’s believability can easily be reached (Thomas & Johnston, 1995). As mentioned earlier, the difference between realistic and convincing described by Disney animators was theorized in 1970 by Prof. Masahiro Mori under the name “Uncanny Valley” (Mori, 1970). Professor Mori’s research originated from the field of robotics and was concerned with the realistically designed human robots and how their appearances and movements affect the human audience.

Generating believable characters and performances for animation is clearly a significant issue within the field of animation. Given that it is a diverse and multidisciplinary field, it seeks answers not only within itself but within other fields. The Uncanny Valley, a theory that first emerged in the field of robotics, has been one of the most significant concepts used by professional companies to describe the negative effects of the overuse of realism within animation. To design and animate convincing characters, early Disney animators developed teachings and techniques driven by the notion referred to as ‘believability’ by Thomas & Johnston (1995). Disney’s notion of believability aims to suspend the audience’s disbelief and judgement, making them convinced by the characters’ performance. A review of literature shows that the way this is achieved changes according to the style of the animation. According to Disney, the key factor is to engender empathy though performance:

> Disney animation makes the audience really believe in those characters, whose adventures and misfortunes make people laugh- and even cry. There is a special ingredient in our type of animation that produces drawings that appear to think and make decisions and act of their own volition; it is what creates the illusion of life. (Quoted in Thomas & Johnston, 1995) (see Fig. 2.33)

Figure 2.33: "The audience feels the suspense in this classic situation as Mickey thinks it is Pluto behind him." (see Thomas & Johnston, 1995, p. 75).

The audience's capacity to feel empathy for a character can be adversely affected by the Uncanny Valley effect described earlier in this chapter; in other words, an ultra-realistic appearance and the effects of ultra-realistic movement performance in an animated form can have negative outcomes, not only reducing the audience's enjoyment but also disrupting believability. This was a factor to be avoided during the experimental stages of this research. Although there is a substantial degree of debate surrounding the matter, it would ultimately appear that the overuse of realism within an animated character is likely to disrupt the notion of believability. Harry Brenton, Marco Gillies, Daniel Ballin and David Chatting suggest that "The Uncanny Valley questions widely held assumptions about the correlation between realism and believability within a virtual world" (Brenton, Gillies, Ballin & Chatting, 2005, p. 1). With these new elements in mind, and given both the importance of believability within this research and the realistic focus of PA, it is worth returning here to the discussion on the Uncanny Valley in more depth.

As hinted at in section 2.1.7, the Uncanny Valley phenomenon is a highly debated subject within the fields of robotics and animation. A considerable amount of studies pertaining to the existence and effects of the phenomenon have been published, and it is important to review the key literature in order to strengthen the relevance and the definition of the phenomenon within the context of this thesis.

In one of the key publications about the Uncanny Valley, Brenton et al. (2005) look at "the role of presence, the mismatch of cue realism, the contribution of the eye and cultural habituation" to determine the validity of the Uncanny Valley effect. Research suggests that the latter should be further measured, so that the response of the audience can be evaluated experimentally, and supports Ferber's (2003) argument in which he objects to the theory of the Uncanny Valley effect (Brenton. et al., 2005). Brenton. et al (2005, p. 1) also stress that "There is considerable anecdotal evidence for uncanny film, CGI and sculpture, but this does not in itself support the valley model". Although the phenomenon of the Uncanny Valley was widely accepted in 1970, a considerable number of counter-theses now dispute the existence of the Valley model within the field of robotics and animation. However, as suggested earlier, both the term and the concept are still in use among professionals and critics to describe the negative effect of certain types of realistic characterization.

Weschler (2002) stresses the unpleasant effect of the Uncanny Valley and pinpoints it as a design limitation. Brenton. et al (2005) also consider "the Valley" to be a design limitation and a problem that design teams need to find a way around or fight their way through when it comes to developing computer-generated imagery (CGI).

The development team behind Shrek (Adamson et al., 2001) have highlighted the sophisticated process involved in creating Princess Fiona, emphasizing their efforts to make her less human because "she was beginning to look real, and the effect was getting distinctly unpleasant" (Brenton. et al., 2005; Weschler, 2002). Hironobu Sakaguchi, director of *Final Fantasy: The Spirits Within* (Sakaguchi, 2001), stated that there was "an eerie sensation as he worked with increasingly photorealistic models: 'it begins to get grotesque. You start to feel like you're puppeteering a corpse.'" (see Brenton. et al., 2005; Weschler, 2002).

Despite all the risky negative effects of the use of realism within animation, there were and is still a large amount of work invested in producing convincingly realistic-looking characters and visuals. Max and Dave Fleischer's rotoscopy brought near real-life movement to character animation. However, Thomas & Johnston (1995) discuss the use of live action footage for animating characters and stress the importance of balancing the realism adopted from the footage when drawing the frames. Thomas & Johnston (1995) also suggest that if the use of realistic movement is excessive or exaggerated, it might end up taking away from the appeal of the character within the movement performance and affecting therefore the audience's reception of the character's movement.

In actual fact Brenton et al (2005) and practitioners within the field are concerned about the negative 'Uncanny Valley' effects caused by characters' appearances, rather than focusing on any effects that might potentially be caused by character movement. Currently, the only known guidelines for common studio practice are the techniques and teachings of Disney Animation Studios. These, however, are specifically focused on key-frame animation; as such, their applications are limited in the context of an animation toolset that is expanding to include techniques relying on digital processes, such as procedural animation. As such, the suggestions made by the Disney Company to avoid the negative effects linked to overuse of real movement only apply to technologies and techniques such as real-life footage referencing and rotoscoping.

This chapter reviewed the notion of realism and believability and the link between them within the context of character animation. The theoretical and practical research undertaken within the context of realism and believability within character animation was also reviewed to gain a stronger understanding of these notions. It is in the intentions of this research to experiment with improving the believability of animated character performance while studying the implementation process of procedural animation. Selecting the notion of believability as the aim of the experiments, makes it easier to measure and compare the outcome of the findings.

2.2.4 Discussions Pertaining to the Notion of Believability

This section includes contemporary discussions among animation professionals and academics, pertaining to the notion of believability.

Eisenstein, Leyda, & Upchurch (1986, p. 21) suggest that the ideological, social and cultural freedom of animation is a strong reason for the appeal it presents to the audience. According to Eisenstein, Leyda & Upchurch, animation as a medium is free from any boundaries that can cause it to be biased and it does not produce work or art under the influence of and specific point of view which makes it neutral. Eisenstein, Leyda, & Upchurch believe that these could be the reasons why animation is attractive to a wide range of audiences.

Eisenstein also adds that the free form of animation appears to ‘contrast with a single-minded approach and stability in form which may be a factor that makes the animated form more appealing; Eisenstein coined the name ‘plasmaticness’, to describe this freeform quality of animation that rejects monotone forms (Eisenstein et al., 1986, p. 21). Eisenstein’s suggests that the audience accepts the fiction and story that animation presents because of its unbound form through which it represents an individual world, instead of mimicking or interpreting the world its audience lives in. As discussed in section 2.2.3, fiction and works of fiction are easier for the audience to accept, which supports Eisenstein’s suggestions about the believability of animation. Not only the representation but the story and acting play a major role in convincing the audience.

Eisenstein’s point of view will be considered during the experimental phase of this research. His suggestions will be taken in to account when designing characters and character animations for the experiments. Regarding believability, Paul Wells wrote:

> Even though Disney dealt with what was a predominantly abstract, non-realist form, he insisted on verisimilitude in his characters, context and narratives. He wanted animated figures to move like real figures and be informed by a plausible motivation (Wells, 1998, p. 23).

Wells (1998) highlights Eisenstein’s views on plasmaticness and ties them to the use of realism within animation. He suggests that levels of realism may differ among animated films, since some animated films may present a greater degree of realism compared to others and therefore the acceptance of the film may differ among audience. Wells also attempts to classify these varying degrees of realism, grouping them according to realist and hyper-realist animation types, and suggests a list of codes and conventions to enable style comparisons (Wells, 1998, p. 23). [9]

• The design, context and action within the hyper-realist animated film approximates with, and corresponds to the design, context and action within the live-action film's representation of reality.

• The characters, objects and environment within the hyper-realist animated film are subject to the conventional physical laws of the 'real' world.

• The 'sound' developed in the hyper-realist animated film will demonstrate diegetic appropriateness and correspond directly to the context from which it emerges (e.g. person, object, or place must be represented by the sound it actually makes at the moment of utterance, at the appropriate volume etc.).

• The construction, moment and behavior tendencies of 'the body' in the hyper-realist film will correspond to the orthodox physical aspects of human beings and creatures in the 'real' world.

Paul Wells (Wells, 1998, p. 26).

Paul Wells also suggests that the discovery of the multi-plane camera enhanced the level of reality in animated film and points out that before multi-plane the illusion of perspective had to be created by the artist; however, during certain actions such as a camera closing in or moving / re-orienting, the background would lose perspective or unintentionally become enlarged (Wells, 1998). Wells (1998, p.23) states that the multi-plane camera fixed issues like these and allowed animators to have more control on the scene by providing fully animatable layers. He suggests that the staging, depth within the scene and the movement of the camera are facts which may have contributed to increasing the realism of the scene. Wells's suggestion shows that not only the teachings and techniques but new tools also contributed towards achieving convincing and realistic animations. Another study on the use of toolsets and software for a higher audience engagement and more believable characters were done outside of the field by Rosalind W. Picard.

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[9] Hyper-Realist Art; appeared in the 1970s to describe art in which a heightened attention is given to descriptive realism, in essence making the ordinary extraordinary. Leading sculptors exhibiting this trend include Duane Hanson and, more recently, Ron Mueck; prominent Hyper-Realist painters and printmakers have included Chuck Close and Richard Estes. In painting, the term is also synonymous with Photorealism (retrieved from Clarke (2010)).

Research done by Picard (1997) focuses on believable digital characters and how they can seamlessly communicate or interact with the audience. Rosalind W. Picard's research lies within the field of digital media and is more concerned with digital characters such as game characters and artificial intelligence; however this research can benefit from Pickard's suggestions on achieving believable characters, since character animation is an important section of computer games within contemporary digital media.

Picard refers to digital characters as 'avatars' and suggests that it is critical to make avatars appear to interact with users; within this context, she states that an avatar should be "personalized, intelligent, believable and engaging" (1997, p. 184). Picard stresses the importance of behaviour, emotional response and the presentation of the characters thoughts. Additionally, Picard (1997, p. 184) puts forward a list of 'emotional components':

- Emotional behaviour;
- Fast primary emotions;
- Cognitively generated emotions;
- Emotional experience: cognitive awareness, physiological awareness, subjective feeling;
- Body-mind interaction.

Another suggestion pertaining to the creation of convincing character animation comes from film practitioner Ed Hooks. In his book *Acting for Animators*, Hooks (2011, p. 18) suggests that 'off screen' is the world the audience lives in, which is the regular reality humans experience every day and 'on screen' is located within the animated world, which is a theatrical reality.

After suggesting the terms 'Regular Reality' and 'Theatrical Reality', Hooks states that regular reality is what viewers know as their regular daily life and daily events, where 100 percent of everything is expressed and shown. Theatrical reality on the other hand, as described by Hooks (2011, p. 18) "has form and is condensed in time and space, with theatrical reality, you only show the parts that tell a particular story".

Eisenberg (2011) suggests that evolving technology has a significant effect on making the characters more convincing in the audience's eyes. She states that film-making technology was still evolving when mythical character Gollum was designed for *Lord of the Rings*

(2001). She also lays an emphasis on facial motion capture and states that the resolution was low and rudimentary, and that the animators had to craft the facial expressions frame by frame. Associate Professor of Computer Science, Courant Institute and Director of the New York University Movement Laboratory Dr. Chris Bregler has also stated “You couldn't track every pixel in Gollum’s face.” Dr. Bregler’s suggestion supports Eisenberg’s views, highlighting the inadequacy of the movement of the creature’s facial expressions and their deformations. Tying the issue to technological limitations, Bregler engages in a discussion about how audiences receive movement. He stresses the importance of movement in animated form and the fact that a single flaw may break the link between the observer and the animated character.

In his interview, Dr. Bregler talks about convincing movement performance of the face and body and discusses the audiences’ acceptance level of these movement performances, suggesting that human audiences constantly compare what they see to their previous experiences of those movement performances; as such, the smallest mistake can easily break the engagement of the audience.

Crafton (2013) suggests that, within the mind of the observer, every feeling, thought and idea leads to the generation of an overall, summed-up opinion about the form and movement of an animated character. Crafton’s approach appears empirical, since he believes that when a human observes in order to collect sensory data, the collected data is being perceived and then judged; following this process, the data becomes a notion or impression Crafton refers to as “agency”, stating:

> Because cartoon subjects are so often allegories about the distribution of creative power, agency - the ability to cause events to occur, to control other beings, to react to events sentiently, or simply to assert autonomy- is involved in every animation performance. (Crafton, 2013, pp. 58-72)

For Crafton, every animation has a “Material Agency”; this includes storyboarding, music, sound design, drawing, manufacturing, and so on; he also defines the animator as a “Physical, Creative Agent”. Finally, Crafton states that the film-maker has no control over the audience’s perception of a character’s “Agency”.

According to Crafton’s approach, the animator is an “Agency” creator. An animator determines qualities for his/her character to reflect, prior to creating the character and its performance. These qualities can be aggressive, funny, etc. Crafton refers to qualities such as these as “Agency”. To reflect these qualities, the animator creates movement performances, acting performances, sounds, aesthetic features, and so on. For example, an animator can benefit from movement performance and aesthetic features to represent an aggressive character. However an animator has no control over whether the audience receives the character as intended. It appears that the movement performance is again a contributing factor to generating convincing personalities and animation.

Crafton (2013) also states that the audience has an evolving awareness. He suggests that through experience the observer becomes more aware of the details of what they observe. The understanding and notion of realism and believability may change over the years, since the evolution of technology allows artists to enhance animated forms in both movement and appearance.

A review of current literature shows that so far, animation professionals and critics suggest that anthropomorphic qualities are what makes a character convincing and what forms the bond between the animation and the viewer. Some practitioners seek to achieve realism rather than cartoons style, while others focus on achieving cartoon-style animations, which they believe are more appealing. However they appear to converge on one point, which is the importance of human emotions and their representations through movement performance.

As suggested by Brenton et al. (2005, p.1), human qualities in a generated character engender empathy within the audience: ‘As a machine acquires greater similarities to a human, it becomes more emotionally appealing to the observer.’ This supports believability, with professional animators suggesting the inclusion of controlled amounts of realism to make an animation convincing. It is worth bearing in mind that, as suggested by Dr. Chris Bregler during an interview about the film *Rise of the Planet of the Apes* (2011), it is easier to convince the audience when the character is a dragon or any other mythical or fairytale creature animation – “but humans or their closest relatives, chimps - that’s more difficult to do. Our human eyes are finely tuned to detecting problems with those depictions, and the illusion breaks down” (Eisenberg, 2011).

Bregler suggests that the awareness of human audiences evolves rapidly and they are getting better at finding the flaws within the animated segments of the film (Eisenberg, 2011). Dr Bregler’s statement supports Professor Donald Crafton’s suggestion about the audience’s awareness when he states that audiences exercise their eyes every time they see an animation, which trains their awareness and makes them better at spotting flaws (Crafton, 2013). It appears that the audiences' acceptance of realistic and believable characters may change over time; as such, this research is positioned to play a critical role within the field by contributing towards a set of guidelines for procedural animation which is one of the youngest and most substantial studio solutions within the practice of animation.

2.2.5 Discussions Pertaining to Performance in Animation

Several factors are required for a character animation to be convincing. These factors can be grouped according to two categories: 'physical appearance' and 'performance'. This section will focus on the discussions pertaining to the performance aspect of the animated character, in line with the thesis's focus on movement.

In 1934 Burbank Disney Studio animators studied acting and performance techniques and teachings to enhance character animations produced by the company (Thomas & Johnston, 1995). Disney and his team studied Russian actor Constantin Stanislavski's teachings to develop appealing performances out of their characters. Stanislavski (1989, p. 119) suggested that the actor should break acting performance down into 'units' and 'objectives'. Every unit should have three categories:

• External or Physical objectives;

• Internal or Psychological objectives;

• Rudimentary or Mechanical objectives.

Ed Hooks (2011, p. 18) states that performance is a key to engendering empathy and suggests the following formula for a strong performance, applicable by animation practitioners in their studio work: "Your character should play an action in pursuit of an objective while overcoming an obstacle." Hooks refers to the movement (motion) of the character with the word 'action' (see Appendix A).

Both Ed Hooks and Constantin Stanislavski suggest that a successfully constructed performance should include obstacles and conflicts. In the guidelines that they have independently formulated for the construction of a successful performance, they both argue that a character can only enter into conflict or encounter obstacles in relationship to him/herself, another character or the surrounding environment. Hooks also suggests that the action should be driven by an objective, which if described in linear terms should follow the sequence ‘action, objective, obstacle’ (Hooks, 2011, p. 19). Within this logic, the character appears to undertake an action towards an objective and then encounters an obstacle. Both Ed Hooks and Constantin Stanislavski’s suggestions show that what communicates the story is the movement performance itself. As mentioned earlier, Ed Hooks also states that “acting is action” (Hooks, 2011, p. 10-12). These suggestions highlight the fact that the movement performance is what constitutes the acting, and that the acting communicates the story.

A number of professionals in the field suggest, like Hooks, that performance and storytelling through acting is beneficial to character animation. Williams (2012, Vol. 1) stresses the importance of performance in character animation and stresses the importance of Disney’s teachings to develop a successful performance. He lists two types of animation: “Moving and morphing objects” and “walking and talking animation”. Both Hooks and Williams seem to agree on the importance of performance as a key feature for an animation to keep the observers interested and to engender empathy among the audience. However Williams’s suggestions should not be misunderstood: he is mainly focusing on short and feature-length character animation and his suggestions when he mentions “moving and morphing objects” refer not to abstract art but to animation without story or performance.

Wells (1998, p. 104) suggests that acting/performance in the animated film represents the relationship between the animator and the animated form (character). Wells also lays emphasis on Constantin Stanislavski’s system of performance, and suggests that the principles of Stanislavski’s system are rather appropriate to hyper-realist animation which sets out to deliver an exaggerated version of naturalism (Wells, 1998, p. 106).[10] In his foreword to Ed Hooks’s book *Acting for Animators*, animator and film director Phillip Bradley Bird (*The Incredibles* (2004), *Ratatouille* (2007), *Mission: Impossible – Ghost Protocol* (2011)) states:

> What is typically lost in discussion about animation is the fact that when you watch an animated film, the performance you’re seeing is the one animator is giving to you. If an animated character makes you laugh or cry, feel fear, anger, empathy or a million other emotions, it is largely due to the work of these other unsung artists,

[10] Naturalism (in art and literature) stands for a style and theory of representation based on the accurate depiction of detail. The name ‘Naturalism’ was given to a 19th-century artistic and literary movement, influenced by contemporary ideas of science and society, which rejected the idealisation of experience and adopted an objective and often uncompromisingly realistic approach to art (retrieved from (*Dictionaries*, 2013b)).

> who invest a lot of themselves in the creation of these indelible moments. (Hooks, 2011, p. x) .

Professor Donald Crafton highlights, and agrees with, Brad Bird's observation, then re-analyses his point, stating:

> Animated films are performances. Animated characters (whether Betty or Mr. Incredible) are actors who may convey strong emotions. The audience responds emotionally to the acting. The animated characters therefore the emotions originate with the animators. The animators create the performances and therefore are the "real" performers. (Crafton, 2013, p. 16)

Both Brad Bird and Donald Crafton describe animation as a performance, which when delivered through the characters conveys strong emotions; this is how Disney suggested engaging the audience. Donald Crafton, although he agrees with Bird, futher qualifies the performance as a conditional performance. He writes:

> The performance in the film, contrarily, is both a result and a springboard. It is dependent on, but separate from, the performance of animation, which comprises these conditional performances by the viewers as their reflections, conversations, affection for the characters, and other reactions develop over time. (Crafton, 2013, p. 17)

Crafton (2013) suggests that the animated character performance should be reviewed under two different headings: 1) Performance in the animated character: "The behaviors, actions, and expressivity of the actors, as well as the dynamic situations, narrative flow, plots, and depictions presented in the films"; 2) Performance of the animated character: "Bird points to viewers' emotional reaction as they experience watching the film in real time. But he also refers to the animators' earlier work of making the film, which involves the performance of animation" (Crafton, 2013, p. 17).

Donald Crafton views the movement of the character's body, the behaviour of the character (where behaviour can be viewed either as a set of personality-based responses or as the physical movements of the character's body parts) and the construction and flow of the narrative, as a single unit. Crafton's approach ties in with that of Paul Wells, who stresses the importance of movement, since movement is what creates and composes the narrative and performance (Wells, 1998). Ed Hooks also states that acting is action, and suggests that action stands for the movement of the character (see Appendix A). Wells refers to the Laban's theories about body dynamics, weight, space and time, suggesting that "Hundreds of animated films can provide good 'acting', but even more can illustrate the prominence of dynamics of movement itself as a narrative principle" (Wells, 1998, p. 111). To sum these different points up, critics and practitioners alike suggest that the movement performance of the character is a key contributing factor towards a convincing character animation. Rudolf Von Laban talks about the importance of harmonic human body movement and their effect on the audience and states that:

> Some people move badly. They lack harmony going about their everyday actions and are considered 'clumsy'. Others seem to have a natural, 'in-born' grace. They are a 'joy to watch.' (Newlove & Laban, 1993, p. 22)

However, the acting of an animation character and that of a real actor shouldn't be taken as the same concept. A review of literature shows that the animated character performance differs from a live-actor's performance.

2.3 Summary and Conclusion

This chapter provided a set of terms composing the vocabulary for this research. It also reviewed the evolution of the field of animation and character animation within a historical context. Finally, it examined a range of debates and discussions relevant to the concepts of believability and character performance in animation.

The early history of film/animation (1800-1950) and character animation was reviewed under the heading "Believability in Animation". The origin and development of the notion of movement within character animation were also investigated. Believability and realism were also reviewed within the context of performance.

A detailed review of the historical evolution of animation and character within animation showed how the field of animation progressively became a storytelling art form. Through the development of devices to demonstrate magic tricks the medium developed a strong interest in engendering empathy among the audience. Artists acquired and polished techniques and styles to deliver stories and communicate through animation. Evidence suggests that the notion of character was used to help strengthen the bond between the audience and the animator, helping to convey narratives and emotions through acting.

Professionals working in the field believe that the success of a character animation performance lies in how convincing it is and how effectively it communicates emotions and thoughts. Critics and practitioners like Ed Hooks and Paul Wells suggest that the acting is action and action is movement; fundamentally, therefore, movement is what constructs the narrative. It is therefore important that the movement performance of the character be engaging and fluent enough to match the expectations of the audience. Underlying this research is the belief that the rapidly developing contemporary animation type procedural animation can contribute towards enhancing the believability of a movement performance and make it more engaging.

Ōten Shimokawa's early attempts at developing a guide for the animating characters reflects an early natural movement of the practice towards building guidelines for the application of techniques and tools to animation. Disney's Studios contributions and their impact provide a strong argument for the positive effects of guidance. However, Disney's teachings apply specifically to key-frame animation, which means that procedural animation lacks the benefit of a common studio practice guide. It is beyond the scope of a single piece of research to compose a comprehensive set of studio practice guidelines for procedural animation; having highlighted a gap in the availability of resources for studio practice, my intention in this thesis is to take an initial step towards providing some guidelines for the successful application of procedural animation to character performance in such a way as to enhance, rather than disrupt, character believability.

As noted in the course of this chapter, Donald Crafton suggests that the expectations of the audience increase day by day, driving artists to find new solutions to enhance their art. This involves developing further sophisticated, complex animations and improving the believability of characters. Expectations with regards to believability in a character may evolve in the future, as it has in the course of animation's history; however, existing literature tends to indicate that the definition has fundamentally remained the same for over 100 years.

This research takes the notion of believability and realism as its point of reference to help define the changes, progress and outcomes of the experimental studies within procedural animation. The notion of believability is an industry-originated definition of and describes an engaging character. Animation critic Paul Wells defines the notion as the "real" or "naturalism" and he suggests that this is what Disney meant by believability. He defines this as the character moving in a similar manner to its real-life equitant, but also informed by a plausible motivation. Wells also describes photo-realist animation as "hyper-naturalist" animation and suggests a list of criteria which briefly explains that animation should mimic real life as it appears, sounds and behaves in order to fall in to this category.

Professor Wells's analysis of the believability notion developed by Disney suggests that Disney aimed to avoid hyper-realist character forms (appearances), instead seeking to embed in his characters features conveying human emotions and behaviours. In this way Disney avoided the comparison of his characters with the real-life equivalents. This approach is also supported by Dr. Bregler, who states that audiences accept fairytale creatures but become distinctly aware of the flaws in an exact (i.e. hyper-realist) replica of a live entity in an animated form.

In a similar vein, Crafton suggests that the audience become more aware of the flaws and details of the animated form the more they are accustomed to observing them, generating further expectations. Disney believed that the way to generate appealing character performance is to combine human qualities with a non-hyper-realist form, which ties the discussion to Brenton's suggestion, quoted earlier, that human qualities make machines more appealing to the audience. These human qualities are defined and listed by Picard and Crafton. Picard suggests a series of behavioural and emotional qualities and specifications. And Crafton groups these under two groups where 'emotion' is the first and 'movement' and 'composition of narrative structure' is the second. Paul Wells suggests that what composes the narrative is the movement itself, while according to Ed Hooks, the acting is action and action is movement. It appears, therefore, that a narrative can not survive without the existence of movement performance and movement stands as one of the fundamental contouring factors of performance.

Bearing in mind, then, that movement and the notion of believability appear to be strongly linked, it can therefore be argued that enhancing character movement may help practitioners to enhance the believability of the animated character. In order to achieve this using procedural animation, and in such a manner that the outcome of the experiments undertaken in the course of this research can be usefully applied in a studio environment, several tasks need to be accomplished. The first, which will be described in the next section, is to clearly break down the overall movement performance of the study's character into the different movement and action types that compose it. The second will be to apply different values to each movement type and examine the effect of different sets of values on the audience. For the purposes of the first task, Laban's Movement Analysis and its action types will be used to group the movement performances and to help build a set of tools that can be applied to a range of character performances. In this way, it is hoped that practitioners using procedural animation will be able to evaluate their outcomes for different categories of movement prior to the development phase, by using the values applied to this research as a point of reference.

Chapter 3: Movement and Believability in Animation

3.0 Introduction

This chapter focuses on current and past research pertaining to movement and procedural animation as they relate to the animated character. The main objective of this chapter is to highlight the contrasts and characteristic differences between this study and other research directly related to this study.

3.1 Field of Research and Theories

This research contributes to the field of Animation and its studio practice. The aim of the experimental studies is to study the application process of procedural animation and to focus only on the movement performance and how the studio practice of procedural animation can be utilized to help enhance the movement performance of an animation character. Thus factors other than movement which may affect the believability of a performance had to be excluded from the animated videos. The videos were designed to test only the effects of procedural enhancement and to study the application process. Therefore these factors had to be reviewed carefully and excluded from the videos in order to help the viewers to seamlessly focus on the movement performances during the reviewing phase of the experiments. These excluded factors are the emotional reactions of a character, narrative or stage acting. Since this research attempts to enhance the believability of movement performance, a base key-framed believable movement performance was mandatory. Therefore this chapter will also include a study of theories which may help achieve a believable movement performance. Finally, informing the practice of the practitioner is the main goal of this research, therefore the experimental stages have to be adaptable to studio practice. In order to achieve an adaptable study, this research grouped movement types based on Laban’s movement types, which were used as a reference and a method.

3.1.1 Narrative Form within Character Animation

Understanding how narrative forms itself through character animation has a substantial importance. As discussed within the previous chapter (chapter 2) is that a considerable number of early cartoons are based on simple combinations of illustrations and soundtracks. This is the way artists maintained the form of the narrative. The notion of acting and performance, caused the narrative form to evolve, from the proto-narrative stage in to it's contemporary state. Narrative, in character animation, structures itself around the notion of conflict. The first examples of the understanding of conflict often led the narrative to the use of force and destruction. Then the notion of thinking character bloomed. Narrative form within character animation today orthodoxly aims to elicit a sympathetic response in the viewer regarding to the decisions and performance of the animated form (Crafton, 2013; Hooks, 2011; Pilling, 1997; Wells, 1998).

3.1.2 Character Animation as a Performing Art

The definition of performance theory is twofold (Bauman, 1978; Ben-Amos, 1971):

- Execution of the folklore is an artistic and performative action.

- Execution of the performance, the form of the art, the action with the observer and listener, all together is one artistic or performative event.

Performing art is a specialized art form of performance where artists express their thoughts and imagination by using their body and voice. Performance plays an important role in character animation. The acting performance of a character convey strong emotions to the observer. However the animated characters' existence raises many questions, since they are the pure human creations and are virtual (Cavell, 1979, p. 168). Therefore literature in the previous chapter (chapter 2.2.5) suggests that the animator is the real performer (Crafton, 2013, p. 16). Thus animated character performances may be grouped under performing arts.

3.1.3 Movement Theory

Movement theory was established by Rudolf von Laban, who suggests that harmonic and natural movement generates joy within the observer (Newlove & Laban, 1993, p. 22). Technical aspects of Movement Theory and its definition are reviewed in the previous chapter (2.1.6).

3.1.4 Audience Reception Theory

Reception Theory is a communication model which analyses how audiences receive, encodes and decodes information through media and literary text. The theory also houses the Active Audience Theory which is a sub-cultural Marxist theory. Active Audience Theory suggests that the audience does not only receive information passively through media but also receives it actively. Both Audience Reception and Active Audience theory are reviewed and defined in the previous chapter (2.1.7 - (iii)).

3.2 Professional Studio Practice and Style

This chapter provides an overview of the professional studio practices and methods created and currently used in professional studios to produce life-like characters.

3.2.1 An Overview of Animation Principles

With the intention of drawing natural movement and constructing physically believable animated forms, Disney animators produced techniques and teachings (Thomas & Johnston, 1995, pp. 47-71). These principles are known as the twelve principles of animation and focuses on enhancing the animated form's ability to communicate through movement performance.

1. Squash and Stretch

This principle enhances the feeling of weight and mass by allowing the character to deform whenever the character touches or hits a rigid surface or takes a large hit or impact. Professionals of the field indicate that this is by far the most important and biggest discovery Disney studios made (Thomas & Johnston, 1995, pp. 47-71).

2. Anticipation

This principle allows the audience to understand what the character is planning to do. Anticipation within the movement of a character entails a planned sequence of movement and makes the aim of the character clearer (Thomas & Johnston, 1995, pp. 47-71). The technique indicates that the character has to execute an action in the opposing direction of the final pose, for example stretching an arm backwards before throwing a punch forwards.

3. Staging

Staging ensures that the audience understand and perceive the story (Thomas & Johnston, 1995, pp. 47-71) by placing the character to the right spot inside the scene. It also means picking the right location for the camera and colouring the environment in such a way that it won't overlap with the characters' main colours, also making sure that there aren't any unnecessary moving or still details in the background that can distract from the main focus of the scene.

4. Straight Ahead Action and Pose to Pose

The two ways of drawing a key-frame animation. Straight ahead means drawing the animation starting from the first frame to the last, one after the another and without skipping any frames. Both Richard Williams and Disney animators indicate that by doing this makes the animation process more creative and inventive (Thomas & Johnston, 1995, pp. 47-71; Williams, 2009).

Pose to pose is drawing with a planned schedule by first creating the key poses (Johnston and Thomas 1995). Richard Williams calls key poses 'extremes' and the frames connecting the extreme poses 'in-betweens' (Williams 2009). Because this is rather planned work it is more suitable for group work; also, according to Williams the extreme poses were drawn by the more experienced animators, while the in-betweens were made by their apprentices (Thomas & Johnston, 1995, pp. 47-71).

5. Follow Through and Overlapping Action

"They don't come to a stop all at once, guys; first there is one part and then another."

Walt Disney (Thomas & Johnston, 1995)

With this principle, Disney animators provided an introduction to the understanding of body dynamics and physics. If a character comes to a full stop, its equipment and parts shouldn't all stop at the same time, otherwise the animation will look very stiff and this stiffness will disrupt the believability and realism of the scene (Thomas & Johnston, 1995, pp. 47-71). Disney animators classify actions in under two sections. The first was 'Follow Through', which refers to the physics applied to the characters' equipment (Thomas & Johnston, 1995, pp. 47-71). For example, if a character carrying a bag jumps, the bag's movement will lag behind the motion of the character.

The second, ‘Overlapping’, concerns the rules of physics that are applied to the character’s body, where the limbs and other parts such as the head, tail and ears have inertia; and having differing mass and weight to the character’s main body, they react differently.

6. Slow In and Slow Out

In real-life, nothing suddenly gets to its top speed; also, nothing stops immediately. This principle develops the understanding of objects speeding up or slowing down in time (Thomas & Johnston, 1995, pp. 47-71). As explained by Thomas & Johnston (1995, pp. 47-71), “By putting the in-betweens close to each extreme and only one fleeting drawing half way between, the animator achieved a very spirited result, with the character slipping from one attitude to the next. This was called slow in and slow out…”

7. Arcs

Disney animators suggest that in order to give natural and convincing movement to objects or creatures, animators have to avoid generating mechanical rotations and movements (Thomas & Johnston, 1995, pp. 47-71). Every part of a character’s body is articulated around a point, around which it rotates creating circular movements. The movement of that point needs to follow a curved line rather than a linear one (Thomas & Johnston, 1995, pp. 47-71).

8. Secondary Action

This principle adds further depth to the character by adding more detail to its movements. Secondary actions are the motions which require less concentration and effort, such as chewing a gum or making the character look around while it is walking. If the walk cycle is the primary action, chewing a gum and looking around can be considered as secondary motions. Secondary actions play a major role in character believability (Thomas & Johnston, 1995, pp. 47-71).

9. Timing

Timing in animation can be considered the most important factor when key-framing a character performance (Thomas & Johnston, 1995, pp. 47-71). Timing defines the speed of an object, giving a meaning to its movement and allowing the audience to read the idea behind the animation. Timing is also a crucial factor for defining the weight and mass of an object.

10. Exaggeration

This is adapting the visual appearance of the character by drawing or deforming it according to the story. A character must have exaggerated motion in order to support the story by highlighting the psychological mood of the character (Thomas & Johnston, 1995, pp. 47-71). This way the thoughts of the character can be easily read by the audience, creating an empathic response in the viewer.

11. Solid Drawing

Disney animators define solid drawings as drawings that consider the three dimensional space, creating characters that have depth and volume (Thomas & Johnston, 1995, pp. 47-71). This principle provides an understanding of lighting, shadow and balance during rotation of a traditional animation character.

12. Appeal

The last principle laid down by early Disney studio artists and Walt Disney highlights the importance of a pleasing presentation and a charming personality: "… The word is often misinterpreted to suggest cuddly bunnies and soft kittens. To us, it meant anything that a person likes to see, a quality of charm, pleasing design, simplicity, communication and magnetism" (Thomas & Johnston, 1995, pp. 47-71). The charisma of a character makes the audience appreciate the animation and involves them in the story.

3.2.2 Principles of Traditional Animation Applied to 3D Computer Animation

In 1987 John Lasseter (Lasseter, 1987) published a paper in which he described various ways of applying traditional principles to 3D computer animation. He reviewed all the principles except solid drawing, which he considered irrelevant to 3D computer animations. Lasseter (1987) detailed the application process of his chosen principles by suggesting methods and techniques and also conducted a series of experiments with the 3D character Luxo Jr.. Hand drawn images of the experiments can be found in Lasseter's paper (see Figures 3.1 and 3.2).

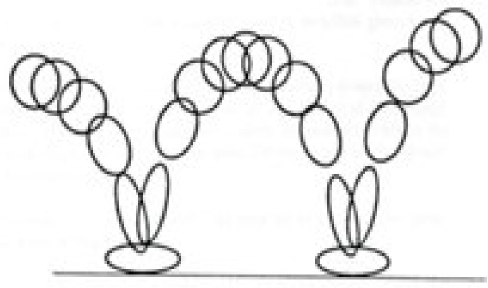


Figure 3.1. : Squash and Stretch principle on the bouncing ball. (Retrieved from Lasseter, 1987).

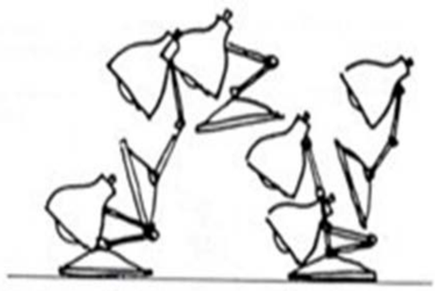


Figure 3.2. : Squash and Stretch principle on the Luxo Jr.'s hop. (Retrieved from Lasseter, 1987).

3.3 Performance and Movement

3.3.1 Twelve Principles of Animation Through Laban's Movement Analysis

Research undertaken by Leslie Bishko (Bishko, 2007), suggests that the Twelve Principles of Animation are not complete movement concepts, which may result by reducing the reality of the character if applied without consideration and careful calculation. Bishko proposes an approach to solving the issue that consists in using Movement Theory and the teachings and techniques of Rudolf von Laban.

Bishko (2007) uses movement theory to analyse and compare the Twelve Principles of Animation, seeking to determine how animation practitioners and professionals can use movement theory, and to see how it enhances the principles of animation. It appears that the main reasons behind her highlighting movement theory are twofold.; One is that Laban's analysis studies the connection between body and mind and how a performer can fluently express his/her thoughts and emotions through the use of movement. The other is that Bishko appears to believe that since the notion of believability is constructed around characteristic realism and self-expression through movement, Laban's theories may enhance this process by improving the communication of the character through movement.

Through a comparative study of Laban's movement teachings, Bishko (2007, pp. 27-28) highlights the resemblance between Laban's Body Theory and the 'Overlapping Action' and 'Follow- through Action' principles from the Twelve Principles of Animation. Following this comparison, Bishko refers to Kestenberg Movement Profile (KMP) and analyses the flow of movement through Shape and Effort and keeps focusing of the analysis and comparison of 'Squash and Stretch' principle. Drawing a parallel between Laban studies and Tex Avery style animations, Bishko analyses Laban's Kinesphere to emphasize the concept of ‘Space’, which is the performer’s involvement with three-dimensional space, then refers to Tex Avery’s use of exaggerated extreme poses to analyse Avery’s extreme use of space. Bishko then refers to the professionals and suggests that within studio practice, it was believed Avery developed his style using extreme Kinesphere for his poses. Bishko states that although the Twelve Principles of Animation are specifically geared for crafting the illusion of life, they can also be applied to non-character forms.

Bishko (2007) leaves the story and characterization out of her scope by grouping them under the contextual and emotional fields of performance, which also supports the grouping logic this research adopted in the previous chapter (Chapter 2). Bishko states that the principles of Disney can be used on non-character objects or forms and she suggests that this process will characterize the object. However she doesn't refer to LMA and test how naturalist movement can affect the outcome of an already characterized movement, or the movement of the non-character object (such as a pair of shorts) which is already attached to a characterized animated form. She also refers back to Tex Avery’s use of extreme poses and exaggerated movement, however does an overview only to compare the similarities and the ways in which she can apply Laban’s methodology to describe Avery’s procedures

A review of the Disney style shows that Tex Avery’s exaggerated animation may oppose some of the principles and suggestions made by the Disney company and the pathway of developing natural movement. Although Tex Avery’s overuse of form and animation of the form appears to be extreme, the audience’s reaction to these extreme animated deformations doesn’t appear to be negative. Also how these extreme movement and deformations benefit or even affect the reception of the character’s performance by the audience. However since there is sufficient research within the Avery’s exaggerated animation style. This may be an avenue for future research since Avery’s style is an accepted one and has been used by many professional studios in film animation (Glintenkamp, 2011, p. 27). Although this research does not focus on a specific style of animation the effects of exaggerated use of procedural enhancements will be tested in the experimental stage.

The research done by Bishko (2007), aims to aid and enhance the principles of animation, which can be referred to as enhancing the believability of the character. She also leaves emotional reactions and acting performance out of her scope, which proves that her scope and focus overlap perfectly with this research. However, she only focuses on comparing the theories and teachings of movement theory with the 12 principles of animation. As such, she doesn't go further into researching their effects or make an attempt at experimenting on the subject matter. She also highlights exaggerated movement but doesn't undertake further research or experiment on examples of the highlighted issue of exaggerated movement. This research, on the other hand, will attend to the issues of enhancing movement performance and exaggerated movement in detail, by designing result oriented experiments and seeking to determine how the viewer responds to these experiments. In the process this research will study the application process of procedural animation and focuses on improving its studio practice.

3.3.2 Animation Character, Animator and the Performance

Birgitta Hosea (2011) examined the notions of Animation, Character Animation and the Animator, ontologically and philosophically, and attempted to provide a definition of these concepts. Hosea approaches animation by considering its place and contribution to live art and argues that post-animation should be considered as a form of live art and animation as a form of performance. In the process she uses an intermedial mixture of interaction design, fine art, dance and theatre. Finally Hosea uses performance as a method in her research and undertakes several portfolio projects, arguing that these projects should be considered as an animation form.

Hosea delivers a detailed analysis of the “Liveliness Theory” and discusses animators role and propose animation as a form of performance through the context of animation and live art. Through an ontological and philosophical debate she demonstrates that performance and animation cannot be separated (Hosea, 2011, p. 161). Finally, she refers to animation characters as substitute actors and defines them as undead entities which animators have to bring to life, our world and time through performance and acting.

Animated performers are controlled by the actions of others: the undead characters enact the performative intent of another and are brought to the realm of the living through movement. Hosea (2011, p. 170) Hosea (2011) approaches the issue from an ontological point of view and by referring to liveliness theory she highlights the strong link between performance and animation. She also emphasizes movement in performance and stresses its importance in constructing the performance. This research stresses the importance of movement in Chapter 2 and focuses on movement theory and procedural animations to enhance the believability of the animated movement performance.

Hosea (2011) examines animation through live art, and observes the audiences reception of animation when it is presented as a live-art performance. Therefore she leaves three-dimensional animation out of her scope, and the techniques and technologies which may enhance the movement performance.

3.3.3 Procedural Animation within Animated Character

Research done by Michael Paul Neff (2005) studies expressive character movement by using procedural animation. Neff gives procedural values to the character controls assuming the result of the process will be an expressive character animation. Neff also focuses only on one type of human body 'action' to narrow down the scope of his experimental stage; he only studies the 'standing-up' action of human characters. (Neff, 2005) argues that the aid of procedurally defined character controllers (handles) are aesthetically important in character movement. In his study Neff improves the kinematic and dynamic outputs of the animated character's movement.

Neff (2005) validates his work by referring to the traditional studies of movement and performing art. This also proves that the research done by Neff sees animation as a performing art. As a second step of his validation, Neff experimentally implements his procedural enhancement process , applying his approach to designing a procedurally prepared control system onto a character model.

Neff refers to animation as a performing art and states that he is aware the field of animation requires characters that are expressive and convincing. He leaves the techniques, teachings, notions and theories coming from within the field of animation out of his scope, regardless of the fact that these techniques, teachings, notions and theories are specified for the notion of expressive character animation, which is the root of believability in the animated form. Neff's way of narrowing the scope of his research leaves many classes of movement types out of it; these might form the basis of further study or a second step to his research. Finally Neff only mentions the aesthetic outcome of the animation, but leaves the surface deformations and object animations attached to the character, as well as the audience's response to procedurally enhanced characters, out of the scope of his research.

The research done by Neff (2005) aims to achieve procedurally animated character controls, but suggests that all that is required from an animator is to produce a believable character. Neff's goal of achieving expressive character animation and his use of procedural animation within character overlaps with this research. However this research approaches the issue through a combination of animation-related theory and practice teachings. It aims to help contribute towards the application process of procedural animation while investigating ways to enhance the believability of the key-frame animated character by supporting animated performance with natural and harmonic movement, provided by procedural enhancements.

3.3.4 Other related research

This sub-chapter reviews related journal entries and academic publications pertaining to this research. The use of Physics-Based Simulations (PBS) also known as procedural animations appears to be largely considered the remit of Computer Sciences. Although there is a considerable volume of publications dealing with PBS for Character Animation, it appears that a significant percentage of these publications aim to provide a technical approach focusing on producing software and interfaces to support the design of PBS based animations and locomotion, leaving animation studies out of their scope. Therefore finding directly related research papers has been a challenging issue for this study.

Research undertaken by Ian Horswill (Horswill, 2008), describes a procedural animation system that combines behaviour-based robot control and Physics-Based Simulations to produce believable character movement. Horswill names the system Twig and suggests that it is intended for interactive narrative applications. He chooses to use PBS to generate procedural animations instead of programming values on character controls. Through a set of scientific experiments, Horswill (2008, pp. 47-49) suggests that the Twig system needs further development and adds: “it provides a proof-of-concept demonstration that the combination of a simplified physics simulation, together with a set of simple control loops, can provide satisfying and believable character movement...”. He also adds that physics-based simulations enhance the believability of the movement of procedural animation and contribute to the style and genre of the animated piece, even with surprisingly simple dynamic simulations.

Given the nature of the research field, Horswill excludes animation theory and practice from his scope. He also focuses on producing character animations and interactive worlds by using only procedural animation and PBS.

This research aims to study in the implementation process of procedural animation and experiments in its contribution towards generating believably character performances. This research also undertakes experimental tests attempting to enhance the key-framed character performance by using procedural animations produced by Physics-Based Simulations, and groups these test based movement performances and enhancements under Laban's basic actions types for practitioners to easily compare and estimate how the level and type of procedural affects the certain types of movement performances. This research therefore approaches Horswill's research from a combined animation theory and practice perspective. The present study also observes audience reception of procedurally enhanced key-frame movement performance.

3.4 Summary and Conclusion

Procedural animation is widely used within Computer Generated Imagery (CGI). However, a considerable proportion of the research on procedural animation originates from the field of computer sciences. As such, it tends to approach the subject mostly from a technical point of view, leaving animation theory and practice out of its scope. As such, finding, investigating and reviewing relevant research was a problematic process.

This chapter provided an overview of the theories and professional studio practices pertaining to the subject of this thesis: Disney's Twelve Principles of Animation are considered to be among the most significant professional studio practice guidelines for character animation and movement performance in character animation and appears to be the only known one; the investigation of theories and practice-based studies of movement is essential in order to produce natural and harmonic movement, and will contribute to the experimental stages of this research; movement and performance based research was also crucial to understand where procedural animation could come in and contribute in to improving the overall movement performance and to see the scale of research undertaken within the context of procedural animation and its contribution to character movement performance. Procedural animation will be used to produce natural movement, therefore research pertaining to the subject has been investigated and reviewed in detail, within the scope of character animation. Finally, understanding how the audience observes movement performance and investigating whether the character can communicate through performance is essential. Therefore audience reception is included within the scope of character animation.

Through existing research, we have seen that performance and movement are inseparable. As the enhancement of the movement of animated character arises as an existing issue within the field of animation, the existing literature suggests that there is still room for improvement within the professional studio practice. Existing research also suggests that procedural animation is a strong toolset which can produce natural and believable movement. This research has mentioned the positive effect of natural and harmonic movement in Chapter 2. The only remaining question is the procedural animation’s effects on key-framed performances and whether the audience reacts positively or negatively to this procedural enhancement process, the application of which is both theory and practice driven. One of the drivers of this study is the belief that the answer to these questions will contribute towards improving the application process of the procedural animation.

This research helps reconfigure the conventional approaches to conceptualizing the difference between developing a character movement performance and studying it. It approaches the issue through a multidisciplinary process. This process includes the use of procedural animation and traditional animation techniques; it is underpinned by animation theory and practice, and aims to inform contemporary animation practice.

Chapter 4: Research Design and Methodology

4.0 Introduction

This chapter includes reviews and discussions pertaining to the selected research method and design approaches, alongside a description of the data collection methods. In addition, a review of the data collection and review phases will also be included in this chapter. The purpose of this practice-led study is to study and make a synthesis of the application process of procedural animation in order to inform the practice of the practitioner pertaining to the affects of the procedural enhancements within a key-framed character movement performance.

4.1 Research Questions

4.1.1 Transfer Stage Questions

- What are the key factors of the photo-realistic focus of visual effects that could enhance a key-framed 3D character animation?
- What are the key factors of procedural animation that could enhance the believability of key-framed 3D character animation?

4.1.2 Reflections and Changes Since MPhil to Ph.D Transfer Stage

During the MPhil stage, my research concentrated on reviewing the animated character performance and studying the structural elements of animated performances. Current literature suggests that these elements are movement, emotional reactions, and how narrative forms within the animated performance. Since these are broad areas, the focus of this research was narrowed down to movement performance only, with the aim of finding ways to enhance the believability of an animated performance; more specifically, to identify tools that might help enhance movement performance (see Chapter 2).

A detailed review of narrative form and the framework of animated character performance has been discussed in the previous chapters (Chapters 2 and 3). Crafton (2013) reviewed the structure of an animated performance by dividing its components into two groups, separating movement and story-telling from emotional responses. Wells (1998) suggested instead that movement itself is what constructs the story and the performance. Film practitioner Ed Hooks (2011) also suggests that acting is action, and that action, in turn, is doing. In order to seek clarification on these concepts, an email exchange was initiated with Ed Hooks, who kindly accepted to answer some questions regarding his approach. He explained that his use of the term ‘acting’ refers to the movement of the character (see Appendix A). An outcome of this exchange in research terms was the decision to focus on studying movement within animated performance.

This research studies the effects of procedural animation on the overall movement performance of an animated character. It experiments with ways of applying procedural animation, basing its approach on Laban’s Movement Analysis. Newlove & Laban (1993) suggested that harmonic, natural movement both engages the audience and gives joy to the observer, while Michael Paul Neff demonstrated procedural animation’s ability to produce natural movement (Neff, 2005; see Chapter 3). One of the assumptions underlying this piece of research is therefore that the natural movement acquired through procedural enhancements might result in improving the believability of a character’s overall movement performance. In order to test this assumption, experiments in adapting procedural enhancements in to key-framed movement performances were conducted.

4.1.3 Ph.D. Stage Questions

Aim

The aim of this research is to develop an understanding for implementing procedural animation, and form this understanding to cultivate a theory of practice that would guide practitioners towards a more succinct method of persuading an audience of a character’s believability by utilizing procedural animation.

Questions

(1) What is the current understanding of the application of procedural animation for character believability?

(2) How can procedural animation affect the overall outcome of a key-framed movement performance within the context of character animation?

4.2 Research Method and Design Approaches

A series of experimental studies were undertaken in order to observe the outcomes of the application of procedural animation to character performance. These studies approached the issue of enhancing believability empirically, through studio practice and animation theory. Since the objective of these studies were to understand the consequence of procedural enhancement from a holistic perspective and attempt to identify the factors which affect believability, a qualitative approach was chosen. This research was carried out using action research as defined by Lewin (1946).

The empirical approach that was employed here suggests that knowledge only or primarily derives from sensory experience. This approach is based on the theory that the mind does not hold advanced experience or any concepts at the outset; it starts out as a ‘blank slate’. As such, the sets of concepts and advanced experience that are acquired can only be derived from direct experience through activities such as watching and hearing, which generate knowledge (Woolhouse, 1988).

British philosopher John Locke argued that humans can gain knowledge only through observation and experimentation (Locke & Phemister, 2008). He suggested that the human brain is a ‘Blank Tablet’ (Tabula Rasa) and describes it as a ‘blank page’ on which a person’s life is written (Locke & Phemister, 2008; Meyers, 2006; Woolhouse, 1988). According to Locke, all knowledge, ideas and notions arise from experiment. John Locke suggested that there are two stages to an experiment. The observer collects sensory data, by using the five sensory organs. The obtained information will then undergo evaluation to generate judgements and notions (Locke & Phemister, 2008; Meyers, 2006; Sellars, Rorty, & Brandom, 1997; Woolhouse, 1988).

Irish philosopher George Berkeley also argued that all knowledge comes from experimentation, but parts with John Locke’s two stages of experimentation and suggests that there is only sensory perception; that humans do not perceive objects subjectively, and that existence is a result of being perceived or perceiving (Berkeley & Dancy, 1998). Berkeley’s approach is also known as Subjective Idealism’ or ‘Empirical Idealism’.

For Scottish philosopher David Hume, all knowledge derives from sensory experience, is an impression left by our sensory experience (Meyers, 2006; Sellars et al., 1997). Hume also suggested that one cannot be aware of any information outside of that provided by our senses and experimentations.

Animated movement performance can only be perceived and judged as believable through visual observation. The approach of this research is to generate experimental studies which reflect the effects of procedural enhancement. The outcomes and contributions of this research can truly inform the practice of the animator when sensory observations are in progress. This requires the practitioner to observe and understand the approach of the research and its background, then to watch the experimentation and review the process and the results to inform their practice and fruitfully compare their own work with the outcomes of this research. Since believability can only be perceived through sensory data, this research uses an empirical approach to collect data in its experimental stages. This study is undertaken as a practice-led research to study the application of procedural animation through experimental studies and collects the reflective data pertaining to the experimental study results through empirical direct observation (conducted experimental studies) and indirect observation (survey based questionnaire and semi-structured interviews) to help inform industry practice.

4.2.1 Research Method

Action research is a qualitative data collection method for undertaking a detailed, pre-planned, and systematic review (Collins, 2010; Stringer, 2013). Action research displays the most effective ways of applying a practice and produces knowledge through an iterative test and evaluation method. It introduces principles and regulations, allowing the production of hypothetical data by obtaining applicable information (Lewin, 1946).

The primary aim of action research is to produce practical knowledge for individuals or communities, with a view to resolving a specific issue and/or improving their economic, political, psychological or sociological context. Action research has a bearing on individuals as well as communities, whether these be small groups or wider organizations.

Action research adopts an experimental and exploratory approach, in the course of which an understanding of an issue is formed; after a phase of observation, plans are made to develop an intervention strategy. This method goes futher than to ask and seek knowledge through literature or observation alone; it also involves experimental studies – in other words, it involves direct intervention. During and after observation and intervention, relevant data is collected in various qualitative types and forms (Winter & Burroughs, 1989).

Observation: Involves noting and recording the events occurring in real time.

Interviewing: A qualitative informal data collection model. Literature suggests that a qualitative interview should be based on participation as it is a discussion or a conversation, rather then a formal set of questions and answers. There are three types of qualitative interviews:

- Unstructured: Also known as in-depth interviews. Their planning involves very little structure. The researcher may just pick one or two discussion topics and let the conversation lead the interview. It is possible to divert the discussion according to the responses coming from the interviewee or due to progress the researcher is making.
- Semi-Structured: Also known as focused interviews. The researcher designs several sequential open ended questions to be discussed with the interviewee. These questions are usually related to broad topics and the researcher gives their interviewee enough time to think and answer. Literature suggests that the nature of the questions should define the topic under investigation; this way the researcher and the interviewee can cover the discussion area in more detail. This form of data collection allows the researcher to encourage the interviewee to elaborate, and engage more with the topic and ask further questions if they are interested. In this way, the researcher may divert the conversation towards a narrower topic within the research field or a more interesting new field of investigation. Literature suggests that this method is more successful when the interviewee has more than one area of discussion to address.
- Structured: a tightly scheduled questioning technique; all questions are asked in the same form and format. Literature suggests that questions can be phrased in a way that limits the range of possible responses. This can be done by giving a limited selection of answers to the interviewee following the question. Since this data collection technique is very much like a researcher-administrated questionnaire, the researcher should consider whether the study requires a structured interview or a questionnaire. The researcher should bear in mind that if the interview is too tightly designed, this may prevent diversion, which may prevent the issue at hand from being investigated deeply enough.

Focus Groups: these are sometimes used if the researcher needs to obtain information from a specific group rather than individuals. Literature suggests that this data gathering technique is used to limit or reduce resources to a more manageable size. During a focus group, a selective group of 6-10 individuals is brought together to create a collective discussion. Through discussion, circumstances, opinions and behaviours should be examined. The outcome of focus group discussions are heavily dependent on the group dynamics. This research used both a survey and interviewing techniques to collect data and analyse results; the investigation did not make use of focus groups.

Action Research protocol is an iterative cycle. After the data collection process has been completed the cycle is repeated to analyse and reflect on the results and make sure the outcome has brought a sufficient understanding or solution to the issue under investigation. The cyclical or iterative protocol starts with conceptualizing or specifying the issue and then moves on to the suggested contribution to knowledge through several interventions and evaluations.

Action Research demands practical participation and involvement with the issue, and the researcher should undertake an action leading to change or intervention in a specific situation within the investigated research field. Literature refers to this action as the “FMA” Model: Framework of Ideas, Methodology Being Applied, Area of Concern” and suggests that the researcher should actively be involved in their planned intervention to make the change in the specified issue.

There are several action research models, which provide different perceptions of events, experience and knowledge:

The Positivist Paradigm: Also known as the Logical Paradigm, it is based on specific concepts that can produce constructive outcomes. It is based on knowledge, notions and convictions which are directly experienced. These experiences are documented among individual, independent observers. The Positivist Paradigm is scientifically based and uses empirical tests to adopt inductive and deductive hypotheses.

The Interpretive Paradigm: Supports relativist ontology and subjectivist epistemology. Relativist ontology holds that reality is constructed intersubjectively through the data collected and analysed socially and experimentally. Subjective epistemology holds that one’s knowledge and self are inseparable, therefore the researcher and the research issue are linked and how one views the world is no different to how one views himself.

The Paradigm of Praxis: Within action research, if the study cannot be placed under the Positivist or Interpretive approach, Praxis allows the researcher to act upon the conditions of the issue to change it. The Praxis approach derives knowledge through practice, while practice itself is informed by knowledge. Praxis is therefore an iterative, ongoing process that rejects neutral investigative approaches. The experimental study stages of this research adopt the Praxis paradigm.

Winter & Burroughs (1989) state that what truly defines action research is the principles that guide the researcher through their studies. They suggest six principles:

Reflexive critique: This involves critically reflecting on the issue to make implicit comments on the resulting judgements, to help develop theoretical considerations for a practical approach.

Dialectical critique: Argues that reality is validated through mutual consent and shared through dialogues. These dialogues develop the concepts related to phenomena and help understand the link and type of relationship between a phenomenon and its context. To understand these, a dialectic critique is required. This critique mainly focuses on the instability of opposing factors within the link that constructs the relationship and assumes that if there is an issue, it must be because of these unstable and opposing factors.

Collaborative Resource: Argues that each collaborator's idea is a potential resource for developing interpretative categories of analysis which will be negotiated among participants. Collaborative Resource maintains a control over the paradoxes affecting single and multiple points of views pertaining to an issue or the approach to solving an issue. As such, it helps avoid the skewing or diversion of the main idea and approach originating from the original researcher.

Risk Analysis: The process of shifting in the context of the research may threaten all existing and previously achieved data and knowledge. This may lead to the open discussion of ideas, judgments and interpretations. Therefore the researcher who uses action research will use risk analysis to ease others into the proposed new framework and encourage participation, by highlighting that all participants will take part in the same process and stating that the intended outcome of the research is to deliver a teaching knowledge.

Plural Structure: Research naturally embodies multiple views, comments and critical approaches. This natural state of research demands plural reporting. This supports the ongoing discussions in the research process.

Theory, Practice, Transformation: During an action research process, theory informs practice and practice refines the theory through an iterative cycle. Groups or individuals take actions based on indirect assumptions, hypotheses and theories. Through observation and experimentation this theoretical knowledge refines and improves. Action researchers define the reasons behind their theories and the logic behind their actions, to question the bases of these reasons. Researchers apply the theoretical approach to practice and analyse the results to refine their suggested assumptions, theories or hypotheses to alternate the links between the theory and practice of a subject.

Action research was chosen as a main method because this study aims to inform the practice of animation practitioners, proposing an approach that enhances the the application process of procedural animation and experiments with achieving believability within the animated characters' movement performance, within a theoretical and practical framework of animation and movement theory. The experiment results will be evaluated using a survey and semi-structured interviews with practitioners, giving an understanding of the needs of the animation community. Experimental studies designed to help reconfigure the conceptualized links between studio applications of procedural animation and animation theory therefore adopt a praxis-based approach.

4.2.2 Research Design

The significant analysis of the fields of film/animation and character animation reported on in Chapter Two brought the issue of believability to the fore. Research directly related to the subject matter was critically analysed in Chapter Three: Movement and Believability in Animation. However a review of current literature shows that there is very little research on the subject of combined animation theory- and practice- driven attempts to enhance the believability of animated character movement performance using procedural animation. Furthermore, there are no common studio practice guidelines for the toolset.

Initial steps were taken to clearly identify the issue. The factors which may affect believability were identified through the review of data and theoretical and practical discussions. The procedural animation toolset and contemporary studio practice were chosen for experimentation. Initial planning for intervention was designed to test and observe the movement performance potential of the procedural animation technique. This initial experimental study was designed with two stages:

- Stage one was designed to test the ability of Procedural Animation to produce convincing, harmonic and believable movement.
- Stage two sought to observe Procedural Animation's potential effects on key-framed movement performance.

The creature chosen as a design case-study for the first stage of this experiment was an octopus from the cephalopod family. The procedurally animated result was compared with live footage of its real-life equivalent. The second phase of the experimental study involved a key-frame animated simple human-like cartoon character. The character was layered with initial procedural enhancements such as a dynamic abdominal section. The results were compared with the non-procedurally enhanced version of the same animated character to signify and identify the visible changes. Observation of the initial intervention results led the research to its second cycle of experimental studies. Detailed procedures, test results and an analysis will be provided in the following chapter.

A plan for the final intervention and action was established. This plan includes a series of procedurally enhanced key-frame performances with different dynamic levels to test the potential effects of procedural enhancement.

The evaluation and analysis of the test results were undertaken in two phases:

Survey: A survey was carried out using the Purposive Sampling Method .

Interview: Semi-Structured interviews were designed to evaluate the survey results. Interviews were carried out using the Convenience Sampling Technique.

Diagram 4.1 provides a visualisation of the research design structure.

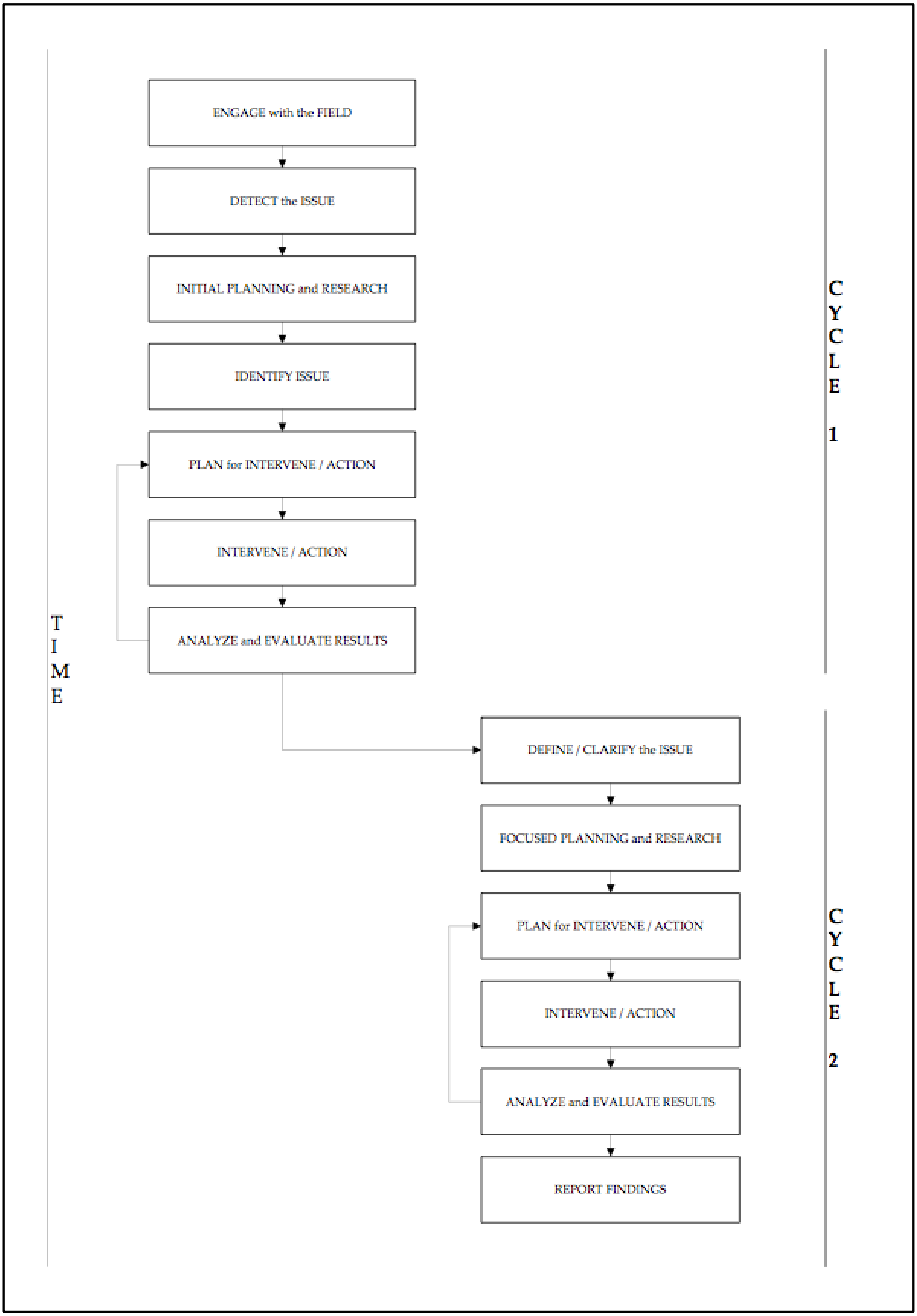


Diagram 4.1: Design of the Research

4.3 Data Collection Methods

This research used qualitative data collection methods including a survey and interviews.

4.3.1 Selection of Respondents

Since this research aims to inform the animation practice, the selected target sample group was composed of working animation professionals/practitioners. Nonetheless, as has been discussed before, the view of non-practising observers is also an important factor. Therefore for the sake of accuracy in the test results, academic teaching staff and researchers in the field of animation were also included in the sample group.

For this study, data was collected from two different sample groups (Appendices K) for the survey-based questionnaire phase, in line with the purposive sampling method.

Once the analysis of the survey completed, a selection of animation practitioners from the sample group were interviewed to discuss and evaluate the outcomes.

4.3.2 Questionnaire

As a research instrument, the questionnaire consists of fixed and predetermined sequential questions and prompts. It is not open-ended or flexible and does not seek to establish an informal interaction.

4.3.3 Questionnaire Design

The questionnaire was designed in August 2013, and the pilot test was concluded in September. The survey was conducted between the 1st of September 2013 and the 15th of November 2013 with animation practitioners and academic staff (doctoral and teaching staff).

The purpose of the survey was to explore and evaluate the impact of procedural animation when layered with a key-framed character performance. Four groups of movies were shown to the interviewees; every group contained three videos of the same key-framed movement performance with different levels of procedural enhancement. Respondents answered questions relating to a specific group after watching those three videos. Some questions provided a list of options, and respondents were instructed to mark the appropriate responses. Personal details were collected at the end of the survey; these will only be used for statistical purposes and will not be shared with third parties under any circumstances. Diagram 4.2 shows the survey /questionnaire design structure.

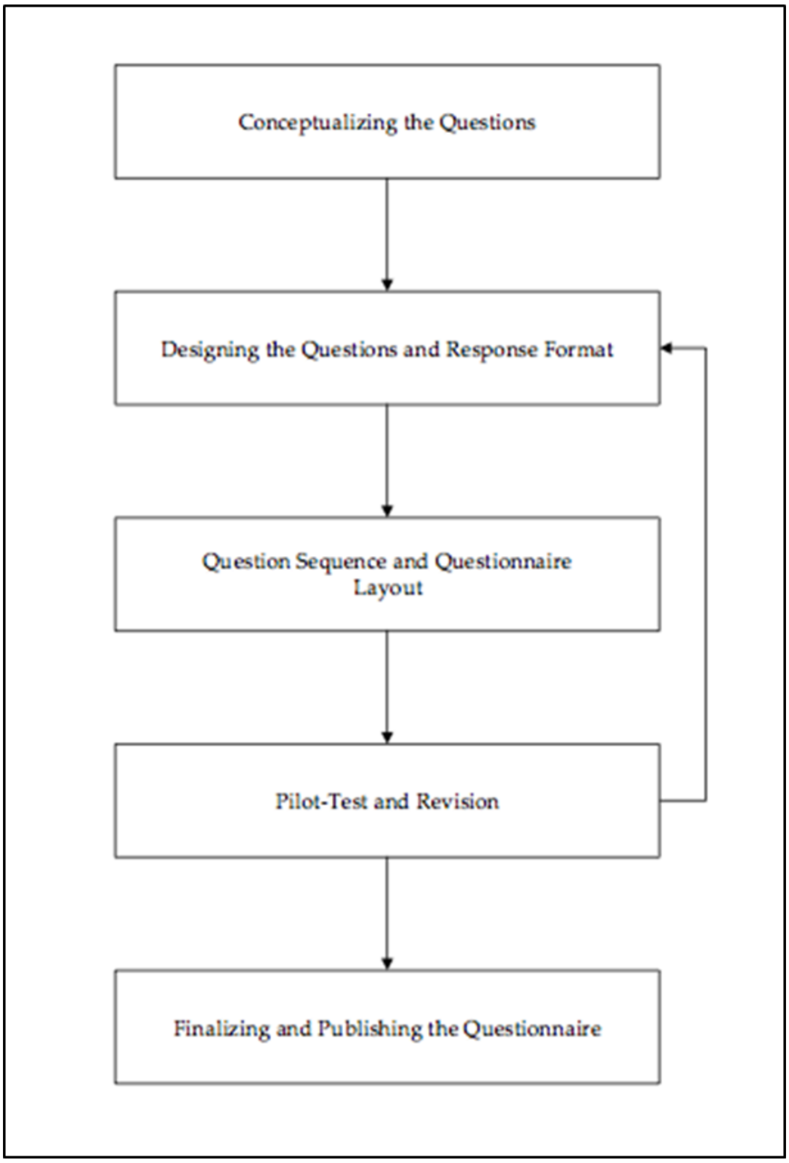


Diagram 4.2: Design of the questionnaire

4.3.4 Interviews

A survey of current literature shows that interviewing is one of the main techniques used in animation research. It was chosen for this study to evaluate and discuss the outcomes of the survey/questionnaire results, due to its significant advantages. Its greatest one is its flexibility and to the fact that it allows the interviewer to be certain that the interviewee fully understands the questions. Face-to-face interviewing gives the interviewer full control over the process and flow of the questioning. In case of confusion or misunderstanding during the process, the interviewer can intervene immediately and fill in gaps or correct issues (Drever, 2003). It also provides fruitful data that can be elicited using several types of questioning techniques. Furthermore, it has been established that interviews provide a higher level of response rate compared to other forms of questioning techniques (Bailey, 1994).

Face-to-face interviewing also allows the interviewer to enhance the effectiveness of the conversation. If the interviewer is able to strengthen the bond of communication and keep it at a significant level during the conversation, data coming from the interviewee will be significant and detailed. In such cases the interviewer can also ask additional questions to go into further detail and gain a deeper insight into the subject. Randomizing the flow of the questions may also provide flexibility during the interview. This can improve the effectiveness of the interview and provide the researcher with richer outcomes.

Furthermore, individuals or sample groups that are more comfortable expressing themselves verbally rather than in writing may find face-to-face interviewing more appealing. This allows the interviewer to elicit data more effectively and fruitfully (Drever, 2003). An added benefit of this format is that unlike a survey-based questionnaire, a face-to-face interview allows the interviewer to track the interviewees' mimics, gestures and messages they send through body language. This aspect of the interview provides an additional chance for evaluation for the researcher. This may help to pick up hints and additional information or help interviewer to lead the conversation more effectively.

There are also practical advantages to face-to-face interviews that can have a bearing on the outcome. For example, conducting an interview means organizing a specific date and time. Doing this helps avoid or deal with potential issues which may affect the interview subject (Bailey, 1994). Interviews also allow the researcher to discuss detailed graphics, charts, statistics and other such complicated outputs. A face-to-face conversation allows the researcher to describe and explain the outputs in detail (Bailey, 1994). Finally, during a face-to-face interview, the interviewee does not have the chance to consult or seek advice from others in order to answer the questions. This ensures the researcher gains individual, untainted point of views (Drever, 2003).

Patton (2002) suggests that the aim of open ended interviews is not to put ideas in to the interviewees' mind but to elicit information that cannot be obtained through observation of data alone. This research adopted the semi-structured interview due to its overall appropriateness to the aims of this study.

4.3.5 Interview Design

An interview form has to be prepared prior to the meeting. This allows the interview process to be valid and reliable (Bailey, 1994; Drever, 2003; Patton, 2002). Key factors to create an appropriate form are as follows:

- Questions have to be clear and easily understandable.
- Structured, semi-structured or unstructured questions can be prepared.
- Questions should have a focus.
- The interviewer must avoid directing the interviewee.
- It is advised to prepare alternative questions.
- Questions have to follow a logical sequence.

4.4 Survey and Interview Phase

This section describes the pilot survey, sample size, survey and interview procedure and the interviewee selection.

4.4.1 Pilot Survey

The pilot survey was undertaken in two stages. In the first stage, the pre-survey was sent to a randomly selected group of animation practitioners and the thesis supervision team. This random sample group did not exceed ten individuals. The survey was revised after the evaluation of the feedback from the sample group. The credentials section, where a name and surname were requested from the participant, was removed. An informative note suggesting the participant watch the videos in full screen view was added. The definitions of key terms were further clarified.

In the second stage, the sample size and the target sample groups were determined. The survey was designed and published using the SurveyMonkey© web-based survey solution. A sample group of three hundred (300) participants was targeted and a direct link invitation was sent to everyone in the sample group. The survey settings were designed to allow participation by invitation only, to keep the survey confidential and to avoid random interventions.

4.4.2 Sample Size

As mentioned earlier, the questionnaire was sent to animation practitioners and researchers. Of a total of 300 questionnaires, 213 were filled in, a return percentage of 71%.

For this study, 213 respondents gave a sampling error of maximum 4.01% at 95% confidence level (see Table 4.1, Appendix B). This is a tolerable level considering the nature of the research and the field of study involved.

Population size	Sample size					
	Continuous data (margin of error=.03)			Categorical data (margin of error=.05)		
	alpha=.10 t=1.65	alpha=.05 t=1.96	alpha=.01 t=2.58	p=.50 t=1.65	p=.50 t=1.96	p=.50 t=2.58
100	46	55	68	74	80	87
200	59	75	102	116	132	154
300	65	85	123	143	169	207
400	69	92	137	162	196	250
500	72	96	147	176	218	286
600	73	100	155	187	235	316
700	75	102	161	196	249	341
800	76	104	166	203	260	363
900	76	105	170	209	270	382
1,000	77	106	173	213	278	399
1,500	79	110	183	230	306	461
2,000	83	112	189	239	323	499
4,000	83	119	198	254	351	570
6,000	83	119	209	259	362	598
8,000	83	119	209	262	367	613
10,000	83	119	209	264	370	623

Table 4.1: Table for Determining Minimum Returned Sample Size for a Given Population Size for Continuous and Categorical Data. (retrieved from Bartlett, Kotrlik & Higgins, 2001, p. 48)

With a sample size of	100	200	300	With a confidence level of	90	95	99
Your margin of error would be	8.01%	4.01%	0.00%	Your sample size would need to be	143	169	207

Table 4.2: Sample-Size Calculation Result of Sample Size for This Research. Calculated by Raosoft (2004).

4.4.3 Survey and Interview Procedure

The survey-based questionnaires were published online. The members of sample the group were invited through email. A reminder email was sent on the 14th of October 2013.

The interviews were carried out following the survey/questionnaire results after the 15th of November.

4.4.4 Interview Selection

The interviewees were selected through a detailed process. First the interviewees needed to be currently working or had to have worked in a professional game, animation or visual effects company. Second, they had to have a strong understanding of, and education in, animation studies.

4.5 Observation and Archive

Observation and archiving were done informally to generate background knowledge on character animation and the use of procedural animation. Game, animation and visual effects studios and their studio practices were observed. Individual artist works and different types of character animation were observed. Additionally, literature pertaining to animation theory and practice was reviewed.

4.6 Data Processing

This research used both qualitative and quantitative data processing methodsin order to to strengthen the findings by validating them and rendering them more reliable.

4.6.1 Questionnaire Analysis

As previously stated, the main purpose of the study is to inform the practitioner about the possible enhancement and effects of procedural animation’s implementation process on the believability of a key-framed animated character movement performance. The questionnaire-based survey aimed to find out how practitioners and academics receive and react to different levels of procedural enhancement. Most importantly, the survey/questionnaire aimed to find out how the targeted sample group viewed the involvement of procedural animation within the context of animation theory and practice.

The data collected through the survey/questionnaire was processed using two descriptive statistic applications. Both SurveyMonkey©'s analyser and IBM SPSS-20.0 (Statistical Package for Social Sciences) were used. Additionally, the reliability and validity of the results were re-calculated and tested using the Raesoft Sample-Size Calculator which was designed to test the validity and reliability of the sample size and wether the response rate was sufficient or not to render a judgment.

4.6.2 Analysis of the Focused Interviews

This research used the semi-structured (Focused) interview method suggested by Merton & Kendall (1946). Interviews included a pre-determined set of open-ended questions which prompted discussions pertaining to the subject of the research and the outcome of the survey/questionnaire results.

The purposes of the use of focused interviewing for this research are:

- To test the validity and the reliability of the hypotheses which derived from the analysis of existing professional studio techniques and animation theory and practice.
- To see if there were any discrepancies between the actual survey/questionnaire results and the anticipated results.

The interview results were analysed using the five stage analysis method suggested by McCracken (1988); these consist in organising and transcribing the collected data, highlighting the emerging themes, analysing and tracking the similarities between the responses, evaluating the final results of the analysis, and finally presenting the data.

The thematic analysis of the interviews was undertaken using the ATLAS.ti software. This software is an academic toolset designed to analyse semi-structured interviews by helping to identify topics and group them under themes.

4.7 Summary and Conclusion

This chapter reviewed and discussed the research methodology. The discussion includes research questions, hypotheses and objectives. The discussions are focused on the construction of this practice-led research and its data collection and data analysis methods. This practice-led research consists of four overlapping phases: the exploration phase, the design phase, the data collection phase and the data analysis phase.

For the pilot survey, a respondent sample was selected among animation practitioners and academics. Following the survey-based questionnaire, semi-structured interviews were carried out with nine animation practitioners.

Cross tabulation and frequency distribution were used as statistical techniques to analyse the data obtained from the survey/questionnaire. The interview data was processed using individual case analysis and cross-case analysis techniques (Patton, 2002).

The following chapter will present the experimental study processes, research findings and interpretations.

Chapter 5: An Experimental Study: Utilising Procedural Animation for Developing Believable Animated Movement Performances

5.0 Introduction

As discussed in the previous chapters, movement performance is a significant factor in the development of believable character performances within the field of animation. Furthermore, It has so far been established that procedural animation may prove to be an effective tool for delivering animated movement that is both realistic and natural-looking.

This practice-led research proposes a synthesis of the implementation of procedural animation, which may help improve the efficiency of its application phase. It experiments with enhancing the believability of key-frame animated character performances to design this synthesis. It offers a multidisciplinary approach that may help reconfigure the concepts currently underlying the development of believable movement performances, recognizing and defining the issue of producing believable animated performances within the context of animation.

The main concern of this research is the implementation process of procedural animation. It aims to contribute towards eliminating or minimising the current trial-and-error or produce-and-test phase of the process..

Chapter Two analysed the notion of believability, breaking down the factors that may affect the notion and focused on the movement performance of a character to draw the research scope. Chapter Five discusses the experimental stages of the research, the techniques and theories used to conduct them. It describes the implementation of the theory to the design, and provides a full technical account of the experiment. The assumption behind generating the experimental animations was that the analysis of these outcomes would lead to a better understanding of the effects of procedural animation, which may help improve the implementation planning phase of the practice. The notion of believability was used as a gauge to help define the effects of procedural enhancements.

The experimental studies designed for this research use Laban's Movement Analysis and Effort Theory as methodological tools to develop referable categories of movement performances. This provides a benchmark against which practitioners can compare and contrast their work.

5.1 The Use of Procedural Animation

In contemporary studio practice, procedural animation is used either to completely animate a character, add detail to the characters' features and animation, or enhance the latter. Unlike key-frame, procedural animation requires a primary force to produce the main or a base animation for procedural enhancements to produce movement. More clearly, procedural animations are not similar to key-frame animation when they are conditioned as enhancements to produce secondary animations. Key-frame animation requires the animator to set keys to distinguish storytelling poses. These are further detailed with the use of in-between poses, which come between two storytelling poses, creating a seamless motion to communicate a narrative through movement performance and acting. Procedural animation involves a real-time calculation of the rules and regulations set within the environment, which doesn't give the animator the full control the key-framing process does. This causes issues, including the difficulty of estimating the results.

The effect of procedural animation used in studios today on movement performance is measured and evaluated by trial and error by studio artists and their supervisors. This process is time-consuming and yet gives no solid indication as to how the audience might receive these procedural enhancements.

A review of current literature shows that there is no evidence of any research that attempts to help utilize procedural animation with a multidisciplinary theoretical approach and help give an insight into its effects within key-framed animated movement performance. At present, there is no common standard studio practice guide for utilizing or applying procedural animation to key-framed movement performances. This research aims to help inform the practice of the animation professional; therefore, the experimental studies were designed using common studio practice and toolsets. The experimental studies conducted here study the application of procedural animation and seek to produce comparative materials which may work towards the development of a common studio practice guide for procedural animation, thus helping to enhance the efficiency of its studio pipeline. In order to produce a comparative material set this research uses and utilizes common studio toolsets.

5.2 An Observational and Comparative-Based Study for an Initial Step towards Utilizing Procedural Animation

The experimental studies described within this chapter were undertaken as an initial step in studying the potential of procedural animation and its implementation process, within the context of enhancing both the believability and realism of the animated movement performance. This experimental study tested physics-based hair simulations and used comparative analysis to evaluate the test results.

5.2.1 Choosing the Character

The sample character chosen for this experimental study was an octopus from the cephalopod family. These creatures perform very complex sets of movements, including the twisting and curling of the limbs, and exhibit significant skin surface deformations (wobbling). Attempting to reproduce these effects in an animated form is proven to be exceptionally time-consuming and challenging to achieve using the key-framing process. This choice of character was therefore highly suited to the use of procedural animation.

The aim of this experimental study was to produce life-like and convincing movement performances using only procedural animation, in order to test the potential contribution of procedural animation to the movement performance of the character and the process of implementing the procedural enhancements.

5.2.2 Observation and Analysis of Sample Character: Involuntary Neuromuscular Dynamics and Locomotion

An octopus's arms is a Muscular Hydrostat, which is a boneless muscle system that helps the octopus to manipulate objects or helps the main body of the creature to move about. This aspect of the octopus's anatomy causes the arms to drag behind the creature when it travels along a certain axis. The biological structure of the creature means the arms involuntarily produce a wavy and floaty movement, given the nature of the environment it lives in. The boneless structure of the creature also causes surface skin and flesh deformations (Young, 1971).

The curvature and twist-based movements play a substantial role in achieving a life-like movement performance, and required a procedural animation type that was adapted to the task. In this instance, the Hair Dynamic toolset of Autodesk Maya was a suitable candidate for the task.

Hair Dynamics are physics-based simulators that are designed to generate hair-like movement performances (Guan, 2013). They apply the rules of Newtonian gravity, air density and several force fields such as turbulence and wind. The assumption behind the toolset selection is that using the ability of hair dynamics to produce curve- and twist-based movements will procedurally generate limb movements that are life-like and convincing.

Young (1971) lists several types of locomotion for cephalopods, including crawling and producing thrust. This experimental study required that the sample character perform both actions. For slow locomotion, a cephalopod performs crawling actions beneath the sea by spinning its arms and creating a pull and push action through contact with the surface (see Fig. 5.1). For faster locomotion, the creature is also able to generate thrust by sucking in water and expelling it to move forward. This action is known as jet propulsion, where the creature conserves momentum (Young, 1971) (see Fig. 5.2).

In addition to all constant and locomotive actions, the sample character had to be able to procedurally demonstrate the illusion of slowing down or speeding up during locomotion. This experimental study attempted to illustrate these actions by generating a character control rig that could automatically produce swing and wave movements in real time according to speed. The wave flow ratio of a fluid is also know as the Reynolds Number (Packard, 1972; Young, 1971) (see Fig. 5.3). The sample character was designed to simulate the creature’s movements during locomotion by calculating Newtonian gravity and air density. In order to help understand the creature’s involuntary arm movements during locomotion, the Reynolds number was studied. The assumption was that the review of how the Reynolds numbers were produced could help understand how to generate speed changes by using procedural animation.

Figure 5.1: Cephalopod (Octopus) Performing Crawl Action (Slow Movement) (Kok, 2007a).

Figure 5.2: Cephalopod (Octopus) Performing Jet Propulsion (Fast Movement) (Kok , 2007b).

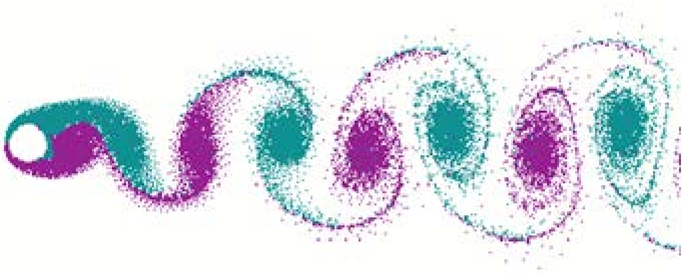


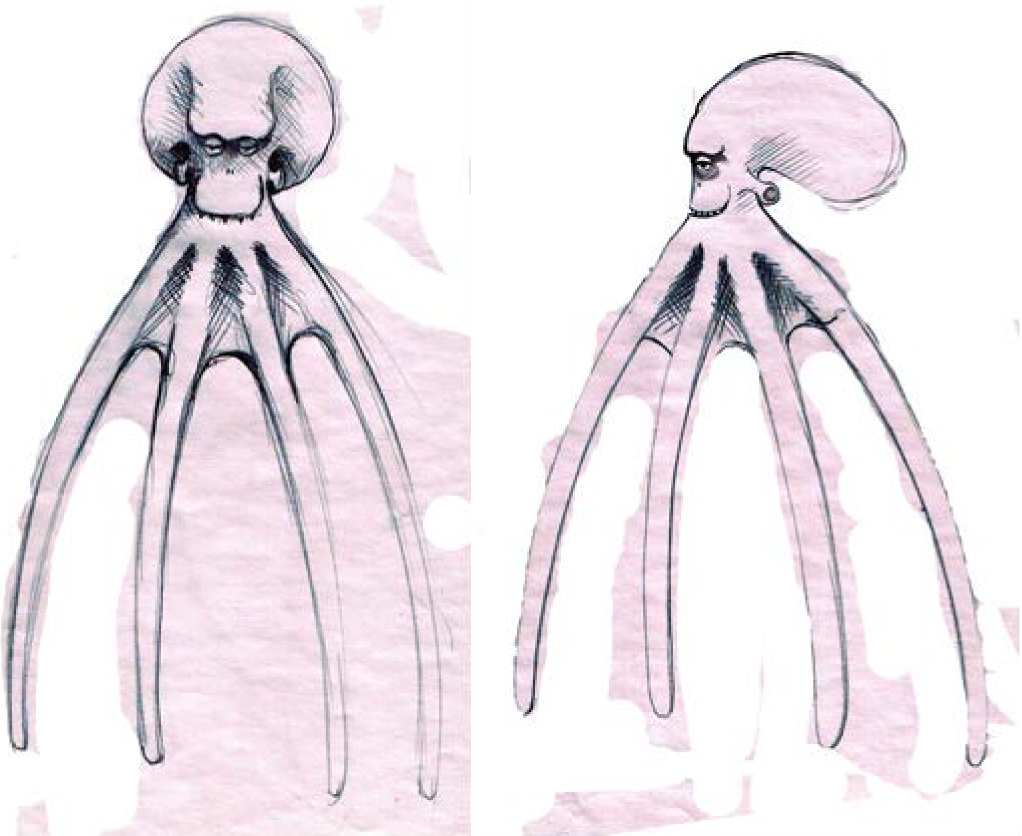
Figure 5.3: A visual example of the Reynolds Number (De La Rosa Siqueira, 2005).

5.2.3 Designing the Character

The design of a character plays a crucial part in generating believability. The visual appearance of a character has to be credible and also easily readable by an audience so that the movement performances of the character can successfully communicate thoughts and emotions to the audience. Within the context of this research, it was assumed greater readability in the character design for the experimental studies would also make the reviewers' task more comfortable. With this in mind, the experiment applied common studio practices and guidelines to help achieve a clear and readable character design and base key-frame animation.

Thomas & Johnston (1995) and Williams (2009) argue in favour of the benefits of solid drawing and its contribution to the clarity of the character. They believe it is a substantial factor in the production of expressive characters. This will help the observer in understanding the animation and the form of the character. Wells (2006, p. 16) argues in favour of the inclusion of fantastic elements in the design of the character and stresses the benefits of the latter in terms of audience reception of the animated form. Wells suggests that re-imagining the world we live in can prove fruitful for the artist and lead observers to grow more interested in a piece of work.

This research focuses on enhancing believability, rather then improving realism, and so applied theory and practice accordingly. To help enhance readability and expressiveness, the cephalopod creature was therefore characterized, rather than designed to mimic its real life equivalent (see Figs 5.4, 5.5. and 5.6). The octopus sample character concept and reference sketches were designed and drawn by Andrew Love. The character sketches and concept arts for the characters were done by concept art experts for two reasons: to save time, and to produce professional level designs. This creative collaboration also opened the door to multiple points of view and different debates during the design stages.



Figures 5.4 – 5.5: Cephalopod (Octopus) Sample Character Reference Drawing by Andrew Love.

Figure 5.6: Cephalopod (Octopus) Sample Character Concept Drawing by Andrew Love.

The sample character's mesh was modelled using polygon-based geometric primitives. This was done to maintain full control of the sample character's topological design and flow. The limbs were designed for their topologies to flow separately from the main body and from each other. This allowed the character to have more distinct, detailed wrinkles and flesh-like deformations between the limbs. It also helped avoid potential pull and push problems among the limbs since the grouping of the topological flow (edge flow) separated their connection points to the main body of the sample character. The facial and head structures of the character were also grouped individually. This made it possible to generate skin deformations without disturbing or unintentionally deforming the rigid or neighbouring sections of the head mesh.

Given the nature of the expected movement performance and its complexity, the topology needed to contain high levels of detail. The mesh allowed the character to demonstrate prodigious levels of twist- and curl-based movement performances alongside skin deformations without collapsing, interpenetrating, folding or breaking. Common standard studio toolsets and techniques were used during the modelling phase, with the aim of creating a clear, accessible experimental study that practitioners might relate to and thus find easier to adapt in practice. All technical modelling phases were undertaken using Autodesk's Maya 2011 studio software package.

Only one issue arose during the modelling phase of the experimental study, which was the need for high polygonal levels. Hair Physics-Based Simulations require a significant level of detail in order for the surface of a mesh to deform believably, and creating a highly detailed mesh can cause technical issues depending on the performance of the computer the practitioner uses.

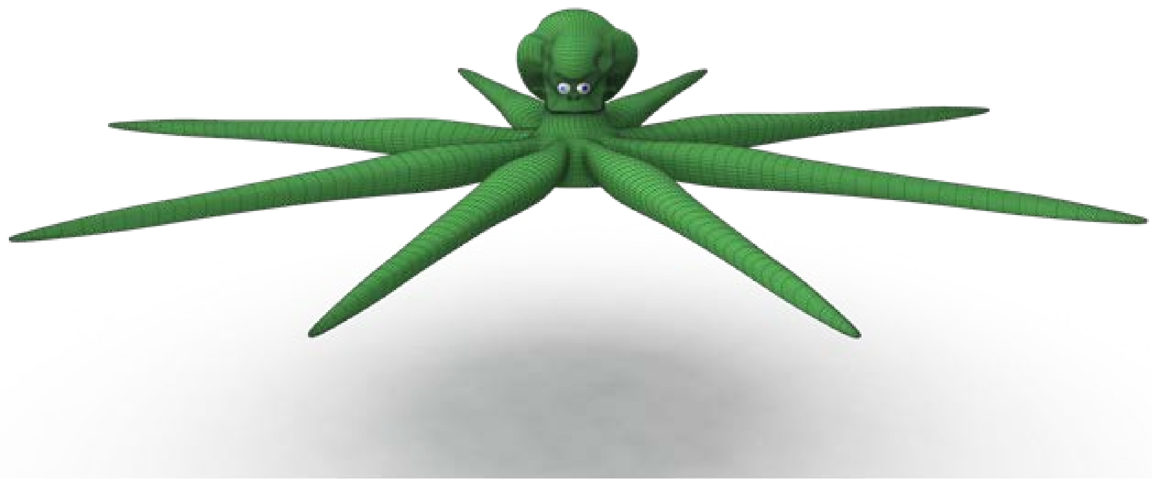


Figure 5.7: Cephalopod (Octopus) Sample Character Complete Model Front View.

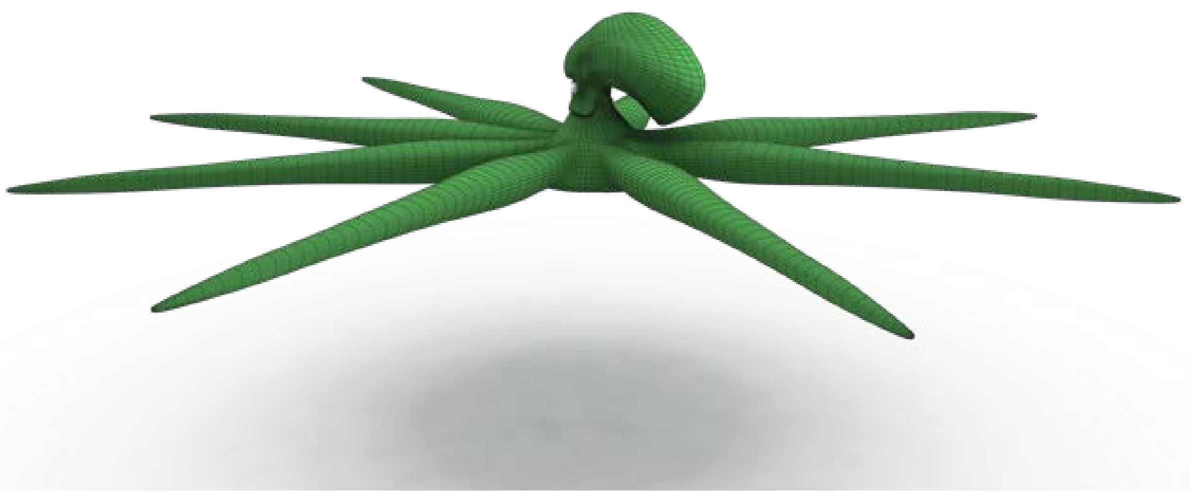


Figure 5.8: Cephalopod (Octopus) Sample Character Complete Model Side View.

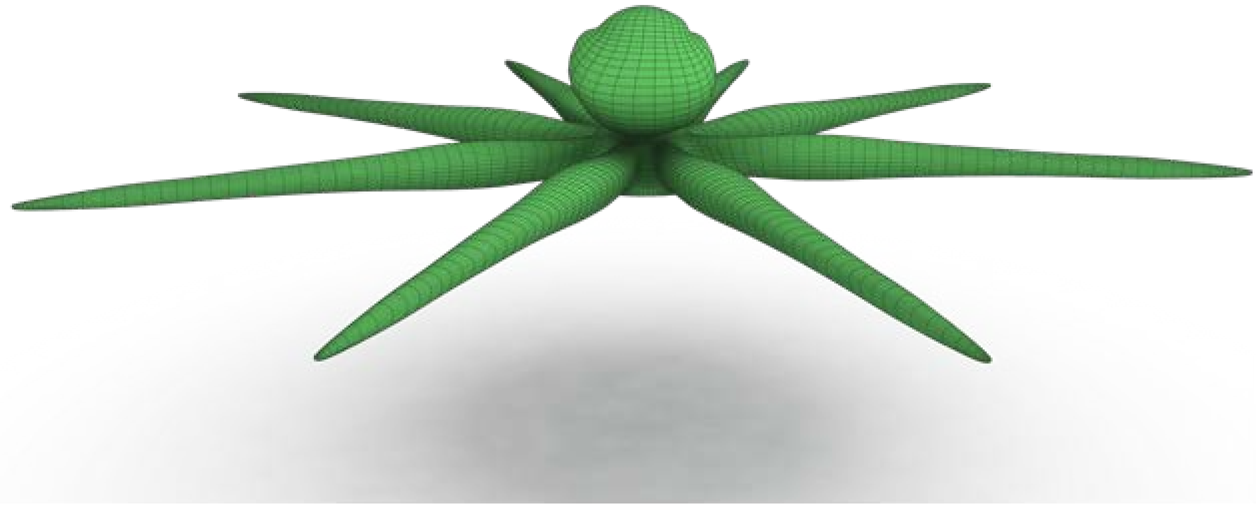


Figure 5.9: Cephalopod (Octopus) Sample Character Complete Model Model Back View.

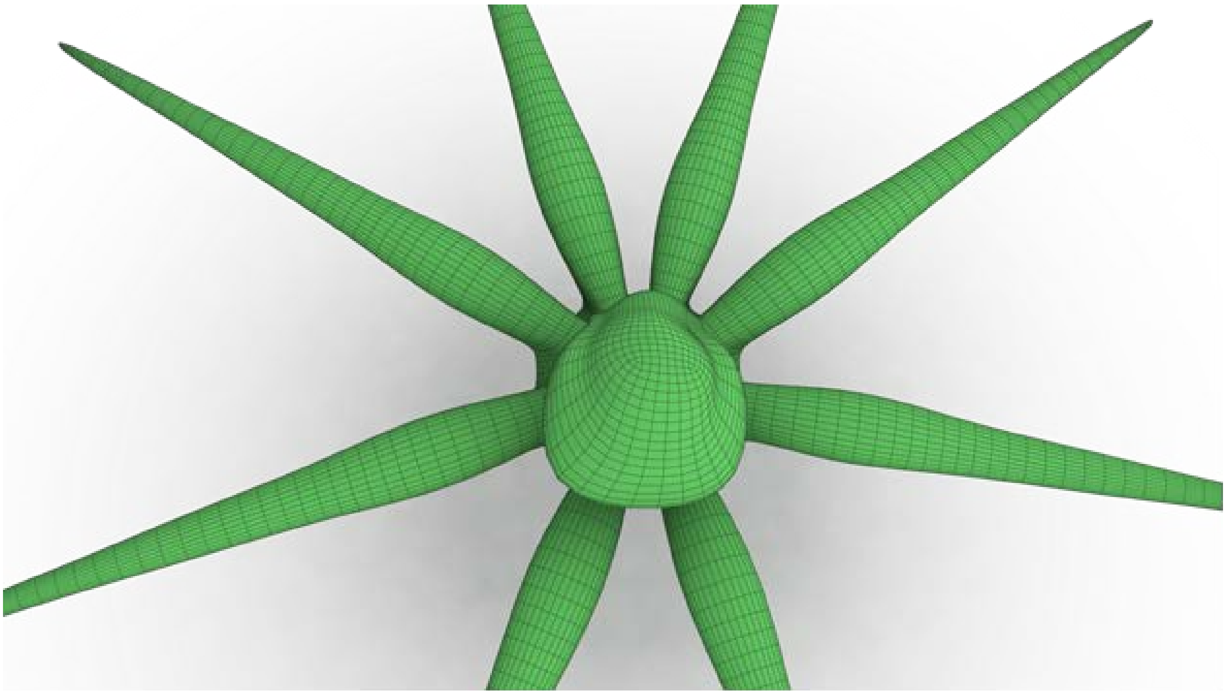


Figure 5.10: Cephalopod (Octopus) Sample Character Complete Model Top View.

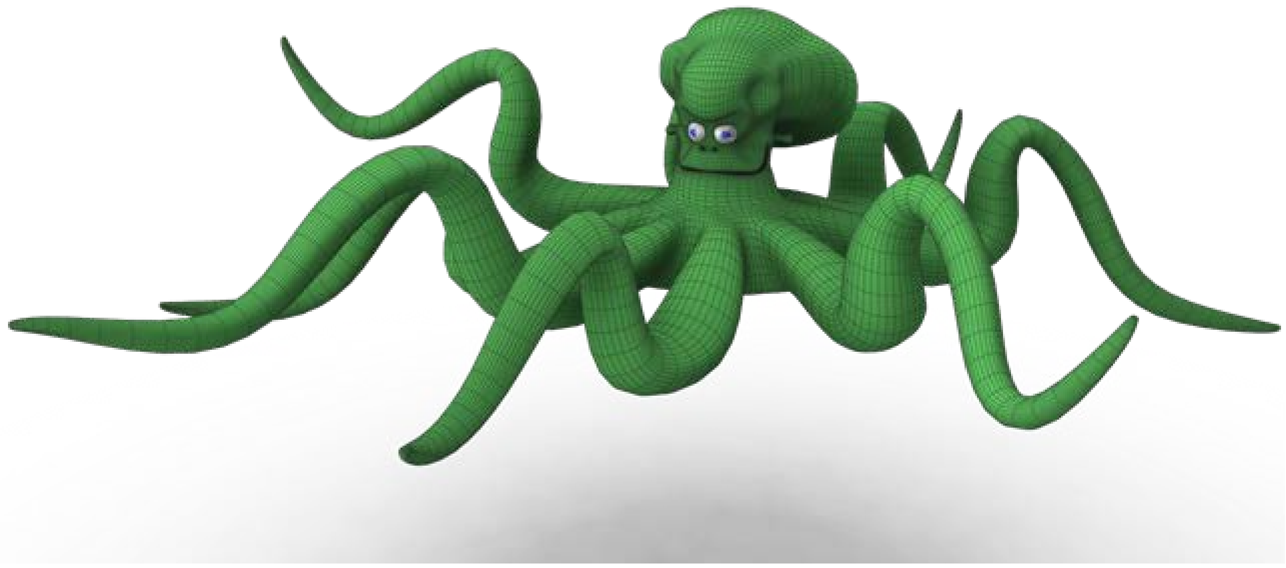


Figure 5.11: Cephalopod (Octopus) Sample Character Complete Model by Baris Isikguner.

5.2.4 Taxonomy of the Dynamic Control Rig

The focus of this experimental study was to develop a character that could procedurally reproduce life-like and convincing movement performances without requiring a key-framing process. A procedurally enhanced character rig was therefore employed. In order for the animation practitioner to easily relate and compare their work to the experiment, the character rigging phase was undertaken with the commonly used studio character rigging toolset Autodesk Maya 2011.

The base rig/skeleton of the cephalopod character was designed according to the topological flow of the character. This allowed more precise deformation on the surface of the character and between the limbs. Autodesk Maya 2011‘s standard bone toolset was used to generate this base rig. All limb bone hierarchies are attached to the root joint and root joint hierarchy controls the entire skeletal structure. Every limb has an individual spline IK (Inverse Kinematic) handler attached to its base hierarchy. This handle type allows the animator to animate the limb bone hierarchy with the support of a curve object. However in this case the standard curve was replaced with a dynamic hair curve. This dynamic hair curve comes with physics-based simulations and editable values that can be manipulated to calculate rules and conditions to produce motion based on the set rules and conditions.

In the last phase of the design section of this experimental study, the octopus character was attached to the generated interactive rig, for testing. Within the 3D software the procedural animation system calculated Newtonian gravity and the density of the surrounding air for the octopus character. This interactive rig also contains embedded force fields such as wind and turbulence. The force fields are adjusted in a way that allows them to trigger random motions. These motions are automatically re-calculated by the dynamic rig, along with Newtonian gravity and air density. This was designed to generate movement performances that are very similar to those of a real cephalopod. In addition to this, a simple control system was added to the character, in case the animator wanted to manually animate it. The controller allows the animator to manipulate the location of the character; the character having an interactive rig also allows it to re-condition itself to the pull direction.

A character rig that was able to generate procedural animations was designed, using the hair dynamics tools in Autodesk Maya 2011. Trial and error experiments were used to develop the rig. The results show that a very complex grouping is required, in order to achieve a link between the hair dynamics and the rig system. The interactive character rig was achieved after generating a working group hierarchy. Although there are several different tools within the professional studio toolset, they appear to produce similar results but provide different user interfaces and in some cases focus on specific tools. This phase of the experimental study used common studio tools and methods to produce the interactive control rig for the sake of clarity and adaptability.

The most challenging issue in the rigging phase was finding the right hierarchy for the rig, which was highly time consuming. In order to allow the skeletal structure to communicate and replicate the hair dynamic curve, a group hierarchy needed to be created. This trial and error process proved to be time consuming and sensitive.

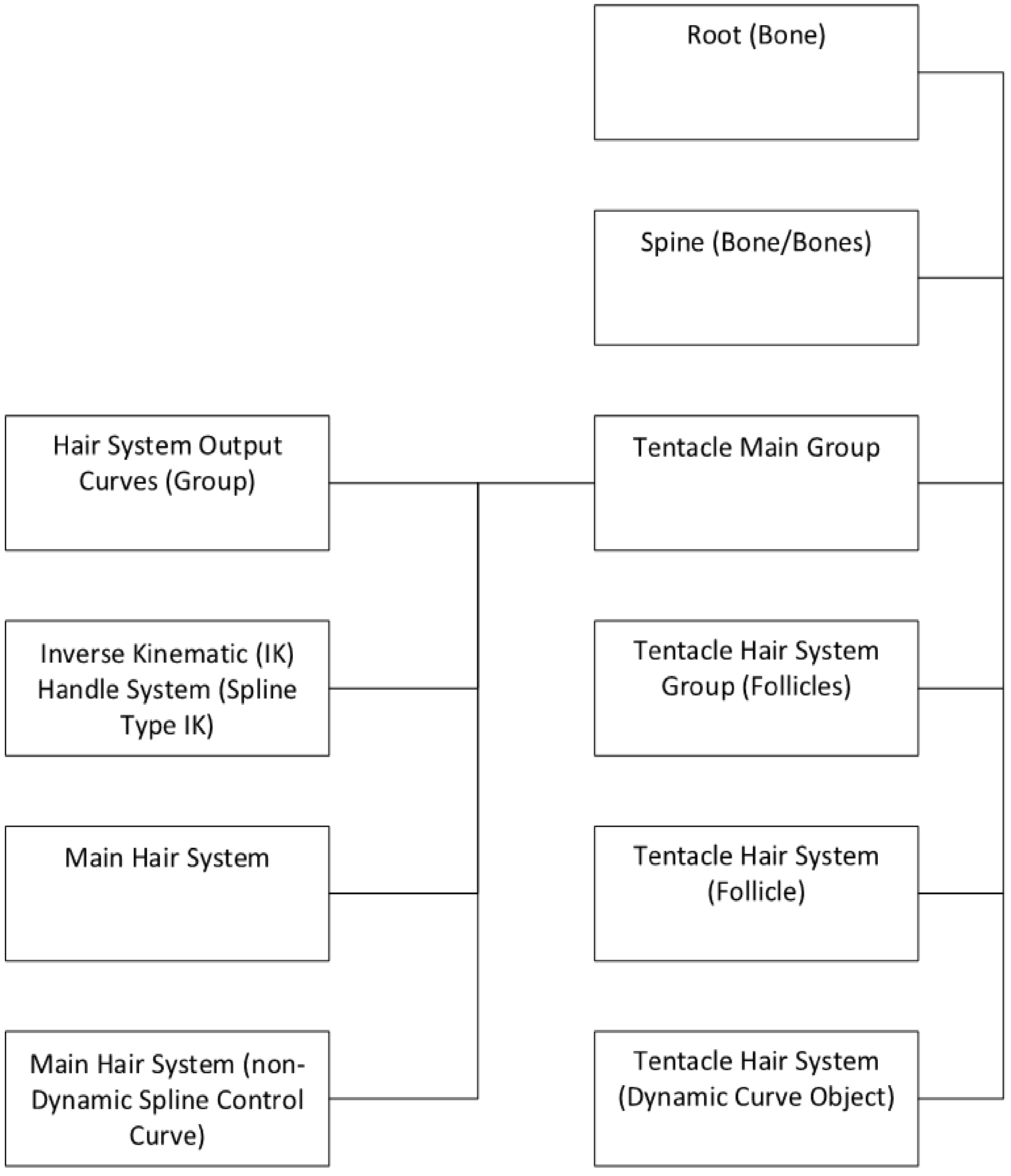


Diagram 5.1: Cephalopod (Octopus) Sample Character Hair Dynamic Rig Single Tentacle Simplified Hierarchy.

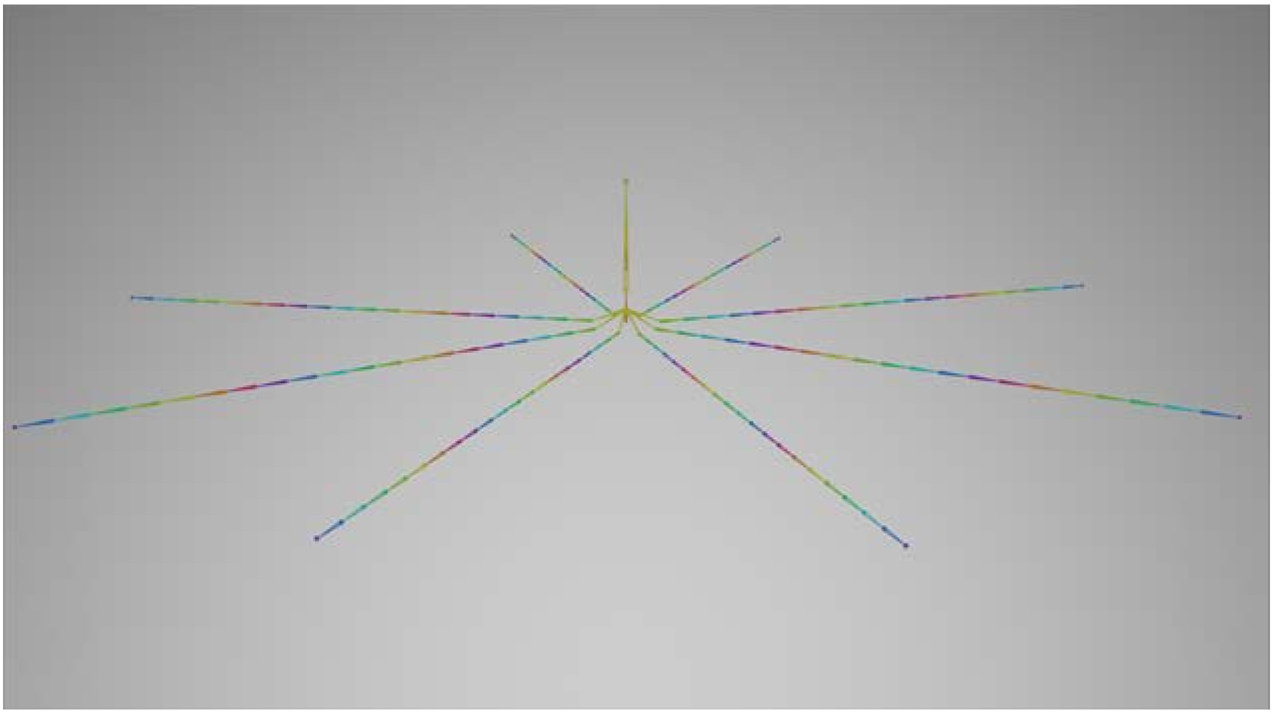


Figure 5.12: Cephalopod (Octopus) Sample Character Skeletal Structure/Rig.

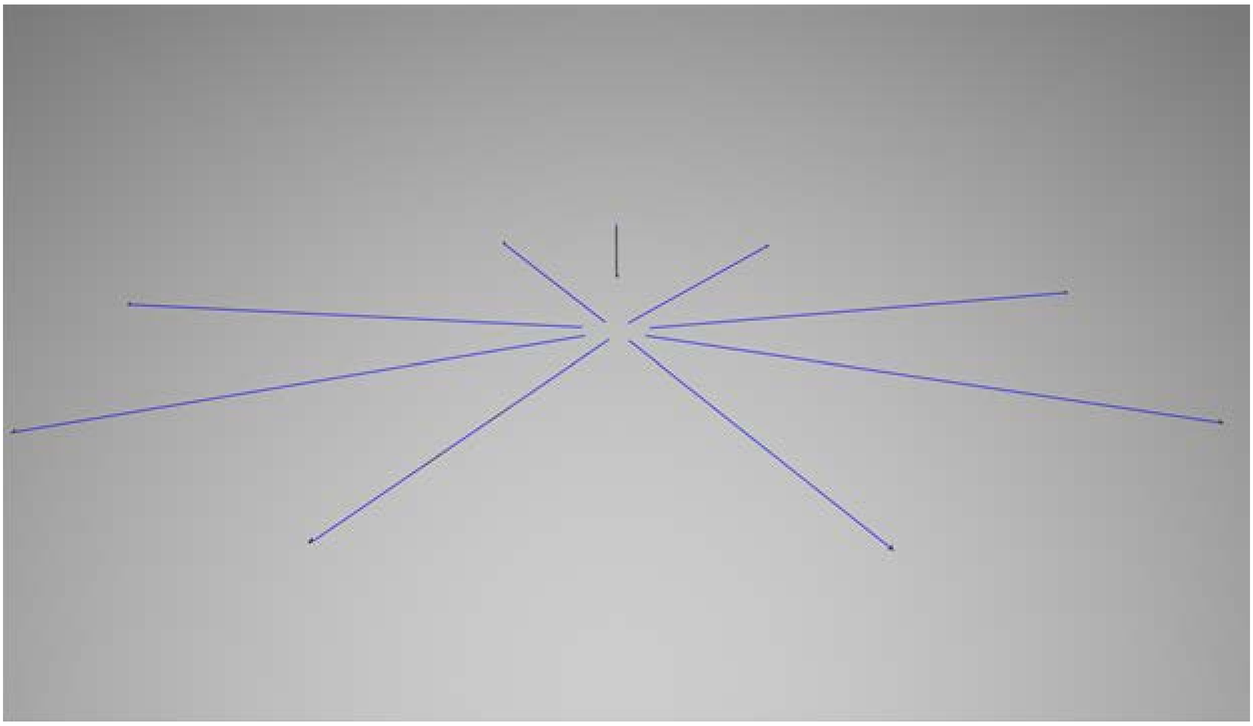


Figure 5.13: Cephalopod (Octopus) Sample Character Hair Dynamic Structure/Rig.

5.2.5 Producing Sample Movement Performance

The sample character's control rig was developed to contain only a single manipulation handle. This handle allows the animator to translate (move alongside a certain axis x, y or z) or rotate the character's main body in the three-dimensional space. There are two main reasons for this design approach: the first is to prevent direct intervention on the character animation and allow the procedurally produced movement performance to naturally come through; this allows the observer to clearly analyse only the procedurally produced animations as they originally appear in real time. The second reason is to allow the animator to test the re-calculation of the character's procedurally produced reactions against the applied force, such as pull, push and rotate.

The dynamically developed interactive rig was designed in line with Hooks's (2011) and Stanislavsky's (1989) suggestions concerning conflict types during a performance (see Chapter 2.2.4). In this experimental study, the conflicts took the form of physical interactions. The dynamic collisions of the designed character helped create interactions with elements of the character itself and its surrounding environment. In addition to the dynamic collisions, the sample character's handle made it possible for it to perform a conflict with a third force.

The force field attached to the character includes primary and secondary rules. The primary rules are Newtonian gravity, which allows the sample character to be affected by simulated Newtonian gravity; this applies a natural pull force to the character and gives its mesh the illusion of a natural uneven rotational and directional pull from the surface alongside a feeling of weight and mass. The second primary force is the air density, which allows the sample character to demonstrate a friction force against the surrounding space, in order to reproduce the conditions of an underwater environment. Since the sample character lives under water, the density of the air is increased to a certain level to give the illusion of a high pressure underwater environment. The secondary forces applied to the character are responsible for the random movement generation that reproduces the floating muscle-like movement and involuntary movements of the cephalopod. These forces are wind, which was given values that would produce wave effects for the limbs and the second force is turbulence, which was assigned values to randomize the wave effect generated by the wave force rule, and also to produce random curl and twist movements for the limbs. The wobble effect on the skin surface of the character was achieved using Autodesk Maya 2011's muscle toolset. The illusion of flesh was created using the Jiggle Weights Tool.

The sample character was designed to produce base movement with its limbs and minimal surface deformations when there is no third force to manipulate the rotation or translation of its main body. This was done to give the illusion of the character floating and producing involuntary neuromuscular movement. The same character rig is able to recalculate rules and regulations which are sent from the force field; this allows the character to act like a puppet and simulate cephalopod-like movement performances when steady or being moved by the sample character rigs handles.

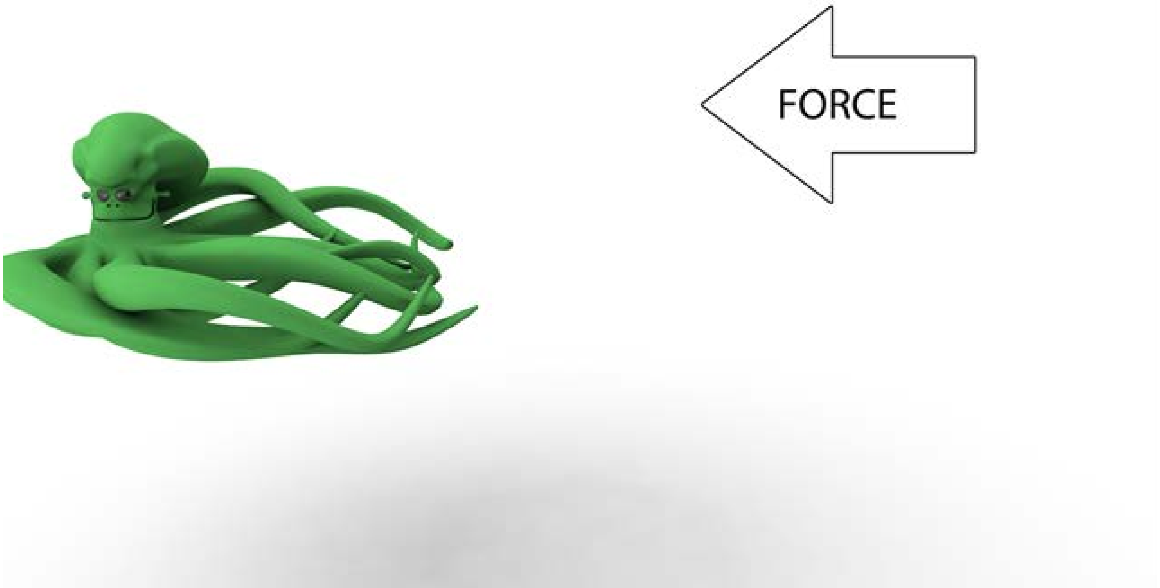


Figure 5.14: Cephalopod (Octopus) Pull and Push Force Example 1.

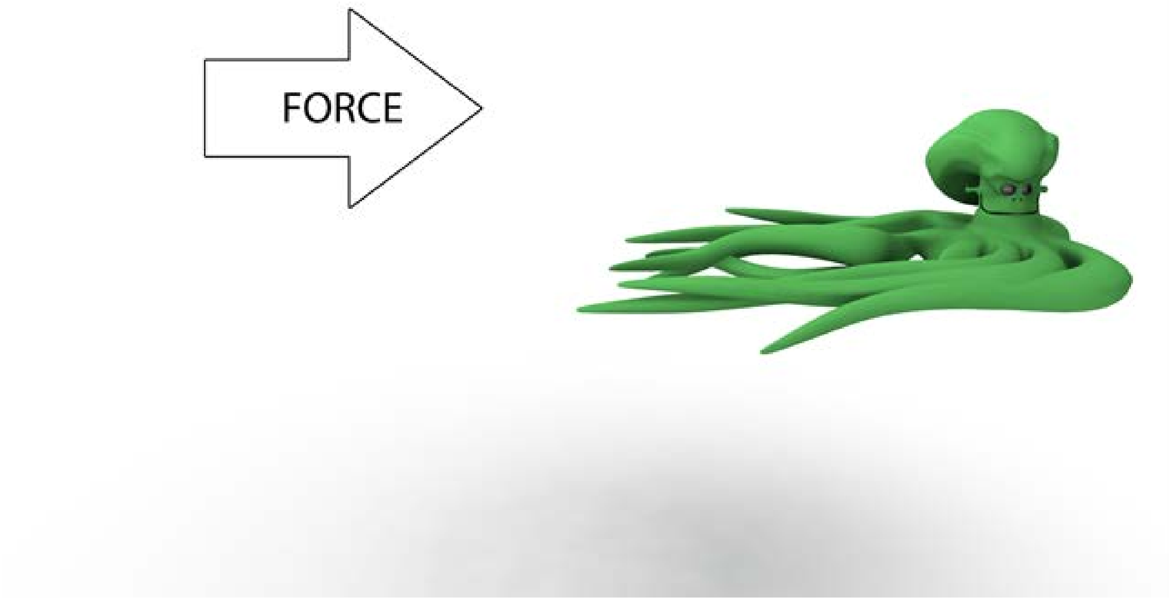


Figure 5.15: Cephalopod (Octopus) Pull and Push Force Example 2.

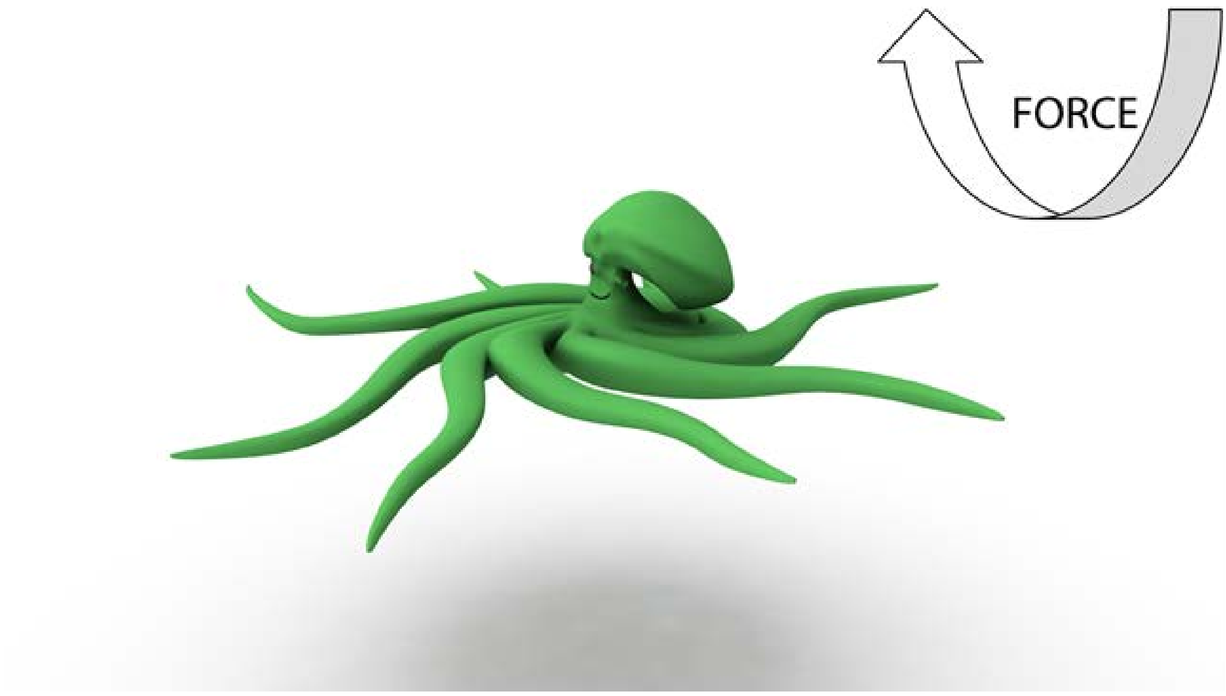


Figure 5.16: Cephalopod (Octopus) Rotational Force Example 1. Rig.

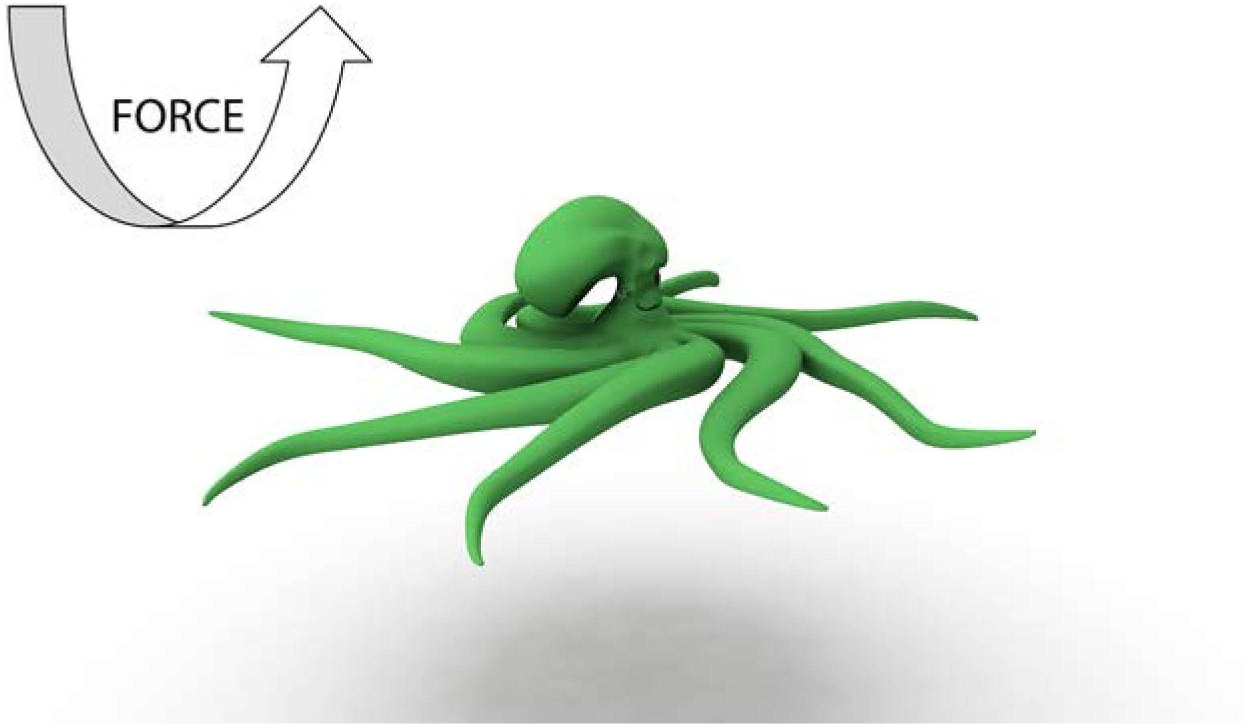


Figure 5.17: Cephalopod (Octopus) Rotational Force Example 2. Rig.

5.2.6 Test Results and Peer Review Journal Entry

The aim of this experimental study was to constitute a character movement performance using only procedural animation and study the methods being used to implement procedural enhancements within the current studio approach to applying procedural animation. The assumption of the experimental study was that procedural animation may prove to be a useful asset for producing life-like, natural and convincing movement performances.

The outcome of the experiment was that there was a significant positive correlation between the real octopus and the interactive 3D octopus. The experiment's outcome confirmed the assumptions of this research in relation to achieving life-like results using procedural animation (see Appendix D). The currently adopted methods – trial and error and produce and test – proved to be a very time consuming and unstable in terms of outcome. This research will make an attempt to eliminate or minimalize the use of these methods by offering a synthesis of the application process of procedural animation.

5.3 Further Tests Pertaining to Procedural Animation

An initial experimental study was undertaken to help determine the character form, type of procedural animations and the visual presentation style of the experimental study's second phase. This first experiment was designed as a decisive test to help plan the second and final phase of the experimental study. This section describes the various test stages conducted in the initial study.

The first experimental study was undertaken to identify the most convenient way of demonstrating the approach of this research and the potential effects of using procedural animation. It was an important step towards the construction of the framework and body of the final experimental phase. The most important issues to be addressed in this experimental study were choosing the form of the character, choosing suitable physics-based simulations (PBS) for the chosen character form and designing a clear presentation for clarity of the demonstrations in order to make the outcomes easier to analyse. Ethical issues the choice of character might cause were discussed, and following a series of trial-and-error tests a humanoid character was selected. The assumption behind this choice was that a humanoid form would make for a more engaging and readable character, thus enhancing the audience's reception of the movement performances. This experimental study made it possible to determine which types of physics-based simulations could be used within the final phase of the experimental study, and where and how they could be applied. Following thorough consideration and discussions with the supervision team, cloth and muscle PBSs were selected.

5.3.1 Choice of Character

Choosing the right character form was a challenging stage. A review of today's professional studio projects shows that a wide range of character forms that can be used. A considerable percentage of these characters exhibit anthropomorphic qualities through their aesthetic forms and movement performances.

Chaminade, Hodgins & Kawato (2007) studied the biological effects of anthropomorphic characters on the human audience and compared the effects with those of non-anthropomorphic characters. They monitored the brain functions and studied how a human brain receives anthropomorphic characters in a narrative compared to non-anthropomorphic ones. As a conclusion, they suggested that anthropomorphic qualities in a character, such as its aesthetic appearance and movement, generate stronger emotions compared to non-anthropomorphic characters; they added also that the acceptance of artificial agents within a narrative such as an animated character performance is easier to activate with the use of anthropomorphic qualities.

One of the aims of this research is to make a synthesis of the application of procedural animation that professionals can use as a point of reference when using procedural animation to help enhance the believability of movement performances. Therefore, avoiding negative factors such as an audience rejection of the character form or movement style or the negative effects associated with the Uncanny Valley was essential for the outcome and success of the experimental study stages. To help generate a clear and readable sample character, humanoid character types were therefore chosen as a basis for the experimental studies. The assumption was that this choice would help viewers adapt and engage quickly, avoiding any issues in analysing or understanding the form or the movement performance of the character.

5.3.2 Designing the Character

A steampunk-style character was designed for this experiment. The initial stages of the experiment were the design and modelling of the character. A simple, low detail character was designed in in line with the suggestions relating to the benefits of characterisation mentioned in chapter 5.2.3.

The sample character was designed using large groups of masses and volumes. The assumption was that this would allow the viewer to fluently and easily follow and observe the procedural enhancements and the deformations caused by these enhancements. The initial sketching and designing of the character on paper was done by Andrew Love (see Fig. 5.18.).

The sample character's mesh was modelled with polygon-based geometric primitives. It was crucial to maintain control over the flow of the topology. Minimal muscle and mass groups were created on the mesh to be procedurally animated (deformed) later as a secondary animation. The objective was to support and emphasize the believability of the original key-frame animation of the character (see Fig. 5.19).

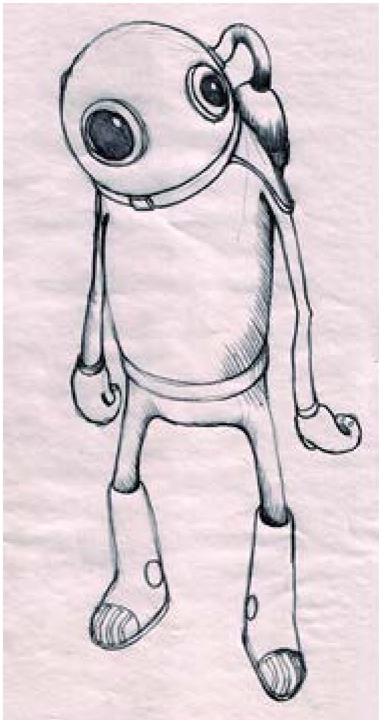


Figure 5.18: Steampunk-style sample character, designed by Andrew Love.

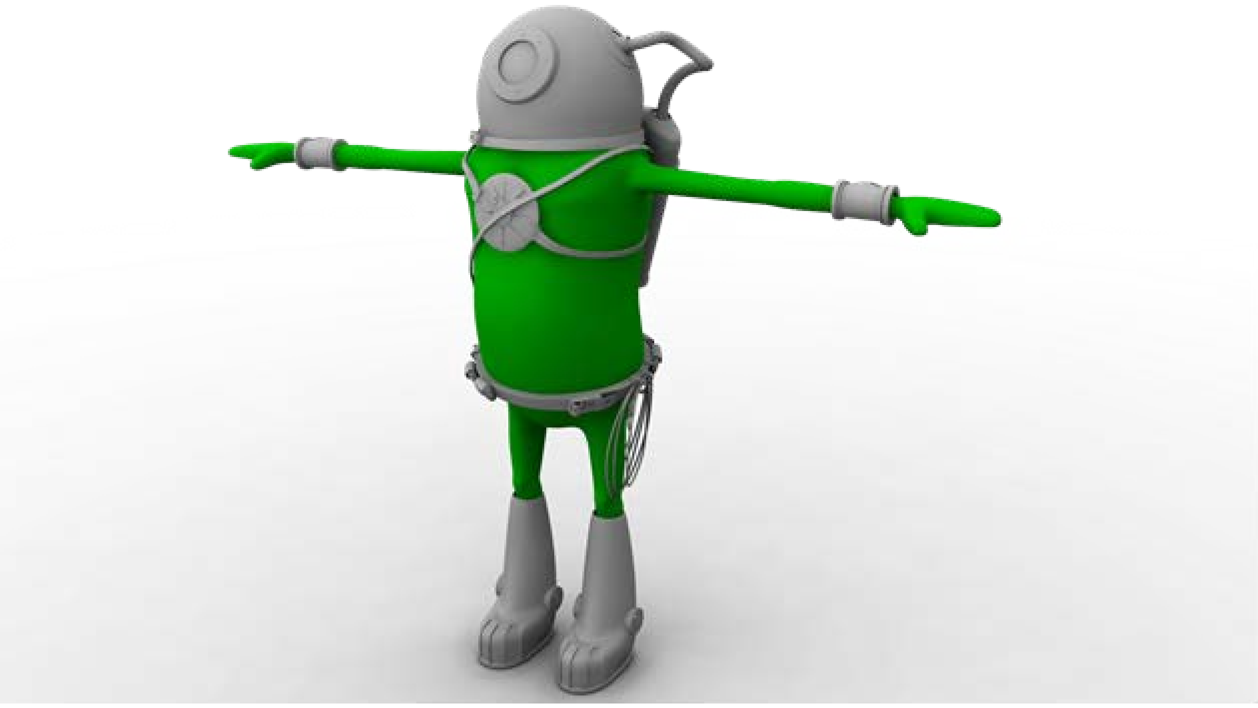


Figure 5.19: Steampunk-style sample character, modelled by Baris Isikguner.

5.3.3 Generating the Control Rig

The core concern of this experiment was to observe how key-frame animation communicates with procedural animation. In order to save time, an auto-rigger plug-in was used to rig the character in a short amount of time. The rig generated by the auto-rigger software was a standard Autodesk Maya rig (see Fig. 5.20, 5.21). The reason for choosing an auto-rigger to generate a Maya rig was that this research follows the studio practices and the toolsets commonly used by practitioners.

The rig used for the sample character was a key-frame animation rig. This allowed substantial freedom in the key-framing process and allowed full control over the creation of a key-frame movement performance. Given that this research aims to contribute towards helping to improve the believability of movement performance by using procedural animation, a base key-framed movement performance was needed; the aim was to achieve it with the aid of the twelve principles of animation developed by Disney Studios.

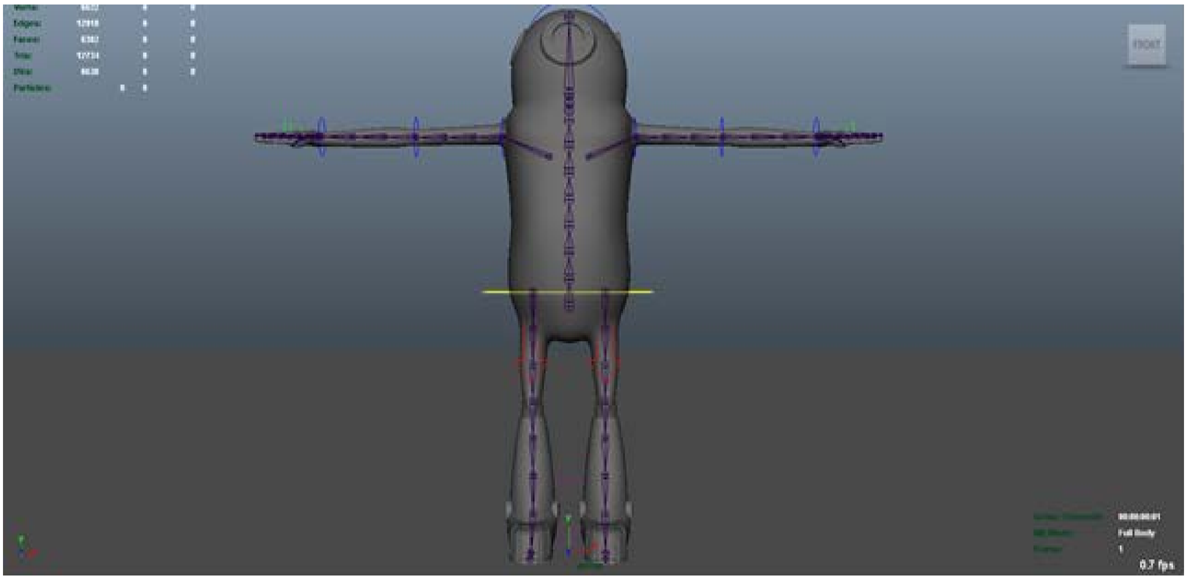


Figure 5.20: Steampunk-style sample character, rig structure front view.

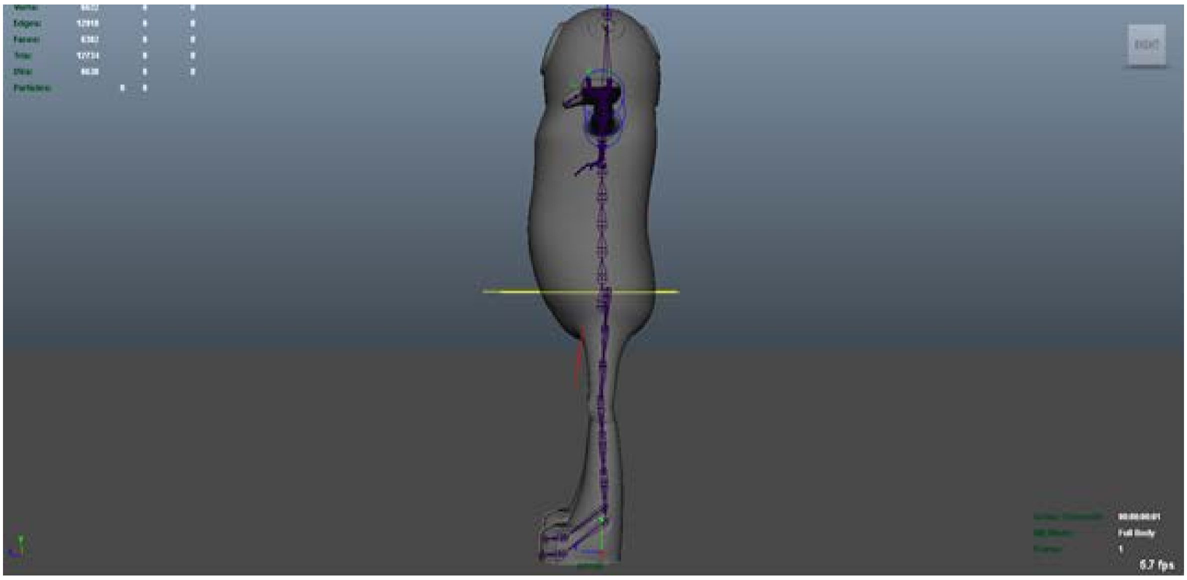


Figure 5.21: Steampunk-style sample character, rig structure side view.

5.3.4 Generating a Key-Framed Movement Performance

The animation process of this experimental study had to be designed in such a way that it would allow the viewer to observe clearly how procedural animation affects the overall movement performance of the animated character. In order for the character to be analysed, this experimental study sought to answer two main questions. First, which type of form would make it easier for the viewer to observe the character and changes to the character; which parts of the sample character's mesh should be procedurally enhanced and why?

Second, how should the character be presented and what type of animated performances should be used for the final phase of the experimental stage?

Further steps in the experimental study were corrections and preparing the character for animation. No issues arose during the character modelling and rigging processes. The animation process was completed with the key-frame pose to pose and the techniques suggested by Williams (2009) and Thomas & Johnston (1995). For clarity's sake an iterative walk cycle was chosen to allow the viewer to clearly observe the procedural enhancements.

5.3.5 Determining the Procedural Level

Determining what procedural enhancements to apply was a challenging issue. As discussed in the previous chapters, too much use of real or natural motion can disrupt the believability of the animated performance, and there were no best practice guidelines regarding the use of procedural animation to achieve movement performance believability. The application process was therefore based on the trial and error method which is the commonly adopted method in current studio practice. The muscle dynamics and rigid dynamics of Autodesk Maya were used to animate the jiggling motions of the abdominal section and the movements of small items of equipment item worn by the character, such as the oxygen pipe on its helmet.

The aim of this experimental study was to design and model a character that would allow clear perception and provide a solid framework for the next experimental study. The procedural muscle physics-based simulations were painted on the character for test purposes, instead of a muscle deformer rig being designed under its mesh. The cloth object's values were set to allow it to act like a hard plastic object. Both dynamics calculated newtonian gravity, while following the main motions of the key-framed movement performance.

5.3.6 Initial Attempt at Layering Procedural Enhancements on Key-Framed Movement Performance

The aim was to allow procedural animation to flow naturally and produce animation according to the re-calculation of the main keyed performance on top. In other words, procedural animation acted as a secondary animation which was designed to provide an extra level of detail to the movement performance. The muscle and cloth dynamics were layered on top of the volumes and objects attached to the character, assuming they would emphasize the contact positions and story telling poses of the sample character by demonstrating an improved level of mass and weight, providing an extra level of naturalism in the deformation of the mesh and the movement performance (see Appendix E).

5.3.7 Final Observations and Discussions

The animated sequence was rendered with a carrousel, which allowed the viewer to observe the sample character from multiple aspects as it rotated three hundred and sixty degrees. This idea was inspired from Eadweard Muybridge's work, described in Chapter Two. The experimental study was observed by an academic panel group during the transfer meeting.

Result of the experiment: Interestingly, this experiment yielded multiple results. The correlation between key-framed animation and procedural animation is engaging because the key-frame literally drove the procedural animations generated by Autodesk Maya's engine. Also the key-framed animation, being believable as a result of the principles used to animate it, gained an improved level of detail, which helped the character to demonstrate more convincing skin deformations with the help of the procedural animations attached to it. On the basis of the first experiment, it was determined that the following experimental phase would include an individual muscle rig to demonstrate procedural enhancements with an increased level of detail. Instead of covering one volume of the character's body the next experimental study was designed to cover all major muscle groups using detailed procedural animation. In addition to the muscle system, a real-time procedural cloth object was designed and attached to the character to help demonstrate the cloth dynamics enhancement during movement performance.

A humanoid character form was judged suitable for further research, and was therefore included in the final phase of the experimental study. The presentation style of the first experiment was deemed clear too, and was therefore kept, but further enhancements of the quality of the image and resolution were needed. Creating a carrousel animation was fruitful in terms of readability and was therefore maintained for the final phase. Lastly, the movement performance needed more variations, given the wide range of movement performances to be covered. However, given that it is almost impossible to cover all types of movement performance, Laban's movement types served as a reference to generate pivotal types of movement performance. This approach aimed to help practitioners to systematically compare their own studio work with the outcomes of this research and use it as a guiding tool to streamline their studio practice.

The experimental study results showed that the muscle and cloth physics-based simulations (PBS) may improve the believability of the key-frame animated performance. However it was hard to formulate a conclusion without having first finalised a comprehensive experimental study and a undertaken substantial observation and analysis with the aid of collaborating groups of viewers.

5.4 Utilizing Procedural Animation to Develop Believable Movement Performances

This section of the chapter describes the final study undertaken in the experimental stage of this research. This was designed to explore the effect of procedural enhancements when layered with a key-frame movement performance. The intention was to design an individual, tailor-made experiment for analysis instead of using already existing visual materials. The main reason behind this choice was the desire to generate easily readable and more focused materials that were designed solely to demonstrate the procedural enhancements. In this way, an analysis could be undertaken without the distraction of unnecessary material within the scenes. Another reason was to generate a study that could serve as a point of reference and comparison for practitioners in relationship to their work. This was done by using Laban's Movement Analysis to group and categorize movement performances, in order to monitor the effects of procedural enhancements on specific basic actions developed by Laban.

The experimental phase of this research applied currently used studio methods and toolsets. The aim of this is to help practitioners to use the outcomes of this research, allowing them to easily replicate the process and adapt it to another standard or style or use it as a guide as it stands to determine and plan their application process and organize their pipelines.

In order to investigate the application stage and effects of procedural enhancements on key-frame movement performances, there had to be a standard and/or an aim to help this research to measure the change(s) procedural enhancement may cause. The standard used here was the notion of believability. Every professional studio may have their own aim in terms of stylistic design, but as the literature reviewed in Chapters Two and Three shows, achieving the notion of believability is a common issue and an aim for every game, animation and visual effects studio. As discussed in earlier chapters the notion of believability can only be perceived through sensory data. With this in mind, the experimental study aimed to generate visual material to be evaluated and discussed in order to help determine the outcome and effect(s) of the use of procedural animation.

5.4.1 Concept Design, Ethical Issues and Designing the Sample Character

Choosing a suitable animation and character style was a challenging issue due to the requirements this research needed to meet in the design phase, as described in chapter 5.3.1. The first narrative designed for this experimental study was a series of short animated scenes that aimed to demonstrate the potential effects of procedural enhancements. Initially, a male and a female character were designed. It was decided that the male should demonstrate the muscle dynamics and the female should demonstrate cloth dynamics. The narrative of the animated sequences was going to be constructed around a series of obstacles between the husband and wife.

The initial design stages for both characters were done on paper by character artist Wanda Zaleski. The male character was designed with a distinct and clearly visible muscle structure to emphasize the muscle dynamics and the deformations, weight and mass enhancements which may help improve the believability of an animated movement performance (see Fig. 5.22 & Appendix F). Since the female character was designed to illustrate cloth dynamics, her aesthetic features weren't exaggeratedly emphasized, however her female features were made distinct and visible enough to shape the cloth material surrounding her (see Fig. 5.23 & Appendix F).

Later in the design process, the use of gender-specific attributes to demonstrate procedural enhancements was abandoned, given the potential ethical issues. Both the characters and the planned scripts were therefore terminated and a decision was made to start again with a completely different approach. The first character design project was terminated before it reached the modelling phase. For the purposes of this chapter, the character designed in the second project is therefore considered to be the first sample character for this experimental study (Sample Character One).

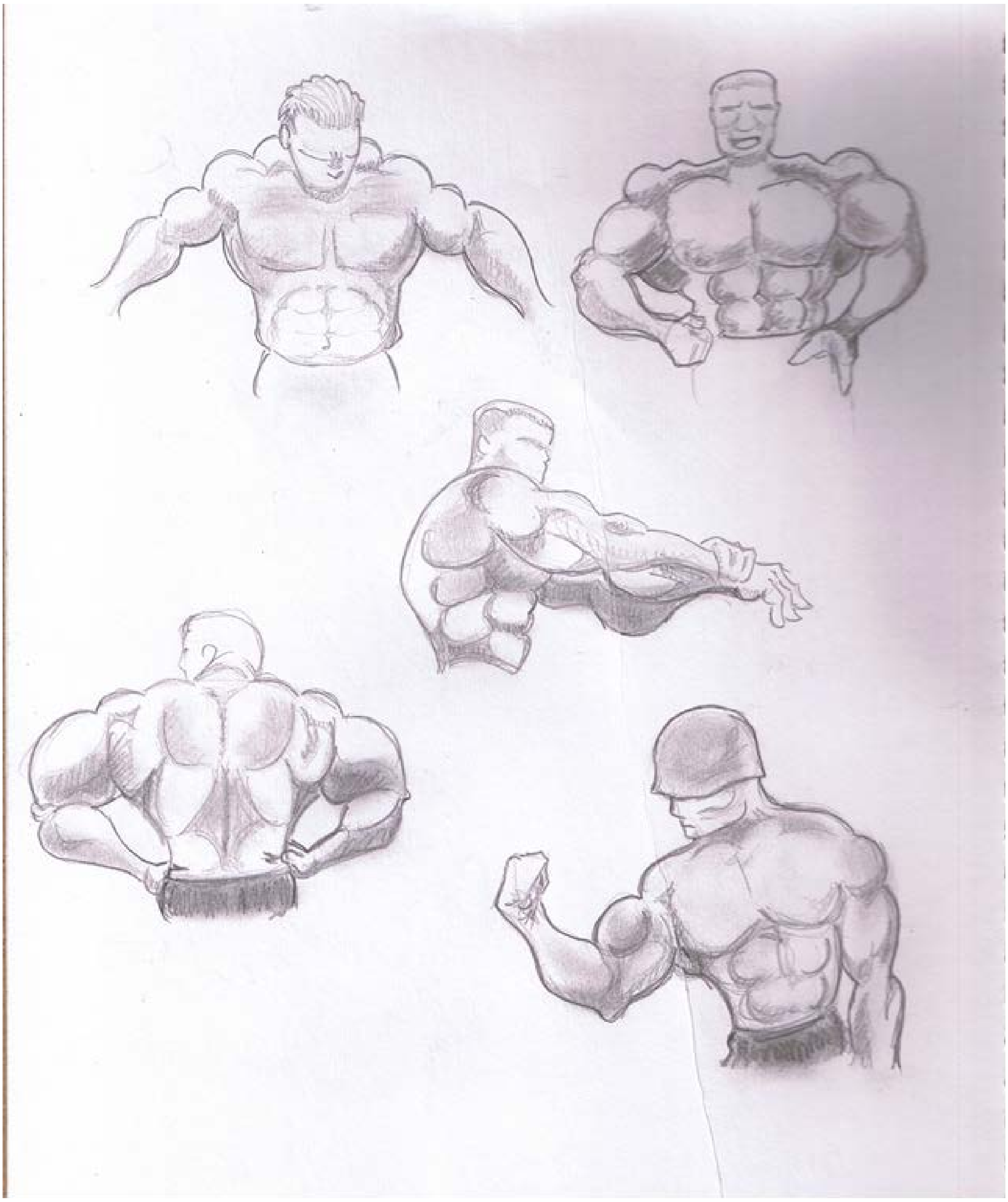


Figure 5.22: Male sample character design by Christina Wanda Zaleski Novoa.

Figure 5.23: Female sample character design by Christina Wanda Zaleski Novoa.

Sample Character One was a humanoid with a genderless form, designed with a non-human skin colour and texture. This was done to avoid any possible ethical issues linked to the choice of character attributes in future stages of the process. The suggestions in terms of characterization made by Wells, Quinn, & Mills (2009), mentioned in sections 5.2. and 5.3, were also considered in the design phase of Sample Character One. The initial design stages of the character were drawn on paper by Andrew Love. The character was designed with humanoid features to help the audience engage with it easily and to enhance the readability of its movement performance (see Figs. 5.24 & 5.25).

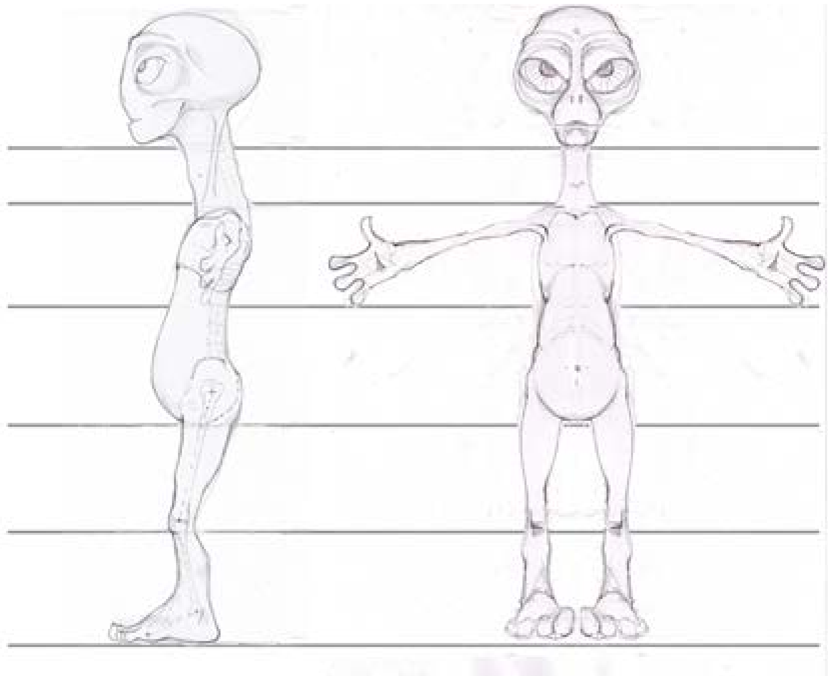


Figure 5.24: Sample Character One, design by Andrew Love.

Figure 5.25: Sample Character One concept design by Andrew Love.

Polygon-based geometric primitives were used to maintain control over the topology during the modelling, detailing and sculpting processes (see Fig. 5.26 & 5.27). Sample Character One was designed with distinctive muscle groups to help improve the readability of the dynamic enhancements, such as the deformation and movement of the mass and feeling of weight during movement performance, and to help fit a dynamic muscle rig beneath its mesh structure (skin) (see Appendix G). A pair of shorts was designed to demonstrate the cloth dynamics on the character. The shorts were designed with a high polygonal level to help achieve convincing deformations and folding surface effects. There were no significant issues during the modelling and design stage. The only delay was caused by the character change.

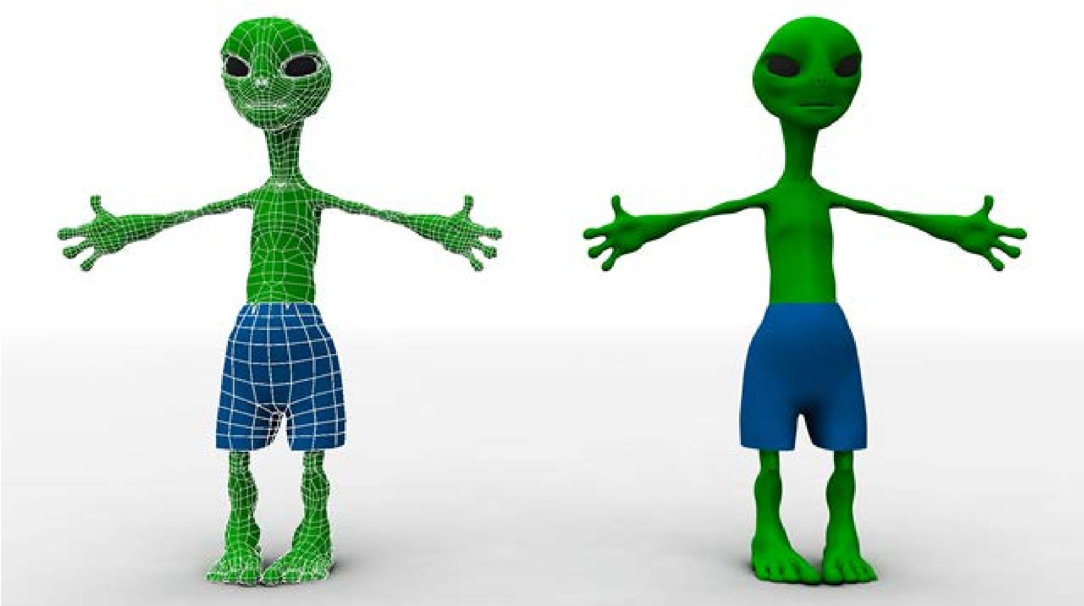


Figure 5.26: Sample character model front view by Baris Isikguner.

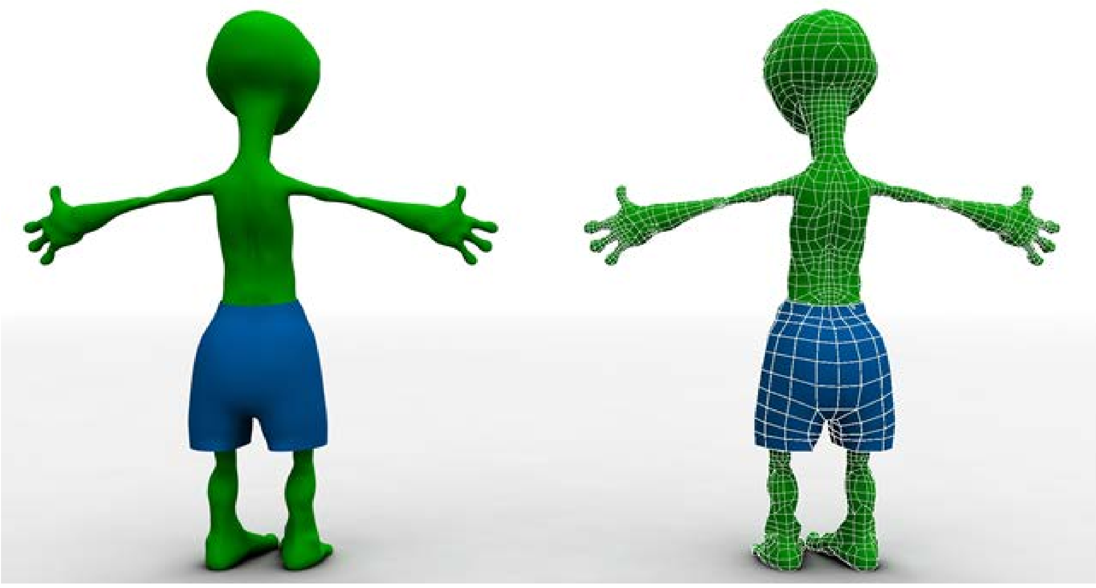


Figure 5.27: Sample character model back view by Baris Isikguner.

5.4.2 Generating the Control Rig for Sample Character One

The first control rig was designed with Autodesk Maya's HumanIK rigging system. HumanIK is designed to rig humanoid characters and is used by game and visual effect companies on an occasional basis. Although HumanIK allows animators to key-frame performances, it was originally designed to implement and edit motion capture performances. The main reason for using HumanIK was that it allowed experimentation with motion capture performance to test the background research done on realistic movement and its potential negative effects (see Chapters 2 and 3).

HumanIK is designed for efficency. It generates a humanoid character rig and controllers in a short amount of time, allowing the animators to focus solely on refining the adaptation between the rig and the character's mesh. This research focuses on the key-frame movement performance and its layering with procedural enhancements. All common studio practice and available toolsets were employed during the experimental stages, in order to find the most suitable way of conducting the final phase of the experimental study.

5.4.3 Testing and Validating Sample Character One and Character Rig One

Further steps were taken to test the character during movement performance. A simple key-frame movement performance was designed for the testing phase, which included actions such as running, jumping, swinging and landing. This animated action included both light and strong weight types, flexible space types, and both sustained and quick timing and bound flow (see Appendix H).

There were no issues with the control rig or its adaptability to the mesh of the character. However, the character's proportions proved to be a challenging issue during the key-framing process. There were two major issues needing to be addressed in the design of Sample Character One. The first issue was the proportions of the sample character's arms, legs and head. The character had a large head and short legs and arms, which made the key-framing process a challenging one in terms of generating action scenes where the character interacted with other objects. In this case it was the bar that the character jumps down from and swings from: given the dimensions of the character's head, its reach exceeded that of the arms. It was almost impossible, therefore, for the character to grab and hold onto the bar with both arms. The animation had to be altered and the action scene changed, so that the sample character could hold and swing with only one arm.

The second issue was the character’s clarity. During an animated sequence, the character’s poses need to be easily readable. This is done by making sure the silhouette of the character’s pose is understandable, a process which is strongly recommended by professionals in the field (Hooks, 2011; Thomas & Johnston, 1995; Williams, 2009) and is also mentioned as an important factor for the readability of the animated performance by Hosea (2011, p. 26). However, since the character had very short limbs and a small body, the generation of readable poses was a challenging task. This was discussed with the supervision team in a panel and it was decided that the issue had to be addressed immediately before further developing the final phase of the experimental study.

Solving the issues related to the character’s physical proportions and sufficiently modifying its aesthetic characteristics would have entailed a significant amount of complex, detailed work. This would have been very time consuming, and since this research did not require a specific type of character, it was decided that a new sample character should be designed, bearing in mind the issues raised during the meeting.

Before abandoning Sample Character One completely, some experimental studies on motion capture performance were undertaken. These took place on a weekly basis over the course of a year, from September 2010 to October 2011; the aim of this series of experiments was to explore the scope of the Uncanny Valley theory. The initial stages of this experiment consisted in preparing the motion-capture studio, rigging the cameras, and calibrating the setup. A performer is essential for the process to work, therefore every session included several participants. The next step in the process was to prepare each participant with the correct equipment for motion capture. Working out what the studio setup should be was a challenge, and some environmental issues also needed to be dealt with. The collected data were applied to 3D characters for tests and some further corrections had to be made before rendering them out. As such, a great number of experimental sessions were conducted.

There were no significant findings from this experiment, since the main objective of the experiment was to learn the technical process of using the studio. Performance capturing was a part of the original research. This experimental study had two aims. The first was to explore the effect of life-like motion when applied to a cartoon character and observe how it affected the overall presentation of the character. The second was to look for potential factors in performance capture methods which might contribute to the overall believability of an animated movement performance.

The movements of seven different performers were captured. Three of the participants were randomly chosen and the other four were specifically selected from the BA, MA and PhD student registry of Nottingham Trent University. The four specifically selected participants were Neo Hsiao, an expert martial artist; Hannah Purdy, an acting professional; Lucy Caetano, a professional model, and Veovan Saicheua, a participant with no specific expertise in movement performance. The range of selected participants were arranged in such a way as to allow the monitoring of all possible movement performances and their effects when applied to a computer-generated character.

All participants were asked to engage in a wide range of movement performances, from small body movements and routine standard movements such as standing to complex actions such as those involved in martial arts or surfing, according to their expertise (see Fig. 5.28). The captured performances directly replicated the movements of the performers. The literature discussed in chapters two and three suggested that developing movement performances using motion capture methods might cause negative effects, depending on how they are applied to the characters. Hooks (2003) suggests that motion capture is a permanent technology and has a future in the field of animation. However, he argues that it is long way from flawless and has yet to develop. Hooks also compared the use of performance capture in game development studios and visual effects studios, and noted that in an animated scene, the performer and the animator can easily focus on a specific act and perfect it. However, this task becomes a challenging issue in game studios, since there are far too many variables in a performance within games. Addressing them all may prove to be inefficient.

Figure 5.28: During a motion capture performance in Waverley building room 105 Nottingham Trent University. Performer: Veovan Saicheua.

The focus of this research is to produce knowledge that can be easily adapted to any field that includes character animation. Key-frame animation was therefore chosen as it is widely used by studios with consistent results that can be estimated, given the high level of control over the animation's outcomes. The applications and outcomes of motion capture, on the other hand, vary extensively from studio to studio and from piece to piece, to such a degree that the same performance shot twice with motion capture can result in two different outcomes.

Key-frame animation was therefore chosen because of its common use and the high level of control over the animation's outcome. Another reason for choosing to test key-frame animation with procedural enhancements was that this research takes the notion of believability as a measurement of the outcome(s) of the procedural enhancements; as discussed in the Chapters Two and Three, key-frame professionals seek to achieve believable performances using the key-framing technique.

Research today focuses on the use of procedural animation in a key-framed movement performance; therefore performance capturing is no longer within the scope of this research. With this in mind, this experiment was terminated and excluded from the next stages of the research and this decision was made during the transfer stage.

5.4.4 Re-Designing the Sample Character - Sample Character Two

Learning from the issues encountered with the first sample character, the second sample character was designed with longer limbs and more manageable proportions to make the character more animation friendly. In its initial stages, the character was designed on paper by Andrew Love (see Fig. 5.29). Sample Character Two was designed as an humanoid character. The size of the head was reduced so it wouldn't collide with any part of the character's body. It was designed without a mouth to simplify the design and to improve the viewers' focus during observation of the movement performance. The overall proportions of the body were scaled and the character was designed with a tall, thin body and taller limbs. This was done to help improve the readability of the character's movement performance and to avoid a potential collapse of the character's mesh. The visibility of the muscle structure was reduced by a reasonable percentage to avoid a potential diversion of the viewers' focus. But the character still retained reasonably visible muscle groups to help achieve a convincing topology and aesthetic features. This was done to improve the readability of the character and audience engagement.

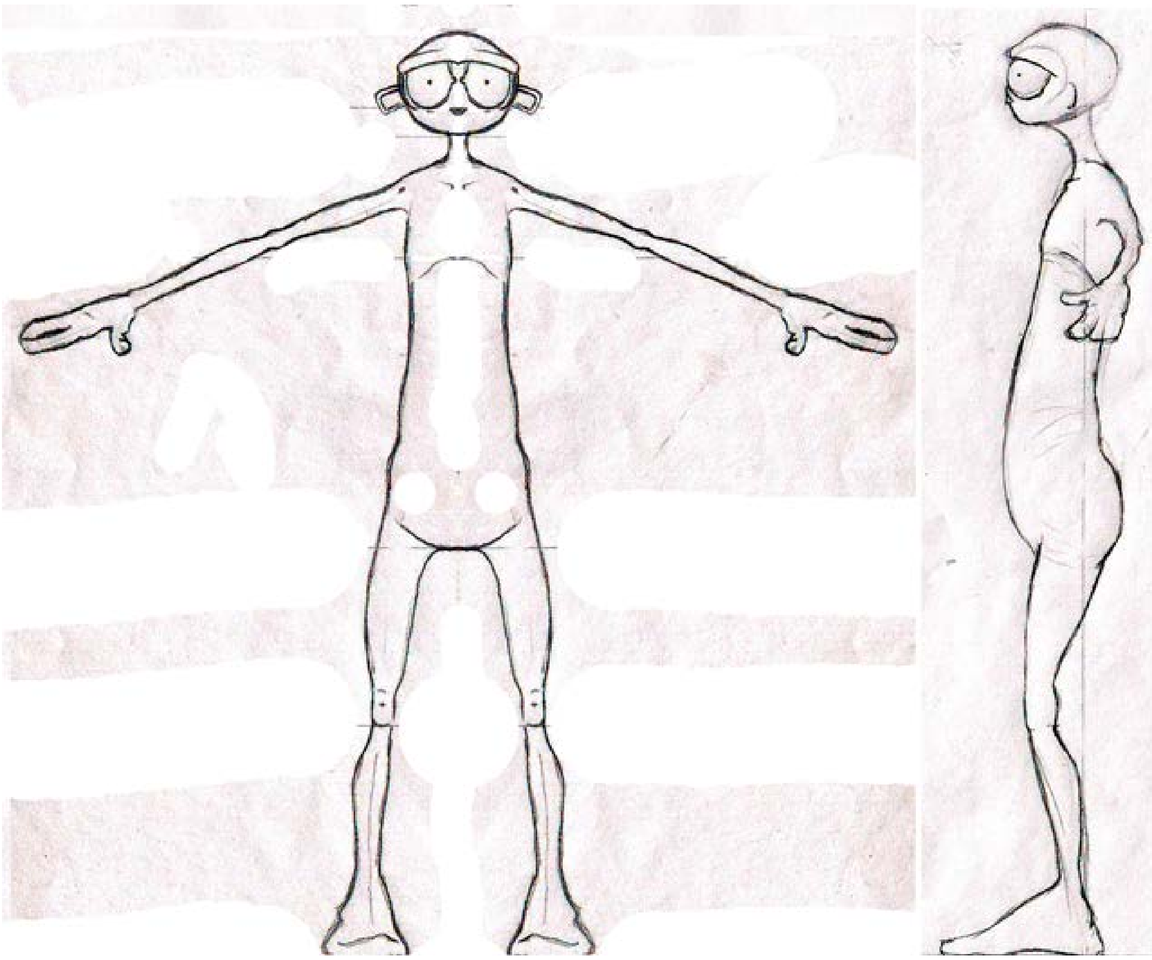


Figure 5.29: Sample Character Two, concept design by Andrew Love.

Polygon-based geometric primitives were used to model the character's mesh. The character's topology was improved and the polygonal level of the character's mesh was slightly reduced. The improvement of the mesh topology was the retopologizing of the character muscle groups and body part connection points. This was done based on the observation results for Sample Character One, and the aim of the improvement was to obtain more convincing deformations from the character's mesh. This refinement can also be related to the "solid drawing" principle suggested by early Disney Animation Studios, which was overviewed in Chapter Three. The reduction of the polygonal level was done for two reasons. The first reason was to achieve a more manageable character mesh and keep complete control of its deformations. The second reason is that this research aims to produce outcomes that can be easily adapted to game development, visual effects and animation studios, and as demonstrated in the first experimental phase, high-level polygonal meshes can produce fluent deformations; however game development companies in some cases may need to produce low polygonal level characters. Therefore the sample character had to have reasonable levels of polygons to help the demonstrations and outcomes of the research be adaptable and considered by all sub fields of three-dimensional character animation (see Fig. 5.30 & 5.31). Through this research all available theories, studies, research and studio practice were reviewed and utilized in order to design and develop a base believable character and movement performance. This made it possible to concentrate on improving believability while studying the application of procedural animation, to help contribute towards the efficiency of its practice and work toward a set of common studio practice guidelines.

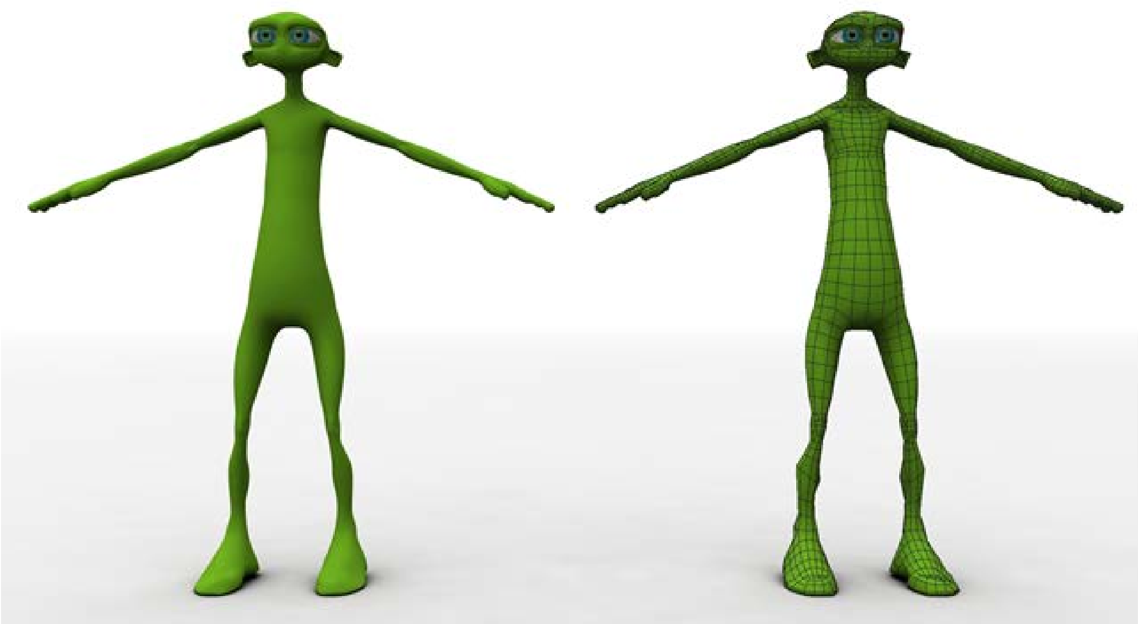


Figure 5.30: Sample Character Two concept model front view by Baris Isikguner.

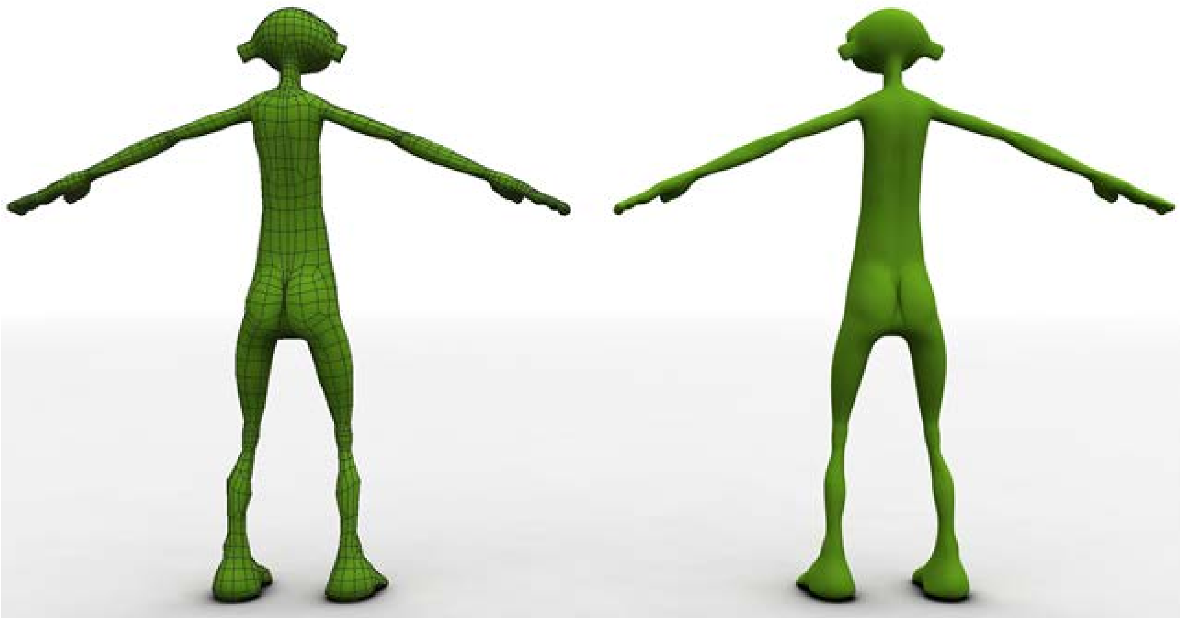


Figure 5.31: Sample Character Two concept model back view by Baris Isikguner.

5.4.5 Generating a New Control Rig - Control Rig Two

A completely new control rig was designed for the second sample character. It was designed in line with the focus of this research, which experiments towards utilizing procedural animation to improve the believability of a movement performance and to help contribute towards a guide for its studio practice. As explained in Section 5.4.3, motion capturing was eliminated from the experimental stages. Control Rig Two was therefore designed as a custom key-frame animation rig, but using only the common studio toolset available to professional development studios. This control rig was designed using the most basic and common methods for control rig development and it was designed to be easily replicated. Control rig two is also perfectly adaptable to and comparable with any possible custom humanoid character rig, since it contains only the mandatory control objects required for a humanoid character and is designed with the common studio toolset available for all game, animation and visual effects studios.

The rig allowed the animator to control the eyes, head, shoulders, arms, hands, fingers, torso, spine, hips, legs, feet, elbow and knees separately. This rig allowed more freedom during the production of the movement performances. A secondary procedural rig was designed and layered under the actual control rig. The muscle procedural rig was designed based on a real human muscle structure. This was done to maintain readability for the viewer and to generate more convincing deformations. The muscle rig contained muscles and muscle groups such as the sternocleidomastoid, biceps, triceps, stomach, gluteus, quadriceps, posterior quadriceps and calf (see Fig. 5.32 & 5.33). These were designed with values that could simulate muscle movement and deformations.

The rig also included a cloth object (the pair of shorts worn by the character) to help explore the effects of cloth dynamics during movement performances. The cloth object was modelled using polygon-based geometric primitives and the topology was designed by referencing the sample character’s topology on the matching parts. This was done to acquire the most convincing folding and deformation effects from the cloth object. The polygonal level was increased to a reasonably high level to give the nCloth dynamic system more freedom to produce convincing cloth animations, but kept at a polygonal level that can be adaptable to pipelines that uses low polygonal levels. The cloth object’s behaviour was designed using the Autodesk Maya nCloth toolset (Appendix I).

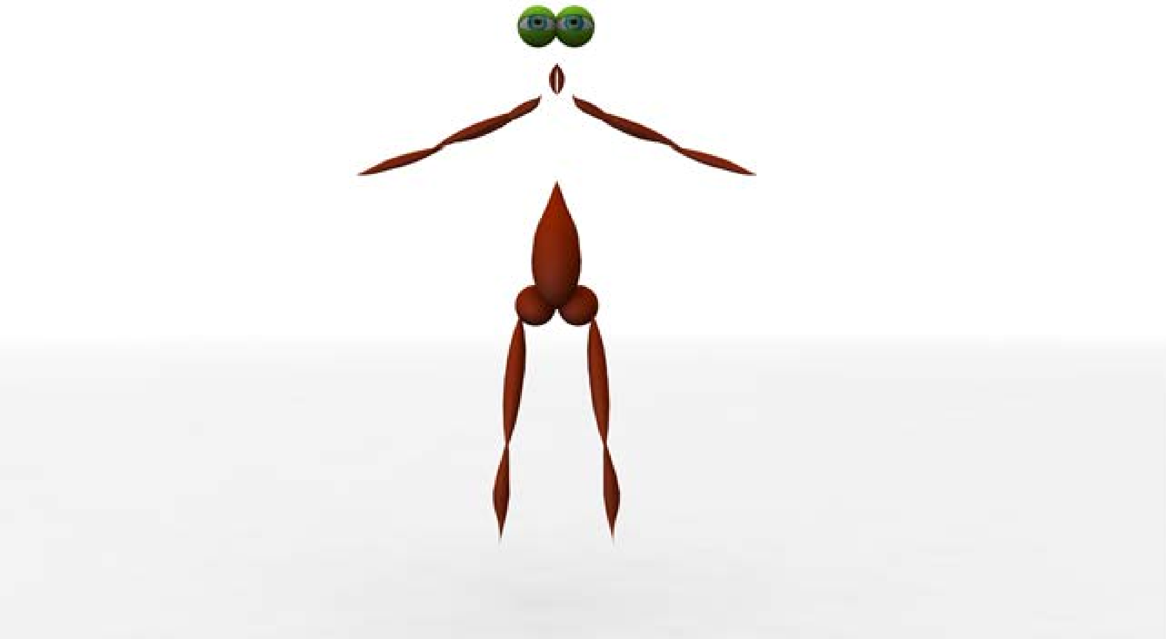


Figure 5.32: Sample Character Two: dynamic muscle rig, front view by Baris Isikguner.

Figure 5.33: Sample Character Two: dynamic muscle rig, side view by Baris Isikguner.

The cloth object had to follow the body mesh of the character and interact with it. It therefore had to be attached to the mesh, but this process was a challenging one given that the object risked going through the rigid body of the character.

There were two ways of approaching this issue: one was to attach the cloth object to the rigid body and set the interaction distance high enough for it not to get too close to the rigid body. The other was to duplicate the cloth object but remove the dynamic attributes from the duplicate object, instead attaching it to the control rig and causing it to act as though it were a part of the character’s skin, then make it invisible and attach the original cloth object to the invisible duplicate. In this way, the deformations of the surface of the character’s mesh wouldn’t affect the attachment points of the character’s mesh and the cloth object. This also meant the interaction distance could be set closer, in order for the cloth to interact with the surface of the character more convincingly. After this process, the dynamic cloth object was attached to the invisible, rigid, non-dynamic shorts to allow a better and more precise follow-through and control over the dynamic cloth object.

This research used common studio practice and toolsets to improve adaptability, therefore the modelling and rigging phase were undertaken using only Autodesk Maya 2013 tools. The entire pre-animation process, from modelling to rigging the character, was recorded and made into a series of audiovisual tutorials to help bachelor degree university students study production level pre-animation processes; these are now in use at Anglia Ruskin University and Nottingham Trent University.

5.4.6 Generating Key-Frame Performances for the Experimental Studies

In order to test the effects of procedural enhancements and make a synthesis of their application and outcome, this research required base movement performances. These movement performances had to be grouped in such a way that the professionals could easily compare their animations to the matching movement performance group to estimate the outcome of their use of procedural enhancements according to the results of this research, and then design their application phase accordingly.

In this stage of the experimental study, key-framed movement performances had to be developed. However, testing every possible movement a character can perform would have been an impossible task. Rudolf Von Laban provides a helpful classification of all human body movement types into four main groups, with each main group containing two elements. Laban analyses and divides movement types as follows (R. Laban, 2011; Newlove & Laban, 1993) (see Table 5.1 and Figure 5.34):

Weight: The force a performer puts behind the movements they make. Weight can be light or strong.

Space: The direction of the movement. A performer can chose to move toward the destination point following a direct path, like an arrow heading to its target, or an indirect way, like a child smelling flowers or playing in a garden on their way back home. Space can be flexible or direct.

Time: The speed of the performer’s movement. Time is also the rhythm of the movement. Laban suggests that although Time has opposing movement types, which are sustained and quick movement, they shouldn't be analysed separately but rather seen holistically: a single movement performance can include a combination of both sustained and quick movement, depending on the situation (Campana, 2011).

Flow: A quality derived from continuous and uninterrupted sequences of movement. However in contrast to this, if the movement performance is interrupted or stopping constantly, it is broken and the continuous quality of the movement performance is replaced with jerkiness. A flow can be bound or free.

Motion Factors	Effort	Elements	Measurable Aspects (objective function)	Classifiable Aspects (movement sensation)
	(fighting)	(yielding)		
Weight	firm	gentle	Resistance strong (or lesser degrees to weak)	Levity light (or lesser degrees to heavy)
Time	sudden	sustained	Speed quick (or lesser degrees to slow)	Duration long (or lesser degrees to short)
Space	direct	flexible	Direction straight (or lesser degrees to wavy)	Expansion pliant (or lesser degrees to threadlike)
Flow	bound	free	Control stopping (or lesser degrees to releasing)	Fluency fluid (or lesser degrees to pausing)

Diagram 5.2: Survey of the Aspects of Weight, Time, Space and Flow Needed for the Understanding of Effort (Laban, 2011, p. 77).

These motion factors and their effort elements are further broken down into under eight basic actions a human body can perform, combining three types of effort element for every motion factor in the process (Campana, 2011; R. Laban, 2011; Newlove & Laban, 1993) (see Table 8). These basic actions played a pivotal role in constructing and categorizing the movement performances for this research and will help contribute towards a more adaptable work for professionals to use within their pipeline.

Pressing: This action is a bound flow action such as pushing an object where other parts of the body such as knees and feet lead the rest of the body. It is a direct, sustained and firm action.

Flicking: This action is a free flow action such as flicking away a fly, where movement happens repetitively and fast but lightly. It is a flexible, sudden and light action.

Wringing: This action can be both bound or free-flow depending on the situation, but is usually performed with bound flow. Examples include wringing a wet cloth to squeeze all the water out of it or twisting the body as though it were a piece of cloth. It is a flexible, sustained and firm action.

Dabbing: This action can be both free- and bound flow depending on the situation. It is a direct, sudden and gentle action, such as gently touching an object or typing on the computer.

Slashing: This action can use both free and bound flow, but is usually performed with free flow. It is a sudden, firm and flexible action such as swinging a sword or performing a fast and cutting action

Gliding: This action can be performed with both free and bound flow, but is usually performed with bound flow. It is a sustained, gentle and sudden action, such as opening both arms like the wings of a plane and slowly gliding through the air.

Thrusting: This action can be performed with both free or bound flow, depending on the situation. It is a firm, direct and sudden action, such as shadow boxing, punching imaginary objects or kicking them.

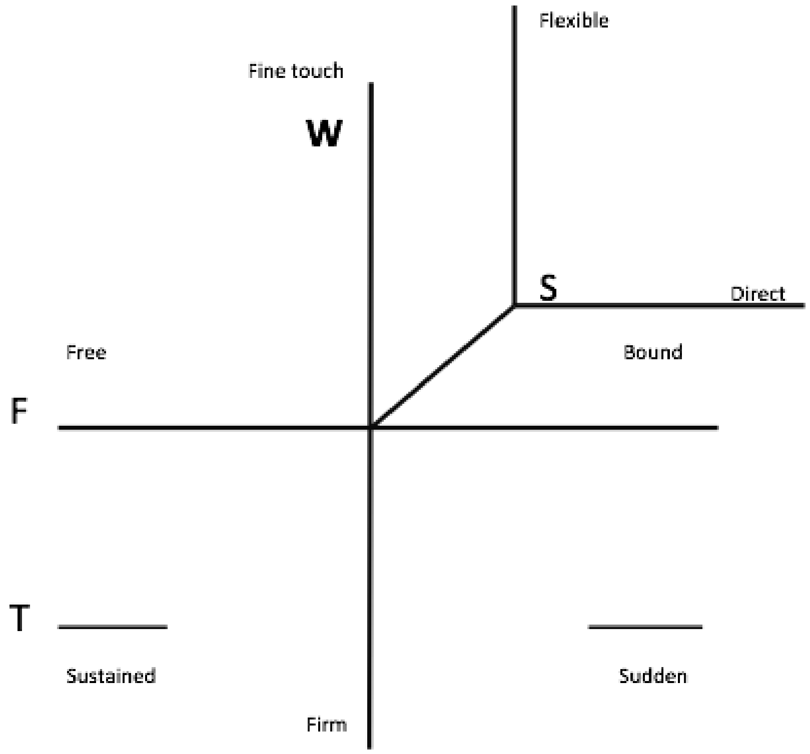
Floating: This action can be performed with either bound or free flow, depending on the situation. It is a flexible, sudden and gentle action, such as the short moment after a jump where the performer leaps and slows down in mid-air for a few seconds before gravity intervenes and the second action starts. This short leaping motion can be described as floating.

	Weight		Time		Space		Flow	
	firm	gentle	sudden	sustained	direct	flexible	bound	free
Pressing	+			+	+		+	
Flicking		+	+			+		+
Wringing	+			+		+	+	+
Dabbing		+	+		+		+	+
Slashing	+		+			+	+	+
Gliding		+		+	+		+	+
Thrusting	+		+		+		+	+
Floating		+	+			+	+	+

Table 5.1: Table of the time, weight, space and flow combinations of eight basic actions. (here, + Stands for ‘Includes’ and - or an empty space stands for ‘Does Not Include’.)

Laban’s movement theory made it possible to test all possible movement performance types to explore the outcome of procedural enhancement when used with a key-framed movement performance. This approach was also designed to help practitioners easily test and categorize their own style and type of movement performance in their workflow and pipeline. In order to cover as much ground as possible, Laban’s movement analysis was therefore used for this study to group possible human body movement types.

The notion of believability is an empirical notion, which only can be perceived and analysed visually. Therefore, in order to test the theory underlying this research, a series of visual materials / experimental animations designed to cover the movement types suggested by Laban had to be developed.



The Effort Graph

Representing the four Motion Factors

W = Weight

T = Time

S = Space

F = Flow each with their two Elements

Figure 5.34: Survey of the Aspect of Weight, Time, Space and Flow Needed for the Understanding of the Effort. (R. Laban, 2011, p. 76)

Laban’s motion factors and their effort elements were used to determine the scope of the movement performance types used for this research (R. Laban, 2011). To allow practitioners to focus on and analyse the constituents of procedural enhancements, four experimental animated movement performances were designed.

Run Cycle: This animated movement performance aimed to demonstrate firm weighting, direct spacing, quick timing and free flow. This combination is also known as Thrusting (see Appendix J).

Walk Cycle: The walk cycle was designed to demonstrate gentle weighting, flexible spacing, sustained timing and free flow. This combination is also known as Floating (see Appendix J).

Swing Cycle: The Swing Cycle was designed to demonstrate a combination of all motion factors and effort elements. This experimental animation combines Wringing, Slashing and Gliding actions (see Appendix J).

Lift Cycle: The purpose of designing this animated movement performance was to demonstrate a combination of all motion factors and effort elements. This experimental animation combines Pressing, Flicking and Dabbing actions (see Appendix J).

		RUN	WALK	SWING	LIFT
WEIGHT	light	-	+	+	+
	strong	+	-	+	+
SPACE	flexible	-	+	+	+
	direct	+	-	+	+
TIME	sustained	-	+	+	+
	quick	+	-	+	+
FLOW	free	+	+	+	+
	bound	-	-	+	+

Table 5.2: Table of the time, weight, space and flow combinations of four experimental animated movement performances. (Here, + stands for ‘Includes’ and - or an empty space stands for ‘Does Not Include’ .)

All the animated performances had to be fluent and readable to ensure the fruitfulness of the analysis phase. These animated cycles were designed to help analyse the effect of the procedural animation on all the motion factors, effort elements and actions of the human body movements described by Laban. The animated movement performances were designed using the key-framing technique and the twelve principles suggested by early Disney animators were been used during the design of the key-frame animated cycles. Sample Character Two was set up using the referencing system within Autodesk Maya. With this system, the character could be mirrored from a particular file. This was done to contain the original file where the character is stored and use it as a template. With this system any changes made to the master file would affect all the animated scenes that were referencing the character from the master file, which allowed the character to be refined or re-edited when needed; this refinement and editing would affect all animated scenes automatically, since they were all referenced from the same file. This was done to save time and to make sure that when the muscle rig was applied, it would be the same rig with the same values in every animated cycle.

5.4.7 Application of the Procedural System to Control Rig Two

In the final phase of this experimental study, the designed muscle rig was applied to the second sample character. In order to test and monitor the affects of the procedural enhancements, three polarized versions of all four cyclic animations were designed. Every version of the animated sequences was designed with different sets of procedural levels and values. The first version of every animated cycle contained no procedural animation, and included only raw key-frame animation. The second version of each animated cycle included natural levels of procedural animation. This was done by observing real-life footage and by referencing real-life equivalents of the objects and body parts. Procedural values, such as the stretching and squashing or jiggling and resistance values of the muscle groups and the surface deformation types and the folding and waviness of the cloth object values, were all set to be as equal as possible to their real-life counterparts. Finally, exaggerated levels of procedural enhancements were applied to the third version of each animated cycle. This was done by increasing the values of the second version with a constraint proportion, until they reached a point where further increasing them would have destroyed the form and made it unreadable for the viewer. The versions of procedural levels and their values are as follows:

Raw Key-frame movement performance: this key-frame movement performance group included no procedural animation. This was done to test the effects of the existence of procedural enhancements in a keyed movement performance. Designing a raw key-frame movement performance will allow this research to review the polarized effects of applying or not having procedural enhancements and their effects on the overall believability, realism or appeal of a movement performance (see Appendix J).

Natural levels of procedural enhancements: Setting up the values for this version of the animated sequences was a challenging task. The behaviour of the body and of body volumes differs dramatically according to the size, weight and form of the person. As such, producing a natural-looking dynamic effect was an complex undertaking. However, the values were adjusted through observation of real-life footage of humans of similar size and form. The purpose of this version was to design a logical minimal level of use for procedural enhancement, to test and analyse the impact of procedural enhancements on the believability, realism or appeal of a key-framed movement performance (see Appendix J).

Exaggerated levels of procedural enhancements: setting up the values for this version of the animated sequences required a thorough trial and error stage due to the lack of guidelines for the practice. Procedural enhancements tend to deform the animated character’s form, therefore an exaggerated use may eventually destroy the form and the readability of the character’s physical appearance altogether. The natural levels applied to the second version of the videos had to be increased proportionally without changing the original constraints of their values, so that they didn't lose the logical movements and adaptations within each and every muscle group. This version was designed in contrast to the first version, where there were no procedural enhancements, and to test how exaggerated levels of procedural enhancements would affect the believability, realism and appeal of a character compared to natural and low levels (see Appendix J).

Three different procedural levels applied to the character made it possible to test how procedural enhancement affects the overall believability, how much of its use may affect the perception of the believability and realism of the movement performance, and to explore whether these enhancements can either disrupt or increase the appeal of the overall movement performance. The procedural levels were discussed and designed through regular meetings and discussions with the supervision team.

The muscle dynamic rig and the behaviour of the cloth object were designed using the nDynamics, Muscle and nCloth node of Autodesk Maya 2013. The gravity settings were set to the standard values suggested by Autodesk Company Laboratories to achieve convincing gravitational force results.

This final phase of the experimental study was designed for the sample group to observe the procedural enhancements directly and to express their opinions through a survey-based questionnaire.

5.4.8 Rendering Process

Because It was crucial to keep all versions of each video looking similar to each other, designing a lighting system and scene setup that would help generate similar-looking visuals for each animation cycle was an important task. A common lighting and scene setup was therefore designed and applied across the board.

An individual scene setup was produced and all the animated sequences were imported into this scene setup in order to make sure that the character size and location were the same and that they were all rendered from the same moving Autodesk Maya Camera. In some sequences, such as the swing cycle and the lift cycle, the camera had to be pulled away to make it easier for the viewer to analyse. The position and the height of the camera were proportionally constrained during this stage. The camera was rotated around the character to allow viewers to see the animated character from all angles during action.

The scene was rendered with object base lighting and supported with global illumination and the final gathering light calculations of the rendering engine Mental Ray. The background was designed as an infinity and white background a light grey floor panel provided a focal point for the audience. The scene was equally and sharply lit and designed to deliver a high intensity of white light with dark and clear shadows. This was done to make the distinct colors clearly visible and to help signify the contrast between shadows and highlights, so that deformations on the surface of the objects and character skin could be clearly made out (see Appendix J).

The colour used for the character was a light, matte green. This was done to help viewers to easily distinguish the character from the rest of the scene and help them focus on the character’s movement performance. The character had no specularity, reflection or refractions on its surface, to avoid the potential confusions these elements may cause during deformations of the surface or during animation (see Appendix J).

The render resolution of the videos was set to 1920 (width) by 1080 (height) (Full HD) and rendered at thirty frames per second (30 FPS) to ensure the quality of the videos was maintained across the board from the viewers' perspective (see Appendix J). Every stage of the experimental study's visual design and presentation was carefully planned to be clear, readable and easily to analyse for a diverse audience.

There were no significant issues during this stage. The only issues encountered were time management and the Autodesk Maya Muscle system being an abstract toolset. The rendering of all scenes took approximately four hundred hours in total.

5.4.9 Summary and Conclusion

This experimental study was undertaken to help:

- Explore ways of categorizing movement performance types to be tested with procedural enhancement.
- Design animated cycles that included all movement performance types.
- Determine different procedural levels for animated sequences.
- Design visual materials to analyse the effects and outcomes of procedural animation when layered with a key-frame performance.
- Demonstrate a way of utilizing procedural animation with a keyed movement performance.

The initial stages of the experimental study aimed to generate a clear, readable and easy-to-analyse visual demonstration of the procedural enhancements on a key-frame movement performance. This was acheived through trial and error. The initial version of the experimental study included two different characters in a narrative animated sequence, with the aim of demonstrating the different types of procedural animations on each character. This plan was later terminated as it posed clarity and readability issues. To help viewers easily focus on the movement performance, a decision was made to focus on only one character.

The second step in the experimental study was to refine the first plan and redesign the visuals for a better demonstration of the outcomes of the procedural enhancement process. The number of characters was reduced down to one and a new character was designed to demonstrate both cloth and muscle dynamics. To avoid any ethical issues, it was decided the character would be a non-human character. However, anthropomorphic features were retained to help the audience easily interact with the character and make the latter's movement performances more readable and clear. The anatomical proportions applied to the character became problematic during the animation stage; the silhouette was hard to read due to its short, small limbs and unproportional design. The character and the project were therefore terminated.

The final step of the experimental study was carefully calculated and planned according to the data and experience gathered from the first two trials. A new sample character was designed with improved proportions and an aesthetically enhanced body. New improvements were made to help the audience easily focus on the movement performance of the character. Limb size was increased and the relative proportions of the body parts were made more readable. Unnecessary details such as facial and skin texture details were dropped to minimal levels to avoid confusing the viewers and affecting their analysis.

This research explores a way of using procedural animation to improve the believability of a key-framed movement performance and studied the application of procedural animation by constructing materials to be examined by viewers. The assumption was that the examination of these experimental studies would provide guidance material for professionals of the field, helping them to determine the application process and plan accordingly to the research findings provided by this study. The first issue was therefore to find a way of categorizing all possible movement performance types. To solve this issue, Laban’s movement theory and his effort research was used. The second issue was to find a way of measuring and describing the effects of procedural enhancements. In order for participants to clearly identify and describe the changes, a set of definitions had to be formulated. This terminology was formulated through a review of literature and current research within Chapters Two and Three, which dealt with the notion of believability and realism within character animation. A glossary was composed to help the sample audience easily describe and decide how the enhancements affected the overall keyed performance of the character, and ensure terms were understood in the same way by both the participants and the researcher.

The believability and realism of an animated character are qualities that can only be experienced through direct observation. This means that a viewer can only decide whether a character is believable or realistic after they observe it. Therefore these notions appeared as empiric notions.

Locke (Locke & Phemister, 2008) stated that learning can only happen through sensory data. Although Locke's analysis was not concerned with animation, his definition can easily be adapted to the field. One can only judge whether an animated performance is believable after watching it, which means the notion of believability is based on an empirical process. In order to monitor the effects of procedural enhancements, a series of design experiments were conducted to prepare visual demonstrations for reviewing purposes. These experimental studies and their results were evaluated with a survey based questionnaire and semi-structured interviews with professionals.

5.5 Overall Review of Experimental Stage Results

Procedural animation is a rapidly growing animation type, technique and toolset within the field of animation, games and visual effects. However, an observation of current studio practice and a review of current literature shows that there is no common practice for using procedural animation within these fields. This practice-led research set out to establish a systematic method that might help optimize the application of procedural animation; in the course of this process, it is hoped that a set of best practice guidelines can be developed for professional games, animation and visual effects studios.

The initial stages of the experimental study were designed to explore the potential outcomes of the use of procedural animation within character movement performances. A sample character modelled on a cephalopod was designed for these initial experiments. The aim was to produce a procedurally animated character which generated convincing and natural movement performances. Real-life footage was used as a reference in this experiment. The assumption of this initial experiment on the application and use of procedural animation within character animation could prove to be an asset for improving believable character performances. This experimental study took inspiration from the suggestions of Rudolf Von Laban, who stated that the harmonic and natural movement gives joy to the observer. This experiment wasn't designed or aimed to improve the joy an observer gains from a character's movement performance but to test whether procedural animation is a practice and toolset which can provide convincing movement performances. This experimental study and its findings confirmed that the use of procedural animation could improve the believability of the movement performance of an animated character. The theory behind this experimental study was that if the toolset proved to deliver standalone convincing and natural movement performances, it could act as an enhancement, which might improve the believability of a key-frame movement performance, since movement performance is one of the three constructing elements of believability. This theory was validated and proven through a comparative study and panel review. The procedural character produced convincing movement performances, proving the potential of procedural animation to enhance a key-framed movement performance.

The intermediate phases of the experimental stage aimed to determine which procedural animation types to use and how to adapt them. This experimental study also included an observation-based study to determine the form of the character. The stages of this experimental study were undertaken through trial and error and discussed with the supervision team. This experimental study was also the first step towards determining the form of the character.

The second stage started by determining the form and characteristics of the sample character. In this stage, the approach to designing the experimental studies was also established and lighting setups and textures were produced. The aim was to create animations that could easily be reviewed and evaluated by the sample group of viewers. After three experiments, it was established that the character should be a humanoid character with anthropomorphic qualities, and that two types of procedural animation, muscle and cloth, should be tested on it. The animations that were designed to demonstrate the procedural enhancements were carefully planned to avoid potential ethical issues and to develop a readable visual framework for the experiments.

The final experimental study reviewed Laban Movement Analysis to create categories of movement to be key-framed. These key-frame movement performances were designed to study the application of procedural animation and to develop a referable study that could be used as a benchmark by professionals of the field. The further stages of the experimental phase consisted in finalising and creating the visuals for analysis and data collection.

The aim of the experimental studies was to contribute towards developing a guide for character animation practitioners, by testing an approach which may help improve the application of procedural animation and giving practitioners a synthesis of specific application processes and their outcomes. Movement performance was chosen as the experimental field and the aim was to experiment with improving the believability of the animated movement performance. The study kept track of the different effects of procedural animation to determine whether these were negative or positive. An initial review of the experimental results showed that this research:

- May provide a basis for the future development of a set of implementation guidelines for procedural animation, based on Rudolf Von Laban’s Effort Research and animation theory, to help further develop pipelines and workflows for the use of procedural animation with human-like characters.
- May provide an efficient approach to utilizing procedural animation, by demonstrating the outcomes and constituents of the use of procedural enhancements on human-like characters to inform the practice of animation professionals.
- May help provide a procedure that allows the practitioner to improve the believability or realism of animated character movement performances without reducing the appeal of the animated character.

The validity and reliability of these results were further tested using a survey-based questionnaire. The resulting data was discussed and evaluated with professionals through interviews.

Chapter 6: Data Analysis – a Practice for Utilizing Procedural Animation

6.0 Introduction

Chapter Five described experimental studies designed to examine the effects of the use of procedural enhancements with the key-frame movement performance of an animated character. These studies used Laban's Movement Theory and the notion of believability as their basis to explore a practice which may help work toward guidelines for an optimal application of procedural animation. Four groups of videos with three versions each, a total of twelve animated sequences, were designed to demonstrate the outcome of the experiments. Chapter Six describes the data gathering and analysis phase of the research and outlines the qualitative and quantitative methods used to obtain information from survey questionnaire and interviews. The initial method for analysis was a survey-based questionnaire, which was distributed to researchers and practitioners from the field of game and animation. The data collected was then further evaluated and discussed with professionals from games and animation development companies.

6.1 Survey-Based Questionnaire

A survey-based questionnaire explored the effects and outcome(s) of the procedural enhancements, when layered with key-framed character movement performances. The questionnaire was designed and published online using SurveyMonkey. The survey was made private and only accepted the responses of participants that had been invited.

6.1.1 Preparations and Viewer Sample Group Selection

The animated sequences were divided into four main groups, with each group based on one animated movement performance. For every movement performance, three different versions were created, one for each of the three different levels of procedural enhancement. The movement performance types were categorized and designed according to Laban's Movement Analysis (see Chapter Five). Within every group, the three different versions of the animation were shown in random order, and the audience were not provided with any information regarding the specific differences between the various versions of the video.

The questions were delivered in two stages. Three sets of questions were designed for each and every animation. The first two sets of questions asked the participants to assess the level of realism and believability of the animated characters' performance by selecting the version in which they felt the movement performance appeared most believable or realistic. The third set of questions asked which version of the video participants felt had the most appealing character movement performance. A clear definition and description of the terms of the survey was attached to every section of the questionnaire to help participants make an informed choice. This first section of the questionnaire was designed to help understand how procedural enhancements affect the viewer's perception of the movement performance. In the second stage, a multiple choice selection list was designed for each animation. Participants were asked to select which specific parts and sections of the character they believed had influenced their response to the first question. This was done to explore and categorize the effects of procedural enhancements within certain movement performance groups suggested by Rudolf Von Laban.

The decision regarding who to include in the sample group was made in two main stages. In the initial stage a sample group of academic staff and researchers from Nottingham Trent University were randomly selected from the global mailing list of the school of Art, Design and Built Environment. The initial test survey group included the supervision team for this research. This was done to test the survey, both technically and content-wise, and gain initial feedback to ensure the survey was solid or make any necessary changes. The final sample group was composed of researchers and teaching staff from the fields of film, animation and games and professionals from the fields of games, animation and visual effects. The academic staff and researchers were randomly selected from the global mailing lists of Anglia Ruskin University, Nottingham Trent University and the Animation Postgraduate Research Group. The professionals were selected randomly from the Creative Front Company global email list. Creative Front is an event organization company working with Anglia Ruskin University that collaborates with companies such as Sony Computer Entertainment, Ninja Theory, JAGEX, Eidos Montreal, Frontier Development, ARMS and many other local, national and international companies around the world. Animation Postgraduate Research Group (Animation PGR) is a United Kingdom-wide animation research group that houses animation, games and visual effects researchers all around the country and organise academic events annually.

6.1.2 Pilot Survey

The pilot survey was run to gain initial feedback, in order to solidify the design and content of the survey-based questionnaire. The aim of the pilot survey was to make the survey-based questionnaire clear and understandable and to make sure the data it delivered was accurate. After the feedback, addendums and refinements were incorporated to the survey. These changes were as follows: A note was added to recommend that the videos be watched in full screen mode. This was done to help improve the experience of the viewer and to help improve their awareness of the small details. The section asking participants to insert their names and surnames was removed.

6.1.3 Survey-Based Questionnaire Data Collection and Analysis

This research aimed for a lower than 5% error margin in the survey-based questionnaire, therefore a minimum of 169 responses were needed for a sample group size of 300 with a 95% confidence level per question. Due to the nature and the length of the survey, the number of the respondents drops in the later sections of the survey questionnaire. However the response rate never drops below 169, which keeps the error margin lower than 5% at all times. There were four main sets of questions and every set contained six questions.

For the first set of questions (1-6) a total of 213 responses were returned, which is 71% of the sample group, with an error margin of 3.62% (see Appendix L).

For the second set (questions 7-12) a total of 205 responses were received. This is 68.3% of the sample group; the error margin was 3.86% (see Appendix L.).

A total of 200 responses were returned to the third set of questions (13-18); this is 66.7% of the sample group. The error margin was 4.01% (see Appendix L.).

For the fourth set (questions 19-24) of the survey-based questionnaire a total of 199 responses were received, this is 66.3% of the sample group. The error margin was 4.04% (see Appendix L).

The error margin for the questionnaire was under 5% in all four groups, and the number of respondents was higher than the minimum threshold (169 respondents), which makes the results valid and reliable at a 95% confidence level.

As mentioned in section 6.1.1 the sample group of participants in the survey included professionals from a range of fields relating to character animation (see Table 6.1 & Appendix K). Forty-nine percent of the sample group was formed of practitioners within the field of games, animation and visual effects (see Table 6.1); 15.8% of the respondents were doctoral level researchers within the same fields (see Table K). The respondents who selected the “Personal (Hobby)” option were academics and teaching staff within related fields (see Table K).

Answer Options	Response	Response %
Personal (Hobby)	59	30.1%
Personal Research	4	2%
Academic Research	6	3.1%
Doctoral Research	31	15.8%
Professional	96	49%
Answered	196	100%
Skipped Question	17	

Table 6.1: Survey Sample Group Relevance to the Field of Character Animation.

All four sets of experimental animation sequences demonstrated the procedural enhancements through a series of basic action groups developed by Rudolf Von Laban (see Chapter 5.4.6). Two different levels of procedural enhancement were applied to the animated character, and in a third video no procedural enhancements were applied at all (see Chapter 5).

Procedural enhancements were applied to the neck, arms, forearms, stomach, buttocks, upper and lower legs of the sample character. A pair of shorts was designed to demonstrate the cloth object. Details regarding both the specific muscle groups and the qualities of the cloth object were provided in Chapter 5.4.5. The following tables were designed to analyse the survey results. In order to help improve intelligibility the procedural levels will be represented as follows :

- Non procedurally enhanced animation will be represented by (-)
- Natural levels of procedural enhancements will be represented by (+)
- Exaggerated levels of procedural enhancements will be shown as (++)

The questionnaire was divided into three sections; the first section focused on the believability of the animation, the second section on its realism and the third section on how appealing the character was. For each section, viewers were asked to first select the version they found most believable / realistic / appealing, then select a series of detailed options through a multiple choice questionnaire aiming to pinpoint which of the video's features had prompted their choice. Respondents were asked to choose from the following list of specific elements:

- Movement of the Neck and Shoulders
- Movement of the Arms
- Movement of the Legs
- Movement of the Torso
- Gravity or effort affecting the character's performance
- Gravity or effort affecting the shorts on the character
- The way the character's skin flexes is (appealing / realistic / believable)
- The character's facial expressions are (appealing / realistic / believable)
- The performance of the character is (appealing / realistic / believable)
- The feeling of weight in the character's movements is (appealing / realistic / believable)
- The timing of the character's movements helps with the character's (appeal / realism / believability)
- The character's physical appearance helps with the character's (appeal / realism / believability)

The following tables will only show the number corresponding to each option due to the lack of space. The alignment and flow of the options does not change and it is the same in every table.

The analysis of the survey results relating to Animation Group One (lift cycle) shows that 79.8% of the respondents found the version with exaggerated levels of procedural enhancements most believable when compared to the other two versions of the same video, and 70.9% of the respondents also found the exaggerated levels of procedural enhancements more appealing compared to the natural and non procedural version of the video. 23.9% of respondents felt that the version they considered realistic was appealing. The analysis shows that the higher amounts of procedural animation gave more appeal and believability to this animated piece (see Table 6.2).

		Believable		**Realistic**		**Appealing**	
	P.A. Level	Response Count	Response Percentage	Response Count	Response Percentage	Response Count	Response Percentage
LIFT	**-**	14	6.6%	48	22.5%	11	5.2%
	+	29	13.6%	156	73.2%	51	23.9%
	++	170	79.8%	9	4.2%	151	70.9%

Table 6.2: Table for the survey analysis of Group One (Lift Cycle).

Of 213 respondents, 152 thought exaggerated levels of procedural enhancements were appealing; of these, 114 attributed the appeal of the animated piece to the movement of the legs, 122 related it to the movement of the shoulders and neck, 113 to the way in which the overall effort of the character performance reflected the pull of gravity and 126 to the effort of the cloth object and its presentation of the feeling of weight and gravity (see Table 6.3).

Of a total of 213 respondents, 171 felt the version of the animation with exaggerated levels of procedural enhancements was the most believable. Of these 171 respondents, 132 picked the neck and shoulder area and the legs, 134 picked the effort the character shows against gravitational pull, and 149 picked the cloth object’s procedural performance as the reason why the exaggerated level version of the animation was believable (see Table 6.3).

(Group 1) Lift Cycle																		
Options	Appealing						Realistic						Believable					
	-		+		++		-		+		++		-		+		++	
	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%
1	3	27.27	12	23.53	122	80.26	13	27.08	26	16.67	2	20	7	50	2	6.90	132	77.19
2	3	27.27	10	19.61	52	34.21	10	20.83	25	16.03	4	40	5	35.71	5	17.24	78	45.61
3	1	9.09	39	76.47	114	75	11	22.92	85	54.49	3	30	4	28.57	20	68.97	132	77.19
4	3	27.27	17	33.33	36	23.68	7	14.58	36	23.08	3	30	2	14.29	10	34.48	54	31.58
5	1	9.09	26	50.98	113	74.34	15	31.25	53	33.97	2	20	4	28.57	15	51.72	134	78.36
6	1	9.09	40	78.43	126	82.89	15	31.25	83	53.21	5	50	3	21.43	22	75.86	149	87.13
7	0	0	13	25.49	31	20.39	5	10.42	62	39.74	1	10	1	7.14	7	24.14	42	24.56
8	1	9.09	14	27.45	59	38.82	11	22.92	41	26.28	3	30	0	0	9	31.03	52	30.41
9	5	45.45	17	33.33	86	56.58	16	33.33	73	46.79	3	30	2	14.29	18	62.07	101	59.06
10	3	27.27	13	25.49	50	32.89	9	18.75	48	30.77	2	20	1	7.14	7	24.14	53	30.99
11	0	0	13	25.49	39	25.66	14	29.17	39	25	3	30	4	28.57	6	20.69	28	16.37
12	2	18.18	3	5.88	26	17.11	4	8.33	8	5.13	1	10	1	7.14	4	13.79	14	8.19
Total	11		51		152		48		156		10		14		29		171	

Table 6.3 Table for the survey analysis of Group One (Lift Cycle) elements.

Of 213 respondents, 156 thought the most realistic version of the video was the one that had natural levels of procedural enhancement. The same animation was also picked as the second most appealing version among the three by 51 respondents. The choice of elements which led viewers to select this specific version of the animation as the most realistic was remarkably consistent (see Table 6.3).

The most frequent selections were the character’s legs (85 respondents), the performance of the cloth object (83 respondents) and the overall performance of the character (73 respondent votes). The review of the results analysis shows that the bigger muscle groups and the procedural enhancements affected the overall movement performance and blended successfully into the movement performance without disturbing the overall performance itself. Furthermore, the cloth simulations were distinctly visible, more so than the muscle deformation; this drew the audience's attention to the textile's natural deformations and movement.

The dabbing action of the character, when it leans and holds the barbell, the pressing action during the struggle and lift, and the flicking action during preparation and before the lift, were presented with different levels of procedural enhancement and the analysis results show that the exaggerated demonstration of weight, mass and deformation within this animation sequence appeared more believable and appealing compared to the other two versions.

Animation Group Two (run cycle) included actions of the thrusting type. Within this movement performance group, 79.5% of the respondents selected the version of the animation that had exaggerated levels of procedural enhancement as the most believable version; 68.8% of the sample group also selected this version of the animation as the most appealing one of the three. Surprisingly, 56.6% of the respondents thought the version of the animation that had no procedural enhancements was the most realistic one. The overall analysis of the second movement performance type (Group Two, Run Cycle) shows that the exaggerated levels of procedural enhancements made this animated movement performance more appealing and believable when compared to the other two versions.

		Believable		**Realistic**		**Appealing**	
	P.A. Level	Response Count	Response Percentage	Response Count	Response Percentage	Response Count	Response Percentage
RUN	**-**	28	13.7%	116	56.6%	27	13.2%
	+	14	6.8%	76	37.1%	37	18.0%
	++	163	79.5%	13	6.3%	141	68.8%

Table 6.4: Table for the survey analysis of Group Two (Run Cycle).

The analysis of the survey results shows that 163 respondents, or 79.5% of the sample group, associated exaggerated levels of enhancements within the animated movement performance with believability and 141 of the respondents, that is to say 68.8% of the sample group, felt that the same version of the animation was more appealing when compared to the other two versions.

Of 205 respondents, 141 respondents felt the exaggerated procedural version of the video was more appealing. Further analysis of the data collected from the survey results shows that 108 of the respondents from the sample group thought the movement of the legs was one of the reasons the animated performance was appealing. 124 of the respondents selected answer 6 (‘Gravity or effort affecting the shorts’) and 107 respondents identified ‘Gravity or effort affecting the performance of the character’ as the source of the character’s appeal (see Table 6.5).

Of 205 respondents, 163 selected the version of the animation that had exaggerated levels of procedural enhancements as the most believable version of the three. Of these 163 respondents, 147 picked the demonstrations of gravitational pull affecting the performance of the cloth object as one of the reasons why the animated performance was believable. 134 respondents picked the movement of the legs and 136 respondents selected the neck and shoulders as the elements that made the overall movement performance more believable (see Table 6.5).

161 respondents of 205 thought the version of the video with no procedural enhancements was the most realistic version of the three. Further observation of the reasons given for the realism of the selected version of the video shows that the respondents’ choices were surprisingly consistent. The survey results indicate that the observers found the overall deformations, movement and the sense of struggle against gravity realistic. No procedural enhancements were applied to this version of the video and the movement performance was a fast thrusting type basic action. This shows that where firm and sudden actions are concerned, procedural animations may disrupt the realism and provide a more cartoon-like entertaining movement performance (see Table 6.5).

(Group 2) Run Cycle																		
Options	Appealing						Realistic						Believable					
	-		+		++		-		+		++		-		+		++	
	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%
1	3	11.11	17	45.95	103	73.05	15	12.93	25	32.89	6	46.15	4	14.29	2	14.29	136	83.44
2	7	25.93	12	32.43	48	34.04	17	14.66	15	19.74	5	38.46	4	14.29	3	21.43	67	41.10
3	19	70.37	23	62.16	108	76.60	45	38.79	40	52.63	6	46.15	23	82.14	4	28.57	134	82.21
4	10	37.04	4	10.81	37	26.24	28	24.14	13	17.11	4	30.77	13	46.43	1	7.14	41	25.15
5	9	33.33	13	35.14	107	75.89	50	43.10	23	30.26	9	69.23	12	42.86	2	14.29	126	77.30
6	21	77.78	27	72.97	124	87.94	47	40.52	39	51.32	9	69.23	19	67.86	2	14.29	147	90.18
7	8	29.63	8	21.62	45	31.91	35	30.17	14	18.42	4	30.77	9	32.14	2	14.29	35	21.47
8	7	25.93	6	16.22	42	29.79	40	34.48	18	23.68	4	30.77	11	39.29	0	0	49	30.06
9	12	44.44	11	29.73	82	58.16	50	43.10	32	42.11	4	30.77	15	53.57	2	14.29	110	67.48
10	8	29.63	3	8.11	58	41.13	41	35.34	17	22.37	3	23.08	15	53.57	4	28.57	52	31.90
11	4	14.81	5	13.51	35	24.82	29	25	13	17.11	3	23.08	7	25	2	14.29	25	15.34
12	5	18.52	1	2.70	21	14.89	14	12.07	8	10.53	0	0	1	3.57	1	7.14	25	15.34
Total	27		37		141		116		76		13		28		14		163	

Table 6.5: Table for the survey analysis of Group Two (Run Cycle) elements.

The run cycle (Animation Group Two) included basic thrusting type actions applied to the legs and arms (punching and kicking type of firm and sudden movements). The character’s upper body, including the head, also performed the same type of actions during the shifts of the run cycle. The overall analysis of Group Two shows that the use of procedural animation within fast phases of movement performance may disturb realism and may enhance the believability and appeal of the movement performance.

The walk cycle (Animation Group Three) included actions of the floating type. The overall analysis of the survey shows that of a total of 200 respondents, 155 viewers, or 77.5% of the sample group, selected the animation version with exaggerated levels of procedural enhancements (see Table 6.6). A large percentage, 149 respondents or 74.5% of the sample group, also selected the same exaggerated procedural version of the animation as the most appealing one. 136 respondents, or 68% of the sample group, thought the version of the animation with natural levels of procedural enhancements was the most realistic one.

This movement performance was designed to emphasize only one type of basic action at a time. The results were strikingly uniform and showed that a very large percentage of the respondents came to similar conclusions regarding different versions of the animation (see Table 6.6). According to the survey, a large number of the respondents agreed that the exaggerated level of enhancements made the character believable within this experimental study. There was very little difference between the responses to the other two versions (see Table 6.6). This shows that when the animated performance is more narrow and focused on a single basic action it is easier for the audience to render a judgement on the causes of their reception of the movement performance. Two of the four main movement performances, the run and walk cycles, demonstrated only one basic action each, while the other two movement performances demonstrated multiple basic actions. It is only fair to acknowledge that a production level scene for an animated film or game is composed of diverse movement performances; as such, a design based on a single basic action is limited in its application. However, the aim of this study is to gain a core understanding of the effects of the procedural enhancement; this is the main reason for designing such extreme movement performances.

		Believable		**Realistic**		**Appealing**	
	P.A. Level	Response Count	Response Percentage	Response Count	Response Percentage	Response Count	Response Percentage
WALK	**-**	26	13.0%	58	29.0%	26	13.0%
	+	19	9.5%	136	68.0%	25	12.5%
	++	155	77.5%	6	3.0%	149	74.5%

Table 6.6: Table for the survey analysis of Group Three (Walk Cycle).

Further analysis of Animation Group Three (walk cycle) shows that 128 of 149 respondents selected the movement of the neck and shoulders to explain why the character appeared more appealing than in the other two versions, 119 of them the neck, 111 the overall gravitational effort performance of the character and 139 selected gravitational effort and the movement of the cloth object attached to the character (see Table 6.7).

136 of 203 respondents (including 3 partial responses) thought the version of the animation that had natural levels of procedural enhancements was the most realistic. There were two surprising results here. First of all, a very high number of respondents agreed on the same version of the animation. Second, a very small number of respondents (6 respondents) considered the exaggeratedly enhanced version of the animation to be the most realistic (see Table 6.7). 155 of the 203 respondents agreed that the exaggeratedly enhanced version of the animation was more believable then the other two versions (see Table 6.7).

Animation Group Three (walk cycle) included a floating action, and it was specifically designed to emphasize this type of movement. Large groups of respondents focused their choices on one version, which was the exaggerated version of the animation, and a very high percentage of the sample group made the same selections from the features list. It appears that the action being a slow phase action made it easier for the sample group to analyse all action phases and movement performances within the animation in detail. The overall analysis of this animation performance shows that the exaggerated levels of procedural enhancements may help improve the believability and appeal of the animated piece, as long as they don’t disrupt the form of the character and interfere with the readability. However, the natural levels of procedural enhancements weren't generally perceived as appealing as the higher procedural levels.

(Group 3) Walk Cycle																		
Options	Appealing						Realistic						Believevable					
	-		+		++		-		+		++		-		+		++	
	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%
1	2	7.69	10	40	128	85.91	9	15.52	38	27.94	1	16.67	1	3.85	9	47.37	132	85.16
2	6	23.08	6	24	47	31.54	8	13.79	23	16.91	4	66.67	5	19.23	3	15.79	60	38.71
3	15	57.69	19	76	119	79.87	21	36.21	71	52.21	2	33.33	18	69.23	14	73.68	129	83.23
4	10	38.46	6	24	28	18.79	17	29.31	39	28.68	1	16.67	14	53.85	6	31.58	38	24.52
5	13	50	9	36	111	74.50	26	44.83	41	30.15	1	16.67	16	61.54	10	52.63	125	80.65
6	18	69.23	21	84	136	91.28	19	32.76	62	45.59	2	33.33	12	46.15	12	63.16	132	85.16
7	12	46.15	5	20	28	18.79	24	41.38	51	37.50	1	16.67	10	38.46	3	15.79	36	23.23
8	9	34.62	4	16	42	28.19	18	31.03	34	25	0	0	10	38.46	5	26.32	53	34.19
9	10	38.46	10	40	93	62.42	24	41.38	58	42.65	3	50	16	61.54	10	52.63	112	72.26
10	6	23.08	6	24	49	32.89	18	31.03	41	30.15	1	16.67	7	26.92	9	47.37	54	34.84
11	5	19.23	5	20	36	24.16	10	17.24	27	19.85	1	16.67	8	30.77	5	26.32	26	16.77
12	5	19.23	1	4	21	14.09	8	13.79	13	9.56	0	0	1	3.85	2	10.53	14	9.03
Total	26		25		149		58		136		6		26		19		155	

Table 6.7: Table for the survey analysis of Group Three (Walk Cycle) elements.

Animation Group Four (the swing cycle) included wringing, slashing and gliding actions. Out of a total of 199 respondents, 154 viewers (77.4%) picked the exaggerated version of the animation as the most believable version of the three. Furthermore, 138 of the respondents, or 69.3%, felt the same version of the animation was more appealing than the other three versions. The most striking result derived from the analysis was that the audience’s perception of believability increased the more they involved procedural enhancements and higher values of procedural animation. This also surprisingly applies to the appeal of the animated sequence. It was hard to decide what this meant without an overall analysis and comparison of all four animation groups and further analysis of the three versions of this groups animations. A very high proportion of the survey group also picked the version of the animation that had natural levels of enhancements as the most realistic one. This is again a surprising result, since this sequence was a fast phase sequence but included calm and slow actions as well (see Table 6.8).

		Believable		**Realistic**		**Appealing**	
	P.A. Level	Response Count	Response Percentage	Response Count	Response Percentage	Response Count	Response Percentage
SWING	**-**	11	5.5%	41	20.6%	12	6.0%
	+	34	17.1%	140	70.4%	49	24.6%
	++	154	77.4%	18	9.0%	138	69.3%

Table 6.8: Table for the survey analysis of Group Four (Swing Cycle).

Further analysis of the data from Animation Group Four shows that 127 of 199 respondents thought the exaggerated procedurally enhanced version of the animation was appealing due to the movement and feeling of weight and mass that the cloth object was demonstrating, 116 of them picked the movement of the arms and 105 selected the overall performance of the character’s effort and reactions to demonstrate the performance and actions to resist gravity. Finally, 106 respondents picked the neck and shoulders (see Table 6.9).The obtained data shows that the largest percentage of the choices focused on the procedurally enhanced sections of the character.

Respondents focused their choices on procedurally enhanced sections again when the sample group was asked which elements they believed made the overall movement performance believable (see Table 6.9). 138 respondents chose the feeling of gravitational effort and movement performance of the cloth object, while 122 of them chose the overall effort and the feeling of weight and mass of the character performance and the movement of the neck and shoulders; 121 respondents selected the arms.

(Group 4) Swing Cycle																		
Options	Appealing						Realistic						Believable					
	-		+		++		-		+		++		-		+		++	
	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%	Res.	%
1	7	58.33	16	32.65	106	76.81	10	24.39	32	22.86	3	16.67	6	54.55	8	23.53	122	79.22
2	4	33.33	9	18.37	38	27.54	11	26.83	20	14.29	5	27.78	5	45.45	7	20.59	65	42.21
3	8	66.67	35	71.43	116	84.06	11	26.83	76	54.29	9	50	7	63.64	28	82.35	121	78.57
4	3	25	20	40.82	30	21.74	7	17.07	39	27.86	4	22.22	4	36.36	10	29.41	42	27.27
5	3	25	21	42.86	105	76.09	17	41.46	65	46.43	8	44.44	7	63.64	17	50	122	79.22
6	6	50	39	79.59	127	92.03	8	19.51	70	50	6	33.33	5	45.45	25	73.53	138	89.61
7	0	0	14	28.57	35	25.36	14	34.15	39	27.86	3	16.67	1	9.09	16	47.06	38	24.68
8	0	0	10	20.41	36	26.09	12	29.27	45	32.14	3	16.67	3	27.27	7	20.59	41	26.62
9	4	33.33	24	48.98	77	55.80	18	43.90	59	42.14	6	33.33	4	36.36	18	52.94	97	62.99
10	2	16.67	16	32.65	39	28.26	8	19.51	47	33.57	2	11.11	4	36.36	14	41.18	45	29.22
11	4	33.33	11	22.45	39	28.26	13	31.71	46	32.86	6	33.33	6	54.55	8	23.53	30	19.48
12	1	8.33	5	10.20	18	13.04	4	9.76	14	10	1	5.56	0	0	1	2.94	21	13.64
Total	12		49		138		41		140		18		11		34		154	

Table 6.9: Survey analysis of Group Four (Swing Cycle) elements.

The overall analysis of the elements that made the performance realistic was again striking, since the same options were consistently selected (see Table 6.9). This again may mean that the naturally designed procedural values blended into the performance without gaining attention and disrupting the realism of the overall movement performance. The data gathered from this group shows that the audience picked the procedurally enhanced parts of the character and that, surprisingly, these enhancements entertained rather than disturbed them. Animation Group Four (swing cycle) included include slashing type basic actions when the character swings from the bar, gliding when the character leaves the bar and leans on it, and wringing when the character jumps and turns back to face the bar again.

It was very hard to draw a final conclusion without a global analysis of all four animation groups. The next step was therefore to make a cross-tabulation overall comparison of all groups to draw a final conclusion on how procedural enhancements may affect the believability of movement performance in a key-framed animation, and why.

6.1.4 Conclusions

An overall analysis of the four groups shows that the audience detected the procedurally enhanced parts of the animated character, when the values and behaviours linked to the procedural enhancements were exaggerated (see Tables 6.3, 6.5, 6.7, 6.9). However, when the procedural enhancements were at natural levels, the participants did not focus their choices solely on the procedurally enhanced parts of the animated performances; a range of features were selected, and choices included the parts of the character that weren't procedurally enhanced. This shows that the audience detected a level of enhancement in the performance; however, they found it hard to pinpoint the individual elements that housed those enhancements. This shows that the enhancements need to be adjusted down to natural levels, to allow the procedural animations to blend into the performance they are layered onto; this avoids the procedural enhancements attracting too much attention and thus disrupting the realism of the overall performance.

The most striking result derived from the data analysis was the correlation between the believability and the appeal of the animated sequence. Although audience members were able to identify the procedurally enhanced sections of the animated movement performance, this did not seem to disturb them: they chose the exaggerated version of the procedural enhancements, in every group, as both the most believable and the most appealing version (see Table 6.10). The audience being aware of the exaggerated parts of the character means that they specifically focused on these parts, finding the secondary animations and deformations these procedural enhancements generated more appealing. This shows that exaggerated procedural enhancements may result in an improvement of the believability and appeal of the key-frame animated movement performance.

However, as the analysis shows, downsides to these enhancements may appear in two different types of situations:

Problems that may occur due to the movement style and type in use: In this research, procedural enhancements adversely affected the realism of the movement performance which included firm and sudden movement types; this led the audience to pick the non-enhanced version of the animated performance as the most realistic one. This might have been an issue had the aim of the project been to achieve a realistic animated character, designed to mimic its real-life equivalent.

Problems that may occur according to the level of procedural values applied or their numbers: this research shows that exaggerated levels of procedural animation may help improve the believability of an animated performance. The analysis of the survey results and overall analysis of the four movement performance groups shows that the achievement of a realist effect may cancel the believability effect and the achievement of believability effect may, in turn, cancel the realism effect (see Table 6.10.). This could be an issue were the project to involve a high number of procedural elements within a character, and should the character be required to perform a realistic movement performance.

		Believable		Realistic		Appealing	
	P.A. LEVEL	Response Count	Response Percentage	Response Count	Response Percentage	Response Count	Response Percentage
Group1 LIFT	_	14	6.6%	48	22.5%	11	5.2%
	+	29	13.6%	156	73.2%	51	23.9%
	++	170	79.8%	9	4.2%	151	70.9%
Group2 RUN	_	28	13.7%	116	56.6%	27	13.2%
	+	14	6.8%	76	37.1%	37	18.0%
	++	163	79.5%	13	13%	141	68.8%
Group3 WALK	_	26	13%	58	29%	26	13%
	+	19	9.5%	136	68%	25	12.5%
	++	155	77.5%	6	3%	149	74.5%
Group4 SWING	_	11	5.5%	41	20.6%	12	6%
	+	34	17.1%	140	70.4%	49	24.6%
	++	154	77.4%	18	9%	138	69.3%

Table 6.10: Survey analysis of all four video groups.

The questionnaire analysis shows that procedural animation, when layered with a key-framed movement performance, may enhance the believability of the overall movement performance. This theory will be further discussed and validated in the following chapter.

6.2 Interview Phase

Semi-structured interviews were undertaken face-to-face with practitioners to further evaluate the survey findings and to solidify the contribution of this research to the field and to professional studio practice. The researcher asked five open-ended questions relating to notion of believability, character animation, professional studio practice, animation, and the aims and findings of this research. Respondents provided a rich and in-depth insight that helped assess and validate the contribution of this research to the field.

Semi-structured interviews provided a considerable amount of contextual data for analysis. This research used Grant McCracken's five step interview data analysis method (McCracken, 1988). The transcripts of the interviews were coded and these codes were categorized to create a schematic, hierarchical dataset. The schematics and taxonomy of the retrieved data were designed and analysed using the qualitative data analysis software ATLAS.ti. John Lofland's decisive study on qualitative data coding was also used to help determine themes for individual and comparative analysis of the transcribed interview data. (Lofland, 2006).

During the experimental stages, the application process of procedural animation was studied. Experimentation was undertaken by trial and error and produce-and-test, which are the standard current design methods in use within the studio practice for procedural animation. These methods proved to be time-consuming and demanded a high level of resources. As discussed in Chapters 2, 3 and 5, there are no common studio practice guidelines for the use of procedural animation within character animation; as such, there was no choice but to follow this inefficient procedure in order to help contribute towards composing a basis for a common studio practice guide. One task in the course of this research was to establish whether professionals working in the field agreed with the thoughts expressed in this thesis regarding the lack of guidance material and inefficiency of the toolset; therefore the interviews investigated this topic also. However, to avoid diverting the interviewees by asking direct questions, the questions were designed in such a manner as to create a space for participants to express their personal views without the need for a direct question.

6.2.1 Preparations and Interviewee Selection

For the purposes of this research a direct connection was established with the industry. Leading game and animation companies were invited to engage with the research outcomes by reviewing them and providing input from a real-world professional perspective. For reasons of confidentiality, the names of companies and employees will not be given here.

The interview stage was the most challenging phase of this research. Selecting the interviewees took longer than anticipated; additionally, getting through to these working professionals and asking them to spare enough time to collaborate in this research was an arduous task in itself. It was made more complex by the difficulties involved in convincing industry representatives to participate in a private piece of academic research.

The aim was initially to conduct twelve interviews. However, it was ultimately only possible to conduct nine of these. Some of the employees targeted for primary research were too busy to spare much time, and were unable to take a short period of leave to attend an interview. Some participants agreed to attend an interview during the weekend; others chose to be interviewed without notifying their employers. The interviews had to be re-arranged and adjusted on numerous occasions in order to fit within the short periods of time available and unpredictable timetables.

The larger multinational companies that had been targeted for participation were less engaged and enthusiastic about this research than small-scale private companies with fewer staff members, a discrepancy that proved frustrating at times. In addition to this, requests to record the interviews were viewed as problematic and caused hesitation, leading many companies and employees to take few steps back or refuse the invitation to their appointments altogether, even though a confidentiality agreement had been promised. The most striking aspect of this was that some companies and employees reconsidered their position (some positively, others negatively) after being informed that this was an academic piece of research.

The interviewees were selected through a detailed process. The first criterion was that the interviewee had to currently be working or have previously worked in a games, animation or visual effects company. Secondly, all practitioners had to have substantial knowledge of, and an education in, animation or game-related studies. This wide range of backgrounds, skills and experience brought considerable insight to this research from a professional perspective.

The interviews were conducted under the theme of utilizing procedural animation to enhance the believability of a key-frame animated character, and designed to give insights on the current state of the practice in the field of procedural animation. Five semi-structured questions were directed at the interviewees for them to give their perspective on the notion of believability, whether they saw believability as a common challenge within the field, how professional studios approach the issue of generating believable character performances, and how they utilize the common toolset to solve these issues. They were asked to interpret and comment on the survey results, the approach employed in this research, and its findings. Finally they were asked how the outcomes of the research might inform their studio practice and how this could be used to help improve the quality of work within a professional framework and pipeline.

There were nine interviewees in total. The initial stages of the preparation for the interviews were email exchanges with the interviewees to book the most suitable time for them, so that the interview would not be rushed. For quality and clarity purposes soundproofed meeting rooms were booked for every individual interview. For six of the interviews the rooms were booked at Anglia Ruskin University, Cambridge School of Art. The names of the rooms are stated in the interview forms for each individual interviewee (see Appendix N). Three of the interviews were conducted in Nottingham with Hot Knife Digital Media Ltd. and the rooms were provided by them in their studios (see Appendix N).

Permission was sought from all interviewees to audio-visually record all the interviews and the question forms were sent to them prior to the interview meeting. These videos were recorded with a high definition camera and a semi-professional microphone. This material can only be used for the purpose of this research, and only the viva examiners and the supervision team involved in this research can view these videos. These will not be shared with any third parties or used for any other purposes (see Appendix P).

On the day of the interview, each interviewee was further informed about the research and the findings of the research before each interview began. The experiments and survey results were shown to all interviewees prior to the interview.

The nine interviewees and their backgrounds were as follows:

Interviewee One: Ahron Khachik

Ahron graduated from Anglia Ruskin University, Cambridge School of Art, Computer Games and Visual Effects. He has worked in several professional companies both local and international around the Cambridgeshire area. He is still working as a freelance artist for game companies and he is also a studio supervisor at Anglia Ruskin Cambridge School of Art, Computer Games Art. In the transcripts and tables Ahron Khachik was coded as [AH]. Ahron was chosen for an interview because of his diverse field experience in both games and animation.

Interviewee Two: Andrew Whitney

Andrew is the founder and chief executive officer of Hot Knife Digital Media Ltd. Since 1993, he and his company have worked on a considerable number of animation projects for companies such as Panasonic, Canon, Boots, BT, Marks & Spencer, E-on, Carillion, HMV, Waterstones, PriceWaterHouseCoopers, Cable and Wireless, Emirates and National Grid. In the transcripts and tables Andrew Whitney was coded as [AW]. Andrew was chosen because of his high level of experience within the field and within the practice and toolset of the field.

Interviewee Three: Imogen Taffs

Imogen is an animator who graduated with a Masters' degree from Nottingham Trent University, Animation and Multimedia. She has been working as a character animator for Hot Knife Digital Media Ltd. since 2012. She also delivers workshops and presentations to universities within the United Kingdom. In the transcripts and tables Imogen Taffs was coded as [IT]. Imogen was chosen because of her Master-level education within the field and also to include the views of freshly graduated practitioners.

Interviewee Four: Julian Hughes-Watts

Julian graduated from the Royal Academy Schools, London, in 1994. He has worked within the computer games industry for several years, starting at the Cambridge-based company Millennium Interactive in 1996, then moving to Sony Computer Entertainment Europe (London Studio), working as a lead artist on several PlayStation titles including Porsche Challenge and Rapid Racer. Julian continued to work as a freelance artist for Sony Computer Entertainment Europe and developed mobile phone and gaming projects for Novomatic and Sega Europe. Julian is also a course leader and senior lecturer at Anglia Ruskin University, Cambridge School of Art, Computer Games Art. In the transcripts and tables Julian Hughes-Watts was coded as [JH]. Julian was chosen because of his high level of experience in both working with internationally recognised professional companies and project,s and his high level experience in educating others in this field.

Interviewee Five: Luis Azuaje

Luis was one of the first graduates of Anglia Ruskin University, Cambridge School of Art, Computer Games and Visual Effects. He has worked in several professional companies as a freelance character artist. He is also a technical officer and studio supervisor at Anglia Ruskin University, Cambridge School of Art, Computer Games Art. Luis delivers professional software-based trainings and master classes on a regular basis for Anglia Ruskin University. In the transcripts and tables Luis Azuaje was coded as [LA]. Luis was chosen because of his high level of technical knowledge within the toolset and the practice and high level, diverse experience as a freelancer.

Interviewee Six: Matthew Stoneham

Matthew graduated from Teesside University in 2001 as a creative artist. He worked for Sony Computer Entertainment Europe Ltd. and Sony Guerrilla Games Ltd. as a Senior Technical Artist and has now moved to Ninja Theory Cambridge as a Principal Technical Artist. Matthew worked on several titles such as Devil May Cry, Enslaved and Fightback. Matthew also delivers master classes for professionals and universities on a regular basis. In the transcripts and tables Matthew Stoneham was coded as [MS]. Matthew was chosen because of his high level knowledge within the field and unmatched experience within three of the leading professional companies of the field.

Interviewee Seven: Oscar Paterson

Oscar graduated from Anglia Ruskin University, Cambridge School of Art, Computer Games and Visual Effects. He has worked for Frontier Developments Ltd. since 2012 as an artist and has worked on titles such as Roller Coster Tycoon and Zoo Tycoon. In the transcripts and tables Oscar Paterson was coded as [OP]. Oscar was selected because of his high level experience in the field and his experience in an internationally known professional company.

Interviewee Eight: Ricky Wood

Ricky graduated from Southampton Solent University in 2003 as a traditional animator. Since then he has been working for Ninja Theory Ltd. where he is currently the Principal Animator. He has worked on game titles such as Heavenly Sword, Enslaved, and Devil May Cry. In the transcripts and tables Ricky Wood was coded as [RW]. Ricky was chosen because of his high level of knowledge in the field of character animation and his experience in one of the leading professional game companies in the world.

Interviewee Nine: Simon Wallett

Simon is the co-founder and co-director of Hot Knife Digital Media Ltd. He graduated from the University of Wales, Newport as a 3D Designer. He has been working in the field of animation as a professional for over twenty years and he is also an hourly paid lecturer at Nottingham Trent University; he has been teaching at university level since 2009. In the transcripts and tables Simon Wallett was coded as [SW]. Simon was chosen because of his high level of experience within the field and experience in teaching the practice and toolset applications relevant to the field.

Theme	Codes	Total	AK	AW	IT	JH	LA	MS	OP	RW	SW
Using procedural animation	Realism is about small details	1	+								
	No common studio practice for procedural animation	4	+	+				+		+	
	Procedural animation and appeal	5	+		+	+			+		+
	Procedural animation and believability	1									+
Believable character animation	Exaggeration and believability	1			+						
	Secondary animation and believability										
	Achieving believability is a challenging issue	9	+	+	+	+	+	+	+	+	+
	Believability is an important factor	2					+				+
	Anthropomorphic qualities	3	+		+	+					
	Mo-Cap and key-frame	1						+			
	Believability as a style and context	7	+	+		+	+	+	+	+	
	Movement and believability	3						+	+		+
Informing the practice of the practitioner	Informing finding	5	+			+	+	+	+		
	Informing the practitioner	8	+	+	+	+	+	+	+		+
	Informing professional studio practice	5	+	+	+	+				+	
Efficiency	Adaptable practice	1	+								
	Saving time and resources	9	+	+	+	+	+	+	+	+	+

Table 6.11: Table of themes, codes and interviewees.

6.2.2 Interview Data Collection and Analysis

All nine audio-visually recorded interviews were transcribed (see Appendix O) and reviewed in two phases, as suggested by Merton & Kendall (1946). In the first phase, the transcripts were reviewed and coded individually; in the second phase, a group-wide comparative review was conducted to highlight the common codes and sections across all nine transcripts, and a thematic analysis was undertaken. In light of the first review four themes were created to house the codes (see Table 6.11). These themes were 'Utilizing Procedural Animation', 'Believable Character Animation', 'Informing the Practice of the Practitioner' and 'Efficiency'.

The analysis that follows is composed of two sections; the first section will examine the interviews individually under the themes derived from the thematic analysis of the transcripts, which was done with the aid of ATLAS ti. interview data analysis software. For clarity purposes, each interview will be examined separately under specific themes in the first section without the researcher's interpretation. The second section will consist of a global analysis of the interview results and will examine the entirety of the interview data. The interview transcripts can be found in Appendix P and the interview recordings can be found in Appendix O.

The first theme was 'Utilizing Procedural Animation'. This theme was analysed to study how professionals approach procedural animation, what they expect to achieve from this studio technique, how they define it and finally what importance it has within professional studio practice.

The first subject raised was exaggeration within animated movement performance. Imogen Taffs stated that this research highlighted the fact that exaggerated movement may help enhance the believability of an animated movement performance, which may again led to a more appealing result for the viewers:

> I also think your research has highlighted that an exaggeration […] aids believability rather than just having something that is representative of what's real, in the real world, but rather an exaggerated version of that is more appealing. (Imogen Taffs, Appendix O & P)

The discussions then turned to secondary elements and animation within a primary movement performance. Julian Hughes-Watts interpreted the survey outcomes and research findings stating that the secondary elements play a strong role in the achievement of believable results. He added that in this research procedural animation is proven a strong technique to provide secondary elements and to replicate the small details of everyday human life. Matthew Stoneham stated that the secondary elements play a crucial role in achieving convincing character animation, along with the style of the movement and the fidelity of it. He also believed that procedural animation is a useful toolset for the provision of secondary elements because of its ability to preserve momentum. Simon Wallett suggested that no object or character is utterly still, and that to achieve a believable performance there always must be a base body movement; simple things like breathing, looking around or small shoulder and spinal movements. He also added that these secondary movements were very hard to achieve and that procedural animation is a good studio technique to incorporate this extra element to the movement performance.

Simon also suggested that there was a noticeable improvement in the procedurally enhanced versions of the videos and he stated that the enhancements increased the quality of the overall animated movement performance.

Ahron Khachick felt that the procedural enhancements that had been applied improved the quality of the animated movement performance. He also suggested that the progressive application of the procedural enhancements removed the flatness of the animated piece, making it more appealing to watch. Imogen Taffs also stated that the exaggerated version of the procedural enhancements was better received, and she added that audiences today would want to see more than just replicas of daily life, preferring a more emphasized version of reality.

For Ahron Khachick, ‘some of the touches with the progressively more dynamic touches definitely […] did the animation some good, it made it more enjoyable to watch.’ (Appendices 14 & 15) Julian Hughes-Watts also stated that small elements and details such as secondary motion and the procedural animation that delivers this secondary motion added more depth to the primary movement performance, ultimately making it more enjoyable. He also emphasized the role procedural animation played in this achievement according to the experimental study outcomes of this research. Oscar Paterson stated that when he viewed the exaggerated versions of the experimental videos, he defined and received them as a form of hyperrealist animated movement performance, adding that this may be the key element explaining why they seemed to appeal to the audience. Simon Wallett suggested that the appeal may come from the increased quality and depth of the movement performance when layered with procedural elements. Simon also added that the extra level of the detail also made the animated performance more believable, since these enhancements injected more life into the overall result. Julian Hughes-Watts stated:

> I think the outcomes show that more exaggeration enhances believability and… We've talked about the prime impulse of the character, what they convey and I think procedural animation can add to that, because you have a secondary element that can couch key-frame animation and provide elements that we […] constantly see in everyday life, […] if you move, and there [are] secondary motions associated with that, often very subtle. (Appendices O & P).

As powerful and useful as it is, four of the interviewees complained about the lack of a guide for common studio practice for procedural animation, saying that developing believable animation performances using procedural animation is very challenging. Ahron Khachick stated that achieving realism or believability are both very delicate processes and even the smallest flaw or an element that stands out may result in destroying the illusion.

Andrew Whitney stated that the industry is still too young and that there is not enough research into the use of rapidly evolving studio techniques such as procedural animation. He believes this area would benefit from further research, development and guidance since procedural animation and its toolset are providing very fruitful results:

> Having solid figures to back up how possibly animation, especially in the computer world, should be working, is a great start. I mean the industry is still very young, you're talking about an industry that started in the 1970s, and it's only started to really hit the main screens in the last fifteen, twenty years. So it's such a young industry, and to start bringing research into it so early is… That's a great idea. If you can sit down and start showing people how secondary motion procedural animation can benefit the production at a very early stage, they can bring that into the pipeline as soon as possible. (Andrew Whitney, Appendices O & P).

Matthew Stoneham also stated that the toolset and practice for animation haven't evolved much and that studios still use what was available twenty years ago. He also highlighted that there were many attempts to increase the quality and rate of output of studio practices by combining several other practices including procedural animation but he stated that this only makes the process more complex and inefficient, which ultimately causes the companies to waste resources. Simon Wallett also stated that achieving believability and using procedural animation are hard tasks and that the artists have to second-guess everything, which leads the projects to a dead end after a certain point. He highlighted the difference between key-frame animation and procedural animation, and stated that there is a common studio practice guide for key-frame animating which practitioners can follow, which is not the case for procedural animation. Simon also complained about the lack of common studio practice guidelines for procedural animation. Matthew Stoneham held similar views:

> From an animation point of view, at its most fundamental level, we're still using the same animation systems now as when I started in the industry twelve years ago. I mean we're blending more animations together, in a more complicated way, and with more complicated rule sets, but broadly speaking, at its most basic level, we're still just blending a database of hand-keyed animations together, and that only gets you so far, really And the more complex it gets, the more difficult it is to manage. (Appendices O & P).

The importance of using procedural animation, the lack of guidelines for common practice and the survey results led the conversations to the second theme: 'Believable Character Animation'. This theme was selected to see how professionals perceive the notion of believability: is it a common issue within the modern games and animation studios, and in what ways do they tackle this issue? What could contribute to solving the issue, and how could solutions be implemented?

Without exception, all interviewees began by expressing how important believability is within a character animation project. Luis Azuaje stated that believability plays a major role to generate empathy among the audience and allow the animated character to create a bond with the viewer and engage the players or viewers. He also felt that the enhancement of believability gave more appeal to the animated piece and made more convincing characters, stating: 'believability is very important to engage the audience.' (Appendices O & P).

For Simon Wallett, the achievement of believability is an essential factor for an animator, and only achieving believability can take the animated piece beyond a standard level. He also added that a standard animation cannot progress very far without the detailed elements provided by secondary animation, and that it requires time and a long iterative refinement process to get beyond this level.

All nine professionals emphasized that achieving a believable character is a complex and challenging issue. Ahron Khachick stated that it is a very delicate process in the context of which the smallest flaw can easily cause the project to fail: 'It's a very delicate thing, where you can get something that looks believable but any one little thing can let the whole thing down.' (Appendices O & P)

Andrew Whitney suggested that the achievement of believability is still an issue in modern studio practice and that projects may suffer unwanted outcomes very quickly. He referred to the Uncanny Valley phenomenon and stated that it definitely disrupts believability, especially in projects where the character forms are hyper-realistic:

> It's a challenge, and it's also a stumbling block. If you look at things like the Uncanny Valley, we're striving at the minute to get believable-looking faces and characters, and the closer they get to looking real, the odder we seem to feel that character is. And as soon as you move into that Uncanny Valley area, you lose the believability. (Andrew Whitney, Appendices O & P)

Imogen Taffs expressed similar opinions to those of Andrew Whitney, and added that the appeal of a project is very important; however, she believed that the views of the professionals and those of the audience who will be watching or playing the product may not always concur. She also suggested that the performance of a character and the balance between the elements that compose the performance need to be very carefully adjusted in detail, in order to make the character enjoyable and ultimately believable.

Julian Hughes-Watts pinpointed a different issue by stating that if within the performance of an animated character the actions of the character were not consistent with what the character should be portraying, then this might cause the believability to fail. He suggested that this was a problem and referred to movement performance and the implied personality of the animated character. He also stated that this is indeed a hard balance to achieve. Luis Azuaje felt that creating a believable character is a challenging issue and he referred to the constantly developing technology of the studios, citing motion capture as an example. He added that these techniques are not enough on their own; he suggested that a human touch is always needed to make the animation believable and he emphasized again how delicate a process that it is.

Matthew Stoneham approached the issue from a game developer's point of view and explained that finding a way around the Uncanny Valley is always a big issue. He gave examples from Ninja Theory's current game project Devil May Cry (2013) and stated that they use two different types of primary animation techniques. The first is the key-frame for in-game animations, since these movement performances are fantastical animations, and the second one is motion-capture for the cut-scene cinematics. He then highlighted the issue of these two types not blending in progressively, which disrupts the believability of the game: "You don't want to be very obvious that you're going for motion capture motion, for example, into something that is hand keyed […], they don't really work together." (Appendix O & P). This means they have to constantly work on different solutions to tackle the issue.

Oscar Paterson stated that producing believable characters was a big challenge for Frontier Developments and he spoke of motion-capture and procedural animation as useful techniques, which help to give life to the character; he referred to this stage as the 'cleaning up' stage. He also stated that Frontier Developments use a variety of tools to counteract the lack of life in a character and to make it more believable; overall, however, he considered the process to be one of trial and error. Ricky Wood also stated that achieving believable characters was a challenge. He referred to Ninja Theory Company projects and he said that the company usually works on less exaggerated, realistic characters in their projects; as such, achieving believability in their work was a major challenge for them. Oscar Paterson emphatically held the same view: "it's definitely a big challenge. … I can't start for words!" (Appendices O & P). For Simon Wallett, the process of developing believable characters is challenging as it consumes time and resources, neither of which the modern games and animation industry has the luxury to waste.

One of the topics raised during the interviews was the anthropomorphic qualities of characters. Ahron Khachick suggested that the personality and behaviour of a character are important factors to generate of a form of human connection within the character. Imogen Taffs stated that the smallest details within the human body and its movement are what create a believable performance. She highlighted involuntary movements and small expressions as an example and suggested that these small touches within an animated movement performance are what breathes life into a character:

> You'd almost expect [believability] to be [the] mimicking of human actions or little twitches and the little things that […] make a performance believable in the sense that it's more humanoid, for example, small hand gestures [...]. (Appendices O & P.)

Julian Hughes-Watts also stated that the prime impulse of an animated character is noticeably affected by its secondary elements, and that these secondary actions can add to the overall performance by bringing the small human elements into the performance, making it more convincing and life-like.

One of the most common discussions relating to this theme was the importance of context and style within the notion of believability and realism in character animation. Ahron Khachick chose to take a separate approach to realism and believability and stated that the notion of believability is a very context-dependent understanding. He suggested that the level of believability and realism required depends on the style of the project.

Andrew Whitney stated that what defines believability is suspending the disbelief of the audience, making the viewers forget that they are watching an animation and helping them to concentrate solely on the content of it. Julian Hughes-Watts also placed realism and believability in distinct categories. He suggested that animating is about assessing movement in life and integrating that to the animation, and he also suggested that there are two approaches to style: an animator can choose to replicate real life and aim for a realistic animation, or over-emphasize representations of real life and aim for a more abstract result. However he suggested that in both cases, believability is required, and that what matters is context.

“[Believability is] making the viewer forget that it’s an animation, and concentrate on the content of what you’re trying to portray within the animation.”

Andrew Whitney (Appendices O & P)

Luis Azuaje argued that although realism and believability are two different realms, believability may add extra appeal to the animation. He stated that decisions in this area depend on the style of project the animator is working on and the aesthetic appearance animators are aiming for in the characters. In some cases a character may appear more appealing aesthetically, but not be believable.

Matthew Stoneham also stated that believability rests on style and context. How a character and its secondary elements behave and move and how secondary elements look also affects believability. Matthew further suggested that in some cases the believability of the animation and character strongly depends on the audience and how they expect a character to be. However, he also added that regardless of the overall style, the audience always have basic expectations regarding movement performance in an animation. This can apply to the aesthetic features or to primary and secondary movement performances associated with the character, such as the behaviour of cloth. Oscar Paterson also stated that the notion of believability is very style-dependent. He described it as the sense of how movement performance appeals to the viewer. He also referred to the rules of motion, citing Disney's principles of animation.

> "You know, for us, it's to do with preserving the suspension of disbelief, really, isn't it; and it doesn't matter, really, whether the character's a hyper real character, or whether it's a cartoony character."
>
> Matthew Stoneham (Appendices O & P).

Ricky Wood suggested that the notion of believability from the animator's point of view alters according to the overall aims of a project, and made distinction between projects aiming for realism, and projects aiming for non-realistic, cartoon-style animation. He explained that in the first case, overall believability depends on the animator successfully imitating real life; on the other hand, if the aim is to produce a cartoon-style animation, then believability will instead increase with higher levels of abstract stylisation.

> "Believability comes from what sort of style you want for your world, so it can mean slightly different things depending on your project."
>
> Ricky Wood (Appendices O & P).

The discussions progressively turned to movement and secondary elements within movement performance, and their effects on the overall believability of the animated piece. Imogen Taffs suggested that controlled exaggeration of an animated character's features may improve its overall believability. She also felt that this gives more life to the character, presenting a character that offers more than just replica of its real life equivalent.

Matthew Stoneham stated that the believability is strongly related to the preservation of the character's momentum, the feeling of weight and mass of the character and the force behind his movements. He also highlighted the importance of secondary motion and the level of secondary animation. Matthew Stoneham also argued that there is a certain expectation with regards to secondary animation and that the viewer will always expect such details to be layered onto the character.

Simon Wallett suggested that although primary animation can provide strong movement performances, the overall performance will gain deeper detail once the secondary elements are incorporated. He believes that these secondary movements noticeably improve the quality of the animated movement performance, thereby enhancing its believability:

> [In] a standard animation, you would […] animate a character keyframe-wise; you could do a very good job, you could spend a large amount of time doing that; there's a noticeable difference in quality when you start adding things like secondary animation. Simon Wallett (Appendices O & P).

All the professionals interviewed confirmed that believability is a tangible concept and that developing believable characters is a challenging issue regardless of what style of project the animator is working on. All nine professionals agreed that secondary animation significantly increases the believability of an animated movement performance. All interviewees also suggested that procedural animation is an effective technique with which to provide this secondary animation; however its practice at the moment is complex and time- and resource consuming.

The third and the fourth themes will be analysed together, since they are connected and related to each other. The third theme was 'Informing the Practice of the Practitioner' and the fourth theme was 'Efficiency'. The final stage of the experiments and their results were evaluated with a survey-based questionnaire and these results were shown to the nine professionals after they were analysed. These two themes were formulated to test the consensus between this research's interpretation of the findings and the practitioners' thoughts on the contributions of this research to the practice of procedural animation.

All interviewees stated that they had found the research results interesting, not least because of the lack of research regarding a guide for the application of procedural animation. Furthermore, professionals have been working on using procedural animation to improve the believability of animated characters but through a process of trial and error and produce-and-test that was repeated for every project. This research provided them with findings that reveal the effects of procedural animation when applied to keyed character movement performances.

Ricky Wood stated that there is not enough research regarding practices relating to procedural animation and that this research will help the practitioner to have an understanding of how the procedural enhancements will be perceived by the audience.

> “I find we don’t do it enough, at Ninja, because you can get too much in your little bubble and do what you think’s right, but it might not be what the public wants.”
>
> Ricky Wood (Appendices O & P)

Simon Wallett stated that the findings of this research highlighted the extent to which procedural enhancements can contribute to a primary key-frame animation, and in what ways it can be used to add more depth to the animated project. Julian Hughes-Watts stated that the findings of this research provided a range of predefined choices for the practitioners, helping them to make judgements at specific points during a project and thus adding more value to their work: “for the practitioner to see a range and make a judgement on how to pitch [animation] would benefit and […] add value” (Julian Hughes-Watts, Appendices O & P)

For Matthew Stoneham, the outcome of this research could provide useful support in the management of resources during a project. He believes this may help companies to save money and determine when they need to invest in software, hardware and animators:

> [Y]ou can use [this research] to inform where you spend your resources, what technology you invest in, whether or not certain potential bits of middleware are interesting and worth the money” (Matthew Stoneham, Appendices O & P)

Luis Azuaje stated that the research was providing information that helps understand a deeper aspect of procedural animators’ practice and how procedural animation can contribute to a project when utilized:

> You are educating the people and saying ‘look, this is really good, can you leave it with this fault, it looks really good but it’s not a hundred percent’. So…yes, I think it’s very interesting (Luis Azuaje, Appendices O & P)

Andrew Whitney felt that this research was a useful approach to the practice of procedural animation, helping to improve studio practice by providing the practitioner with a starting point and eliminating the part of the pre-planning stage that dealt with ways of integrating procedural enhancements to the animation:

> If you’ve got those kind of figures backing up the research you’ve got, that is something you can fundamentally walk into [sic] and go ‘Look, this is the research,

> this is probably where you should be starting your animation’. […] People should certainly start thinking about bringing it into their pipeline (Andrew Whitney (Appendices O & P).

For Ahron Khachick, the research findings and the process behind the experimental study are applicable for further projects that include character animation and procedural animation; in this way, the research helps improve the work of the practitioner:

> [I]t’s got a lot of applications, so I guess it helps the practitioner by giving them always something to think about for next time and improve on their work, rather than just find out [sic] one particular thing that has no application (Ahron Khachick, Appendices O & P).

Oscar Paterson stated that this research helps save time by providing a quick way through the pre-production stage of the use of procedural animation in character animation and eliminates any unwanted surprises that may occur during the later stages of the project: “it saves a lot of time […] messing around on the other side, where something might be too subtle, or too… In the end, boring” (Appendices O & P).

Julian Hughes-Watts also stated that the research could help support professional studio practice by providing animators with a range of experimental demonstrations and their results showing how procedural animation can be perceived and how it may affect the overall keyed performance of an animated character. He believes that this helps inform the practice of the professional regarding the use of procedural animation:

I think it can help the studio to kind of… If you have a base animation, you have a range… There’s no procedural animation here, and this is at its most extreme, […] to the point where it really does break down. I think it’s interesting to be able to pitch it along that [range] and get a sense of what can add to this prime animation. (Julian Hughes-Watts, Appendix O & P)

During the interview Matthew Stoneham stated that he believes the practice of the individual animator and professional studio practice are inseparable, and that informing one will eventually inform the other. Andrew Whitney stated that the research helps streamline the studio practice of a professional companies and inform them of what procedural animation can bring as a secondary animation and how much depth it can provide to a keyed movement performance:

> That’s a great idea. If you can sit down and start showing people how secondary motion procedural animation can benefit the production at a very early stage, they can bring that into the pipeline as soon as possible. (Andrew Whitney, Appendices O & P)

Ahron Khachick stated that this research has a high applicability and can provide helpful support to animators using procedural animation during professional studio projects, stating:

> Especially with something like the topic of dynamics, where you can apply [procedural animation] for almost anything, so you can do this one study, and you can take your research findings, and then from now on, you can then apply it to all future projects. Ahron Khachick, Appendices O & P)

Oscar Paterson stated that this research informs the practice of the practitioner and could help develop a more effective and efficient practice by playing the role of guidance material: “It definitely could inform […] a better or more efficient practice” (Appendices O & P).

For Ahron Khachick, this research could help eliminate the trial and error stage from current practice and help the practitioner to make quicker and more effective decisions and judgements when using procedural animation. He also felt that the scientific approach helped inform the practitioner. Andrew Whitney felt that this research may help bring efficiency to a studio project by cutting down the pre-production process and helping professionals to make judgements and decisions quicker:

> I think it’s about getting to where you need to be with animation a lot quicker, and cutting down the pipeline, and possibly the man hours involved in producing animation. I mean animation has always been a labour intensive industry; the more you can cut down on the man hours and actually concentrate on the art more… I think that’s definitely going to be a great contribution to the industry. (Andrew Whitney, Appendices O & P).

Imogen Taffs stated that this research provides multiple solutions and approaches which can be used within professional studio practice involving procedural animation and could help achieve multiple solutions to a problem: “I think it could help in the sense that it could always provide another way of doing things, so you could get different outcomes as to what you would in other forms of animation [sic].” (Appendices O & P)

With a different approach to evaluating the research, Luis Azuaje stated that this research provides an insight into where the resources of a project should be used, questions how the audience perceives procedural enhancements:

> Are they really going to be wowed by this?’, or ‘the money we’re going to spend on this, is it really necessary?’. So I think by studying the audience, and thinking…or seeing the tendencies of where the industry is going, it does improve the animation [sic]. (Appendices O & P).

Ricky Wood stated that the research may help improve the efficiency and fruitfulness of a pipeline when there is no specific vision directing the project. He believes that the research may provide an informing set of guidelines which can be used to achieve quick and appealing results: “if you don’t have an exacting vision of what you want, I can see it being useful” (Appendices O & P).

Simon Wallett suggested that the outcomes of this research could ultimately lead to cutting time-frames and budgets and bringing efficiency to the practice of using procedural animation in professional studios, helping to produce faster results. All interviewees stated that the outcomes of this research had the potential to help bring efficiency to professional studio projects that involve character animation by informing the practice of the practitioner with regards to procedural animation and standing as a guidance material.

6.2.3 Results and Discussions

Section 6.2.2 put forward four themes and thematically analysed of all four categories. This section this section highlights the connections among the four themes and the results of the thematic analysis; it then discusses and interprets the results (see Diagram 6.1).

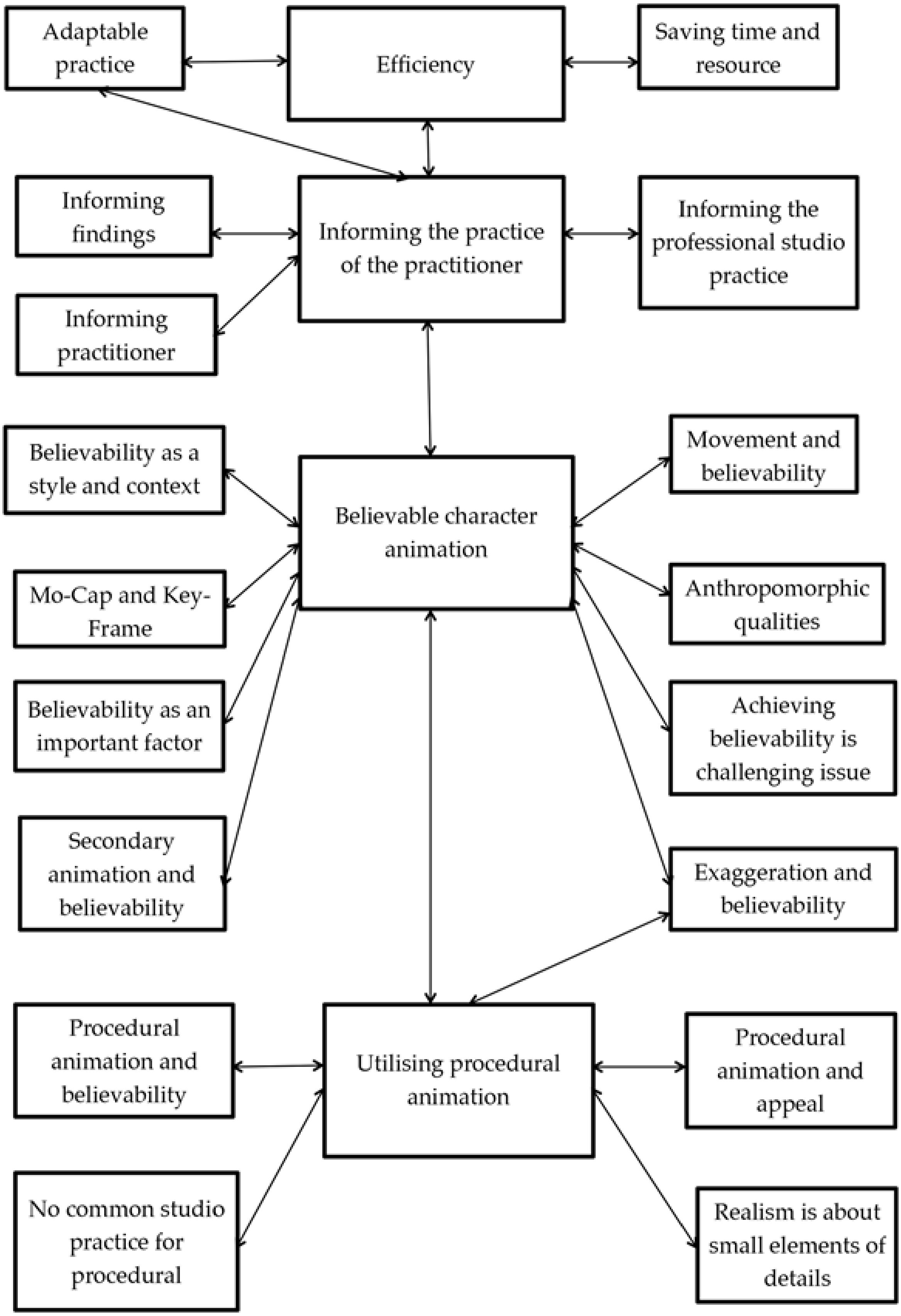


Diagram 6.1: Interview Thematic Analysis Network

The first theme was ‘Utilizing Procedural Animation‘. This theme englobed references to studio practice relating to procedural animation within modern games and animation studios. The interview results show that although procedural animation is inefficient, it is and can be an effective and powerful practice in achieving convincing character animation. However it is also a sophisticated toolset to utilize since it is young and has no studio practice guide for it use.

The second category was labelled ‘Believable Character Animation’. This revealed how modern game and animation studios currently measure various aspects of their character animation work and how they choose to use procedural animation. The interview results showed that the degree of believability and realism are two of the most distinct measurement criteria in the assessment of style outcomes of current studio projects, and that studio professionals believe a project involves a carefully estimated and calculated combination of both of these notions depending on the contextual requirements of the animated narrative. It was also suggested that procedural animation is generally used for secondary animation.

The third and fourth categories were ‘Informing the Practice of the Practitioner’ and ’Efficiency’. These categories were designed to highlight the interviewees’ assessment of the research and its findings. All nine participants stated that the research and its results were interesting and they commented that the ideas contributed by the research may help improve the efficiency of professional studio practices in the practice of procedural animation. They perceived that informing the practitioner about the use and outcomes of procedural animation might help the professional studios to more efficiently manage their resources during the planning phase of their projects and providing practitioners with a starting point and guidance while cutting down the time spent on the trial and error phase.

The concept suggested by Leslie Bishko’s research on Laban’s Movement Theory and the 12 Principles of Animation proved very useful in the experimental stages of this research (Bishko, 2007). Laban’s Movement Theory was used to categorize movement performance types to test the audience’s perception of different levels of procedural enhancements. This allowed a better, clearer analysis of the audience’s perception and improved the adaptability of the research findings.

Michael Paul Neff’s research on producing convincing procedural stand-up actions for animation characters focused on one single animated performance (Neff, 2005). In contrast, this research allows practitioners to review the effects of procedural enhancements and their results with three different procedural levels applied to multiple styles of movement performances.

The thematic analysis of the interviews shows that procedural animation is an important factor in developing believable character movement performances and there is no guide for common studio practice for utilizing procedural animation. As such, every professional studio project requires a trial and error or produce and test stage which professionals feel is inefficient. They felt this research could serve as a guide for the pre-planning stages of studio projects where the application of procedural animation is required. This would increase the efficiency of professional studio practice. Some participants also stated that this research could be especially effective for professional studio projects that have no strict guidance.

6.3 Summary and Conclusion

For the purposes of this research, a series of experimental studies were designed to demonstrate the outcome of the use of procedural animation within character animation. Three different levels of procedural enhancements were determined and movement performance types were categorized in line with Laban’s movement theory. Believability was used as a benchmark for the measurement of the outcomes, to test the impact of procedural animation on character movement performances. The experimental study results were assessed using a survey questionnaire and the analysis results were discussed with professionals working in the fields of gaming and animation. All participants stated that this research could generate a set of guidelines to be applied during the pre-planning stages of the application of procedural enhancements to a humanoid character, heightening efficiency, improving the management of studio resources and reducing the time invested in the trial and error phase of projects involving procedural animation.

The next chapter will present the main findings and recommendations of the research.

Chapter 7: Main Findings and Recommendations

7.0 Introduction

Chapter 7 is the conclusion of the thesis. It begins with the main findings of the research that addresses the research questions, which includes utilizing procedural animation as practiced and suggests an approach to streamlining its practice. The recommendations for the practice of procedural animation and professionals studios associated with a possible set of guidelines for its common studio practice are outlined, before suggestions for further research are made.

This study set out to investigate the use of procedural animation within key-frame movement performances and suggests an approach and guidelines for streamlining the pre-planning stage and managing the implementation process of procedural enhancements.

It is also of interest to determine whether this research can form the basis of a set of guidelines for the common studio practice of procedural animation, and also whether it can help streamline the common studio practice for procedural animation by guiding the implementation process. The aim would be to develop a more efficient practice compared to the current trial-and-error and produce-and-test methods while maintaining and/or improving the believability of the key-frame animated movement performance.

The general theoretical literature on the application of procedural animation is inconclusive with regards to several vital concepts relating to the practice for developing believable character animation. These concepts are the time management and resource management of studios.

This study set out to answer the following two questions:

- What is the current understanding of the application of procedural animation for character believability?

- How can procedural animation affect the overall outcome of a key-framed movement performance within the context of character animation?

Based on professional responses and the experimental study results, the underlying assumption is that the answer to these questions will assist in making recommendations for a useful approach to utilizing procedural animation and therefore improve its common studio practice.

Empirical studies were carried out to study the application of procedural animation while the data analysis examined both the overall reception of these enhancements and the nature of the effects of specific procedural enhancements on a key-framed movement performance. In addressing the research objectives stated in Chapter One, this research has attempted the following:

- To examine what areas of procedural animation may enhance the believability of a key-framed movement performance.
- To identify the areas of procedural animation that are used within professional studio practice.
- To examine the potential of procedural animation to develop convincing and life-like character movements.
- To identify where and how a key-framed character movement can be enhanced procedurally.
- To carry out empirical studies in order to analyse the effects and possible benefits of procedural enhancements on a key-framed movement.

7.1 Summary of the Main Research Findings

The main empirical studies were described and their findings summarized in Chapters Five and Six. This section will synthesise the empirical findings to answer the two main questions underlying this thesis.

7.1.1 Believable Character Animation

This research made an attempt to enhance the efficiency of the planning and implementation stages of current studio practices without disrupting the believability of animated movement performance relating to procedural animation. The notion of believability was chosen to help measure the outcomes of the empirical studies. Believability, within the context of character animation, refers to a character which successfully engenders empathy among the audience and suspends their disbelief. The initial stages required a thorough literature analysis to break down the factors that may help improve the believability of an animated character.

The literature review showed that the notion of believability hinges on two major factors: the perceived emotional reactions of a character and the movement performance within the narrative. The analysis of movement performance showed that the narrative is communicated by a sequence of successive character movements (Wells, 1998). This research focused on the movement of the animated character, exploring the notion of enhancing the believability of the movement by procedurally enhancing the character and its performance.

With a view to streamlining the studio practice relating to character animation, this research included a study of Laban's effort theory and used Laban Movement Analysis as a tool to analyse and describe units of movement from which a performance is comprised. This analysis can be used as an adaptable process to compare empirical results.

Jean Newlove's extension of Laban's studies examines human body movement and expressive movement performance. Newlove focuses on the aspects of how a natural movement performance can be created and lays an emphasis on the harmony of the transitions and moves within the performance (Newlove & Dalby, 2003; Newlove & Laban, 1993). Newlove's study highlights the role movement plays within an appealing performance. This research focuses on movement and investigates the implementation of procedural animation in order to help form the basis of common studio guidelines, which informs the practitioners about the use and the effects of procedural enhancements. The aim in the experimental studies was to utilize procedural animation to augment key-framed movement performances and make an attempt to monitor their change from the viewer's perspective. The underlying assumption was that if the results were analysed in detail this could eliminate a big portion of the practitioners' work, if not all.

The initial stages of the empirical studies described in Section 5.2 were designed to produce standalone character movement performances using an animator-driven procedural coded animation rig, in order to test the hypothesis that procedural animation may be capable of producing harmonic, convincing and appealing movement performances. The results were encouraging. The generated character rig was animated with a single controller, which followed the animator's actions; the driven coded rig in turn produced complex movement performances that were persuasively believable. This empirical study showed that procedural animation could be an asset for producing or enhancing believable characters.

The outcome of the initial empirical study led to the generation of a new hypothesis. It was considered that procedural animation could perhaps enhance the believability of a pre-existing key-framed movement performance.

7.1.2 Towards Utilizing Procedural Animation

The final phase of the empirical studies was undertaken in three stages and began by determining how best to approach the use of procedural animation within keyed movement performances, which was stage one. Stage one was the design stage of the experiments. This stage was carefully planned to produce a synthesis of procedural enhancements that could serve as a reference to help guide practitioners during the planning stages of procedural enhancement applications in their studio work. The initial intention of this stage was to act as an observational study to determine how professional studios approach the use of procedural enhancements within the context of character animation. The second stage tested the observed data and highlighted a pathway for the last empirical stage of the research.

In the second stage, the analysis of the observation-based studies showed that professional studios use procedural animation to simulate detailed movement performances such as muscle, hair and cloth movements. This research synthesized the application of procedural animation by creating a series of movement performances and procedurally enhancing them, revealing its effects by using a systematic approach. The experimental studies aimed to explore the nature of the improvement by utilizing procedural animation as a secondary motion within keyed movement performances.

The aim of the empirical studies was to explore the effects of the different implementation types of procedural animation, to inform the animation practitioner with a detailed analysis of these effects and application types. This was done by demonstrating the outcomes of procedural enhancements when they are utilized as secondary animations in a key-framed movement performance.

The third stage of the empirical study began with the development of key-framed movement performances. Given the very high number and variety of movement performance types developed within professional studio practice, these movement performances had to be categorized to generate an adaptable research finding that could serve as a reference; it was not feasible, within the scope of this research, to observe them individually. Laban's Movement Analysis and his Effort Theory were used to classify groups of movement performance, which allowed for the demonstration of specific movement types and the changes they undergo when movements are layered with procedural enhancements.

In order to analyse and understand the effects of procedural enhancements, three main groups of procedural enhancements were established. These groups of animations with three different procedural levels were determined based on real-life references of cloth and muscle movements, bearing technical limitations in mind during the adjustment of the procedural values, and by observing the methods and tools being used in professional studios. It was decided that the three levels of enhancements would represent life-like procedural enhancements, exaggerated procedural enhancements and a final version showing the raw key-frame movement performance without any procedural enhancements.

Every video included either a single basic action or a set of combinations of Laban's basic action types. A total of four movement performances were developed in line with Laban's study and every video was designed with three different procedural levels. The assumption was that the conclusion of the comparative analysis of these videos would make it possible to form the basis of a systematic approach to planning how to implement procedural elements within a keyed movement performance. It would do this by revealing the effects of procedural enhancements on a key-framed movement performance. This, in turn, could be used to inform professional studio practice, helping practitioners to plan the implementation of a toolset, reducing the time spent on trial and error and working toward a consensus on best practice.

7.1.3 An Approach to Aiding the Professional Application of Procedural Animation

A survey-based questionnaire was designed to allow participants to undertake a comparative analysis of the animations produced for the empirical study. The questions were designed in line with the theory and practice currently used in the field of animation. Participants were asked to provide their opinions using the terms and notions of the field, which were provided and explained in a glossary.

Each participant saw all twelve videos, which were viewed in groups of three. For each group of videos, viewers were required to answer two series of questions. First, they were asked whether they would refer to the movement performance of the character in each video as believable, realistic or appealing. Participants were asked to assign each of these three traits to one video per group only. Once viewers had made their choice, the second series of questions sought to determine which factors the participants believed made the movement performance more believable, realistic or appealing in the respective videos. The participants were not given any information regarding the technical enhancements or contents of the videos.

Where the first group of videos (Group One) was concerned, 79.8% of the respondents felt that the most believable version was the one featuring exaggerated levels of procedural enhancement (see Chapter 6). Figures for the second, third and fourth groups of videos were 79.5%, 77.5% and 77.4% respectively.

The research, its approach to utilizing procedural animation and its main findings were discussed and evaluated with professionals from Sony Computer Entertainments, Ninja Theory, Frontier Development, Hot Knife Digital Media. They suggested that the synthesis undertaken in this research had the potential to help eliminate the inefficient methods currently adopted by practitioners and bring efficiency to the practice of procedural animation.

7.2 Suggestions for Further Research

It is clear that the issues at stake are extensive, multifaceted and highly complex even for local companies working on smaller-scale projects. To generate achievable implementation strategies and develop a common practice with regards to procedural animation, there is a need for further empirical studies at the level of international high-budget companies to allow future assessment of the industrial dimensions of the subject. Exploring the following in future research may facilitate the attainment of this goal:

- The scope of the empirical studies within this research can be further widened, using Laban’s Movement Analysis to design experiments featuring a range of individual basic actions. Including all possible combinations of Laban’s Basic Actions would enable a more detailed analysis of the effects of procedural enhancements.
- This research applied three very distinct dynamic levels to enable a comparative analysis of the effects of procedural enhancements. This process could be made

more relevant to professional studios by adjusting style-based procedural levels in line with their requirements.

- Humanoid characters were used as a basis for the empirical studies included in this research. A further study could be designed to test an extended choice of procedural levels and number of combinations of Laban's basic actions suggested in the previous paragraphs on various different character forms. Widening the selection of character forms would take the adaptability of the research further.

- Finally, this research focused on analysing the effects of procedural animation on the believability of an animated character's movement performance, using the notion of believability as a measurement. This clarified the scope of the study but left other factors, such as narrative storytelling, emotional reactions and acting out of the picture. The effects of storytelling and of the emotional reactions expressed by the character on its believability, and the impact of procedural enhancements on these factors, remain to be studied.

7.3 Implications and Contribution to Existing Knowledge

The main aim of this research was to develop an understanding, and from that understanding cultivate a theory of practice that would help guide future practitioners, undergraduate and postgraduate students towards a more streamlined method for persuading an audience of a character's believability by utilizing procedural animation. The findings revealed that the method of implementation for procedural animation is currently limited, since animation practitioners were found to be using the generate-and-test and the trial-and-error approaches in most of their professional projects. The limited time and resources available to animation practitioners mean that a direct and less elaborate approach is needed. In the current context, the approaches adopted are fragmented, and certain crucial stages in the implementation process of the procedural enhancements are omitted.

The findings also have implications for the teaching of animation at degree level. Undergraduate training and postgraduate education in the field of animation use the same study and practice methods as those applied in professional workflows and pipelines (Aoki and Koning, 2011; Aoki, Koning et al. 2011). However, higher education delivers these skills on a basic level, with the main concern being to teach the fundamental principles and technical skills required. The theoretical and practical knowledge provided by higher education degrees in the field of animation delivers the understanding and tools required to start a professional career. This skillset develops as students gain experience and undertake practical experimentation and research within the professional pipeline. Therefore, expecting undergraduate students to experiment extensively with a complex toolset on the basis of these teachings is not a realistic expectation, since even the three year BA-level degree is barely enough to deliver the necessary knowledge required for an entry-level animator. This means students cannot currently bring new knowledge relative to the implementation of procedural animation to the trade; instead, they will adopt the practices being applied in the industry. Without fresh input, implementation methods for procedural animation therefore run the risk of evolving very slowly, if at all, given the realities of a fast-paced professional context that leaves little room for wider research into alternative practices.

The original contribution of this thesis is that it proposes a systematic approach to the implementation of procedural animation that is based on a combination of theory and empirical research. Such an approach aims to inform the practice of both animation students and animation professionals. This, in turn, will enhance the overall efficiency of contemporary studio practice, and the research processes that are implemented at postgraduate level. Furthermore, this research is the first to propose using Laban Movement Analysis as the core method for a systematic application of procedural animation for believable movement performances. This moves towards developing a set of guidelines for future animation students and practitioners, and devising a more direct and succinct approach to enhancing a character’s believability. In doing so, this thesis seeks to lay the foundations of a future common best practice for studios wishing to exploit the potential of the powerful tools of procedural animation, applying them to the difficult task of creating believable animation.

7.4 Conclusion

This research has made an attempt to inform studio practice relating to procedural animation, and thus enhance its efficiency, by exploring the notion of believability and using Laban’s theory as its toolset. Specific emphasis has been laid on the planning and implementation stages of contemporary studio practice, in the context of character animation projects that may be enriched by procedural animation. The primary concern of this thesis was the approach used by animation practitioners in developing secondary movement performances for key-frame character animations. Empirical studies were conducted by using common studio toolsets and undertaking subsequent interviews with animation practitioners.

It became apparent that the lack of a systematic, streamlined approach to procedural animation was one of the major problems affecting the utilization and efficiency of the toolset. The current problems related to the efficiency of procedural animation within professional studio practice are due to the gaps in the pre-production process. The practitioner has no choice but to generate and test in a process of trial and error to achieve the desired outcomes.

An animation student learns and goes through the same pre-production process as a professional practitioner during his/her studies. However, students do not have enough time to invest in experimenting and exploring the deeper aspects and functions of their practice. Experimentation is a crucial element of professional practice and allows artists to solve problems or produce new techniques and principles that lead to evolutions in the field.

It is therefore recommended that a comprehensive approach and a set of guidelines for implementing procedural animation be developed for a more efficient common studio practice. These guidelines should gear towards demonstrating the appropriate level of procedural enhancements in a given context and their effects on movement performances. Hopefully, these measures would achieve an implementation process that is more user friendly, less time-consuming, and based on a more solid understanding of the links between production (the procedural values assigned) and reception (the audience’s perception of a character’s believability). Reducing time, cost, and complexity would lead both to a more widespread use of procedural animation and to better practice within the field.

This thesis first provided an in-depth critical review and analysis of the notion of believability; it then tied this in to the use of procedural animation within believable movement performances. The present study could therefore form the basis of a supporting textbook that helps understand the theoretical aspects and practical requirements of character animation. Additionally, it offers a critical theoretical analysis of practices in procedural animation for believable character animation, as well as providing practical examples of how to apply procedural animation to support and enhance believability in character animation.

One of my intentions in this research was to focus on the areas of concern to be addressed by practitioners, if procedural animation is to be used to its full potential in future. While the findings highlight the extent of the discipline's needs and offer guidance for both students and animators, the detailed solutions they provide are as yet limited in scope. They are intended as a first step towards, and the start of a dialogue on, the creation of a set of effective common guiding principles for the use of procedural animation. It is my hope that this research might lay the foundations of a future common best practice for studios wishing to exploit the potential of this powerful tool in the difficult task of creating believable animation.

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Appendix A: E-Mail Discussion with Ed Hooks

From: edhooks@edhooks.com
Subject: Ed Hooks/Re: Thank you.
Date: 12 February 2014 19:30
To: Isikguner, Baris Baris.Isikguner@anglia.ac.uk

Good question, Baris. "Action" will always involve physical action, even if the action is almost undetectable to the audience. If I ask you, as an exercise, to lie on the floor and pretend you are a statue, to lie as physically still as possible, and then ask you to multiply 345 x 46 while holding the pose, your eyeballs would involuntarily move. It would be theatrically valid. Your objective would be to arrive at the answer; your action would be to do the arithmetic; your obstacle would be holding still.

In general, economy of movement, even in caricature, is the best option.

Ed

On Wed, 12 Feb 2014 17:57:19 +0000, "Isikguner, Baris" <Baris.Isikguner@anglia.ac.uk> wrote:

> Dear Ed
>
> I am truly sad that I couldn't make it to Animex today although it was a wonderful experience to meet you in the last one.
>
> Unfortunately my working hours are quite tight plus I am submitting my PhD thesis in 2 months.
>
> I would like to say that your work and book, "Acting for Animators", has been a great inspiration for me and towards my study, thank you for that.
>
> Before I end my email I would like to ask you one little question about one of the definitions/ on your book. Please excuse me if this is too blunt but, it has been making me think for some time.
>
> When you say in your book *"Your character should play an action in pursuit of an objective while overcoming an obstacle...",* by the word ***action***, do you refer to movement (motion) of the character?
>
> All the best and thank you for in advance for your time and guidance.
>
> Barış Işıkgüner
> Lecturer in Computer Games Art
> Faculty of Arts, Law and Social Sciences
> Anglia Ruskin University
>
> Mellish Clark Building - 102
> East Road, Cambridge
> CB1 1PT
> Blog:
> http://3ddaily.wordpress.com

Appendix B: Error Margin Calculation Output for 300 Sample Size

Raosoft®

Sample size calculator

What margin of error can you accept? 5 %

5% is a common choice

The margin of error is the amount of error that you can tolerate. If 90% of respondents answer *yes*, while 10% answer *no*, you may be able to tolerate a larger amount of error than if the respondents are split 50-50 or 45-55.

Lower margin of error requires a larger sample size.

What confidence level do you need? 95 %

Typical choices are 90%, 95%, or 99%

The confidence level is the amount of uncertainty you can tolerate. Suppose that you have 20 yes-no questions in your survey. With a confidence level of 95%, you would expect that for one of the questions (1 in 20), the percentage of people who answer *yes* would be more than the margin of error away from the true answer. The true answer is the percentage you would get if you exhaustively interviewed everyone.

Higher confidence level requires a larger sample size.

What is the population size? 300

If you don't know, use 20000

How many people are there to choose your random sample from? The sample size doesn't change much for populations larger than 20,000.

What is the response distribution? 50 %

Leave this as 50%

For each question, what do you expect the results will be? If the sample is skewed highly one way or the other,the population probably is, too. If you don't know, use 50%, which gives the largest sample size. See below under **More information** if this is confusing.

Your recommended sample size is **169**

This is the minimum recommended size of your survey. If you create a sample of this many people and get responses from everyone, you're more likely to get a correct answer than you would from a large sample where only a small percentage of the sample responds to your survey.

Alternate scenarios

With a sample size of	100	200	300	With a confidence level of	90	95	99
Your margin of error would be	**8.01%**	**4.01%**	**0.00%**	Your sample size would need to be	**143**	**169**	**207**

More information

If 50% of all the people in a population of 20000 people drink coffee in the morning, and if you were repeat the survey of 377 people ("Did you drink coffee this morning?") many times, then 95% of the time, your survey would find that between 45% and 55% of the people in your sample answered "Yes".

The remaining 5% of the time, or for 1 in 20 survey questions, you would expect the survey response to more than the margin of error away from the true answer.

When you survey a sample of the population, you don't know that you've found the correct answer, but you do know that there's a 95% chance that you're within the margin of error of the correct answer.

Try changing your sample size and watch what happens to the *alternate scenarios*. That tells you what happens if you don't use the recommended sample size, and how M.O.E and confidence level (that 95%) are related.

To learn more if you're a beginner, read **Basic Statistics: A Modern Approach** and **The Cartoon Guide to Statistics**. Otherwise, look at the **more advanced books**.

In terms of the numbers you selected above, the sample size *n* and margin of error *E* are given by

$$x = Z(^{c}/_{100})^2 r(100-r)$$

$$n = {}^{N x}/_{((N-1)E^2 + x)}$$

$$E = \mathrm{Sqrt}[^{(N - n)x}/_{n(N-1)}]$$

where *N* is the population size, *r* is the fraction of responses that you are interested in, and $Z(c/100)$ is the critical value for the confidence level *c*.

If you'd like to see how we perform the calculation, view the page source. This calculation is based on the Normal distribution, and assumes you have more than about 30 samples.

About **Response distribution**: If you ask a random sample of 10 people if they like donuts, and 9 of them say, "Yes", then the prediction that you make about the general population is different than it would be if 5 had said, "Yes", and 5 had said, "No". Setting the response distribution to 50% is the most conservative assumption. So just leave it at 50% unless you know what you're doing. The sample size calculator computes the critical value for the normal distribution. Wikipedia has good articles on statistics.

How do you like this web page? ○ **Good as-is** ○ **Could be even better**

The Use of Procedural Animation in 3D Key-Framed Character Animation

Group (1)

The Purpose of This Survey: Is to explore and evaluate the effects of procedural animation when layered with a key-framed 3D character performance. There are 4 groups of movies and every group contains 3 videos of the same performance with differing levels of procedural enhancement. Please answer the questions for a specific group after watching those 3 videos. Some questions will provide a list of options, which participants should mark the appropriate responses. Personal details are collected at the end of the survey and will only be used for statistical purposes and will not be shared with third parties under any circumstances. Thank you for your support in my survey and research.

Definition of Terms

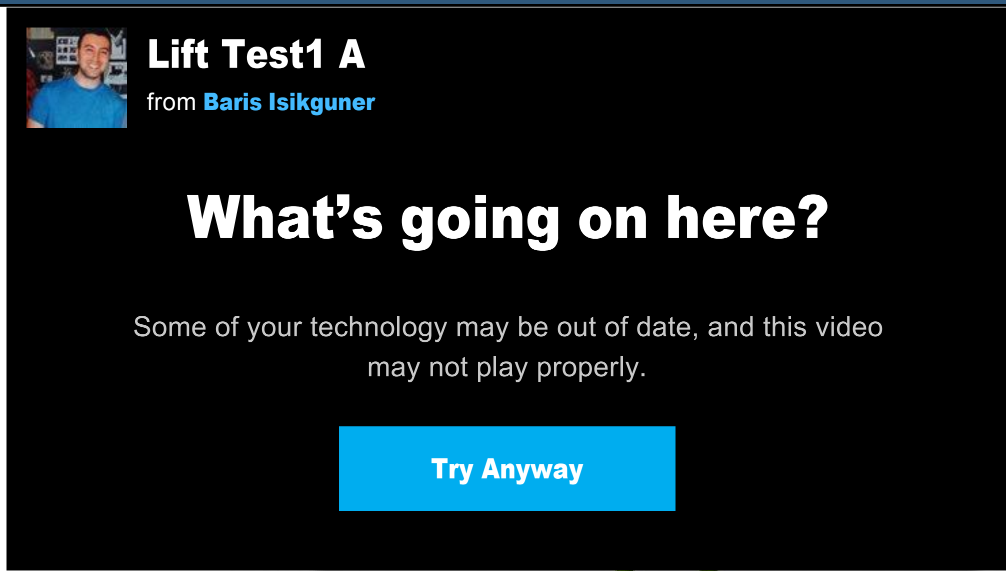
Appeal (in character animation): The state of an animated character evoking or attracting interest via its movements or performance.

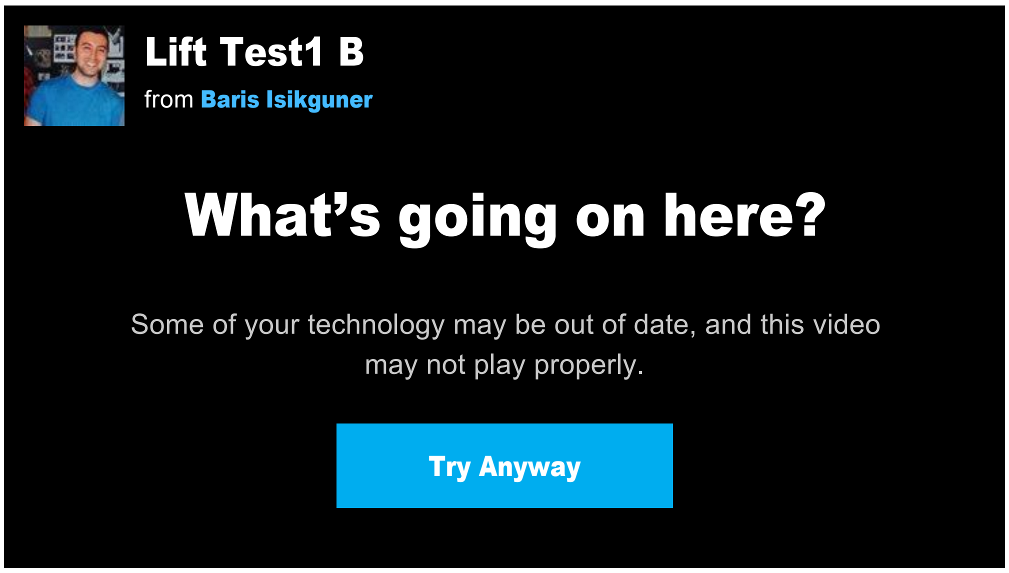
Realism (in character animation): The state of an animated character’s movements being almost or exactly equal to its possible real-life equitant.

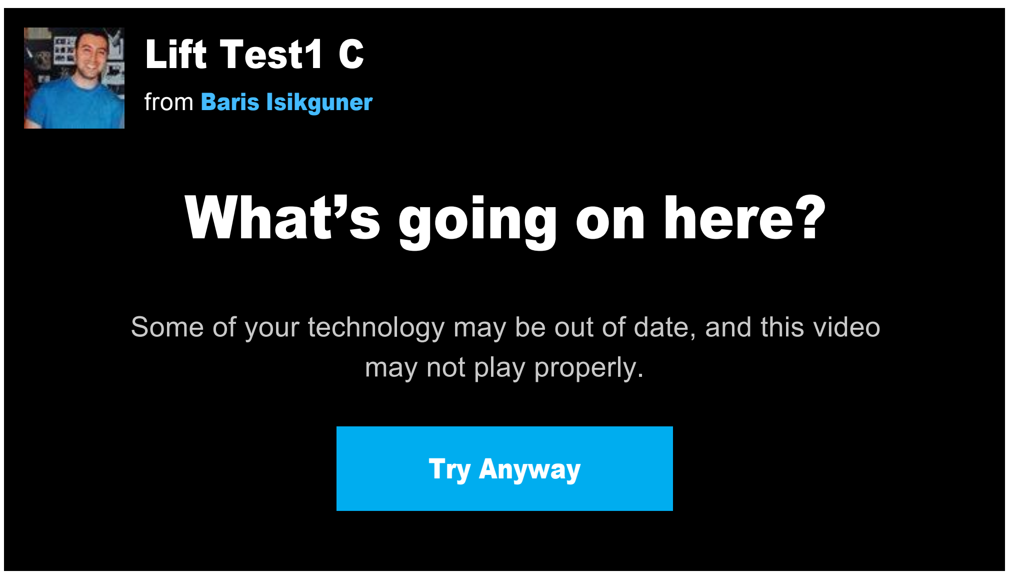
Believability (in character animation): The state of an animated character being a convincing personality that generates an illusion of individuality and motive.

* For better perception, please view the videos in full-screen mode. Thank you.

Page 1







1. In which video is the characters movement most appealing?

- ○ Video (A)
- ○ Video (B)

- Video (C)

2. Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

- Movement of the Neck and Shoulders
- Movement of the Arms
- Movement of the Legs
- Movement of the Torso
- Gravity or effort affecting the characters performance
- Gravity or effort affecting the Shorts on the Character
- The way the characters skin flexes is appealing
- Characters facial Expressions are appealing
- The performance of the Character is appealing
- The feeling of weight in Characters Movements is appealing
- The Timing of the Characters Movements helps with the characters appeal
- Characters Physical Appearance helps with the characters appeal

3. In which video is the characters movement most realistic?

- Video (A)
- Video (B)
- Video (C)

4. Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

- ☐ Movement of the Neck and Shoulders
- ☐ Movement of the Arms
- ☐ Movement of the Legs
- ☐ Movement of the Torso
- ☐ Gravity or effort affecting the characters performance
- ☐ Gravity or effort affecting the Shorts on the Character
- ☐ The way the characters skin flexes is realistic
- ☐ Characters facial Expressions are realistic
- ☐ The performance of the Character is realistic
- ☐ The feeling of weight in Characters Movements is realistic
- ☐ The Timing of the Characters Movements helps with the characters realistic
- ☐ Characters Physical Appearance helps with the characters realistic

5. In which video is the characters movement most believable?

- ○ Video (A)
- ○ Video (B)
- ○ Video (C)

6. Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

- ☐ Movement of the Neck and Shoulders
- ☐ Movement of the Arms
- ☐ Movement of the Legs
- ☐ Movement of the Torso
- ☐ Gravity or effort affecting the characters performance
- ☐ Gravity or effort affecting the Shorts on the Character
- ☐ The way the characters skin flexes is believable
- ☐ Characters facial Expressions are believable
- ☐ The performance of the Character is believable
- ☐ The feeling of weight in Characters Movements is believable
- ☐ The Timing of the Characters Movements helps with the characters believable
- ☐ Characters Physical Appearance helps with the characters believable

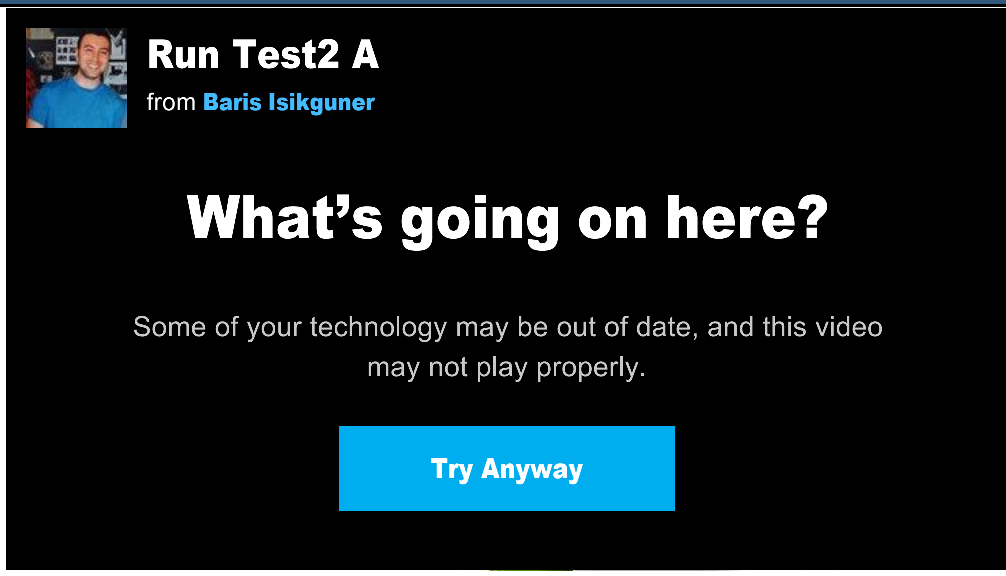
Group (2)

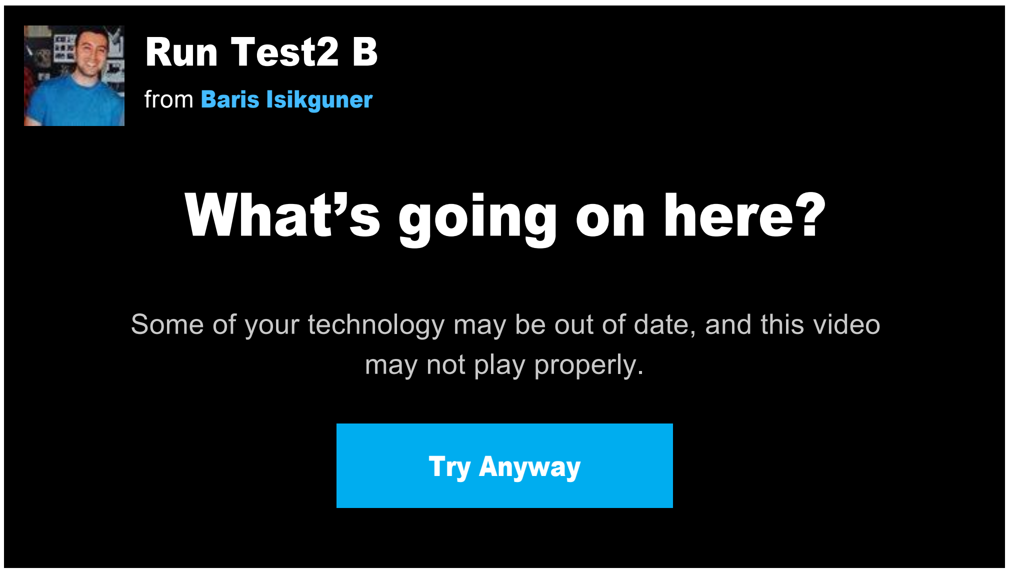
Definition of Terms

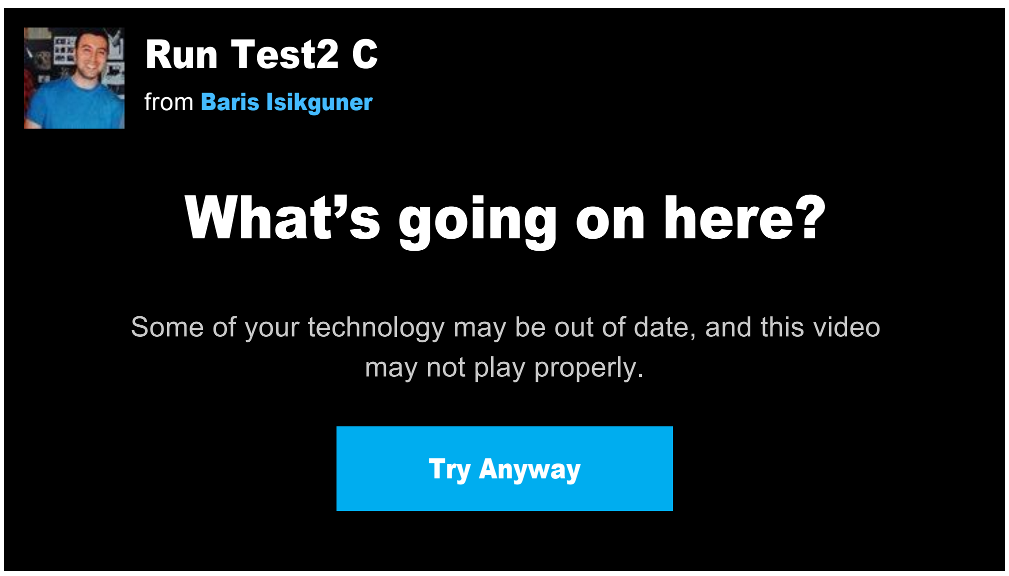
Appeal (in character animation): The state of an animated character evoking or attracting interest via its movements or performance.

Realism (in character animation): The state of an animated character's movements being almost or exactly equal to its possible real-life equitant.

Believability (in character animation): The state of an animated character being a convincing personality that generates an illusion of individuality and motive.







7. In which video is the characters movement most appealing?

- ○ Video (A)
- ○ Video (B)

- ○ Video (C)

8. Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

- ☐ Movement of the Neck and Shoulders
- ☐ Movement of the Arms
- ☐ Movement of the Legs
- ☐ Movement of the Torso
- ☐ Gravity or effort affecting the characters performance
- ☐ Gravity or effort affecting the Shorts on the Character
- ☐ The way the characters skin flexes is appealing
- ☐ Characters facial Expressions are appealing
- ☐ The performance of the Character is appealing
- ☐ The feeling of weight in Characters Movements is appealing
- ☐ The Timing of the Characters Movements helps with the characters appeal
- ☐ Characters Physical Appearance helps with the characters appeal

9. In which video is the characters movement most realistic?

- ○ Video (A)
- ○ Video (B)
- ○ Video (C)

10. Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

- ☐ Movement of the Neck and Shoulders
- ☐ Movement of the Arms
- ☐ Movement of the Legs
- ☐ Movement of the Torso
- ☐ Gravity or effort affecting the characters performance
- ☐ Gravity or effort affecting the Shorts on the Character
- ☐ The way the characters skin flexes is realistic
- ☐ Characters facial Expressions are realistic
- ☐ The performance of the Character is realistic
- ☐ The feeling of weight in Characters Movements is realistic
- ☐ The Timing of the Characters Movements helps with the characters realistic
- ☐ Characters Physical Appearance helps with the characters realistic

11. In which video is the characters movement most believable?

- ○ Video (A)
- ○ Video (B)
- ○ Video (C)

12. Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

- ☐ Movement of the Neck and Shoulders
- ☐ Movement of the Arms
- ☐ Movement of the Legs
- ☐ Movement of the Torso
- ☐ Gravity or effort affecting the characters performance
- ☐ Gravity or effort affecting the Shorts on the Character
- ☐ The way the characters skin flexes is believable
- ☐ Characters facial Expressions are believable
- ☐ The performance of the Character is believable
- ☐ The feeling of weight in Characters Movements is believable
- ☐ The Timing of the Characters Movements helps with the characters believable
- ☐ Characters Physical Appearance helps with the characters believable

The Use of Procedural Animation in 3D Key-Framed Character Animation

Group (3)

Definition of Terms

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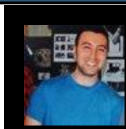
Believability (in character animation): The state of an animated character being a convincing personality that generates an illusion of individuality and motive.



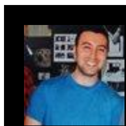
Walk Test3 A

from **Baris Isikguner**

What's going on here?

Some of your technology may be out of date, and this video may not play properly.

Try Anyway



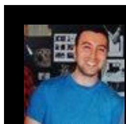
Walk Test3 B

from **Baris Isikguner**

What's going on here?

Some of your technology may be out of date, and this video may not play properly.

Try Anyway



Walk Test3 C

from **Baris Isikguner**

What's going on here?

Some of your technology may be out of date, and this video may not play properly.

Try Anyway

13. In which video is the characters movement most appealing?

- ○ Video (A)
- ○ Video (B)

- ○ Video (C)

14. Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

- ☐ Movement of the Neck and Shoulders
- ☐ Movement of the Arms
- ☐ Movement of the Legs
- ☐ Movement of the Torso
- ☐ Gravity or effort affecting the characters performance
- ☐ Gravity or effort affecting the Shorts on the Character
- ☐ The way the characters skin flexes is appealing
- ☐ Characters facial Expressions are appealing
- ☐ The performance of the Character is appealing
- ☐ The feeling of weight in Characters Movements is appealing
- ☐ The Timing of the Characters Movements helps with the characters appeal
- ☐ Characters Physical Appearance helps with the characters appeal

15. In which video is the characters movement most realistic?

- ○ Video (A)
- ○ Video (B)
- ○ Video (C)

16. Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

- ☐ Movement of the Neck and Shoulders
- ☐ Movement of the Arms
- ☐ Movement of the Legs
- ☐ Movement of the Torso
- ☐ Gravity or effort affecting the characters performance
- ☐ Gravity or effort affecting the Shorts on the Character
- ☐ The way the characters skin flexes is realistic
- ☐ Characters facial Expressions are realistic
- ☐ The performance of the Character is realistic
- ☐ The feeling of weight in Characters Movements is realistic
- ☐ The Timing of the Characters Movements helps with the characters realistic
- ☐ Characters Physical Appearance helps with the characters realistic

17. In which video is the characters movement most believable?

- ○ Video (A)
- ○ Video (B)
- ○ Video (C)

18. Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

- ☐ Movement of the Neck and Shoulders
- ☐ Movement of the Arms
- ☐ Movement of the Legs
- ☐ Movement of the Torso
- ☐ Gravity or effort affecting the characters performance
- ☐ Gravity or effort affecting the Shorts on the Character
- ☐ The way the characters skin flexes is believable
- ☐ Characters facial Expressions are believable
- ☐ The performance of the Character is believable
- ☐ The feeling of weight in Characters Movements is believable
- ☐ The Timing of the Characters Movements helps with the characters believable
- ☐ Characters Physical Appearance helps with the characters believable

The Use of Procedural Animation in 3D Key-Framed Character Animation

Group (4)

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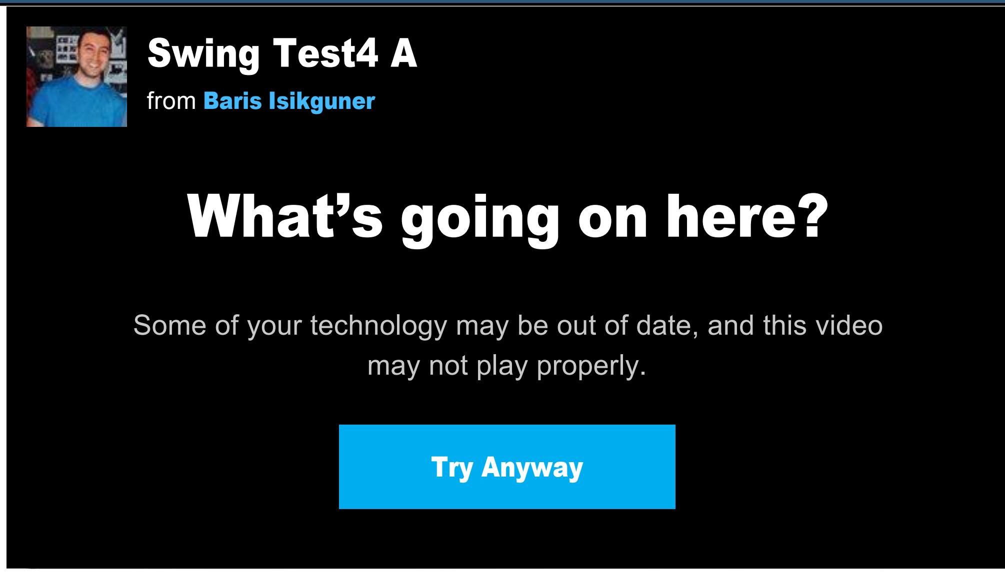
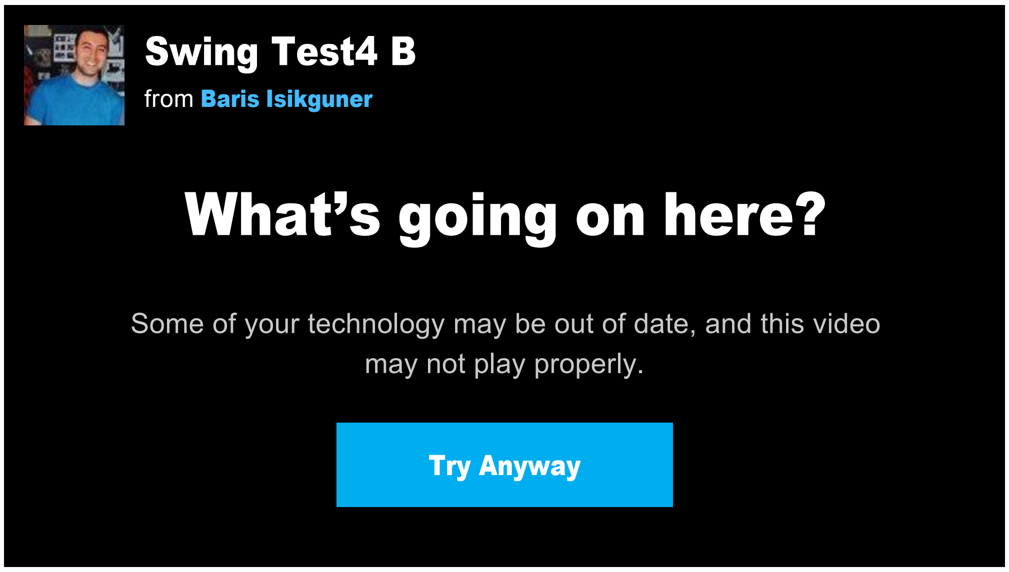
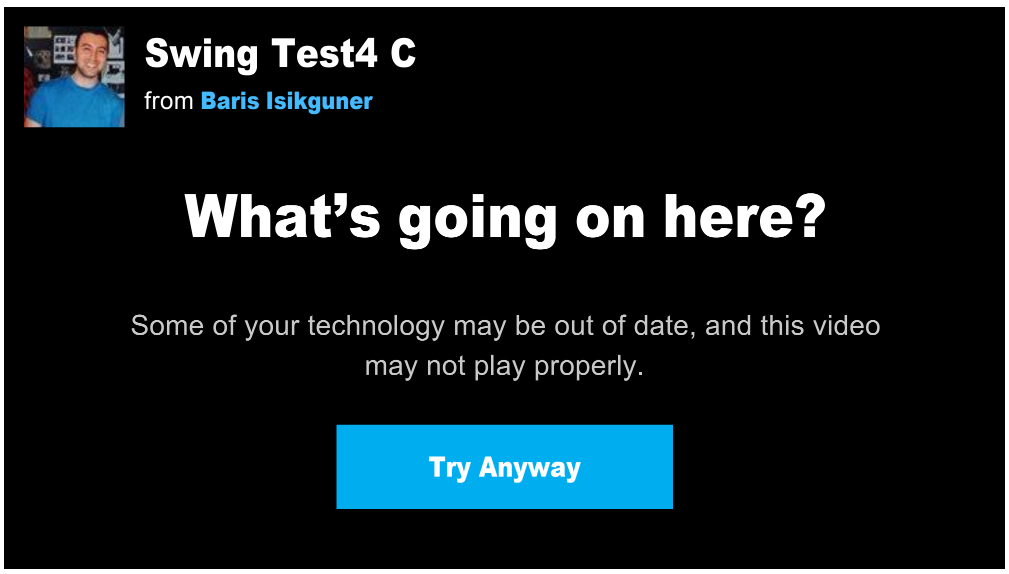






19. In which video is the characters movement most appealing?

- ◯ Video (A)
- ◯ Video (B)

- Video (C)

20. Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

- Movement of the Neck and Shoulders
- Movement of the Arms
- Movement of the Legs
- Movement of the Torso
- Gravity or effort affecting the characters performance
- Gravity or effort affecting the Shorts on the Character
- The way the characters skin flexes is appealing
- Characters facial Expressions are appealing
- The performance of the Character is appealing
- The feeling of weight in Characters Movements is appealing
- The Timing of the Characters Movements helps with the characters appeal
- Characters Physical Appearance helps with the characters appeal

21. In which video is the characters movement most realistic?

- Video (A)
- Video (B)
- Video (C)

22. Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

- ☐ Movement of the Neck and Shoulders
- ☐ Movement of the Arms
- ☐ Movement of the Legs
- ☐ Movement of the Torso
- ☐ Gravity or effort affecting the characters performance
- ☐ Gravity or effort affecting the Shorts on the Character
- ☐ The way the characters skin flexes is realistic
- ☐ Characters facial Expressions are realistic
- ☐ The performance of the Character is realistic
- ☐ The feeling of weight in Characters Movements is realistic
- ☐ The Timing of the Characters Movements helps with the characters realistic
- ☐ Characters Physical Appearance helps with the characters realistic

23. In which video is the characters movement most believable?

- ○ Video (A)
- ○ Video (B)
- ○ Video (C)

24. Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

- ☐ Movement of the Neck and Shoulders
- ☐ Movement of the Arms
- ☐ Movement of the Legs
- ☐ Movement of the Torso
- ☐ Gravity or effort affecting the characters performance
- ☐ Gravity or effort affecting the Shorts on the Character
- ☐ The way the characters skin flexes is believable
- ☐ Characters facial Expressions are believable
- ☐ The performance of the Character is believable
- ☐ The feeling of weight in Characters Movements is believable
- ☐ The Timing of the Characters Movements helps with the characters believable
- ☐ Characters Physical Appearance helps with the characters believable

The Use of Procedural Animation in 3D Key-Framed Character Animation

Participant Details

Personal details are collected at the end of the survey and will only be used for statistical purposes and will not be shared with third parties under any circumstances. Thank you for your support in my survey and research.

25. Please enter your Age range.

- Under 12 years old
- 12-17 years old
- 18-24 years old
- 25-34 years old
- 35-44 years old
- 45-54 years old
- 55-64 years old
- 65-74 years old
- 75 years or older

26. What is the highest degree or level of school you have completed? If currently enrolled please select the highest degree received.

- No schooling completed
- Nursery school to 8th grade
- Some high school, no diploma
- High school graduate, diploma or the equivalent
- Some college credit, no degree
- Trade/technical/vocational training
- Associate degree
- Bachelor’s degree
- Master’s degree
- Professional degree
- Doctorate degree

27. What is your interest in Animation?

- Personal (Hobby)
- Personal Research
- Academic Research
- Doctoral Research
- Professional

The Use of Procedural Animation in 3D Key-Framed Character Animation

Thank you for your participation.

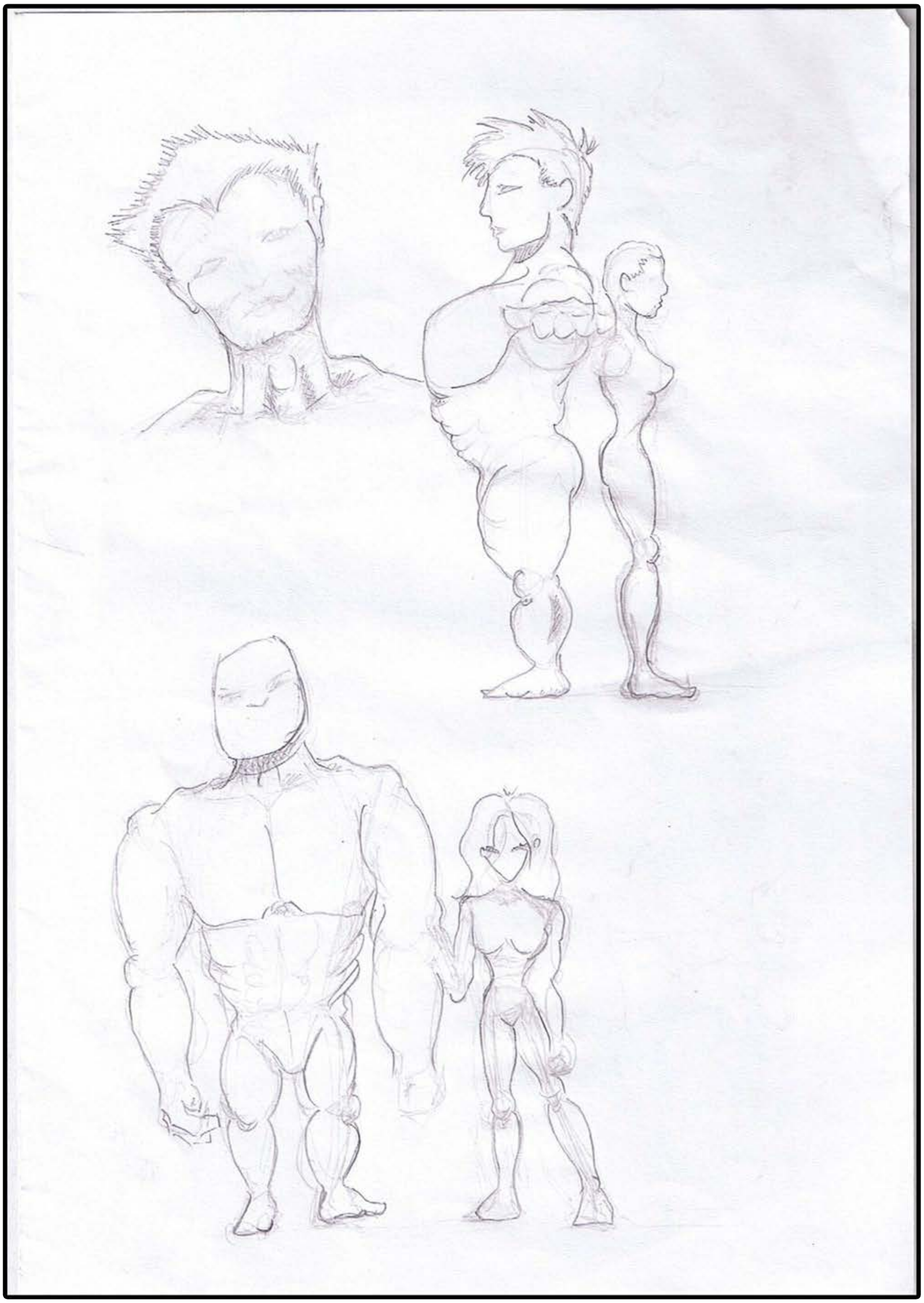
Appendix D: Initial Experimental Study Outcomes and Cephalopod Creature

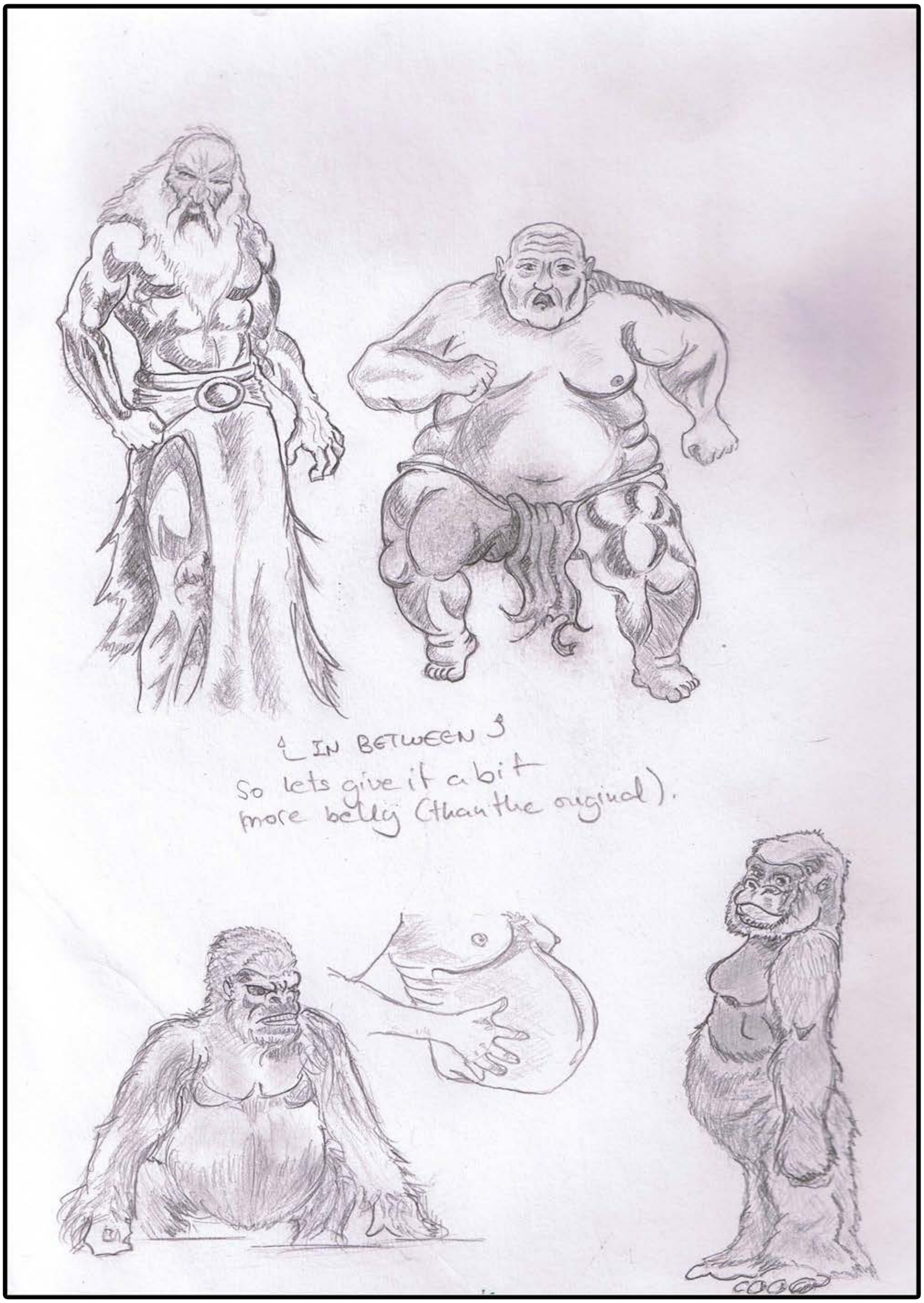
This Content is in USB Flash Drive

Appendix E: Further Procedural Animation Tests Outcomes with Steam-Punk Style Character

This Content is in USB Flash Drive

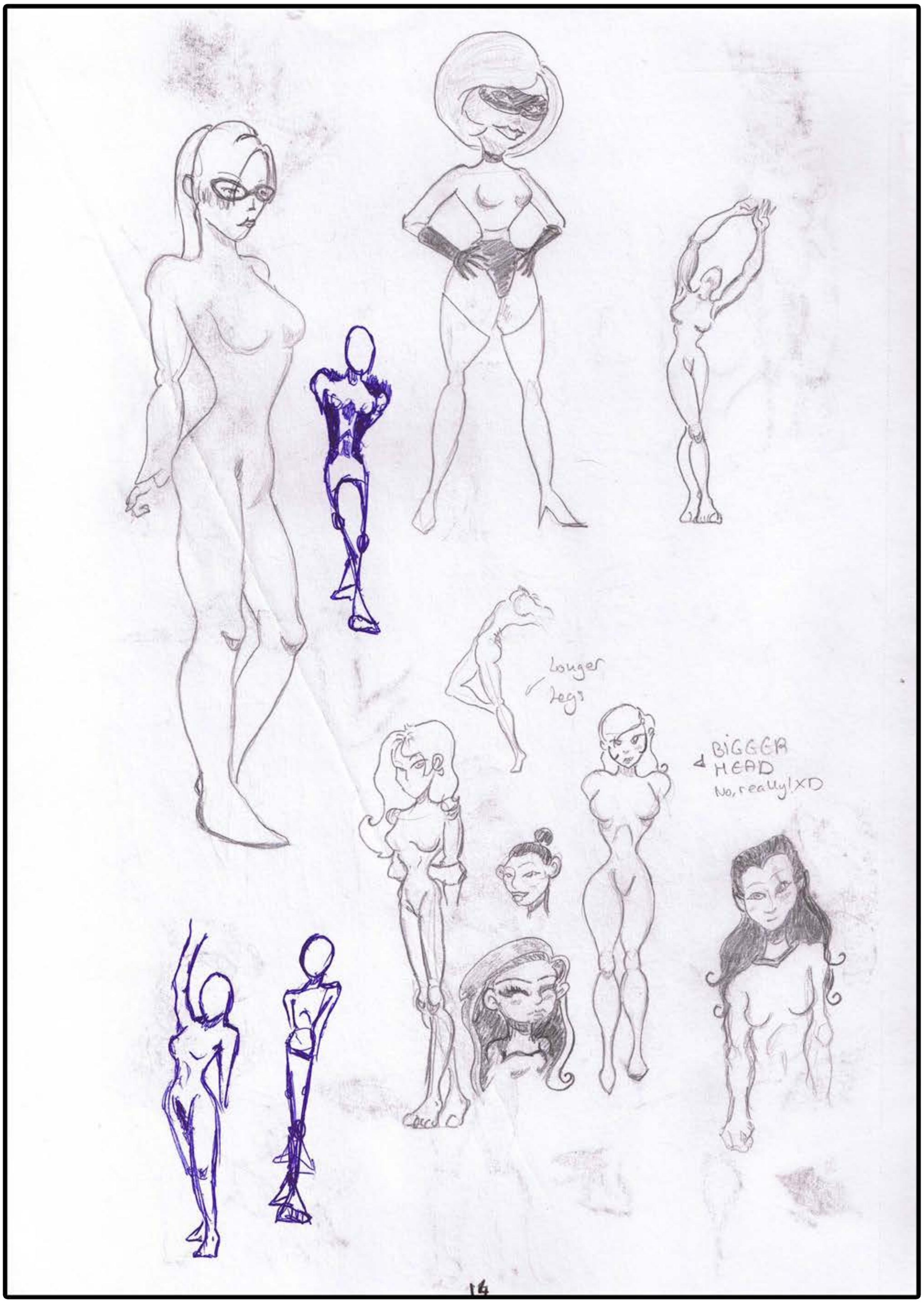
Appendix F: Initial Design Outcomes of
Male and Female Characters for Final Experimental Phase

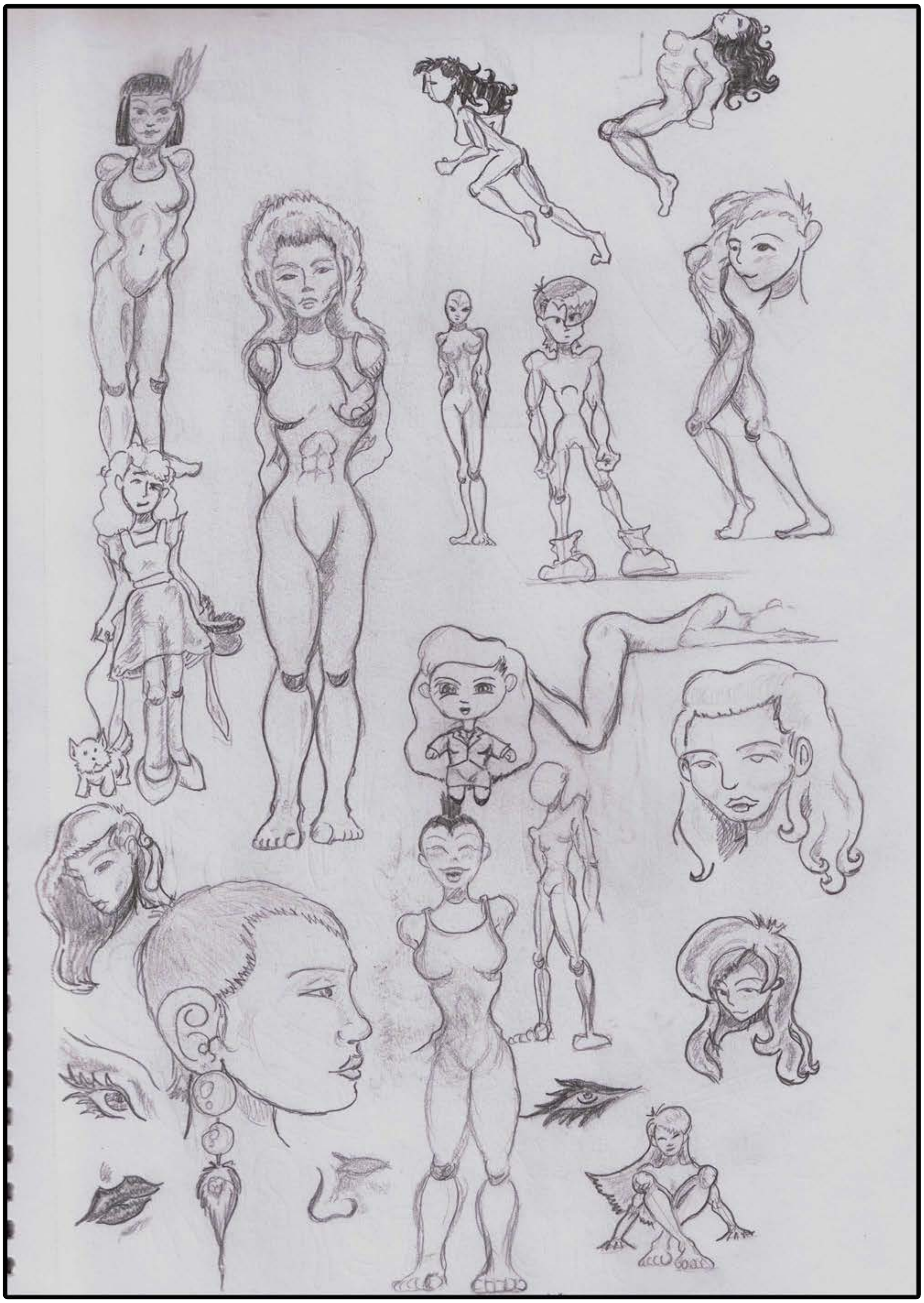



{ IN BETWEEN }
So lets give it a bit
more belly (than the original).

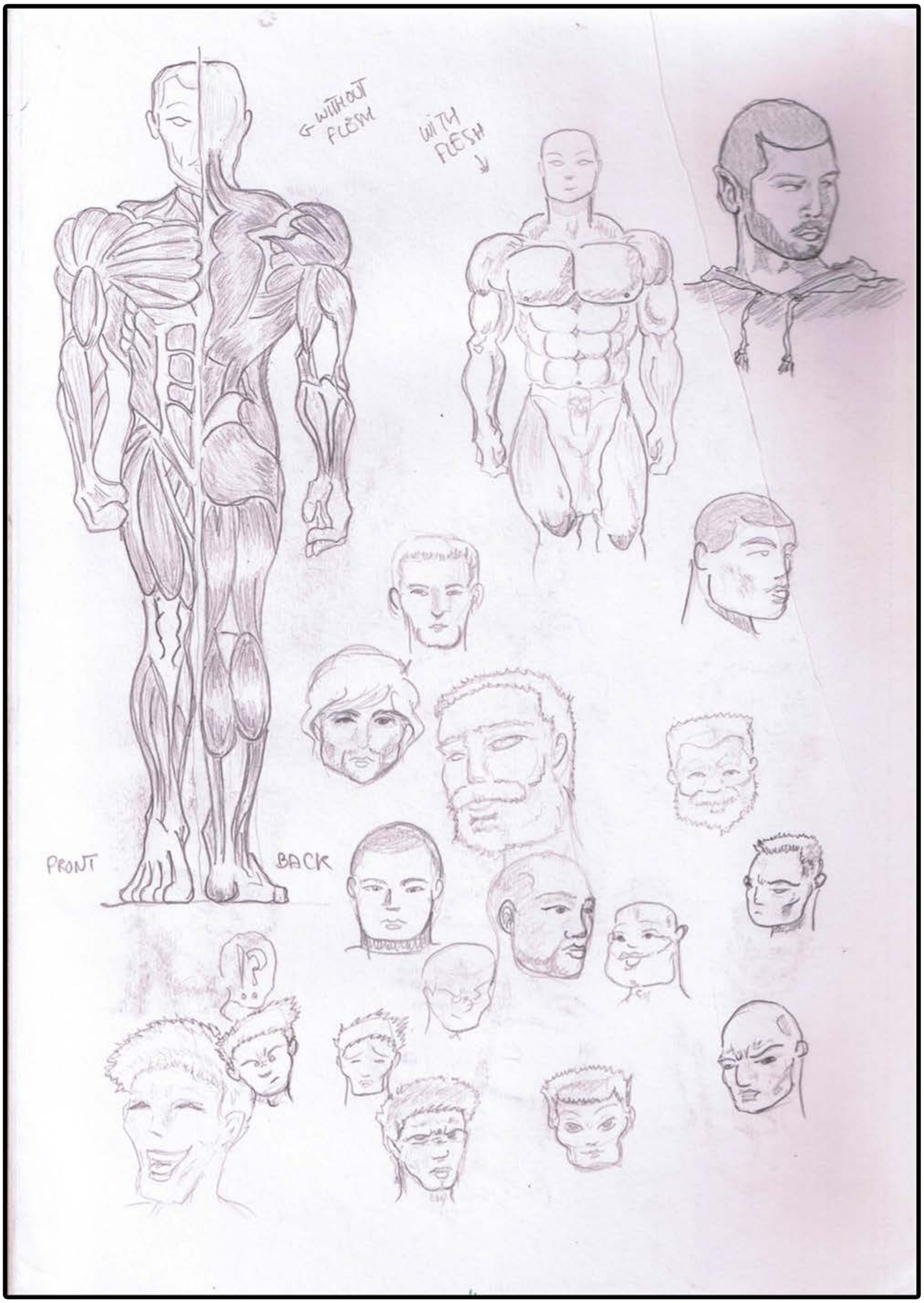

This wld B
the body,
JUST less
hairy.
XD


POSEMANIACS
Get the bodies and add fat, like the bear & gorilla XD
OR
@ the FREAK 8Q grrr!!!


Longer
legs
BIGGER
HEAD
No, really! XD
14

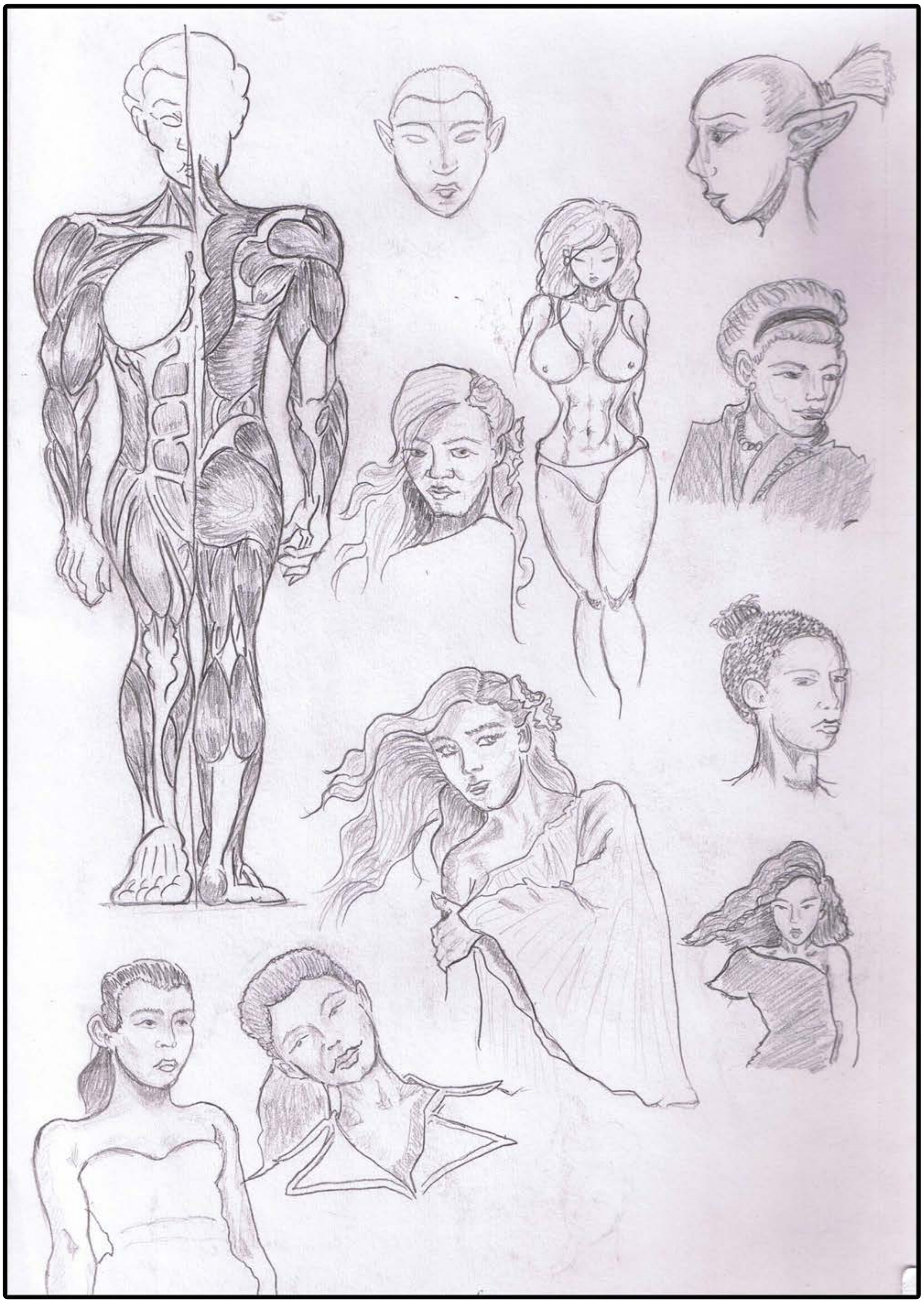



XP forget the face
XP, Not face lucky 2day :D lol.

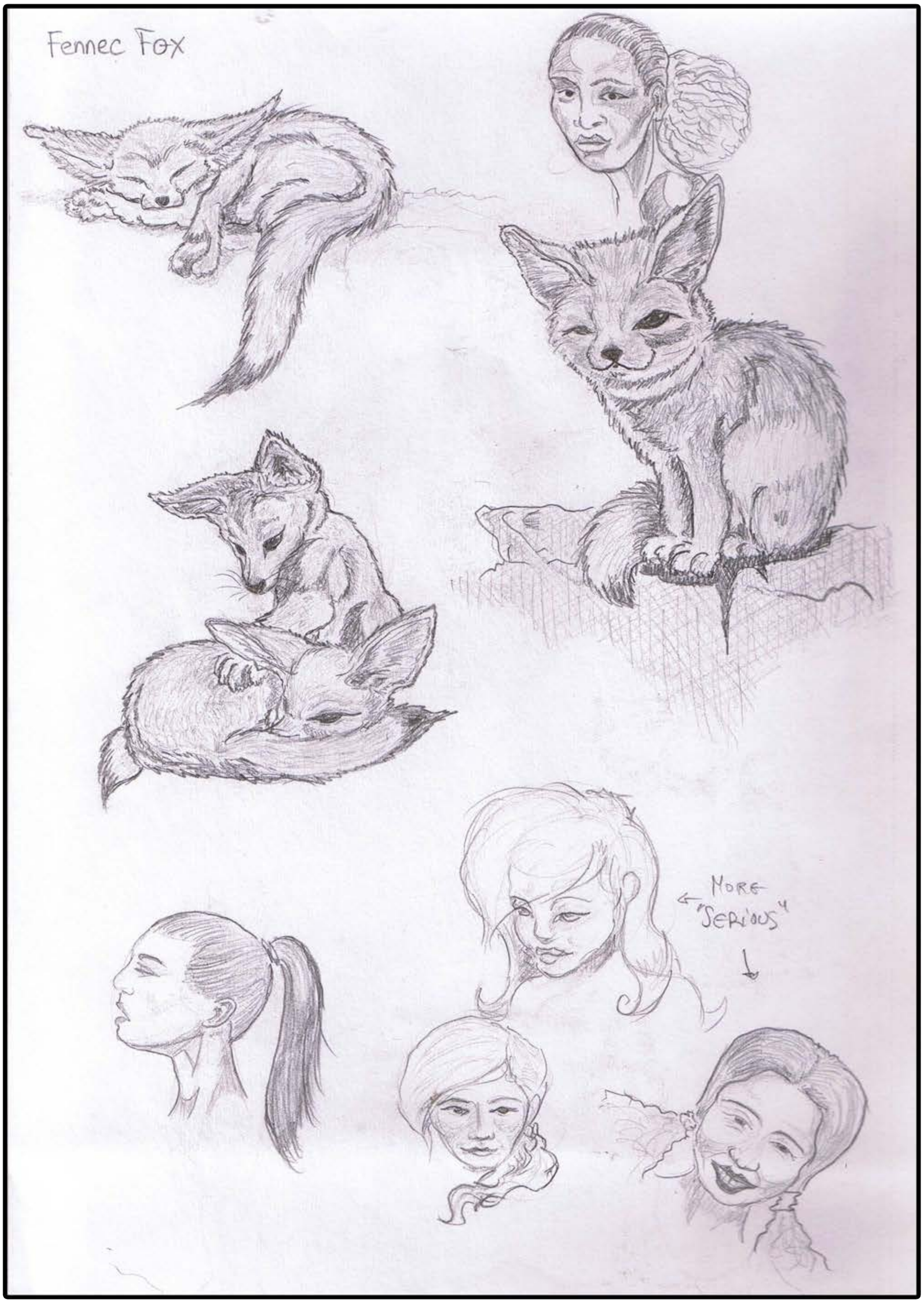


← WITHOUT FLESH
WITH FLESH
FRONT
BACK


MORE
FAT
Like a bear




Fennec fox, small & cute
Research more ;)



Fennec Fox
MORE "SERIOUS"

Appendix G: Sample Character 1 Turntable

This Content is in USB Flash Drive

Appendix H: Initial Animation Test Outcomes of Sample Character 1

This Content is in USB Flash Drive

Appendix I: Final Test Outcomes of Procedural Enhancements of Sample Character 2

This Content is in USB Flash Drive

Appendix J: Final Experimental Stage Outputs (All Animated Movement Performance Groups)

This Content is in USB Flash Drive

Appendix K: Survey Questioner Results and Responses

The Use of Procedural Animation in 3D Key-Framed Character Animation

1. Please enter your Age range.		
Answer Options	Response Percent	Response Count
Under 12 years old	0.0%	0
12-17 years old	0.0%	0
18-24 years old	2.6%	5
25-34 years old	41.3%	81
35-44 years old	46.4%	91
45-54 years old	8.2%	16
55-64 years old	1.5%	3
65-74 years old	0.0%	0
75 years or older	0.0%	0
	answered question	196
	skipped question	17

2. What is the highest degree or level of school you have completed? If currently enrolled please select the highest degree received.		
Answer Options	Response Percent	Response Count
No schooling completed	0.0%	0
Nursery school to 8th grade	0.0%	0
Some high school, no diploma	0.0%	0
High school graduate, diploma or the equivalent	0.0%	0
Some college credit, no degree	0.0%	0
Trade/technical/vocational training	0.5%	1
Associate degree	0.0%	0
Bachelor’s degree	42.9%	84
Master’s degree	54.1%	106
Professional degree	0.5%	1
Doctorate degree	2.0%	4
	answered question	196
	skipped question	17

3. What is your interest in Animation?		
Answer Options	Response Percent	Response Count
Personal (Hobby)	30.1%	59
Personal Research	2.0%	4
Academic Research	3.1%	6
Doctoral Research	15.8%	31
Professional	49.0%	96
	answered question	196
	skipped question	17

The Use of Procedural Animation in 3D Key-Framed Character Animation

1. In which video is the characters movement most realistic?			
Answer Options		Response Percent	Response Count
Video (A)	No Dyn	22.5%	48
Video (B)	++ Dyn	4.2%	9
Video (C)	+ Dyn	73.2%	156
		answered question	213
		skipped question	0

2. In which video is the characters movement most realistic?			
Answer Options		Response Percent	Response Count
Video (A)	+ Dyn	37.1%	76
Video (B)	No Dyn	56.6%	116
Video (C)	++ Dyn	6.3%	13
		answered question	205
		skipped question	8

3. In which video is the characters movement most realistic?			
Answer Options		Response Percent	Response Count
Video (A)	++ Dyn	3.0%	6
Video (B)	+ Dyn	68.0%	136
Video (C)	No Dyn	29.0%	58
		answered question	200
		skipped question	13

4. In which video is the characters movement most realistic?			
Answer Options		Response Percent	Response Count
Video (A)	No Dyn	20.6%	41
Video (B)	++ Dyn	9.0%	18
Video (C)	+ Dyn	70.4%	140
		answered question	199
		skipped question	14

The Use of Procedural Animation in 3D Key-Framed Character Animation

1. In which video is the characters movement most appealing?			
Answer Options		Response Percent	Response Count
Video (A)	No Dyn	5.2%	11
Video (B)	++ Dyn	70.9%	151
Video (C)	+ Dyn	23.9%	51
		answered question	213
		skipped question	0

2. In which video is the characters movement most appealing?			
Answer Options		Response Percent	Response Count
Video (A)	+ Dyn	18.0%	37
Video (B)	No Dyn	13.2%	27
Video (C)	++ Dyn	68.8%	141
		answered question	205
		skipped question	8

3. In which video is the characters movement most appealing?			
Answer Options		Response Percent	Response Count
Video (A)	++ Dyn	74.5%	149
Video (B)	+ Dyn	12.5%	25
Video (C)	No Dyn	13.0%	26
		answered question	200
		skipped question	13

4. In which video is the characters movement most appealing?			
Answer Options		Response Percent	Response Count
Video (A)	No Dyn	6.0%	12
Video (B)	++ Dyn	69.3%	138
Video (C)	+ Dyn	24.6%	49
		answered question	199
		skipped question	14

The Use of Procedural Animation in 3D Key-Framed Character Animation

1. In which video is the characters movement most believable?			
Answer Options		Response Percent	Response Count
Video (A)	No Dyn	6.6%	14
Video (B)	++ Dyn	79.8%	170
Video (C)	+ Dyn	13.6%	29
		answered question	213
		skipped question	0

2. In which video is the characters movement most believable?			
Answer Options		Response Percent	Response Count
Video (A)	+ Dyn	6.8%	14
Video (B)	No Dyn	13.7%	28
Video (C)	++ Dyn	79.5%	163
		answered question	205
		skipped question	8

3. In which video is the characters movement most believable?			
Answer Options		Response Percent	Response Count
Video (A)	++ Dyn	77.5%	155
Video (B)	+ Dyn	9.5%	19
Video (C)	No Dyn	13.0%	26
		answered question	200
		skipped question	13

4. In which video is the characters movement most believable?			
Answer Options		Response Percent	Response Count
Video (A)	No Dyn	5.5%	11
Video (B)	++ Dyn	77.4%	154
Video (C)	+ Dyn	17.1%	34
		answered question	199
		skipped question	14

The Use of Procedural Animation in 3D Key-Framed Character Animation

1. In which video is the characters movement most believable?			
Answer Options		Response Percent	Response Count
Video (A)	No Dyn	3.1%	3
Video (B)	++ Dyn	92.7%	89
Video (C)	+ Dyn	4.2%	4
		answered question	96
		skipped question	0

2. In which video is the characters movement most believable?			
Answer Options		Response Percent	Response Count
Video (A)	+ Dyn	2.1%	2
Video (B)	No Dyn	5.2%	5
Video (C)	++ Dyn	92.7%	89
		answered question	96
		skipped question	0

3. In which video is the characters movement most believable?			
Answer Options		Response Percent	Response Count
Video (A)	++ Dyn	90.6%	87
Video (B)	+ Dyn	5.2%	5
Video (C)	No Dyn	4.2%	4
		answered question	96
		skipped question	0

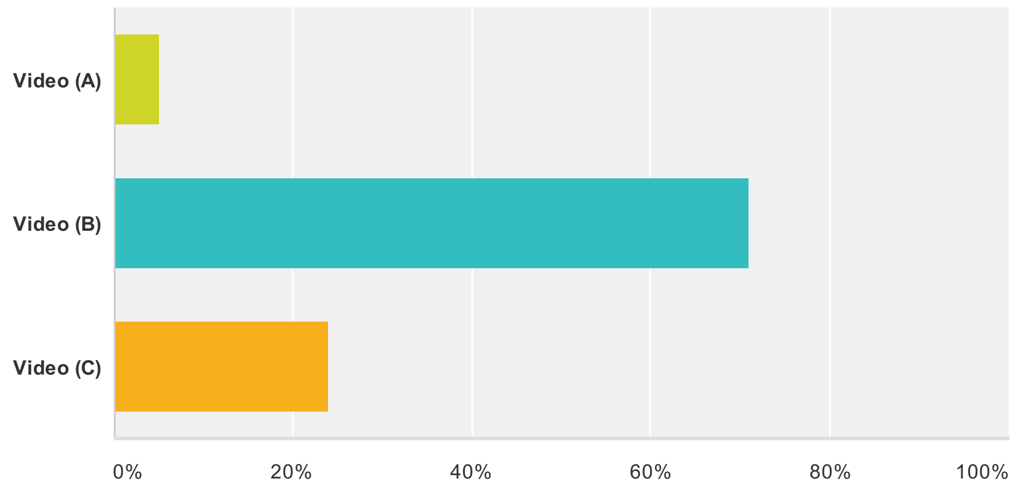
4. In which video is the characters movement most believable?			
Answer Options		Response Percent	Response Count
Video (A)	No Dyn	3.1%	3
Video (B)	++ Dyn	89.6%	86
Video (C)	+ Dyn	7.3%	7
		answered question	96
		skipped question	0

5. What is your interest in Animation?		
Answer Options	Response Percent	Response Count
Personal (Hobby)	0.0%	0
Personal Research	0.0%	0
Academic Research	0.0%	0
Doctoral Research	0.0%	0

Professional	100.0%	96
	answered question	96
	skipped question	0

Q1 In which video is the characters movement most appealing?

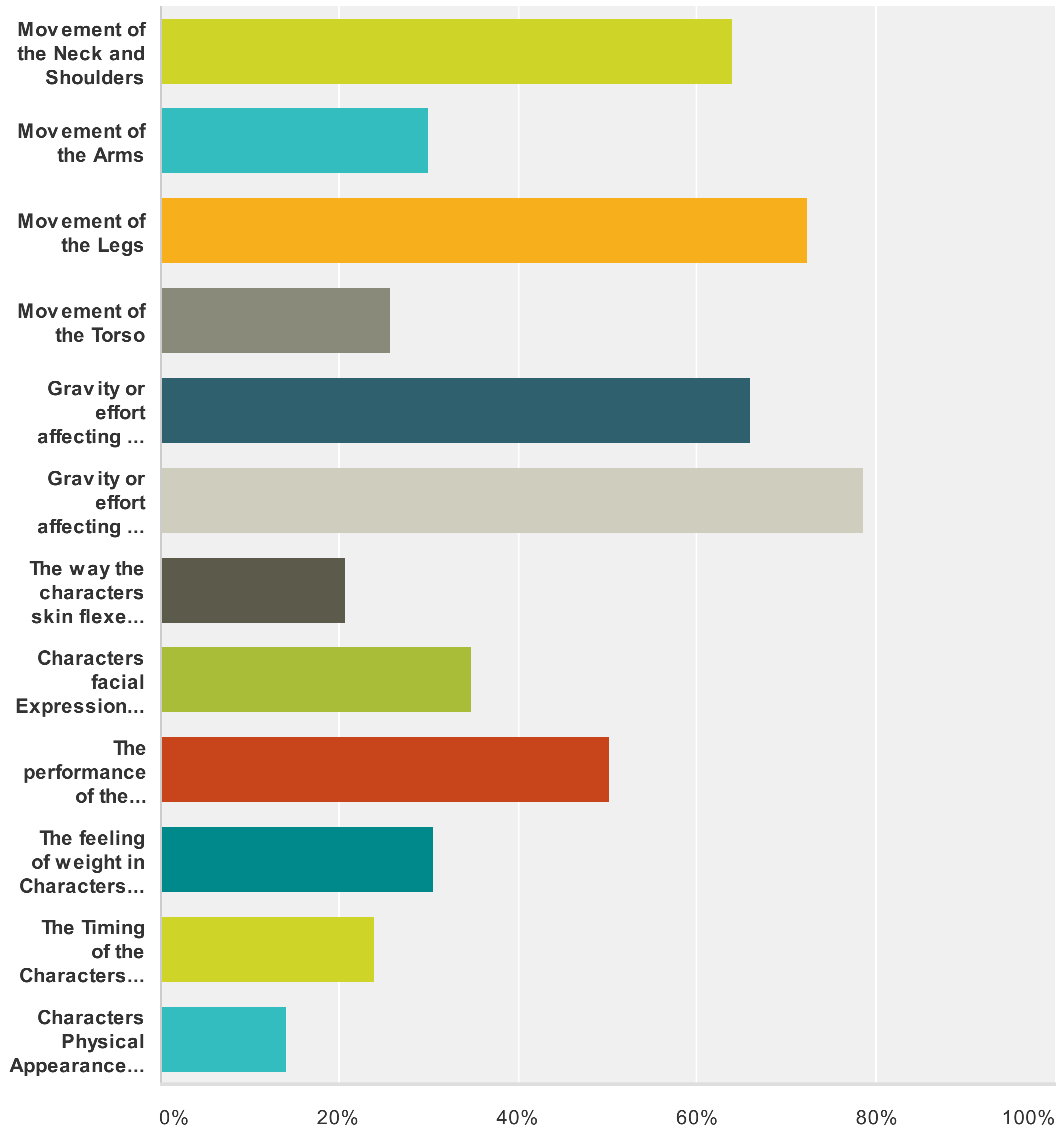
Answered: 213 Skipped: 0



Answer Choices	Responses	
Video (A)	**5.16%**	11
Video (B)	**70.89%**	151
Video (C)	**23.94%**	51
Total		**213**

Q2 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 213 Skipped: 0

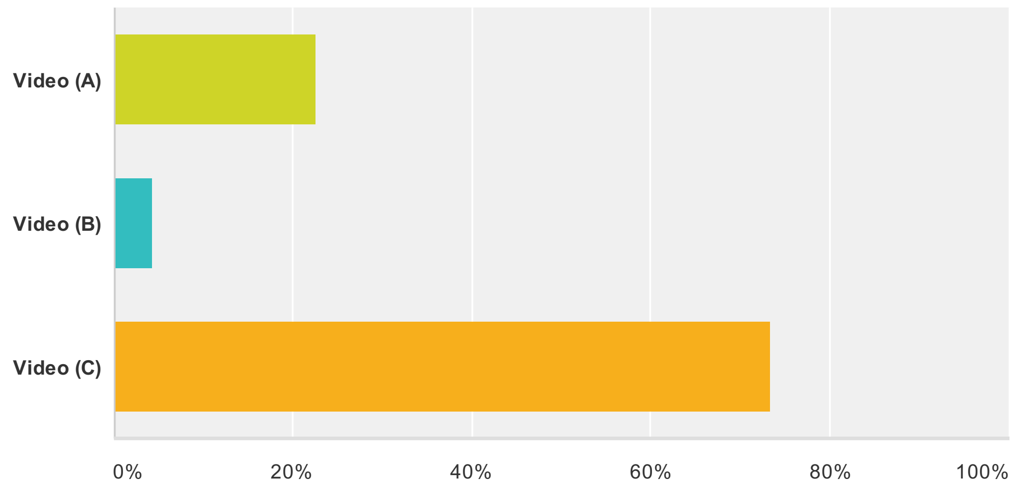


Answer Choices	Responses	
Movement of the Neck and Shoulders	**63.85%**	136
Movement of the Arms	**30.05%**	64
Movement of the Legs	**72.30%**	154
Movement of the Torso	**25.82%**	55
Gravity or effort affecting the characters performance	**65.73%**	140
Gravity or effort affecting the Shorts on the Character	**78.40%**	167
The way the characters skin flexes is appealing	**20.66%**	44
Characters facial Expressions are appealing	**34.74%**	74
The performance of the Character is appealing	**50.23%**	107

The feeling of weight in Characters Movements is appealing	**30.52%**	65
The Timing of the Characters Movements helps with the characters appeal	**23.94%**	51
Characters Physical Appearance helps with the characters appeal	**14.08%**	30
Total Respondents: 213		

Q3 In which video is the characters movement most realistic?

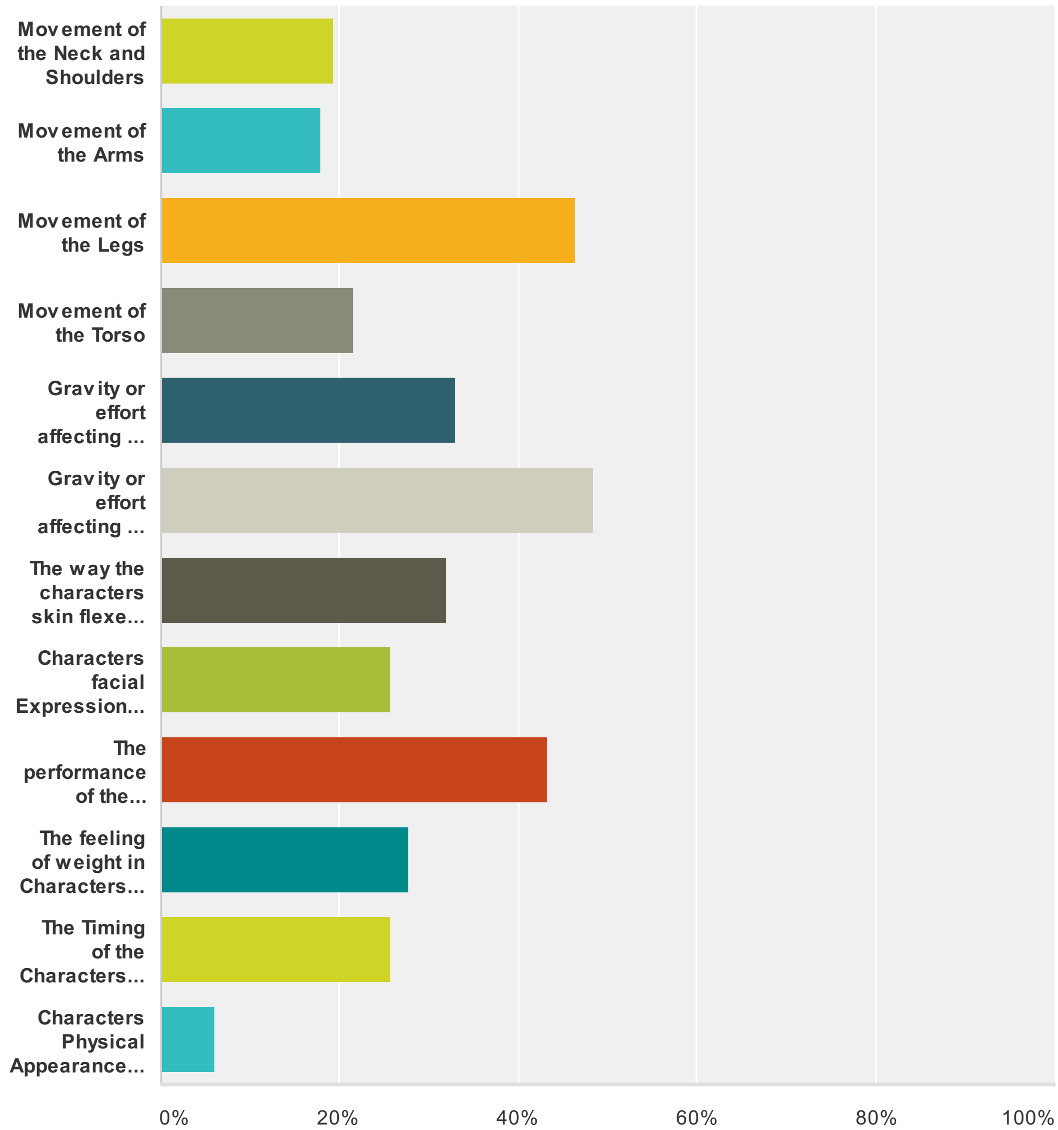
Answered: 213 Skipped: 0



Answer Choices	Responses	
Video (A)	**22.54%**	48
Video (B)	**4.23%**	9
Video (C)	**73.24%**	156
Total		**213**

Q4 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 213 Skipped: 0

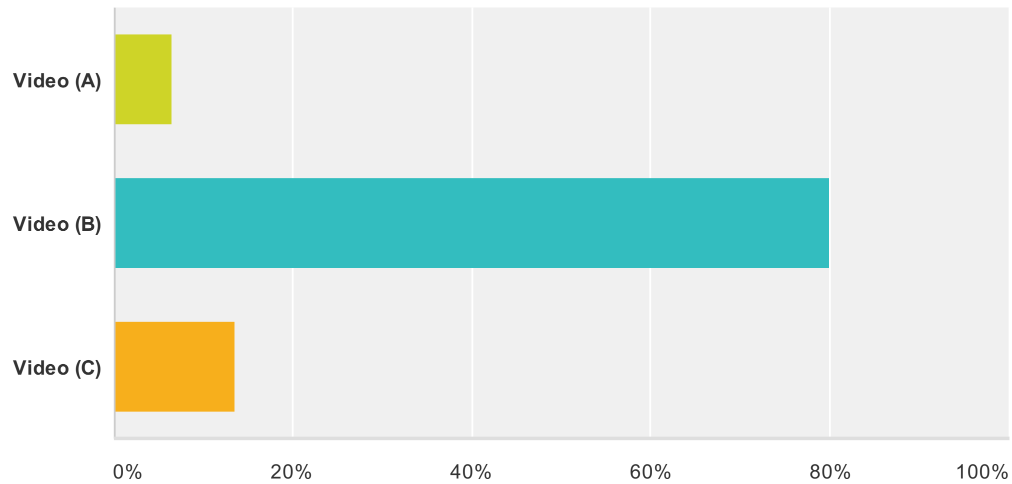


Answer Choices	Responses	
Movement of the Neck and Shoulders	19.25%	41
Movement of the Arms	17.84%	38
Movement of the Legs	46.48%	99
Movement of the Torso	21.60%	46
Gravity or effort affecting the characters performance	32.86%	70
Gravity or effort affecting the Shorts on the Character	48.36%	103
The way the characters skin flexes is realistic	31.92%	68
Characters facial Expressions are realistic	25.82%	55
The performance of the Character is realistic	43.19%	92

The feeling of weight in Characters Movements is realistic	**27.70%**	59
The Timing of the Characters Movements helps with the characters realistic	**25.82%**	55
Characters Physical Appearance helps with the characters realistic	**6.10%**	13
Total Respondents: 213		

Q5 In which video is the characters movement most believable?

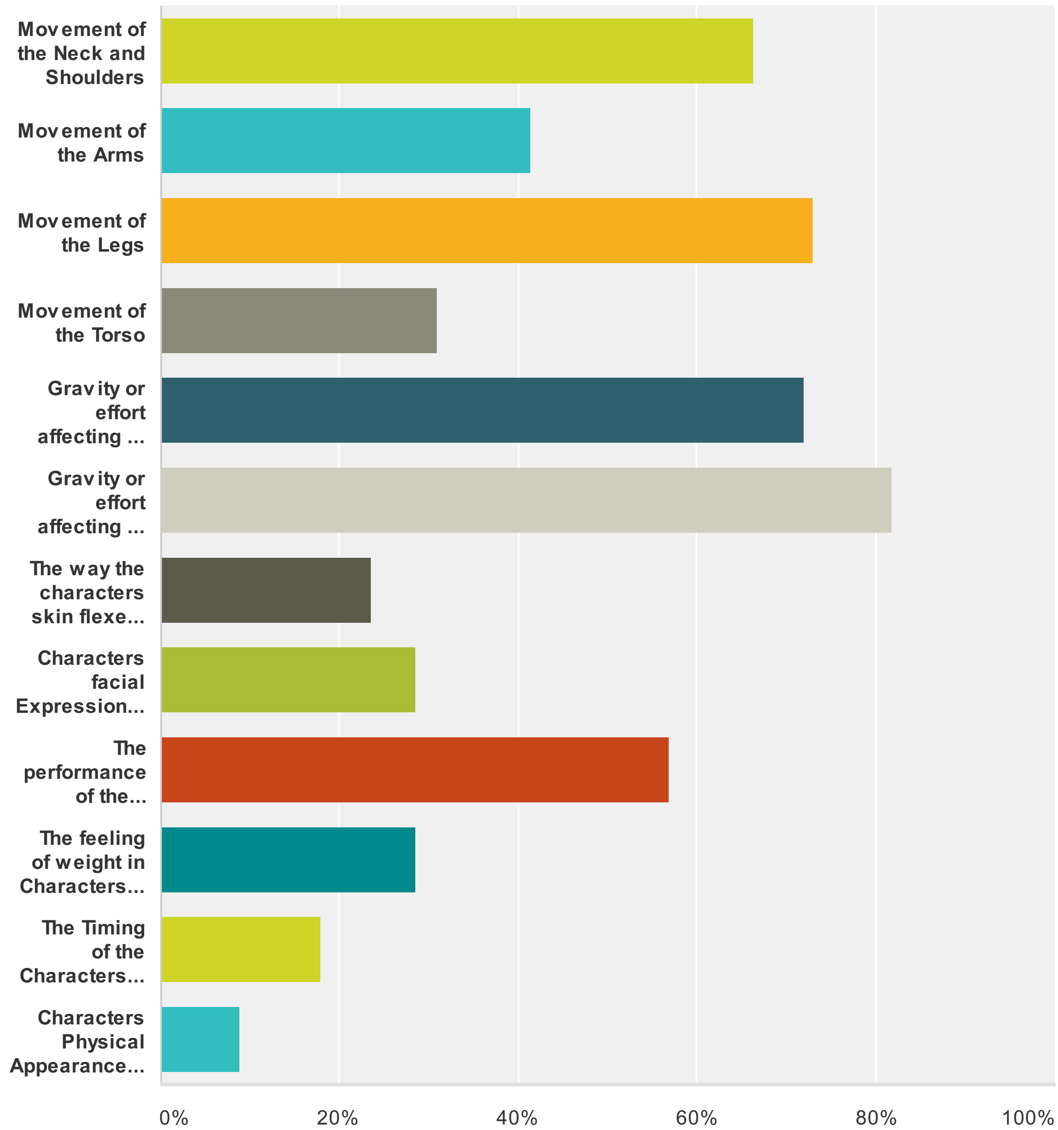
Answered: 213   Skipped: 0



Answer Choices	Responses	
Video (A)	**6.57%**	14
Video (B)	**79.81%**	170
Video (C)	**13.62%**	29
Total		**213**

Q6 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 213 Skipped: 0

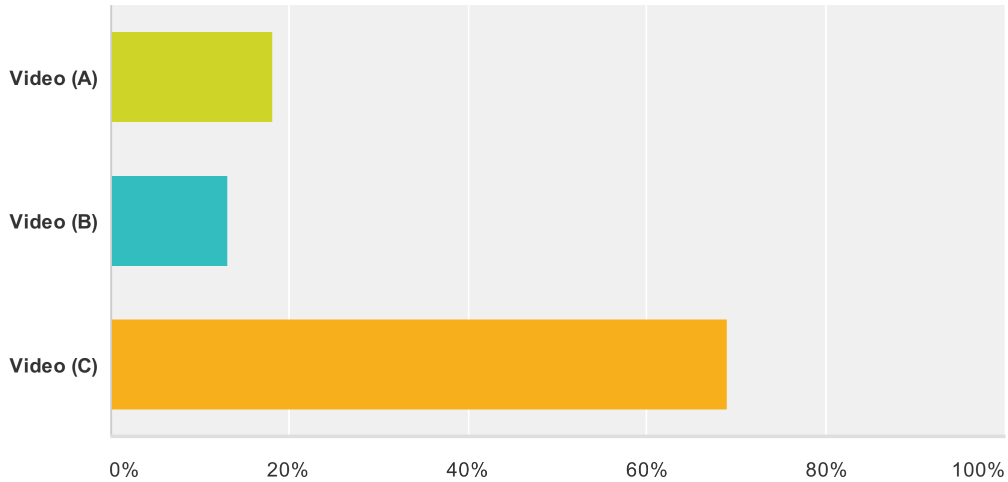


Answer Choices	Responses	
Movement of the Neck and Shoulders	66.20%	141
Movement of the Arms	41.31%	88
Movement of the Legs	72.77%	155
Movement of the Torso	30.99%	66
Gravity or effort affecting the characters performance	71.83%	153
Gravity or effort affecting the Shorts on the Character	81.69%	174
The way the characters skin flexes is believable	23.47%	50
Characters facial Expressions are believable	28.64%	61
The performance of the Character is believable	56.81%	121

The feeling of weight in Characters Movements is believable	**28.64%**	61
The Timing of the Characters Movements helps with the characters believable	**17.84%**	38
Characters Physical Appearance helps with the characters believable	**8.92%**	19
Total Respondents: 213		

Q7 In which video is the characters movement most appealing?

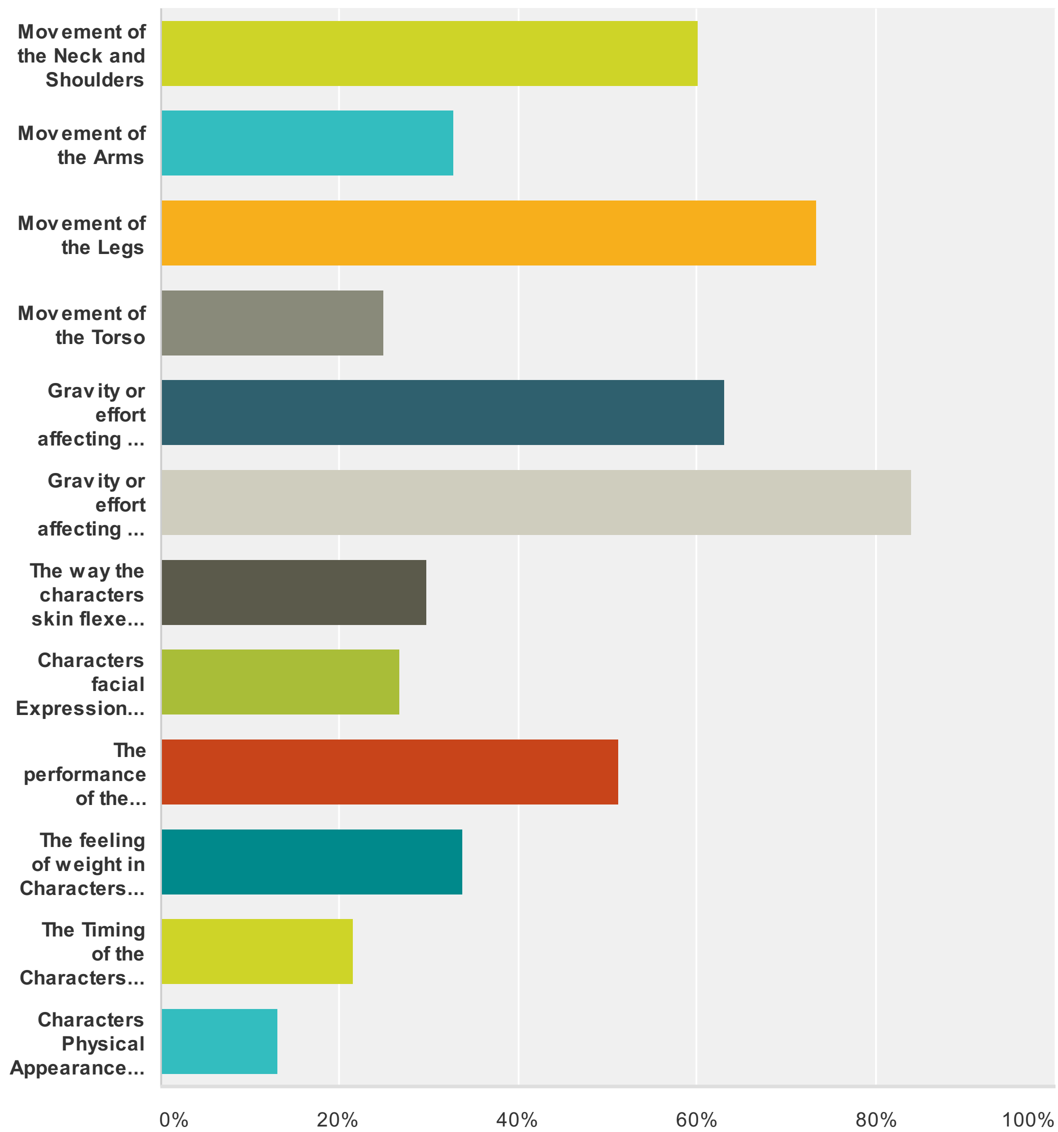
Answered: 205   Skipped: 8



Answer Choices	Responses	
Video (A)	**18.05%**	37
Video (B)	**13.17%**	27
Video (C)	**68.78%**	141
Total		**205**

Q8 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 205   Skipped: 8

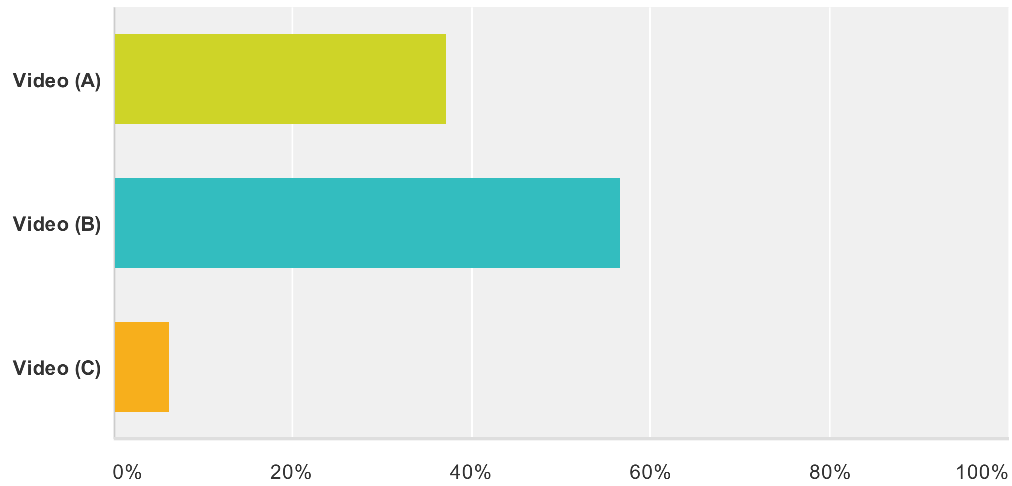


Answer Choices	Responses	
Movement of the Neck and Shoulders	**60%**	123
Movement of the Arms	**32.68%**	67
Movement of the Legs	**73.17%**	150
Movement of the Torso	**24.88%**	51
Gravity or effort affecting the characters performance	**62.93%**	129
Gravity or effort affecting the Shorts on the Character	**83.90%**	172
The way the characters skin flexes is appealing	**29.76%**	61
Characters facial Expressions are appealing	**26.83%**	55
The performance of the Character is appealing	**51.22%**	105

The feeling of weight in Characters Movements is appealing	**33.66%**	69
The Timing of the Characters Movements helps with the characters appeal	**21.46%**	44
Characters Physical Appearance helps with the characters appeal	**13.17%**	27
Total Respondents: 205		

Q9 In which video is the characters movement most realistic?

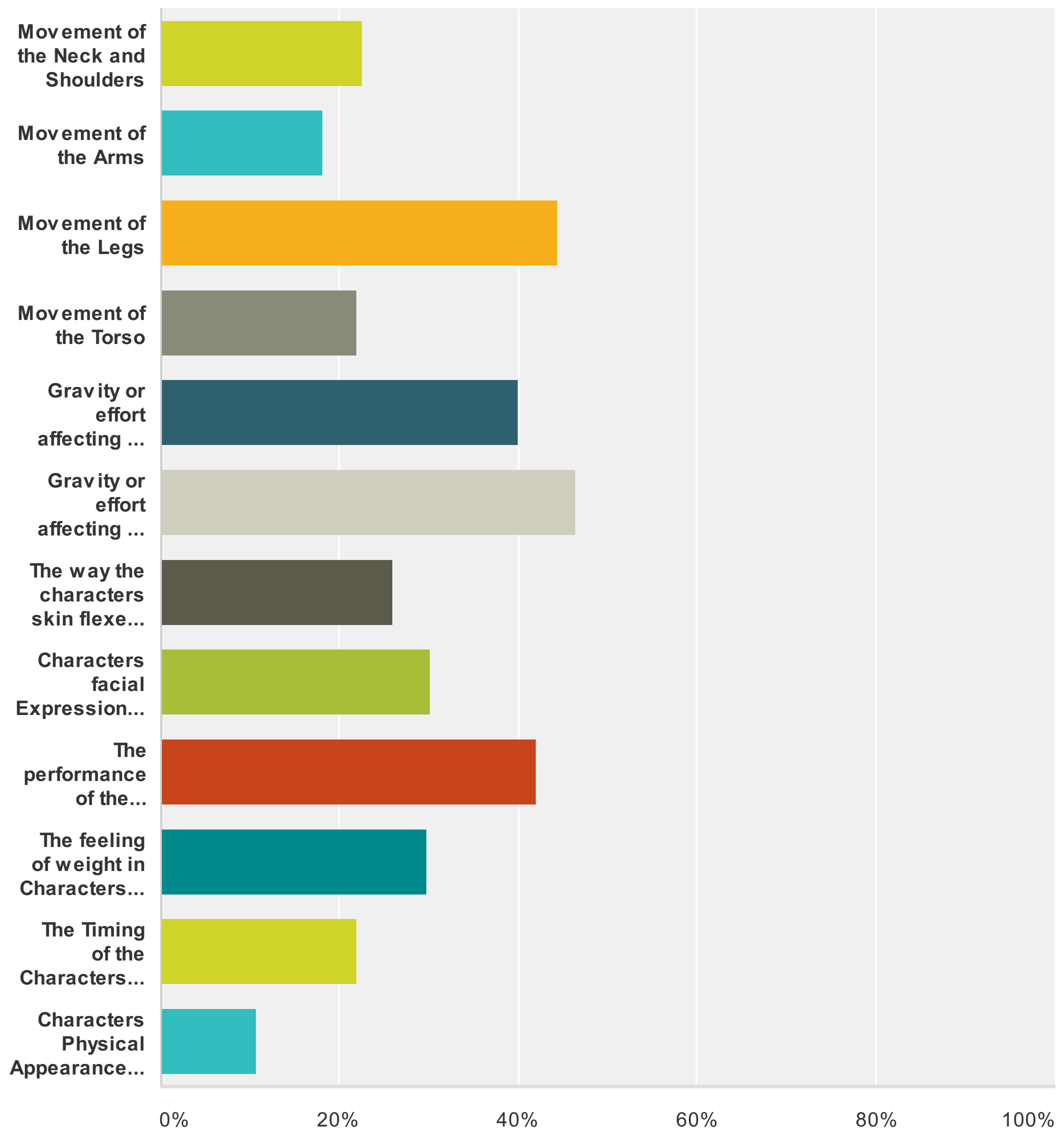
Answered: 205 Skipped: 8



Answer Choices	Responses	
Video (A)	**37.07%**	76
Video (B)	**56.59%**	116
Video (C)	**6.34%**	13
Total		**205**

Q10 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 205 Skipped: 8

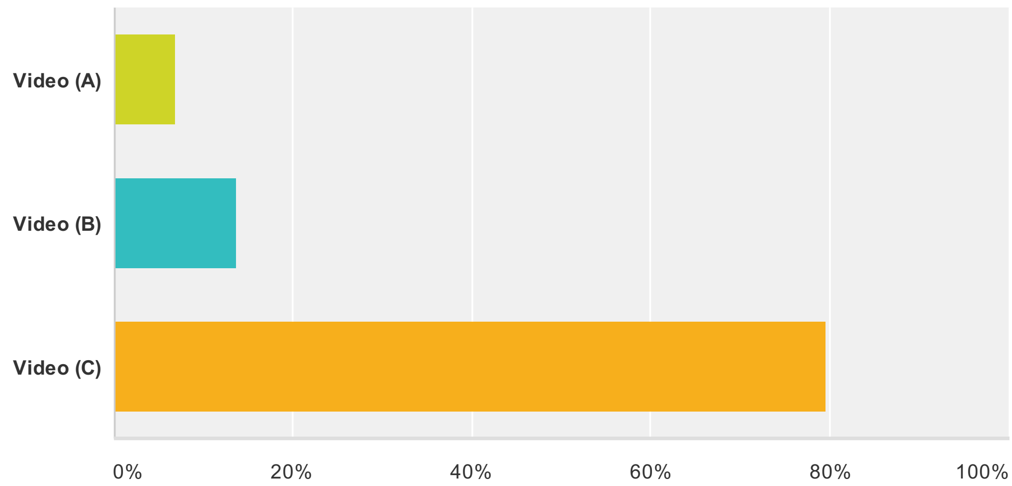


Answer Choices	Responses	
Movement of the Neck and Shoulders	**22.44%**	46
Movement of the Arms	**18.05%**	37
Movement of the Legs	**44.39%**	91
Movement of the Torso	**21.95%**	45
Gravity or effort affecting the characters performance	**40%**	82
Gravity or effort affecting the Shorts on the Character	**46.34%**	95
The way the characters skin flexes is realistic	**25.85%**	53
Characters facial Expressions are realistic	**30.24%**	62
The performance of the Character is realistic	**41.95%**	86

The feeling of weight in Characters Movements is realistic	**29.76%**	61
The Timing of the Characters Movements helps with the characters realistic	**21.95%**	45
Characters Physical Appearance helps with the characters realistic	**10.73%**	22
Total Respondents: 205		

Q11 In which video is the characters movement most believable?

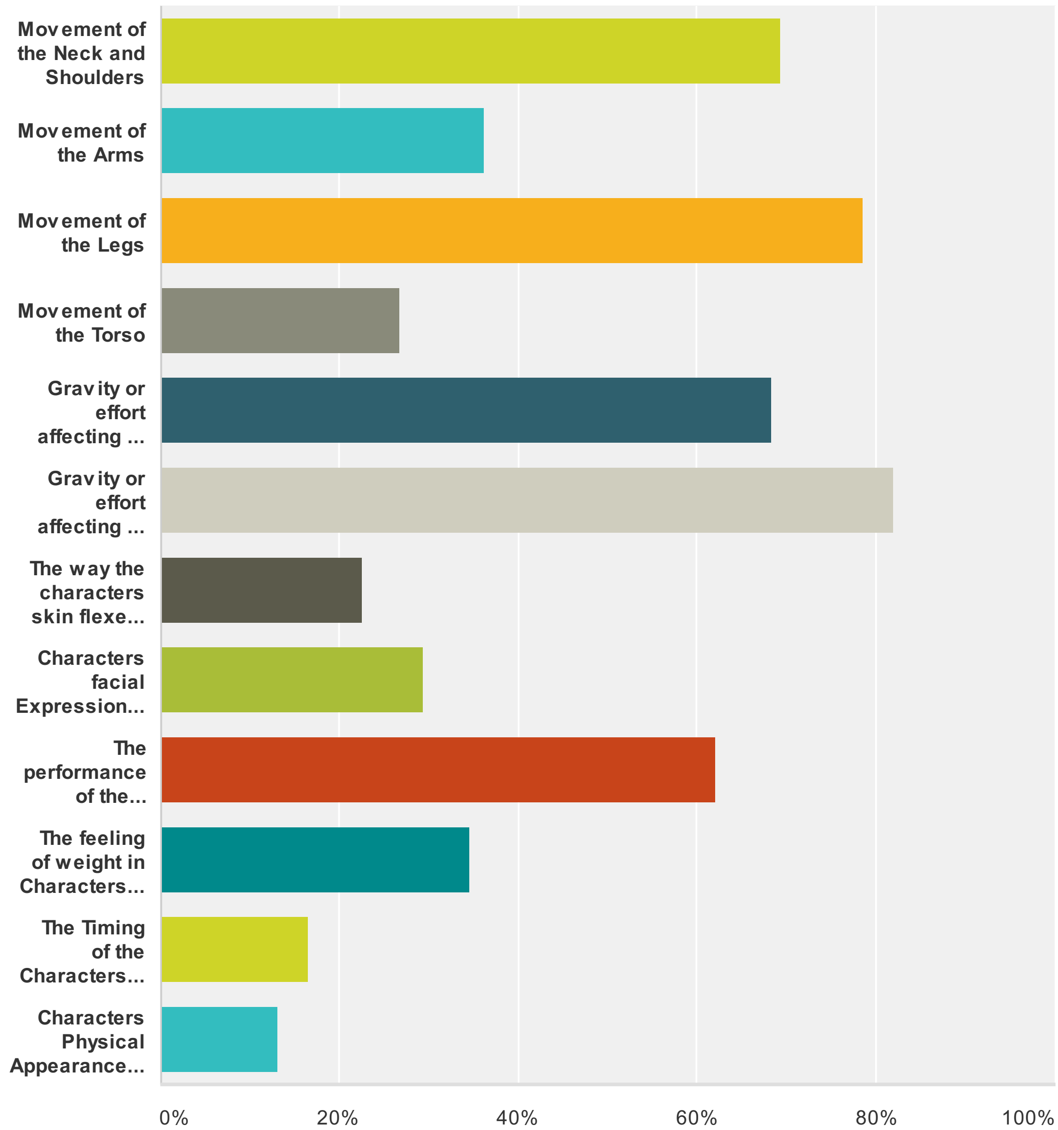
Answered: 205 Skipped: 8



Answer Choices	Responses	
Video (A)	**6.83%**	14
Video (B)	**13.66%**	28
Video (C)	**79.51%**	163
Total		**205**

Q12 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 205 Skipped: 8

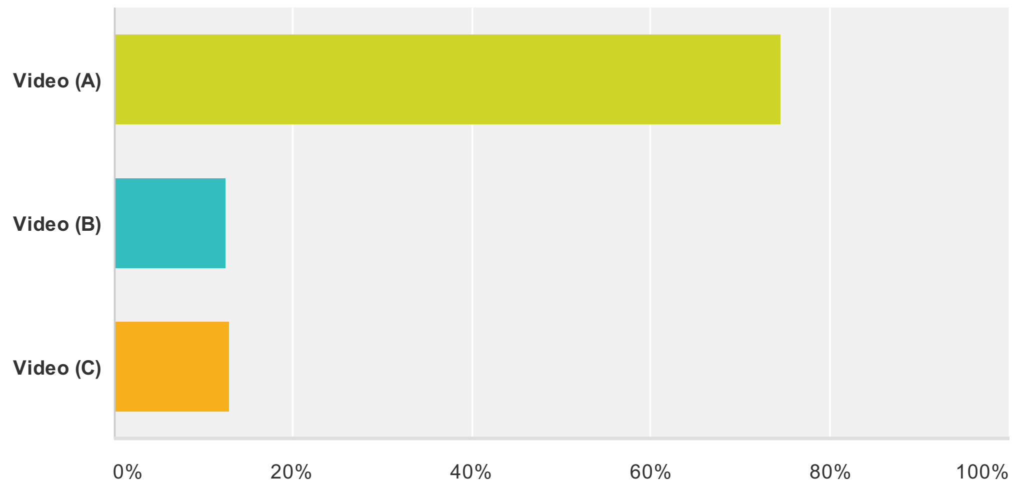


Answer Choices	Responses	
Movement of the Neck and Shoulders	69.27%	142
Movement of the Arms	36.10%	74
Movement of the Legs	78.54%	161
Movement of the Torso	26.83%	55
Gravity or effort affecting the characters performance	68.29%	140
Gravity or effort affecting the Shorts on the Character	81.95%	168
The way the characters skin flexes is believable	22.44%	46
Characters facial Expressions are believable	29.27%	60
The performance of the Character is believable	61.95%	127

The feeling of weight in Characters Movements is believable	**34.63%**	71
The Timing of the Characters Movements helps with the characters believable	**16.59%**	34
Characters Physical Appearance helps with the characters believable	**13.17%**	27
Total Respondents: 205		

Q13 In which video is the characters movement most appealing?

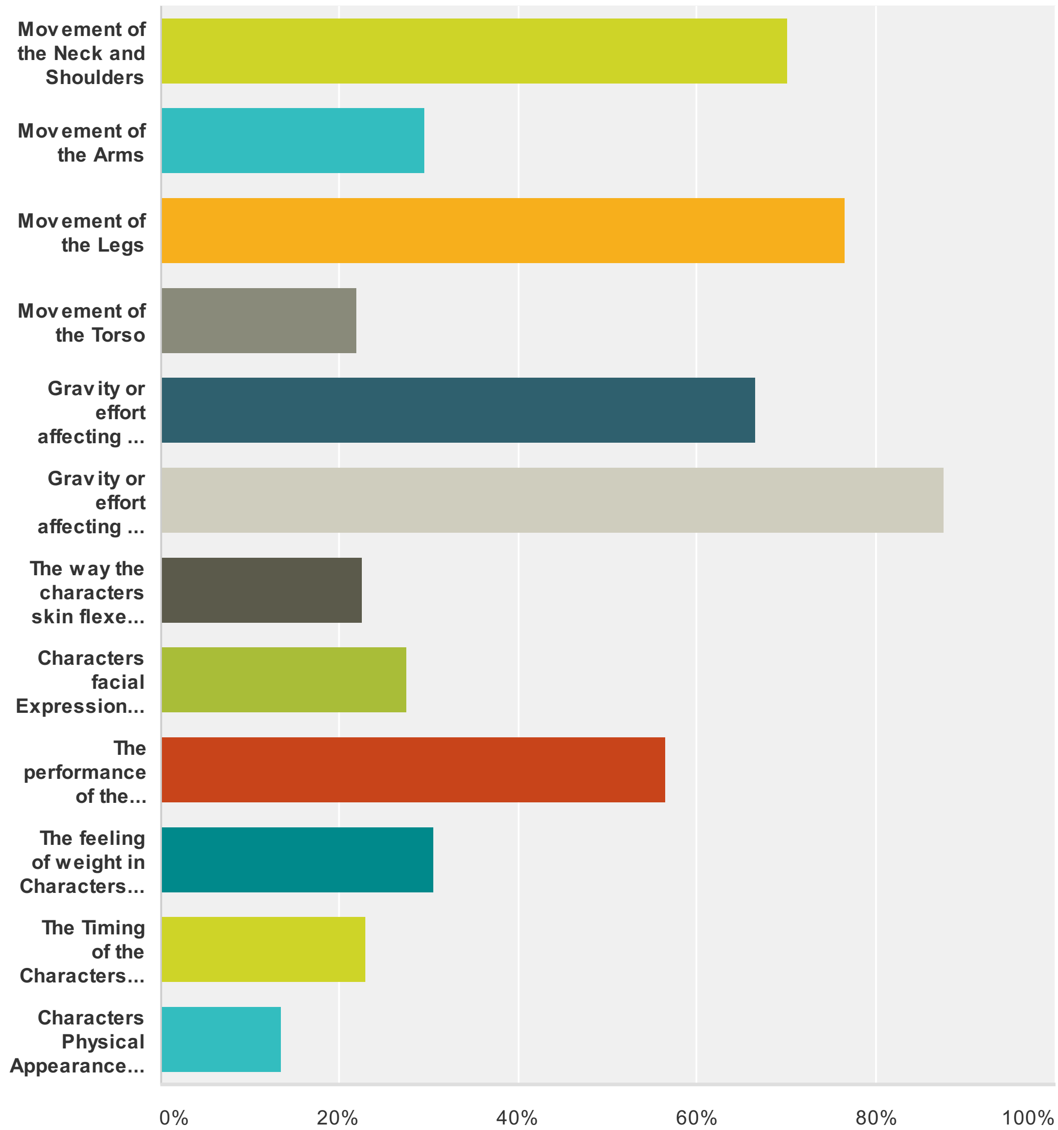
Answered: 200 Skipped: 13



Answer Choices	Responses	
Video (A)	**74.50%**	149
Video (B)	**12.50%**	25
Video (C)	**13%**	26
Total		**200**

Q14 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 200 Skipped: 13

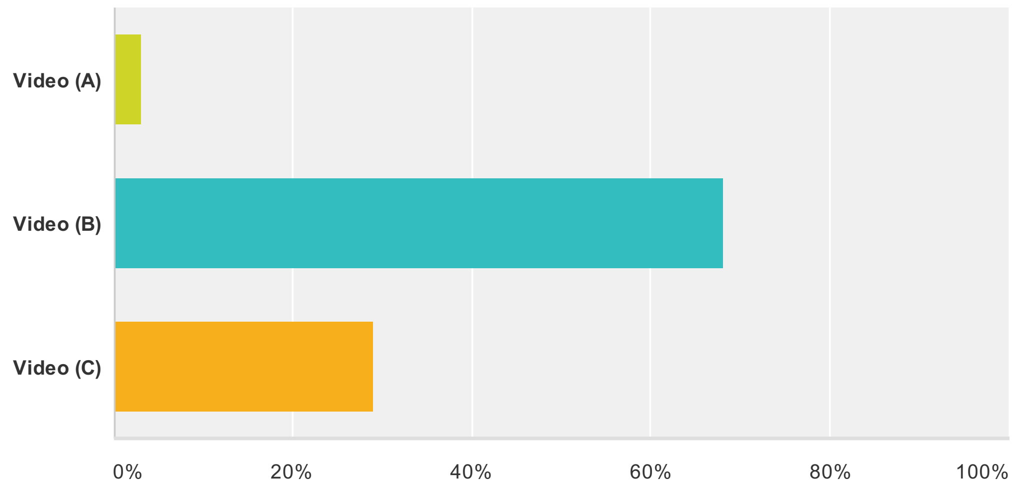


Answer Choices	Responses	
Movement of the Neck and Shoulders	**70%**	140
Movement of the Arms	**29.50%**	59
Movement of the Legs	**76.50%**	153
Movement of the Torso	**22%**	44
Gravity or effort affecting the characters performance	**66.50%**	133
Gravity or effort affecting the Shorts on the Character	**87.50%**	175
The way the characters skin flexes is appealing	**22.50%**	45
Characters facial Expressions are appealing	**27.50%**	55
The performance of the Character is appealing	**56.50%**	113

The feeling of weight in Characters Movements is appealing	**30.50%**	61
The Timing of the Characters Movements helps with the characters appeal	**23%**	46
Characters Physical Appearance helps with the characters appeal	**13.50%**	27
Total Respondents: 200		

Q15 In which video is the characters movement most realistic?

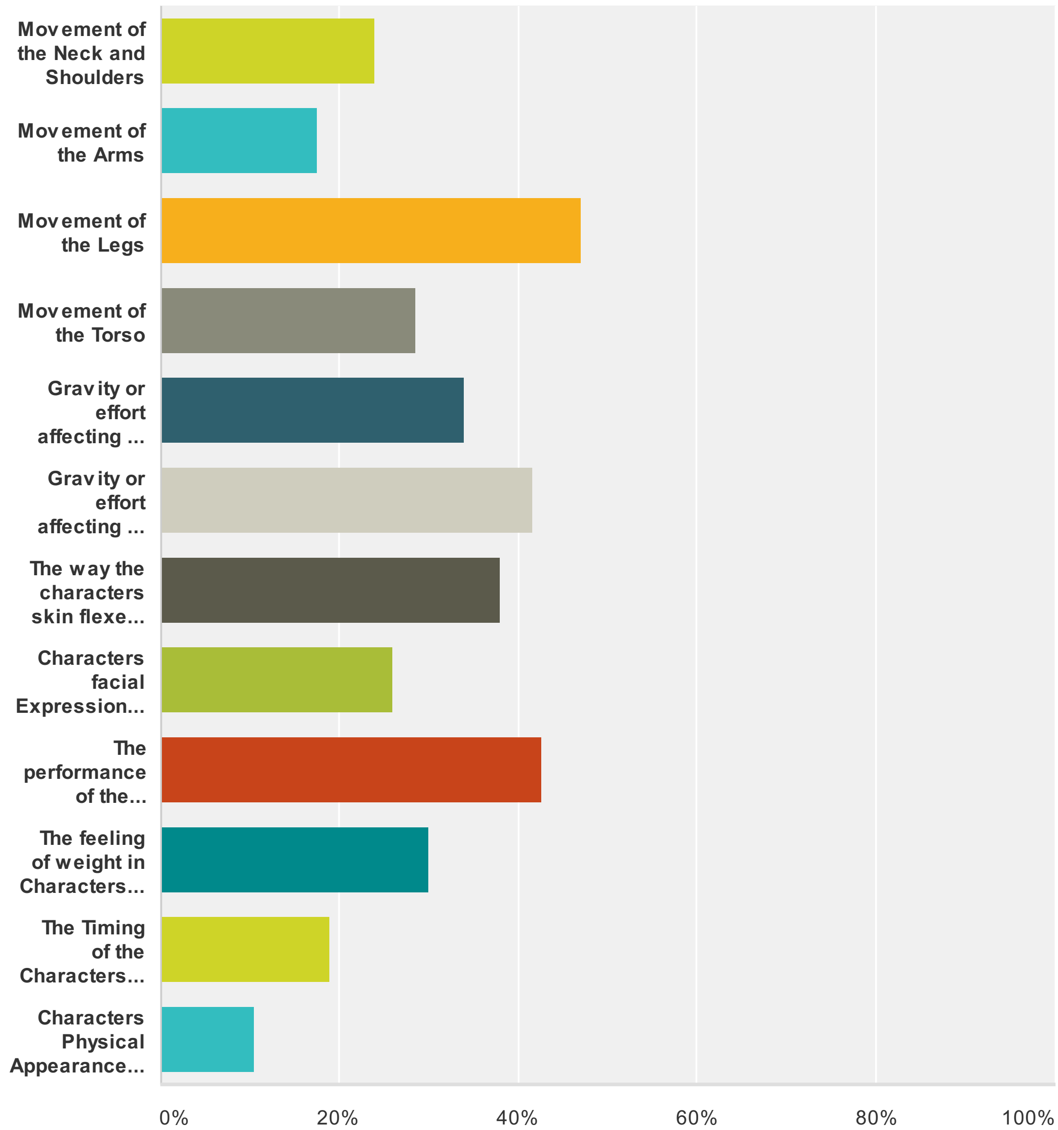
Answered: 200 Skipped: 13



Answer Choices	Responses	
Video (A)	**3%**	6
Video (B)	**68%**	136
Video (C)	**29.00%**	58
Total		**200**

Q16 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 200 Skipped: 13

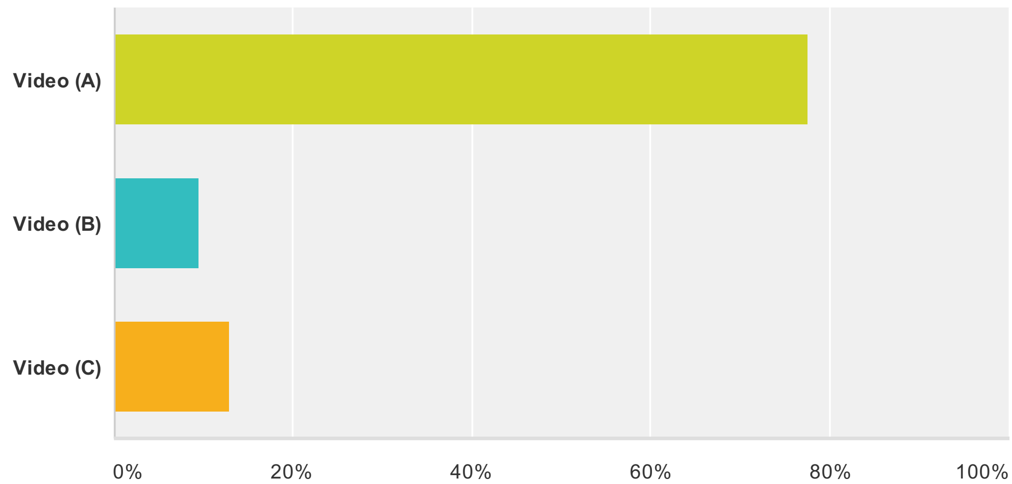


Answer Choices	Responses	
Movement of the Neck and Shoulders	24%	48
Movement of the Arms	17.50%	35
Movement of the Legs	47%	94
Movement of the Torso	28.50%	57
Gravity or effort affecting the characters performance	34%	68
Gravity or effort affecting the Shorts on the Character	41.50%	83
The way the characters skin flexes is realistic	38%	76
Characters facial Expressions are realistic	26%	52
The performance of the Character is realistic	42.50%	85

The feeling of weight in Characters Movements is realistic	**30%**	60
The Timing of the Characters Movements helps with the characters realistic	**19%**	38
Characters Physical Appearance helps with the characters realistic	**10.50%**	21
Total Respondents: 200		

Q17 In which video is the characters movement most believable?

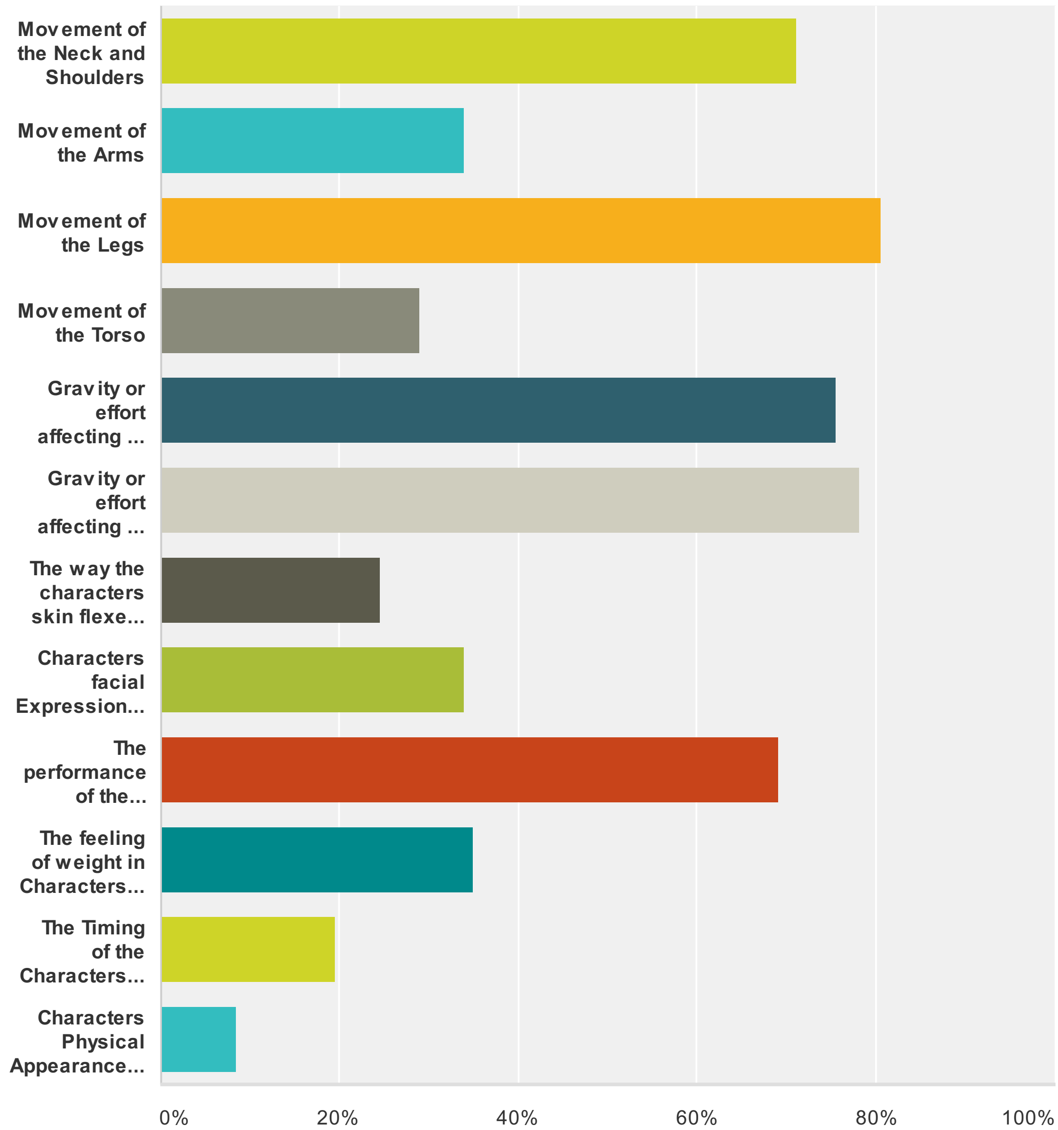
Answered: 200   Skipped: 13



Answer Choices	Responses	
Video (A)	**77.50%**	155
Video (B)	**9.50%**	19
Video (C)	**13%**	26
Total		**200**

Q18 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 200 Skipped: 13

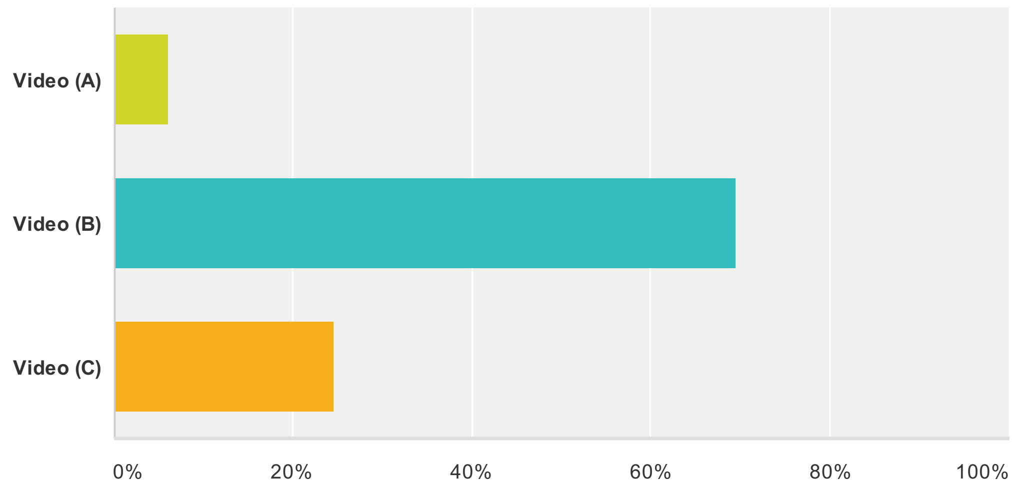


Answer Choices	Responses	
Movement of the Neck and Shoulders	71%	142
Movement of the Arms	34%	68
Movement of the Legs	80.50%	161
Movement of the Torso	29.00%	58
Gravity or effort affecting the characters performance	75.50%	151
Gravity or effort affecting the Shorts on the Character	78%	156
The way the characters skin flexes is believable	24.50%	49
Characters facial Expressions are believable	34%	68
The performance of the Character is believable	69%	138

The feeling of weight in Characters Movements is believable	**35%**	70
The Timing of the Characters Movements helps with the characters believable	**19.50%**	39
Characters Physical Appearance helps with the characters believable	**8.50%**	17
Total Respondents: 200		

Q19 In which video is the characters movement most appealing?

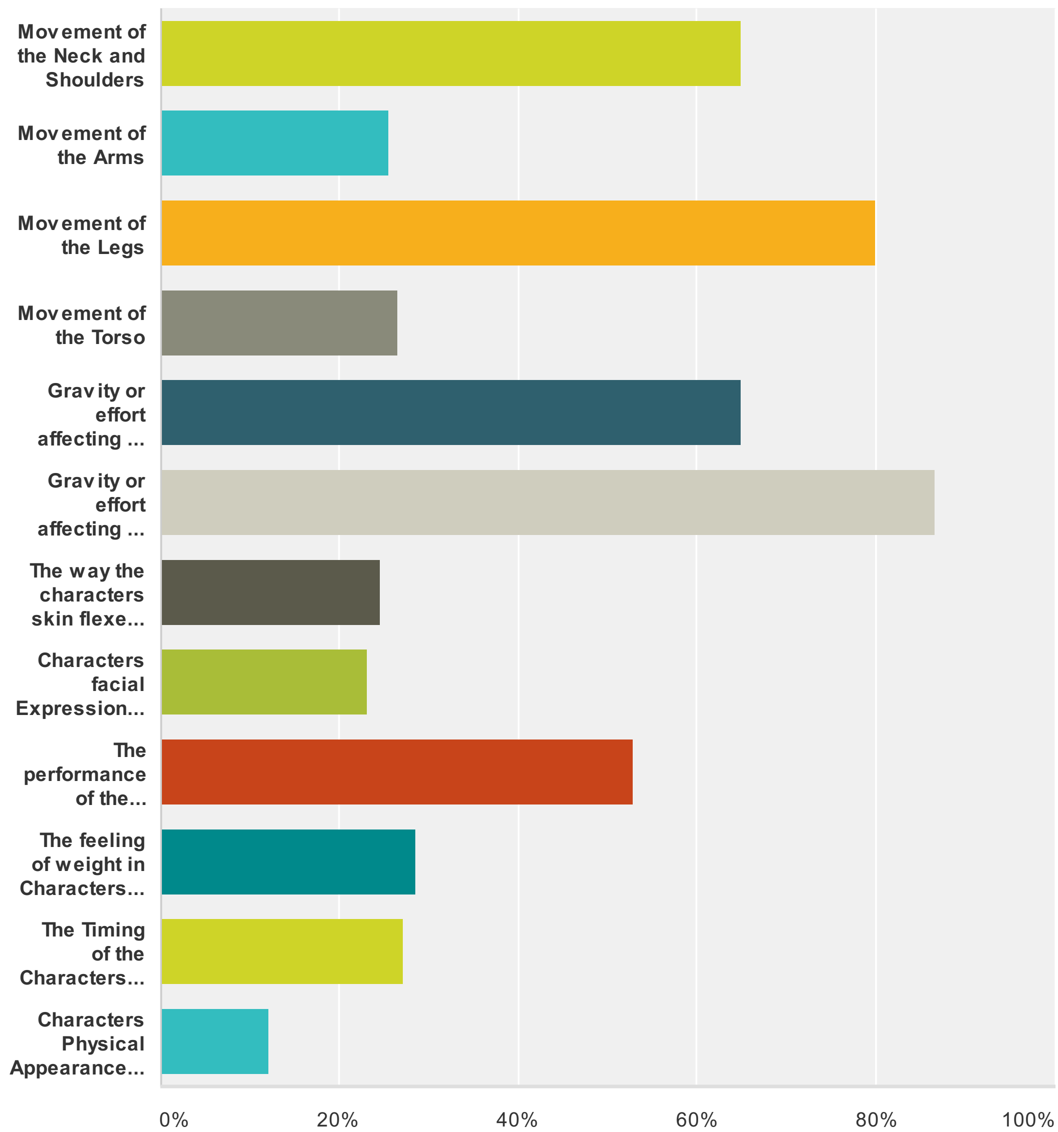
Answered: 199 Skipped: 14



Answer Choices	Responses	
Video (A)	**6.03%**	12
Video (B)	**69.35%**	138
Video (C)	**24.62%**	49
Total		**199**

Q20 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 199 Skipped: 14

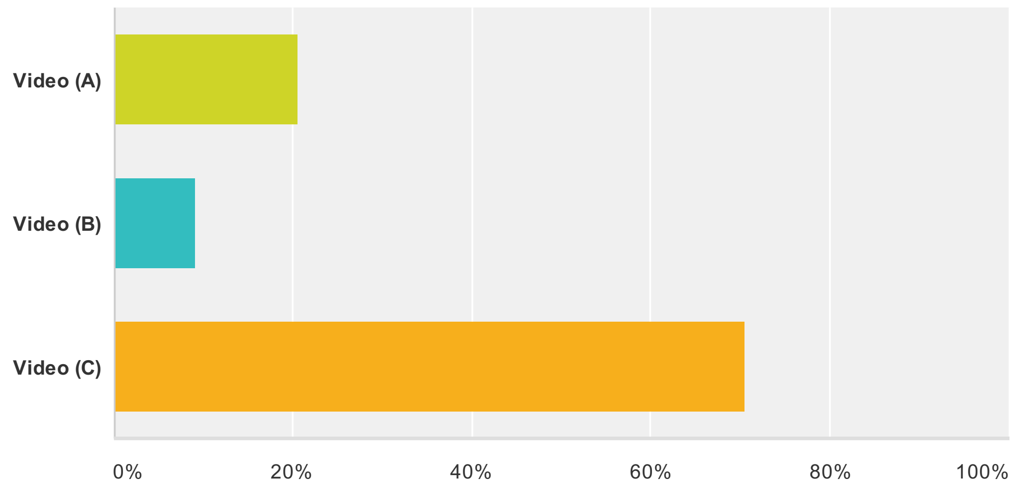


Answer Choices	Responses	
Movement of the Neck and Shoulders	64.82%	129
Movement of the Arms	25.63%	51
Movement of the Legs	79.90%	159
Movement of the Torso	26.63%	53
Gravity or effort affecting the characters performance	64.82%	129
Gravity or effort affecting the Shorts on the Character	86.43%	172
The way the characters skin flexes is appealing	24.62%	49
Characters facial Expressions are appealing	23.12%	46
The performance of the Character is appealing	52.76%	105

The feeling of weight in Characters Movements is appealing	**28.64%**	57
The Timing of the Characters Movements helps with the characters appeal	**27.14%**	54
Characters Physical Appearance helps with the characters appeal	**12.06%**	24
Total Respondents: 199		

Q21 In which video is the characters movement most realistic?

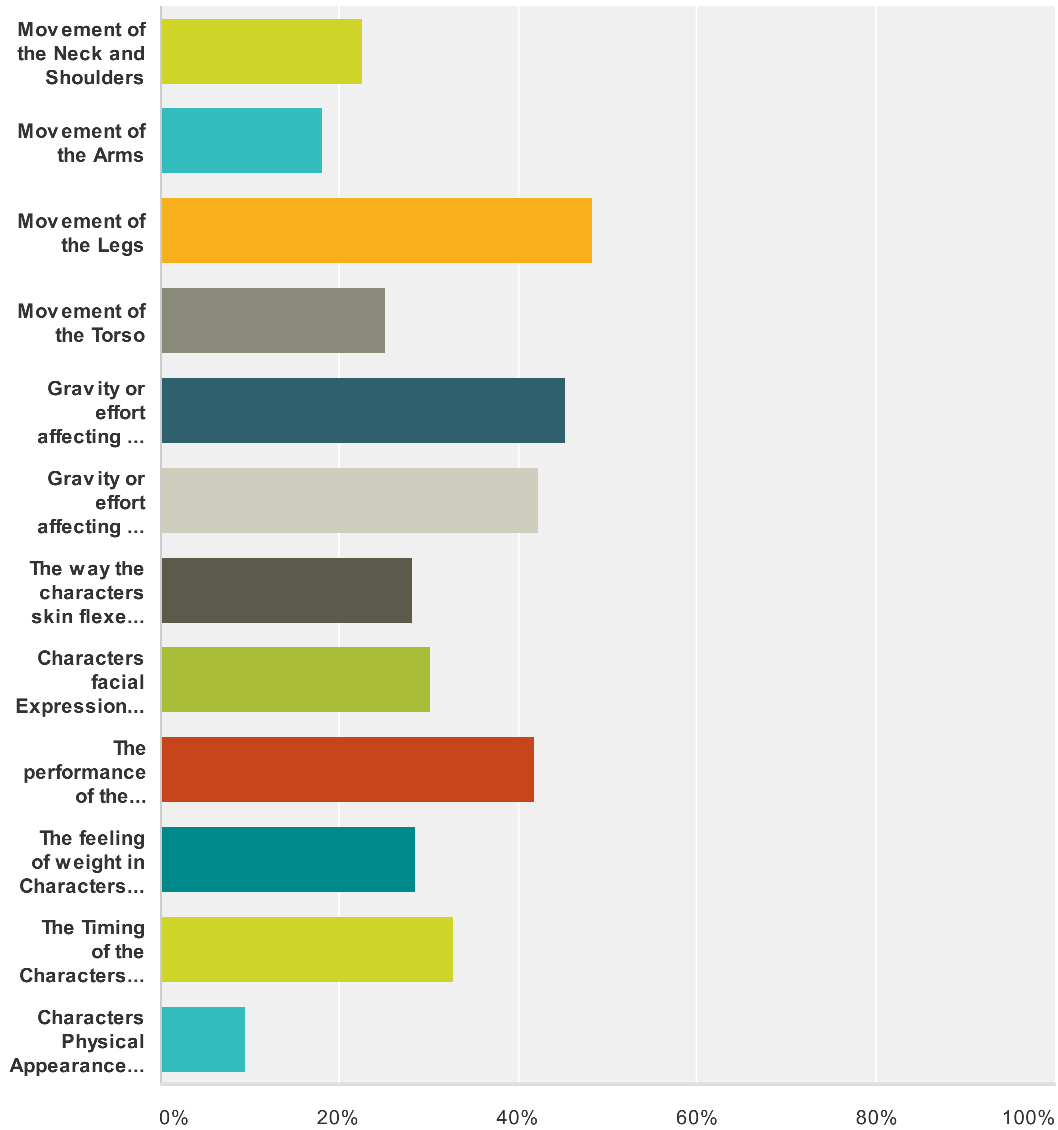
Answered: 199   Skipped: 14



Answer Choices	Responses	
Video (A)	**20.60%**	41
Video (B)	**9.05%**	18
Video (C)	**70.35%**	140
Total		**199**

Q22 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 199 Skipped: 14

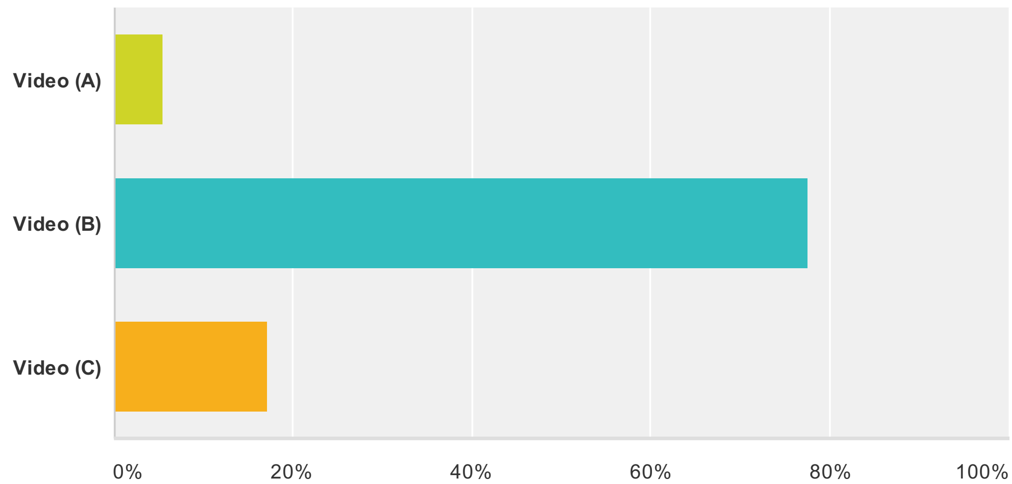


Answer Choices	Responses	
Movement of the Neck and Shoulders	22.61%	45
Movement of the Arms	18.09%	36
Movement of the Legs	48.24%	96
Movement of the Torso	25.13%	50
Gravity or effort affecting the characters performance	45.23%	90
Gravity or effort affecting the Shorts on the Character	42.21%	84
The way the characters skin flexes is realistic	28.14%	56
Characters facial Expressions are realistic	30.15%	60
The performance of the Character is realistic	41.71%	83

The feeling of weight in Characters Movements is realistic	**28.64%**	57
The Timing of the Characters Movements helps with the characters realistic	**32.66%**	65
Characters Physical Appearance helps with the characters realistic	**9.55%**	19
Total Respondents: 199		

Q23 In which video is the characters movement most believable?

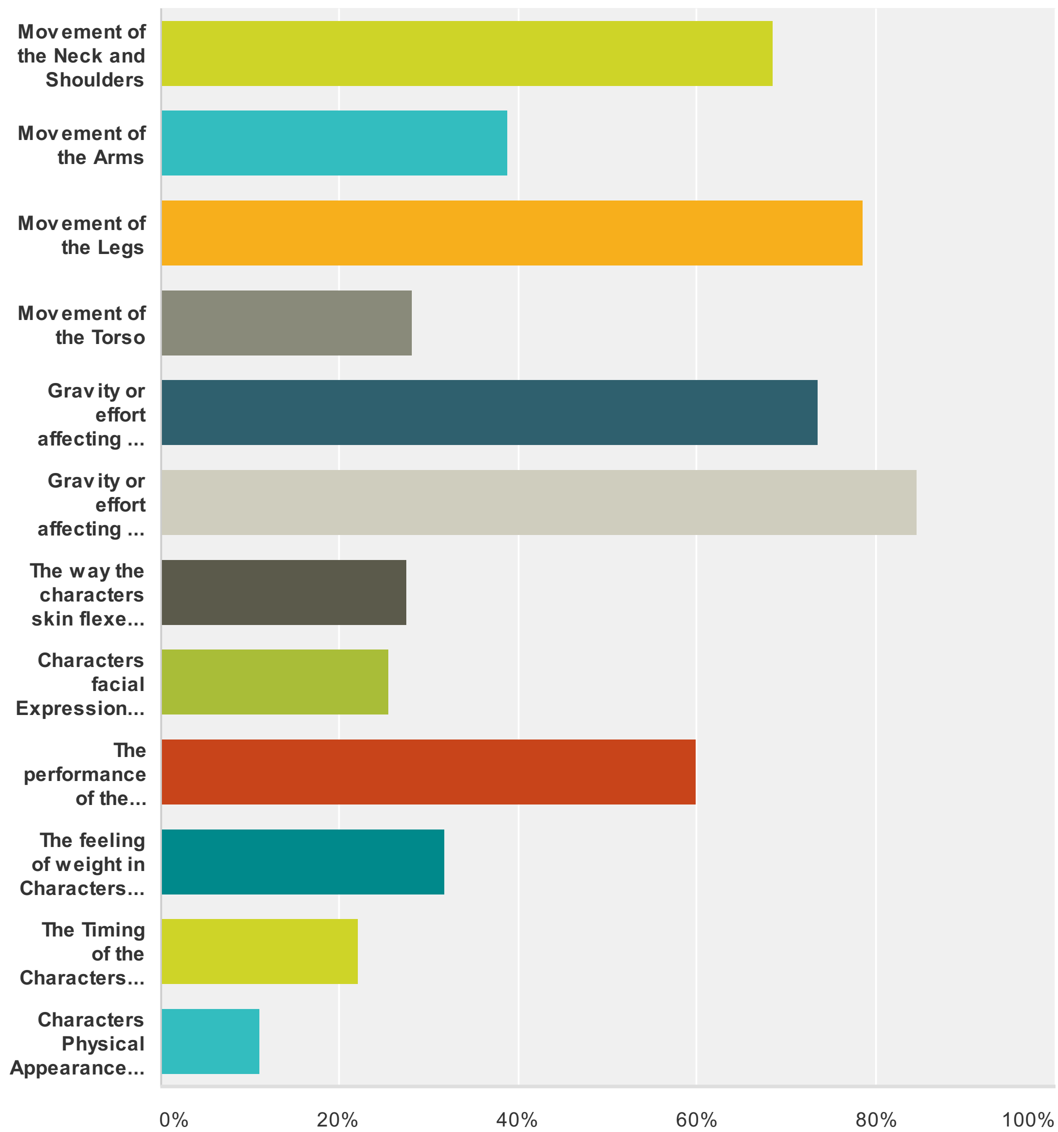
Answered: 199   Skipped: 14



Answer Choices	Responses	
Video (A)	**5.53%**	11
Video (B)	**77.39%**	154
Video (C)	**17.09%**	34
Total		**199**

Q24 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 199 Skipped: 14

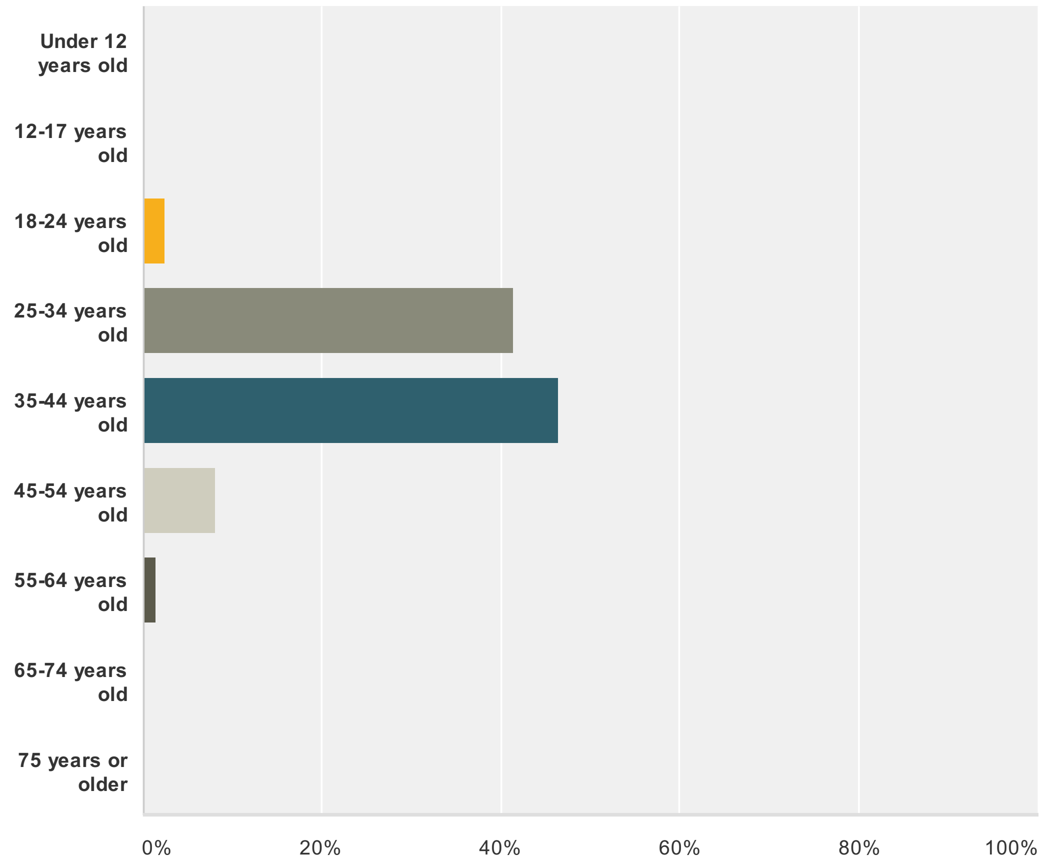


Answer Choices	Responses	
Movement of the Neck and Shoulders	68.34%	136
Movement of the Arms	38.69%	77
Movement of the Legs	78.39%	156
Movement of the Torso	28.14%	56
Gravity or effort affecting the characters performance	73.37%	146
Gravity or effort affecting the Shorts on the Character	84.42%	168
The way the characters skin flexes is believable	27.64%	55
Characters facial Expressions are believable	25.63%	51
The performance of the Character is believable	59.80%	119

The feeling of weight in Characters Movements is believable	**31.66%**	63
The Timing of the Characters Movements helps with the characters believable	**22.11%**	44
Characters Physical Appearance helps with the characters believable	**11.06%**	22
Total Respondents: 199		

Q25 Please enter your Age range.

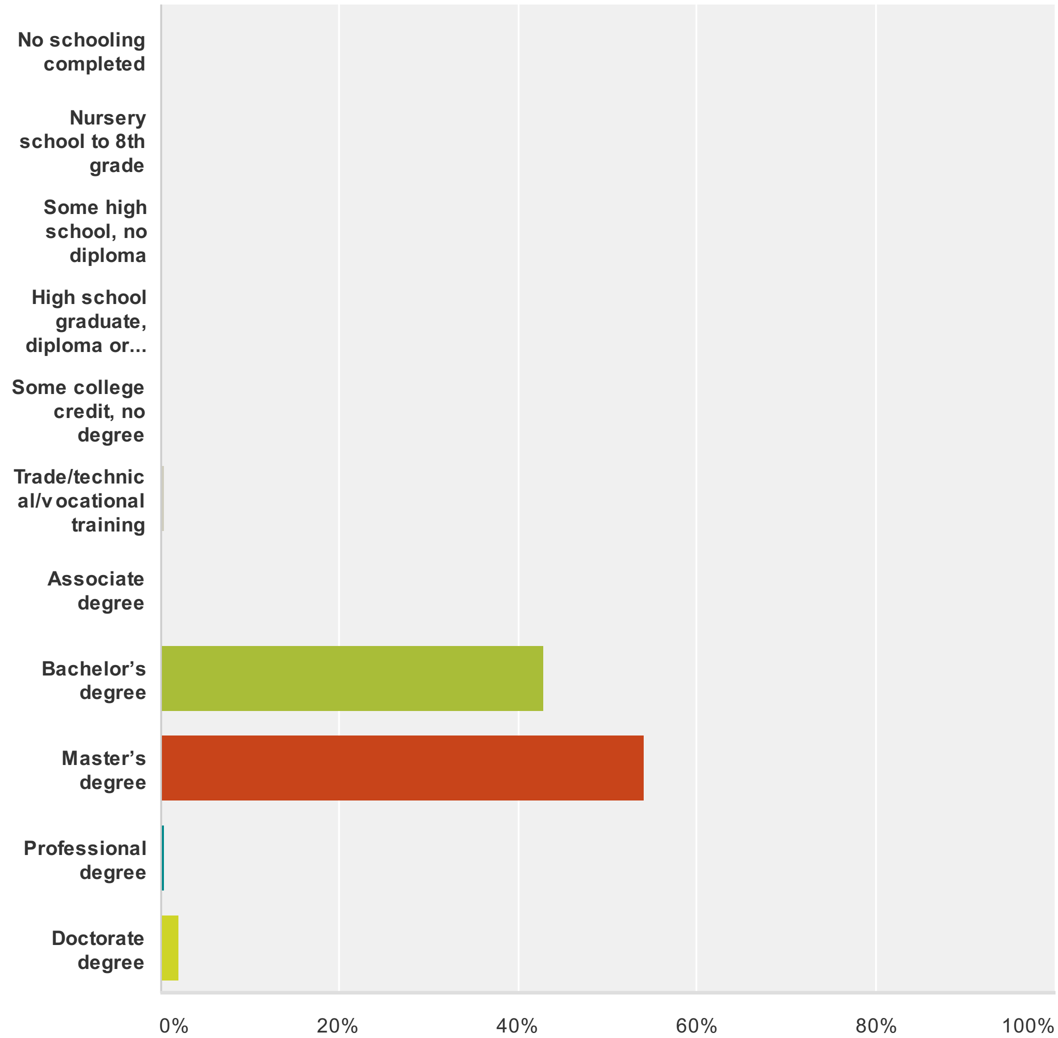
Answered: 196 Skipped: 17



Answer Choices	Responses	
Under 12 years old	**0%**	0
12-17 years old	**0%**	0
18-24 years old	**2.55%**	5
25-34 years old	**41.33%**	81
35-44 years old	**46.43%**	91
45-54 years old	**8.16%**	16
55-64 years old	**1.53%**	3
65-74 years old	**0%**	0
75 years or older	**0%**	0
Total		**196**

Q26 What is the highest degree or level of school you have completed? If currently enrolled please select the highest degree received.

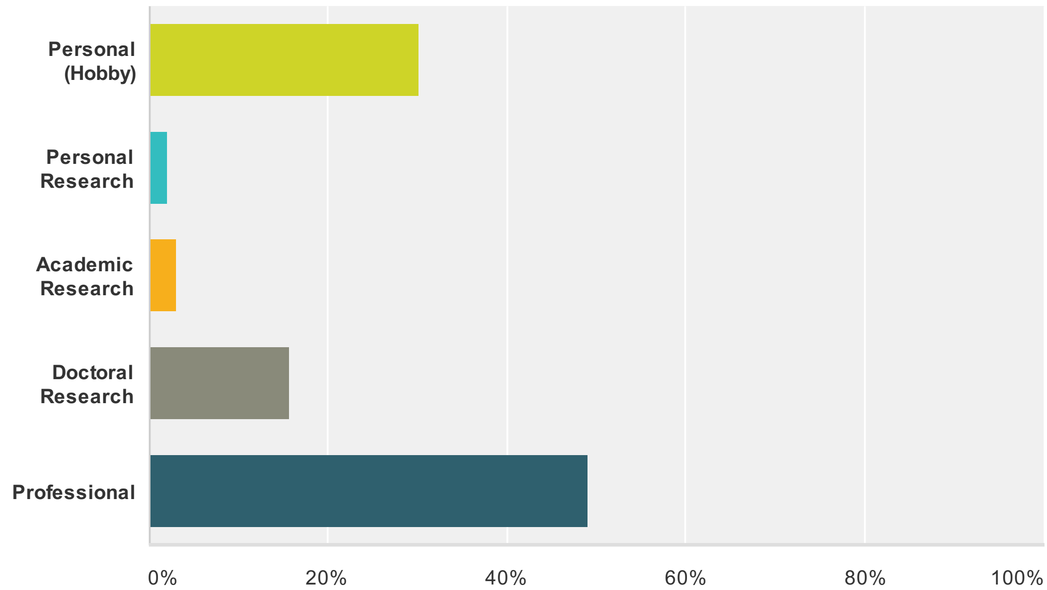
Answered: 196   Skipped: 17



Answer Choices	Responses	
No schooling completed	0%	0
Nursery school to 8th grade	0%	0
Some high school, no diploma	0%	0
High school graduate, diploma or the equivalent	0%	0
Some college credit, no degree	0%	0
Trade/technical/vocational training	0.51%	1
Associate degree	0%	0
Bachelor's degree	42.86%	84
Master's degree	54.08%	106
Professional degree	0.51%	1
Doctorate degree	2.04%	4
Total		**196**

Q27 What is your interest in Animation?

Answered: 196 Skipped: 17



Answer Choices	Responses	
Personal (Hobby)	**30.10%**	59
Personal Research	**2.04%**	4
Academic Research	**3.06%**	6
Doctoral Research	**15.82%**	31
Professional	**48.98%**	96
Total		**196**

Appendix L: Error Margin Calculation Output for Every Animated Performance Group

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Sample size calculator

What margin of error can you accept? 5% is a common choice	5 %	The margin of error is the amount of error that you can tolerate. If 90% of respondents answer yes, while 10% answer no, you may be able to tolerate a larger amount of error than if the respondents are split 50-50 or 45-55. Lower margin of error requires a larger sample size.
What confidence level do you need? Typical choices are 90%, 95%, or 99%	95 %	The confidence level is the amount of uncertainty you can tolerate. Suppose that you have 20 yes-no questions in your survey. With a confidence level of 95%, you would expect that for one of the questions (1 in 20), the percentage of people who answer yes would be more than the margin of error away from the true answer. The true answer is the percentage you would get if you exhaustively interviewed everyone. Higher confidence level requires a larger sample size.
What is the population size? If you don't know , use 20000	300	How many people are there to choose your random sample from? The sample size doesn't change much for populations larger than 20,000.
What is the response distribution? Leave this as 50%	50 %	For each question, what do you expect the results will be? If the sample is skewed highly one way or the other,the population probably is, too. If you don't know, use 50%, which gives the largest sample size. See below under More information if this is confusing.
Your recommended sample size is	169	This is the minimum recommended size of your survey. If you create a sample of this many people and get responses from everyone, you're more likely to get a correct answer than you would from a large sample where only a small percentage of the sample responds to your survey.

Alternate scenarios

With a sample size of	100	213	300	With a confidence level of	90	95	99
Your margin of error would be	8.01%	3.62%	0.00%	Your sample size would need to be	143	169	207

More information

If 50% of all the people in a population of 20000 people drink coffee in the morning, and if you were repeat the survey of 377 people ("Did you drink coffee this morning?") many times, then 95% of the time, your survey would find that between 45% and 55% of the people in your sample answered "Yes".

The remaining 5% of the time, or for 1 in 20 survey questions, you would expect the survey response to more than the margin of error away from the true answer.

When you survey a sample of the population, you don't know that you've found the correct answer, but you do know that there's a 95% chance that you're within the margin of error of the correct answer.

Try changing your sample size and watch what happens to the alternate scenarios. That tells you what happens if you don't use the recommended sample size, and how M.O.E and confidence level (that 95%) are related.

To learn more if you're a beginner, read Basic Statistics: A Modern Approach and The Cartoon Guide to Statistics. Otherwise, look at the more advanced books.

In terms of the numbers you selected above, the sample size n and margin of error E are given by

$$x = Z(^{c}/_{100})^{2} r(100-r)$$

$$n = {}^{N\,x}/_{((N-1)E^{2} + x)}$$

$$E = \mathrm{Sqrt}[^{(N - n)x}/_{n(N-1)}]$$

where N is the population size, r is the fraction of responses that you are interested in, and Z(c/100) is the critical value for the confidence level c.

If you'd like to see how we perform the calculation, view the page source. This calculation is based on the Normal distribution, and assumes you have more than about 30 samples.

About Response distribution: If you ask a random sample of 10 people if they like donuts, and 9 of them say, "Yes", then the prediction that you make about the general population is different than it would be if 5 had said, "Yes", and 5 had said, "No". Setting the response distribution to 50% is the most conservative assumption. So just leave it at 50% unless you know what you're doing. The sample size calculator computes the critical value for the normal distribution. Wikipedia has good articles on statistics.

How do you like this web page? ○ Good as-is ○ Could be even better

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What is the population size? If you don't know, use 20000	300	How many people are there to choose your random sample from? The sample size doesn't change much for populations larger than 20,000.
What is the response distribution? Leave this as 50%	50 %	For each question, what do you expect the results will be? If the sample is skewed highly one way or the other,the population probably is, too. If you don't know, use 50%, which gives the largest sample size. See below under More information if this is confusing.
Your recommended sample size is	169	This is the minimum recommended size of your survey. If you create a sample of this many people and get responses from everyone, you're more likely to get a correct answer than you would from a large sample where only a small percentage of the sample responds to your survey.

Online surveys with Vovici have completion rates of 66%!

Alternate scenarios

With a sample size of	100	205	300	With a confidence level of	90	95	99
Your margin of error would be	8.01%	3.86%	0.00%	Your sample size would need to be	143	169	207

Save effort, save time. Conduct your survey online with Vovici.

More information

If 50% of all the people in a population of 20000 people drink coffee in the morning, and if you were repeat the survey of 377 people ("Did you drink coffee this morning?") many times, then 95% of the time, your survey would find that between 45% and 55% of the people in your sample answered "Yes".

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$$E = \mathrm{Sqrt}[^{(N-n)x}/_{n(N-1)}]$$

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How do you like this web page? ○ Good as-is ○ Could be even better

Raosoft®

Sample size calculator

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What confidence level do you need? Typical choices are 90%, 95%, or 99%	95 %	The confidence level is the amount of uncertainty you can tolerate. Suppose that you have 20 yes-no questions in your survey. With a confidence level of 95%, you would expect that for one of the questions (1 in 20), the percentage of people who answer yes would be more than the margin of error away from the true answer. The true answer is the percentage you would get if you exhaustively interviewed everyone. Higher confidence level requires a larger sample size.
What is the population size? If you don't know , use 20000	300	How many people are there to choose your random sample from? The sample size doesn't change much for populations larger than 20,000.
What is the response distribution? Leave this as 50%	50 %	For each question, what do you expect the results will be? If the sample is skewed highly one way or the other,the population probably is, too. If you don't know, use 50%, which gives the largest sample size. See below under More information if this is confusing.
Your recommended sample size is	169	This is the minimum recommended size of your survey. If you create a sample of this many people and get responses from everyone, you're more likely to get a correct answer than you would from a large sample where only a small percentage of the sample responds to your survey.

Alternate scenarios

With a sample size of	100	200	300	With a confidence level of	90	95	99
Your margin of error would be	8.01%	4.01%	0.00%	Your sample size would need to be	143	169	207

More information

If 50% of all the people in a population of 20000 people drink coffee in the morning, and if you were repeat the survey of 377 people ("Did you drink coffee this morning?") many times, then 95% of the time, your survey would find that between 45% and 55% of the people in your sample answered "Yes".

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$$E = \mathrm{Sqrt}[^{(N - n)x}/_{n(N-1)}]$$

where N is the population size, r is the fraction of responses that you are interested in, and Z(c/100) is the critical value for the confidence level c.

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Sample size calculator

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What confidence level do you need? Typical choices are 90%, 95%, or 99%	95 %	The confidence level is the amount of uncertainty you can tolerate. Suppose that you have 20 yes-no questions in your survey. With a confidence level of 95%, you would expect that for one of the questions (1 in 20), the percentage of people who answer yes would be more than the margin of error away from the true answer. The true answer is the percentage you would get if you exhaustively interviewed everyone. Higher confidence level requires a larger sample size.
What is the population size? If you don't know , use 20000	300	How many people are there to choose your random sample from? The sample size doesn't change much for populations larger than 20,000.
What is the response distribution? Leave this as 50%	50 %	For each question, what do you expect the results will be? If the sample is skewed highly one way or the other,the population probably is, too. If you don't know, use 50%, which gives the largest sample size. See below under More information if this is confusing.
Your recommended sample size is	169	This is the minimum recommended size of your survey. If you create a sample of this many people and get responses from everyone, you're more likely to get a correct answer than you would from a large sample where only a small percentage of the sample responds to your survey.

Alternate scenarios

With a sample size of	100	199	300	With a confidence level of	90	95	99
Your margin of error would be	8.01%	4.04%	0.00%	Your sample size would need to be	143	169	207

More information

If 50% of all the people in a population of 20000 people drink coffee in the morning, and if you were repeat the survey of 377 people ("Did you drink coffee this morning?") many times, then 95% of the time, your survey would find that between 45% and 55% of the people in your sample answered "Yes".

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$$n = {}^{N\,x}/_{((N-1)E^{2} + x)}$$

$$E = \mathrm{Sqrt}[^{(N - n)x}/_{n(N-1)}]$$

where N is the population size, r is the fraction of responses that you are interested in, and Z(c/100) is the critical value for the confidence level c.

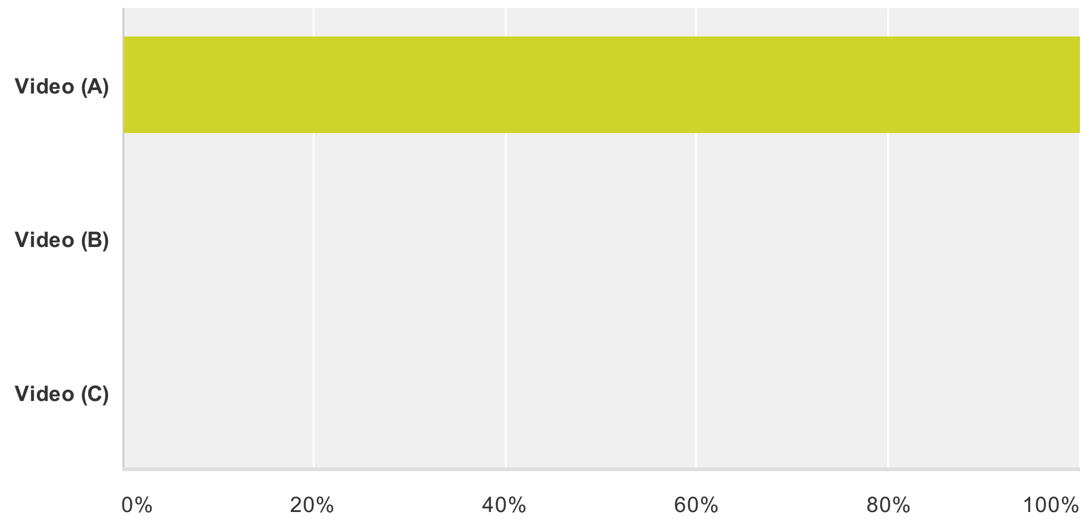
If you'd like to see how we perform the calculation, view the page source. This calculation is based on the Normal distribution, and assumes you have more than about 30 samples.

About Response distribution: If you ask a random sample of 10 people if they like donuts, and 9 of them say, "Yes", then the prediction that you make about the general population is different than it would be if 5 had said, "Yes", and 5 had said, "No". Setting the response distribution to 50% is the most conservative assumption. So just leave it at 50% unless you know what you're doing. The sample size calculator computes the critical value for the normal distribution. Wikipedia has good articles on statistics.

How do you like this web page? ○ Good as-is ○ Could be even better

Q1 In which video is the characters movement most appealing?

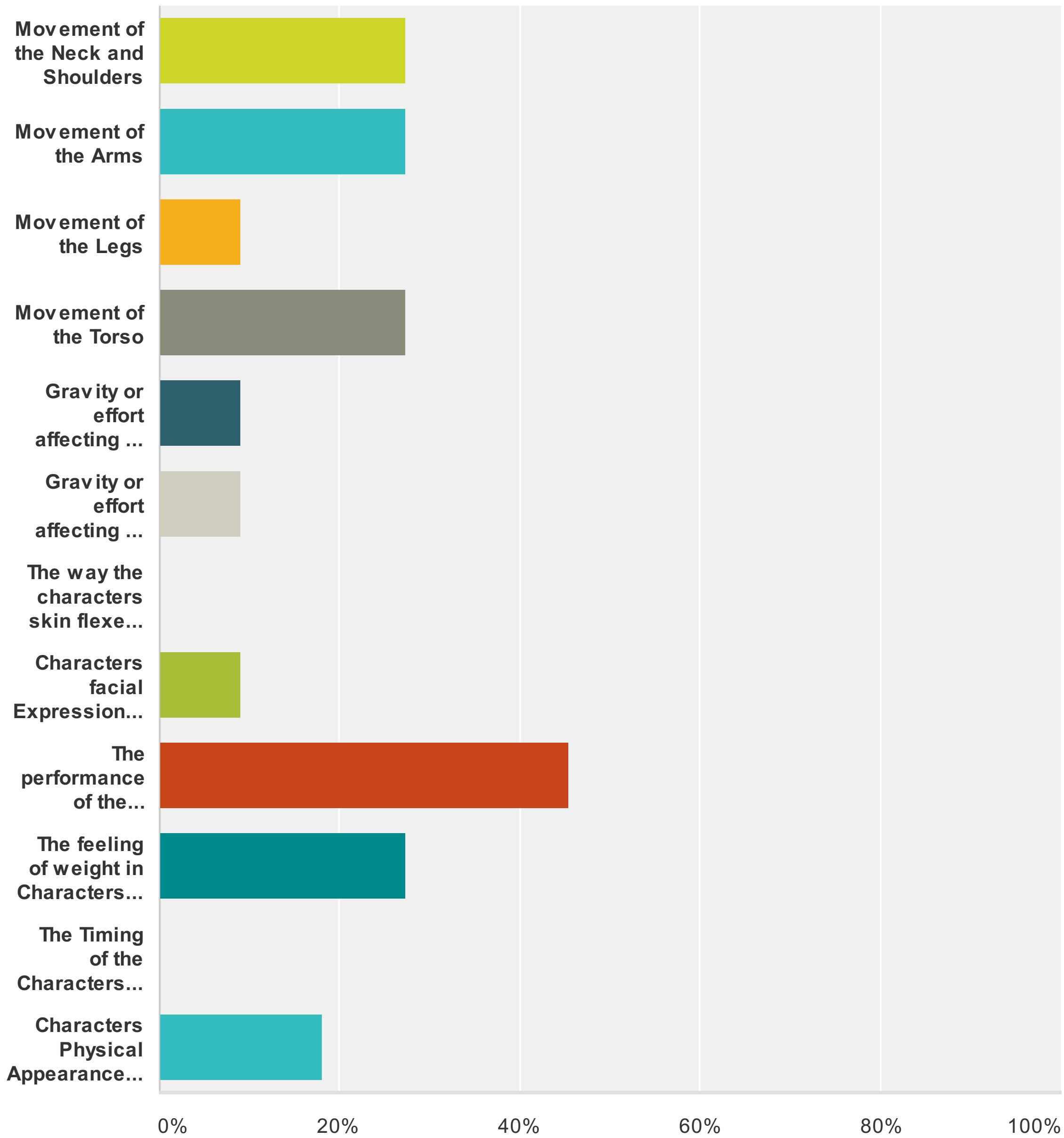
Answered: 11 Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	11
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**11**

Q2 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 11 Skipped: 0

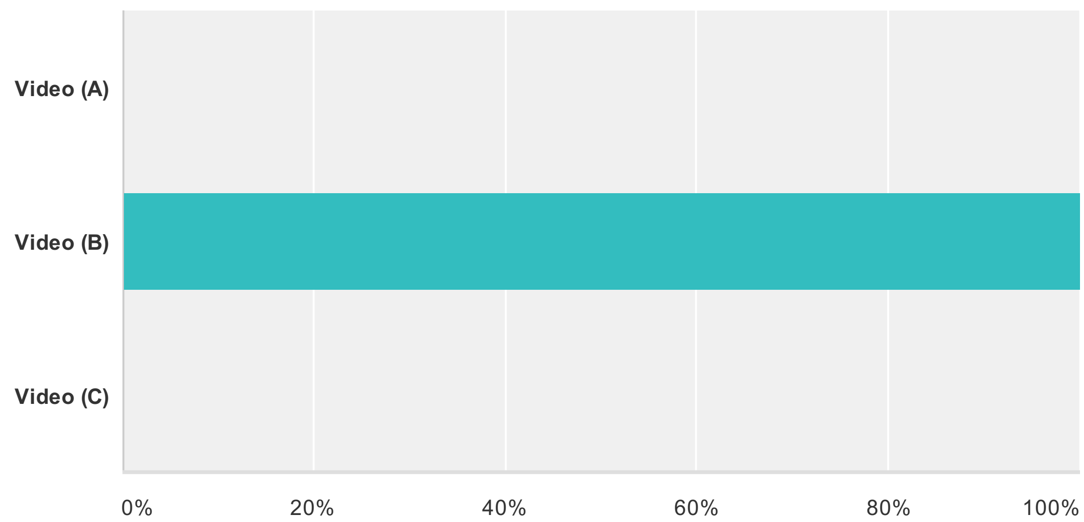


Answer Choices	Responses	
Movement of the Neck and Shoulders	27.27%	3
Movement of the Arms	27.27%	3
Movement of the Legs	9.09%	1
Movement of the Torso	27.27%	3
Gravity or effort affecting the characters performance	9.09%	1
Gravity or effort affecting the Shorts on the Character	9.09%	1
The way the characters skin flexes is appealing	0%	0

Characters facial Expressions are appealing	**9.09%**	1
The performance of the Character is appealing	**45.45%**	5
The feeling of weight in Characters Movements is appealing	**27.27%**	3
The Timing of the Characters Movements helps with the characters appeal	**0%**	0
Characters Physical Appearance helps with the characters appeal	**18.18%**	2
Total Respondents: 11		

Q1 In which video is the characters movement most appealing?

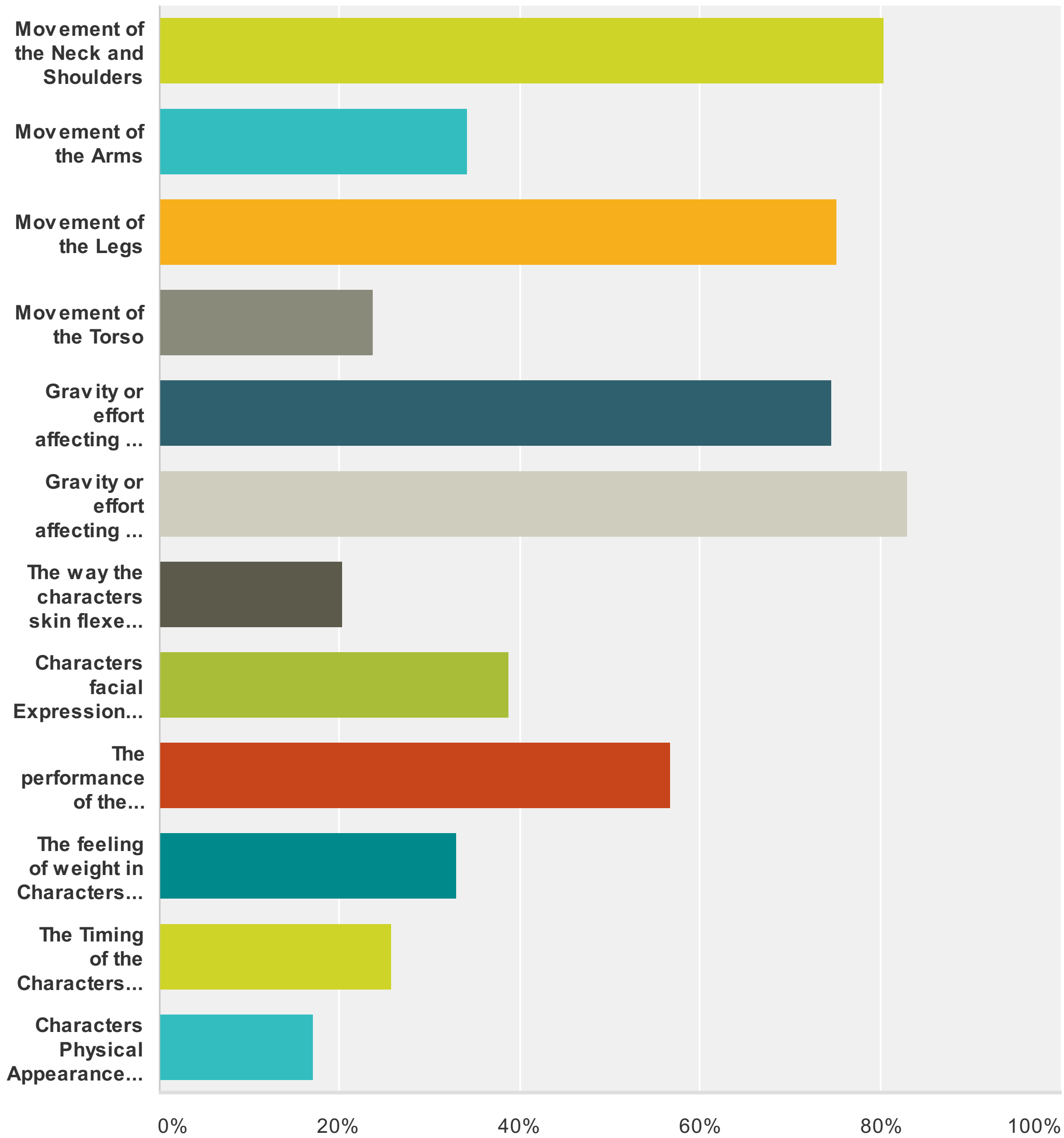
Answered: 152 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**100%**	152
Video (C)	**0%**	0
Total		**152**

Q2 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 152 Skipped: 0

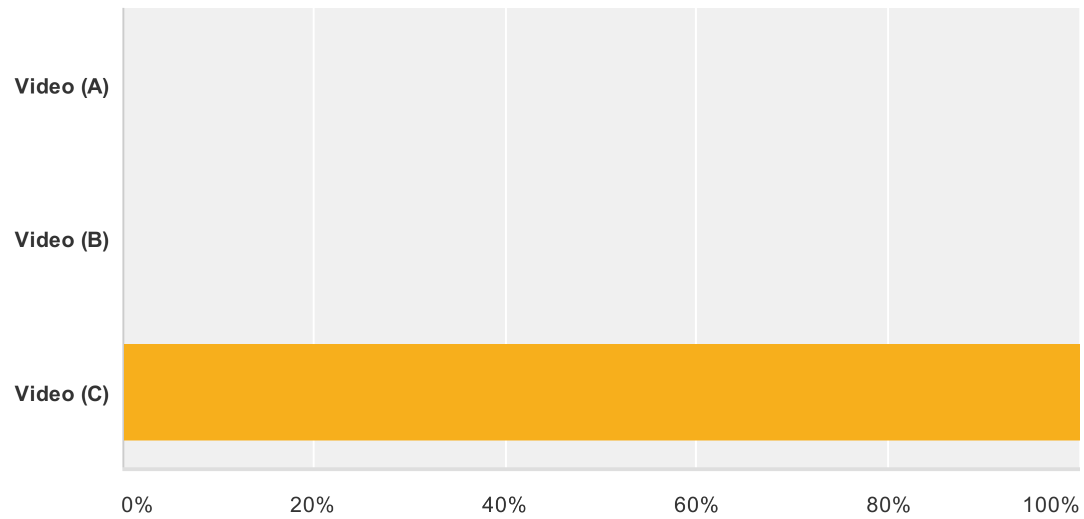


Answer Choices	Responses	
Movement of the Neck and Shoulders	80.26%	122
Movement of the Arms	34.21%	52
Movement of the Legs	75%	114
Movement of the Torso	23.68%	36
Gravity or effort affecting the characters performance	74.34%	113
Gravity or effort affecting the Shorts on the Character	82.89%	126
The way the characters skin flexes is appealing	20.39%	31

Characters facial Expressions are appealing	**38.82%**	59
The performance of the Character is appealing	**56.58%**	86
The feeling of weight in Characters Movements is appealing	**32.89%**	50
The Timing of the Characters Movements helps with the characters appeal	**25.66%**	39
Characters Physical Appearance helps with the characters appeal	**17.11%**	26
Total Respondents: 152		

Q1 In which video is the characters movement most appealing?

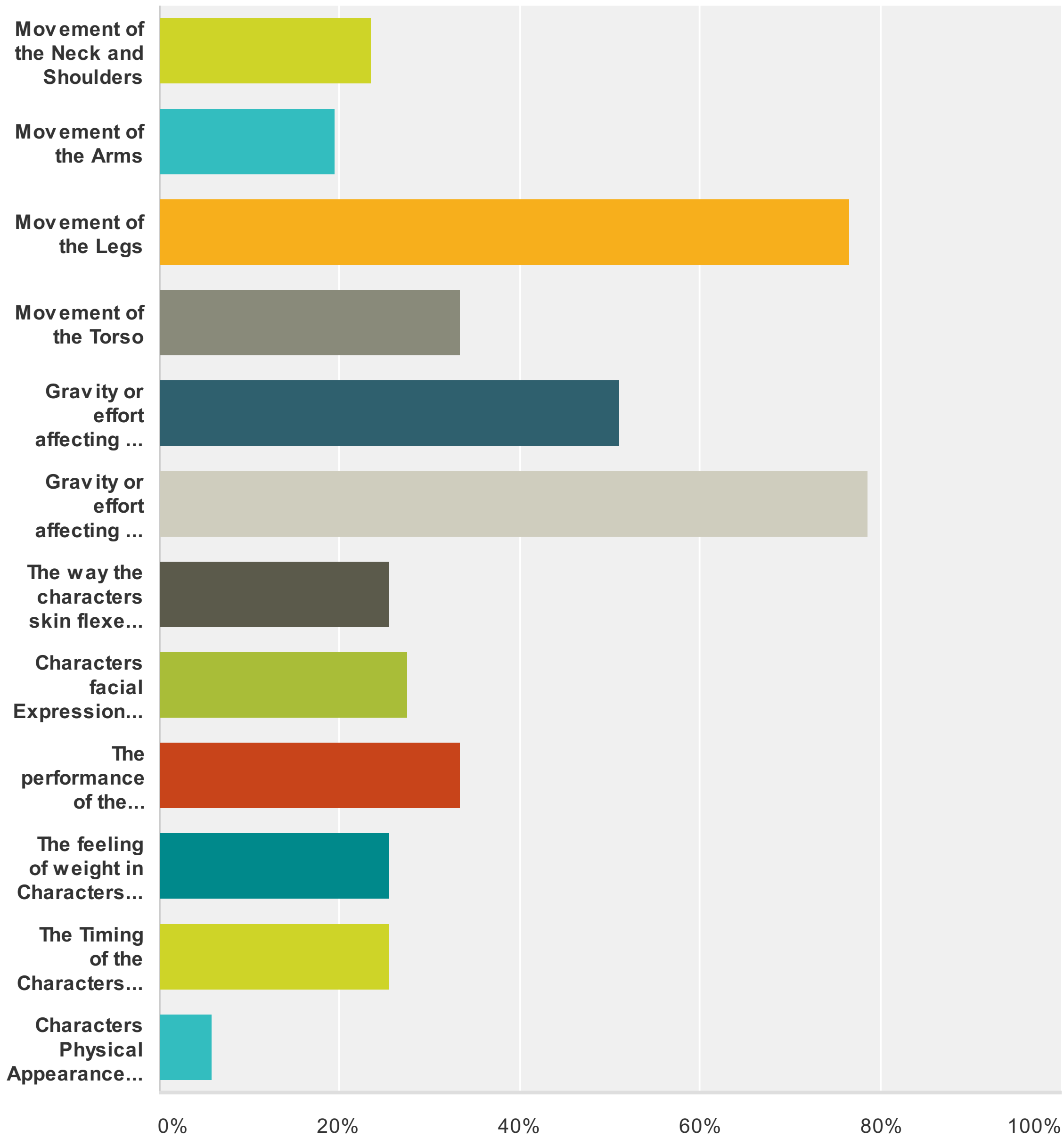
Answered: 51 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**0%**	0
Video (C)	**100%**	51
Total		**51**

Q2 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 51 Skipped: 0

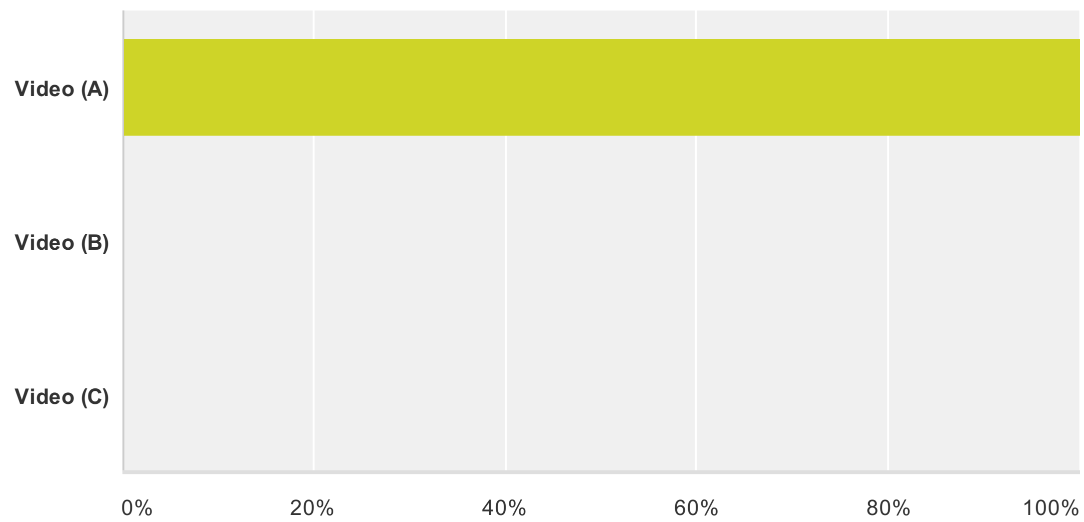


Answer Choices	Responses	
Movement of the Neck and Shoulders	23.53%	12
Movement of the Arms	19.61%	10
Movement of the Legs	76.47%	39
Movement of the Torso	33.33%	17
Gravity or effort affecting the characters performance	50.98%	26
Gravity or effort affecting the Shorts on the Character	78.43%	40
The way the characters skin flexes is appealing	25.49%	13

Characters facial Expressions are appealing	**27.45%**	14
The performance of the Character is appealing	**33.33%**	17
The feeling of weight in Characters Movements is appealing	**25.49%**	13
The Timing of the Characters Movements helps with the characters appeal	**25.49%**	13
Characters Physical Appearance helps with the characters appeal	**5.88%**	3
Total Respondents: 51		

Q3 In which video is the characters movement most realistic?

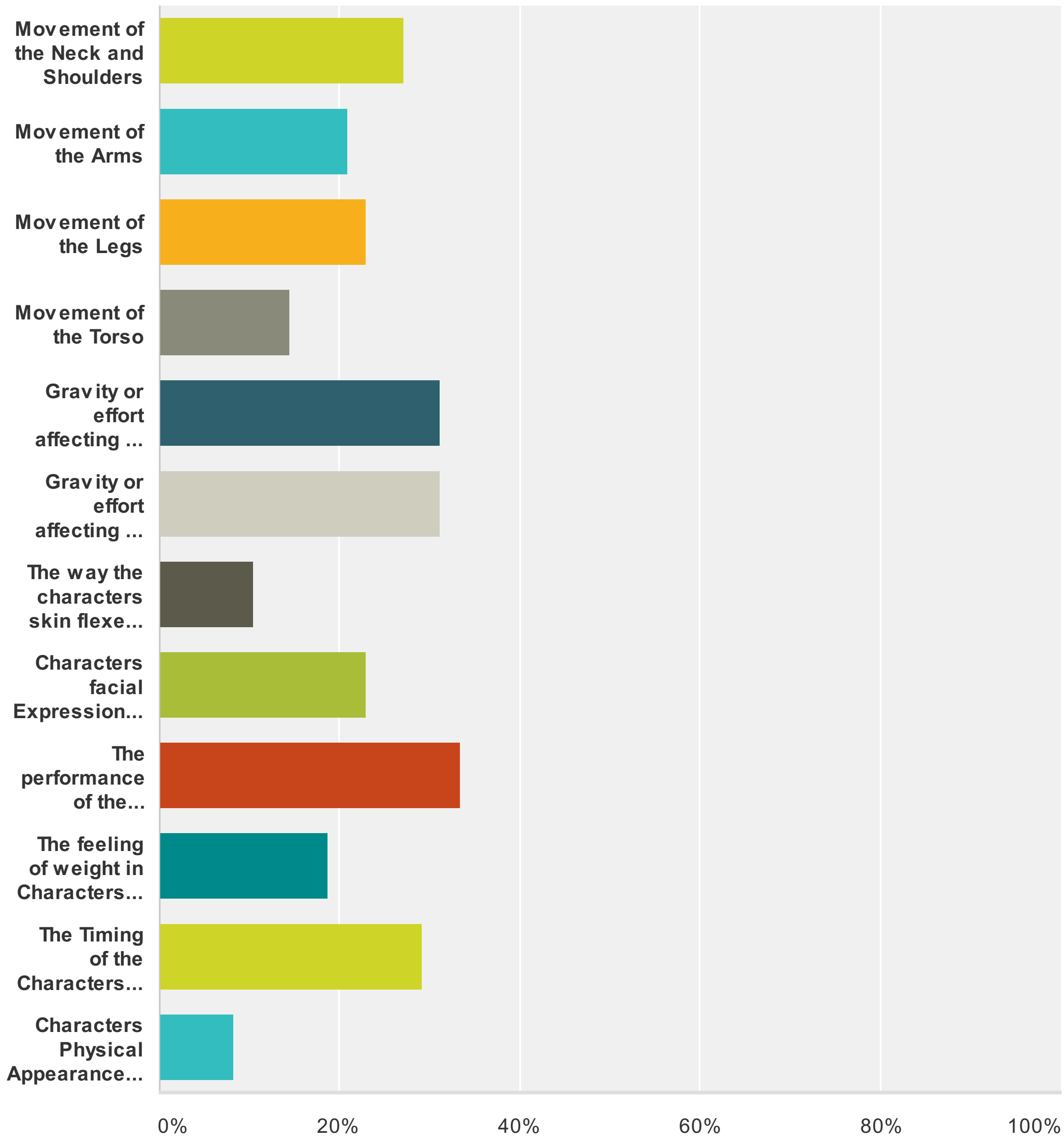
Answered: 48 Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	48
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**48**

Q4 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 48 Skipped: 0

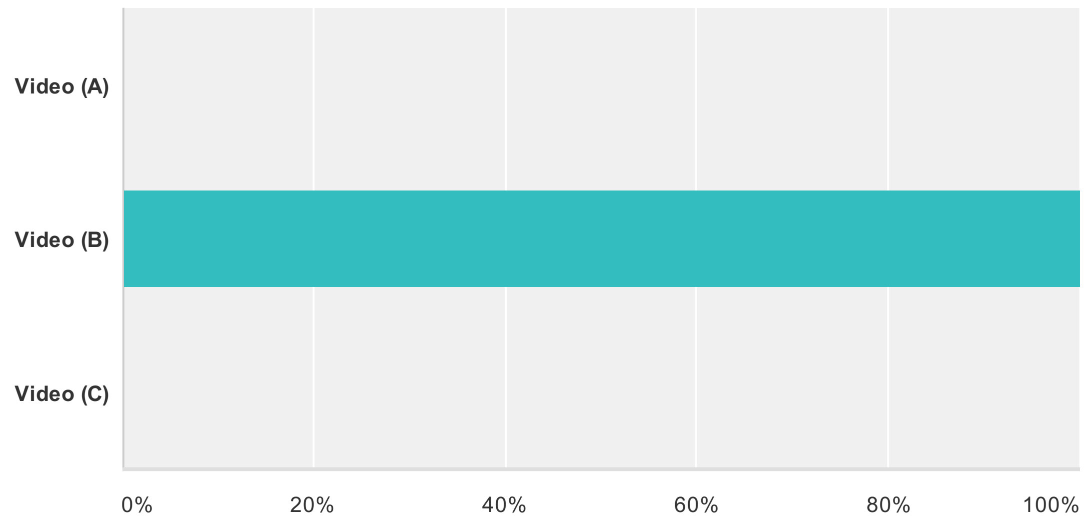


Answer Choices	Responses	
Movement of the Neck and Shoulders	27.08%	13
Movement of the Arms	20.83%	10
Movement of the Legs	22.92%	11
Movement of the Torso	14.58%	7
Gravity or effort affecting the characters performance	31.25%	15
Gravity or effort affecting the Shorts on the Character	31.25%	15
The way the characters skin flexes is realistic	10.42%	5

Characters facial Expressions are realistic	**22.92%**	11
The performance of the Character is realistic	**33.33%**	16
The feeling of weight in Characters Movements is realistic	**18.75%**	9
The Timing of the Characters Movements helps with the characters realistic	**29.17%**	14
Characters Physical Appearance helps with the characters realistic	**8.33%**	4
Total Respondents: 48		

Q3 In which video is the characters movement most realistic?

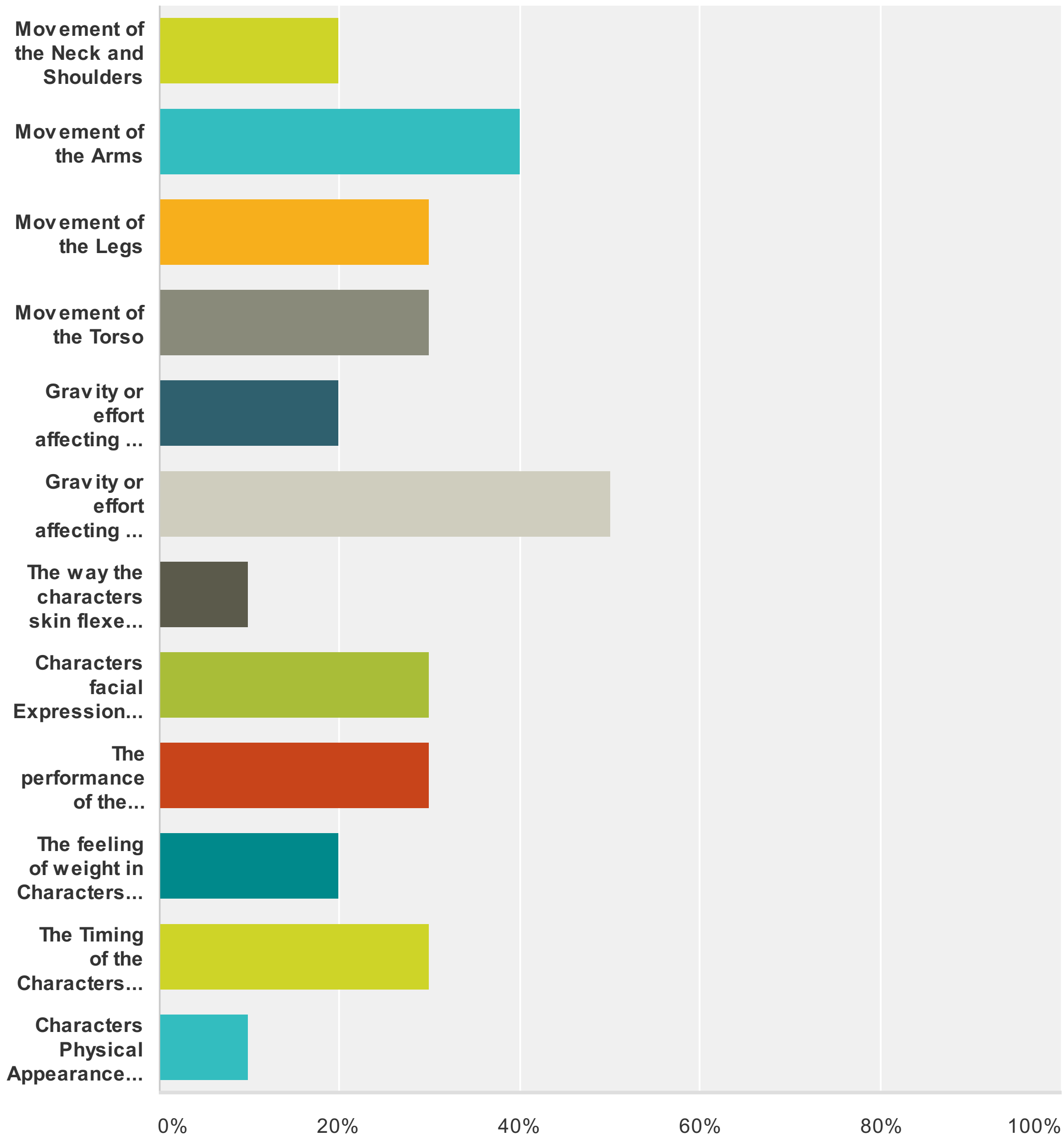
Answered: 10 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**100%**	10
Video (C)	**0%**	0
Total		**10**

Q4 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 10 Skipped: 0

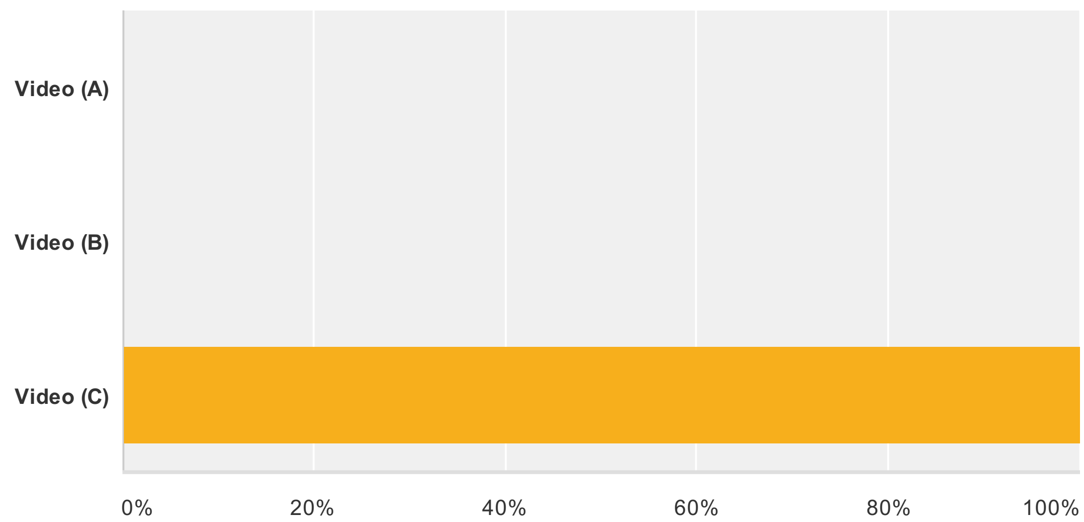


Answer Choices	Responses	
Movement of the Neck and Shoulders	**20%**	2
Movement of the Arms	**40%**	4
Movement of the Legs	**30%**	3
Movement of the Torso	**30%**	3
Gravity or effort affecting the characters performance	**20%**	2
Gravity or effort affecting the Shorts on the Character	**50%**	5
The way the characters skin flexes is realistic	**10%**	1

Characters facial Expressions are realistic	**30%**	3
The performance of the Character is realistic	**30%**	3
The feeling of weight in Characters Movements is realistic	**20%**	2
The Timing of the Characters Movements helps with the characters realistic	**30%**	3
Characters Physical Appearance helps with the characters realistic	**10%**	1
Total Respondents: 10		

Q3 In which video is the characters movement most realistic?

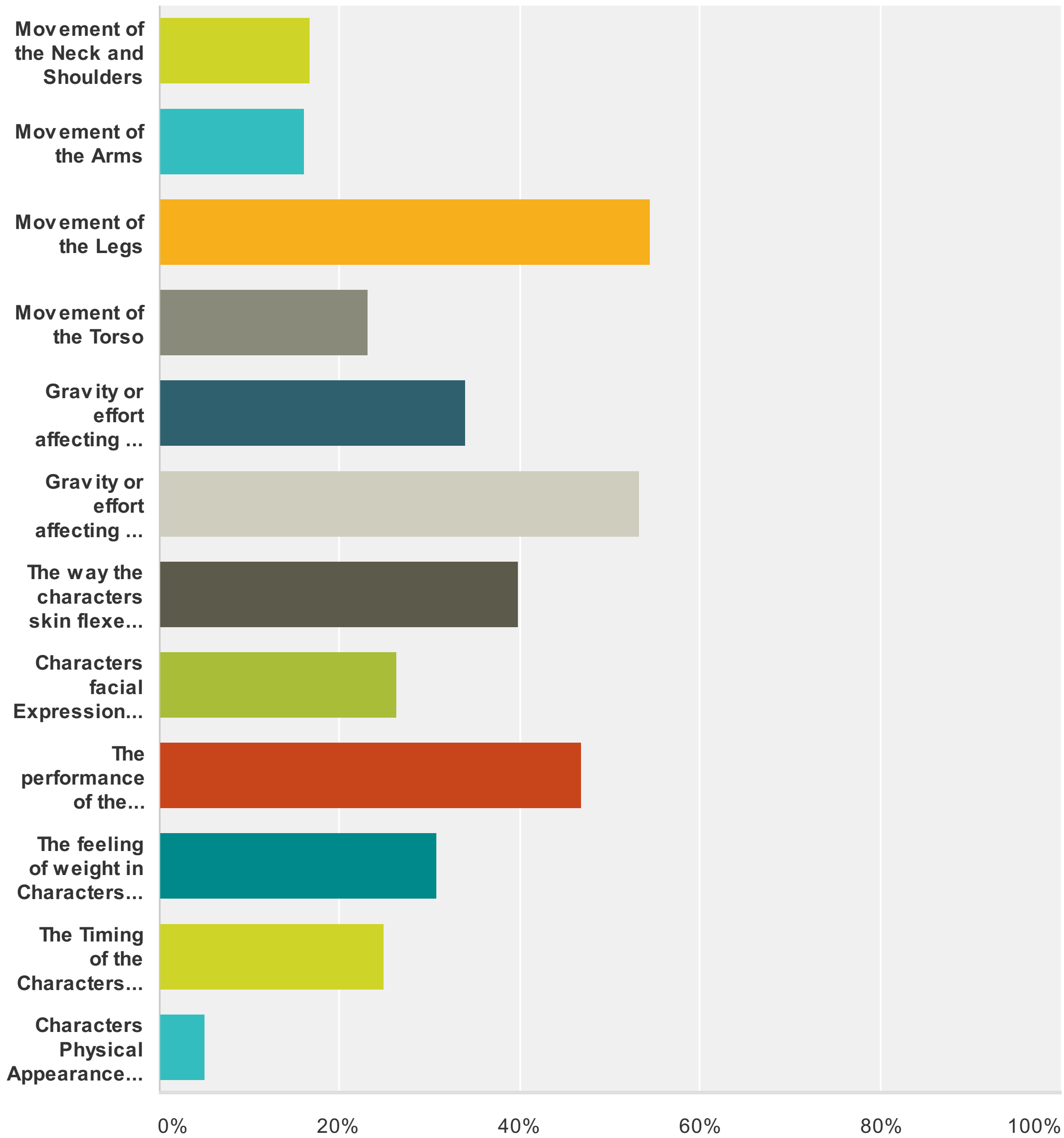
Answered: 156 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**0%**	0
Video (C)	**100%**	156
Total		**156**

Q4 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 156 Skipped: 0

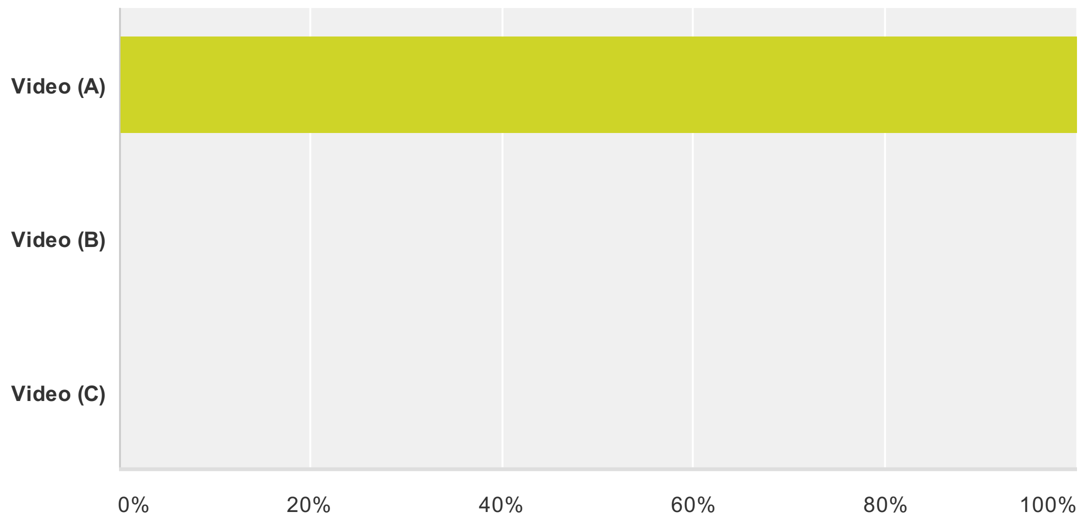


Answer Choices	Responses	
Movement of the Neck and Shoulders	16.67%	26
Movement of the Arms	16.03%	25
Movement of the Legs	54.49%	85
Movement of the Torso	23.08%	36
Gravity or effort affecting the characters performance	33.97%	53
Gravity or effort affecting the Shorts on the Character	53.21%	83
The way the characters skin flexes is realistic	39.74%	62

Characters facial Expressions are realistic	**26.28%**	41
The performance of the Character is realistic	**46.79%**	73
The feeling of weight in Characters Movements is realistic	**30.77%**	48
The Timing of the Characters Movements helps with the characters realistic	**25%**	39
Characters Physical Appearance helps with the characters realistic	**5.13%**	8
Total Respondents: 156		

Q5 In which video is the characters movement most believable?

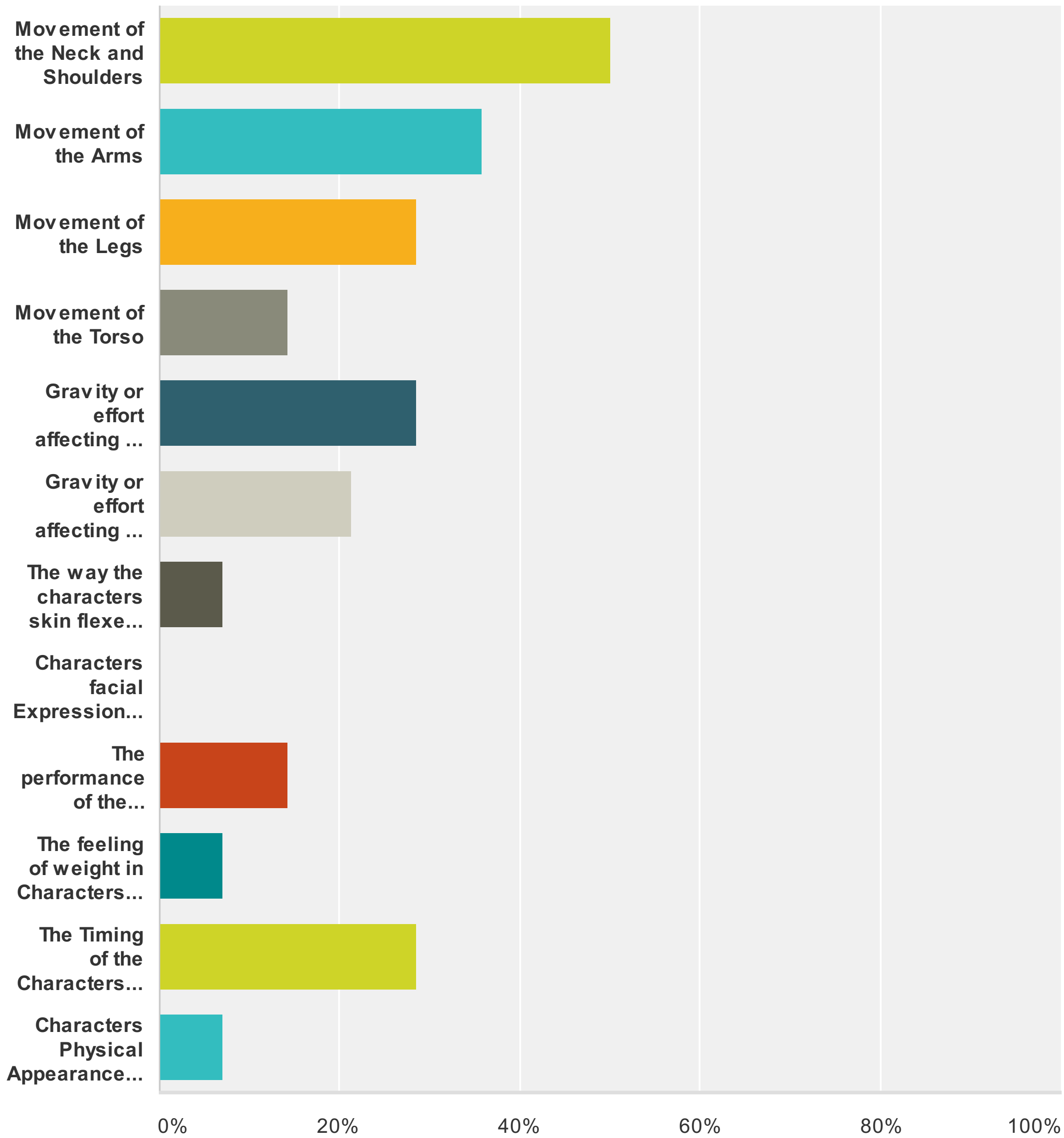
Answered: 14 Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	14
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**14**

Q6 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 14 Skipped: 0

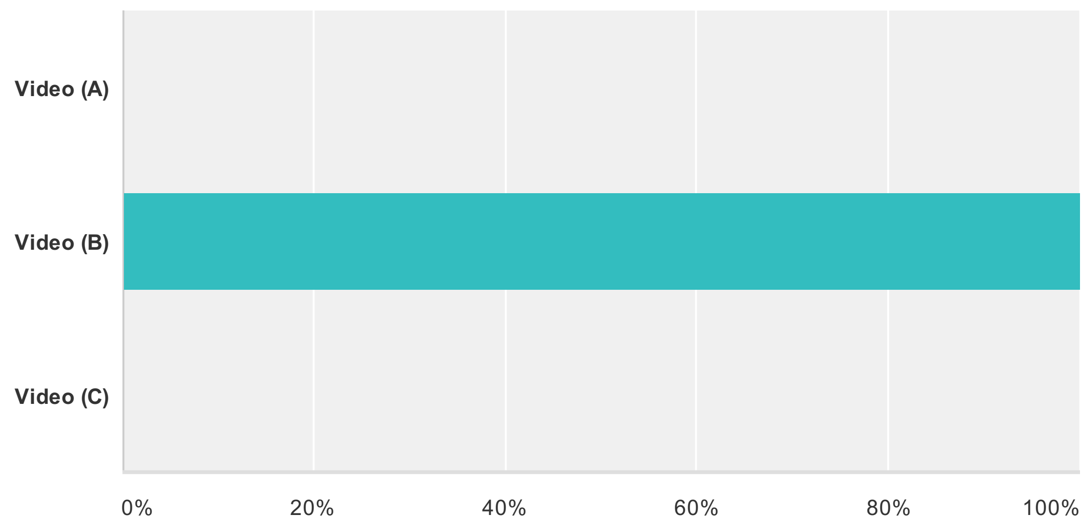


Answer Choices	Responses	
Movement of the Neck and Shoulders	50%	7
Movement of the Arms	35.71%	5
Movement of the Legs	28.57%	4
Movement of the Torso	14.29%	2
Gravity or effort affecting the characters performance	28.57%	4
Gravity or effort affecting the Shorts on the Character	21.43%	3
The way the characters skin flexes is believable	7.14%	1

Characters facial Expressions are believable	**0%**	0
The performance of the Character is believable	**14.29%**	2
The feeling of weight in Characters Movements is believable	**7.14%**	1
The Timing of the Characters Movements helps with the characters believable	**28.57%**	4
Characters Physical Appearance helps with the characters believable	**7.14%**	1
Total Respondents: 14		

Q5 In which video is the characters movement most believable?

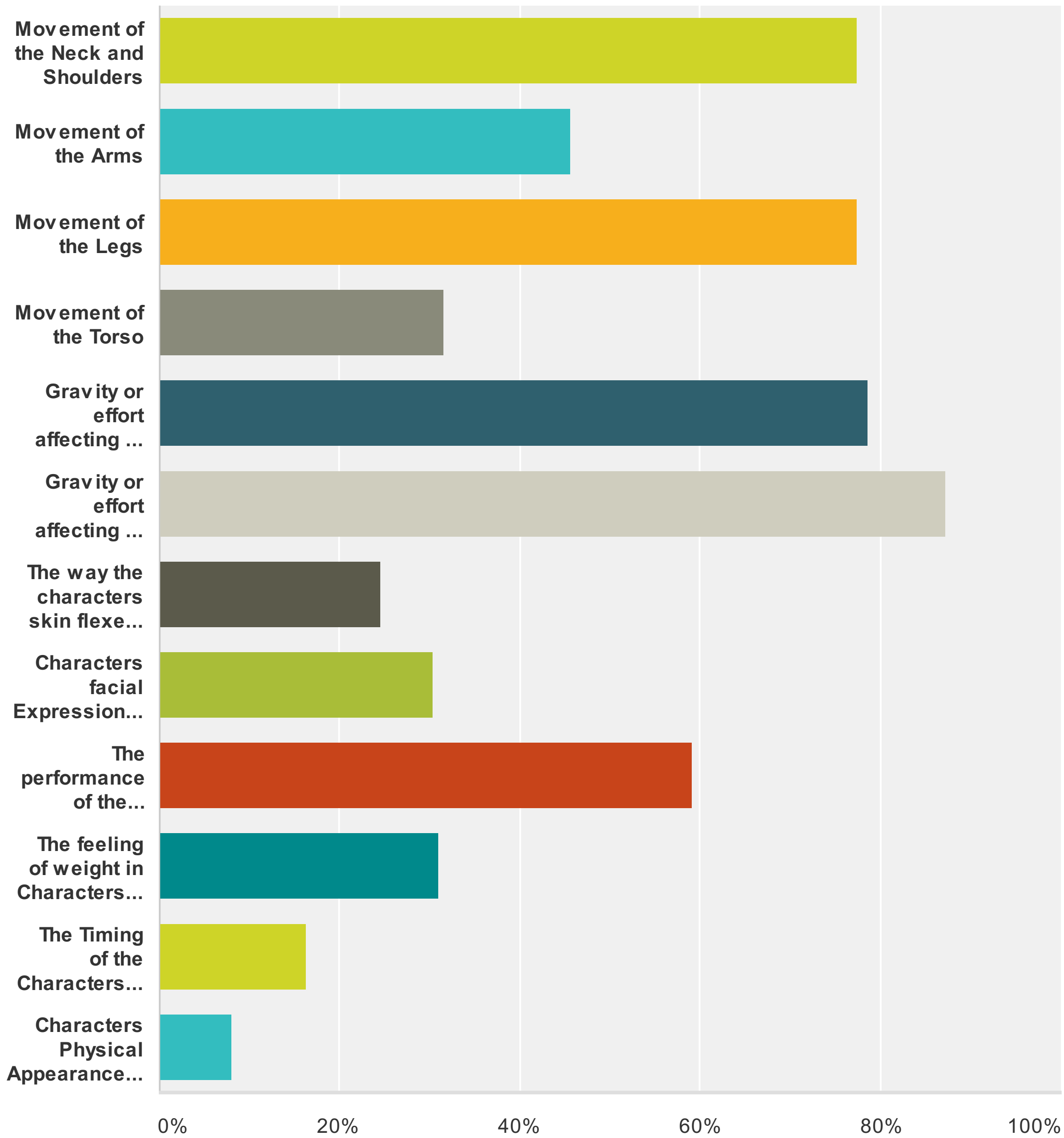
Answered: 171 Skipped: 0



Answer Choices	Responses	
Video (A)	0%	0
Video (B)	100%	171
Video (C)	0%	0
Total		171

Q6 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 171 Skipped: 0

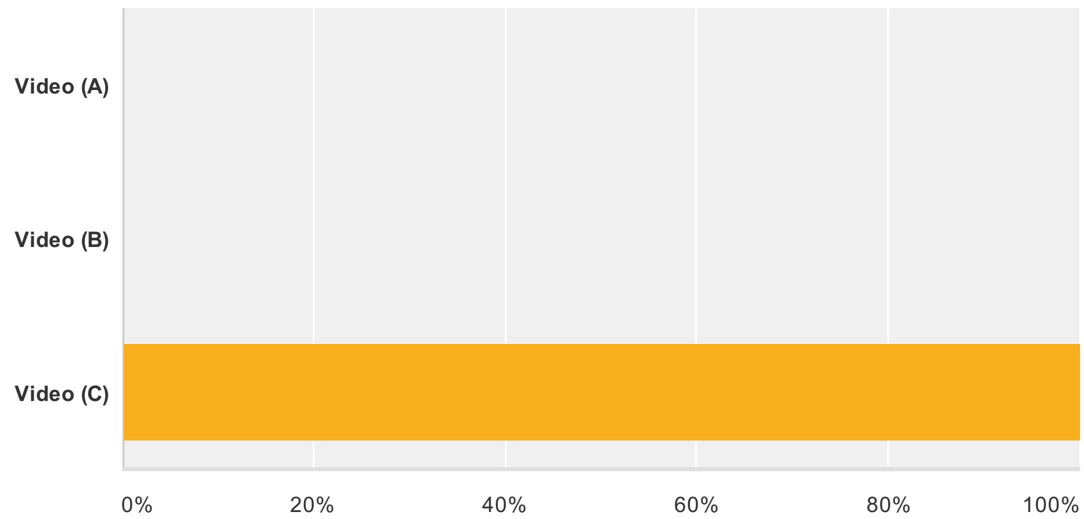


Answer Choices	Responses	
Movement of the Neck and Shoulders	77.19%	132
Movement of the Arms	45.61%	78
Movement of the Legs	77.19%	132
Movement of the Torso	31.58%	54
Gravity or effort affecting the characters performance	78.36%	134
Gravity or effort affecting the Shorts on the Character	87.13%	149
The way the characters skin flexes is believable	24.56%	42

Characters facial Expressions are believable	**30.41%**	52
The performance of the Character is believable	**59.06%**	101
The feeling of weight in Characters Movements is believable	**30.99%**	53
The Timing of the Characters Movements helps with the characters believable	**16.37%**	28
Characters Physical Appearance helps with the characters believable	**8.19%**	14
Total Respondents: 171		

Q5 In which video is the characters movement most believable?

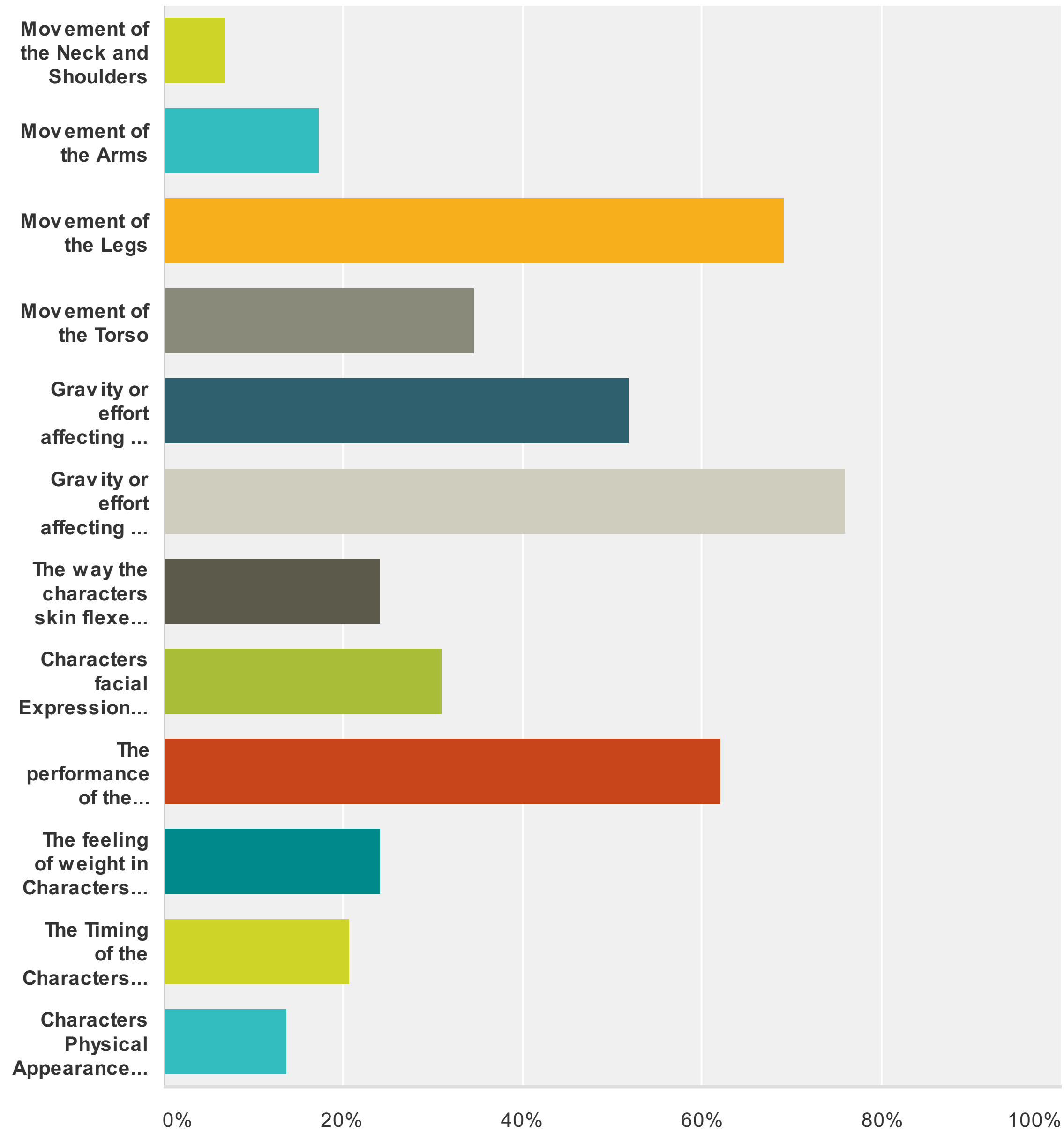
Answered: 29 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**0%**	0
Video (C)	**100%**	29
Total		**29**

Q6 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 29 Skipped: 0

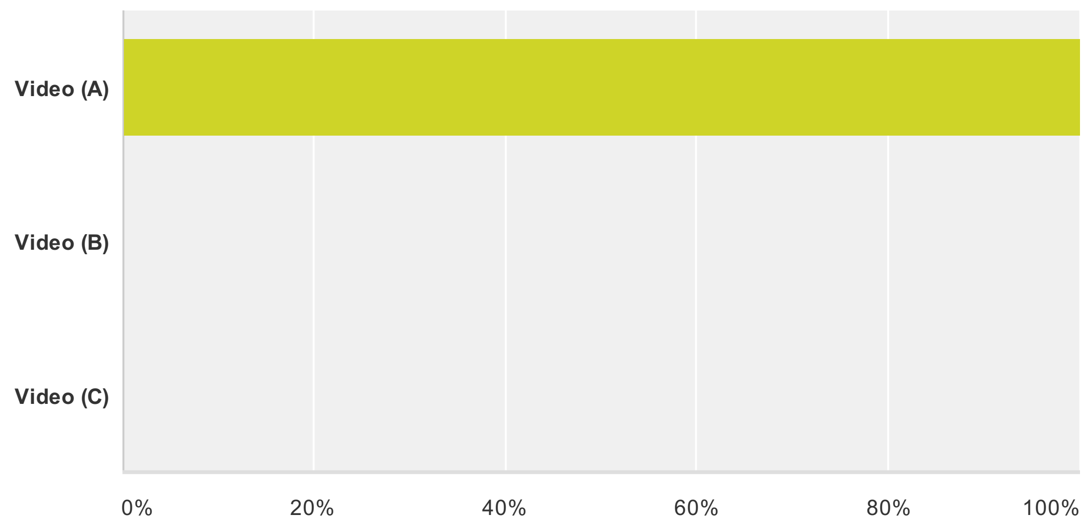


Answer Choices	Responses	
Movement of the Neck and Shoulders	6.90%	2
Movement of the Arms	17.24%	5
Movement of the Legs	68.97%	20
Movement of the Torso	34.48%	10
Gravity or effort affecting the characters performance	51.72%	15
Gravity or effort affecting the Shorts on the Character	75.86%	22
The way the characters skin flexes is believable	24.14%	7

Characters facial Expressions are believable	**31.03%**	9
The performance of the Character is believable	**62.07%**	18
The feeling of weight in Characters Movements is believable	**24.14%**	7
The Timing of the Characters Movements helps with the characters believable	**20.69%**	6
Characters Physical Appearance helps with the characters believable	**13.79%**	4
Total Respondents: 29		

Q7 In which video is the characters movement most appealing?

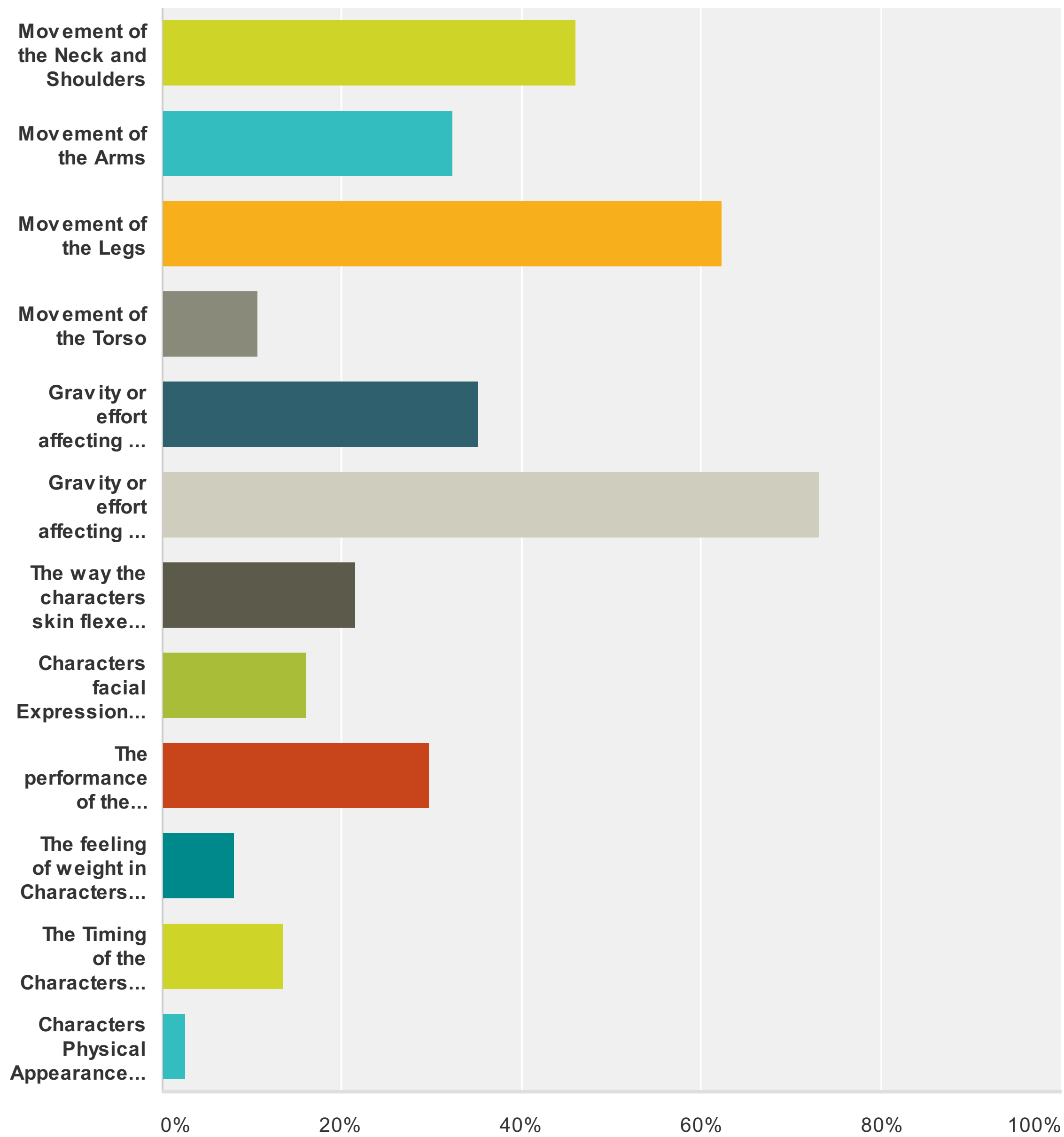
Answered: 37 Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	37
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**37**

Q8 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 37 Skipped: 0

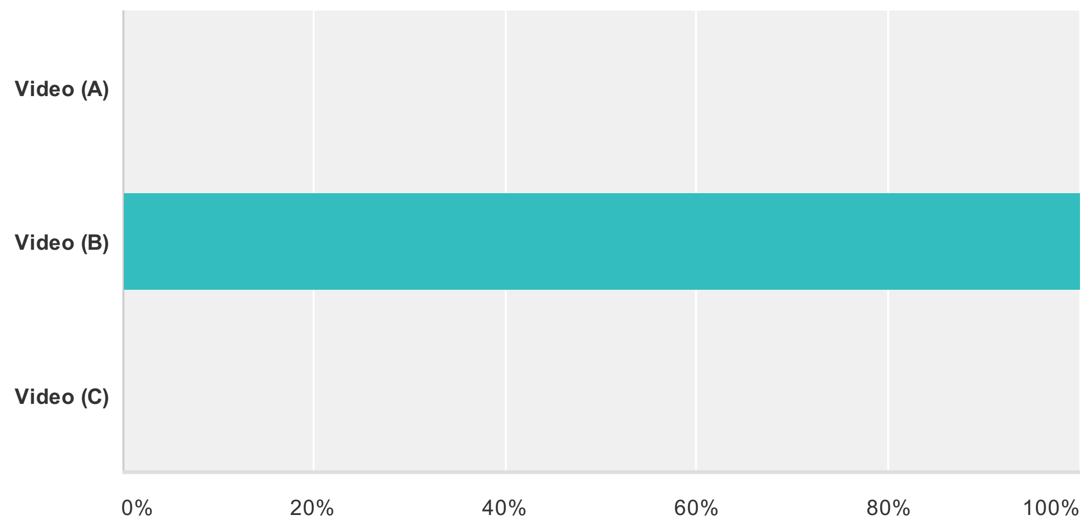


Answer Choices	Responses	
Movement of the Neck and Shoulders	45.95%	17
Movement of the Arms	32.43%	12
Movement of the Legs	62.16%	23
Movement of the Torso	10.81%	4
Gravity or effort affecting the characters performance	35.14%	13
Gravity or effort affecting the Shorts on the Character	72.97%	27
The way the characters skin flexes is appealing	21.62%	8

Characters facial Expressions are appealing	**16.22%**	6
The performance of the Character is appealing	**29.73%**	11
The feeling of weight in Characters Movements is appealing	**8.11%**	3
The Timing of the Characters Movements helps with the characters appeal	**13.51%**	5
Characters Physical Appearance helps with the characters appeal	**2.70%**	1
Total Respondents: 37		

Q7 In which video is the characters movement most appealing?

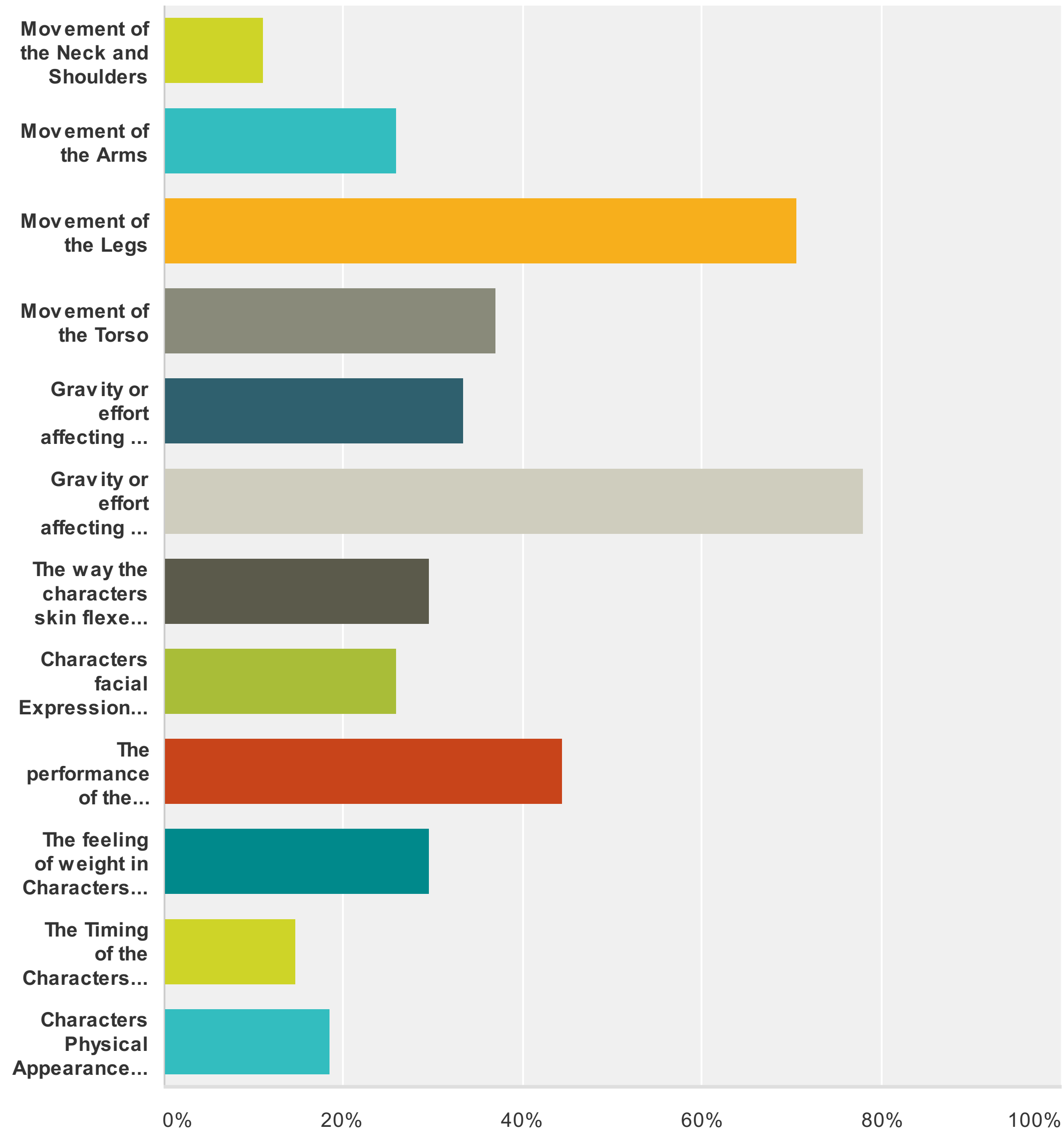
Answered: 27 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**100%**	27
Video (C)	**0%**	0
Total		**27**

Q8 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 27 Skipped: 0

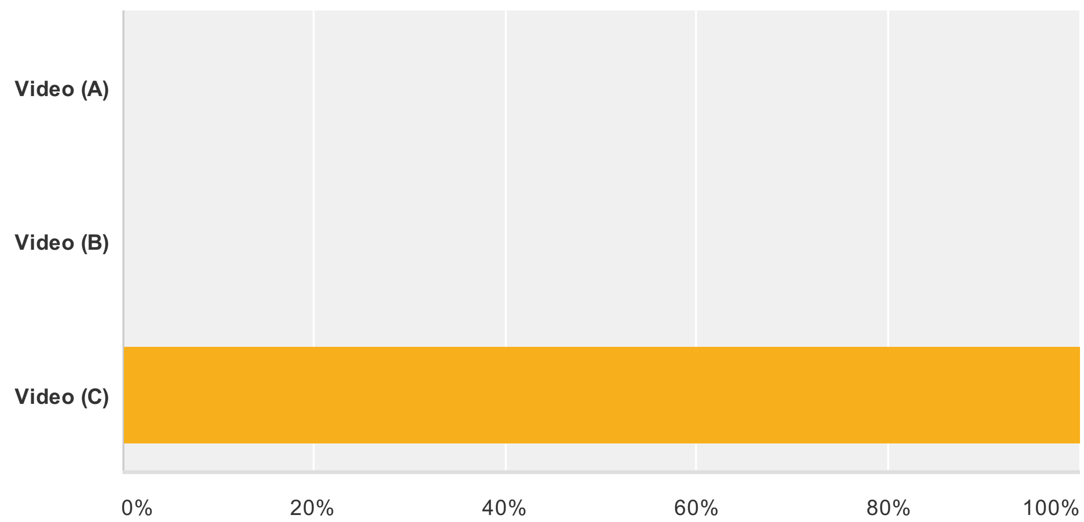


Answer Choices	Responses	
Movement of the Neck and Shoulders	11.11%	3
Movement of the Arms	25.93%	7
Movement of the Legs	70.37%	19
Movement of the Torso	37.04%	10
Gravity or effort affecting the characters performance	33.33%	9
Gravity or effort affecting the Shorts on the Character	77.78%	21
The way the characters skin flexes is appealing	29.63%	8

Characters facial Expressions are appealing	**25.93%**	7
The performance of the Character is appealing	**44.44%**	12
The feeling of weight in Characters Movements is appealing	**29.63%**	8
The Timing of the Characters Movements helps with the characters appeal	**14.81%**	4
Characters Physical Appearance helps with the characters appeal	**18.52%**	5
Total Respondents: 27		

Q7 In which video is the characters movement most appealing?

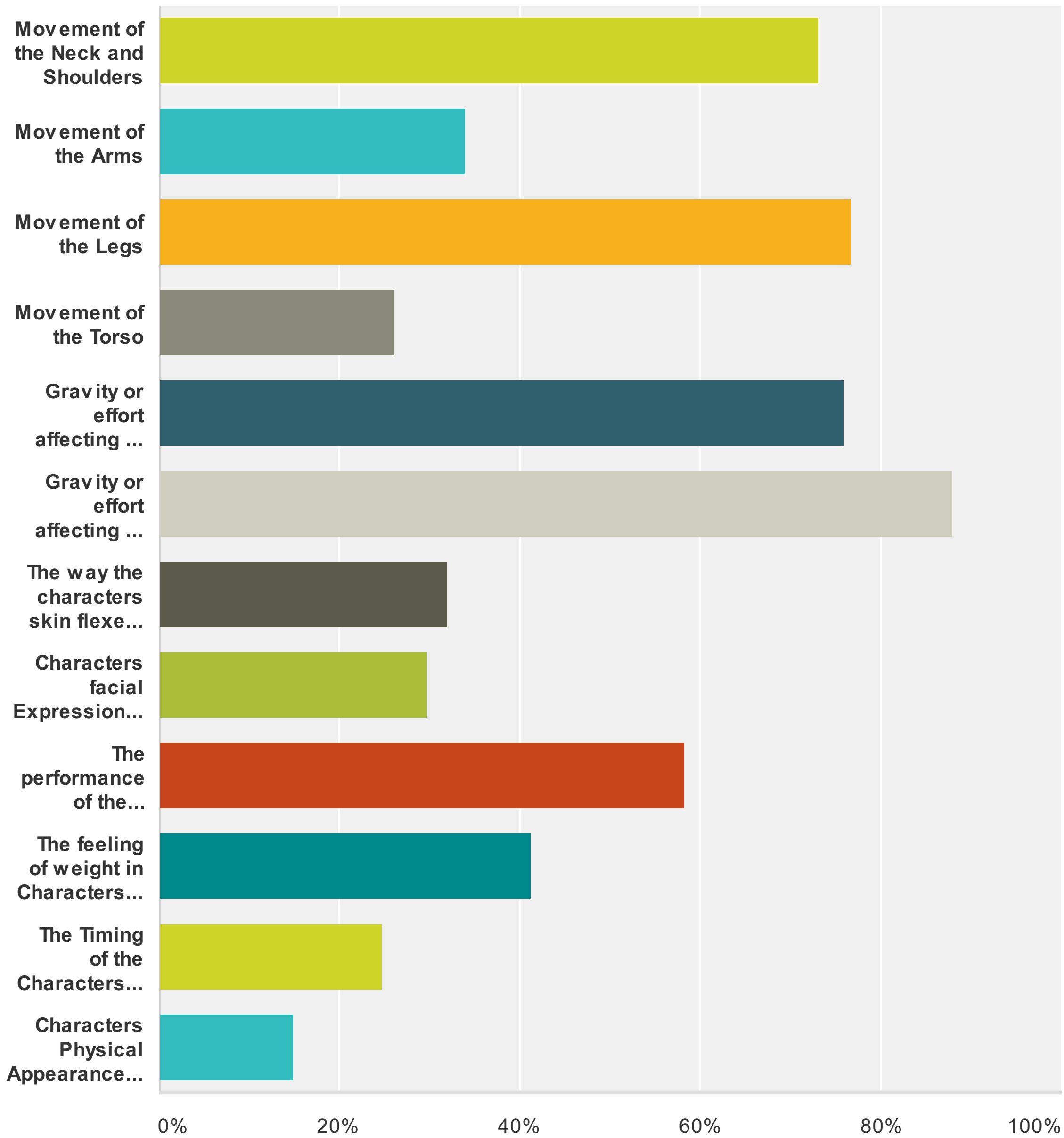
Answered: 141 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**0%**	0
Video (C)	**100%**	141
Total		**141**

Q8 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 141   Skipped: 0

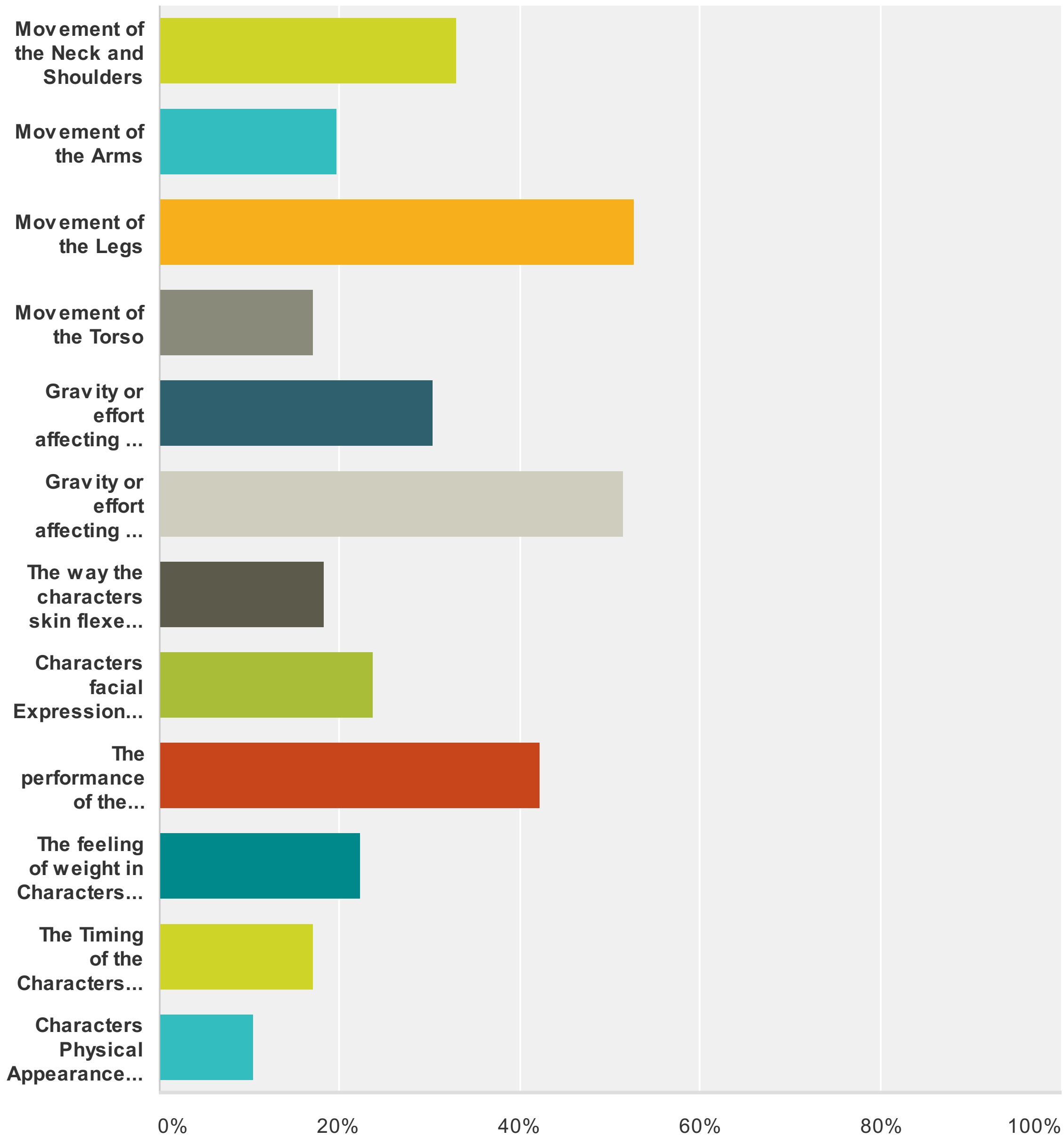


Answer Choices	Responses	
Movement of the Neck and Shoulders	**73.05%**	103
Movement of the Arms	**34.04%**	48
Movement of the Legs	**76.60%**	108
Movement of the Torso	**26.24%**	37
Gravity or effort affecting the characters performance	**75.89%**	107
Gravity or effort affecting the Shorts on the Character	**87.94%**	124
The way the characters skin flexes is appealing	**31.91%**	45

Characters facial Expressions are appealing	**29.79%**	42
The performance of the Character is appealing	**58.16%**	82
The feeling of weight in Characters Movements is appealing	**41.13%**	58
The Timing of the Characters Movements helps with the characters appeal	**24.82%**	35
Characters Physical Appearance helps with the characters appeal	**14.89%**	21
Total Respondents: 141		

Q10 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 76 Skipped: 0

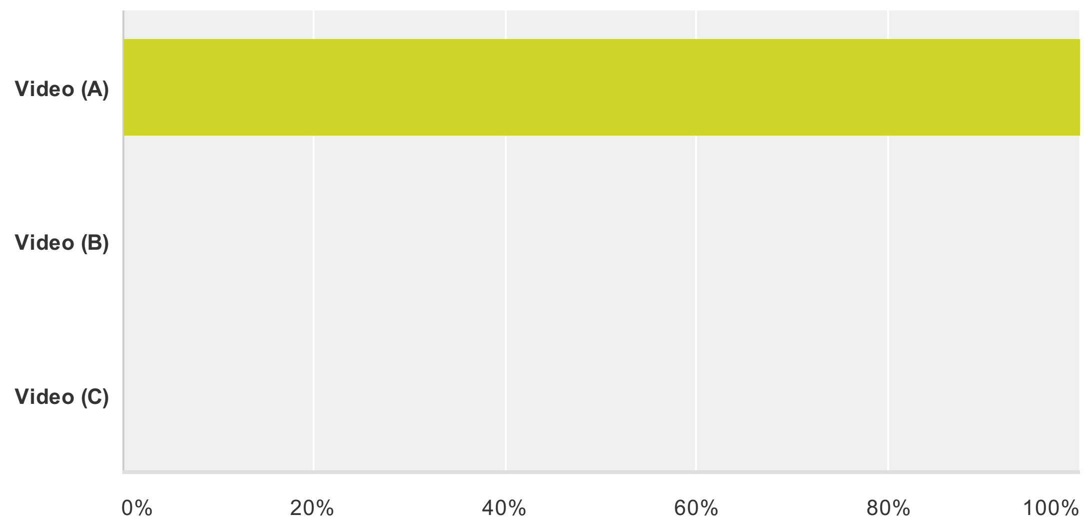


Answer Choices	Responses	
Movement of the Neck and Shoulders	**32.89%**	25
Movement of the Arms	**19.74%**	15
Movement of the Legs	**52.63%**	40
Movement of the Torso	**17.11%**	13
Gravity or effort affecting the characters performance	**30.26%**	23
Gravity or effort affecting the Shorts on the Character	**51.32%**	39
The way the characters skin flexes is realistic	**18.42%**	14

Characters facial Expressions are realistic	**23.68%**	18
The performance of the Character is realistic	**42.11%**	32
The feeling of weight in Characters Movements is realistic	**22.37%**	17
The Timing of the Characters Movements helps with the characters realistic	**17.11%**	13
Characters Physical Appearance helps with the characters realistic	**10.53%**	8
Total Respondents: 76		

Q9 In which video is the characters movement most realistic?

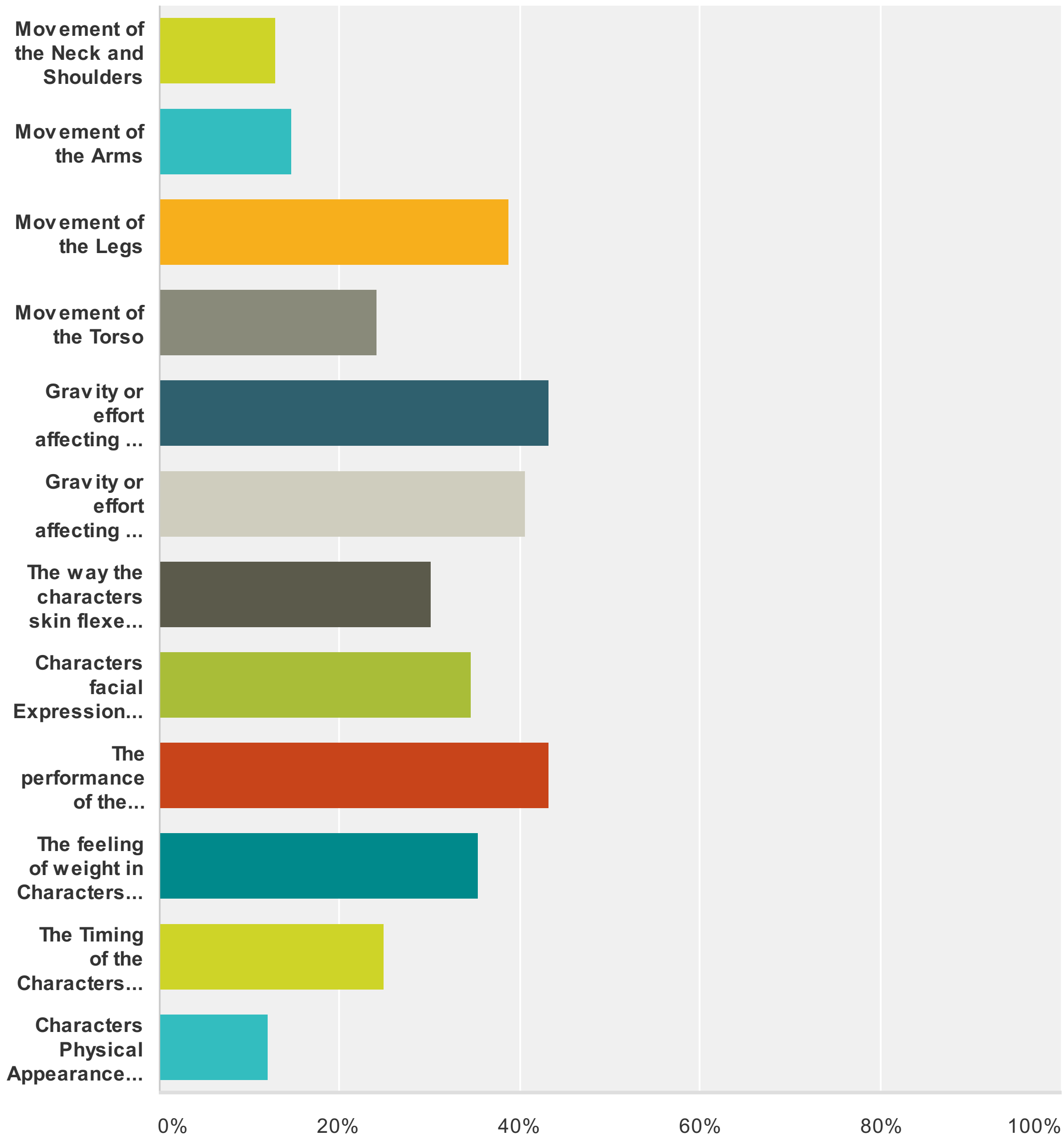
Answered: 76 Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	76
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**76**

Q10 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 116 Skipped: 0

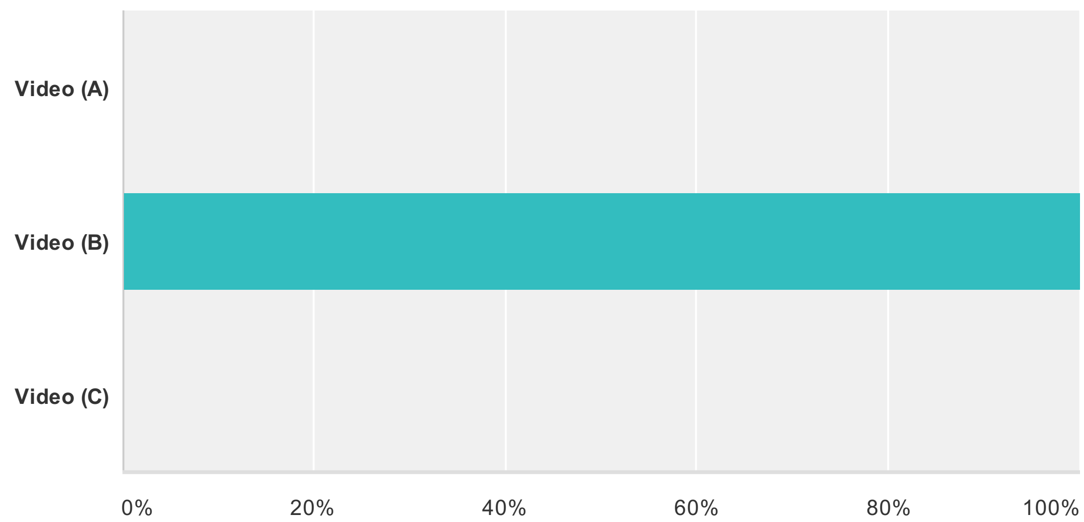


Answer Choices	Responses	
Movement of the Neck and Shoulders	**12.93%**	15
Movement of the Arms	**14.66%**	17
Movement of the Legs	**38.79%**	45
Movement of the Torso	**24.14%**	28
Gravity or effort affecting the characters performance	**43.10%**	50
Gravity or effort affecting the Shorts on the Character	**40.52%**	47
The way the characters skin flexes is realistic	**30.17%**	35

Characters facial Expressions are realistic	**34.48%**	40
The performance of the Character is realistic	**43.10%**	50
The feeling of weight in Characters Movements is realistic	**35.34%**	41
The Timing of the Characters Movements helps with the characters realistic	**25%**	29
Characters Physical Appearance helps with the characters realistic	**12.07%**	14
Total Respondents: 116		

Q9 In which video is the characters movement most realistic?

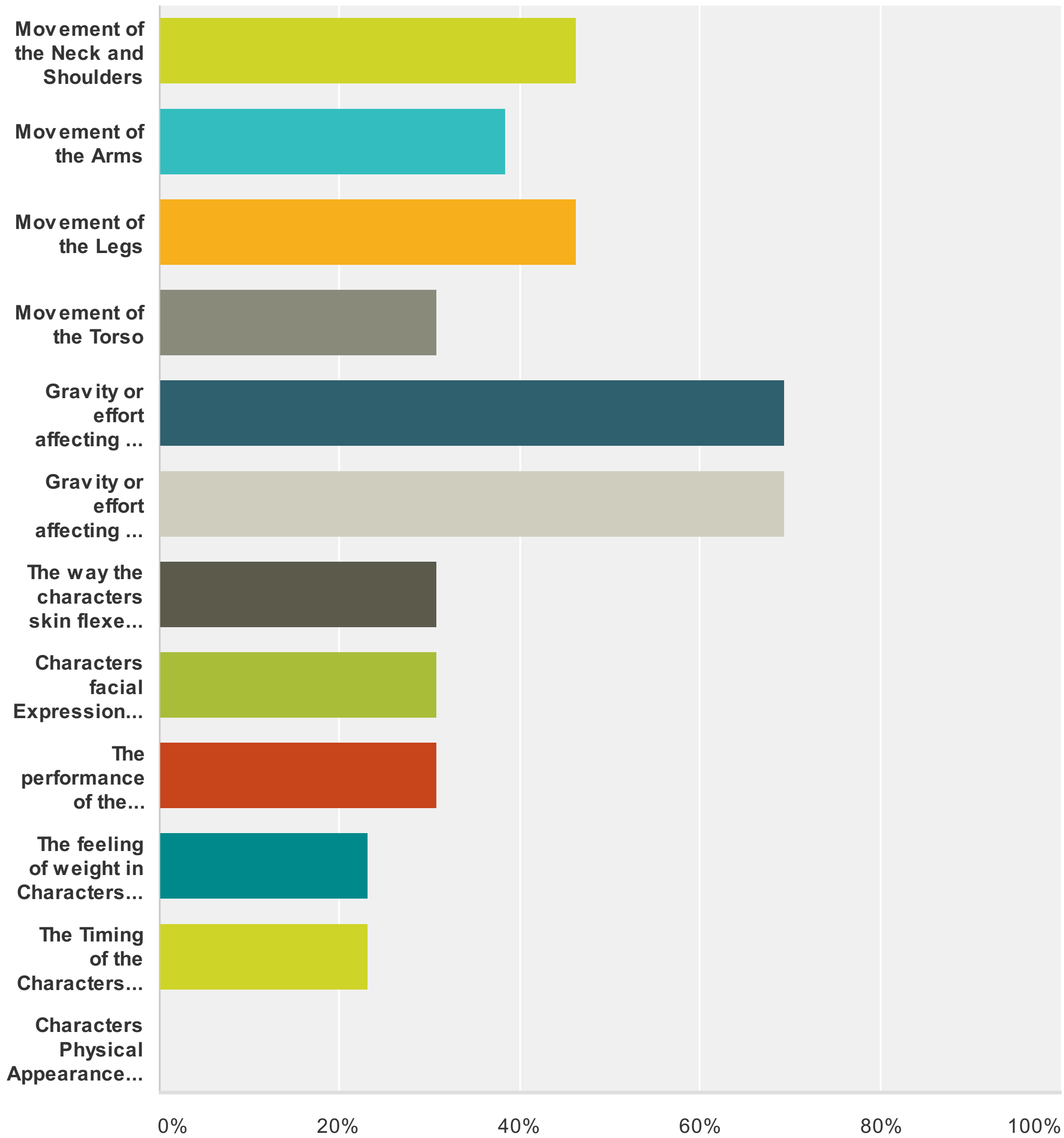
Answered: 116 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**100%**	116
Video (C)	**0%**	0
Total		**116**

Q10 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 13 Skipped: 0

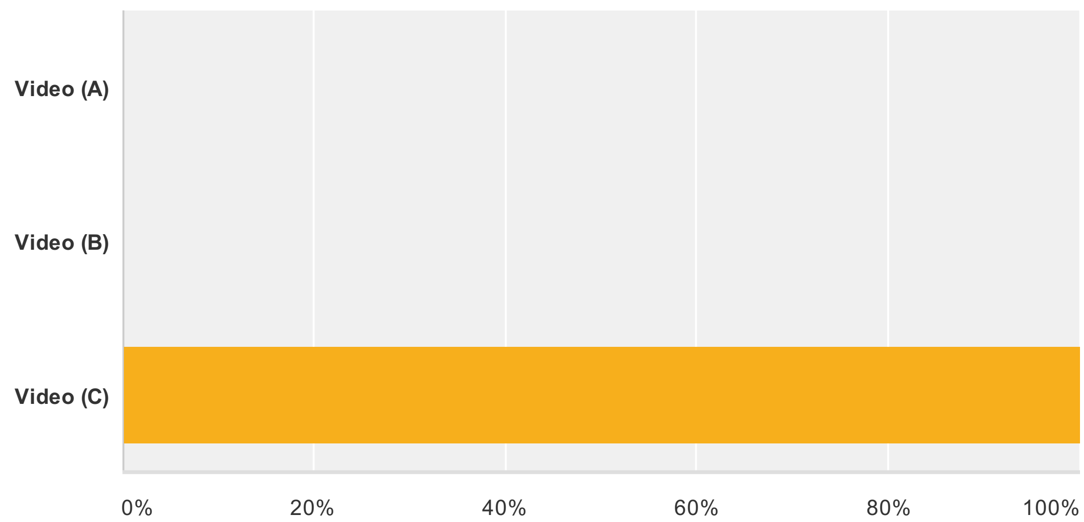


Answer Choices	Responses	
Movement of the Neck and Shoulders	**46.15%**	6
Movement of the Arms	**38.46%**	5
Movement of the Legs	**46.15%**	6
Movement of the Torso	**30.77%**	4
Gravity or effort affecting the characters performance	**69.23%**	9
Gravity or effort affecting the Shorts on the Character	**69.23%**	9
The way the characters skin flexes is realistic	**30.77%**	4

Characters facial Expressions are realistic	**30.77%**	4
The performance of the Character is realistic	**30.77%**	4
The feeling of weight in Characters Movements is realistic	**23.08%**	3
The Timing of the Characters Movements helps with the characters realistic	**23.08%**	3
Characters Physical Appearance helps with the characters realistic	**0%**	0
Total Respondents: 13		

Q9 In which video is the characters movement most realistic?

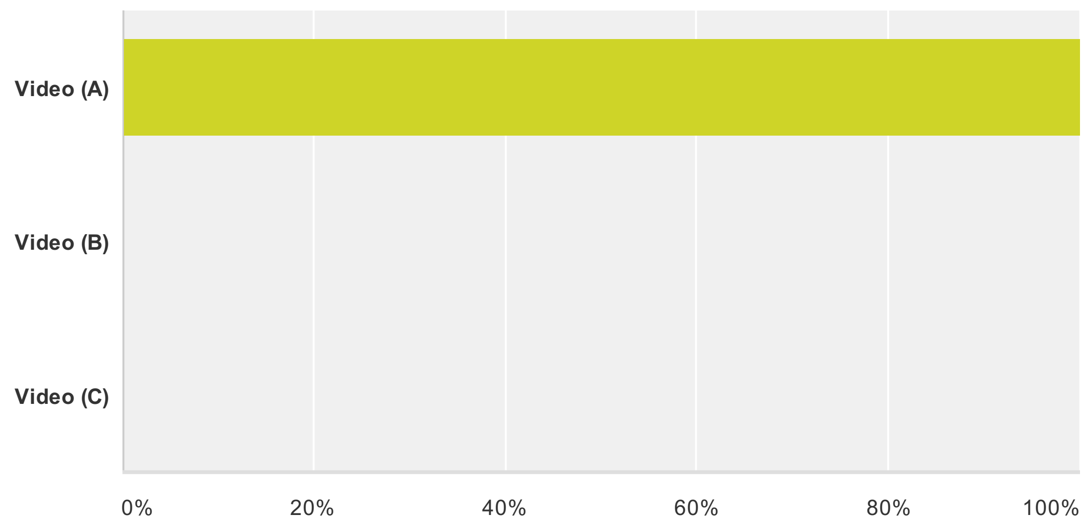
Answered: 13   Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**0%**	0
Video (C)	**100%**	13
Total		**13**

Q11 In which video is the characters movement most believable?

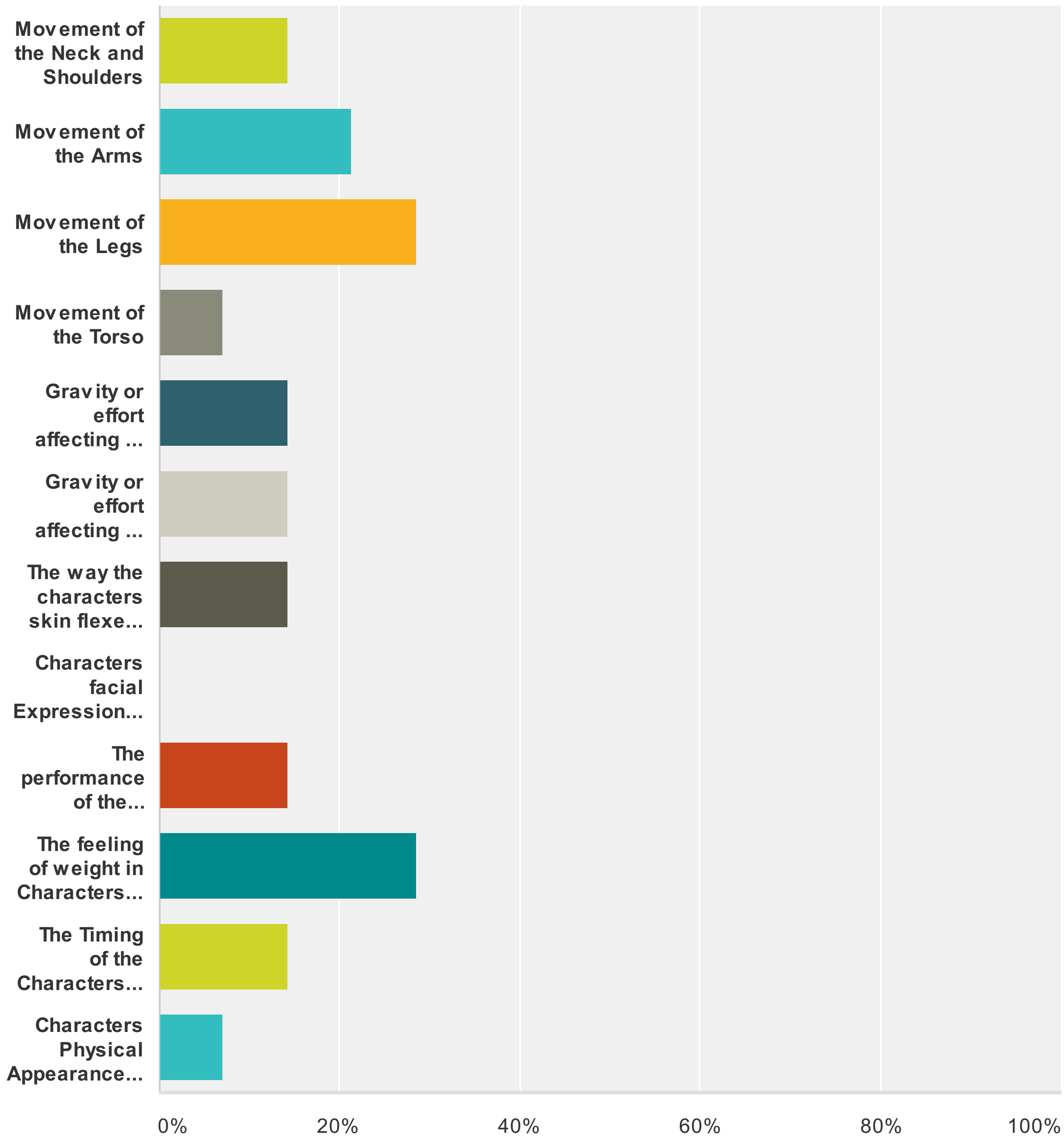
Answered: 14   Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	14
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**14**

Q12 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 14 Skipped: 0

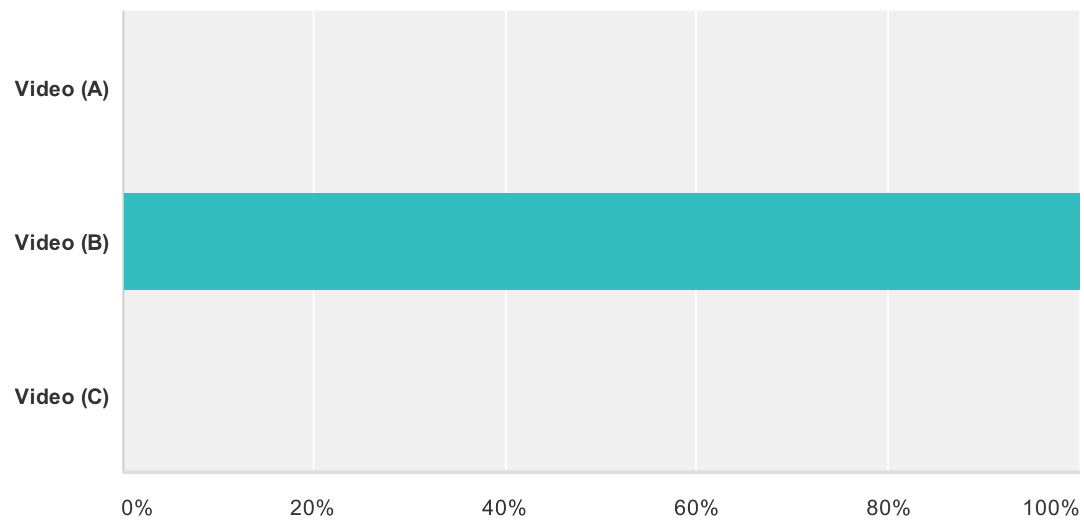


Answer Choices	Responses	
Movement of the Neck and Shoulders	14.29%	2
Movement of the Arms	21.43%	3
Movement of the Legs	28.57%	4
Movement of the Torso	7.14%	1
Gravity or effort affecting the characters performance	14.29%	2
Gravity or effort affecting the Shorts on the Character	14.29%	2
The way the characters skin flexes is believable	14.29%	2

Characters facial Expressions are believable	**0%**	0
The performance of the Character is believable	**14.29%**	2
The feeling of weight in Characters Movements is believable	**28.57%**	4
The Timing of the Characters Movements helps with the characters believable	**14.29%**	2
Characters Physical Appearance helps with the characters believable	**7.14%**	1
Total Respondents: 14		

Q11 In which video is the characters movement most believable?

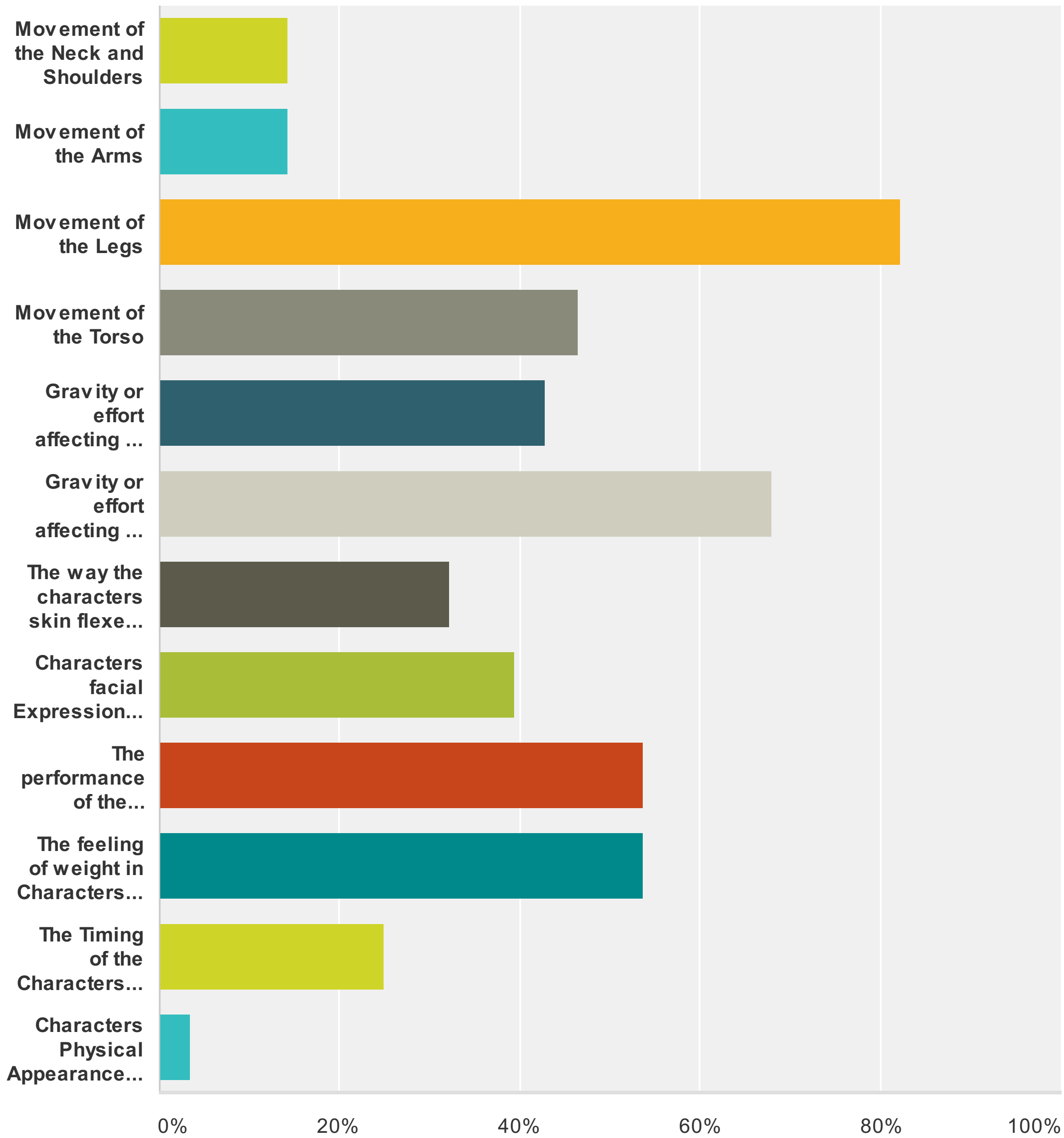
Answered: 28 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**100%**	28
Video (C)	**0%**	0
Total		**28**

Q12 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 28 Skipped: 0

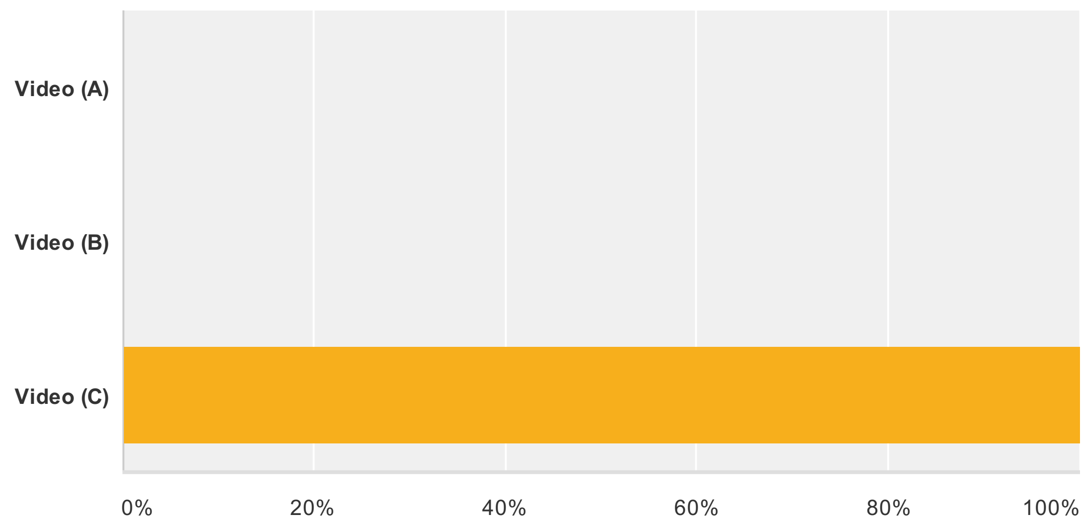


Answer Choices	Responses	
Movement of the Neck and Shoulders	14.29%	4
Movement of the Arms	14.29%	4
Movement of the Legs	82.14%	23
Movement of the Torso	46.43%	13
Gravity or effort affecting the characters performance	42.86%	12
Gravity or effort affecting the Shorts on the Character	67.86%	19
The way the characters skin flexes is believable	32.14%	9

Characters facial Expressions are believable	**39.29%**	11
The performance of the Character is believable	**53.57%**	15
The feeling of weight in Characters Movements is believable	**53.57%**	15
The Timing of the Characters Movements helps with the characters believable	**25%**	7
Characters Physical Appearance helps with the characters believable	**3.57%**	1
Total Respondents: 28		

Q11 In which video is the characters movement most believable?

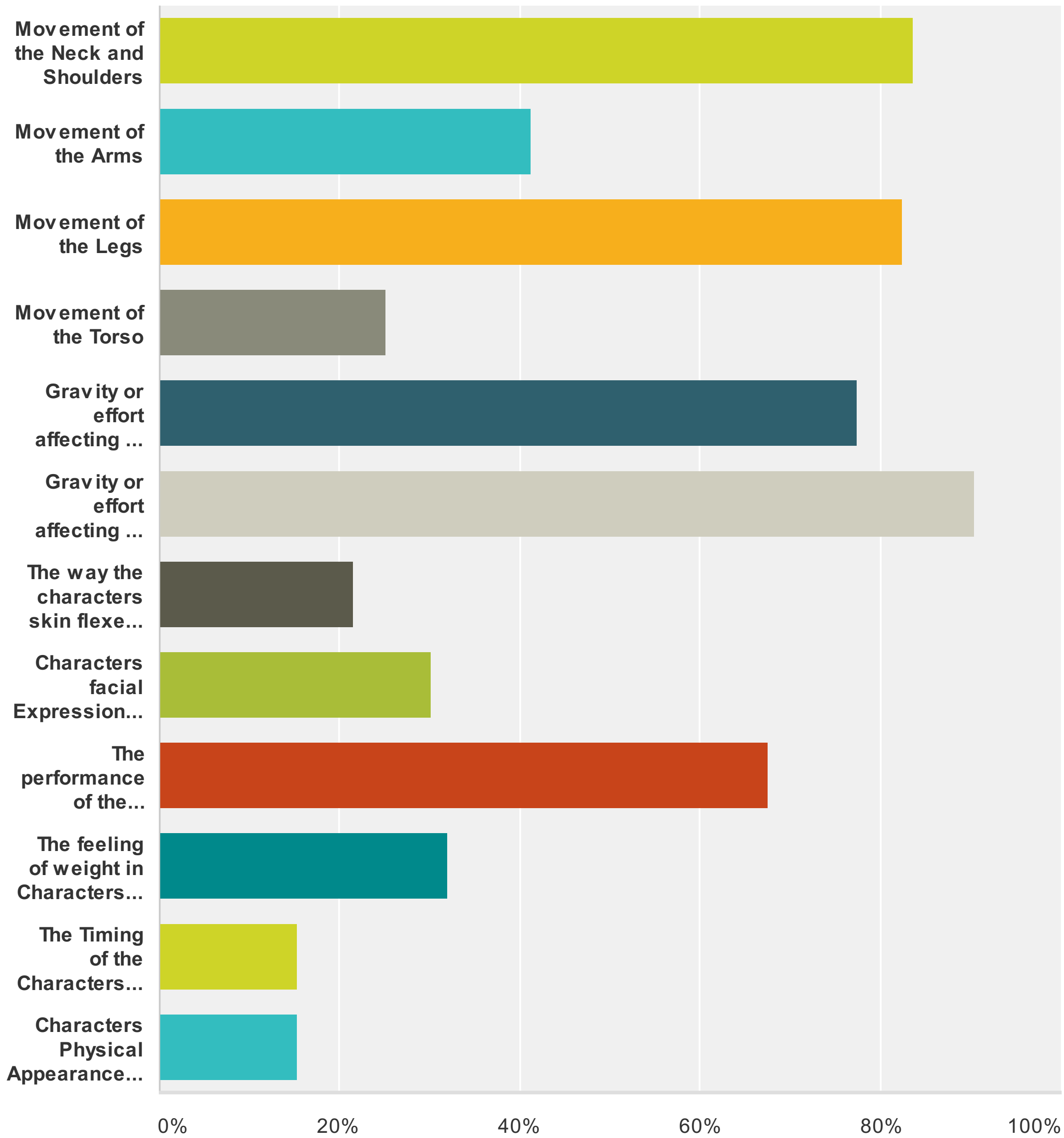
Answered: 163   Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**0%**	0
Video (C)	**100%**	163
Total		**163**

Q12 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 163 Skipped: 0

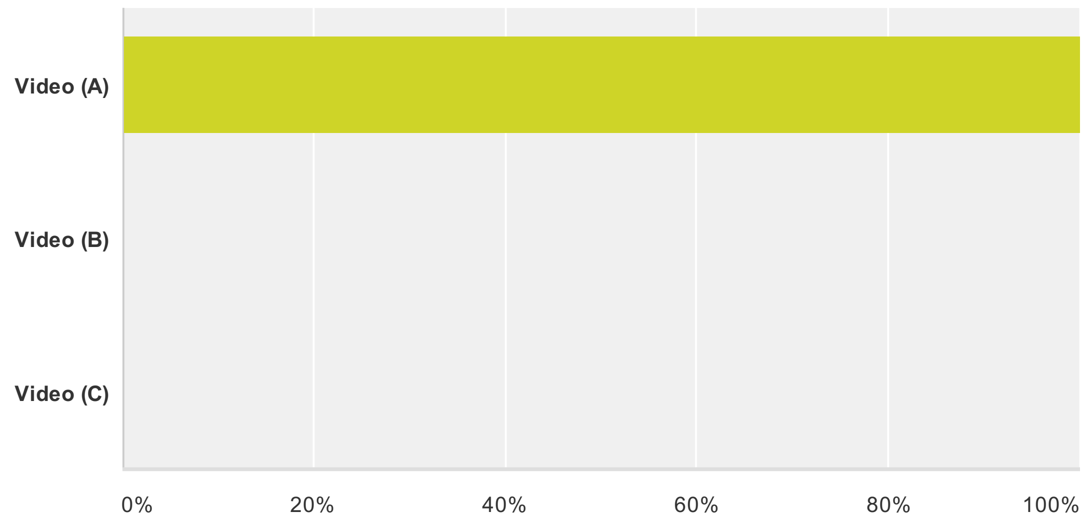


Answer Choices	Responses	
Movement of the Neck and Shoulders	83.44%	136
Movement of the Arms	41.10%	67
Movement of the Legs	82.21%	134
Movement of the Torso	25.15%	41
Gravity or effort affecting the characters performance	77.30%	126
Gravity or effort affecting the Shorts on the Character	90.18%	147
The way the characters skin flexes is believable	21.47%	35

Characters facial Expressions are believable	**30.06%**	49
The performance of the Character is believable	**67.48%**	110
The feeling of weight in Characters Movements is believable	**31.90%**	52
The Timing of the Characters Movements helps with the characters believable	**15.34%**	25
Characters Physical Appearance helps with the characters believable	**15.34%**	25
Total Respondents: 163		

Q19 In which video is the characters movement most appealing?

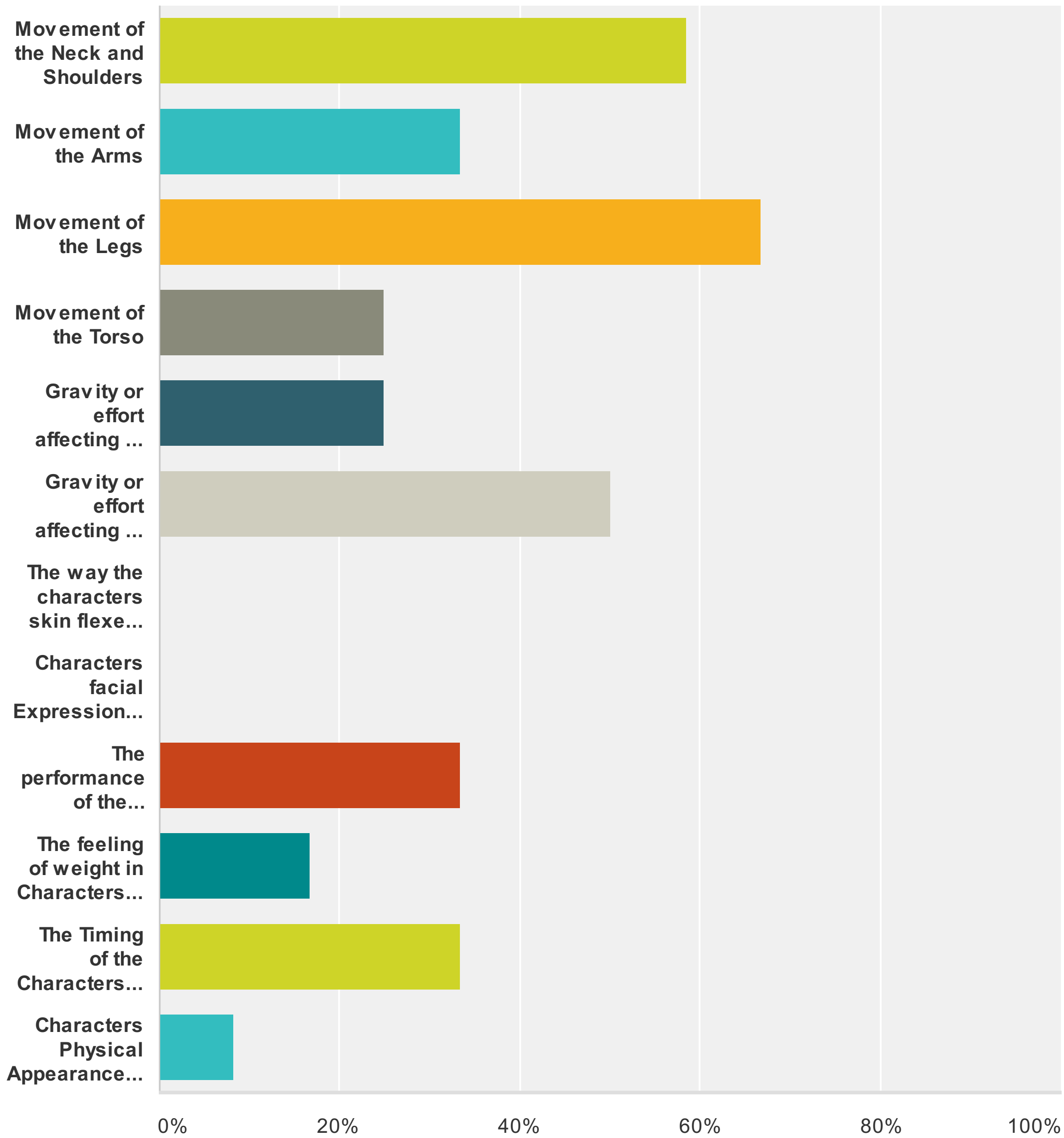
Answered: 12 Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	12
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**12**

Q20 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 12 Skipped: 0

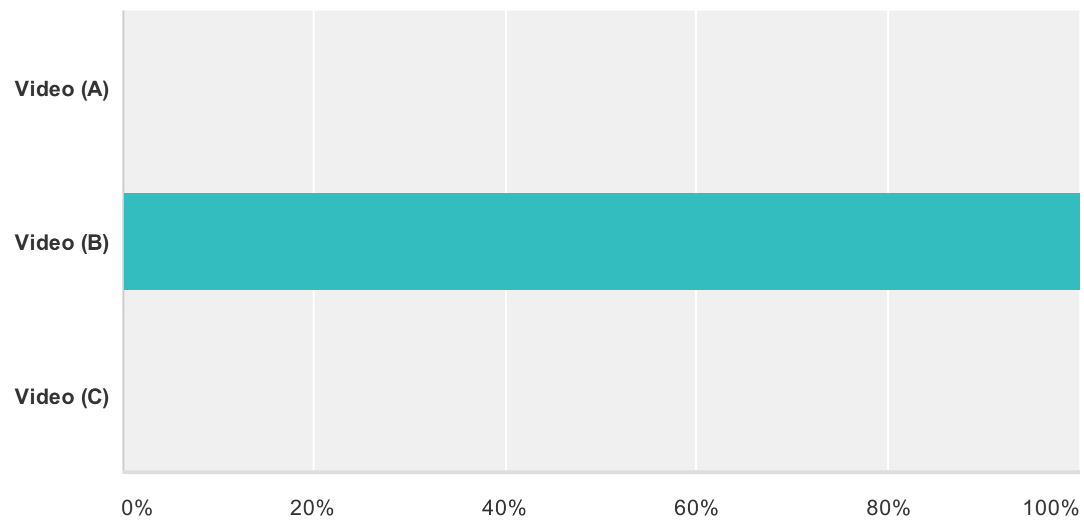


Answer Choices	Responses	
Movement of the Neck and Shoulders	58.33%	7
Movement of the Arms	33.33%	4
Movement of the Legs	66.67%	8
Movement of the Torso	25%	3
Gravity or effort affecting the characters performance	25%	3
Gravity or effort affecting the Shorts on the Character	50%	6
The way the characters skin flexes is appealing	0%	0

Characters facial Expressions are appealing	**0%**	0
The performance of the Character is appealing	**33.33%**	4
The feeling of weight in Characters Movements is appealing	**16.67%**	2
The Timing of the Characters Movements helps with the characters appeal	**33.33%**	4
Characters Physical Appearance helps with the characters appeal	**8.33%**	1
Total Respondents: 12		

Q19 In which video is the characters movement most appealing?

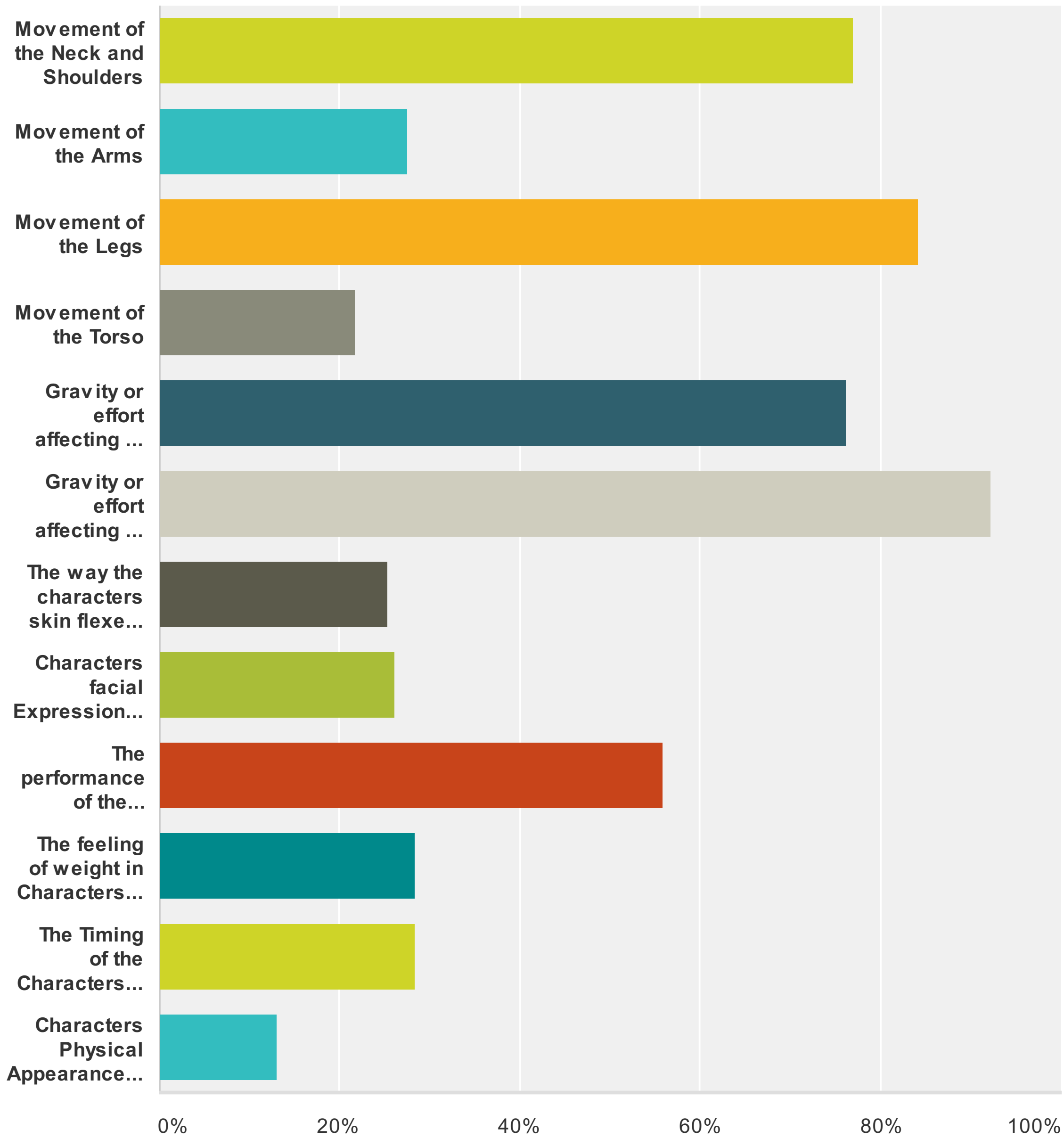
Answered: 138 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**100%**	138
Video (C)	**0%**	0
Total		**138**

Q20 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 138 Skipped: 0

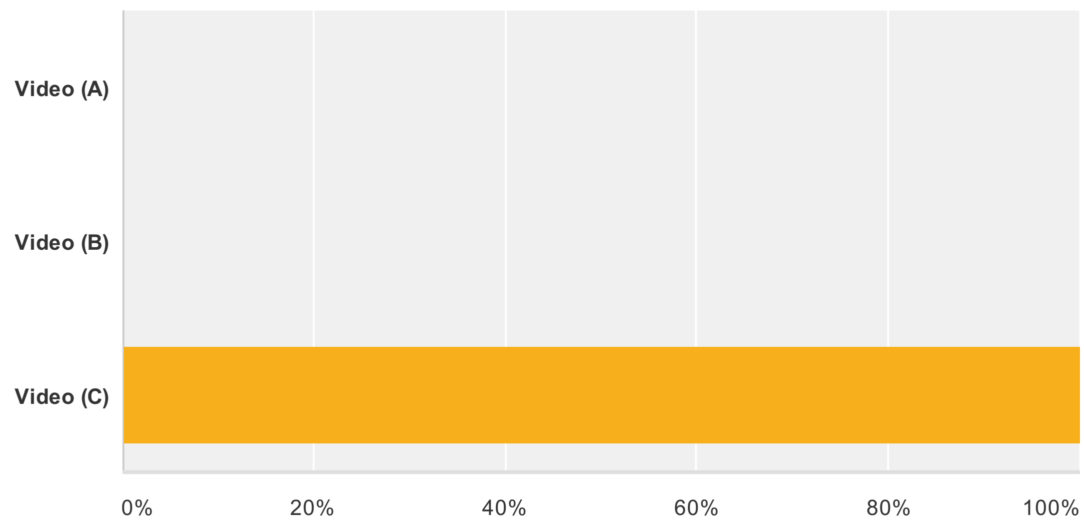


Answer Choices	Responses	
Movement of the Neck and Shoulders	76.81%	106
Movement of the Arms	27.54%	38
Movement of the Legs	84.06%	116
Movement of the Torso	21.74%	30
Gravity or effort affecting the characters performance	76.09%	105
Gravity or effort affecting the Shorts on the Character	92.03%	127
The way the characters skin flexes is appealing	25.36%	35

Characters facial Expressions are appealing	**26.09%**	36
The performance of the Character is appealing	**55.80%**	77
The feeling of weight in Characters Movements is appealing	**28.26%**	39
The Timing of the Characters Movements helps with the characters appeal	**28.26%**	39
Characters Physical Appearance helps with the characters appeal	**13.04%**	18
Total Respondents: 138		

Q19 In which video is the characters movement most appealing?

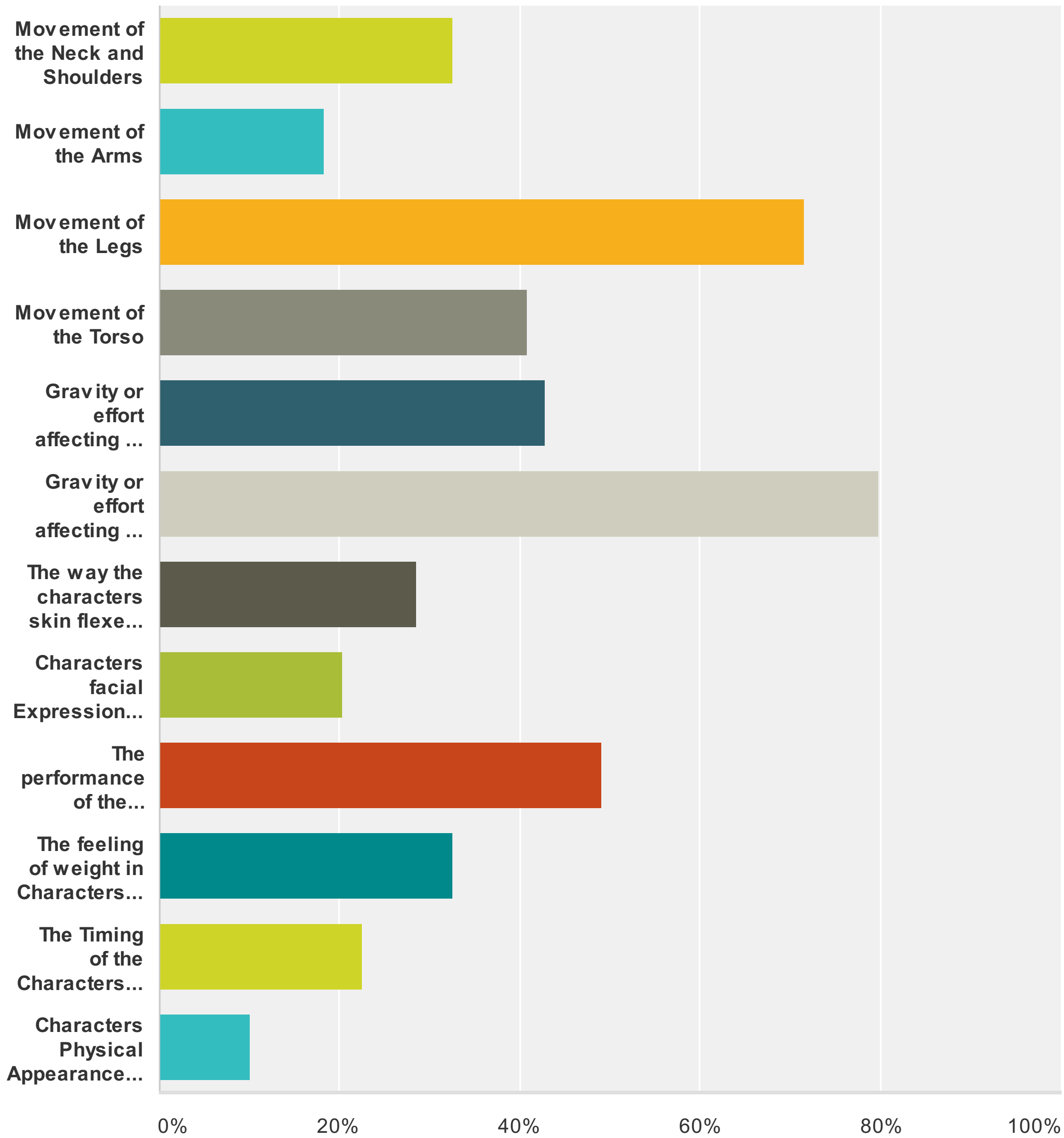
Answered: 49 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**0%**	0
Video (C)	**100%**	49
Total		**49**

Q20 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 49 Skipped: 0

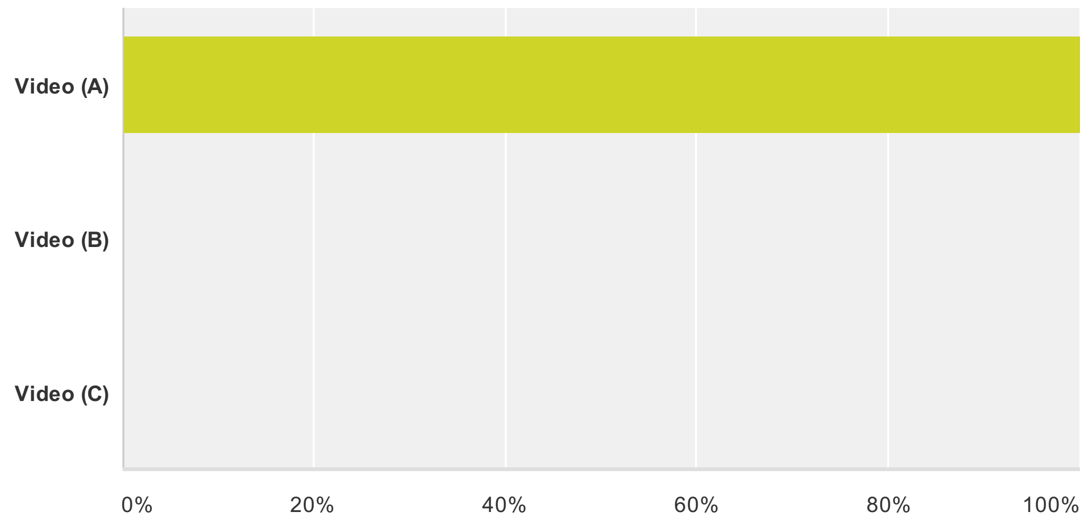


Answer Choices	Responses	
Movement of the Neck and Shoulders	32.65%	16
Movement of the Arms	18.37%	9
Movement of the Legs	71.43%	35
Movement of the Torso	40.82%	20
Gravity or effort affecting the characters performance	42.86%	21
Gravity or effort affecting the Shorts on the Character	79.59%	39
The way the characters skin flexes is appealing	28.57%	14

Characters facial Expressions are appealing	**20.41%**	10
The performance of the Character is appealing	**48.98%**	24
The feeling of weight in Characters Movements is appealing	**32.65%**	16
The Timing of the Characters Movements helps with the characters appeal	**22.45%**	11
Characters Physical Appearance helps with the characters appeal	**10.20%**	5
Total Respondents: 49		

Q21 In which video is the characters movement most realistic?

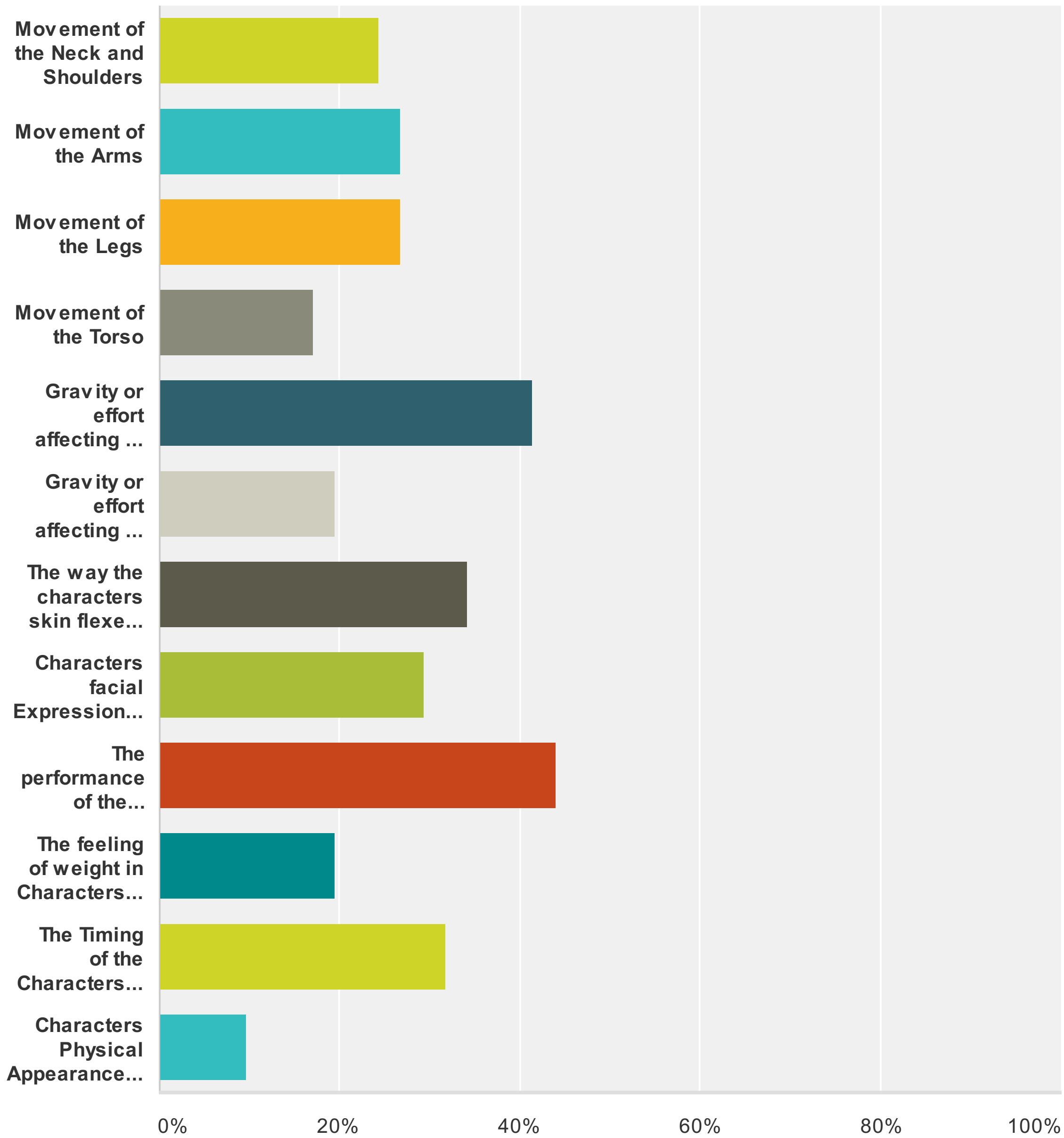
Answered: 41 Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	41
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**41**

Q22 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 41 Skipped: 0

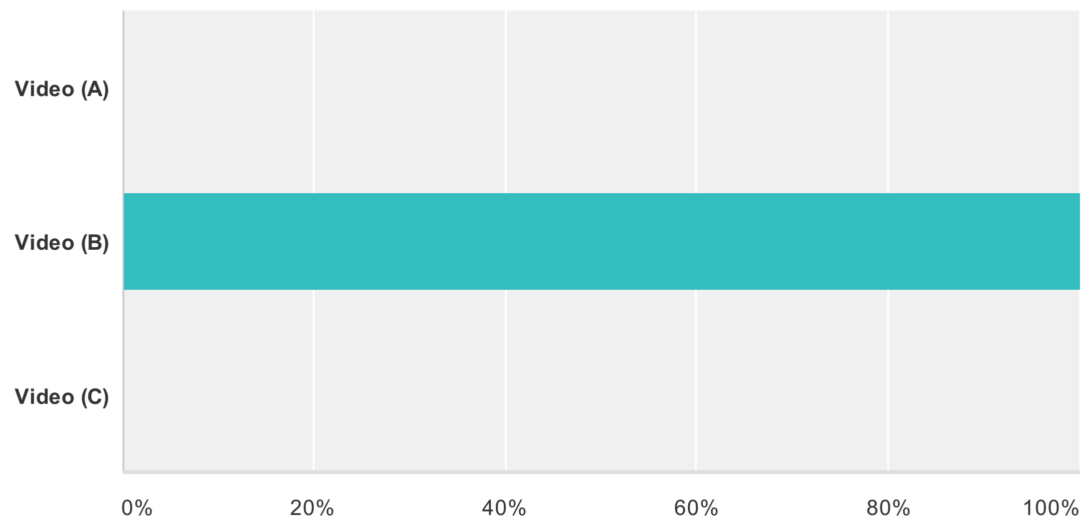


Answer Choices	Responses	
Movement of the Neck and Shoulders	**24.39%**	10
Movement of the Arms	**26.83%**	11
Movement of the Legs	**26.83%**	11
Movement of the Torso	**17.07%**	7
Gravity or effort affecting the characters performance	**41.46%**	17
Gravity or effort affecting the Shorts on the Character	**19.51%**	8
The way the characters skin flexes is realistic	**34.15%**	14

Characters facial Expressions are realistic	**29.27%**	12
The performance of the Character is realistic	**43.90%**	18
The feeling of weight in Characters Movements is realistic	**19.51%**	8
The Timing of the Characters Movements helps with the characters realistic	**31.71%**	13
Characters Physical Appearance helps with the characters realistic	**9.76%**	4
Total Respondents: 41		

Q21 In which video is the characters movement most realistic?

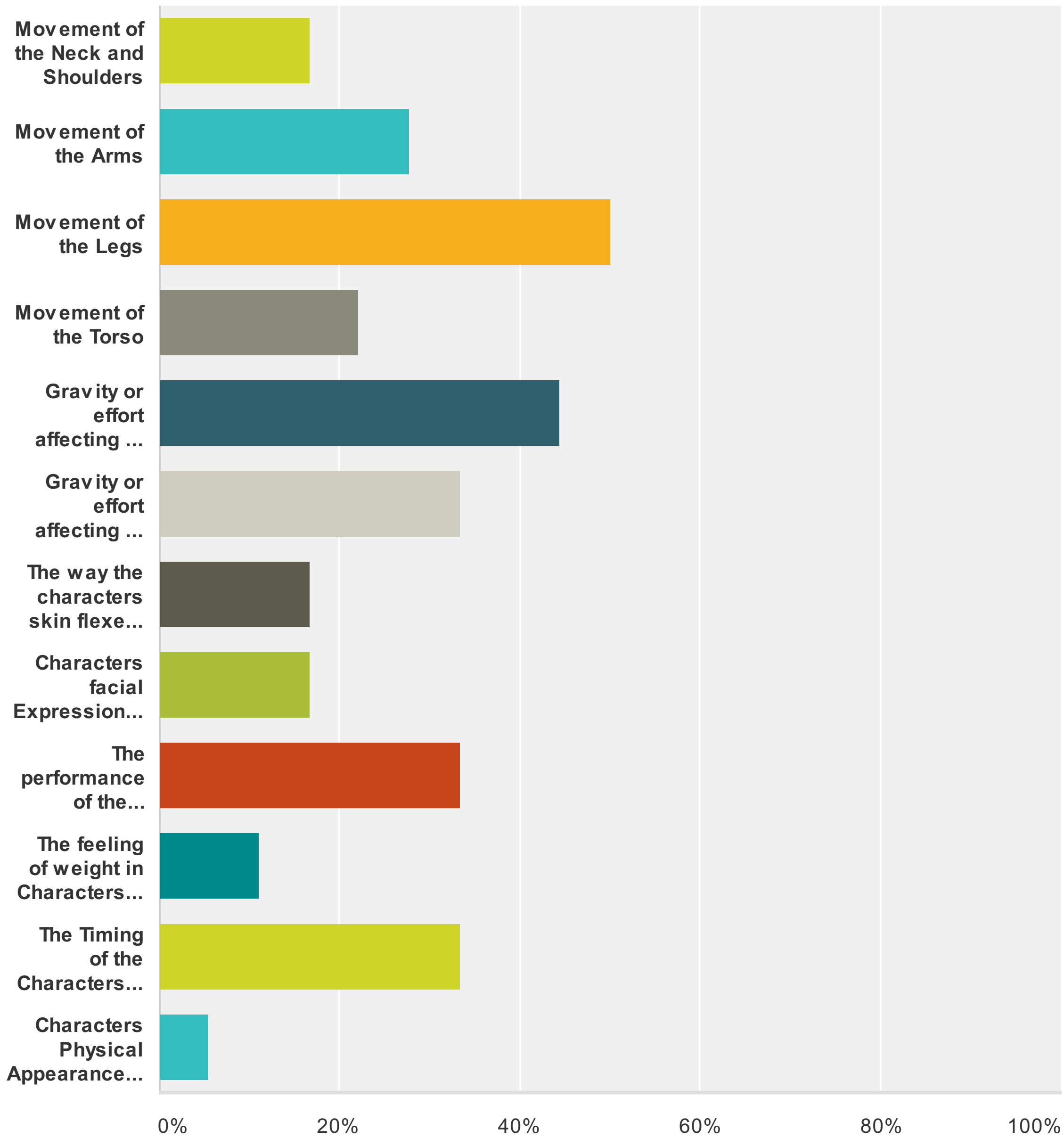
Answered: 18 Skipped: 0



Answer Choices	Responses	
Video (A)	0%	0
Video (B)	100%	18
Video (C)	0%	0
Total		18

Q22 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 18 Skipped: 0

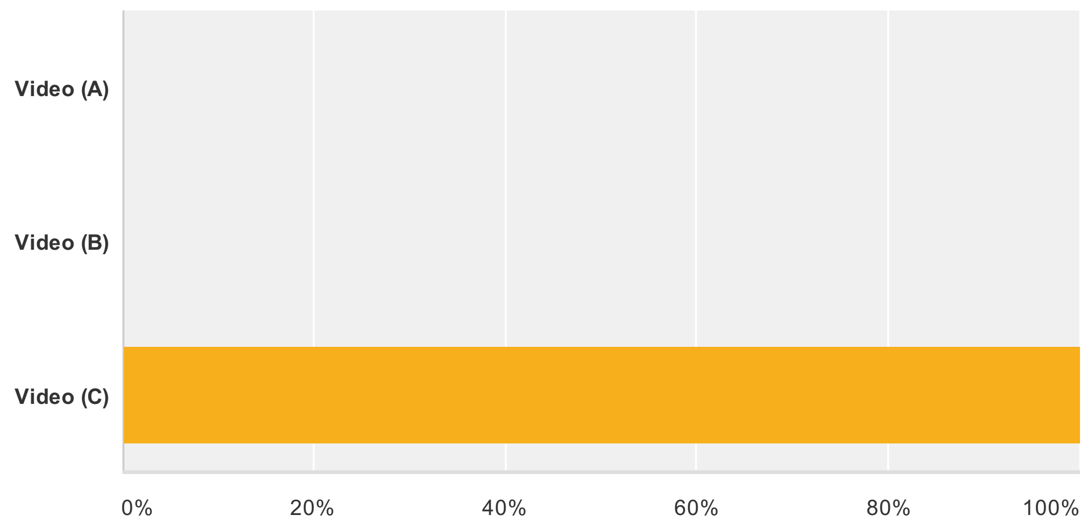


Answer Choices	Responses	
Movement of the Neck and Shoulders	16.67%	3
Movement of the Arms	27.78%	5
Movement of the Legs	50%	9
Movement of the Torso	22.22%	4
Gravity or effort affecting the characters performance	44.44%	8
Gravity or effort affecting the Shorts on the Character	33.33%	6
The way the characters skin flexes is realistic	16.67%	3

Characters facial Expressions are realistic	**16.67%**	3
The performance of the Character is realistic	**33.33%**	6
The feeling of weight in Characters Movements is realistic	**11.11%**	2
The Timing of the Characters Movements helps with the characters realistic	**33.33%**	6
Characters Physical Appearance helps with the characters realistic	**5.56%**	1
Total Respondents: 18		

Q21 In which video is the characters movement most realistic?

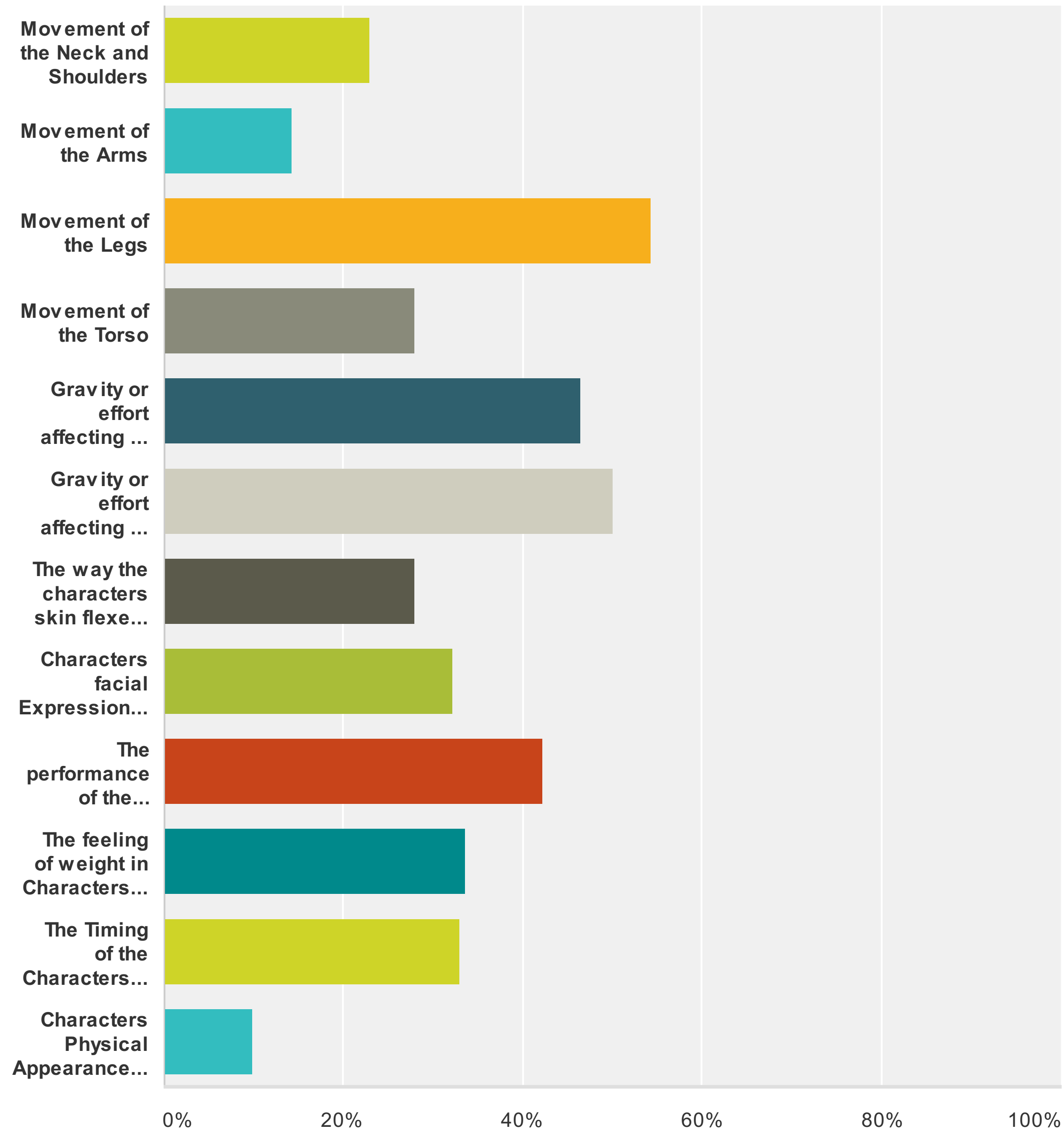
Answered: 140   Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**0%**	0
Video (C)	**100%**	140
Total		**140**

Q22 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 140   Skipped: 0

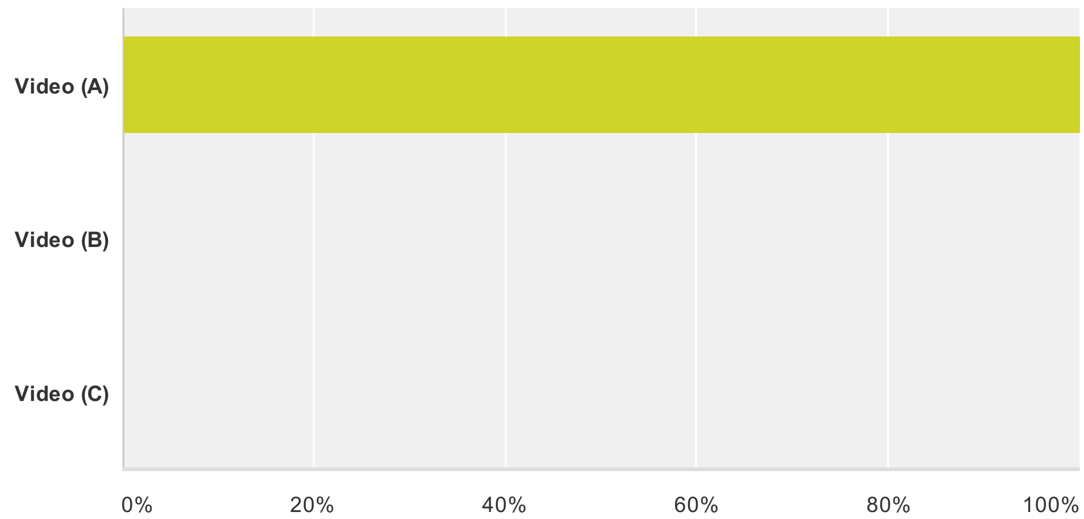


Answer Choices	Responses	
Movement of the Neck and Shoulders	22.86%	32
Movement of the Arms	14.29%	20
Movement of the Legs	54.29%	76
Movement of the Torso	27.86%	39
Gravity or effort affecting the characters performance	46.43%	65
Gravity or effort affecting the Shorts on the Character	50%	70
The way the characters skin flexes is realistic	27.86%	39

Characters facial Expressions are realistic	**32.14%**	45
The performance of the Character is realistic	**42.14%**	59
The feeling of weight in Characters Movements is realistic	**33.57%**	47
The Timing of the Characters Movements helps with the characters realistic	**32.86%**	46
Characters Physical Appearance helps with the characters realistic	**10%**	14
Total Respondents: 140		

Q23 In which video is the characters movement most believable?

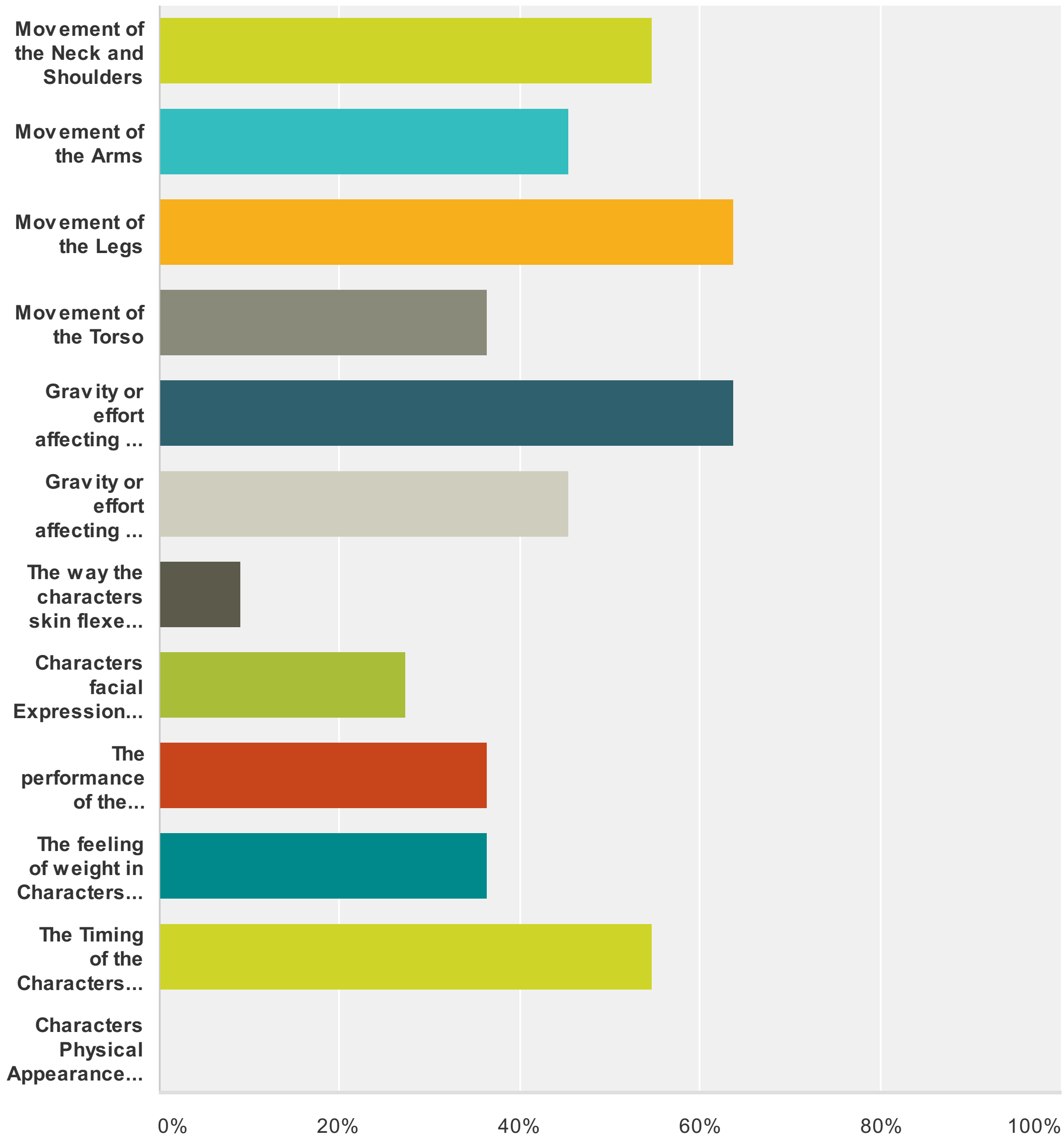
Answered: 11 Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	11
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**11**

Q24 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 11 Skipped: 0

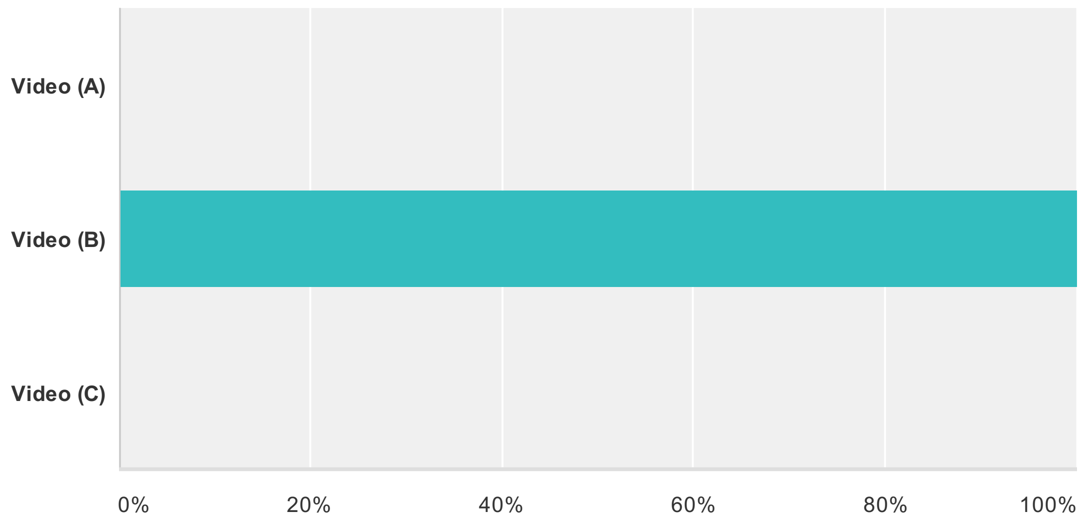


Answer Choices	Responses	
Movement of the Neck and Shoulders	**54.55%**	6
Movement of the Arms	**45.45%**	5
Movement of the Legs	**63.64%**	7
Movement of the Torso	**36.36%**	4
Gravity or effort affecting the characters performance	**63.64%**	7
Gravity or effort affecting the Shorts on the Character	**45.45%**	5
The way the characters skin flexes is believable	**9.09%**	1

Characters facial Expressions are believable	**27.27%**	3
The performance of the Character is believable	**36.36%**	4
The feeling of weight in Characters Movements is believable	**36.36%**	4
The Timing of the Characters Movements helps with the characters believable	**54.55%**	6
Characters Physical Appearance helps with the characters believable	**0%**	0
Total Respondents: 11		

Q23 In which video is the characters movement most believable?

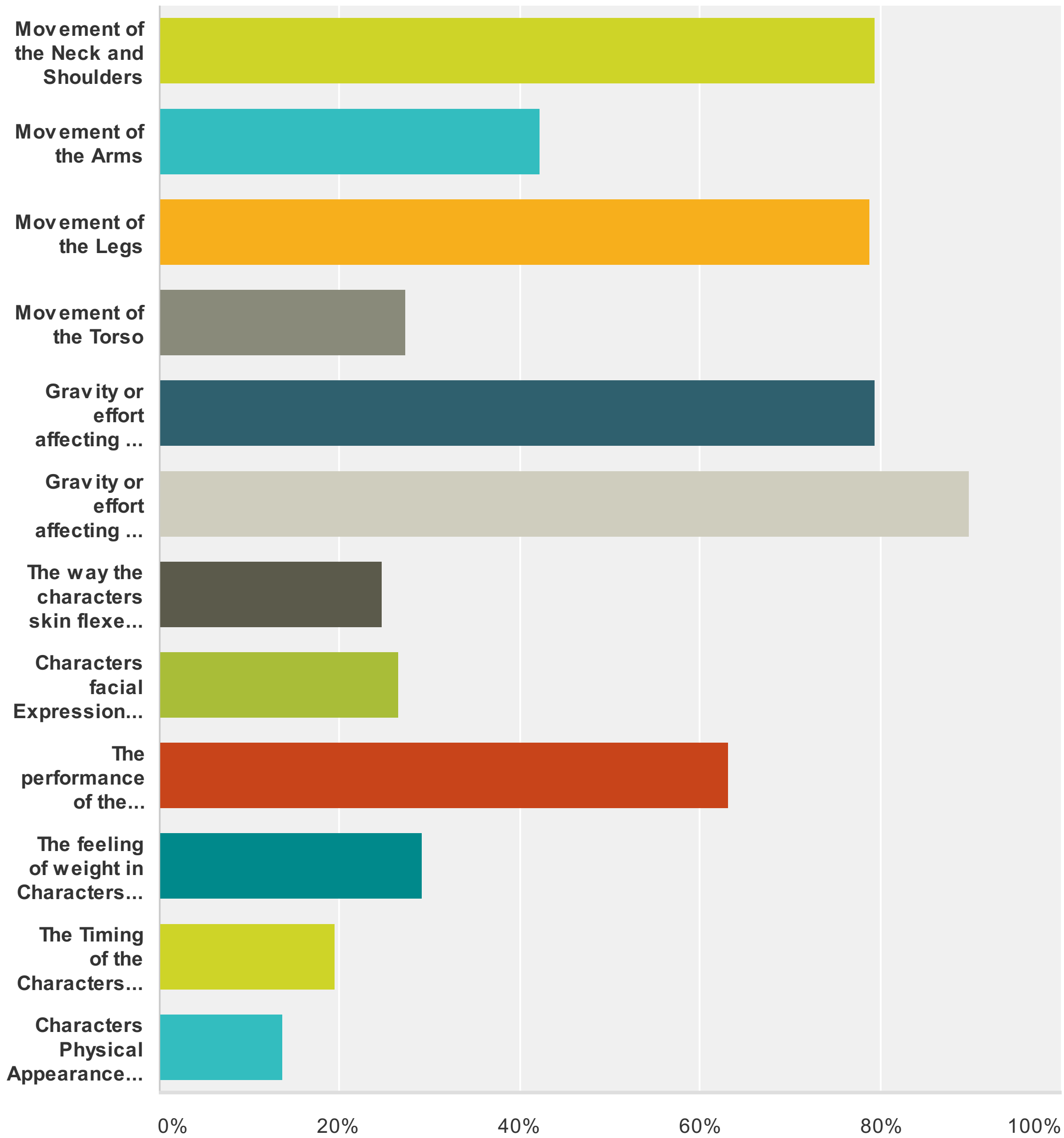
Answered: 154   Skipped: 0



Answer Choices	Responses	
Video (A)	0%	0
Video (B)	100%	154
Video (C)	0%	0
Total		154

Q24 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 154 Skipped: 0

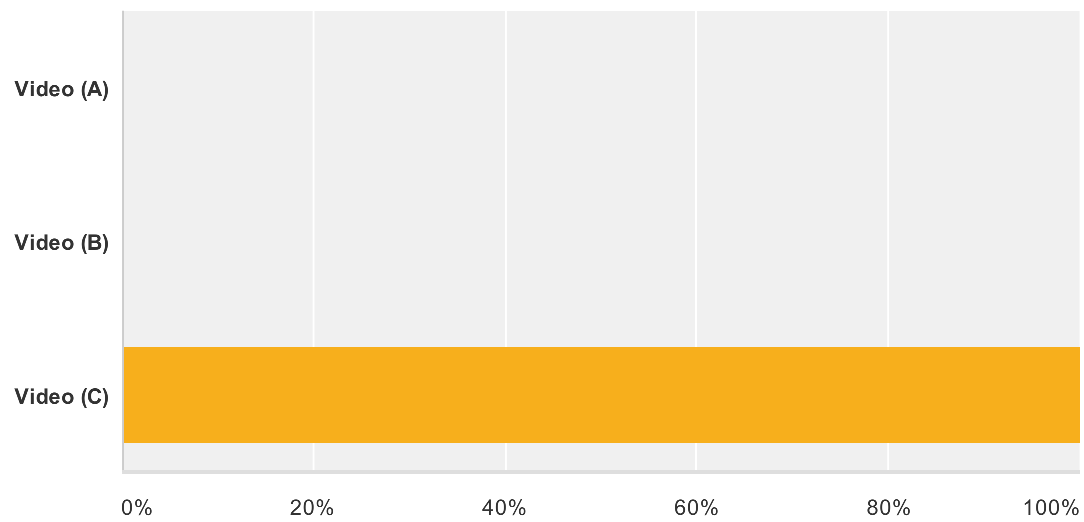


Answer Choices	Responses	
Movement of the Neck and Shoulders	**79.22%**	122
Movement of the Arms	**42.21%**	65
Movement of the Legs	**78.57%**	121
Movement of the Torso	**27.27%**	42
Gravity or effort affecting the characters performance	**79.22%**	122
Gravity or effort affecting the Shorts on the Character	**89.61%**	138
The way the characters skin flexes is believable	**24.68%**	38

Characters facial Expressions are believable	**26.62%**	41
The performance of the Character is believable	**62.99%**	97
The feeling of weight in Characters Movements is believable	**29.22%**	45
The Timing of the Characters Movements helps with the characters believable	**19.48%**	30
Characters Physical Appearance helps with the characters believable	**13.64%**	21
Total Respondents: 154		

Q23 In which video is the characters movement most believable?

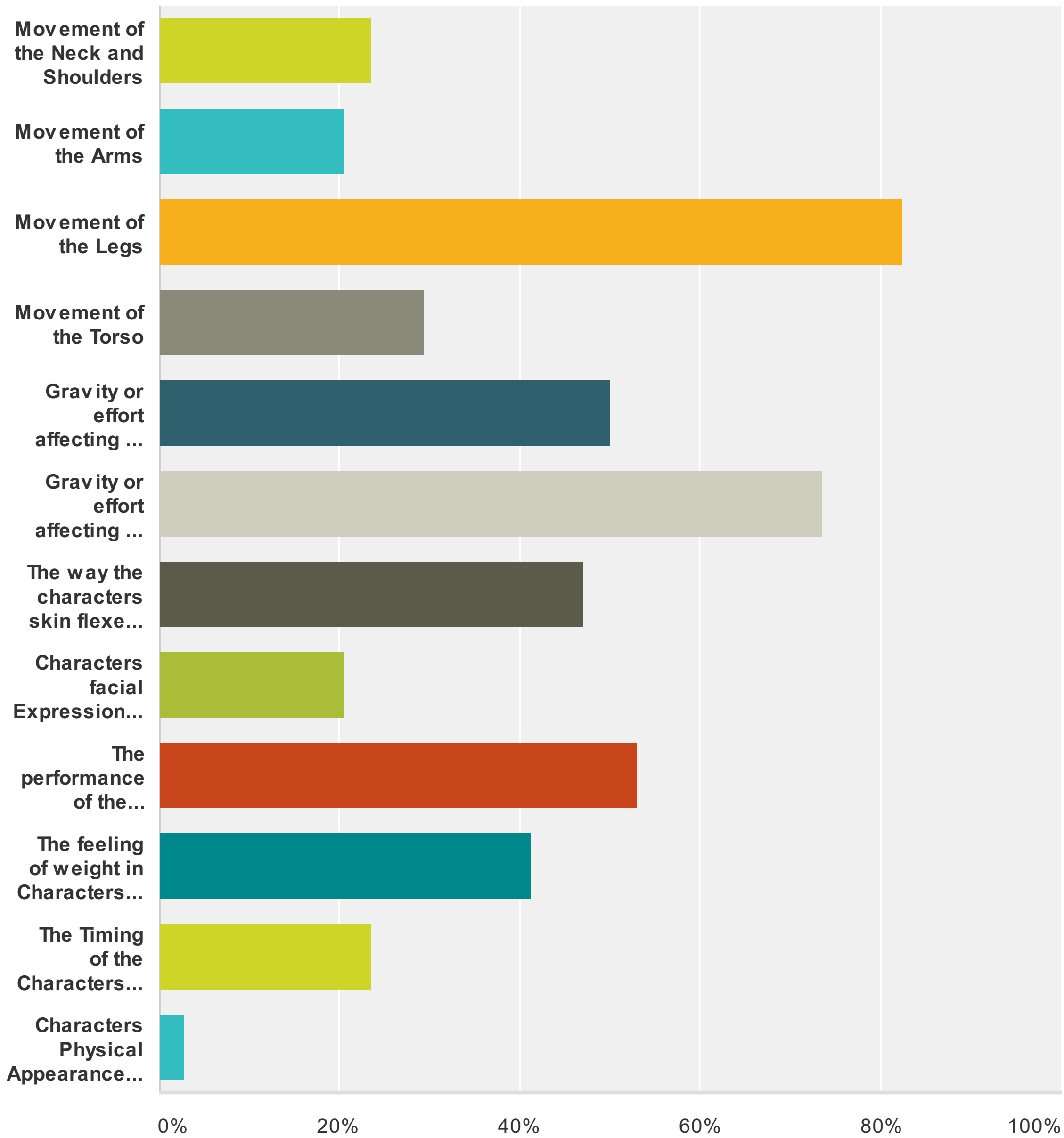
Answered: 34 Skipped: 0



Answer Choices	Responses	
Video (A)	0%	0
Video (B)	0%	0
Video (C)	100%	34
Total		34

Q24 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 34 Skipped: 0

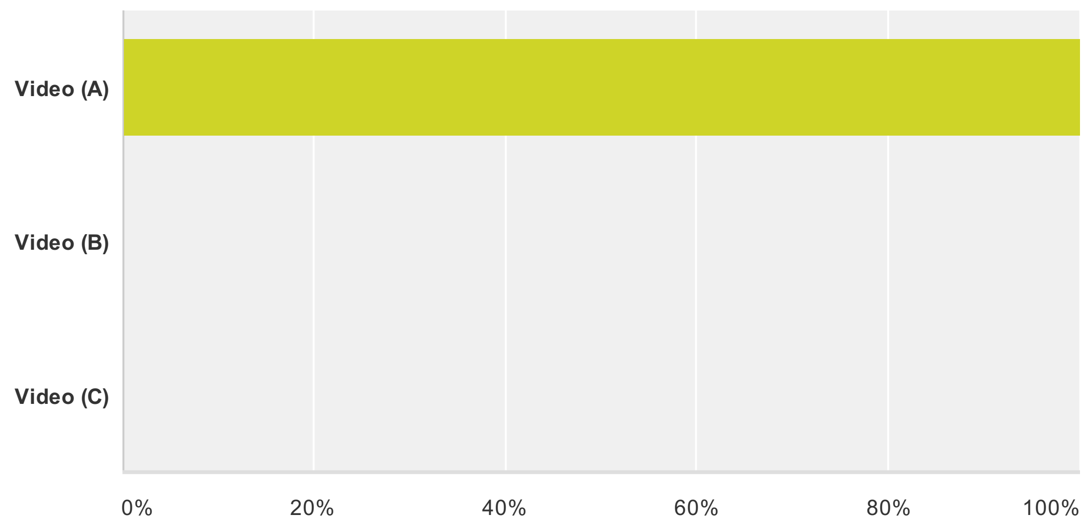


Answer Choices	Responses	
Movement of the Neck and Shoulders	23.53%	8
Movement of the Arms	20.59%	7
Movement of the Legs	82.35%	28
Movement of the Torso	29.41%	10
Gravity or effort affecting the characters performance	50%	17
Gravity or effort affecting the Shorts on the Character	73.53%	25
The way the characters skin flexes is believable	47.06%	16

Characters facial Expressions are believable	**20.59%**	7
The performance of the Character is believable	**52.94%**	18
The feeling of weight in Characters Movements is believable	**41.18%**	14
The Timing of the Characters Movements helps with the characters believable	**23.53%**	8
Characters Physical Appearance helps with the characters believable	**2.94%**	1
Total Respondents: 34		

Q13 In which video is the characters movement most appealing?

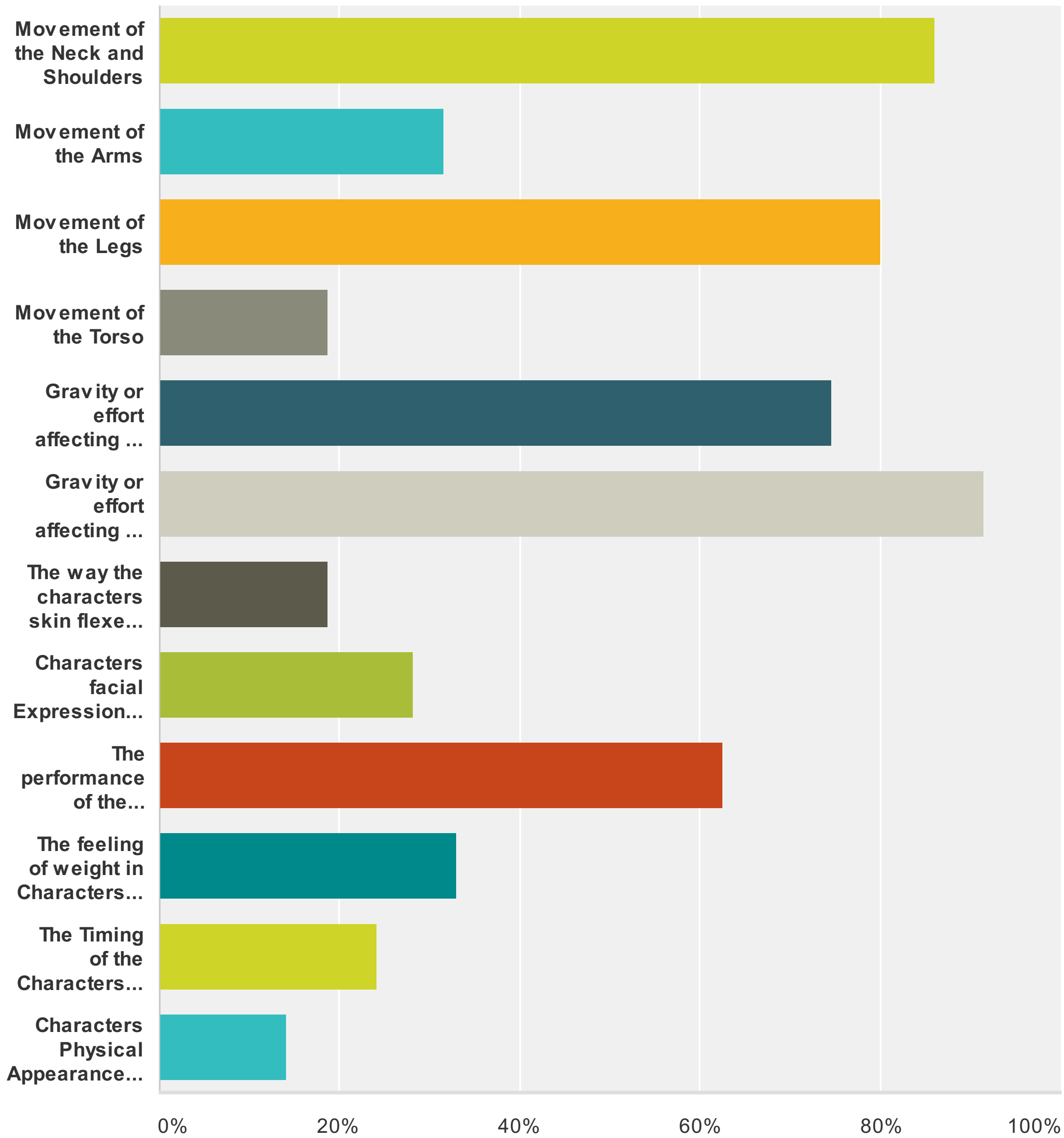
Answered: 149   Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	149
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**149**

Q14 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 149 Skipped: 0

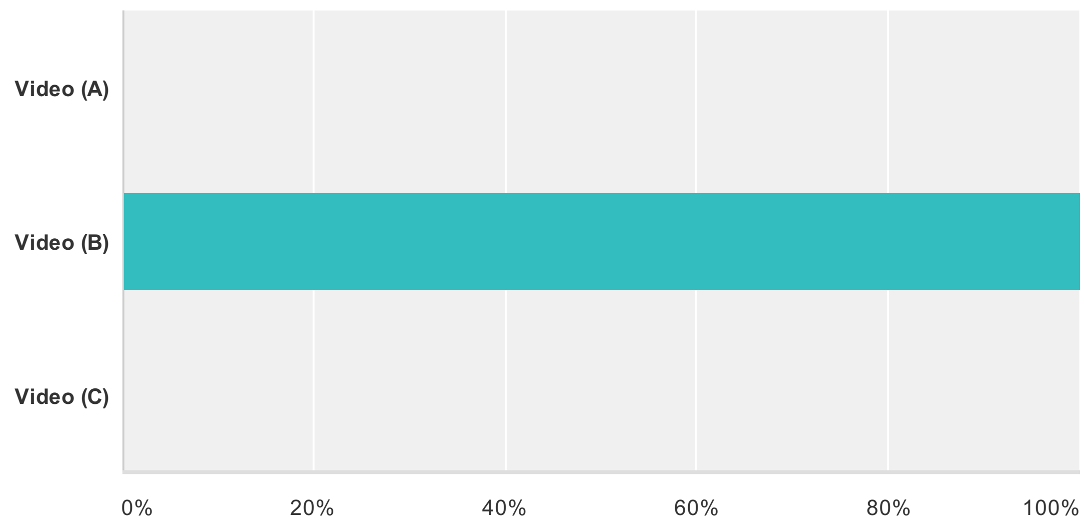


Answer Choices	Responses	
Movement of the Neck and Shoulders	85.91%	128
Movement of the Arms	31.54%	47
Movement of the Legs	79.87%	119
Movement of the Torso	18.79%	28
Gravity or effort affecting the characters performance	74.50%	111
Gravity or effort affecting the Shorts on the Character	91.28%	136
The way the characters skin flexes is appealing	18.79%	28

Characters facial Expressions are appealing	**28.19%**	42
The performance of the Character is appealing	**62.42%**	93
The feeling of weight in Characters Movements is appealing	**32.89%**	49
The Timing of the Characters Movements helps with the characters appeal	**24.16%**	36
Characters Physical Appearance helps with the characters appeal	**14.09%**	21
Total Respondents: 149		

Q13 In which video is the characters movement most appealing?

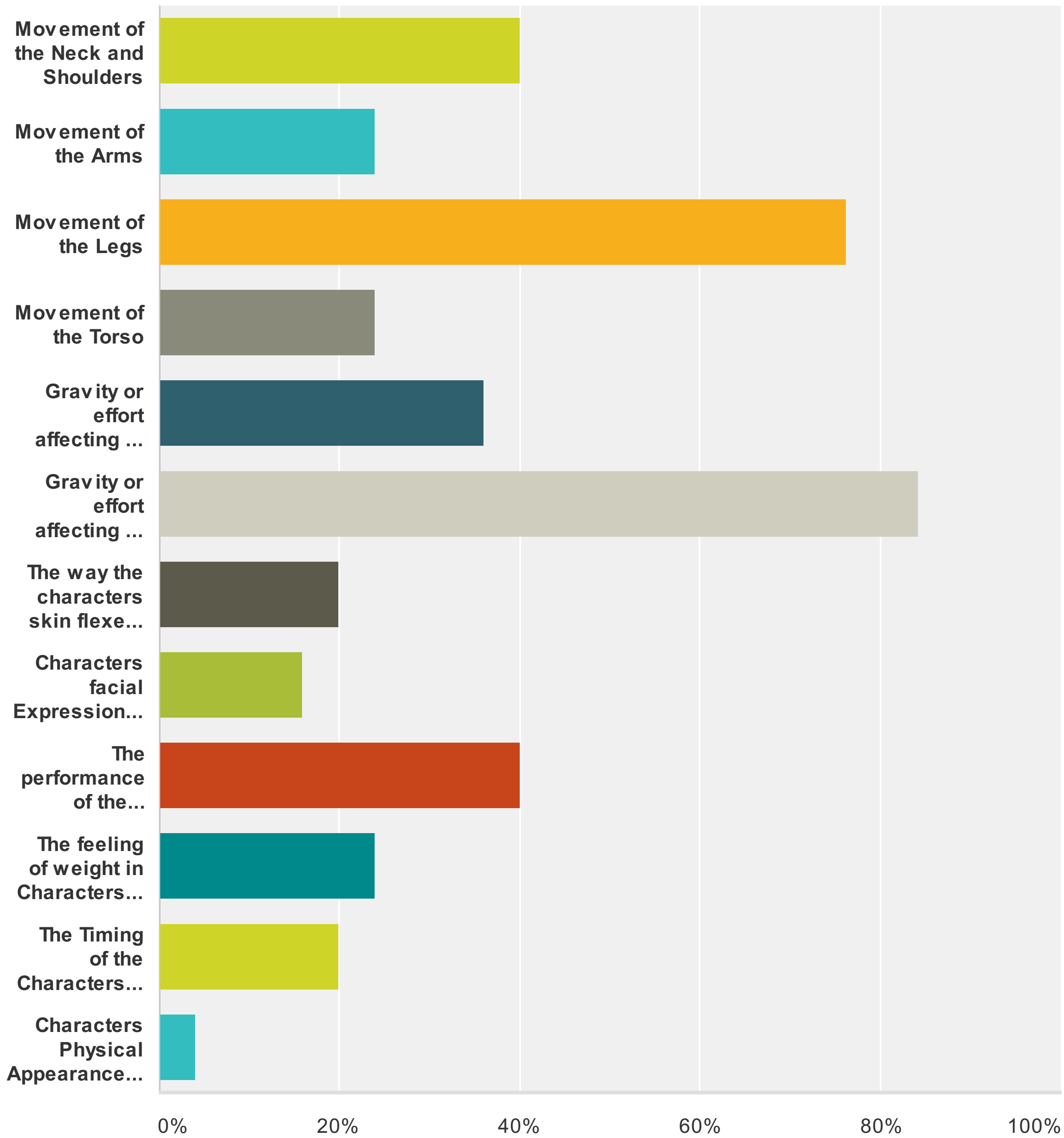
Answered: 25 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**100%**	25
Video (C)	**0%**	0
Total		**25**

Q14 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 25 Skipped: 0

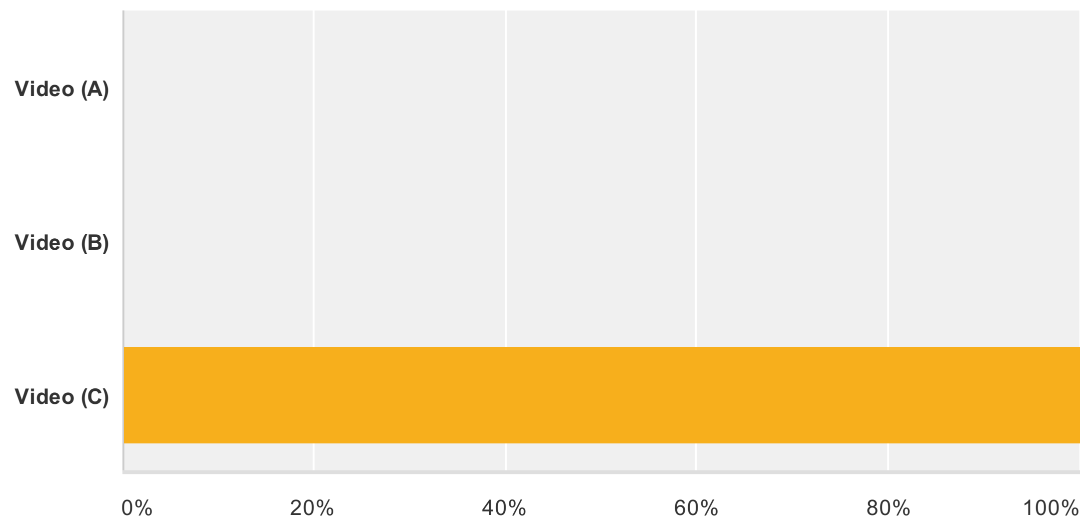


Answer Choices	Responses	
Movement of the Neck and Shoulders	**40%**	10
Movement of the Arms	**24%**	6
Movement of the Legs	**76%**	19
Movement of the Torso	**24%**	6
Gravity or effort affecting the characters performance	**36%**	9
Gravity or effort affecting the Shorts on the Character	**84%**	21
The way the characters skin flexes is appealing	**20%**	5

Characters facial Expressions are appealing	**16%**	4
The performance of the Character is appealing	**40%**	10
The feeling of weight in Characters Movements is appealing	**24%**	6
The Timing of the Characters Movements helps with the characters appeal	**20%**	5
Characters Physical Appearance helps with the characters appeal	**4%**	1
Total Respondents: 25		

Q13 In which video is the characters movement most appealing?

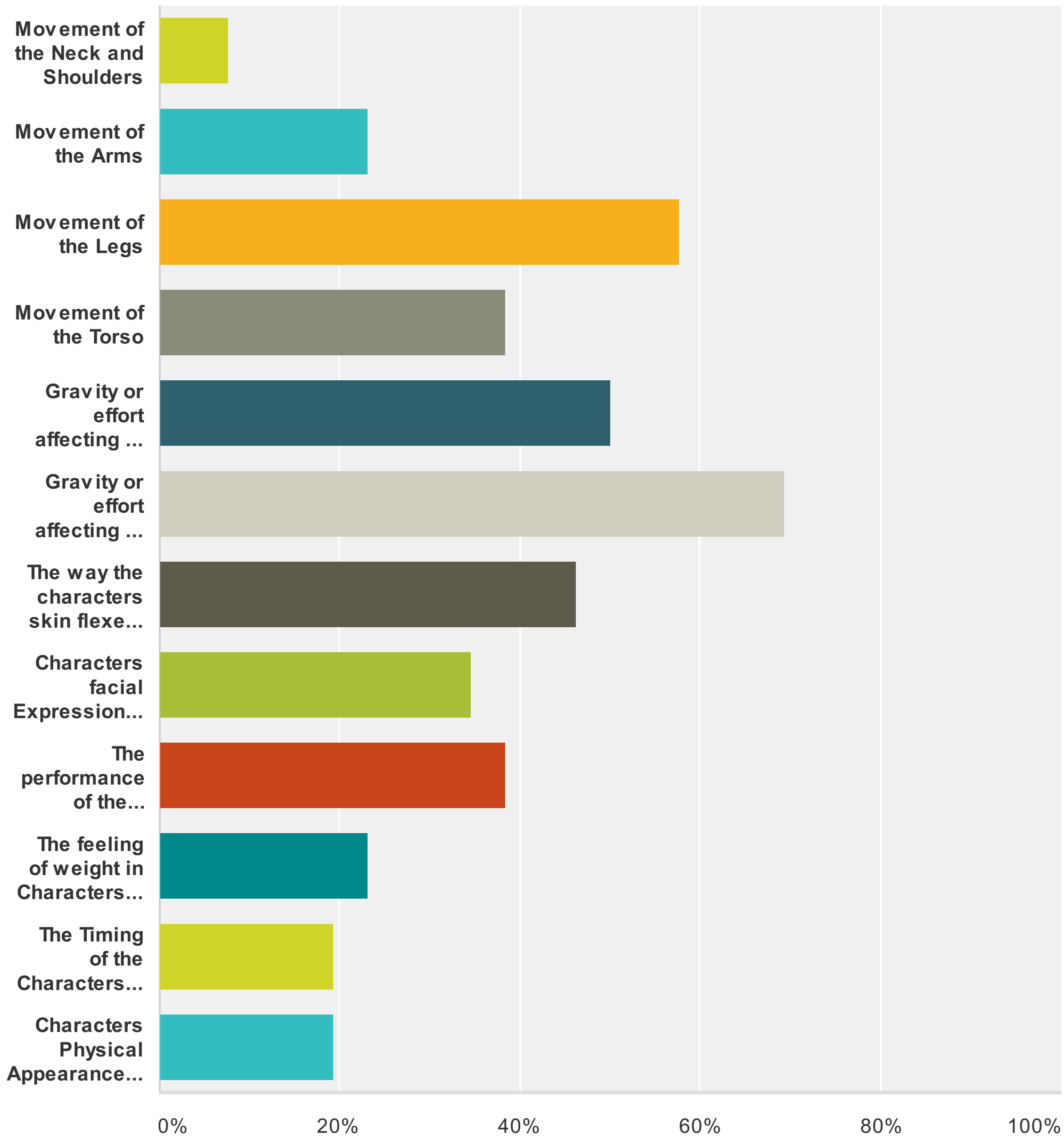
Answered: 26   Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**0%**	0
Video (C)	**100%**	26
Total		**26**

Q14 Are there any sections or elements of the characters body that move in a more appealing manner than any other part? Please select the sections or elements which provide the appeal.

Answered: 26 Skipped: 0

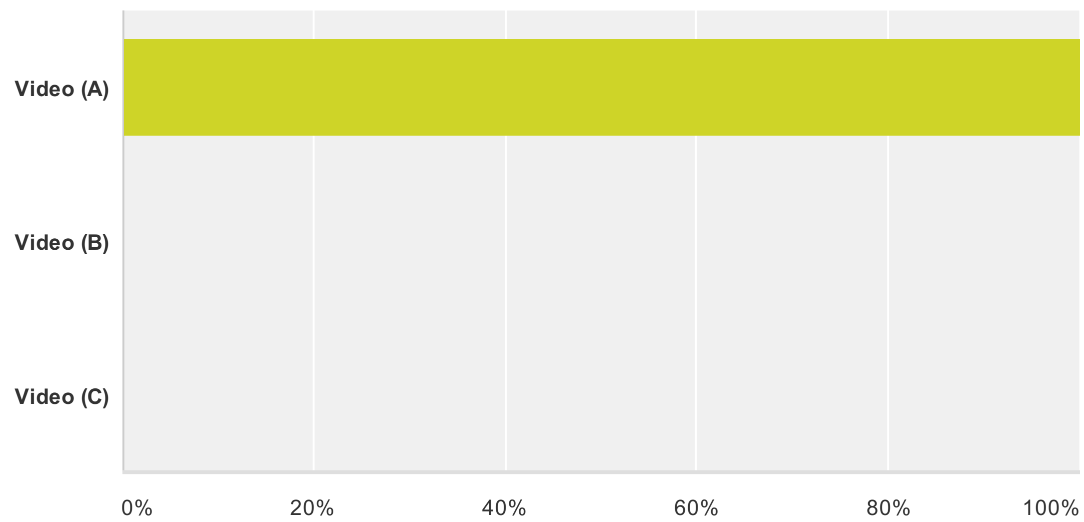


Answer Choices	Responses	
Movement of the Neck and Shoulders	7.69%	2
Movement of the Arms	23.08%	6
Movement of the Legs	57.69%	15
Movement of the Torso	38.46%	10
Gravity or effort affecting the characters performance	50%	13
Gravity or effort affecting the Shorts on the Character	69.23%	18
The way the characters skin flexes is appealing	46.15%	12

Characters facial Expressions are appealing	**34.62%**	9
The performance of the Character is appealing	**38.46%**	10
The feeling of weight in Characters Movements is appealing	**23.08%**	6
The Timing of the Characters Movements helps with the characters appeal	**19.23%**	5
Characters Physical Appearance helps with the characters appeal	**19.23%**	5
Total Respondents: 26		

Q15 In which video is the characters movement most realistic?

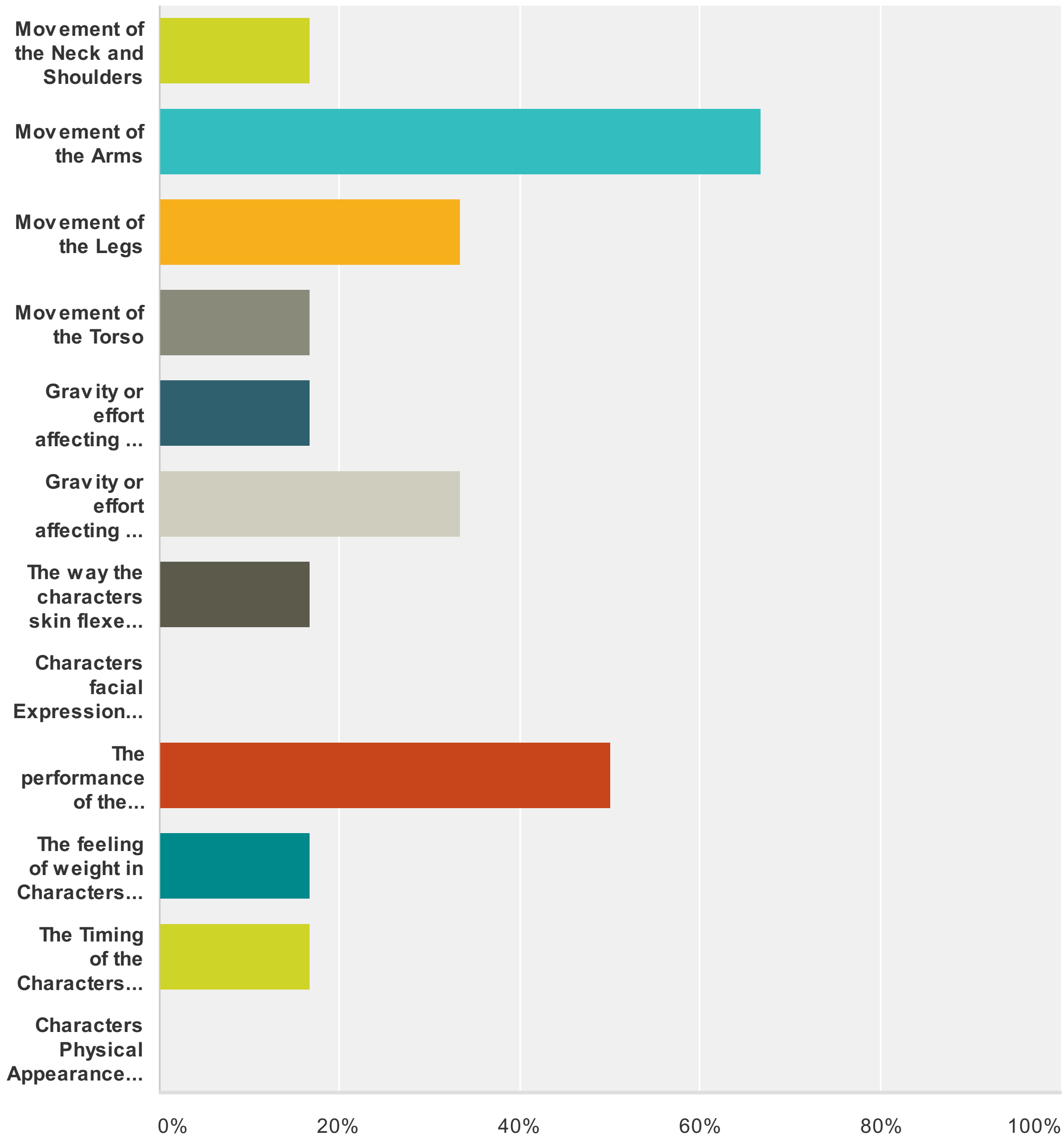
Answered: 6   Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	6
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**6**

Q16 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 6 Skipped: 0

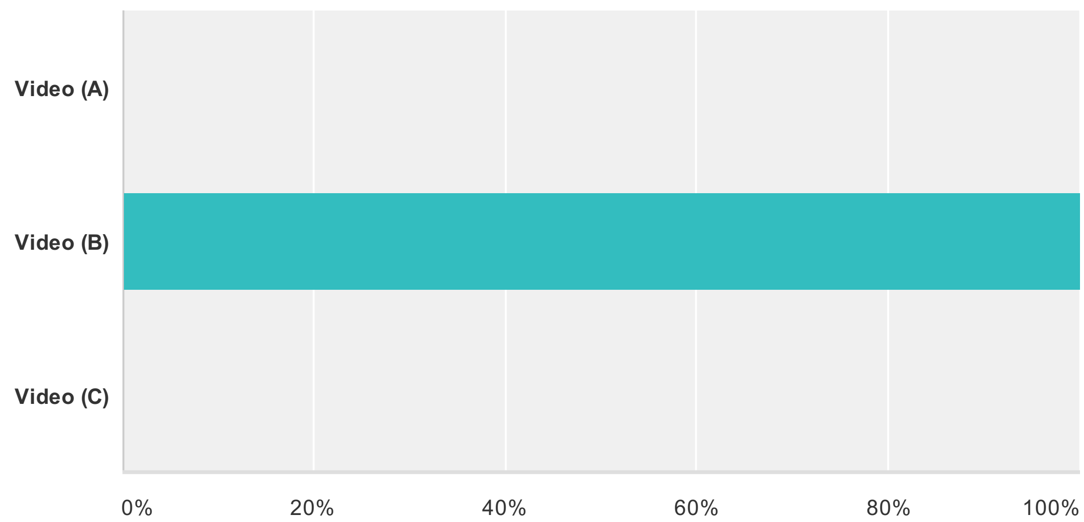


Answer Choices	Responses	
Movement of the Neck and Shoulders	16.67%	1
Movement of the Arms	66.67%	4
Movement of the Legs	33.33%	2
Movement of the Torso	16.67%	1
Gravity or effort affecting the characters performance	16.67%	1
Gravity or effort affecting the Shorts on the Character	33.33%	2
The way the characters skin flexes is realistic	16.67%	1

Characters facial Expressions are realistic	**0%**	0
The performance of the Character is realistic	**50%**	3
The feeling of weight in Characters Movements is realistic	**16.67%**	1
The Timing of the Characters Movements helps with the characters realistic	**16.67%**	1
Characters Physical Appearance helps with the characters realistic	**0%**	0
Total Respondents: 6		

Q15 In which video is the characters movement most realistic?

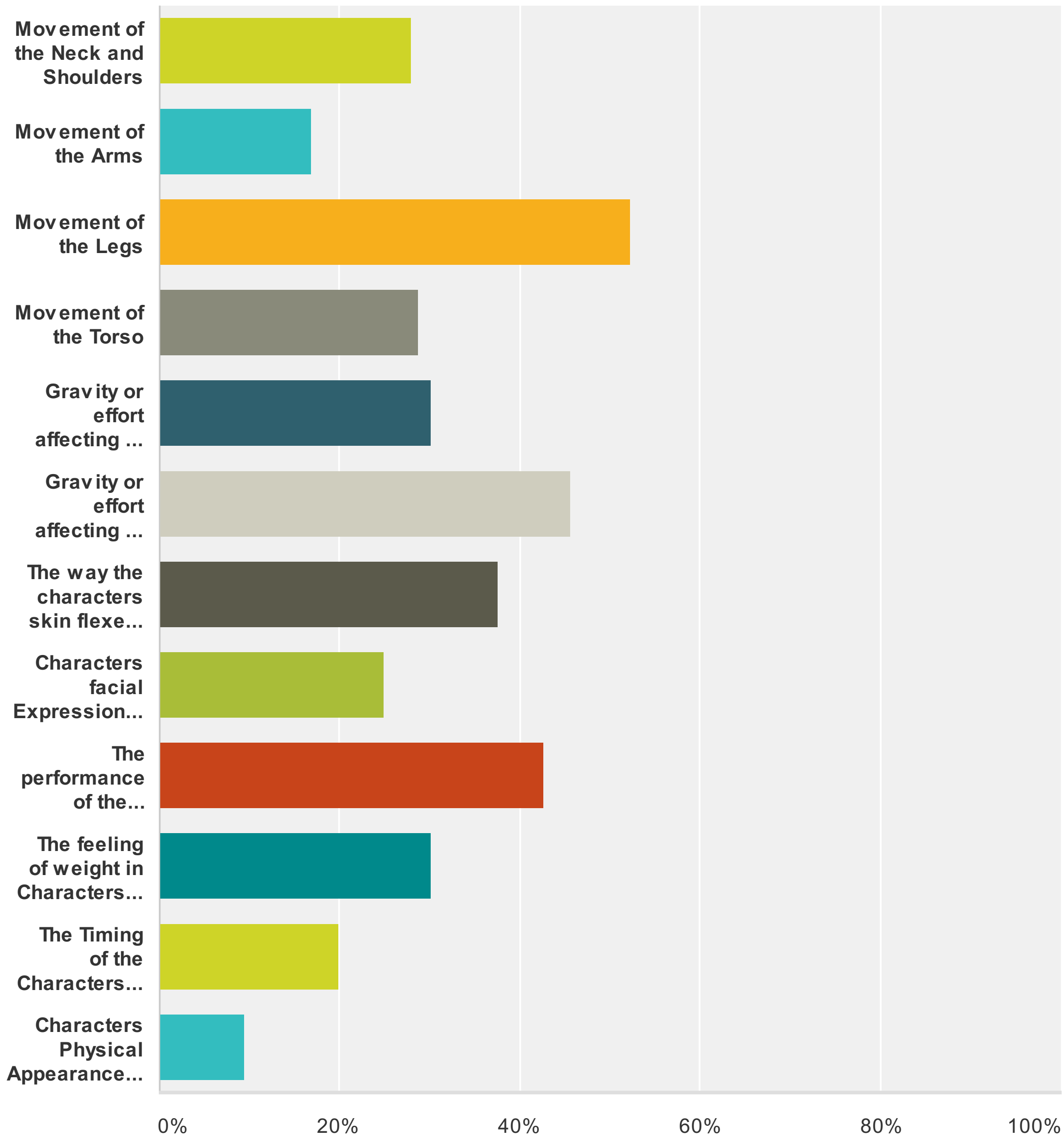
Answered: 136 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**100%**	136
Video (C)	**0%**	0
Total		**136**

Q16 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 136 Skipped: 0

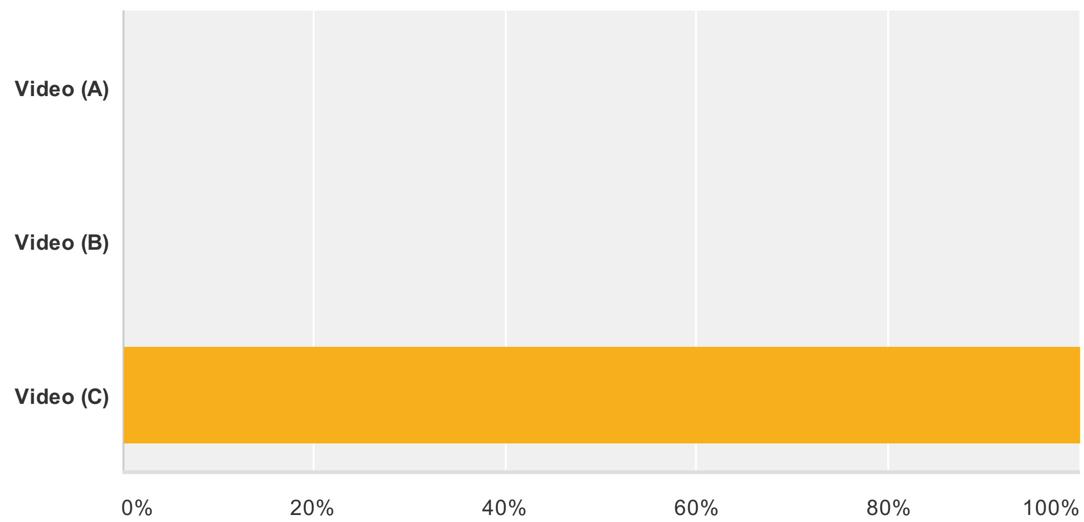


Answer Choices	Responses	
Movement of the Neck and Shoulders	27.94%	38
Movement of the Arms	16.91%	23
Movement of the Legs	52.21%	71
Movement of the Torso	28.68%	39
Gravity or effort affecting the characters performance	30.15%	41
Gravity or effort affecting the Shorts on the Character	45.59%	62
The way the characters skin flexes is realistic	37.50%	51

Characters facial Expressions are realistic	**25%**	34
The performance of the Character is realistic	**42.65%**	58
The feeling of weight in Characters Movements is realistic	**30.15%**	41
The Timing of the Characters Movements helps with the characters realistic	**19.85%**	27
Characters Physical Appearance helps with the characters realistic	**9.56%**	13
Total Respondents: 136		

Q15 In which video is the characters movement most realistic?

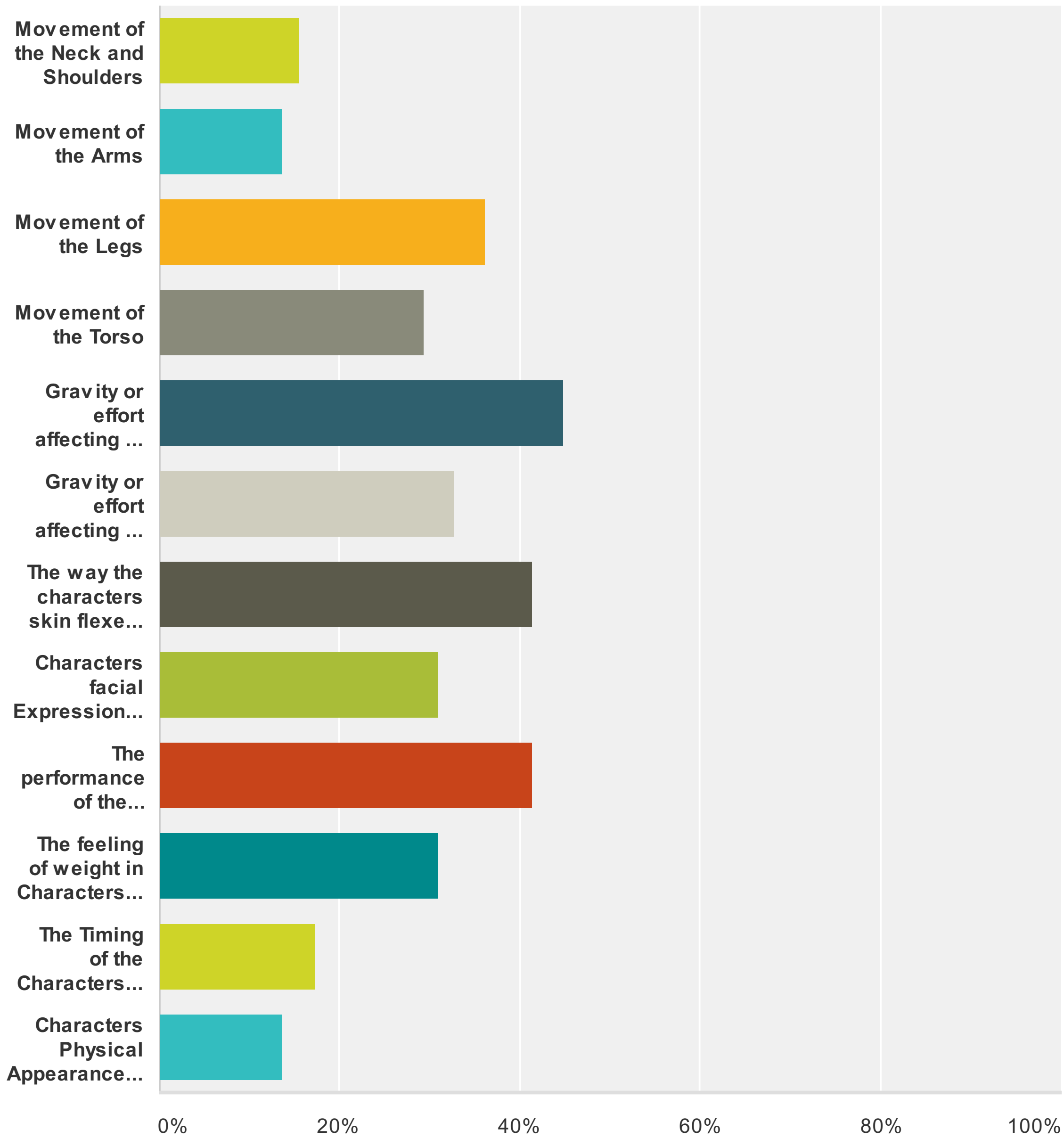
Answered: 58 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**0%**	0
Video (C)	**100%**	58
Total		**58**

Q16 Are there any sections or elements of the characters body that move in a more realistic manner than any other part? Please select the sections or elements which provide the realism.

Answered: 58 Skipped: 0

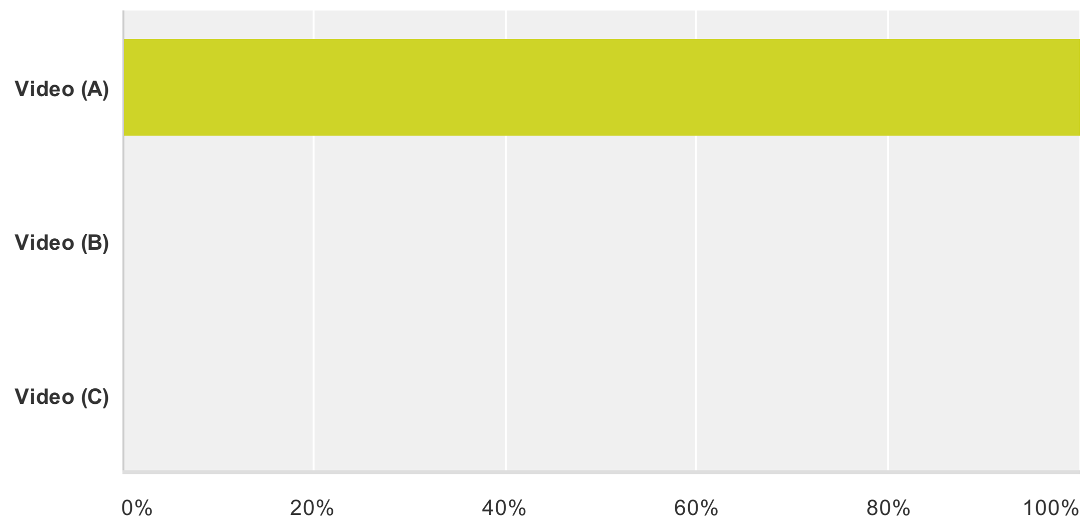


Answer Choices	Responses	
Movement of the Neck and Shoulders	**15.52%**	9
Movement of the Arms	**13.79%**	8
Movement of the Legs	**36.21%**	21
Movement of the Torso	**29.31%**	17
Gravity or effort affecting the characters performance	**44.83%**	26
Gravity or effort affecting the Shorts on the Character	**32.76%**	19
The way the characters skin flexes is realistic	**41.38%**	24

Characters facial Expressions are realistic	**31.03%**	18
The performance of the Character is realistic	**41.38%**	24
The feeling of weight in Characters Movements is realistic	**31.03%**	18
The Timing of the Characters Movements helps with the characters realistic	**17.24%**	10
Characters Physical Appearance helps with the characters realistic	**13.79%**	8
Total Respondents: 58		

Q17 In which video is the characters movement most believable?

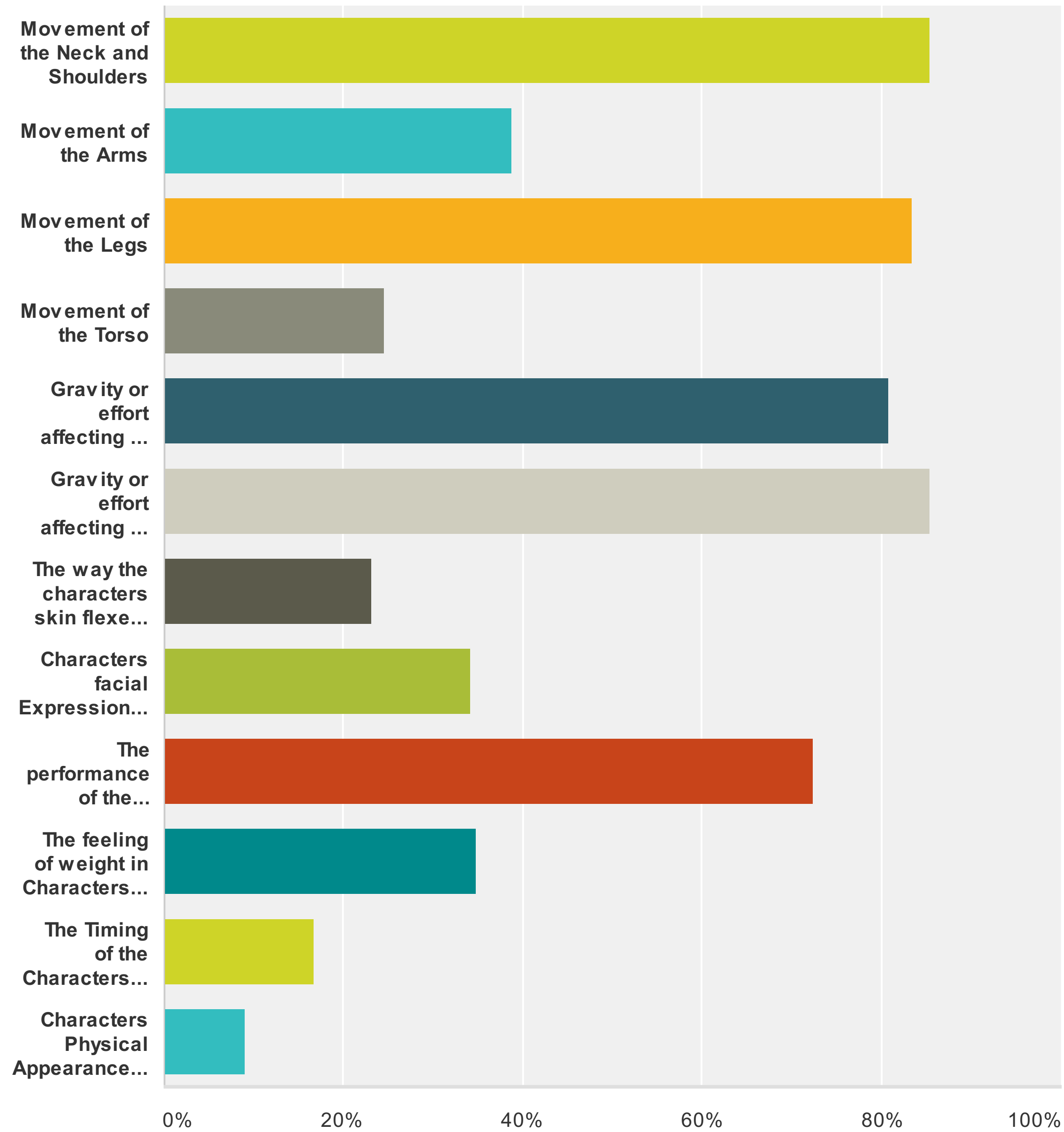
Answered: 155 Skipped: 0



Answer Choices	Responses	
Video (A)	**100%**	155
Video (B)	**0%**	0
Video (C)	**0%**	0
Total		**155**

Q18 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 155 Skipped: 0

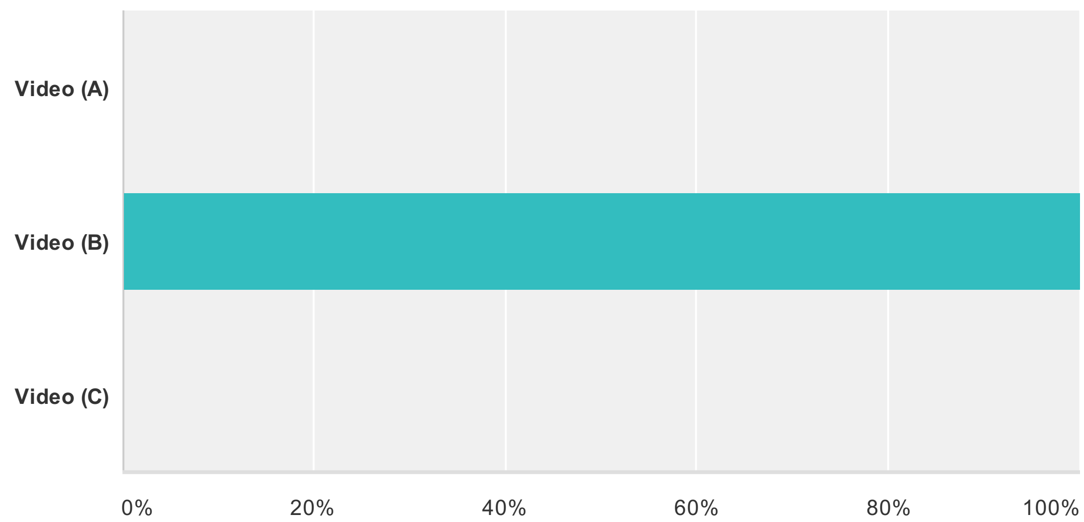


Answer Choices	Responses	
Movement of the Neck and Shoulders	**85.16%**	132
Movement of the Arms	**38.71%**	60
Movement of the Legs	**83.23%**	129
Movement of the Torso	**24.52%**	38
Gravity or effort affecting the characters performance	**80.65%**	125
Gravity or effort affecting the Shorts on the Character	**85.16%**	132
The way the characters skin flexes is believable	**23.23%**	36

Characters facial Expressions are believable	**34.19%**	53
The performance of the Character is believable	**72.26%**	112
The feeling of weight in Characters Movements is believable	**34.84%**	54
The Timing of the Characters Movements helps with the characters believable	**16.77%**	26
Characters Physical Appearance helps with the characters believable	**9.03%**	14
Total Respondents: 155		

Q17 In which video is the characters movement most believable?

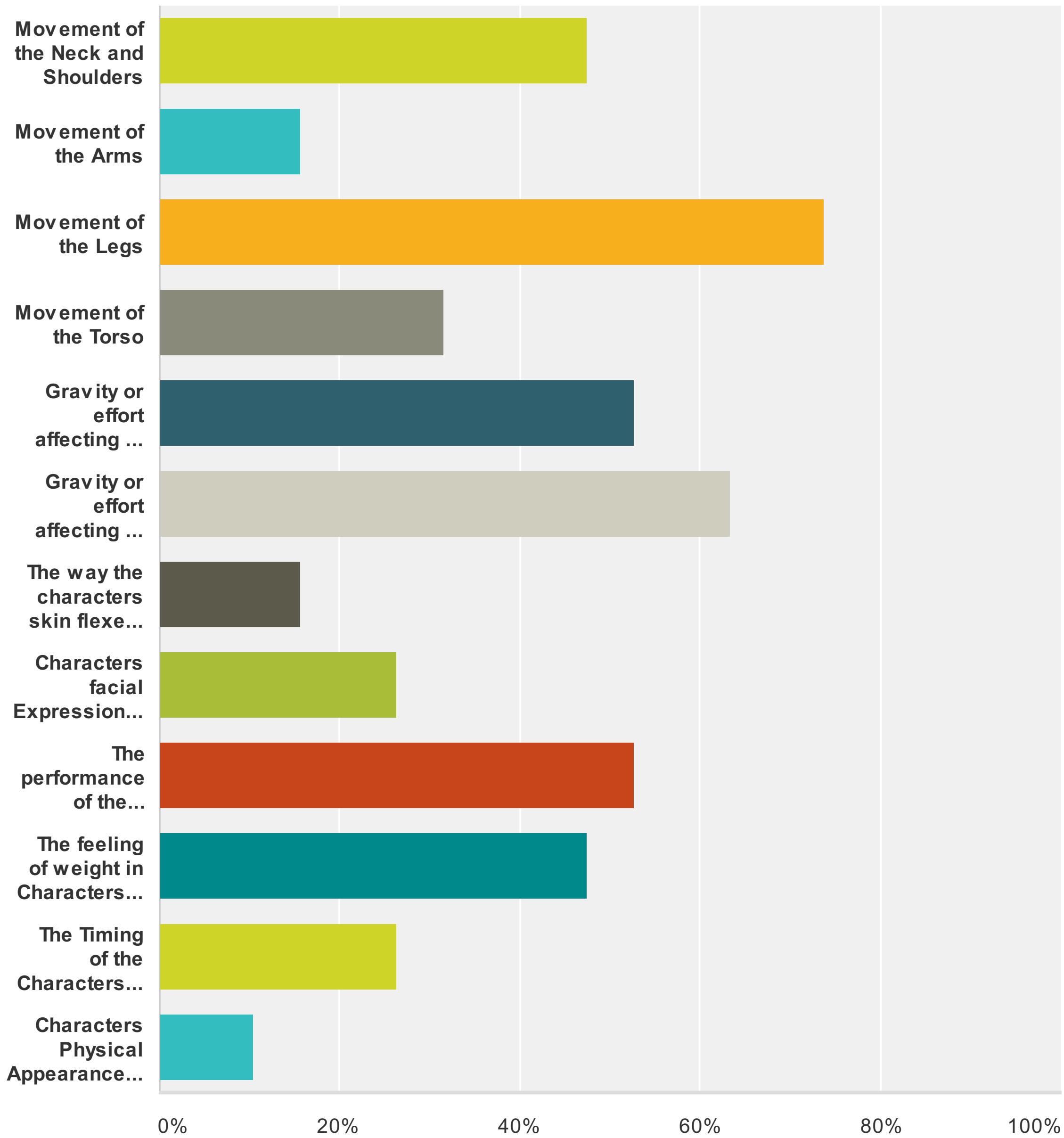
Answered: 19 Skipped: 0



Answer Choices	Responses	
Video (A)	0%	0
Video (B)	100%	19
Video (C)	0%	0
Total		19

Q18 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 19 Skipped: 0

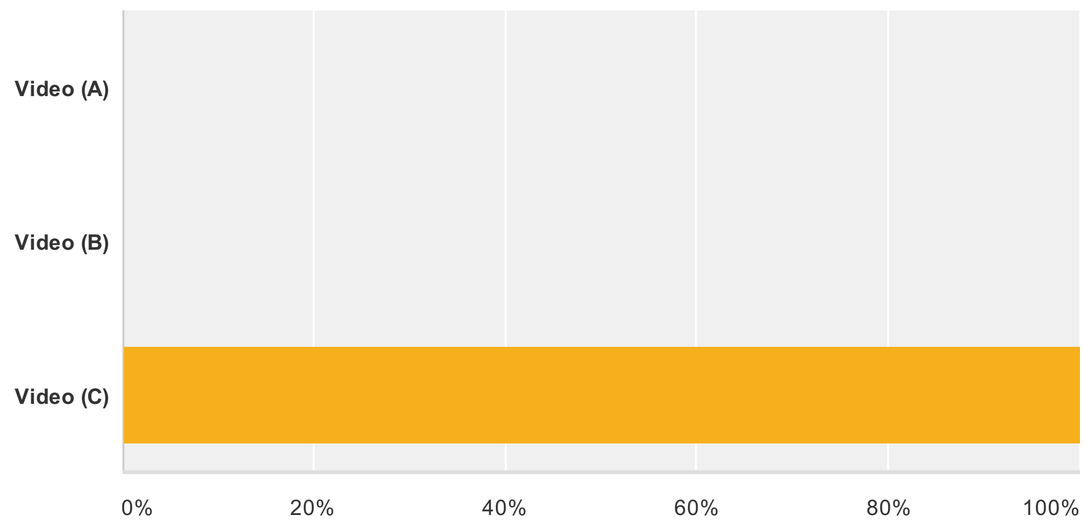


Answer Choices	Responses	
Movement of the Neck and Shoulders	47.37%	9
Movement of the Arms	15.79%	3
Movement of the Legs	73.68%	14
Movement of the Torso	31.58%	6
Gravity or effort affecting the characters performance	52.63%	10
Gravity or effort affecting the Shorts on the Character	63.16%	12
The way the characters skin flexes is believable	15.79%	3

Characters facial Expressions are believable	**26.32%**	5
The performance of the Character is believable	**52.63%**	10
The feeling of weight in Characters Movements is believable	**47.37%**	9
The Timing of the Characters Movements helps with the characters believable	**26.32%**	5
Characters Physical Appearance helps with the characters believable	**10.53%**	2
Total Respondents: 19		

Q17 In which video is the characters movement most believable?

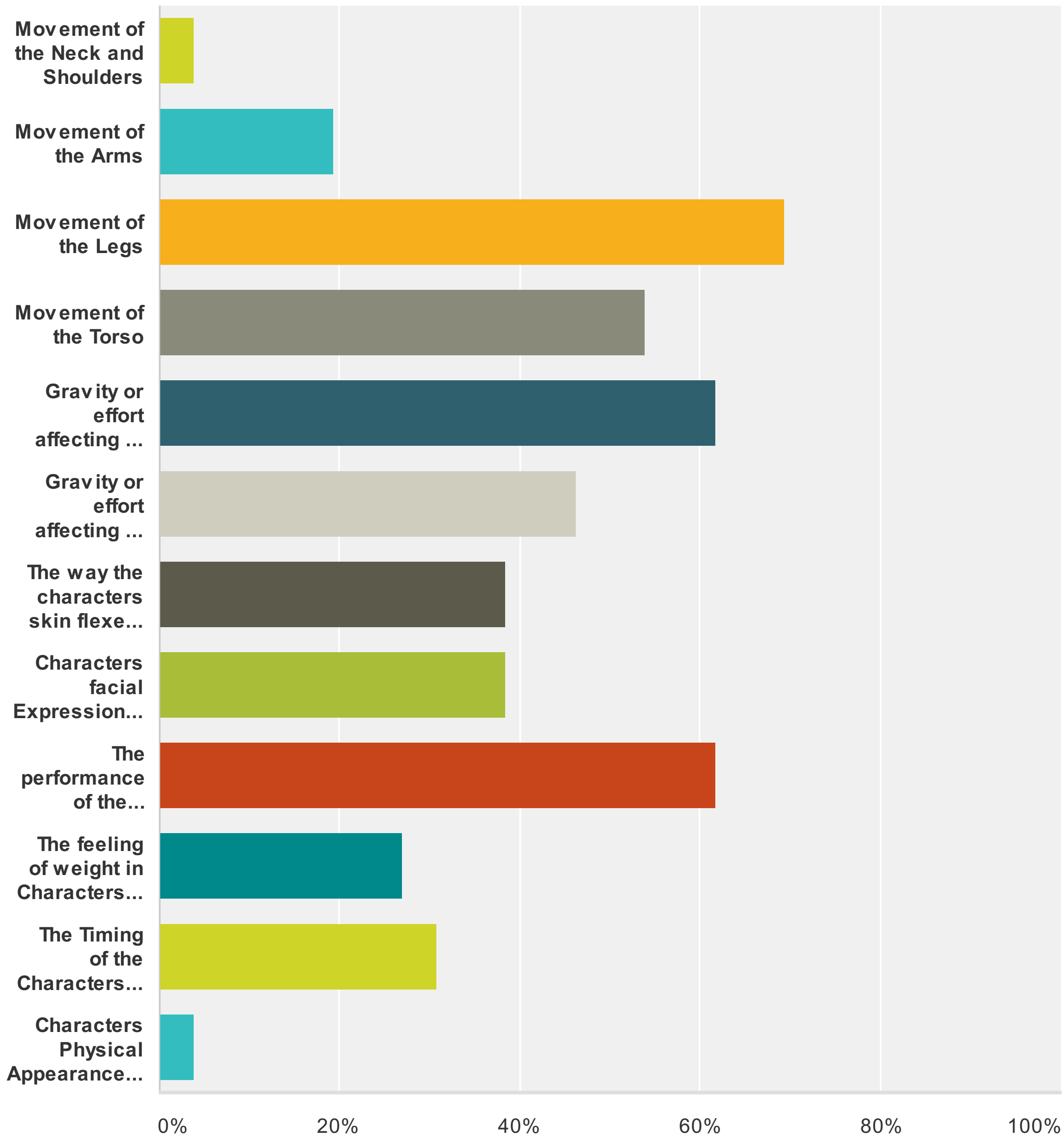
Answered: 26 Skipped: 0



Answer Choices	Responses	
Video (A)	**0%**	0
Video (B)	**0%**	0
Video (C)	**100%**	26
Total		**26**

Q18 Are there any sections or elements of the characters body that move in a more believable manner than any other part? Please select the sections or elements which provide the believability.

Answered: 26 Skipped: 0



Answer Choices	Responses	
Movement of the Neck and Shoulders	**3.85%**	1
Movement of the Arms	**19.23%**	5
Movement of the Legs	**69.23%**	18
Movement of the Torso	**53.85%**	14
Gravity or effort affecting the characters performance	**61.54%**	16
Gravity or effort affecting the Shorts on the Character	**46.15%**	12
The way the characters skin flexes is believable	**38.46%**	10

Characters facial Expressions are believable	**38.46%**	10
The performance of the Character is believable	**61.54%**	16
The feeling of weight in Characters Movements is believable	**26.92%**	7
The Timing of the Characters Movements helps with the characters believable	**30.77%**	8
Characters Physical Appearance helps with the characters believable	**3.85%**	1
Total Respondents: 26		

INTERVIEW FORM

Purpose of the Interview: Reviews and Discussions pertaining the use of procedural animation within character movement performance.

Interviewer: Baris Isikguner

Interviewee: AHRON KHACHIK

Interviewee Job Title: ENVIRONMENT ARTIST – Popleaf /ARU

Interviewee Age: 25

Interview Takes Place In: HELMORE 111 ANGLIA RUSKIN UNIVERSITY

Date of the Interview: 11/11/13

Time of the Interview: 4pm

INTERVIEW QUESTIONS

1) With your own words; how would you describe the notion of believability, within the context of animation?

2) Would you describe believability as a considerable challenge or as an issue for professional studio projects, includes character performances? *+_+ Why?*

3) With your own words; how would you evaluate or add your point view to the survey outcomes pertaining the procedural animation.

4) How would these survey findings could help contribute to the professional studio practice.

5) How could these survey findings could help inform the practice of the practitioners.

INTERVIEW FORM

Purpose of the Interview: Reviews and Discussions pertaining the use of procedural animation within character movement performance.

Interviewer: Baris Isikguner

Interviewee: Andrew Wright

Interviewee Job Title: Director

Interviewee Age: 44

Interview Takes Place In: HOT KNIFE.

Date of the Interview: 27/11/13.

Time of the Interview: 5:30.

INTERVIEW QUESTIONS

1) With your own words; how would you describe the notion of believability, within the context of animation?

2) Would you describe believability as a considerable challenge or as an issue for professional studio projects, includes character performances? +_+ *Why?*

3) With your own words; how would you evaluate or add your point view to the survey outcomes pertaining the procedural animation.

4) How would these survey findings could help contribute to the professional studio practice.

5) How could these survey findings could help inform the practice of the practitioners.

INTERVIEW FORM

Purpose of the Interview: Reviews and Discussions pertaining the use of procedural animation within character movement performance.

Interviewer: Baris Isikguner

Interviewee: Imogen Tafts

Interviewee Job Title: Junior Animator / Visualiser

Interviewee Age: 23.

Interview Takes Place In: Hot Knife Digital Media

Date of the Interview: 27th November 2013

Time of the Interview: 4:30 pm.

INTERVIEW QUESTIONS

1) With your own words; how would you describe the notion of believability, within the context of animation?

2) Would you describe believability as a considerable challenge or as an issue for professional studio projects, includes character performances? *+_+ Why?*

3) With your own words; how would you evaluate or add your point view to the survey outcomes pertaining the procedural animation.

4) How would these survey findings could help contribute to the professional studio practice.

5) How could these survey findings could help inform the practice of the practitioners.

INTERVIEW FORM

Purpose of the Interview: Reviews and Discussions pertaining the use of procedural animation within character movement performance.

Interviewer: Baris Isikguner

Interviewee:

JULIAN HUGHES-WATTS

Interviewee Job Title:

SENIOR LECTURER / LEAD ARTIST SONY COMPUTER ENTERTAINMENT EUROP (PREVIOUS)

Interviewee Age:

44

Interview Takes Place In:

RUSKIN 110

Date of the Interview:

13/11/2013

Time of the Interview:

BETWEEN 5 - 6 pm

INTERVIEW QUESTIONS

1) With your own words; how would you describe the notion of believability, within the context of animation?

2) Would you describe believability as a considerable challenge or as an issue for professional studio projects, includes character performances? *+_+ Why?*

3) With your own words; how would you evaluate or add your point view to the survey outcomes pertaining the procedural animation.

4) How would these survey findings could help contribute to the professional studio practice.

5) How could these survey findings could help inform the practice of the practitioners.

INTERVIEW FORM

Purpose of the Interview: Reviews and Discussions pertaining the use of procedural animation within character movement performance.

Interviewer: Baris Isikguner

Interviewee: Luis Azuaje

Interviewee Job Title: . Technical officer Computer games
- Part time lecturer in Character Rigging in ARU

Interviewee Age: 38

Interview Takes Place In: Anglia Ruskin University, Cambridge

Date of the Interview: 13/11/13

Time of the Interview: 14:00 - 16:00

INTERVIEW QUESTIONS

1) With your own words; how would you describe the notion of believability, within the context of animation?

2) Would you describe believability as a considerable challenge or as an issue for professional studio projects, includes character performances? +_+ *Why?*

3) With your own words; how would you evaluate or add your point view to the survey outcomes pertaining the procedural animation.

4) How would these survey findings could help contribute to the professional studio practice.

5) How could these survey findings could help inform the practice of the practitioners.

INTERVIEW FORM

Purpose of the Interview: Reviews and Discussions pertaining the use of procedural animation within character movement performance.

Interviewer: Baris Isikguner

Interviewee: Matt Stoneham

Interviewee Job Title: Principal Technical Artist

Interviewee Age: 34

Interview Takes Place In:

Date of the Interview: 15th November 2013

Time of the Interview:

INTERVIEW QUESTIONS

1) With your own words; how would you describe the notion of believability, within the context of animation?

2) Would you describe believability as a considerable challenge or as an issue for professional studio projects, includes character performances? *+_+ Why?*

3) With your own words; how would you evaluate or add your point view to the survey outcomes pertaining the procedural animation.

4) How would these survey findings could help contribute to the professional studio practice.

5) How could these survey findings could help inform the practice of the practitioners.

INTERVIEW FORM

Purpose of the Interview: Reviews and Discussions pertaining the use of procedural animation within character movement performance.

Interviewer: Baris Isikguner

Interviewee: OSCAR PATERSON

Interviewee Job Title: ANIMATOR

Interviewee Age: 22

Interview Takes Place In: HEL 217 (ARU)

Date of the Interview: 16TH NOVEMBER 2013

Time of the Interview: 14:00 - 16:00

INTERVIEW QUESTIONS

1) With your own words; how would you describe the notion of believability, within the context of animation?

2) Would you describe believability as a considerable challenge or as an issue for professional studio projects, includes character performances? +_+ *Why?*

3) With your own words; how would you evaluate or add your point view to the survey outcomes pertaining the procedural animation.

4) How would these survey findings could help contribute to the professional studio practice.

5) How could these survey findings could help inform the practice of the practitioners.

INTERVIEW FORM

Purpose of the Interview: Reviews and Discussions pertaining the use of procedural animation within character movement performance.

Interviewer: Baris Isikguner

Interviewee: RICKY WOOD

Interviewee Job Title: PRINCIPAL ANIMATOR

Interviewee Age: 31

Interview Takes Place In: ARU MEL 102

Date of the Interview: 28/11/13

Time of the Interview: 15:00

INTERVIEW QUESTIONS

1) With your own words; how would you describe the notion of believability, within the context of animation?

2) Would you describe believability as a considerable challenge or as an issue for professional studio projects, includes character performances? *+_+ Why?*

3) With your own words; how would you evaluate or add your point view to the survey outcomes pertaining the procedural animation.

4) How would these survey findings could help contribute to the professional studio practice.

5) How could these survey findings could help inform the practice of the practitioners.

INTERVIEW FORM

Purpose of the Interview: Reviews and Discussions pertaining the use of procedural animation within character movement performance.

Interviewer: Baris Isikguner

Interviewee: SIMON WALLETT

Interviewee Job Title: CO DIRECTOR/ANIMATOR

Interviewee Age: 45

Interview Takes Place In: HOT KNIFE DIGITAL MEDIA

Date of the Interview: 27-11-13

Time of the Interview: 2-30 - 4.30.

INTERVIEW QUESTIONS

1) With your own words; how would you describe the notion of believability, within the context of animation?

2) Would you describe believability as a considerable challenge or as an issue for professional studio projects, includes character performances? *+_+ Why?*

3) With your own words; how would you evaluate or add your point view to the survey outcomes pertaining the procedural animation.

4) How would these survey findings could help contribute to the professional studio practice.

5) How could these survey findings could help inform the practice of the practitioners.

Interview transcriptions - Interview 1

Baris (B); Ahron Khachick (AK)

B: Hi Ahron, Thank you for attending the interview. Now I'm just going to …you've seen the results, the experiment results, and I'm just going to ask you one or two questions. Now the first one: with your own words, how would you describe the notion of believability within the context of animation?

AK: I think believability and realism aren't necessarily the same thing, first off. It depends what you're going for. It's very context dependent; like I suppose, with Pixar animation or with characters that aren't necessarily like, supposed to be realistic in their own right, there are less rules about what makes something believable or not believable; but I guess as opposed to if you were trying to create a render like a video game of like humans, you know, trying to get a one to one realistic kind of thing. It's usually about the little things, like dynamics, things like flexing, cloth, hair, little things like that. Like lots of simultaneous little things as opposed to like any one big thing, is what I would say. And also trying to…try and incorporate human elements to everything, whether it's like a toy dinosaur or a person or whatever. Some kind of human connection, I think that's really important as well.

B: Ok, thank you. Would you describe believability as a considerable challenge, or as an issue for professional studio projects, including character performances?

AK: Yes, for sure, it's… It's a very delicate thing, where you can get something that looks believable but any one little thing can let the whole thing down. And you can have the Uncanny Valley thing, right, where sometimes things look almost too believable for the context in which the animation is; for example you'll have a computer game with a very low poly character and you can see that you know, like you can almost see the faces of the mesh that constructs the character, but the animation and the stuff they're doing is almost.. It's eerie, because it's very realistic, it's almost hyper realistic, and things tend to be accentuated, like, you know, they're almost over-acting, especially when you pair it up with the voice acting as well. So I think it can go both way; it can be a challenge of not being believable enough, and almost being believable in the wrong way, or just too believable within whatever context that it’s in. And I think it really depends on a lot of things like what you’re trying to make, and who the audience is, and what the context is of that particular scene or that particular piece of work that you’re trying to do.

B: Thank you. With your own words, how would you evaluate, or add your point of view, to the survey outcomes pertaining to the procedural animation we have?

AK: Ok, er… I thought the results were interesting, I saw the different clips and I would say that the fact that there was a correlation between the professional and non-professional point of view, in that they were both kind of had a very similar opinion of the outcome. My opinion’s pretty much the same; I thought that some of the touches with the progressively more dynamic touches defintely made the animation …did the animation some good, it made it more enjoyable to watch. I’m not sure about whether to say ‘believable’ or ‘realistic’ or … but it created a more visual, interesting visual piece. I’d say some aspects of the dynamics became a little bit over the top; some of the shorts and stuff was flying all over the place… but compared to having nothing it was an improvement I think. I think it definitely depends which aspect of the character you’re talking about, really, but I’d say overall, especially with lie the bar bending, like the bar bending and little touches like that were… it was preferable to the original video which had nothing in it.

B: Thank you. Ok, how could these survey findings help contribute to the professional studio practice?

AK: well, for a start it’s all about I guess animation is all about stopping and looking at the little things, right, so whenever you have a situation where you’re kind of reviewing - you’re doing like an A-B comparison, or in this case an A-B-C, stopping and looking at different stages of the dynamics, you know, like zero, mild, and then extreme…I guess …and the fact that you’ve gone and asked people what they think of it, and you’ve actually got numbers, you’ve actually got hard evidence, is good, and the fact that you’ve asked professionals is even better, and so it kind of… I guess it.. art and animation is very subjective, but when you do this kind of research it helps eliminate a lot of the kind of opinionate… a lot of the kind of misty… of the mystery about it, a little bit, and it’s kind of quite reassuring, if that makes sense? It makes it more scientific, which is good for learning, always. But.. Yeah.

B: Ok, thank you! Last question.

AK: Sure!

B: How could these survey findings and this research help inform the practice of the practitioner?

AK: ah.. ok. Well, I guess it's kind of similar to the last question in a way, but... I think just stopping and looking at what you've done, analysing your own work is always good, and knowing what people want to see, or what people respond to, what people react to when they see it, and if they actually tell you, like this was... I preferred this one, or this one, it's always good, so you can use it for next time, right? You can… Especially with something like the topic of dynamics, where you can apply it for almost anything, so you can do this one study, and you can take your research findings, and then from now on, you can then apply it to all future projects, no matter you know whether it's a guy picking up a bar, or whether it's like a- I don't know, a cat animation, or a... someone shooting animation… You can kind of apply, it's got a lot of applications, so I guess it helps the practitioner by giving them always something to think about for next time and improve on their work, rather than just find out one particular thing that has no application.

B: Ok, thank you, thank you for that!

AK: You're very welcome!

Interview transcriptions - Interview 2

Baris (B); Andrew Whitney (AW)

B: Hi Andy, thank you for having me in Hot Knife. You've seen the research; you've seen the results, and I'd like to ask you a couple of questions.

AW: Sure.

B: For the first question: with your own words, how would you describe the notion of believability, within the context of animation?

AW: I think it's making the viewer forget that it's an animation, and concentrate on the content of what you're trying to portray within the animation. If there's something in the animation which the viewer starts to look at and become aware of, then it takes them away from the illusion that you're trying to create by animating. Once there's something in there that, again, the user or the viewer picks up on, that isn't right, that's when the believability goes. I think you can extend what is believable, or what audiences will accept with animation in a way that you can't with film, which is why it's a great medium to work with really.

B: Ok, thank you. Second question: would you describe believability as a considerable challenge or as an issue for professional studio projects that include character performances?

AW: Erm… Yeah, I mean – it's a challenge, and it's also a stumbling block. If you look at things like the Uncanny Valley, we're striving at the minute to get believable-looking faces and characters, and the closer they get to looking real, the odder we seem to feel that character is. And as soon as you move into that uncanny valley area, you lose the believability. I think to a degree, an audience will accept a stylised character quicker than it will a highly detailed realistic-looking character. Because they suspend disbelief when they have a stylised character in a way that they don't when they have a realistic-looking character. Things like secondary animation will help sell the stylistic character, but if you have a realistic character, and you start adding secondary motion on that, if it's not *perfect*, if it’s not utterly correct, it’s going to look weird, and people will stop believing that character in a de facto realistic sense, and then what you’re trying to do is gone.

B: Ok, thank you. Third question: with your own words, how would you evaluate these research findings and the survey results?

AW: The work that you’ve done?

B: Yes.

AW: Erm…I’d evaluate that as very encouraging for second…for that non-procedural animation, it looks like it’s a great place to start. If you’ve got those kind of figures backing up the research you’ve got, that is something you can fundamentally walk into and go ‘Look, this is the research, this is probably where you should be starting your animation’. I’m… people should certainly start thinking about bringing it into their pipeline.

B: Thank you. Third question: how could these survey findings, these research findings, help contribute to the professional studio practice ?

AW: I think it’s about getting to where you need to be with animation a lot quicker, and cutting down the pipeline, and possibly the man hours involved in producing animation. I mean animation has always been a labour intensive industry; the more you can cut down on the man hours and actually concentrate on the art more… I think that’s definitely going to be a great contribution to the industry.

B: Thank you. Final question: How could these survey findings help inform the practice of the practitioner?

AW: Having solid figures to back up how possibly animation, especially in the computer world, should be working, is a great start. I mean the industry is still very young, you’re talking about an industry that started in the 1970s, and it’s only started to really hit the main screens in the last fifteen, twenty years. So it’s such a young industry, and to start bringing research into it so early is… That’s a great idea. If you can sit down and start showing people how secondary motion procedural animation can benefit the production at a very early stage, they can bring that into the pipeline as soon as possible.

B: Ok, thank you so much, thank you!

AW: Pleasure!

Interview transcriptions – Interview 3

Baris (B); Imogen Taffs (IT)

B: Hi Imogen, thank you for having me in Hot Knife.

IT: It's quite alright!

B: Now - you've seen the research; you've seen the results, and I'd like to ask you one or two questions about the research now.

IT: Sure.

B: Now the first question: with your own words, how would you describe the notion of believability, within the context of animation?

IT: I think believability is kind of one of those questions where we have come to hark back to principles of animation, and I think where we'd look at believability – you'd almost expected to be mimicking of human actions or little twitches and the little things that kind of make a performance believable in the sense that it's more humanoid, for example, small hand gestures and such. But I also think that … Well, I also think your research has highlighted that an exaggeration of that aids believability rather than just having something that is representative of what's real, in the real world, but rather an exaggerated version of that is more appealing, and it's more believable because… Well you remember Ed Hooks mentioned once at his conference that people have…people live their lives every day in, you know, we want to see something we don't see, we want to see something that is an exaggerated version of … because it's the difference between theatre and real world. So I think that's kind of how I would think about believability, that it is more human, or…well, not necessarily human, but whatever it is you're trying to portray: human, animal, object, whatever it is, but an exaggerated form of – it's the difference between realism and believability… I would assume.

B: Ok, thank you. Second question: would you describe believability as a considerable challenge or as an issue for professional studio projects that include character performances?

IT: Sorry, could you just repeat that question again?

B: (repeats question)

IT: Yeah, I would think it is an issue, and could cause problems, because if you're creating something in a studio environment then ultimately there's an end audience or an end consumer for that bit of work that you're working on and you would want that to be appealing, and you would want not just for you to find it nice as a professional, think 'oh, that is done really nicely', but you would want people from gaming, or film, or advertising, or wherever you're taking the project to, you'd want them to enjoy it, and I think a big bearing on believability would be, you know, important that that came across, in your … What am I trying to say? That your character performance was believable so that in the end it was enjoyable for whoever it was that was consuming that, whatever environment that was in, gaming or wherever. Because I think if you didn't have that, that kind of right balance and you have that right kind of… If you don't for example hit the nail on the head with it I think it could really kind of hinder your project, or hinder your character's performance.

B: Ok –

IT: I'll just try and give you an example of that…

B: It's fine!

IT: I'll have a go at it… Like [Assassin's Creed 3] for example, Conor, compared to Etsio from the previous games, it's just a huge difference, I mean… Technically, there wasn't too much wrong, but his character was completely unbelievable, you couldn't relate to him as a character, so I don't know what proportion of that comes down to his motion or what he would put across, but something in his performance was not coming across properly which made it I think quite unsuccessful compared to previous games. I think that's maybe a a case where it's not, something's not gone right in the believability of his performance, whether that is through motion or through him as a character, but I think that's probably a lot in the field that would contribute to the believability of his performance.

B: Ok, thank you. Third question: with your own words, how would you evaluate or add your point of view to the research results?

IT: I think it's clear that – well I personally found the one with some dynamics more realistic; having no dynamics was…you could tell, it was flatter, it wasn't as realistic in the way that it didn't move in the way that you would expect it to move; I think that's the thing, that people want to see what we have in real life, but a theatrical version of it. So I think I understand why people would prefer the exaggerated version of each of the animations, because I think that's , on some level that's what we want. We don't want to see just real life in front of us, we want to see a bigger version of things that we can't achieve perhaps in real life. So I thought the most realistic would have been the one with some dynamics, but probably the most believeable in the sense of what you'd enjoy as a consumer would be the one with the most dynamics added to it.

B: OK, thank you. Fourth question: how could these survey findings help to contribute to the professional studio practice ?

IM: I think it could contribute to a professional studio environment in the sense that if this is obviously achieved through the implementation of procedural animation, I think to have that as a base when you're creating things, whether that's a slight, kind of involving some dynamics into…erm… what am I trying to say? –into animation, I think it could help in the sense that it could always provide another way of doing things, so you could get different outcomes as to what you would in other forms of animation. I think the survey findings are interesting as I think that maybe it's almost kind of good to sit and reassess that if you were to use... For example, if you were to use, just create a model and skin it, rig it with a cat rig, for example, if you're using 3D max or whatever, but.. I mean you could first off when you first layer that put a generic sort of walk cycle on it, human walk cycle, it's incredibly exaggerated and it doesn't work perfectly straight away so I think, you know, you always take some sort of human input to dial that down into something that's not too wild, but not too what you'd expect at the same time. So I think it's almost good to reassess what it is that's enjoyable from the three videos; you can kind of bear in mind… I think it's quite interesting the results that you've got as well, that probably wouldn't have been expected from what you would initially have thought that would have come back with the kind of extreme amounts of exaggeration that was put onto some of the videos. So I think it's always good to bear in mind that that's actually appealing, where maybe people in a kind of professional environment would not always kind of think. Because obviously, you know, realism is really popular, but then others, like a lot of games, and things like… Last of Us and Assassin's Creed for example are so realistic in the sense that it's similar to what you'd expect in real life with motion but maybe almost that bit of exaggeration depending on what you're trying to achieve of course, but that extra bit of exaggeration can be maybe a kind of benefit performances of characters.

B: Ok, thank you. Last question: how could these survey findings help inform the practice of the practitioner?

IT: Probably kind of similar to what I was kind of talking about before, you know; as a practitioner of animation to always remember what is found appealing, what is found believable, because there's a such a huge difference between what's believable and what's realistic; so I think to have that input from people in industry or who research it or who have an understanding of animation is quite interesting. So I think your research findings would benefit practitioners' practice by constantly reevaluating what it is that they do and what it is that is considered enjoyable by the end audience, perhaps. So yes, I think it would be somewhat…interesting, definitely interesting and not what was expected from what I saw, so yes.

B: Ok, thank you so much!

Interview transcriptions – Interview 4

Baris (B); Julian Hughes-Watts (JH)

B: Hi Julian, thank you for accepting my interview request. You've seen the results, and you've seen the research, and now I want to ask you one or two questions.

JH: Ok.

B: The first one: with your own words, how would you describe the notion of believability, within the context of animation?

JH: Well, believability in a context of animation… There's a realistic take, I'd say, with motion capture data; you see that within animation, you look at it and think ok, well I know where it comes from; within key-framed animation it's seeing, well – you're assessing movements in life, realistic movements with something that you're key framing, setting it against that, and you're constantly assessing: is it realistic? Is it believable? These are two things within it, and… Believability is… you can have this realist take, but there's also a bit of exaggerated cartoon motions within it, where you're not divorced from reality, but you may have an exaggerated character, and you're immersed within that world, and you believe what's happening. You believe the character and those actions that the character is performing kind of tallies with what you consider that… a character to be, and feels right. And those actions kind of tie in with characterisation.

B: That's great. Second question: would you describe believability as a considerable challenge or as an issue for professional studio projects that include character performances?

JH: I think you have the key character and kind of what's driving them, and what's… You know, the initial impulse to articulate movement, and what is that expressing? Where it can break down, believability, is if the actions and the animation is discordant to what you consider that character to be, so I think that… Within that, that could be a problem, yeah.

B: Alright, thank you. With your own words, again, how would you evaluate, or add your own point of view to, the survey outcomes pertaining to procedural animation?

JH: I think the outcomes show that more exaggeration enhances believability and…we've talked about the prime impulse of the character, what they convey and I think procedural animation can add to that, because you have a secondary element that can couch key-frame animation and provide elements that we all… we constantly see in everyday life, and if you move, and there's secondary motions associated with that; often very subtle. It's a kind of layered animation sort of thing. You can have a prime…primary key-framed elements and the believability is enhanced through secondary elements, through… procedural elements that can enrich it. I think the fact that it was the exaggerated one that showed through in the data… It's interesting, because I think there's everyday life we're picking up on cues but within art…within the context of an animation, within film; within acting, often, you know, something has to be kind of over-emphasized to appear naturalistic, even though in the real world it would be seen as an over-emphasis, but within an artificial context, within art, some over-emphasis can… an exaggeration can sell. Can sell the viewer.

B: Thank you. Fourth question: how could these survey findings, help contribute to professional studio practice ?

JH: I think it can help the studio to kind of… If you have a base animation, you have a range… There's no procedural animation here, and this is at its most extreme, by most extreme, to the point where it really does break down. I think it's interesting to be able to pitch it along that and get a sense of what can add to this prime animation.

B: Thank you. Right, last question: how could these survey findings help inform the practice of the practitioner?

JH: The practice of the practitioner… I think, as in the last question, studio practice, I think…for the practitioner to see a range and make a judgement on how to pitch it would benefit and kind of add value and kind of… I think having the knowledge that greater exaggeration […] procedural animation […] overlay dynamic elements and exaggeration doesn't necessarily mean that believability will break down. It's an interesting one to consider, so having the knowledge and being able to have a range of views along that is great, is an interesting one for an animator to consider and pose, and then can opt for something that could have procedural animation, but then it's how far do you want to push it. I think that what this does show is that you can really push it, and it may actually emphasize believability in terms of the viewer's response.

B: Thank you!

Interview transcriptions – Interview 5

Baris (B); Luis Azuaje (LA)

B: Hi Luis, thank you for accepting my interview form.

LA: My pleasure!

B: Now you've seen the research and the results. Now as a professional, I'd like you to answer one or two questions about the research and the findings. Now the first one is: with your own words, how would you describe the notion of believability, within the context of animation?

LA: I always say it depends on the project. I believe that believability is very important to engage the audience, obviously, but it's always these two realms, which is about being truthful to what things look like and as well to trying to push the boundary, [make it look -] this is really good but if we do this little bit extra it might appeal much better. So it might.. It will look better. It might not be believable, but it will look better. As well it's always depending on the director or on the project you're working on, as well. So it's about taste.

B: Thank you. Would you describe believability as a considerable challenge or an issue for professional studio projects including character performances?

LA: Yes, it is. With the new technologies that are coming out now, say like motion capture, things like that, or facial and motion capture, it is very important, it is very difficult to achieve. But there's always a human element of the animator element behind trying to enhance it to make it look much better.

B: Thank you. With your own words, how would you evaluate or add your point of view to the survey outcomes pertaining to the procedural animation we have?

LA: Say that again?

B: With your own words, how would you evaluate or add your own point of view to the survey results, the research results that we have right now?

LA: I think they are very interesting, because as you describe they were professionals in the field, and they all tended to have this consistent data along the choices that you showed, of those animations that you showed us earlier, and… Like I said earlier, it would be very interesting to know the amount of person that they do work in actual character procedural animation and see if they do agree with it. Obviously, there might be some that may say that you didn't have any data in specific [specifically] about that, but I think it's very interesting.

B: Thank you. How could these survey findings, these research findings, help contribute to professional studio practice ?

LA: Primordially, I believe that they are trying to tackle the loose… that lost gap that is the audience, instead of… A lot of students are trying to say 'Well, I'm going to make this, that looks really good', and explore [explode?] it and break it down in parts, but they never take into consideration the audience: 'Are they really going to be wowed by this?', or 'the money we're going to spend on this, is it really necessary?'. So I think by studying the audience, and thinking…or seeing the tendencies of where the industry is going, it does improve the animation. I believe the audience these days are very sophisticated, and as such we should have products that are sophisticated, because they are a mature audience. You can [not?] expect to produce something that in 1920 would have been amazing, that now would be something that, 'ok, I've seen it, done it' – no 'wow' there. So I think as the audience – you studied the audience in this case, instead of creating something, as we said, about breaking things apart and creating different animations; you are actually studying how the audience are perceiving those animations, and that as well improves the feedback that we get from them, and see where the industry is going.

B: Thank you. Last question: How could these survey findings and the research findings help inform the practice of the practitioner?

LA: I believe that the… Generally speaking, it is very interesting, and very strange, the findings of the study you're doing there. Like you were mentioning earlier about where to strike when it comes to procedural animation? Do we go for something very real, or do we go for something that is fairly real, or the notion that we think it looks real, but we can still enhance it, and make it… Giving a little bit of the 'Hollywood' effect. So I think it was very interesting, the other day I saw a 'behind the scenes' of this new movie called *Gravity* that is in the cinema, and a lot of people from NASA, which is the audience as well, they said wow this is one of the movies that… apart everything is breaking apart, falling apart, procedural animation, they found that it is quite… It has quite attached to the rules of physics, but there was still one guy from NASA saying ‘well, I saw the shuttle spin around a hundred times, like that, in two seconds’, and then he said [laughs] ‘well, I did my calculations’ and it takes about, I don’t know, this many pounds per square centimetre to make the shuttle in space spin that much, you know? And they said well, but generally speaking it’s really good; so it’s really good, but there’s still a little bit of Hollywood effect. So what you’re saying, what you’re doing with this project is that you are saying, well… You are educating the people and saying ‘look, this is really good, can you leave [it] with this fault, it looks really good but it’s not a hundred percent’. So…yes, I think it’s very interesting.

B: That’s…great. Thank you very much, Luis, and thank you for attending.

LA: Thank you.

Interview transcriptions – Interview 6

Baris (B); Matthew Stoneham (MS)

B: Hi Matt, thank you for accepting my interview request. You've seen the research and the results, Now I'd like to ask you a few questions.

MS: Yes.

B: With your own words, how would you describe the notion of believability, within the context of animation?

MS: So… what makes the character believable? Well a lot of it comes down to… You know, I used to be an animator, and I can't remember what the basic principles of animation are [laughs], because I haven't done it for so long. But in terms of body movement, it's sort of…preservation of momentum; overlapping motions are really key, and proper respecting of weights and forces, things like that. In its basic sense? I think depending on the character, there's certain expectations about what level of secondary detail there is, and it's also a style choice I suppose as well. I think there is…Whoever your audience is, they get educated really, really quickly, and that sets a…levels of expectations, for whatever they're looking at. And so I think you have to kind of be aware of that, to a certain extent. You know, if characters have items of clothing on them, I think there is an expectation from most people that they behave like they expect clothing to behave. I think to a certain extent that holds true regardless of the style of the character…

B: Great, thank you. Second question: would you describe believability as a considerable challenge or an issue for professional studio projects which include character performances?

MS: Massive challenge. From a games point of view, there's… Well. Take [the DMC], for example. There's a huge sub bank of animations that are key framed by hand, because they're fantastical animations; you know, all of our cut scenes were motion captured. So it's like, believability… Making something believable – like there's so many different things that contribute to that, both in terms of the style of movement, and the fidelity of it, and all of the secondary elements that sort of sit on top of that. And for us in games there's two really distinct areas of animation: there's all the in-game things which presents one set of challenges, and there's the cut scenes that presents a different set of challenges; and then there's also the issue, as I was alluding to a moment ago, of bringing those things together so that they make sense. And it's not a case of jarring, being jarring for the person playing the game. It's like… You don't want to be very obvious that you're going for motion capture motion, for example, into something that is hand keyed and, you know, they don't really work together. A lot of… What helps quite a lot in the in-game animations is sort of secondary elements; the in-game animations are… like the finer result of the character motions blended together from lots of different animations; and because of that, you can't animate in overlapping motion that will carry through a whole string of animations. So from that point of view, like secondary animation stuff that we can layer in top of that and procedurally, either cloth or rigid body dynamics, is really useful, because it gives you a sense of preservation of momentum, as a character runs and blends in and out of other actions; and it really helps kind of…like soften the edges of where an animation blends into another. And if you had like a…well whatever, like a jacket or a ponytail on a character, and it's only being driven by author animation, there's no way that you're going to have a nice sort of overlapping motion to it as the character's animations are being blended in from different parts. And the human brain is really good at picking up on those things that aren't right, and it sticks out like a sore thumb. You know, for us, it's to do with preserving the suspension of disbelief, really, isn't it; and it doesn't matter, really, whether the character's a hyper real character, or whether it's a cartoony character. You have to sort of set a level of expectation, like a… I don't know how to describe it, really, but… I *really* don't know how to describe it! (laughs). I've backed myself into a dead end. (thinks) You know, with games or whatever you try to construct a believable world, where nothing kind of stands out as being wrong. And it doesn't matter… like something quite trivial can shatter the entire relation. Because it just sort of snaps you out of that … and sort of having procedural animation elements is really useful and kind of… preserving the believability of a character in motion, particularly when you're playing a game. Erm… I was going to say something else, but I've forgotten what it was. Yes, that was it. I mean in terms of like game technology, you know, rendering materials, lighting effects, have all advanced massively. There's a huge amount of investment from NVidia and AMD on next generation GPUs and GPU revisions come year on year on year; and so certain areas of games, the kind of visual quality in games have advanced massively: skin shadows, you know, ambient occlusion, sub-surface scattering, materials, they've all progressed in leaps and bounds, really. From and animation point of view, at its most fundamental level, we're still using the same animation systems now as when I started in the industry like twelve years ago. I mean we're blending more animations together, in a more complicated way, and with more complicated rule sets, but broadly speaking, at its most basic level, we're still just blending a database of hand-keyed animations together, and that only gets you so far, really… And the more complex it gets, the more difficult it is to manage and balance those systems, so you're limiting… At some point you need a useful issue to that, because it's the law of donation and returns, really; if you keep adding more and more complexity to it, it gets impossible to manage, and you can only get so far. I mean, from my point of view, procedural animation, in terms of like …cloth dynamics and muscle systems, it's really good, for the reasons I sort of mentioned; but also, procedural animation in terms of dynamically adjusting body positions, as well, it's something that's really useful. And for things like, you know, if you… If you've got a single run animation, for example, that doesn't necessarily work on all terrains; if your character wants to open a door, in a game, but the player has control the character, it's like well, if you've got a method of animation that does that, but you need to… That only works if you're in a fixed position relative to the door, and it's like so how do you resolve that? So procedural animation, both in terms of like secondary stuff and player at the top, but also in terms of exerting a degree of control over the body is really interesting as well. Just basically to improve character interactions between them and their world, and so you feel that like it's part of that world, rather than kind of sort of slightly disassociated with it. And nobody's done a really good job of that yet. I mean Autodesk do a humanIK that is in MotionBuilder and Maya which happed to be rubbish, but they do an integration with Unity3 and Unity4 but I haven't used it yet, so I don't know if it's any good (laughs).

B: Ok, third question: again, with your own words, how would you evaluate or add your point of view to the survey outcomes pertaining to the procedural animation, the results that we have?

MS: The survey results?

B: Yes.

MS: Are you able to explain the question a bit more?

B: Yes! How would you evaluate, or how would you… analyse, assess the research, and the outcome of the research, which is the survey results.

MS: Yes. Whether it's useful to us, or my students?

B: Oh, generally.

MS: Just generally. How do I evaluate it? So… the thing that stood out was the difference between the professional and non-professional guys. Am I on topic? Alright. So in our studio, day in, day out you're kind of making judgements… Because remember we've got a finite set of resources, so we can't do everything. So we're always making judgements about what we think is important to a game. And not just in time, but we're authoring to seethea platform that has to render a frame out, you know, sixty times a second and do it all the AI and all the game playing code, and all the platforming and all this sort of stuff. So everything we do is always a massive compromise based on resources, both hardware and personal. And so we're always making, trialling decisions about what is and isn't important within that context. And so it was kind of interesting… I've sort of always thought, when trying to assess the value of something visually, I've always sort of suspected that we're probably not the best people to do that, because by the very definition of being there in this industry, we're kind of not really representative of our target audience. Our motivation is kind of a love of the thing in of itself, but that's not necessarily the best starting point to make decisions; they should be commercial decisions really. And I was kind of quite surprised at the difference in response between professional and non professional people that had taken the survey. I don't know if I'm on dangerous grounds statistically, but… I can't read into that, but my suspicions about not being in the better placed to make these special decisions is probably correct. Because you know, it is really hard, it's like - what is important to the end user? It's not always easy to kind of, to try and understand that , and it's not necessarily obvious that that is completely out of line with what you might think.

B: Ok, thank you. Fourth question: how could these survey findings help contribute to the professional studio practice ?

MS: Potentially it could help – well, it goes back to what we were saying a second ago, really. If you say we've got a set… we can statistically prove that within this context these things are critical to the larger percentage of your audience then you can use that to inform where you spend your resources, what technology you invest in, whether or not certain potential bits of middleware are interesting and worth the money, so… Like, as an example we're going to look at a real integration of Autodesk HumanIK; we think that has value, but that's us, and actually are we really representative of…you know, we're saying the same again. So if you have proper statistical data that shows what is and isn't important to your target audience, then you can make better informed decisions about where you spend your money and resources. And hopefully, you're going to end up with a better product.

B: Thank you. Last question: How could these survey findings help inform the practice of the practitioner?

MS: So on a more individual basis, rather than on a studio basis?

B: Yes.

MS: That's pretty difficult. I mean, from my point of view the two things are quite closely linked. My role at the studio's fairly sort of strategic, so I'm kind of doing… my concerns are more studio wide rather than personal. I'll try and think…(thinks) I mean for me, really, the two things are *really* closely linked. I'm struggling, I suppose, to separate the notion of how the survey results would alter my approach on a personal level, versus how they would help me inform the studio, because that's sort of the same thing, in a professional capacity at least . My job at Ninja Theory is very much to help define and steer the overall course of the studio, so it really is one and the same thing, for me. I was sort of trying to cast my mind back to when I was an animator, or even just think of our animation team, but… No, I can only really authoritatively speak on me…!

B: Ok, Thank you very much for attending!

MS: My pleasure…

Interview transcriptions - Interview 7

Baris (B); Oscar Paterson (OP)

B: Hi Oscar, thank you for accepting my interview request.

OP: Hi, that's fine!

B: You've seen the research and the survey results, the results of the research, and now I would like to ask you a few questions about it, if you don't mind.

OP: Ok.

B: Now the first question: with your own words, how would you describe the notion of believability, within the context of animation?

OP: So believability would be a sense that movement is appealing to the person who's seeing it. So it would have to basically adhere to certain rules of motion, so overlap, squash and stretch… And that depends on the sort of animation: the style, the characters that are being used.

B: Ok, thank you. Second question: would you describe believability as a considerable challenge or as an issue for professional studio projects that include character performances?

OP: Yes, certainly, it's definitely a big challenge. … I can't start for words! (laughs)

B: It's alright! You can just…take you time.

OP: yes, er… are you sort of going to cut it into bits…?

B: Oh, we can restart if you want to!

OP: Sorry, I'm not very good at interviews on camera…

B: It's alright!

OP: Ok, so it's a considerable challenge, yes. So we would use various different things: motion capture is certainly very good, except there's something about motion capture that is lifeless, in certain situations, which needs cleaning up and embellishing. And certainly dynamics, or procedural animation, definitely helps in that context.

B: Ok, thank you. Third question: with your own words, how would you evaluate or add your point of view to the survey outcomes pertaining to the procedural animation that we have?

OP: So those survey outcomes strike me as a kind of example of how hyperrealism seems appealing to people. It's like looking at caricatures of people or strong lighting in a film; it's never realistic. You'd never see that kind of lighting in a normal situation or a normal conversation, it just enhances something, and it's a way for a director, or whoever's creating, to get their vision across; and I think the skewed results towards people liking over-dynamic or over-procedural animation is… Seems to me like an example of that same feeling. You know, people want… They prefer a strong sense of dynamics rather than a realistic one.

B: OK, thank you. Fourth question: how could these survey findings help contribute to the professional studio practice?

OP: Well… I think, now that… I mean, if there's a sense that going further towards a sort of heavy procedural or dynamic simulation is actually going to be received better than a realistic one, then it saves a lot of time sort of messing around on the other side, where something might be too subtle, or too… In the end, boring, I suppose. It's better to exaggerate rather than keep it on a sort of lower level. I think that helps in the creation of tools for dynamics, or just general kind of artistic vision; it's much… You can speed things up, I think.

B: OK, thank you. Last question: how could these survey findings help inform the practice of the practitioner?

OP: So again, I think it's knowing that there's… heavy dynamics are well received, or heavy procedural animations are well received is… It definitely could inform, you know, a far… a better or more efficient practice, you know; from animators or just people in general, I think… yeah, it's… (hesitates) Sorry! (laughs)

B: Ok, ok! Thank you so much for attending and accepting the interview.

OP: That's alright!

B: Thank you!

OP: Thank you!

Interview transcriptions - Interview 8

Baris (B); Ricky Wood (RW)

B: Hi Ricky, thank you for accepting my interview offer. You've seen the research; you've seen the results; now I would like to ask you one or two questions about it. Now the first question is: with your own words, how would you describe the notion of believability, within the context of animation?

RW: I define believability… believability comes from what sort of style you want for your world, so it can mean slightly different things depending on your project. If you are doing a realistic project, believability will most likely come from sticking quite close to reality: if things look real, you expect them to behave in a realistic way. If you are exaggerating your character designs, your colours, visually, if it's not very close to reality, you're a little bit more free to go away from reality, but it can still be believable if the two are carefully… If you're careful not to exaggerate one element only. That might produce a comical effect but it may be less believable. I'm trying to think of an example, like… Wiley Coyote, and the Roadrunner: it's extremely exaggerated actions, but the stories and the characters are so exaggerated that you can kind of believe that he'll run off the edge of a cliff, hang there for a moment, maybe pull out a comedy sign, like 'uh-oh', wave to the camera and then fall. It's totally not realistic, but it doesn't – the designs and the stories are so exaggerated you can still get away with that and be believable.

B: Ok, thank you. Second question: would you describe believability as a considerable challenge or as an issue for professional studio projects that include character performances?

RW: It's definitely a challenge. Again, it depends on how exaggerated you want to go; if it's very abstract, it's up to the animators, in many cases, to sell the believability by respecting the character design and creating movements which kind of fit the level of abstraction. If…like the kind of games that we work on in Ninja Theory, it's quite realistic; it's definitely a challenge to solve realistic cloth and things like this within budget (laughs), because that can be very expensive to do. I think on pre-rendered movies, as well, it's an issue, because… I suppose because we're used to cloth as… It's the age old thing: when you see a walk cycle, the reasons why it’s one of the hardest things to animate, we just… It’s burnt into us, as humans, we know how people move. I think the same could be said for cloth. I think we know when something is a bit wrong. If the character looks realistic but the cloth is moving in a very crazy way but they’re moving… the body’s moving realistically, I think you’re going to run into some troubles there, and that’s always difficult to animate in a realistic way. It’s easier to do the exaggerated stuff!

B: Ok, thank you. Third question: with your own words, how would you evaluate or add your your own point of view to the survey outcomes?

RW: Add my own point of view, erm… I would have found it very interesting to see this character next to a very realistic character, but with the same level of physics applied – sorry, I need to get some water!

B: Sure!

RW: I would have found that an interesting addition to the survey, to see how…whether people’s perceptions changed. What else would I add…? Maybe applied to not just the character; for example, it could be… I’m trying to think of an inanimate object; not the classic flag, but something that moves. Something moving that isn’t a person, so your focus is only on the dynamics. I would find that an interesting addition as well.

B: Fourth question: how could these survey findings, these research findings, help contribute to the professional studio practice ?

RW: I think that… that where it’s going to contribute the most is when the studio… I kind of see this as a survey of… A kind of general survey which is useful when you don’t have a specific goal in mind, so… Again, going back to what we do at Ninja, we often want quite… (music in background) it’s kind of zen music or something! (laughter) Kind of relaxing in the corner of my ear… We often want quite precise end results. So we’ve animated Dante from DMC to have very stylish combat animations, and we wanted the jacket to be very stylish as well. So we wouldn’t be looking at a survey like this for that kind of result; however, if we just wanted to get to a quick end result and wanted to go with the kind of mass appeal of it, I could see that being useful, when you’re looking for a kind of quick result that is… You’re going to feel you’re getting somewhere quickly, rather than experimenting and having an art lead arguing with an art director arguing with a… someone else; because they’ve all got different opinions about what they think is right. Yes, I suppose in a long… in the short answer, if you don't have an exacting vision of what you want, I can see it being useful then.

B: Thank you. Final question: How could these survey findings help inform the practice of the practitioner?

RW: I find…Surveys like this are…I don't know if companies like this, but I find we don't do it enough, at Ninja, because you can get too much in your little bubble and do what you think's right, but it might not be what the public wants. And you don't always want to do just what the public wants, because also you… That's how you push boundaries; you envision new things. It's all about creativity: combining things and then making something new. But I do think it's always beneficial to understand what people like and from there you can make decisions about where you want to go with that. Because you might decide 'well actually the majority likes this, BUT we're still confident that if we do <u>this</u> – and not just applying to physics, but anything: story points, whatever, character design – you might go well yes, the general public likes this, but we're confident this is going to be working, this could be the new thing that then the public likes.

B: Ok, thank you, thank you so much.

RW: Thank you for asking me!

Interview transcriptions – Interview 9

Baris (B); Simon Wallett (SW)

B: Hi Simon, thank you for having me in Hot Knife. You've seen the results; you've seen the research, and now I would like to ask you a couple of questions about it.

SW: Sure!

B: Now, the first question: with your own words, how would you describe the notion of believability, within the context of animation?

SW: I think for us there's multiple parts to believability. Some of that might be photorealism; and some of it, obviously, if we're dealing with character animation it's all about the believability that the character is alive, it's thinking, it's anticipating… It's doing the billion things that our brains do per second. So yes, I think it's kind of essential, and it defines a kind of level beyond which… Like, a standard animation, you would say animate a character keyframe wise you could do a very good job, you could spend a large amount of time doing that; there's a noticeable difference in quality when you start adding things like secondary animation, and on and on, before… And we kind of use certain automated processes, which might be plug-ins that come with the software, or might be extra things, or… you know, people even script those elements to add that extra aspect toward, you know, for believable animation. Now obviously, you know, if that's character animation and bipedal animation that's difficult, because we're so used to seeing everybody moving, and the way that everybody kind of acts; so it's really noticeable when those elements are there. Sometimes they're very difficult to define: what is it that makes that believable. But certainly first stage animation, keyframe animation, second stage keyframe animation, you can keep refining it, but I think there is kind of scope there for the things that we can't see in bringing a character to life, and believability.

B: Thank you. Second question: would you describe believability as a considerable challenge or as an issue for professional studio projects which include character performances?

SW: Yes, certainly; I mean it's an adage of the amount of time it takes to get a procedural… ah, sorry: the amount of time that it takes to get believable animation. You know, if you've got an infinite amount of time you can keep going back and refining, or using resource material as a basis – especially if you're doing a motion, or you know, a bit of character acting. So if you've got good reference material and standard keyframe you can kind of get there, but it's still… you're taking an inanimate object, you're trying to second guess everything for it, which you can do to a certain degree, but there's always going to be something else that you're missing, and you know, we might discuss elements that, you know… All about bodies: even as I'm talking,I'm gesticulating; there'll be various muscles that I'm unaware of that are kind of firing and acting… So nobody, or no object is ever utterly still, really; a believable character is never utterly still. So I can certainly see that there's an area there that you can bring something to, procedurally, that just gives that extra element. Otherwise, you would spend an inordinate amount of time getting a realistic kind of performance.

B: Ok, thank you. Third question: with your own words, how would you evaluate, or add your point of view to the survey outcomes pertaining to procedural animation?

SW: So describing essentially what I've seen… I mean we were looking at standard key frame animation, then key frame animation with procedural to a mild degree and then to a greater degree, pushing it right to the point of breaking the model. For myself personally, the kind of… the middle, with keyframe with a bit of procedural really started to be a noticeable difference in quality, as much in the movement and extra motions that would be, you know, very difficult to animate, so the character as he was weightlifting, you know, you've got those little twitches of arms, of muscles kind of really straining, which happens so quickly, really, to even keyframe that doing every single frame is too slow; you know they're happening on a quarter frame, or whatever. So it adds to an extra smoothness, and really, you know, little subtleties that you don't necessarily notice specifically if you were to analyse it, but again, probably as an overall performance it seems more natural, and that something's… nothing… The character there was never still for any one second; even if he was stood still, there was like a little bit of extra…the shorts were flapping and flowing. So I think it does bring a noticeable element of quality, of additional thinking, additional animation to the objects, that I think… Keyframe you'd just spend donkey's years trying to nail down, and kind of looking, and I don't think you'd ever quite get it.

B: Thank you. How would you evaluate the survey, the survey outcomes?

SW: The survey seemed quite interesting, especially the professionals who obviously liked the extremes of the keyframe and the procedural animation, even though it wasn't necessarily the most realistic. Now whether or not that was because of the design, the character was quite a cartoony character and we're very used to seeing hypermotion and things taken to the extreme, you know; Tex Avery cartoons… So that I find quite interesting. I mean when I was watching it, I was leaning more towards the middle with, you know, a subtle bit of animation, which if you were doing a human character would be the more realistic. It's more those little things, rather than complete over the top… So I found it quite interesting the professionals kind of preferring or identifying with the over the top performances. But yes, it seems there were good questions asked of the survey, and it was fairly obvious from outside of the professional worlds that everybody could notice that difference between standard, over the top and middle and that they preferred the kind of, singly preferred the middle ground of just a little bit extra to add to the realism.

B: Ok, thank you. Fourth question: how could these survey findings, these research findings, help contribute to the professional studio practice ?

SW: It certainly pointed out to anybody who wasn't aware of how much I think procedural aspects can bring to animation, and…You know, I've been kind of doing computer animation and graphics for over twenty years now, and there's certainly not only with character animation but with modelling and textures and materials, there is a real boom for procedurally produced aspects, so… You know, we have this bit of material software called Substance, which we create procedurally through mass algorithms; materials and things like wood grain, or felt, or wool. All things which are quite difficult to texture or to model. They can do those procedurally, you know, you give them a few parameters and you can get something pretty photorealistic, and it's the same with cloud simulations, and all the simluations, you know – particle effects… are all based on procedural parameters that create realistic cloud formations, or flames and fire… And so you can see in each element of computer graphics, CGI, that procedural stuff is being used to augment or completely replace traditional methods or ways that… you just wouldn't be able to do that. So there's a big surge in all aspects of CGI, I think, in procedurals, and the motion, you know, if it was a suite of plug ins that were available, that'd give you a base foundation on which to animate your character. So maybe your character is nervous and has nervous ticks before you even start to give him a walk cycle or run or make him act in a key frame. So if they're already doing something and it looks like they're alive to start with – and that's fantastic, you know, that solves three quarters of the problem of believability, I think, right – before you've even started and kind of going 'ok, hand goes there', or 'it's got to pick up an object, and then look at it'… You've got it – it's doing that, but it's doing it in… You know, if you have nervous or lovesick, or whatever – a whole mode of procedural motions about the human type and the way the brain's working. It just breathes life and believability into the character.

B: Ok, thank you. Last question: how could these survey findings, the research outcome, help inform the practice of the practitioner?

SW: I think again, it's knowing that there are options out there. I mean, I've been aware of procedural, you know, some aspects of procedural animation for a while; not only with the software that we use, but extra kind of plugins, and even through kind of computer games, you know; I've got an awareness of that. But not necessarily how to implement it or how I would go – apart from going to start coding things… which our software will allow to do, but I haven't got that headset, let alone the time to go ok, actually, I'd like to start adding these secondary animation elements. So it would be nice, you know – one, an awareness that there are tools or toolsets that could be out there, whether or not they're plugins or they're a suite of plugins, or that they could be included within an overall software package would be great to start with. And it's then – for us, it's then pushing to our clients what we can then kind of now do; you kinf of go: a couple of years ago, we couldn't even do x, y and z but now we can do that and we can go the next stage further. And as people's, and our clients', visual language and knowledge becomes more sophisticated, you know, each major blockbuster film is always pushing the technology and believability, and people are really used to seeing those blockbusters, and then coming to us and going 'hey, can you do Ironman stuff that I've just seen in a feature film', for a millionth of the budget that they had. And so you're always trying to match that quality of feature film stuff, but on a shoestring budget, with a hundredth of the amount of tools. So if there are those sorts of plugins that can help us kind of join on to the film industry of the games industry, you know, budget-wise that would help us. And I daresay the film industry, as well, a lot of their performances are absolutely fantastic, but that's taken a suite of animators, three years to get one facial animation that looks absolutely superb… If they – they’re always going to be looking to do that in a quicker time period, with less people, and so if you did have these aspects, generic, procedural animations that were available, so they got a starting block from which to kind of go, you can see that that’s going to be an absolute winner. It’s cutting times, budgets and increasing the turnaround time that they can produce stuff [in].

B: Ok, thank you so much, thank you.

Appendix P: Interview Recordings

This Content is in USB Flash Drive